CONSTRUCTION OF RESIDENTIAL FLATS, SBILD & OTHER COMMERCIAL OUTFITS AT HINJEWADI, PUNE, MAHARSHTRA, IN EPC MODE

PART E: CHPTER D

(HT & LT EXTERNAL & INTERNAL ELECTRICAL WORKS)

CLIENT

SBI

PMC

muralage

ARCHITECTURE, MASTER PLANNING, INTERIOR DESIGN, LANDSCAPING, PROJECT MANAGEMENT

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1 HT & LT EXTERNAL & INTERNAL ELECTRICAL WORKS

1.0 General:

Commercial and residential buildings, together with ancillary facilities, are proposed to be constructed in accordance with the approved architectural plans.

1.1 Scope of Work:

The scope of work shall cover all HT & LT External & Internal Installations for commercial and residential buildings as mentioned in Design Base Report (DBR) works complete as required for Electrification of proposed Works. It shall cover designing of complete Electrical System for the entire complex, preparation of Shop Drawings, supply of all equipment, material, electrical Fixtures & Accessories required, installation, testing and commissioning of all electrical installations, obtaining statutory approvals (like Sanctioned load & contract demand, High Rise Building permission, lift license, DG Approval/sanction etc.) from MSEDCL/PWD /CEA/CEIG/etc, for the project for the following, but not limited to, main items/systems:

1.1.1 ESS & External Electrical Installation:

i. 11/22/33 KV/ 0.433 kV Sub-Stations - comprising of but not limited to following:
ii. 11/22/33 KV VCB HT Panel with Battery Charger etc.
iii. Space & Metering panel, RMU etc room provision as per DISCOM/CEA/CEIG/PWD requirement.
iv. Compact Substations (CSS) with Dry type transformer and Automatic Power Factor Correction (APFC) Capacitor Panels with Hybrid Active Harmonic filters to improve Power factor & mitigation of harmonics.
v. Main LT Panels with auto change over facility and electrical interlocking.
vi. Sandwich Bus Ducts from Transformers to LT Panel etc.
vii. All Associated Equipment & accessories required
viii. Independent 11/22/33kV underground interconnecting cable from Ring Main System to 11/22/33 KV ESS Substations.
ix. Lightening Protection System & Earthing Network
x. 11/22/33kV HT Power Cables, 1.1 kV LT power cables and Control Cables etc.
xi. Hybrid (Solar & Conventional) Street Light System
xii. Electrical distribution comprising of feeder cables from ESS (Electrical Substation) to individual block, services, Main panel, etc. Separate distribution shall be provided for Lighting load, Power/AC Load. Separate LT panels/VDB at each floor shall be provided for feeding power supply and Mechanical Ventilation Fans.

The Electrical distribution should include the following system also need to be considered for IGBC Platinum & Net Zero Building Certification (Energy) to be provided by EPC agency.

Automatic Common area, Utility Rooms, car parking lighting shutoff shall be provided through inbuilt PIR based occupancy sensors.

All Motors shall be IE-5 as per IGBC Norms. All pumps / electric motors shall be BIS certified and BEE 5 star rated only. All pump motors / motors shall be of minimum IE 5 Class as per IEC TS 60034-30-2.

LPD as per ECSBC 2023 or Latest shall be maintained.

All Exterior lighting shall be controlled by photo sensor or astronomical time switch. Exit signs shall not exceed 5W per face.

11/22/33KV/.433 KV receiving Sub-Stations as per site condition

Emergency power supplying distribution system as per NBCS-2026 for critical requirement for functioning of fire and life safety system and equipment, shall be planned for efficient and reliable power and control supply to the following systems and equipment where provided.

Application of Fire Survival Cable confirming to IS 17505 (Part-1): 2020			
S No. (1)	System Description (2)	Cable Fire Rating Required (°C) (3)	Time for which System should Withstand (Minutes) (4)
(i)	Fire pumps	FS (950/FWS)	180
(ii)	Pressurization	FS (950/FWS)	180
(iii)	Smoke venting including its ancillary systems, such as dampers and actuators	950	60
(iv)	Fire-fighting shaft (staircase, lift,lift lobby)	FS (950/FWS)	180
(v)	Fireman's lifts (including all lifts)	FS (950/FWS)	180
(vi)	Exit signage lighting	950	120
(vii)	Emergency lighting	950	120
(viii)	Fire alarm system		
(a)	Conventional (zone- based system)	650	60
(b)	Intelligent addressable system	650	60
(ix)	Magnetic door hold- open devices	650	60
(x)	Lighting in fire command center and security room	FS (950/FWS)	180

1.1.2 Special Conditions For Electrical Services:

i. The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The requirement offered by the Contractor shall be complete in all respects.

ii. The Contractor shall obtain all statutory approvals and sanctions (electrical loads &contract demand sanction, approval of drawings /High rise building permission / ESS/ D.G.'s Approval/sanction / Estimate / Lift license / approval of meter & Meter Room etc. from the concerned authorities like MSEDCL/DISCOM/PWD/CEA/CEIG etc. and permits required for the electrical installation work. All statutory fees and cash deposits paid on behalf of the bank in this regard will be reimbursed against receipt/documentary evidence. On completion of work, the Contractor shall obtain NOC from SEB / PWD/CEA/CEIG/MPCB/CPCB/PWD & Director of Safety of the concerned state; a copy of the same along with all approved drawings shall be delivered to SBI / PMC / Engineer in charge.

iii. The SBI shall have full power regarding the materials or work to be got tested through

independent agency at the EPC Contractor's expenses in order to prove their soundness and adequacy. The Contractor will rectify the defects/suggestions pointed out by SBI/ independent agency at his own expenses.

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

1.1.3 Drawings:

As-Built Drawings:

The Contractor shall prepare detailed coordinated electrical shop drawing indicating Light Points, Power Points, Call Bell Points, Ceiling Fans, Exhaust Fan Points, Switch Boards, Distribution Boards (Light, Power & UPS), Lighting Fixtures, Convenience outlets, Single Line Diagram for complete HT/ LT electrical scheme, DG Sets, HT Panel, Transformers, LT Panels, Capacitor Panels, RTPFC Panels, PCC Panel, UPS Incoming/ Outgoing panels, Lift Panels, HT/ LT Cable Schedules, Solar PV System, Earth Pit Layout, Earth Strip routes, HT/ LT Cable Routes, Street Light Layout & Street Cable routes, Schematic Diagrams & Floor wise Shop Drawings for all LV works namely, Telephone, etc. with other relevant services and submit to the SBI for approval or the PMC/Engineer in charge before commencing the work.

GA Drawings, SLD & Control wiring diagrams, Room trench details for all HT & LT Panels, Capacitor Panels, UPS panels, Floor Electrical Panels, Transformers, DG Sets etc. shall be prepared & submitted. The shop drawings shall indicate all setting out details and physical dimensions of all equipment/items/ components with wiring and cable details, cable schedule and routes, manhole trap and fixing details as well as for conduit indicating run and size of wire/cables, outlet/pull/junction boxes etc. with fixing details etc. for the above-mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings shall not relieve the Contractor of his responsibility for providing maintenance free and fool proof system including any missing component/accessories to meet the intent of the specifications. Contractor will submit 2 prints for preliminary approval and finally six prints for distribution. The recommended location/ position of the all equipment as shown on the layout drawings will be adhered to unless stated otherwise.

On completion of the work and before issue of certificate of virtual completion, the Contractor shall submit to the SBI, required Sets of 'As Built' drawings (in AutoCAD & PDF format) along with soft copy of the executed works incorporating all such changes and modifications during engineering and execution along with Operation and Maintenance Manuals, Warranty & Guarantee Certificates from Original Equipment Manufacturers (OEM), authorized Suppliers & Vendors, as applicable.

These drawings must provide:

i. Run and size of conduit, inspection and pull boxes including routing and locations.
ii. Number and size of conductor in each conduit.
iii. Locations and rating of sockets and switches controlling the light and power outlet.
iv. A complete wiring diagram as installed and schematic drawings showing all connections in the complete electrical system.
v. Location of outlets of various services, junction boxes, light fixtures.
vi. Location of all earthing stations route and size of all earthing conductors.

vii. Layout and particulars of all cables.
viii. Location and details of Transformers, HT/ LT Panels, Feeder Pillars, capacitor control panels etc.
ix. Location of transformer and its details and control wiring diagram.
x. Location of Hume pipe and manhole including HT/LT cable layout and scheduling
xi. Layout of cable trays with support and their fixing details.
xii. Location of all earthing station, route and size of all earthing conductor.\
xiii. Layout and particulars of rising mains with fixing details.

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

1.1.4 Manufacturer's Instructions:

Where manufacturers have furnished specific instructions, relating to the material/ equipment to be used on this job, covering points not specifically mentioned in this document, manufacturers' instructions should be followed. All operating and maintenance manuals, warranty cards etc related to all major electrical equipment, plant and accessories shall be handed over to SBI/PMC.

1.1.5 Materials And Equipment:

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

1.1.6 General Details:

Space Heaters & Lighting.

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

Fungistatic Varnish

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

Ventilation Opening

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

Degree of Protection

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

a) Installed out door: IP-65.
b) Installed indoor in air-conditioned area: IP-52.
c) Installed in covered area: IP-52.
d) Installed indoor in non-air-conditioned area where possibility of entry of water is limited: IP-42.
e) For L.T. switchgear (AC and DC distribution boards): IP-52.
f) The degree of protection shall be in accordance with IS: 13947 (Part-I)/IEC-947 (Part-I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

1.1.7 Rating Plates, Name Plates And Labels:

Rating Plates, Name Plates and Labels are to be provided & attached permanently in a conspicuous position to all equipment & items installed in various buildings. A rating plate of non-corrosive material engraved with manufacturer's name, year of manufacture, equipment name, diagram, type or serial number etc. together with details of the loading conditions of equipment. The rating plate of each equipment shall be according to relevant BIS & IEC norms, as applicable.

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

1.1.8 First Fill of Consumables, Oil and Lubricants:

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

1.1.9 Design Improvements / Deviations:

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

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

1.2 Quality Assurance Programme:

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

i. His organization structure for the management and implementation of the proposed quality assurance programme.

ii. Documentation control system.

iii. Qualification data for bidder's key personnel.

iv. The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

v. System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.

vi. Control of non-confirming items and system for corrective actions.

vii. Inspection and test procedure both for manufacture and field activities.

viii. Control of calibration and testing of measuring instruments and field activities.

ix. System for indication and appraisal of inspection status.

x. System for quality audits.

xi. System for authorizing release of manufactured product to the Purchaser.

xii. System for maintenance of records.

xiii. System for handling storage and delivery.

xiv. A quality plan-detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

1.2.1 Quality Assurance Documents:

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

i. All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.

ii. Welder and welding operator qualification certificates.

iii. Welder's identification list, listing welders and welding operator's qualification procedure and welding identification symbols.

iv. Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.

v. Stress relief time temperature charts/oil impregnation time temperature charts.

vi. Factory test results for testing required as per applicable codes/ mutually agreed quality plan/ standards referred in the technical specification.

vii. The quality plan with verification of various SBI inspection points as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

1.3 Inspection, Testing and Inspection Certificate:

i. The SBI/ PMC/ duly authorized representative shall have at all reasonable times free

access to the Contractor's/ Manufacturer's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

ii. All equipment being supplied shall confirm to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the SBI the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies.

iii. The Contractor shall give the SBI thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The SBI, unless witnessing of the tests is virtually waived off, will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/ inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of SBI and he shall forthwith forward to the SBI duly certified copies of tests in triplicate.

iv. The SBI shall within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.

v. When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the SBI shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the SBI, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the SBI. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the SBI to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of clearance by the SBI.

vi. The Contractor shall arrange all necessary tools and testing facilities for inspection purpose including arrangement of air travel (inland as well as abroad), conveyance, lodging, boarding and other miscellaneous expenses etc. SBI shall depute its inspection engineers (2 or more as decided by SBI) after receipt of inspection call from the Contractor. All such expenses incurred by the Contractor towards inspection of equipment by SBI' inspection engineers shall be borne by the Contractor.

vii. For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by SBI or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

viii. The inspection by SBI and issue of Inspection Certificate thereon shall in no way absolve the liabilities and responsibilities of the Contractor in respect of the agreed quality

assurance programme forming a part of the Contract.

ix. The SBI will have the right of having at their own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material complies with the specifications.

x. The SBI reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Contractor.

1.4 Tests:

1.4.1 Charging Tests:

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

1.4.2 Commissioning Tests:

i. The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions, which do not correspond to the specified conditions.

ii. All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

iii. Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.

iv. The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment.

1.5 Packaging:

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

1.6 Protection:

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections

shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

1.7 Finishing of Metal Surfaces:

1.7.1 Charging Tests:

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

Priming: Priming is not normally required on good quality concrete substrates. However, absorbent surfaces such as porous concrete, sand/cement and cement boards will require sealing (as per manufacturers specification) to prevent absorption of polyurethane waterproofing.

Cracks: All shrinkage and non-moving structural cracks should be pretreated with not less than a 1.3mm coating of polyurethane extending 75mm either side of the crack. Allow to cure overnight before general application.

Application: Single component pitch modified polyurethane should be applied by brush, trowel, squeegee or airless spray (two coat application for standard grade on vertical surfaces) at a minimum wet film thickness of 1.3mm (1.3 litre/m2).

Flood test: Prior to placement of protection, flood to a minimum depth of 50mm of water for 24 hours. Drains shall be plugged and barriers placed to contain the water.

Curing and protection: Polyurethene membrane waterproofing must be cured for a minimum of 24 hours @ 25°C before placing protection. Where damage to the membrane is possible (by traffic, backfilling, etc) it should be protected by a cementitious screed or protection boards.

For vertical surface: The entire treatment will be taken upto 30 cm on parapet wall or upto parapet projection as per manufacturer's specification.

If a water test is to be run, the membrane should be fully cured.

1.7.2 Hot Dip Galvanizing:

i. The minimum weight of the zinc coating shall be 700 gm/sq.m and minimum thickness of coating shall be 85 microns.

ii. The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discolored patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

iii. After galvanizing drilling or welding shall be performed on the galvanized parts of the earthing materials. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

iv. The galvanized steel shall be subjected to six one-minute dips in copper sulphate solution as per IS-2633.

v. Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

a. Coating thickness,

b. Uniformity of zinc,

c. Adhesion test,

d. Mass of zinc coating.

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

1.7.3 Painting:

i. All sheet steel work shall be degreased, pickled, phosphate in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces which will not be easily accessible after shop assembly shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

ii. After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, staving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be shoved.

iii. Powder coating/electrostatic painting of approved shade shall be applied.

iv. The exterior color of the paint shall be as per Shade No. 697 of IS-5 or as approved by PMC/Engineer in charge and inside shall be white or as approved by PMC/Engineer in charge. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.

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

1.8 Handling, Storing and Installation:

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

ii. Contractor shall follow the unloading and transporting procedure at site, as well as storing, testing and commissioning of the various equipment being procured by him separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's Engineer(s) and shall extend full co-operation to them.

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

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

iv. Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

v. The Contractor shall submit to the SBI every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

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

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

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

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

x. The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

1.9 Protective Guards:

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

1.10 Design Co-Ordination:

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

1.11 Design Coordination Meeting:

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

1.12 Tools & Tackles:

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

1.13 Safety Codes & Precautions:

The Contractor at his own expenses shall arrange for safety provisions as required to comply with the statuary regulations, ISI recommendations and CPWD codes.

The Contractor shall provide necessary barriers, warnings, signals and other safety measures to avoid accidents. He shall indemnify SBI against any claims arising out of negligence in this respect.

1.14 Regulations & Standards:

All equipment's their installation, testing and commissioning shall confirm latest CPWD/ IS specifications in all respects. Indian Standard Code of Practice for Electrical Wiring Installation IS:732-2019. It shall also be in conformity with Indian Electricity Rules and the Regulations, National Electric Code, National Building Code 2016, ECBC, latest CPWD specifications amended up to date and requirements of the Local Electric Supply Authority. In general, all materials equipment and workmanship shall confirm to the Indian Standards specifications and codes latest as amended. Some of the applicable codes/standards are as under:

a)	CPWD General specifications for electrical works	Part-I (Internal) 2023
b)	CPWD General specifications for electrical works	Part-II (External) 2023
c)	CPWD General specifications for electrical works	Part-III (Lifts & Escalators) 2003 & (Amendment) Bill 2020.
d)	CPWD General specifications for electrical works	Part-IV (Substation) 2013
e)	CPWD General Specifications for Electrical Works	Part V, Wet Riser & Sprinkler System - 2020
f)	CPWD General Specifications for Electrical Works	Part VI, Fire detection and Alarm System- 2018
g)	CPWD General specifications for electrical works	Part VII, (DG Sets) 2013
h)	CPWD General specifications for electrical works	Part VIII, Gas Based Fire Extinguishing System - 2013
i)	Guide for uniform system of marking and identification of conductor and apparatus terminals.	IS 11353 -1985
j)	Low voltage switchgear and control gear assemblies	IS/IEC 61439
k)	Specification for low voltage switchgear and control gear assemblies	IS 8623 (Part -2-1993)
l)	Code of practice for selection, Installation and maintenance of switchgear and control gear.	IS 10118 Part – 1 - 4
m)	PVC insulated (heavy duty) electric cables	IS 1554

n)	PVC insulated cables for working voltages up to and including 1100V.	IS 694
o)	Conduit for electrical installations	IS 9537
p)	Accessories for rigid steel conduits for electrical wiring	IS 3837
q)	Boxes for the enclosure of electrical accessories	IS 14772
r)	General and safety requirements for luminaries	IS 1913
s)	Code of practice for earthing	IS 3043
t)	Electrical accessories – circuit breakers for over current protection for household and similar installations.	IS 8828
u)	Low Voltage switchgear and control gear	IS 13947 Part 1 – 5
v)	Residual current operated Circuit Beakers	IS 12640
w)	Current Transformers	IS 2705
x)	Voltage Transformers	IS 3156
y)	Direct acting indicating analogue electrical measuring instruments and their accessories	IS 1248 part – 1 to 9
z)	Control Switches (switching device for control and auxiliary circuits including contactor relays) for voltages up to and including 1000V AC and 1200 V DC.	IS 13947 & IS 1336
aa)	High-voltage switchgear and control gear - Common specifications	IEC: 62271 - 1
bb)	Measuring relays and protection equipment - Part 24: Common format for transient data exchange (COMTRADE) for power systems.	IEC: 60255
cc)	Current Transformers	IEC: 600441-1
dd)	Voltage Transformers	IEC: 600441-2
ee)	Standard Voltages	IEC: 60038
ff)	Switch gear assemblies including metal enclosed bus.	ANSI IEEE C 37/20

In case of contradiction in specification the priority of the documents shall be CPWD/ IS Specifications, Drawings, Technical Specifications.

2 11/22/33KV/0.433 KV SUBSTATIONS:

2.1 GENERAL:

Vacuum Circuit Breaker shall be incorporated in HT Panel boards in required combination of incoming panels, coupler panel, outgoing transformer panels & outgoing feeder panels. VCB's shall confirm to IEC 298 and 694, IS 3427, BS 5227 and VDE 0670, Part 6 as well as the regulations mentioned therein. VCB's shall be indoor type & suitable for operation on 11/22/33 kV, 3-Phase, 50 Hz AC supply as per DISCOM incoming supply. Metering and protection in the panels as detailed herein after.

2.2 TYPE & CONSTRUCTION:

i. The metal clad panel shall be fully extensible and compartmentalized to give.

   a) Circuit Breaker Compartment

   b) Bus bar Compartment

   c) CT and Cable Compartment

ii. The compartments shall be safe to touch, and compartments thus formed shall be dust proof & vermin proof. A separate metering chamber for fixing the necessary instrumentation of metering and protective equipment shall be provided with panel on the front.

iii. The VCB shall consist of three air insulated poles incorporating mechanism of interrupters. The body of interrupters shall be made of nickel chromium steel supported on insulators made out of metalized aluminum oxide. The contacts shall be of chromium copper and butt shaped.

ii. Vacuum Circuit Breaker shall be mounted on truck or a carriage mechanism. In case of truck mechanism, the breaker shall be on a trolley while in a carriage operations with front door closed. The draw out carriage shall have two positions for the circuit breaker viz isolated/test & service position. Bus bars shall be insulated type made of high conductivity copper supported on cast epoxy monobloc designed to withstand full short circuit currents and shall be provided all along the length of the HT Board.

iii. It shall be horizontal isolation, horizontal draw out type, fully interlocked, with dust and vermin proof construction, suitable for indoor instillation. The panel shall be supplied with the manufacturer's test certificates.

iv. The steel work should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and recognized phosphate process and shall then be given powder coating (Electrostatic) paint of manufacturer's standard shade.

v. The switchgear constructions shall be such that breaker operation and internal explosions do not endanger the operating personnel, and the front of the panel shall be specially designed to withstand these. Pressure relief flaps shall be provided for safely venting out gases produced inside the high voltage compartment, bus bar compartment and termination compartment. These flaps shall be vented upwards and cannot be opened from outside. These relief flaps shall be of such construction as not to permit ingress of dust/water in harmful quantities under normal working conditions. Enclosure shall be constructed with sheet steel of at least 2.0 mm thickness. It shall have a rigid, smooth, leveled, flawless finish.

vi. Voltage transformer of burden not less than 100 VA and of proper ratio as specified shall be provided. The accuracy class for the VT shall be 0.5 as per is 3156 Part 1 to III for incomer and class I for outgoing panels. The PT shall be of cast epoxy resin construction. It shall be fixed/withdrawable type. HRC fuses circuit Breaker shall be provided on both HV and

LV side. Adequate space at the rear of the panel shall be provided for the termination of power & control cables. The panel shall be provided with a suitable terminating arrangement for the termination of cables. Burden of PT should match the requirements of the client.

vii. The making contact arms (upper & lower) of the circuit breaker shall be encased in poly prolene tubes. Penetration type bushings shall be provided in the bus bars

viii. & cable compartment for the fixed contacts.

ix. Safety shutters shall be provided to cover up the fixed high voltage contacts on bus bar and cable sides when the carriage is moved to Isolated/Disconnected position. The shutters shall move automatically with the movement of the draw out carriage. It shall, however, be possible to open the shutters of bus bars side and cable side individually.

x. Mechanically operated circuit breaker auxiliary switches of minimum 5 NO + 5 NC ways, shall be provided for control and indication purposes. Control wiring shall be done by 1.5 sq. mm, 1.1 kV grade stranded copper PVC insulated wires. All control device shall be MCB type.

xi. Terminal blocks shall be clamp type suitable for connection of only 2 wires per terminal and shall be 1100 V grade. The LT control circuit shall be routine tested to withstand 1.5 kV for one minute.

xii. Busbar compartment shall be provided at the rear. Electrolytic copper bus bars shall be of rectangular cross section and insulated. Bus bars shall be supported properly by cast epoxy resin insulators so as to withstand thermal and dynamic stresses during system short circuits. Bus bars shall be provided with necessary color coding for phases indication. The bus bars shall be designed to withstand a temperature rise of 60 deg. C above and ambient temperature of 45 deg. C.

2.3 BUSBAR & REGULATORS:

i. All bus bars and jumper connections shall be of electrolytic copper confirming to relevant IS Standards. They shall be adequately supported on epoxy insulators to withstand electrical and mechanical stresses due to specified short circuit currents. Busbar cross section shall be uniform throughout the length of switch board.

ii. Contact surface at all joints shall be properly cleaned and No-oxide grease applied to ensure an efficient and trouble free connections. All bolted joints shall have necessary washers for maintaining adequate contact pressure. All connection hardware shall have high corrosion resistance.

iii. Bus bar insulators shall be of track-resistance, high strength, and non- hygroscopic, non-combustible type & shall be suitable to withstand stresses due to over voltages and short circuit current. Busbar shall be supported on the insulator such that the conductor expansion and contraction are allowed without straining the insulators. The temperatures of the bus bars and all other equipment, when carrying the rated of relevant Indian Standards, duly considering the specified ambient temperature.

EARTHING AND PROTECTIVE EARTHING

Copper earthing bus shall be provided. It shall be bolted/ welded to the framework of each panel. The earth bus shall have sufficient cross time fault currents to earth without exceeding the allowable temperature rise. Suitable arrangement shall be provided at each end of the earth for bolting. Earthing conductors and earth bus shall run inside at the back of the panel for entire length. Facilities shall be provided for integral earthing of bus bars & feeder circuits.

METERING AND PROTECTION

The VCB Panel Board shall be provided with epoxy resin current transformers for metering and protection. The protection CT's shall be of accuracy class 5P 10 of 2705-Part –III- 1992. The metering CTs shall confirm to the metering ratio and accuracy class

0.5 of is 2705-1992 for the incomer and Class I for the outgoing panels. Ammeter and voltmeter to be installed on panel shall be digital type. Voltmeter transformer of burden not less than 100 VA shall be 0.5 as per IS 3156 Part-I to Part- III for incomer and class I for outgoing panels. The PT shall be fixed/withdrawable type. HRC fuses/ MCB shall be provided on both HV and LV side. All meters shall be 96mm squire pattern, flush mounting type necessary selector switches. Necessary lamps of low voltage type with built in resistors shall be provided (maximum wattage
2.5watt. Burden of CT should match with as per requirements.

Metering and Protection to be provided in Panels shall be as detailed below:

11/22/33 KV HT Panel for Main Receiving Station:

630A,11/22/33 kV - VCB BREAKER / SF6 / LBS
11or22or33 KV/110 Volts, 3 phase PT Class -0.5 accuracy and 100 VA burden with 1 No. Voltmeter (0-33 KV), digital type with built-in selector switch and protection MCBs for HT metering up to 33 KV on Incomer (IS-3156)
Ammeter Digital Type with built-in selector switch.
Microprocessor based relay with O/L, S/C and E/F protection. Relay shall be communicable on Modbus protocol of IBMS.
dual core dual ratio 3 CTs of suitable ratio 15 VA burden and accuracy Class- 0.5 for metering and class 5P10 for protection. (IS-2705-1992)
calibrated intelligent multi-function digital panel meter of class 0.5 accuracy with communication interface port RS 485 for giving output on MOD BUS protocol of IBMS for receiving V, A, KVA, KVAh, KW, KWH, Hz, KVAR , PF, MDI individual total harmonic distortion with suitable rating CTs etc complete with wiring connections etc.
R/Y/B phase LED indication lamp
Red - ON, Green - OFF, TRIP, TRIP CIRCUIT HEALTHY, SPRING CHARGE, DC ON (LED TYPE).
Push button for Emergency Tripping with 1 NO + 1 NC contacts & inscription plates.
Trip / Neutral / Close Breaker Control Switch.
Master Trip Relays / Lockout Relays / Anti pumping / Aux. Relays/ Over
current/ Earth Fault/ Phase Sequence Relay for Incoming VCB Feeders as required.
BUS COUPLER- 630 A,11/22/ 33 kV **VCB BREAKER / LBS with:**
Red - ON, Green - OFF, SPRING CHARGED. Indication LED lamps
Trip / Neutral / Close Breaker control switch.
OUTGOING PANELS – 630 A, 11/22/33 KV VCB BREAKER PANEL
Ammeter digital type with built-in selector switch.
Microprocessor based relay with O/L, S/C and E/F protection. Relay shall be communicable on Modbus for protocol of IBMS.
dual core 3 CTs of 15VA burden and accuracy Class-1.0 for metering and class 5P10 for protection.

R/Y/B phase LED indication lamp
Red - ON, Green - OFF, TRIP, TRIP CIRCUIT HEALTHY, SPRING CHARGE, DC ON and AC ON. Indication LED lamps
Push button for Emergency Tripping with 1 NO + 1 NC contacts & inscription plates.
Trip / Neutral / Close Breaker control switch.
Calibrated intelligent multi-function digital panel meter of class- 1.0 accuracy with communication interface port RS 485 for giving output on BACNET / MOD BUS protocol IBMS for receiving V, A, KVA, KVAh, KW, KWH, F, KVAR & PF etc. complete with wiring.
8 window solid state audio/ Visual Annunciators with Test/ Accept/ Reset push buttons and Electronic Hooter.
Master Trip Relays / Lockout Relays / Anti pumping / Aux. Relays/ Over current/ Earth Fault for Outgoing VCB feeder as required.

The Incoming, Outgoing and Bus Coupler feeders for all 11/22/33 KV VCB HT Panels shall be motorized, operated, controlled and monitored through BMS.

Also Incoming, Outgoing and Bus Coupler for all 11/22/33 KV VCB HT Panels shall have the provision to be operated in Manual Mode also.

2.4 Operating Mechanism:

i. Vacuum Circuit Breaker shall be equipped with motorized spring charge. These operating mechanisms shall be of the stored energy type. In the closed state of the breaker, the energy stored in the springs shall be suitable for O-C-O duty.

ii. Interlocking and Safety Arrangement- Vacuum Circuit Breaker shall be provided with the following safety and interlocking arrangements:

a) The draw out carriage cannot be moved from either test/disconnected to service position or vice versa, when the circuit breaker is 'On'.

b) The circuit breaker cannot be switched 'ON' when the carriage is in any position between test & service position.

c) The front door of the panel cannot be opened when the breaker is in service position or in an intermediated position.

d) The low voltage plug & socket cannot be disconnected in any position except test/isolated position.

e) The door cannot be closed unless the LV plug has been fitted.

f) It shall be possible to mechanically close and trip the circuit breaker through push buttons with the circuit breaker in service position and the door closed.

g) Individual explosion vents shall be provided for breaker, busbar, cable chambers on the top of the panel to let out the gases under pressure generated during an unlikely event of a fault inside the panel.

h) Circuit Breaker & sheet metal enclosure shall be fully earthed.

i) Self locking shutters shall be provided which close automatically and shall be interlocked with the movement of the draw out carriage mechanism.

1. **Rating:** The rating of the vacuum circuit breaker shall be as below

   Rated current 630A for I/C and O/G Panels
   Rated Voltage 11/22/33 KV
   Rated Frequency 50 Hz
   Rated Breaking capacity 21.3 kA (350 MVA)
   Rated making capacity as per relevant standards.

2. **Accessories**: Circuit Breakers shall be provided with the following accessories.

   a. Auxiliary Switch with minimum 5 NO + 5 NC auxiliary contacts.

   b. Tripping Coil

   c. Mechanical Operation Counter

   d. Spring Charging Handle

3. **Mounting:** - Vacuum Circuit Breakers shall be mounted as per manufacturer's standard practice.

4. **Auxiliary Supply**

   a. The tripping shall be at 24 Volt D.C. through a power pack unit or Battery Charger

   b. Space heater indication & other auxiliary supply requirement shall be at 230 V AC. Necessary termination arrangements complete with isolating switch, control fuse & link shall be provided at one place in the panel for receiving the purchaser's cable.

2.5 Tests

- **Factory Tests**

The circuit breakers panel shall be subjected to routine tests at manufacturer's works in accordance with the details specified in the relevant IS specifications. These shall however necessarily comprise of the following.

a. Power frequency voltage test on the main power circuit.

b. Verification of the correct wiring/Functional Test.

c. Dielectric test at 1.5kV on the control circuit. Apart from above, the Contractor shall submit the routine test certificates for the following equipment.

   i. Circuit Breakers

   ii. Current Transformers

   iii. Voltage Transformers

d. Temperature rise test.

e. Impulse & power frequency voltage test

f. Short time current test on circuit breaker.

- **Site Test**

General

a. Verification for completion of equipment, physical damage/deformities.

b. Alignment of panel, interconnection of bus bars & tightness of bolts & connection etc.

c. Interconnection of panel earth busbar with plant earthing grid.

d. Inter panel wiring between transport sections.

e. Cleanliness of insulators and general Cleanliness of panel to remove traces of dust, water etc.

- **Circuit Breaker & Panel**

a. Check for free movement of circuit breaker, lubrication of moving part & other parts as per manufacturers manual.

b. Manual/Electrical operations of the breaker and Functional test as per drawings.

c. Megger before the Hi Pot test.

d. H.T. Test - Hi Pot test (Power frequency withstand test for one minute at 28kV RMS). At site Hi Pot test is carried out at 80% of 28kV RMS value.

e. Megger after the Hi Pot test.

f. CT/PT ratio/polarity primary injection test.

g. Secondary injection test on relays to practical characteristics.

3 11/22/33 KV HT CABLES

The 11/22/33 kV (E) HT cable shall be laid as per DBR & SLD.

The HT cable from DP structure to HT breaker panel of residential and commercial blocks each shall be parallel redundant (2 runs).

The size & runs of the HT cables shall be decided as per the Electrical Load requirements and rated short circuit capacity of Substations / DISCOM specifications & HT cable Schedule shall be got approved from SBI/PMC/Engineer in charge. The cable shall be (1W+1S) configuration for each feeder from receiving Station to substation.

3.1 Construction

All HT cables shall be of 11/22/33 kV grade, armoured, aluminum conductor, XLPE insulated, earthed & PVC sheathed. All HT cables shall be manufactured & tested in accordance with relevant IS Code Specifications.

3.2 11/22/33 KV Cable Joints/ Terminations

Terminal joints shall be carried out as per IS specifications. Heat shrink cable termination kit shall be used for terminations & straight through joints.

3.3 Installation of Cables

Cable laying in ground, Cable trays, Ducts or fixing on Wall shall be carried out as per CPWD specifications 2023 for Electrical works Part II as amended up to date. Cable route marker shall be provided at regular intervals as per CPWD specifications. Cost of cable route markers is deemed to be included in the cost of cables/cable laying.

4 LT PANELS

4.1 GENERAL

The scope of supply covers design, fabricate, integrate, pack, dispatch to site along with routine testing as per IEC of Low Voltage Switchgear & Control gear Assemblies up-to 1000 V (Will be termed as ' LT Panel ' here forth). Main LT Panel, Distribution Boards & Sub Panels shall be factory fabricated by Original Equipment Manufacturer or their authorized system integrators/ channel partners. All LT Panels, Distribution Boards & Sub Distribution Panels shall comply with IEC-61439 & manufactured accordingly. The Panels shall be indoor type, metal clad, floor mounted, free standing, totally enclosed, extensible type, air insulated, cubicle type for use on 415 Volts, 3-phase, 50 cycles system. All LT Panels shall be designed to accommodate suitable ratings of Incoming Feeders, Outgoing Feeders, Bus Couplers etc. to cater to electrical load requirements of various buildings & facilities. All LT Panels & Sub- Panels shall be BMS compatible and wired accordingly so that all relevant electrical parameters can be communicated to BMS system. All necessary wiring, cabling etc between LT Panels, Sub- Panels etc and BMS shall be carried out as per norms. All Incoming & Outgoing feeders of Main LT Panels located in Substations shall be controlled and monitored through BMS System. Incoming Feeders from Transformers & DG Sets shall also be controlled through ACBs, PLC for auto Load change over.

All Incomers & bus-coupler ACBs & MCCBs of all LT panels including of sub-station main panels shall be motorized and BMS compatible.

Degree of protection shall be IP-42 for Indoor & IP-54/65 for Outdoor Panels. All Outdoor Panels shall be weather proof, Double Door with suitable canopy on top. The short circuit current rating of LT switchgears shall be ≥ 50 kA.

All LT Panels shall be provided with necessary instruments for Monitoring & Metering purpose to meet ECSBC & IGBC requirements.

All incoming feeders of LT panels shall have R, Y, B, ON, OFF & Trip LED Type indication lamps. All outgoing feeders of LT panels shall have ON, OFF & Trip LED Type indication lamps.

Multifunction meters with BMS compatibility shall be provided in all incoming feeders of all LT Panels to be installed in Buildings. Suitable digital energy meter with CTs, wiring etc. shall be provided for all outgoing feeders of all LT panels to be installed in buildings.

Main LT Panels in ESS buildings shall have Multifunction meters with BMS compatibility in all Incoming Feeders & all Outgoing Feeders.

Site Conditions: The LT Panel will be located indoors and shall be designed to operate satisfactory at rated load under the service conditions. This equipment will be subject to the ambient temperature conditions at the site as specified in the Project Requirements.

a. Location - Indoor,

b. Altitude above main sea level - < 300M above sea level.

c. Design Ambient Temperature - 40 Deg. C

d. Temperature rise - As per IEC 61439

e. Relative Humidity Max - 95%

f. Relative Humidity Min - 10%

g. Pollution - Up to Degree of pollution-3

h. Application - Indoor

4.2 Construction

a) Standards

The equipment covered under this specification shall confirm to the latest revisions of relevant Indian and International Standards some of which are listed below:

IEC 61439 part 1 & 2	2020	: Low voltage switchgear and control Gear assemblies
IS13947	1993	: General requirements of Switchgear and Control Gear for Voltage not exceeding 1000 / 1200V AC
IS 11353	1985	: Guide for uniform system of marking Identification of Busbar and Terminals.
IS 13703	1993	: Low voltage fuses
IS 2705	1992	: Current transformers
IS 694	1990	: PVC insulated cables for voltages including 1100 V with Copper and Aluminum Conductor.
IS 1248	1983	: Direct Acting Electrical Indicating Analog
IS 8623	1993	: Low voltage Switch gear & control gear assemblies
IS 5082		: Electrolytic Aluminum Busbar, Trunking system, Rod tubes sections for Electrical Purposes
IS13779	1999	: AC Electric Meters / Static Meters.

b) Main/Sub Panels shall be:

i. Made of metal enclosed, indoor, floor mounted, free-standing construction (unless otherwise specified) type.

ii. Made up of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.

iii. Provide dust and damp protection.

iv. Be readily extensible on both sides by the addition of vertical sections after removal of the end covers in case of Main Panels.

v. All panels shall be front access type.

Main/Sub Panels shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as the effects of humidity, which are likely to be encountered in normal service.

Each vertical section shall comprise of the following:

i. A front-framed structure of rolled/ folded sheet steel channel section, of minimum 2 mm thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, moulded case

circuit breaker, main horizontal bus bars, vertical risers and other front mounted accessories. The structure shall be mounted on a rigid base frame of 100 mm height with folded sheet steel of minimum 2 mm thickness. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.

ii. A cable chamber housing the cable end connections, and power/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 section without coming into accidental contact with live parts in an adjacent section.

iii. 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 1 mm diameter perforations to prevent entry of vermin.

iv. 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 assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

The height of the panels should not be more than 2400 mm for MV Panels. Operating handle of breaker in top most compartments shall not be higher than 1800 mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be less than 350 mm.

Doors and covers shall be of minimum 2 mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 1.6 mm thickness. All sheet panels shall be smoothly finished, leveled and free from flaws. The corners should be rounded. The apparatus and circuits in the power control centers (panels) shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

Apparatus forming part of the Main/Sub Panels shall have the clearances more than as given below.

i. Between phases - 32 mm

ii. Between phases and neutral - 26 mm

iii. Between phases and earth - 26 mm

iv. Between neutral and earth - 26 mm

When, for any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions.

Creepage distances shall comply with those specified in relevant standards.

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

Functional units such as circuit breakers and moulded case circuit breakers shall be arranged in multi-tier formation, except that not more than two air circuit breakers shall be housed in a single vertical section. Cable entry for various feeders shall be from the rear. Panel shall be suitable for termination of bus duct for incoming breakers.

Metallic/insulated barriers shall be provided within vertical sections and between adjacent

sections to ensure prevention of accidental contact with:

i. Main bus bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.

ii. Cable termination of one functional unit, when working on those of adjacent unit/units.

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

Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

4.3 Metal Treatment & Finish

All steel work used in the construction of the Main/Sub Panels should have undergone a rigorous metal treatment process as follows: -

a. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.

b. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.

c. A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting 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.

d. Passivating in de-oxalite solution to retain and augment the effects of phosphating.

e. Drying with compressed air in a dust free atmosphere.

f. Panel shall be powder coated with epoxy-based powder paint after the above process so as to render the material suitable for corrosive environment.

g. Paint shade shall be Pebble (light) grey, shade No RAL 7032 unless otherwise specified.

4.4 Busbars

The bus bars shall be air insulated and made of high conductivity, high strength aluminum alloy complying with the requirement of IS-5082.

The bus bars shall be suitable braced with non-hygroscopic SMC supports to provide a through fault withstand capacity of at least 50 kA RMS symmetrical for one second. The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent bus bars. Large clearances and Creepage distances shall be provided on the bus bar system to minimize possibilities of fault.

The Main/Sub Panels shall be designed that the cables are not directly terminated on the terminals of breaker etc. but on cable termination links. Cross-section area/ size of aluminum bus bars shall be designed considering current density as 0.8 Amp per sq.mm. Likewise, Cross-section area/ size of copper bus bars shall be designed considering current density as 1.2 Amp per sq mm. The main bus bars shall have continuous current rating throughout the length of Panels. The cross section of neutral bus bars shall be same as that of phase bus bar for bus bars of capacity up to 200 Amp; for higher capacity the neutral bus bar shall not be less than half (50%) the cross section of that the phase bus bars. The busbar system shall consist of main horizontal bus bar and

auxiliary vertical bus bars run in bus bar alley/chamber on either side in which the circuit could be arranged/connected with front access.

Connections from the main bus bars to functional circuit shall be arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Bus bars to be colour coded with PVC sleeves.

All MCCBs & ACBs shall be provide with spreader links/terminals or Bus Bar extension pieces for easy termination of cables.

Clamp or screw type control terminal blocks shall be provided for outgoing control cables.

All Round Panels Clearance should be maintained as per Standards.

Minimum 20% spare terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.

4.5 Switchgears

Refer 16.4 – LT switchgears

Protection Relays:

Provision of Relays like Surge Protection, Over Load, Short Circuit, Earth Fault, Under Voltage & Reverse Power etc. shall be incorporated in incoming Feeders in addition to the relays already inbuilt in the ACBs as mentioned above.

4.6 Cable Terminations

Cable entries and terminals shall be provided in the Main/Sub Distribution Panels to suit the number, type and size of aluminum/Copper conductor power cables and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. A cable chamber 150 mm. high shall be provided at the bottom throughout the length and depth of the MDB/SDB. 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.

4.7 Auxiliary Wiring & Terminals:

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

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

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

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

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

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

4.8 Labels

Labels shall be anodised aluminum with white engraving on black background shall be provided for each incoming and outgoing feeder of Main/Sub Distribution and all Panels.

4.9 Test At Manufactures Work

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates from CPRI/NABL shall be submitted.

4.10 Installation, Testing & Commissioning

Installations of LT Panels shall be done as per CPWD norms/Specifications.

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine Meggar test. Checks and tests shall include the following.

a. Operation checks and lubrication of all moving parts.

b. Interlocking function check.

c. Insulation Test: As per CPWD Specifications for Electrical Works Part-I (2023)

d. Trip tests & protection gear test.

5 AIR CIRCUIT BREAKERS

5.1 GENERAL

Air Circuit Breakers shall be incorporated in Main Distribution Panels wherever specified. ACBs shall confirm to IS 13947 (Part 2) & IEC 60947 (2) in all respects. ACBs shall be suitable for operation on 415 volts, 3 phase, 50Hz, AC supply.

All electrical panels shall be provided with meters & controls suitable for BMS/SCADA control & meeting requirements of ECSBC.

5.2 TYPE AND CONSTRUCTION

Air Circuit Breakers shall be of enclosed pattern, dead front type with 'trip free' operating mechanism. It shall have microprocessor based electronic release. Air Circuit Breakers shall be EDO type (Electrically draw out type unless otherwise specified) with horizontal draw out carriage. The ACBs shall be strong and robust in construction with suitable arrangements for anchoring when in fully engaged or fully drawn-out positions. The carriage or cradle on which the breakers are mounted shall be robust design made of fabricated steel, supported on rollers. Cradle shall also comprise of main and secondary separable contacts and all draw out mechanism in a completely fig welded assembly.

There shall be no dependence upon the switchboard frame for any critical alignment. The withdrawal arrangement shall be such as to allow smooth and easy movement.

All the current carrying parts of the circuit breakers shall be silver plated, suitable arcing contacts shall be provided to protect the main contacts. The contacts shall be of spring-loaded design. The sequence of operation of the contacts shall be such that arcing contacts 'make before' and break after' the main contacts. Arcing contacts shall be provided with efficient arc chutes on each pole and these shall be such suitable for being lifted out for inspection of main as well as arcing contacts. The contact tips and arc chutes shall be suitable for ready replacement. Self-aligning isolating contacts shall be provided. The design of the breaker shall be such that all the components are easily accessible to inspection, maintenance and replacement. Inter phase barriers shall be provided to prevent flashover between phases.

5.3 OPERATING MECHANISM

Air Circuit breaker shall be provided with a quick-make, trip free operating mechanism, the operating mechanism shall be 'strain-free' spring operated. The operating handle shall be in front of the panel type. The design shall be such that the circuit breaker compartment door need not be opened while moving the breaker from completely connected, through test, into the disconnected position. Electrically operated breakers shall have a motor wound spring charged closing mechanism. Breaker operation shall be independent of the motor, which shall be used solely for charging the closing spring. The operating mechanism shall be such that the breaker is at all times free to open immediately and the trip coil is energized. Mechanical operation indicator shall be provided to show open and closed position of breaker. Electrically operated breakers shall be additionally provided with mechanical indication to show charged and discharged condition of charging spring. 24-volt DC supply through battery backup for closing and opening for tripping circuit.

Means shall be provided for slow closing and opening of the breaker for maintenance purposes and for manual charging and closing of electrically operating breakers during emergencies.

Also, all incomer and bus coupler ACBs in all panels such as Main LT Panels, Main Essential LT

Panel (DG Panel) etc. shall be motorized ACBs.

5.4 INTERLOCKING AND SAFETY ARRANGEMENT

Air Circuit Breakers shall be provided the following safety and interlocking arrangements:

a. It shall not be possible for breaker to be withdrawn when in "ON" position.

b. It shall not be possible for the breaker to be switched on until it is either in fully inserted position or for testing purposes it is in fully isolated position.

c. The breaker shall be capable of being racked into 'testing', 'isolated' and 'maintenance' positions and kept locked in any of these positions.

d. A safety catch to ensure that the movement of the breaker, as it is withdrawn is checked before it is completely out of the cubicle.

e. The operating mechanism shall provide for racking the breaker into connected, test and disconnected positions without operating compartment door. When cubicle door shall be open position, the breaker can be pulled out to a fourth position, maintenance, where free access shall be possible to all parts of the breaker.

5.5 RATING

The rating of the circuit breaker shall be as per the DBR/ drawings. Rated service breaking capacity (Ics) of the breakers shall be 50kA unless otherwise specified at 415 volts. The rated making capacity shall be as per the relevant standard. Rated service short Circuit Breaking capacity shall be equal to the Rated Ultimate Short circuit breaking capacity (Icu) and short circuit withstand values (Icw) for 1 sec.

5.6 RELAYS & ACCESSORIES

All ACBs (except bus couplers) shall be provided with micro-controller-based release to offer accurate and versatile protections with complete flexibility and in the following zones:

- Overload (Phase & Neutral) protection with adjustable time delay.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection with intentional time delay.

The release should provide local LED indication for identification of type of fault, without requiring using external power supply. The release shall meet the EMI / EMC requirements.

Transformer & DG set Incomer ACB releases shall have LED display showing all Power & Energy Parameters (I, Imax, %loading, Iavg, V, Freq, PF, W, VAr, VA, Wh, VArh, Vah, MD-Active, MD-Reactive, MD-Apparent, Temperature in each Phase).

The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation; release shall also be connected to aux. supply for display of parameters during off or lightly loaded conditions.

The ACB should have breaker control through Modbus Breaker control.

The breaker shall be fitted with following accessories for control, signal and interlocking.

i. Auxiliary contacts 6 NO + 6 NC, of rating 16Amp at 415 volts 50Hz.

ii. Shunt release for tripping the breaker remotely and shall be suitable for 240 volt/415 volt 50Hz with range of operation from 10% to 130% of rated voltage.

iii. Micro switches shall be mounted on the cradle of draw out breaker to indicate the position of the breaker on the cradle.

a) Kit for test/isolated indication.

b) Kit for service position indication.

c) Kit for shutter assembly.

iv. Accessories for following interlocking schemes shall be provided.

a) Accessory kit for locking the breaker in isolated position. This kit is useful for interlocking scheme as well as keeping personnel and equipment safe.

b) Door interlock kit: Panel or cubicle door cannot be opened with the ACB in Test or Service position.

c) Lockable trip push button.

5.7 MOUNTING

Circuit Breakers shall be mounted as per manufacturers' standard practice.

5.8 TESTING

i. Testing of each circuit breaker shall be carried out at the works as per IS 2516 and the original test certificate shall be furnished in triplicate. The tests shall incorporate at least the following.

ii. Impulse withstand test.

iii. Power frequency withstand test.

iv. Short circuit test.

v. Temperature - rise test under rated conditions.

6 MOLDED CASE CIRCUIT BREAKERS.

6.1 GENERAL

Molded Case Circuit Breaker shall be incorporated in the Main/Sub Distribution Boards wherever specified. MCCBs shall confirm to IS 13947 (Part 2) & IEC 60947
(2)in all respects. MCCBs shall be suitable either for single-phase AC 230 volts or three phase 415 volts. All MCCBs shall have microprocessor based over current and short circuit releases with adjustable current setting from 0.4In to 1.0 In.

6.2 TECHNICAL SPECIFICATIONS

The MCCB should be current limiting type with trip time of less than 10 milli sec under short circuit conditions. All MCCB should be 4 poles type unless stated otherwise.

MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2 / IEC 60947-2 and should have test certificates for breaking capacities from independent test authorities CPRI / ERDA.

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

The MCCBs shall be provided with following type of Relays for overload, short circuit & earth fault protection in the LT panels boards.

All incoming ACBs /MCCBs of LT Panel boards shall be with Microprocessor based release having inbuilt adjustable protections against Over Load (L), Short Circuit (S) and Ground Faults (G)] with time delay.

The outgoing MCCBs shall be with Thermal Magnetic type release for with adjustable Overload and fixed short circuit protections. MCCBs of ratings 250A & above shall be provided with Microprocessor based.

All MCCBs should be provided with the Rotary Operating Mechanism. The ROM should be with door interlock (with defeat feature) & padlock facility

MCCB should have Spreader links & Phase barriers as standard feature. Superior quality of engineering grade plastics confirming to glow wire Tests as Per IEC 60695-2-1 should be used for insulation purpose.

The handle position shall give positive indication of ‘ON’, ‘OFF’ or ‘Tripped’ thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contacts.

For Motor application, motor duty type MCCBs shall be selected with reference to Type 2 coordination chart provided by the manufacturer.

All incoming MCCBs of all Block Panels, sub panels, metering panels etc. shall be motorized MCCBs as per BMS requirement.

6.3 CONSTRUCTIONS

The MCCB's cover and case shall be made of high strength heat treatment and flame-retardant thermo-setting insulating material. Operating handle shall be quick make/quick break, trip-free type. The operating handle shall have suitable "ON", "OFF" "and" "tripped" indicators. Three phase MCCBs shall have common operating handle for simultaneous operation and tripping of all the three phases. MCCBS shall be provided with rotary handle.

Suitable extinguishing device shall be provided for each contact. Tripping unit shall be of thermal magnetic or static release type provided in each pole & connected by a common trip bar such that tripping of any pole operates all three poles to open simultaneously. MCCB shall be current limiting type.

Contact trips shall be made of suitable air resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

6.4 BREAKING CAPACITY

All MCCB shall be 4 pole type except in the starters where 3 pole type to be provided. All MCCBs shall have following short circuit current rating/breaking-

(i) MCCB Below 250A in Main LT Panel rating – 35 kA

(ii) MCCB Below 250A in Other Panels rating – 25 kA

(iii) MCCB above 250A - 630A in All Panels rating – 50 kA

The rated service breaking capacity should be equal to rated ultimate breaking capacities (Ics=Icu).

6.5 TESTING

a. Original test certificate of the MCCB as per Indian Standards (IS) 315C- 8370 shall be furnished.

b. Pre-commissioning tests on the Main Distribution/Sub Distribution Board incorporating the MCCB shall be done as per standard.

c. MCB units shall be used up to and including 63 A. MCCB units shall be used above 63 A upto & including 630 A. ACB shall be used for 800 A and above ratings.

7 LV DISTRIBUTION BOARDS

1. The EPC Contractor shall design, manufacture, supply, install, test and commission all Low Voltage (LV) Distribution Boards complete in all respects as per the approved electrical design, Single Line Diagram (SLD), applicable IS/IEC standards, National Building Code (NBC), CEA Regulations and project requirements.
2. The Distribution Boards specified herein represent the minimum technical requirements. The final configuration, ratings, fault levels, incomer/outgoing feeder capacities, busbar ratings, short circuit withstand capacity and protection schemes shall be based on the detailed design submitted by the EPC Contractor and approved by the PMC/Bank.
3. All Distribution Boards shall be factory-built, floor/wall mounted as required, fabricated from CRCA sheet steel with powder-coated finish and shall be double door type with hinged lockable doors. The boards shall be provided with removable gland plates, adequate cable alleys, earthing studs, danger notices and circuit identification labels.
4. All Indoor Distribution Boards shall have a minimum degree of protection of IP-43.
5. All Outdoor Distribution Boards shall have a minimum degree of protection of IP-65, suitable for outdoor installation with weatherproof construction.
6. All ETPN MCB Distribution Boards shall be provided with phase-wise Double Pole RCBOs and outgoing MCBs of appropriate ratings as per the approved design.
7. All VTPN MCB Distribution Boards shall be provided with either:
8. Four Pole RCBO, or
9. Four Pole MCB/MCCB with separate Four Pole RCCB/ELCB,
10. along with outgoing MCBs of appropriate ratings as per the approved design.
11. Residual Current Protection shall be provided as follows:
12. Residential LDBs, Commercial LDBs and Residential Flat DBs: RCBO sensitivity 30 mA.
13. Power Distribution Boards (PDBs): RCBO/RCCB sensitivity 100 mA.
14. UPS Output Distribution Boards: RCBO/RCCB sensitivity 300 mA.
15. The following Distribution Board configurations shall be adopted unless otherwise approved:
16. Flat Distribution Boards, Hostel Room Distribution Boards and Executive Room Distribution Boards shall be Double Door SPN DBs.
17. VIP Suites shall be provided with ETPN Distribution Boards.
18. All Lighting Distribution Boards (LDBs), Power Distribution Boards (PDBs), UPS Distribution Boards and similar final distribution boards shall be ETPN type.
19. All Distribution Boards feeding individual LDBs, PDBs, Air Conditioning Outdoor Units (ODUs) and other sub-distribution boards shall be TPN MCCB Distribution Boards (VDBs).

20. All incomers and outgoing feeders shall be adequately rated based on the calculated load, diversity, voltage drop, fault level and discrimination study. The protective devices shall ensure proper coordination and selectivity.
21. All Distribution Boards shall be provided with:
22. Copper busbars of adequate current carrying capacity and fault withstand rating.
23. Separate neutral and earth bars.
24. Phase barriers, shrouds and touch-safe construction.
25. Engraved circuit identification labels.
26. Spare capacity of minimum 20% outgoing ways (minimum two spare ways), unless specified otherwise.
27. The EPC Contractor shall submit detailed GA drawings, Single Line Diagrams, load schedules, busbar calculations, protection coordination study and DB schedules for approval before manufacture.
28. The makes of enclosure, switchgear and protective devices shall be from the Bank's approved makes and shall conform to relevant IS/IEC standards.
29. All Distribution Boards shall be tested at works and site in accordance with applicable IS/IEC standards. Routine test certificates shall be submitted before dispatch, and successful testing and commissioning reports shall be furnished after installation.
30. The EPC Contractor shall ensure that all Distribution Boards are designed for safe operation, ease of maintenance, future expansion and compliance with all statutory regulations.

8 MEASURING INSTRUMENTS, METERING & PROTECTION

8.1 GENERAL

Direct reading electrical instruments shall be in conformity with IS 1248. The accuracy of direct reading shall be 0.5 for voltmeter and 0.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between-10 degree Centigrade to + 50 degree Centigrade. All meters shall be of flush mounting type of 96mm square or circular pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instrument glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible without removal of the seal. The meters shall be provided with white dials and black scale markings.

The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside. The direction of deflection shall be from left to right.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three-phase supply.

The specifications herein after laid down shall also cover all the meters, instrument and protective devices required for the electrical work. The ratings type and quantity of meters, instruments and protective devices shall be as per DBR/Drawings.

8.2 Digital Ammeters

Ammeters shall be standard digital type. The ammeters shall be calibrated as per the latest edition of IS:1248. Ammeters shall be instrument transformer operated, and shall be suitable for 5A secondary of instrument transformer. The scales shall be calibrated to indicate primary current, unless otherwise specified. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

8.3 Digital Voltmeters

Voltmeters shall be standard digital type. The voltmeters shall be calibrated as per the latest edition of IS:1248. The range for 415 volts, 3 phase voltmeters shall be 0 to 500 volts. Suitable selector switch shall be provided for each voltmeter to read voltage between any two lines of the system. The voltmeter shall be provided with protection fuse of suitable capacity.

8.4 CURRENT TRANSFORMERS

Current transformers shall be in conformity with IS: 4201 - 1983 as amended up to date in all respects. All current transformers used for medium voltage applications shall be rated for 1kV. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated acceptable minimum class of various applications shall be as given below:

Measuring: Class 0.5 to 1

Protection: Class 5P10.

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 50 KA on medium voltage system. Terminals of the current

transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

All Current Transformer shall be Cast resin type

8.5 MISCELLANEOUS

- Control switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.
- Indicating lamps shall be of the filament type of low watt consumption, provided with series resistor where necessary, and with translucent lamp covers, bulbs & lenses shall be easily replaced from the front.
- Push buttons shall be of the momentary contact, push to actuate type fitted with self-reset contacts & provided with integral escutcheon plates marked with its functions.

9 LT CABLES

9.1 GENERAL

LT Cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings, specifications, relevant Indian Standards specifications as per given below. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drums.

Total number of runs and size of LT power cables shall be designed so that the distribution losses do not exceed 3% of the total power usage in the system as per ECBC norms.

CODES OF PRACTICE GUIDE		
S. NO.	**Reference**	**Description**
1	IS 694: 1990 IEC 60227 - 1 to 5: 1979	PVC insulated cables for working voltages up to and including 1100 V
2	IS 694: 2010	Polyvinyl chloride insulated sheathed and unsheathed cables with rigid and flexible conductor for rated voltages up to and including 450/750 V: Part general requirements(fourth revision)
3	IS: 7098: 1988 (Part-I)	XLPE insulated (heavy duty) electric cables. For working Voltages up to and including 1100 V (third revision)
4	IS 4288: 1988	PVC insulated (heavy duty) electric cables with solid aluminium conductors for voltages up to and 1100 V (second revision)

9.2 CABLE CONDUCTOR MATERIAL

a) The LT Power cables shall be XLPE insulated, PVC sheathed FRLSH, copper conductor armoured cable for sizes up to & including 16 sq.mm, unless otherwise stated.

b) For LT Power cable sizes above 16 sqmm, cables shall be XLPE insulated, PVC sheathed FRLSH Aluminium conductor armoured cables, unless otherwise stated.

c) LT Control cables shall be XLPE insulated PVC sheathed FRLSH type copper conductor armoured cables, unless otherwise stated.

d) All LT Power & Control cables shall confirm to IS: 7098: 1988 (Part-I) with up to date amendments.

9.3 INSTALLATION OF CABLES

Cables shall be laid directly in ground, pipes, masonry ducts, on cable tray, surface of wall/ceiling etc. as indicated on drawings and/or as per the direction of PMC / Engineer in charge. Cable laying shall be carried out strictly as per CPWD specifications.

9.4 INSPECTION

All cables shall be inspected at site and checked for any damage during transit.

9.5 JOINTS IN CABLES

The Contractor shall take care to see that the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoiding of cable joints. This apportioning shall be got approved from PMC/Engineer in charge before the cables are cut to lengths.

9.6 LAYING CABLES IN GROUND

Cables shall be laid by skilled experienced workmen, using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. With great care it shall be unrolled on over wooden rollers placed in trenches at intervals not exceeding 2 meter. Cables shall be laid at depth of 0.75 meters below ground level for LT Cables and 1.20 meter below ground level for HT cable. A cushion of sand total of 250 mm shall be provided both above and below the cable, joint boxes and other accessories. Cable shall not be laid in the same trench or alongside a water main.

The cable shall be laid in excavated trench over 80mm layer of sand cushion. The relative position of the cables, laid in the same trench shall preserved. At all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a radius of bent not less than 12 times the diameter of cables. Minimum 3-meter-long loop shall be provided at both ends of cable.

Hume pipes (Heavy Duty) or HDPE DWC pipes of appropriate diameter shall be used for all HT & LT cables laid underground.

Distinguishing marks may be made on the cable ends for identifications of phases. Insulation, tapes of appropriate voltage and in red, yellow and blue colours shall be wrapped just below the sockets for phase identifications.

9.7 CABLE ROUTE MARKERS:

Cable route marker shall be provided at regular intervals as per CPWD specifications. Cost of cable route markers is deemed to be included in the cost of cables/cable laying.

9.8 PROTECTION OF CABLES:

The cables shall be protected by hume pipes / HDPE DWC pipes for the full length of underground cable. Where more than one cable is laid in the same trench, the hume pipes shall cover all the cables. Cable under road crossings and any other places subject to heavy traffic shall be protected by running them through Hume Pipes (Heavy Duty) of suitable size for road crossing of the HT&LTcables.

9.9 EXCAVATION & BACK FILL

All excavation (hard rock, soil, cc road, bt road etc,.) and back fill required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceeding 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The Contractor shall restore all surfaces, road ways, sidewalks, curbs, wall or the works cut by excavation to their original condition to the satisfaction of the SBI/PMC in - Charge.

9.10 LAYING OF CABLES ON CABLE TRAY/SURFACE OF WALL/ CEILING

Cable shall be laid on Ladder/perforated HDGI. Cable tray Cables shall be properly dressed before cable ties/clamps are fixed. Wherever cable tray is not proposed, cables shall be fixed on surface

of wall or ceiling slab by suitable MS clamps/saddles. Care shall be taken to avoid crossing of cable.

9.11 CABLES ON HANGERS OR RACKS

The Contractor shall provide and install all iron hanger racks or racks with die cast cleats with all fixings, rag bolts or girder clamps or other specialist fixing as required. Where hangers or racks are to be fixed to wall sides, ceiling and other concrete structures, the Contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good.

The hangers or racks shall be designed to leave at least 25mm clearance between the cables and the face to which it is fixed. Multiple hangers shall have two or more fixing holes. All cables shall be saddled at not more than 150mm centres. These shall be designed to keep provision of some spare capacity for future development.

9.12 CABLES TAGS

Cable tags shall be made out of 2mm thick aluminium sheets, each tag 1-1/2 inch in dia with one hole of 2.5mm dia, 6mm below the periphery. Cable designations are to be punched with letter/number punches and the tags are to be tied inside the panels beyond the glanding as well as below the glands at cable entries. Tray tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 metres.

9.13 TESTING OF CABLES

Prior to installation burying of cables, following tests shall be carried out. Insulation test between phases, phase & neutral, phase & earth for each length of cable.

i. Before laying.
ii. After laying.
iii. After jointing.

Along with the test as prescribed in IS Code, cross sectional area shall also be checked. On completion of cable laying work, the following tests shall be conducted in the presence of the SBI/PMC in Charge.

i. Insulation Resistance Test (Sectional and overall).
ii. Continuity Resistance Test.
iii. Earth Test.

All tests shall be carried out in accordance with relevant Indian Standard code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipments and labour for conducting the above tests & shall bear all expenses of conducting such test.

10 CABLE TRAY

10.1 LADDER TYPE CABLE TRAY

Ladder type cable tray shall be fabricated out of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a centre to centre spacing of 250 mm. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. Ladder type cable trays shall be Hot Dip Galvanized as per IS-2629 latest as amended. Zinc coating/ galvanizing shall be applied uniformly and thickness of zinc coating/ galvanizing shall not be less than 65 microns.

10.2 PERFORATED TYPE CABLE TRAY WITH COVER

I. The cable tray shall be fabricated out of slotted/perforated Hot Dip Galvanized (HDG), M.S. Sheet as double bended channel section. The channel section shall be supplied in convenient length and assembled at site to the desired lengths. All cable trays and its accessories, supporting structures, suspenders etc. shall be Hot Dipped Galvanized only as per relevant IS- Codes. Zinc coating/ galvanizing shall be applied uniformly and thickness of zinc coating/galvanizing shall not be less than 65 microns.

II. Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II - External, 2023 as amended up to date. The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section.

III. Two coupler plates, each of minimum 200 mm length, shall be bolted on each of the two sides of the channel section with 8 mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

IV. The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II - 2023. The sizes shall be specified considering the same.

V. The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100 mm. The overall width of one cable tray shall be limited to 900 mm.

VI. Dimensions of Cable Trays shall be as following:

Sr	Width	Depth	Thickness
1	100 mm to 300 mm	50 mm	2 mm
2	375 mm to 450 mm	62.5 mm	2 mm
3	600 mm to 900 mm	75 mm	3 mm

VII. Factory fabricated bends, reducers, tee/ cross junctions, coupler plates etc. of suitable size shall be provided as per good engineering practice. Details are typically shown in figure 3 of CPWD General Specification of Electrical Work Part II-2023 or as amended up to date. The radius of bend, junctions etc. shall not be less than the minimum permissible radius of

bending of the largest size of cable to be carried by the cable tray.

VIII. The cable tray shall be suspended from the ceiling slab with the help of 10mm dia, Hot Dip Galvanized (HDG), MS rounds or 25 mm X 5 mm (HDG) flats at specified spacing as per CPWD General Specification of Electrical Work Part II -2023 or as amended up to date. Flat type suspenders may be used for channels up to 450 mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50 mm x 50 mm x 5 mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by Client to take the weight of the cable tray with the cables.

IX. The entire cable trays including all accessories like bends, reducers, coupler plates, tee/cross junctions etc and supporting structures like rods, suspenders, angle, channels etc shall be Hot Dip galvanized as per IS-2629 Code latest as amended.

X. The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.The cable trays shall be measured, in case of item rate contracts, on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross- joints, etc, and paid for accordingly.

11 SANDWICH BUS DUCTS/TRUNKING, RISING MAINS

11.1 Scope:

These specifications are intended for design, manufacturing, Supply, Installation, testing & commissioning of 3 Phase 3 Wire / 3 Phase 4 Wire (100% Neutral) / 3 Phase 5 Wire Sandwich type Aluminum Busbar Trunking System.

11.2 System details:

The Busbar Trunking System shall be suitable for operational Voltage of 415V / 690V / 1000V with supply frequency of 50Hz, minimum insulation voltage of 1100V & impulse withstands voltage of 12 kV.

11.3 Standards:

The Busbar Trunking System shall be designed to comply in accordance with the following international standards,

IEC 61439 – Part 1 : Low voltage switchgear & control gear assembly- General rules IEC 61439 – Part 6 : Busbar Trunking Systems (busways)
IEC 60529 : Degree of protection

3 – Part 2 : Specification for Low Voltage Switchgear & Control gear Assemblies
IS 1893 – Part 1 : Criteria for Earthquake Resistant Design of Structures IEEE 693:2005 : High Seismic Qualification Level Wherever required and specified, the Busbar Trunking System shall confirm to Fire Rating of 600 deg C for 2 Hours.

Busbar Trunking System should also have Seismic Zone-5, Flame Propagation and Fire Resistance certification.

11.4 Manufacturer:

The manufacturer must have an established track record in design and manufacture of sandwich busbar trunking system, and must have supplied busbar trunking systems for at least 20 years.

11.5 Design & Construction requirements:

- General:

  The Busbar Trunking System shall be of sandwich construction, non- ventilated and natural cooled design. It shall be possible to mount the Busbar Trunking System in any orientation without affecting the current rating.

- Bus bars:
  - The bus bars should be made of high conductivity electrical grade Aluminum with conductivity >60%
  - Purity of Aluminum conductor should not be less than 99.6%
  - Aluminum bus bars should be Tin plated at the joint area
  - Provision for mounting external earth strip to be provided on both side of busduct. 2 Nos. Copper earth strips of appropriate size shall be provided for the complete run of bus bars enclosure.

- Insulation:
  - Each bus bar shall be individually insulated by means of Multi-Layer Class- F Insulation, each layer shall have withstand breakdown voltage of minimum 6 kV.
  - The insulation material used shall be of minimum Class F (155 deg. C)
  - Insulation must be Halogen free & RoHS compliance
- Housing:

  The housing shall be made of minimum 1.6 mm electro-galvanized sheet steel, epoxy powder coated with RAL7032 shade. Enclosure must be dust & vermin proof IP rating of indoor busduct must be IP-54 / IP-55 & Outdoor busduct should be IP- 65 / IP-66 with canopy.
- Joints:
  - The joint design shall have inbuilt provision of absorbing expansion & contraction of 12mm per joint during operation.
  - The joint insulation must be of single piece moulded design of thermoset material for longer life and higher temperature withstand & better insulation property.
  - The joint construction must allow +/- 3mm adjustment at the time of installation, for ease of adjusting to site measurement variations.
  - The joint bolt must be insulated with a bolt insulator. The bolt insulator must be of moulded one piece.
  - The joint design shall have inbuilt provision to prevent excessive insertion of busduct which can damage the bolt insulator.
  - The busbar ends shall not have holes or slots at the joints to avoid reduction in cross section area which will lead to temperature increase. The electrical continuity shall be through pressure plates, achieving a high contact area of joint cross section and expansion capability.
  - It shall be possible to install and remove the joints without disturbing the adjacent feeder section
  - Joint set should have insulators with temperature withstand capacity of class-F
- Plug-in Unit / Tap off units:
  - Plug in boxes will be of draw out type. Contacts will be of silver plated copper and spring loaded. Earth connection will be the first to make and last to break during insertion and with drawl. Plug in boxes will be made from 1.6 mm CRCA sheet steel powder coated.
  - Each section of Bus Bar enclosure plugs in ports spread at interval of approximately 600 mm for the insertion of plug in boxes.
  - Inside the plug in Boxes MCCB will be located as per requirements. The operating handle will be interlocked with plug in box cover so that MCCB can be operated only with the suitable cover in closed position. The plug in box will be interlocked with bus bar trunking so that it cannot be inserted or removed with the plug in box lid open. MCCB will be of 4 pole type. Short circuit breaking capacity of MCCB in Plug in Box should be same as that of bus trunking i.e. 50 KA.
  - When the MCCB in the Plug-in unit is in 'ON' position, the operator should not be able to open the door.
  - The design of plug-in units shall be such that, the PE conductor shall be of 'First-Make' 'Last-Break' type.

- The Plug-in unit will be suitable for accommodating MCCBs or other accessories, as required. The Plug-in unit should allow the flexibility of accommodating different reputed MCCB makes, to be mutually agreed depending on the tender requirements.
- Plug-in unit must achieve IP-54 protection
- Plug-in units should be plug-in type up to 400A & Bolt-on Type from 630A
- It should be possible to offer Bolt-on Type Tap-off Box for 100A & higher ratings to withstand vibration due to crane movement, heavy machines in industries

11.6 Routine & Type Tests:

- The busduct shall be type tested at a reputed test laboratory (certified by ASTA or ERDA) for the tests as per IEC-61439 Part-1 (Low voltage switchgear & control gear assembly- General rules) & Part 6 (Bus bar trunking systems & bus ways)
- Short circuit testing of busduct should be for duration of 1 Sec. Neutral & Earth conductor should also be tested for 60% short circuit rating of phase conductor
- Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory as per IEC-60529
- Dielectric test.
- Busduct should be tested for minimum Seismic Zone-4 & High Seismic Qualification level as per IEEE:693

11.7 Installation: -

The Bus Section shall be joined together with flanges and tie bolts. Bus trunking shall be suspended at a uniform height as per site conditions above floor/Ground level with suitable MS suspenders and MS supports duly Hot dip Galvanised.

12 CAPACITOR PANEL & HYBRID HARMONIC FILTER

12.1 SCOPE

Supply, installation, testing and commissioning of medium voltage capacitors and Automatic Power Factor Correction Panel (APFC) for improvement in power factor of electrical system. It will be connected to main LT panel. It shall improve power factor upto unity from initial power factor. Capacitor panel shall be provided with day/ night mode selector switch and double ratio C. Ts, for day/ night mode. Day/ night mode shall be selected based on estimated day / night load requirement.

Hybrid Harmonic filter shall comprise two separate panels for harmonic correction and power factor improvement. Harmonic compensation shall be done through IGBT based Active Harmonic filter and Power factor correction shall be done through Automatic Power Factor Correction panels with passive detuned filters.

The system shall automatically maintain a minimum power factor of 0.99 (lagging) under Grid operation

12.2 RATING

The rating of Capacitor units shall be as per CPWD specifications for Electrical Works (Part - 4) Substations 2013.

12.3 ACTIVE HARMONIC FILTER

- Active Harmonic Filter to mitigate low voltage system harmonics

The Active Harmonic Filter (Type AHF) is intended to remove harmonic distortion from the phase conductors in a 3-phase electrical system resulting in reduced phase current, reduced current distortion and reduced upstream electrical system harmonic voltage distortion.

- Principle of operation

AHF should measure level of harmonics in supply line and eliminate it by generating the counter harmonics. It should employ a DSP which determines the harmonic current amplitude to be injected in the opposite phase angle of each harmonic order.

The active filter shall not only provide harmonic mitigation, but also, power factor correction and load balancing. Harmonic correction, PF correction and Unbalance correction should be able to set with priority and filter should work to employ the priority as per the user settings.

a. The active harmonic filter shall mitigate harmonics from the 2nd harmonic up to the 15th harmonic and limit harmonic distortion at their point of connection to within the harmonic limits specified herein. The active filter shall be connected in parallel (shunt) to the load.

b. The active filter shall be suitable for connection at an electrical distribution panel, transformer secondary or at an individual load.

c. The active filter shall be suitable for connection to a distorted voltage source and its operation shall not be adversely affected by pre-existing voltage distortion.

d. The active filter shall be suitable for operation on an electrical system having a generator as its power source.

e. AHF should have high attenuation up to 96% of individual harmonics

f. AHF shall allow user to select any 10 order of harmonics out off 2nd to 15th harmonics order.

g. It should be possible to use filter for single harmonic elimination

h. PF compensation should be leading as well as lagging

- Following features are essential requirements for the point of reliability

a. For capacities from 100 Amp onwards the filter design should adapt modular construction

b. The display should be Touch screen SVGA display with true RMS readout & FFT analysis. The wave form should be visible on the display.

c. High grade cooling fans shall be used.

d. In case of future repair requirements, the same shall be done through card level replacement and not the whole module

- Electrical Ratings:

a. System Voltage: 433V AC ± 10%, 3ph 4 Wire/3 wire

b. Line voltage tolerance: ±10%

c. System Frequency: 50 Hz

d. Frequency tolerance: 50 Hz ± 5%

e. Multiple filter units for parallel connection may be used to achieve total current requirements for combined power factor correction and harmonic mitigation.

f. Current transformers shall be with Class 1 or better with 15VA rating.

g. Flexibility to select CT ratio shall be available.

h. Remote indication contacts: 1No. potential free contact.

i. Surge withstand capability per ANSI/IEEE STD C62.41-1991.

j. Should comply with IEC/IEEE 62040 – 2 category C3

- Basic Product Requirements

The active harmonic filter shall meet the following basic requirements: -

1. Active filters shall include input surge suppression.

2. Active filters shall include forced air cooling system.

3. Active filter shall be able to connect in both open loop and closed loop configuration

4. Active filter should have a HMI touch screen display having the functionality of a power analyzer and should display Load side, supply side and filter parameters as mentioned below-

a. Voltage

b. Current

c. Power factor

d. Filter Temperature

e. Voltage and current waveforms

f. Voltage and current Harmonic spectrum

g. Active, Reactive & Apparent Power

h. Alarm indications & log details

5. Active filter shall be isolated from the power supply when powered “off”.

6. IGBT modules shall be self-protected for maximum reliability.

7. Each power module shall have its own independent set of fuses.

8. The response time shall be at least 1 ms and the correction time shall be 20 to 40 ms

9. AHF shall have inbuild logic to avoid over-loading without tripping.

- Construction:

1. Constructed on metal panel with minimum IP 42.

2. Filter shall be suitable for operation within an ambient temperature between $0^{O}C$ and $50^{O}C$.

3. Shall be able to work with higher temperature with automatic de-rating.

4. Storage temperature shall be from $0^{O}C$ to $70^{O}C$.

5. Active filters shall be suitable for operation in relative humidity up to 95% non- condensing.

12.4 APFC PANELS WITH PASSIVE FILTERS:

Automatic Power Factor Correction panel shall be totally enclosed, metal clad, sheet steel fabricated, fixed feeder type, dust and vermin-proof, free standing, floor mounting type. The enclosure shall be pre-treated as per 11 tanks process and finished with powder coating of shade RAL 7032. The panel shall be factory build to ensure

Step-less Power Factor Correction (for both leading and lagging current), Control response time: 25µs

Harmonics Compensation up to 51st order (2nd priority) Load Current Balancing in the three phases (3rd priority)

- Proper thermal design, by providing louvers and fans in appropriate location,
- Accurate selection of switchgear, capacitors-reactors and others in the panel.
- Safety during operation, inspection and maintenance

Basic Design Specifications

An automatic power factor correction relay, microprocessor based, with arrangement for sensing the power factor of the inductive load (maximum 14

channels) and giving signal to the feeders of power capacitors as per the setting of P.F. and electronic circuit to ensure that once a capacitor gets cut off, it is not put on at least for a minute. The relay should automatically manage capacitor banks according to the reactive power required to correct the power factor of the load to the power factor set on the relay. The capacitors must be turned “on” and “off” to correct the power factor of the load to the power factor set on the relay. The relay should have automatic and manual mode of operation with an LED to indicate the operating mode. The auto / manual function makes it possible to turn the capacitor banks “on” and “off” manually regardless of the line value measured.

Rated System Voltage	440 V / 415 V / 380 V / 400 V
Rated Frequency	50 Hz
Short Circuit Rating	> 30 kA
Altitude	1000 m
Duty	Continuous
Ambient temperature	-5° C to 50° C
Power Supply	Three phase, four line
Relay current input	-- / 5A, from CT on line
Signal	
Enclosures	The load bearing structure is made of 2 mm sheet steel
	The front door and partition are made of 1.6 mm sheet steel
	The internal switchgear components are accessible on opening the front door and Capacitors & Reactors shall be accessed through back door
	Ingress protection - IP42
Installation	Indoor, wall mounted (up to 100 kVAr), floor mounted (100 kVAr and above) in a well-ventilated, non-dusty environment, cable entry from bottom
Control	Auto + Manual
Incomer	3 Pole MCCBs up to 630 A (400 kVAr) , 3 Pole ACBs above 630 A (above 400kVAr)

Other important features required are:

- Various system parameter displays on APFC Relay
- Fully automatic / manual setup and operation
- Minimal joining in all the connections to ensure better reliability and lower losses.
- Use of special connecting cables suitable for high temperature withstands.
- Flush mounted meter to indicate line voltage and current.

12.5 CAPACITOR BANK:

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

Capacitor voltage shall be minimum 480 V when used with 7% reactors.Capacitors shall be MPP Heavy Duty type/ Gas filled type. The capacitor element used in unit shall have metallized polypropylene film (MPP) having low loss dielectric and impregnated with such impregnate, which shall have high dielectric constant, low viscosity and high chemical stability. The impregnate should be resin filled. The capacitor unit shall have over pressure dis-connector protection. Discharge resistance shall reduce the residual voltage to less than 50 volts within one minute

General specifications:

- 3 phase, delta connected, 50 Hz

 Overvoltage +10% (for 8h / 24h), + 15% (for 30m / 24h), + 20% (5m/24h), +30% (1m/24h)

- Overcurrent: 1.8 x In
- Peak Inrush current withstand: 250 x In
- Total watt-losses: < 0.45 W / kVAr
- 6000 switching operations per year

 IEC 60831

12.6 DETUNED FILTER

- Detuned harmonic filter reactors shall be used along with power capacitors to mitigate harmonics amplification and to avoid electrical resonance in LV electrical networks.
- The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin. The insulation shall be Class H.
- The reactors shall be made of high grade aluminum windings, having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 60289 / IS 5553.
- The permitted tolerance of inductance is ± 3% of rated inductance value.
- Reactor tuning factor shall be 7 % (189 Hz) and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.
- The limit of linearity of inductance of the filter reactor is: 1.8*In with L=0.95*LN.
- The reactor shall be fitted with a temperature sensitive micro-switch in the center coil (normally open) for connection to trip circuits in case of high operating temperatures.
- Power loss in each reactor shall be less than 5 W/kVAr
- Each reactor shall have routine test certificate for the above tests.
- All the reactor shall be copper wound.

12.7 Contactor

- All contactors shall be AC6B duty 3 pole air-break, magnetic, capacitor duty type. The rating of contactor shall be suitably assigned. The contactors shall be so chosen as to withstand inrush current due to parallel switching. Contactor should be with damping resistors to limit capacitor charging current The individual capacitor bank/step shall be switched automatically / manually with selector switch as required using magnetic contactors suitable for switching capacitive currents. The contactor coil voltage shall be as specified.
- The minimum life expectancy of the contactor shall be one million switching operations
- Contactor should be with surge suppressor
- Operation voltage up to 690V
- Insulation voltage 1 kV
- Rated impulse withstand up to 8 kV

12.8 APFC Controller

The APFC controller should be microprocessor based and should correct power factor with the help of contactors by switching the required no. capacitor banks

The controller should offer power factor correction without any need for manual intervention. The controllers should decide optimum configuration of capacitor banks in order to achieve desired power factor by taking into consideration the kVAr of each step, no of operations, total usage time, re-connection time of each step etc. Besides manual switching of capacitors should also be possible directly through the controller, The APFC controller should have the following basic features

- 3nos. CT operated
- Backlit LCD display with multiple parameters displayed at the same time
- Auto step programmable
- Capable of measuring VTHD and ITHD values at least up to 15^{th} order
- Automatic CT reversal sensing and correction
- Should be 1A / 5A CT selectable.
- Sensing shall be done at LT as well as HT side of the transformer
- Display of average weekly power factor
- Keypad lock feature to prevent operation by unauthorized persons
- Alarms for under/over compensation, high VTHD/ITHD, over temperature, capacitor failure, capacitor over-current, over/under voltage
- Individual capacitor's ON/OFF status and capacitor failure indication
- Temperature sensing feature with alarm in case of panel over heating
- Should have RS485 communication protocol.

12.9 Switchgear & Protection:

Suitable capacity duty contactor for each step shall be used and must be capable of capacitor switching duty. Bus bars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cable used shall have superior mechanical, electrical and thermal properties. Internal wiring between main bus bars, contactor, capacitor etc shall be made with 1100-volt grade PVC insulated FRLS copper conductor of appropriate size by using suitable copper crimping terminal ends etc suitable bus links for input supply cable termination shall be provided.

Control circuit shall be duly protected by using suitable rating MCB. An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset). 440 Volt caution board shall be provided on the panel.

12.10 Tests at Manufacturer's Works:

All routine and type tests as per IS:2834 relevant to capacitor bank's as amended up to date shall be carried out at manufacturer's works and test certificates to be submitted.

12.11 Test at Site:

Insulation resistance with 500 V DC Meggar shall be carried out and test results should be recorded.

Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute. Each discharge resister shall be tested for its working.

12.12 Installation:

Capacitor bank shall be installed at least 30 cm away from the walls on suitable frame work of welded construction. The earth terminals provided on the body of capacitor bank shall be bonded to main capacitor panel earth bus with 2 nos 8 SWG copper or 6 SWG GI earth wire.

Contractor shall also submit four sets of installation and maintenance manual

13 EARTHING & LIGHTNING PROTECTION SYSTEM

Earthing system shall confirm to CPWD General Specifications for Electrical Works (Part I- Internal), 2023. Earthing system shall comprise of suitable nos. of Earth pits with GI & Copper Plate electrodes as per IS-3043 & CPWD specifications.

Neutral Earthing with suitable size Copper strips and Copper plate earth pits for Transformer, DG Sets and other equipment as specified by OEMs shall be provided. earthing of all sus. The body earthing for transformers, DG, HV & MV panels shall be done separately (2 Nos. for Each equipment) and shall also made a common earth bus network.

Like for a single transformer, the total number of earth electrodes shall be 4 (2 for neutral and 2 for connection to a common earth bus for body earthing).

13.1 ELECTRODES

The earth electrodes shall be as per CPWD General Specifications for Electrical Works (Part I-Internal), 2023.

13.2 LOCATION OF EARTH ELECTRODES

Distance of earth electrode from any building and other earth electrode shall be as per CPWD specification & IS codes. Care shall be taken that the excavation of earth electrode may not affect the column footings or foundation of the building. In such cases electrodes may be farther away from the building. The location of the electrode earth will be a place where the soil has reasonable chance of remaining moist. As far as possible, entrances, pavements and road ways, are to be definitely avoided for locating the earth electrode.

13.3 WATERING ARRANGEMENT

Method of watering arrangement shall comply with CPWD general specifications.

13.4 SIZE OF EARTH LEAD

The recommended sizes of copper earth bus lead in case of Sub-stations shall be in accordance with General Specifications for Electrical Works (Part I-Internal), 2023 amended up to date. The minimum size of earth lead shall be 25 mm x 5 mm copper or equivalent GI strip.

13.5 INSTALLATION

All joints shall be riveted and sweated. Joints in the earth bar shall be bolted and the joints faces tinned. Where the diameter of the bolt for connecting earth bar to apparatus exceeds one quarter of the width of the earth bar, the connection to the bolt shall be made with a wider piece of flange of copper jointed to earth bar. These shall be tinned at the point of connection to equipment and special care taken to ensure a permanent low resistance contact to iron or steel. All steel bolts, nuts, washers etc. shall be cadmium plated, main earth bars shall be spaced sufficiently on the surface to which they are fixed such as walls or the side trenches to allow for ease of connections. Copper earthing shall not be fixed by ferrous fittings. The earthing shall suitably be protected from mechanical injury by galvanized pipe wherever it passes through wall and floor. The portion within ground shall be buried at least 60 cm deep. The earthing lead shall be securely bolted and soldered to plate or pipe as the case may be. In the case of plate earthing the lead shall be connected by means of a cable socket with two bolts and nuts. All washers shall be of the same materials as the plate or pipe. All iron bolts, nuts and washers shall be galvanized.

13.6 TESTING

After installation, the tests as specified in CPWD General Specifications for Electrical Work (Part I-Internal), 2023 shall be carried out and results recorded LIGHTNING PROTECTION SYSTEM. Lightening Protection System shall be provided for all buildings, blocks and facilities constructed under this contract as per IS/IEC-62305:2010 amended up to date and NBCS 2026. However, All earth pits shall be GI maintenance free chemical earth pits. Finial shall be of GI material and for earth grid/mesh & downcomers, required size aluminium round conductor shall be used.

13.7 SAFETY REQUIREMENTS

Safety provisions shall be generally in conformity with appendices (A) and (C) of CPWD General Specifications of Electrical Works (Part I-Internal), 2023. In particular, following items shall be provided:

(i) Insulation Mats
Insulation mats confirming to IS 15652: 2006 shall be provided in front of all H T & LT Panels as well as other control equipment as specified.

(ii) First Aid Charts and First Aid Box
Charts (one in English, one in Hindi, one in regional language), displaying methods of giving artificial respiration to a recipient of electrical shock shall be prominently provided at appropriate place. Standard first aid boxes containing required materials should be provided in each sub-station.

(iii) Danger Plate
Danger Plates shall be provided on HV and MV equipments. MV danger notice plate shall be 200 mm x 150 mm made of mild steel at least 2 mm thick vitreous enameled white on both sides and with the descriptions in signal red colour on front side as required. Notice plates of other suitable materials such as stainless steel, brass or such other permanent nature material shall also be accepted with the description engraved in signal red colour.

(iv) Fire Extinguishers
Portable CO2 confirming to IS 2878: 1976/ chemical confirming to IS 2171: 1976 extinguishers, HCFC Blend A (P-IV) shall be installed in the sub-station at suitable places. Other extinguishers recommended for electric fires may also be used.

(v) Fire Buckets
Fire buckets confirming to IS 2546: 1974 shall be installed with the suitable stand for storage of water and sand.

(vi) Tool Box
A Standard tool box containing necessary tools required for operation and maintenance shall be provided in the sub-station.

(vii) Caution Board
Necessary number of caution boards such as “Man on Line” ‘Don’t Switch on’ etc. shall be available in the sub-station.

(viii) Key Board
A keyboard of required size shall be provided at a proper place containing castle keys, and all other keys of sub-station and allied areas

14 TECHNICAL SPECIFICATIONS – SOLAR PV SYSTEM

14.1 GENERAL:

This section specifies the design, Supply, Installation, Testing and Commissioning of on grid Solar Photovoltaic Power Plant confirming to MNRE specifications as amended, consisting of Mono Crystalline-PERC Bi-facial silicon solar cells/panels, net metering facility, necessary protections, earthing, mounted on hot dipped GI structure of suitable strength with following components complete as required: -

a) Solar Photovoltaic Module of capacity 500 Wp or above, manufactured in India, confirming to IS 14286/IEC 61215, IS/IEC 61730-Part-1, IS/IEC 61730-Part-2. Solar Photovoltaic Module conversion efficiency shall not be less than 16.5%. PV modules used in solar power plants/ systems must be warranted for their output peak watt capacity, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years.

b) Power Conditioning Unit (PCU) of 350-800 V DC Input voltage range and 400 V AC, three phase, 4 wire, 50Hz +/- 2.5 Hz, output voltage suitable to generate AC Power with efficiency not less than 97%, total harmonic distortion less than 3% and suitable for ambient temperature from 0 to 50 degree C. The PCU shall adjust the voltage and frequency level to suit the Grid Voltage Frequency.

c) Data Monitoring System complete with accessories.

d) Fixing of Array junction box & Main junction box with IP 65 protection and termination arrangement for incoming and outgoing cable along with glands, lugs and other accessories etc. as required.

e) Lightning and surge voltage protection.

f) Connections & Interconnections by supplying & fixing required size Solar cables, XLPE insulated copper conductor 1.1 kV grade armoured power and control cables between solar modules, main power cable to grid supply PCU unit along with supplying & fixing of necessary channel/conduit lugs and other accessories etc. as required.

14.2 SOLAR PHOTOVOLTAIC MODULES:

The total Solar PV minimum array should comprise of Mono crystalline-PERC Bi-facial modules of minimum 500 Wp and above wattage. The Photovoltaic module must be tested and certified by an independent testing laboratory that is accredited in accordance with ISO Guide 25.

a. The PV modules should be of Indigenous make. The PV modules must confirm to the latest edition of any of the following / equivalent BIS standards for PV module design qualification and type approval:

- Crystalline Silicon Terrestrial PV Modules IEC 61215 / IS14286
- In addition, the modules must confirm to IEC 61730 Part 1(requirements for Construction) & Part 2 (requirements for testing, for safety qualification).
- Further, the PV modules must also qualify the Salt Mist Corrosion Testing as per IEC61701 / IS 61701
- SPV module Conversion efficiency should be equal to or greater than 14% at STC and AM 1.5 radiations.

b. The PV modules shall perform satisfactorily in humidity up to 100 % with temperature between -40ºC to +85ºC. Since the modules would be used in a high voltage circuit, the high voltage

insulation test shall be carried out on each module and a test certificate to that effect be provided.

c. Other general requirement for the PV modules and subsystems shall be the following:

i. Solar cells technology employed in the module production shall have to be certified and a certificate giving details of major materials i.e. cells, Glass, back sheet, their makes and data sheets to be submitted.

ii. The rated output power of any supplied module shall not have negative tolerance.

iii. The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary more than 3 (three) percent from the respective arithmetic means for all modules and/or for all module string, as the case may be

iv. Except where specified, the front module surface shall consist of impact resistant, low- iron and high-transmission toughened glass.

v. The module frame, if any, shall be made of aluminum or corrosion-resistant material which shall be electrolytically compatible with the structural material used for mounting the modules.

vi. The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type IP65 rated.

vii. Necessary I-V curves at 250 C, 450,600 and at NOC are required to be furnished.

viii. Fill factor of module shall not be less than 0.70

14.3 ARRAY STRUCTURE:

a. The array structure shall be so designed that it will occupy minimum space without scarifying the output from SPV panels.

b. Structural material shall be corrosion resistant and electrolytically compatible with the material used in the module frame, its fasteners, nuts and bolts. Galvanizing should meet ASTM A-123 hot dipped galvanizing or equivalent which provides at least spraying thickness of 70 micron on steel as per IS 5905.

c. Structures shall be supplied complete with all members to be compatible for allowing easy installation at the roof top site and the structure atop sloping roofs shall be done by the Bidder.

d. Each structure shall have a provision to adjust its angle of inclination to the horizontal as per the site conditions.

e. The array structure shall be grounded properly using maintenance free earthing kit.

f. Each panel frame structure should be so fabricated as to be fixed on the rooftop column/wall structures. The structure should be capable of withstanding a wind load of 200 km/hr. after grouting & installation. The front end of the solar array must be one meter above the rooftop. Grouting material for SPV structures shall be as per M15 (1:2:4) concrete specifications.

g. The Contractor shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings. Such details shall include, the following:

    i. Determination of true south at the site;

    ii. Array tilt angle to the horizontal, with permitted tolerance;

iii. Details with drawings for fixing the modules;

iv. Details with drawings of fixing the junction/terminal boxes;

v. Interconnections details inside the junction/terminal boxes;

vi. Structural installation details and drawings;

vii. Electrical earthing;

viii. Inter-panel/Inter-row distance with allowed tolerances; and

ix. Safety precautions to be taken.

k. The array structure shall support SPV modules at a given orientation and absorb and transfer the mechanical loads to the rooftop columns properly. All nuts and bolts shall be of very good quality stainless steel. Detailed design and drawing shall have to be submitted for acceptance and approval before execution of work.

14.4 POWER CONDITIONING UNIT (PCU)

The PCU required of appropriate capacities as follows, should convert DC power produced by SPV modules, in to AC power and adjust the voltage & frequency levels to suit the local grid conditions. PCU should be appropriate capacity of proposed solar PV plants

14.4.1 POWER CONDITIONING UNIT (INVERTER PLUS MPPT CHARGE CONTROLLER)

Input Voltage:

- From PV Module: Minimum 08KWp, 120V nominal DC from Solar PV Array.
- From AC source 415V, 3 ph, 50 Hz

Output Voltage:

Suitable for charging 120 V, 600AH tubular plate lead acid VRLA Gel type battery bank.

Protection:

- Short Circuit
- Deep discharge
- Over charging (Automatic trickle charge mode on full charge)
- Input surge voltage
- Over current (Load)
- Battery reverse polarity
- Solar Array reverse polarity

Indication (LED/LCD Indication):

- String on
- Mains on
- Input on
- Control on

- Charge on
- 80% charged, 100% charged
- Charger overload
- Battery on trickle
- Battery disconnected/fault battery reverse polarity
- Low solar power
- System fault
- Charger over temperature
- Input over/under voltage (for AC)
- Operating Temp: 0-50 Deg C
- Humidity: 0-95% non condensing
- Enclosure IP 32
- No Load Consumption: < 1%

14.5 INVERTER:

14.5.1 Common Technical Specification:

- Control Type :Voltage source, microprocessor assisted, output regulation
- Output Voltage : 3 phase, 415 Volt AC
- Frequency : 50 Hz
- DC link voltage range : 0 to 800 V
- Total Harmonic Distortion - less than 3%
- Maximum current ripple - 4% PP
- Reactive Power - 0.95 inductive to 0.95 capacitive
- Operating Temp. Range - 5 deg C to 55 deg C
- Housing Cabinet - INVERTER to be housed in suitable switch cabinet, Within IP 65 Degree of ingress protection for outdoor and IP 20 for Indoor.
- Inverter efficiency - 95% and above at full load,
- Power Control- MPPT

14.5.2 Other important Features/Protections required in the INVERTER

- Mains (Grid) over-under voltage and frequency protection
- Array ground fault detection
- Automatic fault conditions reset for all parameter like voltage, frequency and/or black out.
- MOV type surge arrester on AC and DC terminals for over voltage protection from lightening-

induced surges.

- INVERTER should be rated to operate at 0-55 deg. centigrade unless provision for air conditioning is included in INVERTER
- Overload capacity (for 10 sec) should be 150% of continuous rating.
- PCU shall be capable to synchronize independently & automatically/to be phase locked with Power Supply Authority grid power line frequency to attain synchronization & export power generated by the solar panel to Power Supply Authority grid.
- The DC to AC conversion efficiency shall at least be 95percent at full load. The idling current at no load must not exceed 2 percent of the full load current.
- Transformer less inverters shall be preferred. Restriction of DC components on AC side shall be achieved.
- The INVERTER shall be capable of operating in parallel with the grid utility service and shall be capable of interrupting line-to-line fault currents and line-to-ground fault currents.
- The INVERTER shall be able to withstand an unbalance output load to the extent of 30%.
- The INVERTER shall include appropriate self-protective and self-diagnostic features to protect itself and the PV array damage in the event of INVERTER component failure or from parameters beyond the INVERTER's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the INVERTER front panel to cause the INVERTER to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the INVERTER, including commutation failure, shall be cleared by the inverter protective devices and not by the existing site utility grid service circuit breaker.
- The INVERTER shall go to shut down/standby mode, with its contacts open, under the following conditions before attempting an automatic restart after an appropriate time delay;

(i) Insufficient Solar Power Input

When the solar available from the PV array is insufficient to supply the losses of the INVERTER, the INVERTER shall go to a standby/shutdown mode. The INVERTER control shall prevent excessive cycling during rightly shut down or extended periods of insufficient solar radiation.

(ii) Utility-Grid Over or Under Voltage

The INVERTER shall restart after an over or under voltage shutdown where the utility grid voltage has returned to within limits for a minimum of two minutes.

(iii) Utility-Grid Over or Under Frequency

The INVERTER shall restart after an over or under frequency shutdown when the utility grid voltage has returned to within limits for minimum of two minutes.

- The INVERTER generated harmonics measured at the point of connection to the utility services when operating at the rated power shall not exceed a total harmonics current distortion of 3 percent, a single frequency current distortion of 4 percent and single frequency voltage distortion of 1 percent, when the first through the fiftieth integer harmonics of 50 Hz are considered.
- The INVERTER power factor at the point of utility services connection shall be 0.95 lagging or leading when operating at above 25 percent of the rated output. The internal copper wiring of the INVERTER shall have flame resistant insulation. Use of PVC is not acceptable. All conductors shall be made of standard copper.

- Full protection against accidental open circuit and reverse polarity at the input shall be provided.
- The INVERTER shall have an appropriate display on the front panel to display the instantaneous AC power output and the DC voltage, current and power input. Each of these measurements\ displays shall have an accuracy of 1 Percent of full scale or better.
- The Inverter shall be with Bi-directional full sine wave charge controller 120 V DC output.
- Electrical safety, Earthing and Protections shall be as per CPWD specifications for Electrical works Part I- 2013.

14.5.3 Factory testing

- The INVERTER shall be tested to demonstrate operation of its control system and the ability to be automatically synchronized and connected in parallel with a utility service, prior to its shipment.
- Factory testing shall not only be limited to measurement of phase currents, efficiencies, harmonics content and power factor, but shall also include all other necessary tests/simulations required and requested by the Purchasers Engineers. Tests may be performed at 25, 50, 75 and 100 percent of the rated nominal power.
- A factory Test Reports (FTR) shall be supplied with the unit after all tests. The FTR shall include detailed description of all parameters tested qualified and warranted.

14.6 Operating modes:

Operational or MPP tracking mode: The control system continuously adjust the voltage of the generator to optimize the power available. The power conditioner must automatically re-enter stand-by mode when input power reduces below the standby mode threshold. Front Panel display should prove the status of the INVERTER, including AC Voltage, Current, Power output & DC Current, Voltage and Power input, pf and fault Indication (if any)

14.7 Codes and standards:

The quality of equipment supplied shall be controlled to meet codes listed in relevant ISI and other standards, such as:

- IEEE 928 Recommended Criteria for Terrestrial PV Power systems.
- IEEE 519 guide for Harmonic Control and Reactive Compensation of Static Power Controllers.
- National Electrical NEPA 70-(USA) or equivalent national standard.
- National Electrical safety Code ANSI C2-(USA) or equivalent national standard.
- JRC Specification 503 (Version 2.2 March 1991) or JPL Block V standard for PV modules.

14.8 Plant metering/data logging

18.6.1 PV array energy production: Digital Meters to log the actual value of AC/DC Voltage, Current & Energy generated by the PV systems shall have to be provided. 1 Nos. two way LT 415V energy meters (import – export) class 0.2S ABT compliant shall be incorporated in the system one for each Solar PV Plant.

18.6.2 Data logging systems(Hardware and software) one for each Solar PV Plant, for plant control and monitoring shall be provided with the following features suitable Computers: Desktop Computer 3 GHz Pentium i7 latest (3MB Cache) with 500 GB HDD, 4 GB RD RAM, 2 Parallel & 2 Serial Port, Wi-Fi Lan Card, DVD RW Drive, 20" LED Display, USB Scroll Mouse, along with All in one 1200 dpi/12 ppm Desktop LaserJet printers along with a 1 KVA on-line ups with 1 hour

battery backup.

18.6.3 Remote Supervisory Control and data acquisition through SCADA software at the purchaser location through Handheld device /GSM cellular device with latest software/hardware configuration and service connectivity for online/real time data monitoring/control complete to be supplied and operation and maintenance /control to be ensured by the Contractor.

18.6.4 All major parameters should be available on the digital bus and logging facility for energy auditing through the internal microprocessor and can be read on the digital LCD/LED front panel at any time the current values, previous values for up to a month and the average values. The following parameters should be accessible via the operating interface display:

- AC Voltage
- AC Output current
- Output Power
- DC Input Voltage
- DC Input Current
- Time Active
- Time disabled
- Time Idle
- Temperatures (C)
- Inverter Status

14.9 Disconnection and islanding

Disconnection of the PV generator in the event of loss of the main grid supply is to be achieved by in built protection within the power conditioner. This may be achieved through rate of change of current, phase angle, unbalanced voltage or reactive load variants. Operation outside the limits of power quality as described in the technical data sheet should cause the power conditioner to disconnect the grid. Additional parameters requiring automatic disconnection are:

- Neutral voltage displacement
- Over current
- Earth fault
- Reverse power

In case of the above, tripping time should be less than 0.5 seconds. Response time in case of grid failure due to switch off or failure based shut down should be well within 5 seconds.

Automatic reconnection after the grid failure is restored

INVERTER shall have facility to reconnect the Inverter automatically to the grid following restoration of grid, subsequent to grid failure condition. The system should have integrated SCADA and software or plant control and remote communication with web monitoring to monitoring individual strings and complete power plant.

14.10 ARRAY JUNCTION BOX, MAIN JUNCTION BOXES WITH STRING MONITORING FEATURE TO THE INVERTER:

The junction boxes are to be provided in the PV yard for termination of connecting cables. The Junction Boxes shall be made of FRP/Powder Coated Aluminum with full dust, water & vermin proof arrangement. All wires/cables must be terminated through cable lugs. The JBs shall be such that input & output termination can be made through suitable cable glands.

- Copper bus bars/terminal blocks housed in the junction box with suitable termination
- Threads
- Confirming to IP65 (for outdoor)/ IP 21 (for indoor) standards and IEC 62208
- Hinged door with EPDM rubber gasket to prevent water entry.
- Single compression cable glands.
- Provision capacity MOVs provided within the box to protect against lightening.

14.11 ENERGY METER

A 3-Phase Energy Meter of suitable current rating shall be provided as approved by SBI/PMC in charge to measure the quantum of energy. Meter must be provided with the necessary data cables. Energy Meter should be 0.5 Class of accuracy.

14.12 DC DISTRIBUTION BOARD:

Each Solar PV Plant shall have its separate DC Distribution panel to receive the DC output from the array field with analog measurement meter for voltage, current and power from different MJBs so as to check any failure in the array field.

DCDBs shall be dust & vermin proof. The bus bars are to be made of copper of desired size. Suitable capacity MCBs/MCCBs to be provided for controlling the DC power output to the INVERTER along with necessary surge arrestors.

14.13 AC DISTRIBUTION PANEL BOARD

Each plant shall be supplied with its dedicated AC Distribution panel which shall be located at an appropriate location in the building itself. ACDBs are to be provided at the cable terminating points emanating from the inverters. The AC power from inverter of each individual Solar PV Plant shall be fed into its dedicated AC Distribution panel. Thereafter, the outputs shall be terminated into the main LT supply.

AC Distribution Panel Board (DPB) shall control the AC power from inverter and should have necessary surge arresters. Interconnection from ACDB to mains at LT bus bar is to be carried out and complete equipment along with metering to be installed in the ACDB.

Panel type: Wall mounting type & CRCA 2.5 mm thick with IP 32 protection Cable Gland suitable to Incoming & out going cable

14.14 SOLAR CABLES:

- Solar cables of suitable size & cross section shall be provided for the interconnection purpose in photovoltaic power generation. Solar cables shall interconnect solar panels and other electrical components of the photovoltaic system. Solar cables shall be UV resistant and weather resistant. Solar cables shall withstand a large temperature rangefrom -40°C to +90°C ambient and shall be

generally laid outside.

- Solar cables shall be Tinned Copper XLPO insulated & LSZH sheathed suitable for 1100 VAC/ 1800 VDC.
- All cable tests and methods should confirm to IEC 60189 or other relevant standards.
- Cabling in the yard shall be carried out as per IE rules. All other cabling above ground should be suitably mounted on cable trays with proper covers.
- The size of cable for connecting module to terminal box, terminal box to panel junction box, panel junction box to array junction box and array junction box to PCU to Battery Bank/ACDB shall be as per site requirement. The decision of PMC/Engineer in charge shall be final.
- Cables ends: All connections are to be made through suitable cable/lug/terminals; crimped properly & with use of cable glands.
- Multi Strand, Annealed high conductivity copper conductor
- PVC type 'A' pressure extruded insulation
- Overall PVC insulation for UV protection and confirm to IEC 69947.
- Armored cable for underground laying
- Selected cable should carry a current density of minimum 1.2 Amp/Sq.mm
- All electrical/wires inside the building to be fixed in Rigid Steel Conduit for wiring inside the building.
- The cable's insulation must be able to withstand thermal and mechanical loads.
- The insulation and jacket materials shall be extremely resistant to weathering, UV- radiation and abrasion. Additionally, solar cables shall be salt water resistant and resistant to acids and alkaline solutions. Solar cables shall be suitable for fixed installation as well as for moving applications without tensile load. These solar cables shall be especially designed for outdoor use for withstansing direct sun radiation and air humidity. Cables should be halogen free flame retardant and made of cross-linked jacket material. The solar cables shall also be installed in dry and humid conditions indoors.
- For laying/termination of cables, latest BIS/IEC codes/ standards to be followed.

14.15 FIRE EXTINGUISHERS:

- The firefighting system for the fire protection of solar power plants shall be consisting of:
- CO2 type 4.5 kg fire extinguishers in the control room for fire caused by electrical short circuits.
- Sand buckets in the control room. The installation of fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing the batteries and PCUs.

14.16 LIGHTNING PROTECTION

There shall be required number of suitable lightening arrestors installed in the array field.

14.17 EARTHING PROTECTION

Each array structure of the PV yard should be grounded properly. In addition the lightening

arrester/masts should also be provided inside the array field. Provision should be kept for shorting and grounding of the PV array at the time of maintenance work. All metal casing/shielding of plant should be thoroughly grounded in accordance with Indian Electricity Act. /IE Rules. Earth resistance should be tested in presence of the representative of PMC / Engineer in charge.

14.18 DANGER BOARDS

Danger board should be provided as and where necessary as per IE act/IE rules as amended up to date.

15 TECHNICAL SPECIFICATION – LIFTS

15.1 GENERAL

The scope of work shall cover design, supply delivery, installation, testing and commissioning of passenger lifts/ passenger cum bed lifts/Service lifts. All lifts shall be VVVF operated, gearless, Central opening and with Machine room less. The Lifts shall be with facility for duplex/triplex selective/collective operation. Car enclosure finish shall be SS (as per OEM) scratch proof moonrock/honeycomb. SS handrail not less than 600mm long at 900mm above floor level , to be provided inside the lift car as per requirement. Suitable lights and fans as per requirement shall be provided. Lift car size, Lift well size, Lift pit overhead, entrance width, car height etc. shall be as per NBC 2016 or OEM standards. The dimensions of Lift well shown in tender drawings are only indicative and EPC Contractor shall provide the same as required by OEM. The scope of work shall also include the following item of civil works.

a) All lifts for residential blocks (Tower A & B) shall be of landings for G+19 Floor + Terrace and of travelling speed 2.0 metre / second (Minimum). Out of total six lifts for Tower A & B, all passenger lifts shall be 13 passenger capacity minimum and service lifts (2 Nos) shall be 16 passenger capacity minimum.

b) The above specifications are minimum requirement and the lifts shall be designed for “High End Building” as per NBCS 2026. The EPC contractor has to submit the detailed design and calculation for approval of PMC/SBI before commencement of works. No extra cost will be paid for additional capacity, speed, quantity etc.

c) Out of 3 lifts in each residential block Tower, 2 passenger lifts shall be in ‘Duplex’ mode of operation and service lift shall be in independent (Simplex) mode of operation.

d) The above duplex lifts in each residential tower shall be preferred to be as Capsule lifts as per actual final design and site requirements to be approved by SBI / PMC.

e) All lifts for Commercial block – commercial area (sub block) – shall have landings for G+5 Floor + Terrace and of travelling speed 1.5 metre / second. (Minimum).

f) All three lifts as per Sl.No.e) above shall be minimum 16 passenger capacity and in ‘Triplex’ mode of operation .

g) For commercial block, the above specifications are minimum requirement and the lifts shall be designed for “Premium Class” of building as per NBCS 2026. The EPC contractor has to submit the detailed design and calculation for approval of PMC/SBI before commencement of works. No extra cost will be paid for additional capacity, speed, quantity etc.

h) All lifts for Commercial block – Hostel area (sub block)– shall have landings for G+7 Floor + Terrace and of travelling speed 1.5 metre / second (Minimum)

i) Among the 3 lifts as per Sl.No.h) above, Two lifts will be in duplex mode of operation and remaining one lift (VIP Lift) and service lift shall be independent in operation.

j) All three passenger lifts inn commercial block-Hostel sub block shall be of minimum 13 passenger capacity and the Service Lift shall be of minimum 20 passenger capacity.

k) The above specifications are minimum requirement and the lifts shall be designed for “Premium Class” of building as per NBCS 2026. The EPC contractor has to submit the detailed design and calculation for approval of PMC/SBI before commencement of works. No extra cost will be paid for additional capacity, speed, quantity etc.

l) Necessary scaffolding temporary barricade in the hoist way required during the erection of the elevators.

m) Minor building work comprising of cutting holes and making good the car and counterweight rail brackets, hall buttons and indicators including laying of sills in position.

n) Steel items such as machine beams, bearing plates buffer support channels, sill angles and fascia plates etc.

o) Suitable trap doors with steel chequered plate covers.

p) Providing and install a suitable vertical iron ladder for access to the pit.

q) Fire Lift shall have UPS with 15 minute battery backup as per Bill -22, HLA-2020.

r) Lift Shaft Shall be provided with LED Bulkhead Light, Light point & Power Socket with Switch at each floor as per CPWD Norms

s) Entire Shaft shall run with 2Runs of Suitable Earth Flat as per OEM requirements & CPWD Norms

t) Necessary Distribution Board as per OEM requirements & CPWD Norms

u) All lifts shall be IS 17515 Part 1 to 3 compliant. All lifts shall be Energy Classification 'A' efficient as per IS 17515 Part-2.

v) The flooring in each lift shall consist of anti-skid inlay Italian marble as per design approved by PMC & SBI.

w) All Lift car Interiors including cladding shall be of premium design as per design approved by PMC & SBI.

x) All lifts should be provided with LED Digital Screen of suitable size with required power and communication cabling. It includes the required license and software for managing display message from separate server/computer provided by the Bank (SBI).

y) Bell facility for lift operator should be there for VIP Lifts if any.

z) All lifts should be provided with modern ceiling with sufficient modern LED lighting and fans as per design approved by PMC & SBI.

aa) Lift License/Safety certificate should be obtained for all the lifts from local Govt. Authorities/PWD/Electrical Inspectorate for regular use of the lifts.

bb) Any other item required for successful completion and commissioning of lifts. (including the hoisting beam in the machine room)

The work shall be done in accordance with regulations of any local code and following ISI codes which govern the requirements of installations.

- IS: 1860-1980 code of practice for installation, operation and maintenance of Electric Passenger and Goods Lifts.
- IS: 3534-1976 Outline dimensions of Electric Lifts.
- IS: 4666-1980 Specifications for Electric passenger and Goods Elevators.
- Indian Electricity Act 1910.
- Indian Electricity Rules, 1956.

The lift motor shall be controlled by a variable voltage variable frequency (V.V.V.F.) micro-processor control system which shall control and monitor every aspect of lift operation at all stages of the car motion cycle on real time basis. Variable voltage variable frequency drive system (with close loop) shall be used.

15.2 SHOP DRAWINGS AND APPROVAL OF ELECTRICAL INSTALLATIONS:

The selected tenderer shall prepare a furnish shop drawings for approval by The Client, such shop drawings shall be based on the Architectural drawings and requirements laid down in specifications, local laws and regulations etc. The detailed drawings shall be submitted within one month of placement of order. The successful tenderer shall obtain the approval of electrical Inspector and other local authorities as per requirements before submitting the drawings to Client/ Engineer. The Contractor shall not proceed with in installation work till the drawings are approved by the PMC/Engineer in charge.

Approval of Contractor's drawings shall not absolve the Contractor of any of his obligations to meet the requirements of specification under this contract

Five sets of completion drawings operation manual, maintenance manual, spare parts details shall be submitted to the Client/ Engineer after completion of work.

15.3 GUARANTEE

The Contractor shall guarantee the equipment against all defects of materials and workmanship for a period as mentioned in the Tender from the date of Handing over of the equipment as certified by the owner. Any defects arising during the guarantee period shall be rectified and replaced by the tenderer, at his own expense, to the satisfaction of the Client.

15.4 PERMITS, INSPECTION & LICENSE FEE

The Contractor shall arrange all necessary local, provincial or national government permit/License and shall make arrangements for inspection and tests required thereby. Expenses to be borne by EPC Contractor.

15.5 POWER SUPPLY

The apparatus shall be designed to operate on 415 + 10% - 20% Volts, 3 Phase, 4 wires, 50 Hz A.C. Supply for illumination signal equipment shall be 240 Volts single phase 50Hz A.C.

15.6 ELECTRICAL WIRING

The necessary A.C. supply of 3 Phase, 415 Volts 50 HZ shall be made available in the main control switch unit to be provided by the Contractor. All the electrical works beyond the main supply switch shall be carried out by the Contractor i.e. supply and installations of panels for drive motors, switches and control complete with wiring as per system requirement and approval of the Engineer.

The wiring shall be carried out strictly in accordance with Indian Electricity Rules and Indian code of Practice for Electrical Wiring Installation IS-732-1963 System Voltage not exceeding 650 V).

The cable and conduits to be used shall be of suitable size and grade confirming to relevant IS specification. Wiring for LT switchboard to the motor terminal shall be with heavy duty 1.1 KV grade XLPE insulated PVC sheathed, FRLS aluminium cable. All the trailing cables used for control and safety device shall confirm to IS: 4289-1967, Specifications for lifts cables. The trailing cable circuits for controls, safety devices, lighting and signaling shall be separate and distinct.

Power wiring between controller and main board to various landings shall be drawn in suitable size heavy gauge conduit stove enameled/painted confirming to I.S specifications.

The Voltage and frequency of the supply shall be subjected to variations permissible under Indian Electricity Acts and Rules.

15.7 CAR FRAME:

The car frame, which supports the car platform and enclosures, shall be made of structural steel and equipped with suitable guides and a car safety device mounted underneath the car platform. The hoist ropes shall include adjustable self/ aligning hinges. The car shall be so mounted on the frame that vibration and noise transmitted to the passenger is minimized.

15.8 CAR SAFETY AND GOVERNER:

Suitable car safety to stop the car whenever excessive descending speed is attained shall be operated by a centrifugal speed governor connected to the governor through a continuous steel rope.

The governor shall be provided with self tensioning device to keep governor rope in proper tension even after rope stretch. Suitable means shall be supplied to cut off power from the motor and apply the brake on application of the safety.

15.9 COUNTER BALANCE:

A Suitable guided structural steel frame with appropriate filler weights of cast iron shall be furnished to promote smooth and economic operation.

15.10 TERMINAL AND FINAL LIMITS:

Terminal limit switches shall be provided to slow down and stop the car automatically at the terminal landings within permissible over travel and final limit switches shall be provided to automatically cut off the power and apply the brake, should the car travel beyond the permissible over travel. They shall act independently of the operating devices and buffers.

15.11 TERMINAL BUFFERS:

Heavy duty spring buffers shall be installed as a means of stopping the car and counterweight at the extreme limits of travel. Buffers in the pit shall be mounted on steel channels which shall extend between both the car and counterweight rails.

15.12 CONTROLLER:

A Controller shall be provided to control starting stopping and speed of the elevator motor and also be automatically able to apply the brake if any of the safety devices operate or if power fails from any cause. In case of power failure and again restore of power the lift shall land to next floor and shall not go to basement/lowest level. Suitable software/hardware or rescue device shall be provided.

15.13 REVERSE PHASE RELAY:

A reverse phase relay shall be provided on the controller which is designed to protect the lift equipment against phase reversal and phase failure.

15.14 GUIDES:

Machined steel tee guides shall be furnished for the car and counterweight. The guide rails should be of steel solid and shall have tongued and grooved joints. Sliding clips shall be used for fastening the guides to allow building settlement without distorting the guide rails. To keep down the noise level and to reduce wear and tear of the sections, only Nylon Ribs shall be used in the guide shoes, after smoothening of the rails. The flanges shall be machined for the fish plate mounting such that rail alignment at joints almost remain constant.

15.15 FOUNDATIONS:

The machine shall be placed directly above the hoist way upon the machine room slab or as per design.

15.16 ROPES:

The elevator shall be provided with traction steel ropes. Steel wire rope having a tensile strength of not less that 12.5 Ton/cm^2 of good flexibility shall be used for lift. The lift rope shall confirm to IS: 14665 – (Part-4- Sec-8):2001.

15.17 MACHINE:

The machine shall be gearless type.

15.18 BRAKE:

The direct current brake shall be spring applied and electrically released and designed to provide smooth stop under variable loads. The brake should be capable of operation automatically by various safety devices, current failure, and by normal stopping of car. It should be possible to release the brake manually, such releases brake manually, such releases requiring the permanent application of manual force so as to move the lift car in short sties. For this purpose one set of brake release equipment shall be supplied.

15.19 MOTOR:

The motor shall be suited to the service proposed and arranged for adequate lubrication. The motor shall be class F insulation and one (1) hour rated squirrel cage induction type having high starting torque. It shall also be provided with Thermisters embedded in the stator windings for the highest degree of thermal motor protection.

15.20 CONTROL

The control shall be variable voltage variable frequency A.C. variable voltage, closed loop control system using solid state devices and electronic speed pattern generator to command the motor from a velocity transducer and load compensation circuits for a comfortable ride.

In Normal operation, the electromagnetic brake shall only be applied when the lift has come to a complete standstill. The brake shall only be meant for holding the lift in position at every landing, providing stopping without any jerking effect.

Each controller cabinet containing memory equipment shall be properly shielded from the pollution.

15.21 MICROPROCESSOR

The control shall employ a microprocessor working on a program such that precision leveling and highly efficient handling of passengers for least possible waiting and reduced travel time is ensured. The microprocessor system should be designed to accept programming with minimum

downtime. It should be able to monitor the state of input calls (such as car calls from COP and hall calls from hall fixtures) and output commands such as starting, decelerating and stopping the elevator. It should be able to generate floor location data, thereby, providing a reference position to establish the safety zones for door opening and closing, and also to initiate leveling slowdown.

15.22 DUPLEX COLLECTIVE OPERATION

The operation shall be duplex collective with/without attendant for each elevator and shall consist of the following: -

15.22.1 IN THE CAR

There shall be furnished a flush type attractively finished stainless steel panel which contains a series of luminous buttons numbered to correspond to the landings served, an emergency stop switch and an emergency call button connected to a bell which serves as an emergency signal.

15.22.2 AT HOISTWAY LANDINGS

There shall be provided an UP luminous push button and a DOWN luminous push button at each intermediate landing and a single button at the terminal landings.

The car shall not start unless the door is in the closed position and all hoist way doors are closed in the locked position.

If the car is idle and one or more car or landing buttons above the landing at which the car is standing are pressed, the car shall start in the UP direction and proceed to the highest landing for which any button is pressed and stops at intermediate landing for which a car button or up landing button is pressed sufficiently in advance of the car's arrival at such landings to permit these stops to be made. After each stop, the car shall proceed in the UP direction until it reaches the highest landing for which a call is registered. The car shall not stop on the UP trip at any landing in response to a DOWN call.

Similarly, if the car is idle and one or more car or landing buttons below the landing at which the car is standing are pressed, the car shall start in the DOWN direction, proceed to the lowest landing for which any button is pressed and stop at each intermediate landing for which a car button is pressed.

When the car is idle and a button for a landing above the car and a landing below the car are pressed, the car shall start towards the landing corresponding to the button pressed first. The call registered for the landing in the opposite direction from the car shall be answered after the car has responded to the farthest call in the direction established by the button pressed first.

A time relay shall hold the car for an adjustable interval of few seconds at the landings at which stops are made to enable passengers to enter or leave the car.

15.22.3 Lift Voice Announcement:

The lift shall be provided with floor announcement system with volume control.

15.22.4 Lift instructions:

Steel plate containing following instructions shall be provided inside each lift car:

i. Lift number

ii. Capacity Kg, persons.

iii. Any other instruction as per manufacturer's standard or other relevant codes.

Steel plate containing following instructions shall be provided outside each lift car, on all floors:

i. Lift number

ii. Capacity Kg, persons.

iii. Any other instruction as per manufacturer's standard or other relevant codes.

15.23 OTHER DETAILS

a. Work shall be carried out as per CPWD specifications unless otherwise specified.

b. Suitable scaffolding in the hoist way, cutting work and all minor civil works, if any, required shall be done by Contractor without any extra cost.

d. All steel items in machine room, hoist way and lifting arrangement in the lift machine room shall be provided by the Contractor without any extra cost.

e. At the time of erection, testing & commissioning of lift works all the landing door openings shall be suitably protected by the Contractor to avoid any miss happening.

f. All exposed metal parts will be painted with good quality anticorrosive low VOC paint after erection and before commissioning of the lift.

It should be possible for an attendant to operate any car.

15.24 CAR DOOR/LANDING DOOR

The car entrance shall be provided with stainless steel centre opening doors with 50% vision Glass for Passenger Lift in moon rock finish or as per direction of PMC / Engineer in charge. The lift car door shall have a fire resistance rating of two hours.

15.25 HOISTWAY DOORS:

At each landing, a center/ telescopic opening, stainless steel sliding door with 50% vision Glass for Passenger Lift giving a clear opening as per CPWD general specifications for electrical works –Part-III – Lifts & Escalators, shall be provided.

15.26 SIGNAL AND OPERATIVE FIXTURES:

The following signal and operative fixtures shall be provided for each lift in stainless steel face plates except in fireman's switch which shall have a glass face plate.

a. CAR OPERATING PANEL

There shall be one (1) No. panel in car, with hinged stainless steel face plate and shall comprise Braille illuminated floor buttons, door open and emergency stop controls emergency call buttons, door open and emergency stop controls emergency call button, two position key operated switch, a Buzzer, UP and DOWN direction light panels, a non stop button, and an integral interphone. The jewels and accentuator shall be of modular construction, face plate mounted, rewired using snap on lugs.

b. HALL BUTTONS AND HALL POSITION INDICATOR

There shall be provided combined signal fixture (one riser) of compact design and of attractive

hairline stainless steel face plate at the elevator entrance on each floor which for terminal landings shall have a single luminous push button and for intermediate landings shall have an UP Braille illuminated push button and a DOWN Braille illuminated push button. The jewels shall be of modular construction mounted on a stainless steel face plate. Whenever a button is pressed, the jewel shall light up to indicate registration of the call and shall remain enlighted till the car arrives.

c. CAR POSITION INDICATOR IN CAR

This shall be of compact design and of attractive hairline finish stainless steel face plate with easy to read digital display of the floors, indicating through which floor the elevator is passing or on which floor the elevator is stopped. This shall also incorporate illuminated arrows showing the direction of travel.

d. BATTERY OPERATED ALARM BELL AND EMERGENCY LIGHT

A solid state siren type alarm unit operated by 2 Nos. 9 volt rechargeable Nickel Cadmium batteries shall be provided which shall give a waxing and waning siren when alarm bell in the car is pressed momentarily.

An emergency light unit using a 9 volt dry battery power pack and incandescent lamp with stainless steel face plate shall be provided inside the car which shall operate automatically in the case of power failure.

e. OVERLOAD WARNING

Overload warning radars with audio-visual indication (visual indication shall show OVERLOADED) with stainless steel face plate shall be installed in the elevator car, so that when there is overload in the car the sign shall light up a flash indicating OVERLOADED and a buzzer shall operate during this period and the doors shall remain open unit the overload is removed.

f. FIREMAN'S SWITCH

A toggle switch covered by a glass cover shall be provided on the ground floor for each elevator which shall permit a fireman to call the elevator to the ground floor by canceling all car and landing calls. The elevator shall then stop at the ground floor with the door open to permit the fireman to have exclusive use of the elevator without any interference from the landing calls.

g. INTERPHONE

Interphone shall have one master unit in each machine room, one master unit on the ground floor for each 1 (outside hoist way) and one slave unit in each elevator car.

15.27 ELECTRIC DOOR OPERATOR FOR CAR DOOR AND HOISTWAY DOOR:

An electric door operator for opening and closing the car door shall be provided. The opening of a car and hoist way doors shall be such that the doors shall start opening meant for so that by the time the elevator stops completely, the elevator and hoist way doors shall be fully open.

The equipment shall consist of a machine on the elevator car operating the car door when the car is stopping at a landing.

The car door and hoist way door shall be mechanically connected and shall move simultaneously in opening and closing.

The car and hoist way doors shall be power opened and closed and shall be checked in opening and closing with an oil cushioning mechanism built into the gear unit.

Each hoist way door shall be provided with an interlock which will prevent movement of the car away from the landing unit.

The doors are closed in the closed position as defined in the ISI codes.

An electric contact for the car door shall be provided which shall prevent car movement from the landing unless the door is in the closed position as defined in the ISI codes. The locking arrangement shall be so designed that the electrical circuit cannot be completed unless the doors are in the closed position and mechanical latching is effected.

Necessary switches shall be provided in the elevator machine room to control the operation of the doors.

The car and hoist way, doors shall open automatically as the car is stopping at a landing. The closing of the car and hoist way door must occur before the car can be started. Doors can be stopped and reversed during their closing motion.

15.28 DOOR HANGER AND TRACKS:

For the car and each landing door, sheave type two-point suspension hangers complete with tracks shall be provided. Means shall be provided to prevent the door from jumping off the track and for vertical and literal adjustment of doors.

Sheaves and rollers shall be of steel and shall include shielded ball bearing to retain grease lubrication. Adjustable ball bearings rollers shall be provided to take the upward thrust of the doors. Tracks shall be of suitable steel section with smooth surface. The locking of the two leaf parting type doors should be positive.

15.29 SAFETY SENSOR:

A safety sensor(one on each door panel) shall extend to the full height of the car door.

15.30 LANDING ENTRANCE MATERIAL'S:

These shall consist of headers, extruded aluminium sills and strut angles.

15.31 WIRING:

Complete wiring in the equipment room from controller to various landings shall be done in heavy gauge conduit / metal duct & shall confirm to IE rules 1956 . DC power & AC power shall not run in same conduit / duct and they shall be laid as per IE rules.

15.32 AUTOMATIC RESCUE DEVICE:

Automatic Rescue Device to be provided for all the lifts with battery backup so that it can land to the nearest level in case of power failure. Automatic Rescue Device shall have suitable battery backup so that it can operate minimum seven times in a day provided the duration between usage is at least 30 minutes.

15.33 TESTING OF LIFTS

The Contractor after the installation of the lifts has to conduct the following test and furnish the readings to ascertain the performance of the lifts.

1. Levelling Test :
2. Safety Gear Test :

3. Contract Speed Test :
4. Lift Balance :
5. Car and Landing Interlock Test :
6. Controllers Test :
7. Normal Terminal Stopping Switches :
8. Final Terminal Stopping Switches :
9. Insulation Resistance Test :
10. Ropes :
11. Buffer Test :
12. Earthing :
13. Performance Test :

15.34 List of IS codes for Lift installations applicable is given below:

19.36.1 Code of practice for installation, operation and maintenance of electric passenger & Goods Lifts – IS 1860

19.36.2 Code of Practice for installation, operation and maintenance of electric service Lifts – IS 6620

19.36.3 Specification for electric passenger & goods lifts IS-4666

19.36.4 Electric service lift. IS-6383

19.36.5 Online dimension for electric lifts IS-3534

19.36.6 Code of practice for installation and maintenance IS-4591

19.36.7 Specification for steel wire suspension ropes for lifts & hoists. IS-2365

19.36.8 Glossary of terms relating to wire ropes IS-2363

19.36.9 Specification for lifts cables IS-4289

19.36.10 Glossary of terms for electrical cables & conduits IS-1591

19.36.11 Specification for rubber insulated cables IS-434/1

19.36.12 Specification for varnished, cotton cloths & tape for electrical IS- 3352 Purpose

19.36.13 Specification for lift door locking devices and contracts IS-7759

19.36.14 Specification for hot rolled and slit steel bars IS-1173

19.36.15 Method of loading rating of worm gear IS-7443

19.36.16 Code of practice for selection for selection of standard worn IS- 7403 and helical gear box

19.36.17 Isometrics screw threads IS-4218

19.36.18 Degree for protection provided by enclosure for low voltage IS- 2147 Switchgear and control gear

19.36.19 Specification for HRC cartridge fuse links upto 650 volts. IS-2208

19.36.20 Code of practice for electrical wiring installation IS-732 (System voltage not exceeding 650 volts).

19.36.21 Voltage & frequency for AC transmission & distribution system IS-5850

19.36.22 Specification for AC Contractors voltage not exceeding 1000V IS-2959

19.36.23 Heavy duty air break switched & composite unit of air break IS- 4047 Switches& composite unit of air break switches and fuses For voltage not exceeding 1000 volts.

19.36.24 General requirements for switch gear & controller for voltage IS- 4237 Not exceeding 1000 volts.

19.36.25 Specification for motor starter of voltage up to 650 V IS-1822

19.36.26 Nomenclature of floors & storeys IS-2332

19.36.27 Code of practice for sound insulation of non-industrial buildings. IS -1950

19.36.28 Code of practice for installation & maintenance of inducting motor IS-906

19.36.29 Specification for three phase induction motor. IS-235

19.36.30 Guide for testing three induction motor IS-4029

19.36.31 Specification for degree of protection provided by enclosure IS-4691 for rotating electrical machinery

19.36.32 Designation of method of cooling for rotating electrical machines. IS-6362

19.36.33 Classification of insulating materials for electrical machinery and IS- 1271 Apparatus in relation to their thermal stability in service.

19.36.34 Code of practice for earthing. IS-3043

19.36.35 Electrical installation fire safety of building IS-1646

19.36.36 Code of practice for the protection of buildings and allied IS- 2309 Structures against lighting

19.36.37 Specification for hoist way door locks IS-7754

19.36.38 Rules for the design, installation, testing and operation of the IS- 1735 lifts, escalator and moving parts.

16 TECHNICAL SPECIFICATION FOR WIRING & ALLIED WORKS

16.1 METAL OUTLET BOXES & COVERS.

The switch box shall be made of modular metal boxes with suitable size modular cover plates. Modular metal box shall be made of mild steel on all sides except on the front. The metal box (other than modular type) shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanized mild steel. Metal boxes up to 20 x 30 cm size M.S. box shall have wall thickness of 18 SWG and MS boxes above 20 x 30 cm size shall be of 16 SWG. The metallic boxes shall be painted with anticorrosive paint before erection. Clear depth of the box shall not be less than 60mm. All boxes shall be covered from top with Phenolic laminated sheet of approved shade. These shall be of 3 mm thick synthetic phenolic resin bonded laminated sheet as base material and confirm to grade P-I of IS: 2036-1994.

16.2 NON-METALLIC CONDUIT WIRING SYSTEM

Scope

This chapter covers the detailed requirements for wiring work in non-metallic conduits. This chapter covers both surface and recessed types of wiring work.

Application

- Recessed conduit work is generally suitable for all applications. Surface conduit work may be adopted in places like workshops etc. and where recessed work may not be possible to be done. The type of work shall be as specified in individual works.
- Flexible non-metallic conduits shall be used only at terminations, wherever specified.

Special Precautions-

- If the pipes are liable to mechanical damages, they should be adequately protected. Non-metallic conduit shall not be used for the following applications: -
- In concealed/inaccessible places of combustible construction where ambient temperature exceeds 60 degrees C.
- In places where ambient temperature is less than 5 degrees C.
- For suspension of fluorescent fittings and other fixtures.
- In areas exposed to sunlight.

16.3 Conduits

- All non-metallic conduit pipes and accessories shall be of suitable material complying with IS 2509: 1973 and IS 3419: 1989 for rigid conduits and IS 9537 (Part 5): 2000 for flexible conduits. The interior of the conduits shall be free from obstructions. The rigid conduit pipes shall be heavy guage FRLSH and ISI marked.
- The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter. The dimensional details of rigid non-metallic
- No non-metallic conduit less than 20 mm in diameter shall be used.
- The maximum number of PVC insulated aluminium/copper conductor cables of 650/1100 V grade

confirming to IS 694: 1990 that can be drawn in one conduit of various sizes as per CPWD specification/NEC 2023. Conduit sizes shall be selected accordingly.

Conduit Accessories

- The conduit wiring system shall be complete in all respect including accessories.
- Rigid conduit accessories shall be normally of grip type.
- Flexible conduit accessories shall be of threaded type.
- Bends, couplers etc. shall be solid type in recessed type of works, and may be solid or inspection type as required, in surface type of works.
- Saddles for fixing conduits shall be heavy gauge non-metallic type with base.
- The minimum width and the thickness of the ordinary clips or girder clips shall be as per CPWD specification.
- For all sizes of conduit, the size of clamping rod shall be 4.5 mm (7 SWG) diameter.

Outlets

- The switch box shall be made of either rigid PVC molding, or mild steel, or cast iron on all sides except at the front. The regulator boxes shall however be made only of mild steel or cast iron.
- PVC boxes shall comply with the requirements laid down in IS 14772: 2000. These boxes shall be free from burrs, fi ns and internal roughness.
- The thickness of the walls and base of PVC boxes shall not be less than 2 mm.
- The clear depth of PVC boxes shall not be less than 60 m.
- 3 mm thick phenolic laminated sheet covers for all types of boxes shall be as per requirements.

16.4 Installation

a) Common Aspects for Both Recessed and Surface Conduit Works

- The erection of conduits of each circuit shall be completed before the cables are drawn in.
- Conduit Joints

  - All joints shall be sealed/cemented with approved cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.
  - The PMC/SBI, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc.

- Conduit joints after preparation shall be submitted for inspection before being fixed.
- All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.

  - Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

- Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

- Outlets

- All switches, plugs, fan regulators etc. shall be fitted in flush pattern.

Additional Requirements for Surface Conduit Work

- Conduit pipes shall be fixed by heavy gauge non-metallic saddles with base, secured to suitable approved plugs with screws in an approved manner, at an interval of not more than 60 cm, but on either side of couplers or bends or similar fi ttings, saddles shall be fi xed at a closer distance from the centre of such fi ttings.
- Slotted PVC saddles may also be used where the PVC pipe can be pushed in through the slots.
- Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips as required by the Engineer in-charge. Where it is not possible to use these for fi xing, suitable clamps with bolts and nuts shall be used.
- If the conduit pipes are liable to mechanical damage, they shall be adequately protected.

16.5 Earthing Requirements

- A protective (earth) conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non-current carrying metallic parts of the installation. These shall be terminated on the earth terminal in the switch boxes and/or earth terminal blocks at the DBs.
- Gas or water pipe shall not be used as protective conductors (earth medium).

16.6 SWITCHES.

All 6- and 16-Amp switches & sockets shall be modular type of 240 volts A.C. grade having anti-bacterial & anti-fungal properties. All switches & sockets shall be fixed on modular metal boxes. These devices should be made from treated plastic that contains micro silver ions. These silver ions must act as a barrier against micro-organisms like bacteria & fungi, stopping their growth and spread. The switches & sockets should be tested & validated as per global safety standards and have self-disinfecting surface resulting in 99.9% reduction in bacteria growth. All 6 Amp socket shall be 3 pin type and 16 Amp socket shall be 5/6 pin type (unless otherwise specified) suitable for 16/6 Amp. All modular switches, sockets, fan regulators, telephone outlets, TV outlet etc. shall be in white/off-white finish unless otherwise specified. The switches controlling the lights or fans shall be connected to the phase wire of the circuit. Switch boards shall be located at 1200 mm above finished floor level unless otherwise indicated on drawings or directed by PMC/SBI.

In case of computer power points, Data points, telephone points etc. to be fixed on laminated partition board (furniture), same shall be fixed on laminated board (portion of laminated board meant for fixing power points) with base plate/cover plate as applicable, duly fixed with screws.

One modular switch may control maximum one, two or three light points as per requirement and as directed by PMC/SBI. One light point controlled by 2 switches shall be provided in the staircases as directed by PMC/SBI. Depending on area of rooms, halls etc. one or more than one switchboard shall be provided as directed by PMC/SBI. At least one number 6A Socket with Switch shall be provided in each switchboard as directed by PMC/SBI. Suitable power points and light points shall be provided for urinal sensors and hand dryers in the toilets as directed by PMC/SBI. At least 10% Light fixtures shall be provided and operated with UPS supply with switches fed from UPS Distribution Boards.

16.7 COVER PLATE

All modular switches, sockets, telephone outlets etc. shall be fixed on modular metal boxes with modular base plates and modular cover plates on top.

16.8 WALL SOCKET PLATE

Each outlet shall have a switch located beside the socket preferably on the same cover plate/modular base. The earth terminal of the socket shall be connected to the earth wire.

16.9 WIRING

All PVC insulated copper conductor wires shall confirm to relevant IS Codes. All wires/ cables shall be stranded type irrespective of its size.

All internal wiring shall be carried out with PVC insulated FRLSH, Copper wires of 650/1100 Volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/fan. A light/fan switchboard may have more than one circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring.

Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switchboards. A separate earth wire shall be provided along with circuit wiring for each circuit. For point wiring red/yellow/blue colour wire shall be used for phase and black colour wire for neutral.

Circuit wiring shall be carried out with red, yellow or blue colour PVC insulated FRLSH copper wire for RYB phase wire respectively and black colour PVC insulated FRLSH Copper wire for the neutral wires. Green/Green-Yellow Colour copper wire shall be used as earth continuity conductor and shall be drawn along with other wires. 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 conduits shall be thoroughly cleaned of moisture, dust and dirt. Drawing and jointing of copper conductor wires and cables shall be as per CPWD specifications for Electrical works (Part - I) 2023.

Maximum number of PVC insulated 650/1100 V grade aluminium/copper conductor cable confirming to IS: 694 – 1990.

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

16	-	-	2	-	4	3	7	6	-	-	-	-
25	-	-	-	-	3	2	5	4	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

NOTE:

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

16.10 JOINTS.

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits and junction boxes. Conductors shall be continuous from outlet to outlet.

16.11 LOAD BALANCING

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

16.12 COLOUR CODE FOR CIRCUIT WIRING.

Colour code for circuit and sub main wiring installation shall be Red, Yellow, and Blue for three phases. Black for neutral and yellow/green or green only for earth in case of insulated earth wire.

16.13 CLASSIFICATION OF POINTS.

16.13.1 General

Classification of Point wiring shall be as per CPWD specification for Electrical Works (Part-I-Internal) 2023.

16.13.2 Point Wiring (Modular)

Definition of Point Wiring

A point (other than socket outlet point) shall include all work necessary in complete wiring to the light points/fan/exhaust fan/call bell point from the controlling switch/MCB. The scope of wiring for a point shall, however, include the wiring work necessary in tapping from another point in the same distribution circuit i.e. from first switch board (wiring from distribution board to first switch box is covered in the circuit wiring and is not in the scope of point wiring) to subsequent switch board(s) in the same distribution circuit. The point wiring includes all materials specified below including chasing the wall (in case of recessed wiring in wall), fixing the conduit and making the wall good as it originally was. It also includes supply, drawing, testing and commissioning of wires.

Scope of point wiring

1 Following shall be deemed to be included in point wiring.
2 Supply & fixing conduit & conduit accessories for the same and wiring cables (including supplying and drawing wires) between the switch box and the point outlet.
3 The wires used for the point wiring and power wiring shall be of 1100 Volts grade FRLSH (flame Retardant Low Smoke Halogen) Insulated multi stranded copper conductor single core cables.
4 All fixing accessories such as clips, nails, screws, phil plug, rawl plug etc. as required.
5 Modular switches, modular base plates and modular cover plates over the same. regulators, sockets with Metal boxes etc. in recessed or surface.
6 Outlet boxes, junction boxes, pull-through boxes etc. but excluding modular metal boxes if any, provided the switchboards for loose wires/conduit terminations.
7 In case of recessed wiring in wall the scope includes chasing of wall, fixing the conduit and making the wall good as it originally was.
8 Control modular switch (5/6A) as specified.
9 Ceiling rose or connector (in case of points for ceiling/exhaust fan point, prewired light fittings and call bells).
10 Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.
11 Interconnecting wiring between points on the same circuit, in the same switch box or from another. Interconnecting wiring from first switchboard to subsequent switch board(s).
12 Protective (loop earthing) conductor as required from one metallic switch box to another in the distribution circuits, and from switchboard to each point (light/fan/exhaust fan/call bell etc).
13 In each Bedroom One Light Point, One Fan shall be in two-Way Control
14 All staircase light points shall be in two-way control.
15 Bushed conduit where wiring cables pass through wall etc.
16 Ceiling rose (in the case of pendants except stiff pendants).
17 TV outlet point wiring shall be terminated in suitable size of G.I. box along with splitter at every floor. The interconnections of all splitter boxes fixed at all floors shall be done properly with conduits to form proper distribution system with the prior approval of PMC / Authority Engineer-in charge.
18 Lamp holder (in the case of goose neck type wall bracket, batten holder and fittings which are not pre-wired).
19 Back Plate (in the case of stiff pendants).
20 Telephone outlet point wiring shall be terminated in suitable size of G.I. Junction box direct from ELV Shaft to each Point. However, conduit for telephone wiring may be provided through branching by providing suitable size of G.I. box along with suitable tag block at each floor. The inter connections of all junction boxes fixed at all floors shall be done properly making proper distribution system with the prior approval of Engineer-in-charge. Providing incoming television / telephone cables from the site boundary of building is covered in the scope of this bid. However, pipes for laying of these cables shall also be provided by the bidder as per direction of Engineer-in-Charge.

16.14 Circuit and Sub Main Wiring

Circuit Wiring

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

Sub main Wiring

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

16.15 Power Plug Wiring

6 A Plug Wiring

Wiring for all 6A Socket Outlets other than those provided with common switchboards shall be done with 2 X 2.5 sqmm PVC insulated FRLSH copper wire in suitable size MS Conduit (including supplying and fixing PVC Conduit) along with 1 X 2.5 sqmm PVC insulated FRLSH copper earth wire. Up to 3 points may be connected to one circuit.

16A Power Plug Wiring

Wiring for all general purpose power plugs shall be done using 3 x 2.5 Sq.mm PVC insulated FRLSH copper wire

AC & Geyser point

Wiring for all AC & Geyser point shall be done with 2X4 sq mm PVC insulated FRLSH copper wire in suitable size PVC Conduit (including supplying and fixing PVC Conduit) along with the 1 X 4 sqmm PVC insulated FRLSH copper earth wire, directly from the MCB- Distribution Board or from one power socket outlet to another in case of computer power points. Looping shall not be done in general 16A power points (other than computer power points).

Wiring for 20/25A/32A Metal Clad Socket Outlets

Wiring for all 20/25/32A Metal Clad Socket Outlets shall be done with 2X6 sqmm PVC insulated FRLSH copper wire in suitable size PVC Conduit (including supplying and fixing PVC Conduit) along with 1 X 6.0 sqmm PVC insulated FRLSH copper earth wire directly from the MCB-Distribution Board. Wiring for 20/25/32A Metal Clad Socket outlet shall be done on linear basis i.e. complete wiring directly from MCB-Distribution Board to the socket outlet.

16.16 LED Light Fixtures - GENERAL

Indoor & Outdoor type LED Lighting Fixtures shall confirm to following specifications:

16.16.1 LED Light Fixtures – Outdoor

Sl	Criteria	Specification
	The Luminaire Construction	Single Piece Pressure die cast Aluminium alloy housing for better thermal conductivity. Seperate driver and optical compartment for Thermal isolation. Each LED should be covered with IP-66 or more protected lens. Luminaire with glass/PC/Acrylic cover/diffuser will not be accepted due to accumulation of insects/dust and decrease in light output.
	Operating Voltage Range	140 - 270 VAC
	Frequency	50 Hz
	Power Factor@240 VAC	≥ 0.90

	Driver	Driver Efficiency ≥85% Driver inbuilt Surge Protection: 2 KV Silicon Potted IP66 Over voltage Protection Short circuit Protection Thermal Protection
	THD @240 VAC	≤ 10%
	Ingress Protection	IP-66
	Impact Resistance	IK-08
	Colour Temperature	5300 K to 6000 K
	Color Rendition Index - CRI	≥70
	System Efficacy	≥110 Lumens per Watt
	Junction Temperature of	
		NICHIA/Philips Lumileds/ CREE/ OSRAM/ Samsung/
	Operating Temperature	
	Average Operating Life	50,000 Hours @ L 70B50
	Humidity	10 to 90 %

All relevant Test Reports for Light Fixtures from NABL accredited laboratory shall be submitted at site along with Ligh Fitting consignments.

16.16.2 BALLASTS/ Driver

Ballasts/ Driver shall be electronic type and having high power factor type. Ballasts shall have manufacturer's lowest sound level and case temperature rise rating.

16.17 Standards:

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

Luminaries – General requirement - IS – 10322 (Part-1) Luminaries – Constructional requirement - IS – 10322 (Part-2) Luminaries – Screw and Screwless termination - IS – 10322 (Part-3) Luminaries – Methods of Tests - IS – 10322 (Part-4)

Particular requirement – General purpose Luminaries -IS – 10322 (Part-5/Sec-1)

Particular requirement – Recessed Luminaries - IS – 10322 (Part-5/Sec-2) Particular requirement – Luminaries for Road and
Street lighting - IS – 10322 (Part-5/Sec-3) Particular requirement – Flood Lighting - IS – 10322 (Part-5/Sec-5) Emergency lighting units - IS – 9583: 1981 Flame
proof electric lighting fittings - IS – 2206 (Part 1 of 4) Standard for Eye and Skin / Photobiological Safety - IEC 62471
Standard for Led Drivers - IEC 61347-2-13

The equipment should be compliant to IEC 60598-1, 2, 3, IEC 62031and IEC/PAS 62612 depending on the type of luminaire. In addition to the above luminaire shall adhere to relevant BIS standards IS 15885, 16101, 16102, 16103, 16104, 16105, 16106, 16107 (Part I & II), 16108 as per the application requirement.

16.18 TESTING

After all lighting fixtures are installed and are connected their respective switches, test all fixtures

to ensure operation on their correct switch in the presence of the engineer.

All non-operating fixtures or ones connected to the wrong or inconveniently located switch shall be correctly connected as directed by the Engineer In- charge. Stickers are to be placed on each light fixture w.r.t. controlling switch of respective light.

16.19 CEILING FANS WITH BRUSH LESS DIRECT CURRENT (BLDC) MOTOR:

All ceiling fans shall be provided with suspension arrangement in the concrete/slab/roof members. Contractor shall ensure that provision is kept at appropriate stage at locations shown on the drawing. Fan box with MS hook shall be provided as per CPWD specification.

Contractor shall carry out Supply, Installation, Testing and Commissioning of 1200 mm sweep, BEE 5-Star rated, Ceiling Fan with Brush Less Direct Current (BLDC) Motor, class of insulation: B, 3 nos. blades, 30 cm long down rod, 2 nos. canopies, shackle kit, safety rope, copper winding, Power Factor not less than 0.9, Service Value (CMM/W) minimum 6.85, Air delivery minimum 215 CMM, 350 RPM (tolerance as per IS: 374-2019), THD less than 10%, remote or electronic regulator unit for speed control and all remaining accessories including safety pin, nut bolts, washers, temperature rise - 75 degree C (max.), insulation resistance more than 2 mega ohm, suitable for 230 V, 50 Hz, single phase AC Supply, earthing etc. complete as required.

Ceiling fan shall be Heavy Duty, double ball bearing type and shall confirm to relevant IS Standards. Ceiling Fans shall be White/ Off-white in colour. Ceiling fans shall be provided with electronic regulators with stepped control. Electronic regulator shall be of 2-Modules suitable for 240 Volts AC supply 50HZ AC supply complete with motor, blades, frame, bracket, louver/ shutter etc as required. Philips or Havells or Crompton EXHAUST FANS.

Exhaust fans shall be with double ball bearing and confirming to IS 2312 (latest revision). Exhaust fan shall be complete with copper wound motor, capacitor, Louver/shutter, frame and mounting bracket. Exhaust fan shall be suitable for operation on 240 volts' single phase A.C supply with BEE 5-star rating & comply to ECSBC norms.

17 EXTERNAL STREET LIGHTING SYSTEM:

17.1 Scope of Work:

The scope of works under External Street Lighting System requires illumination of all external areas like streets, roads, ornamentals, boundary walls, parks, gardens, landscaping, porches, building facades, walkways, pathways etc., which shall be illuminated confirming to NBC 2026, ECSBC 2024 and CPWD specifications maintaining required Lux levels. Suitable LED fixtures shall only be used with inbuilt harmonic suppression mechanism for external area illumination. Solar and conventional street light poles, bollards, gate lights, post-top lantern etc. shall be used for this purpose keeping in view aesthetical and architectural requirements. The external lighting shall be fed from outdoor type feeder panels and automatically controlled through 24-hour Digital/ Astronomical Timers.

All Hybrid (solar & conventional) street light poles of single arm /double arm, as required shall be GI Octagonal with heights as per relevant IS Codes, NBCS Code & ECSBC.

17.2 GENERAL SPECIFICATION FOR HIGH MAST

17.2.1 SCOPE:

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding of High Mast. High Mast lighting shall be provided as per specification Type-I, unless stated otherwise, as per direction of PMC/SBI.

17.2.2 APPLICATION STANDARDS:

The equipment covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with the latest editions of the following Indian, International standards and shall confirm to the regulations of the local authorities.

- IS 875 (Part III) 1987 (Code and practices for design loads for structures)
- IS 2062: 2006 (Hot rolled low, medium and high Tensile structural steel)
- BSEN 10025/DIN 17100 (Grades of MS Plates)
- BSEN 60529 (Degree of provided by Enclosures- IP code)
- BS 5135 / AWS (Welding)
- BS EN ISO 1461: 1999 (Galvanizing)
- BS EN 5649-4: 1982 (Lighting columns, Recommendations for surface protection of metal lighting columns)
- TR No. 7 1996 of ILE, UK (Specifications of Masts and foundations)

17.2.3 GENERAL CONSTRUCTIONS:

The High Mast shall be designed to withstand the maximum wind speed as per IS: 875. The top loading, i.e. the weight and the area of luminaries are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI – 1982. The Mast shall be designed using limit state principle. The limit states to be considered are: (i) Ultimate and (ii) Serviceability; based on a design wind speed with a return period of 25 years. The total Height of the High Mast, with luminaries mounting carriage cum head frame and luminaries

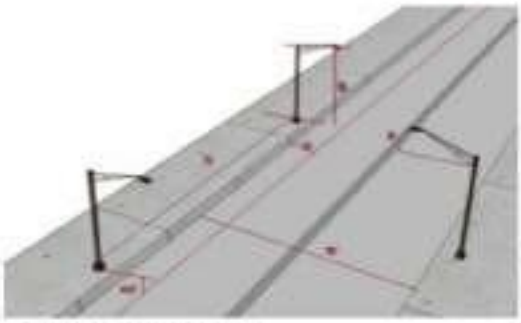
installed all be measured as the vertical distance between the base flange plate and the plane in which the lamps lie in their operating position.

17.2.4 STRUCTURE:

The High Mast shall be of continuously tapered, polygonal cross section; ranging from 8 to 20 sided, and shall be based on proven In-Tension design confirming to the standards referred above, to give an assured performance and reliable service. The structure shall be suitable for wind loading as per IS 875 part3 1987.

Typical Calculation of Road Lighting:

- Luminaries are properly selected and mounted on a location most feasible and effective with minimum cost. For a 230 volts system, a voltage drop of 5% is allowed although in extreme cases 15% voltage drop is sometimes tolerated.



- **Street illumination level in Lux (E)=(Al x (cu x mf)) / (w x d)**
- E = The illumination in Lux
- w = Width of the roadway
- d = Distance between luminaries
- cu = Coefficient of utilization. Which is dependent on the type of fixture, mounting height, width of roadway and the length of mast arm of outreach?
- **Al = Average lumens, Al = (E x w x d) / Cu x mf**

17.2.5 CONSTRUCTION:

The High Mast shall be manufactured using steel plates, confirming to BS-EN 10-025. The high mast shall be manufactured in two sections for 12.5 meters, 16 metres and 20 metres. In case of 25 meters and 30 meters high mast shall be manufactured in three sections. Each mast section shall be fabricated out of single plate duly folded and welded. The Mast shaft shall have polygonal cross section and shall be continuously tapered with single/Double longitudinal welding. There shall not be any circumferential welding and pole shafts with more than two longitudinal welds shall not be acceptable. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process. No site welding and bolted joints shall be done on the mast. The minimum overlap distance shall be 1.5 times the diameter at penetration. The minimum top diameter and bottom diameter shall be as specified in data sheets and plate thickness shall be as per the structural design requirements. The calculation for civil design and foundation details shall be submitted by the EPC Contractor for approval of PMC/Engineer in charge. The mast shall be provided with fully penetrated flange, which shall be free from any lamination or incursion. The welded connection of the base flange shall be fully developed to the strength of the entire section. The base flange shall be provided with supplementary gussets between the bolt- holes to ensure elimination of helical stress concentration.

17.2.6 GALVANIZING:

For environmental protection of the mast the entire fabricated mast shall be hot dip galvanized internally and externally as per BS EN ISO 1461 standards with an average coating thickness of minimum 85 micron. The galvanizing shall be done in single dipping only. Double dip-galvanized shafts with overlapping are not acceptable. Further, no post galvanizing painting, touch-up or rectification shall be allowed.

17.2.7 DOOR OPENING:

All adequate door opening shall be provided as per the GTP such that the minimum distance from the mast flange plate to the bottom of the door opening shall twice the width of the door opening. The door shall be flushed with the exterior surface. The door opening shall be such that it permits clear access to equipment like winches, cables, plug and socket, etc. and also facilitate easy removal of the winch. The door opening shall be complete with a close fitting, vandal resistant, weatherproof door, provided with heavy duty double internal lock with special paddle key. The minimum radius at the corners of openings shall be 20mm. The door opening shall be carefully designed and reinforced with welded steel section, so that the mast section at the base shall be unaffected and undue buckling of the cut portion is prevented.

17.2.8 DYNAMIC LOADING FOR THE MAST:

The mast structure shall be suitable to sustain an assumed maximum reaction arising from a wind speed as per IS: 875 (Part-III) 1987 (three second gust) and shall be measured at a height of 10 meters above ground level. The design life of the mast shall be minimum of 25 years.

17.2.9 LANTERN CARRIAGE:

i. FABRICATION:

A fabricated raising and lowering type Lantern Carriage cum head frame shall be provided at the top of high mast shaft properly secured for fixing and holding the flood light fittings and control gear boxes. The Lantern Carriage shall be of special design and shall be of steel channel construction. The Lantern Carriage shall be so designed and fabricated to hold the required number of flood light fittings and the control gear boxes, and also have a perfect self-balance. The Lantern Carriage shall be fabricated in two/three halves and joined by bolted flanges with stainless steel bolts and nylon type stainless steel nuts to enable easy installation or removal from the erected mast. The inner lining of the carriage shall be provided with protective PVC arrangement, so that no damage is caused to the surface of the mast during the raising and lowering operation of the carriage.

The entire Lantern Carriage shall be hot dip galvanized after fabrication. The lantern carriage shall be fabricated out of M.S. channel with suitable reinforcements. Also an certificate to this effect quoting safe working load shall be supplied with each carriage. The carriage shall carry a permanently attached label stating the safe working load. Both the Mast Shaft and Luminaries Mounting Carriage shall be sourced from one manufacturer only so as to ensure compatibility and overall finish of the material.

ii. JUNCTION BOX:

Weather proof junction box, made of Cast Aluminum shall be provided on the Carriage Assembly as required, from which the inter-connections to the designed number of the flood light luminaries and associated control gears fixed on the carriage shall be made.

iii. RAISING AND LOWERING MECHANISM:

For the installation and maintenance of the luminaries and lamps, it will be necessary to lower and raise the Lantern Carriage Assembly. To enable this, a suitable Winch Arrangement shall be provided, with the winch fixed at the base of the mast and the specially designed head frame assembly at the top.

iv. WINCH:

The winch shall be of completely self-sustaining type, without the need for brake shoe, springs or clutches. Each driving spindle of the winch shall be positively locked when not in use by gravity activated PAWLS. The capacity, operating speed, safe working load, recommended lubrication and serial number of the winch shall be clearly marked on each winch. The gear ratio of the winch shall be calculated considering minimum working load not less than 750 kg. The winch shall be self-lubricating type by means of an oil bath and the oil shall be readily available grades of reputed producers. The winch drums shall be grooved to ensure perfect seat for stable and tidy rope lay, with no chances of rope slippage. It shall be possible to operate the winch manually by a suitable handle and electrically by an external power tool also. It shall be possible to remove the double drum after dismantling, through the door opening provided at the base of the mast. A test certificate shall be furnished by the Contractor from the original equipment manufacturer, for each winch in support of the maximum load operated by the winch.

b. STAINLESS STEEL WIRE ROPES:

The suspension system shall essentially be without any intermediate joint and shall consist of only non-corrodible stainless steel of AISI 316 grade. The stainless-steel wire ropes shall be of marine grade 7/19 construction, the central core being of the same material. The overall diameter of the rope shall not be less than 5mm for 12mtr. High mast and 6mm for 16mtr. And 20mtr. High mast. The breaking load of each rope shall not be less than 2350 kg giving a factor of safety of over 5 for the system at full load as per the TR-7 referred to in the beginning of this specification. The end constructions of ropes by compression splices. Continuous lengths of stainless-steel wire ropes shall be used in the system and no intermediate joints are acceptable in view of the required safety. No intermediate joints/ terminations, either bolted or else, shall be provided on the wire ropes between winch and lantern carriage. The design of the whole suspension system shall be such that the wire ropes can be removed and replaced from ground level without the necessity of lowering the mast or use of special equipment.

c. ELECTRICAL SYSTEM, CABLE AND CABLE CONNECTIONS:

The control panel at the bottom of the mast shall have facility for terminating up to 1.1kV, 4C x 25 sq. mm, Aluminium conductor, armoured, XLPE incoming cable. The outgoing from this panel shall be the trailing cable, which is terminated at the weather proof junction box provided at the top. This cable shall be minimum 6 cores, 2.5 sq. mm,1100V, electrolytic grade, EPR insulated, copper conductor and PCP sheathed cable to get flexibility and endurance. The connections from the top junction box to the individual luminaries shall be made by using 3 core 4 sq.mm flexible PVC cables of reputed make. The cable shall run via metal ducts or tubes provided in luminary's carriage up to individual luminaries and control gear units. All steel conduits shall be of heavy gauge welded type with hot dipped galvanized finish.

d. LIGHTNING SPIKE:

One number heavy duty hot dip galvanized lightning spike shall be provided for each mast. The lightning spike shall be minimum 1.2 M in length (except for 12.5m where it will be 0.6m) and shall be provided at the centre of the head frame. It shall be bolted solidly to the head frame to get a direct conducting path to the earth the mast. The lightning spike shall not be provided on the

lantern carriage under any circumstances in view of safety of the system.

e. AVIATION OBSTRUCTION LIGHTS:

Provision for mounting LED type aviation obstruction lights of reliable design shall be provided on top of each mast for20m high masts only.

- Dimensions are subjected to tolerance allowed as per IS.
- Diameter of wire rope may increase to 8 mm wherever qty. of light fittings are more on lantern carriage.
- Motor can be supplied in single and three phase as per requirement.

20 METER HEIGHT						
S.No	**Description [Lighting Mast]**	**Specification**				
	Type	1	2	3	4	5
1	High mast Height [mtrs] incl. Luminaires Carriage	20	20	20	20	20
1.1	Material Construction	BSEN100025 or Eqiv	BSEN100025 or Eqiv	BSEN100025 or Eqiv	BSEN100025 or Eqiv	BSEN100025 or Eqiv
1.2	Welding	As per IS	As per IS	As per IS	As per IS	As per IS
1.3	No. of Sides	20	20	20	20	20
2	WIND LOAD DATA taken for this project	as per IS 875	per IS 875	as per IS 875	as per IS 875	per IS 875
3	Mast Section Details					
3.1	Top Diameter [In mm]	166	166	206	208	210
3.2	Base Diameter[In mm]	419	419	489	489	518
3.3	Number of Sections[Nos]	2	2	2	2	2
3.4	Top Sections length[mm]xthickness[mm]	10375X3	10375X4	10375X4	10375X4	10375X5
3.5	Middle SectionLength[mm]xthickne ss[mm]	NA	NA	NA	NA	NA
3.6	Bottom Section Length[mm]xthickness[mm]	10375X4	10375X4	10375X4	10375X5	10375X6
3.7	Over lapping [between Sections]	375	375	375	375	375
3.8	Base Flange Diameter[mm]	630	630	730	730	730
3.9	Base FlangeThickness[mm]	32	32	32	32	32

3.10	P.C.D [mm] x Hole Dimensions [mm]	530	530	630	630	630
3.11	No.Of Bolts[Qty]	12	12	16	16	20
3.12	Foundation bolts Details	1200x24 mm	1200x24 mm	1200x24 mm	1200x24 mm	1200x24 mm
3.13	Metal Treatment Protection for Mast	Galvanised	Galvanised	Galvanised	Galvanised	Galvanised
3.14	Thickness of Galvanisation (min.)	min 65 micron for sheet thickness of 2mm up to 4 mm and 86 Microns for 5 mm and above.				
3.15	Size of opening and door at base	1000mmx300 mm	1000mmx300 mm	1000mmx300 mm	1000mmx300 mm	1000mmx300 mm
3.16	Type of locking arrangement	Anti-Vandalism	Anti-Vandalism	Anti-Vandalism	Anti-Vandalism	Anti-Vandalism
3.17	Size of Anchor Plate & Thickness	mx6mm	mx6mm	mx6mm	mx6mm	mx6mm
3.18	Details of Template	mx6mm	mx6mm	mx6mm	mx6mm	mx6mm
4	HEAD FRAME	3-POINT	3-POINT	3-POINT	3-POINT	3-POINT
4.1	Construction	MS.Fabricated				
4.2	Metal Treatment protection for HEAD FRAME	Galvanised				
4.3	Pulley Arrangements (For Steel Wire Rope)	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS
4.4	Pulley Arrangements (For Electric Cable)	1 set OF PULLEY	1 set OF PULLEY	1 set OF PULLEY	1 set OF PULLEY	1 set OF PULLEY
5	LANTERN CARRIAGE					
5.1	Matreial of Construction	IS2062	IS2062	IS2062	IS2062	IS2062
5.2	Diameter of Carriage Ring(mm)-1NO	1200	1200	1200	1200	1200
5.3	Construction	M.S fabricated	M.S fabricated	M.S fabricated	M.S fabricated	M.S fabricated
5.4	Number of Joints	3	3	3	3	3
5.5	Buffer arrangements between Carriage & MAST	Will be provided	Will be provided	Will be provided	Will be provided	Will be provided
6	Compensating Disc between L-Ring and DD Ring	PROVIDED	PROVIDED	PROVIDED	PROVIDED	PROVIDED

7	Safety Locking on both sides at Base of Mast	PROVIDED	PROVIDED	PROVIDED	PROVIDED	PROVIDED
8	Winch	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap
9	Stainless Steel wires diameter	6 mm	6 mm	6 mm	8 mm	6 mm
9.1	Number of Ropes	3	3	3	3	3
9.2	C/disc to D/d.Winch	o[6mm size]	o[6mm size]	o[6mm size]	o[6mm size]	o[6mm size]
9.3	C/disc to Lantern Ring	ee[6mmsize]	Three[6m m size]	ee[6mmsize]	ee[6mmsize]	ee[6mmsize]
9.4	Thimbles & Terminals	Provided.	Provided.	Provided.	Provided.	Provided.
9.5	Factor Of Safety	>5	>5	>5	>5	>5
10	POWER TOOL	Gear Ration 53:1	Gear Ration 53:1	Gear Ration 53:1	Gear Ration 53:1	Gear Ration 53:1
10.1	Model	Integral	Integral	Integral	Integral	Integral
10.2	Input Supply	415v,50c/s;3 - ph	415v,50c/s;3 - ph	415v,50c/s;3 - ph	415v,50c/s;3 - ph	415v,50c/s;3 - ph
10.3	WATTAGE	1.5KW	1.5KW	1.5KW	1.5KW	1.5KW
10.4	Num. Of Speeds	Single	Single	Single	Single	Single
10.5	Reversible/Non-reversible	Reversible	Reversible	Reversible	Reversible	Reversible
10.6	Operating Speed	1400 Rpm	1400 Rpm	1400 Rpm	1400 Rpm	1400 Rpm
11	Lightning Arrestor [1.2m Length]	will be provided	will be provided	will be provided	will be provided	will be provided
12	Aviation Obstruction light	Provision for mounting will be provided				

Note:

a. Dimensions are subjected to tolerance allowed as per IS.

b. Diameter of wire rope may increase to 8mm wherever qty. of light fittings are more on lantern carriage.

c. Motor can be supplied in single and three phase as per requirement.

17.3 Standard Galvanised Octagonal Poles

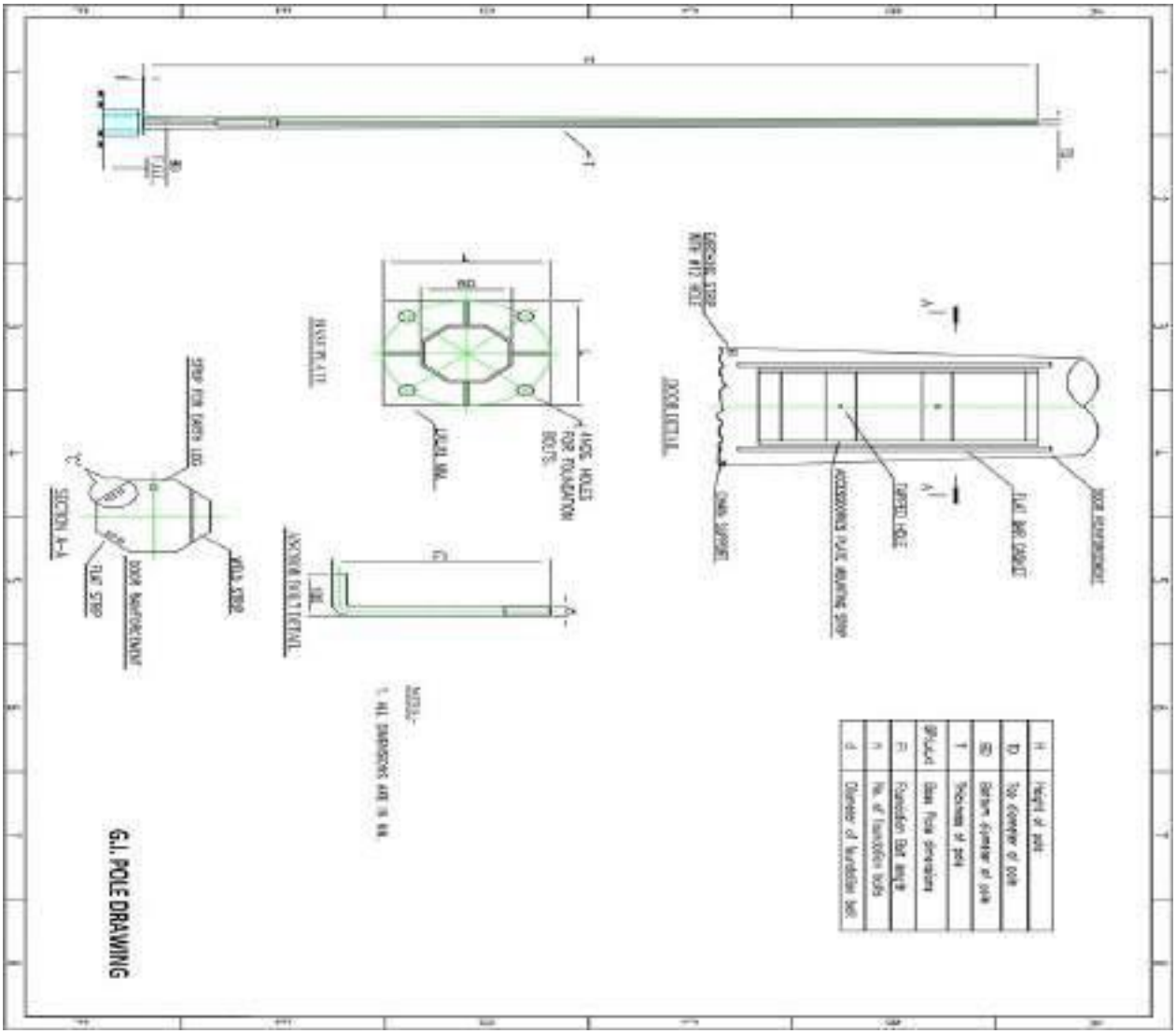
Octagonal poles shall be designed as per ILE TR7 & BS5649 for structural design & as per IS875 (Part III), 1987 for dynamic loading.

The pole shaft shall be made single piece MS structure continuously tapered having polygonal (8/12 sides) cross section and a single longitudinal welding. The welding will be done as per BS 5135 / IS 9595. No circumferential welding shall be allowed in the pole shaft. The MS shall confirm

to BSEN 100025/100027. The structure shall be single hot dip galvanized as per BS 729 / IS 2629. A suitably designed door shall be provided at approximate 700mm height from the pole base. The door opening will be suitably reinforced for structural strength. The door shall be flushed with pole external surface and shall provide easy access for electrical connections at a maintainable height. A Suitable base flange will be welded and plate reinforcements will be provided between base flange & pole. Foundation accessories will be as per IS 1367.

		POLE DETAILS			NDATION DETAILS		BOLT
POLE DESCRIPTION	IGHT	TOP	BOTTOM	CKNES S	BASE PLATE	LENGTH	NOS	DIA.
	H	TD	BD	T	BP: LXLXT	FL	N	D
GI OCTAGONAL POLE	3000	70	130	3	200 X 200X 12	450	4	16
GI OCTAGONAL POLE	4000	70	130	3	220 X 220X 12	450	4	20
GI OCTAGONAL POLE	5000	70	130	3	200 X 200 X 12	600	4	24
GI OCTAGONAL POLE	6000	70	130	3	220X 220 X 16	600	4	24
GI OCTAGONAL POLE	7000	70	130	3	220 X 220 X 16	700	4	24
GI OCTAGONAL POLE	8000	70	135	3	225 X 225 X 16	750	4	24
GI OCTAGONAL POLE	9000	70	155	3	260 X 260 X 16	750	4	24
10 MTR GI OCTAGONAL POLE	10000	70	175	3	275 X 275 X 16	750	4	24
11 MTR GI OCTAGONAL POLE	11000	90	210	3	300 X 300 X 20	750	4	24
GI OCTAGONAL POLE	12000	90	240	3	320 X 320 X 20	750	4	24

NOTE: ALL DIMENSIONS ARE IN MM.



26. Solar Street Lighting System

17.4 **Solar Street Light Poles – All In One Type:**

All-In-One' Type integrated Solar Street Light Poles with solar PV modules, GI Octagonal Pole, Height as specified in Design basis report, battery with 48 hours back-up, light fixture complete may be provided subject to approval of technical specifications by SBI/PMC 'All- In-One' Type Solar Street Light poles shall not be hybrid type.

SCOPE & SPECIFICATION FOR 'ALL IN ONE" INTEGRATED SOLAR STREET LIGHTS (Single/double Arm- STREET LIGHTS):

The EPC Contractor shall carry out planning, designing, supplying, fixing and installing, testing & commissioning of LED Integrated, Solar Street light 36-40 Watt inbuilt charge controller, with health monitoring system, over charging protection installed on high mast fixing vertically on selected location with following specifications-

(a) LED Luminary- LED-Light Output-25 Lux, LED Life Span:> 50,000 hrs. LED Efficiency:>110 lm/W, Operating Voltage 12V DC to 13V DC with necessary accessories.

(b) Solar MONO Panels: Size 1120 X 305 X 140 mm

(c) Battery-LiFePO4, Per fixture Minimum 12.8V,27 Ah, Duty Cycle-12 hours/day, Autonomy 2 days, Ingress Protection IP65 with necessary accessories.

(d) GI Octagonal pole - Mounting Height minimum 6M (or as specified in Design Basis Report/ BoQ), Hot Dip Galvanized with necessary accessories with single decorative arm.

17.5 Façade & Flood Lighting:

EPC Contractor shall carry out Design, Planning, Supply, Installation, Testing and Commissioning of Façade Lighting for the buildings. Luminous efficacy must be more than >120 Lumen/watt or as per OEM standards. Color Rendering Index (CRI) must be more than 70 or as per OEM standards.

17.5.1 Scope of work for Façade Lighting:

EPC Contractor shall carry out Design, Planning, Supply, Installation, Testing and Commissioning of LED RGB/RGBW flood fighting luminaire for facade lighting with die-cast aluminium housing, powder-coated finish, of 600 Watts or as per OEM design calculations and approved by SBI/PMC in-charge. Luminaire shall be capable of producing dynamic color changing light for with 16 million colors by DMX/Ethernet based control. The beam angle of the fitting shall be narrow, medium, wide or asymmetric as per the requirement. Luminaire shall be complete with driver and capable of operating at line voltage without any separate power supply from 100-270 V AC, having electrical safety class, built-in surge protection of up to 10 kV, 50 Hz with power factor > 0.90. Fixture shall be suitable to operate at an ambient temperature range of -10°C to +50°C and shall be IP-65 and IK-06 rated. Lifetime shall be at least 50,000 burning hours @ L 70 B50 at 50°C. Luminaire shall be confirming to BIS (IS- 10322) and shall be complete with all necessary accessories required for proper working of fixture including weather proof connection cables, water proof connectors etc. as required.

17.5.2 Façade Design Concept:

Façade will allow the building to perform better in terms of energy efficiency & day lighting requirement:

- Sufficient day light.
- Energy efficiency with 50,000 burning hours LED life
- Minimize glare using of direct view luminaire & wall grazing & radiation.
- Bringing daylight to deeper areas.
- Using of Narrow beam flood lights for pillars.
- RGBW linear grazer/linear BAR lights for wall grazing or washing shall be provided.
- For Building Facia lit up floodlights can be provided minimum of 4 m distance from the object. Glare shield can be proposed in floodlights.
- IP67/IP68 LED RGBW/ mono color strip to illuminate cove, Edge of Building.
- Direct View Glare free Linear Bar/ nodes to Illuminate Glass Facades.
- DMX/RDM based control system for façade can be incorporated.

17.5.3 FAÇADE DESIGN

Performance Requirements, Design Life and Durability

The Façade Works shall be appropriate & adequate for its intended purpose. The works shall be designed, fabricated and installed to achieve the specified levels of performance throughout the

design life in this section, under the general exposure conditions set out in the appendix to BS 7543, subject to any special conditions in this specification:

The Works shall be designed, supplied, installed and warranted by the Contractor to comply with the requirements of this section. The expected life of products used in the Facade shall be confirmed by providing the following information:

- The economic life of the product/material in the environment in which it shall be used (this is not a warranty or guarantee);
- Requisite maintenance procedures which must be followed in order to achieve the economic life of the product/material;
- An assurance from the Contractor/manufacturer that the product is suitable for its intended application;
- Relevant product data including names of Contractor and manufacturers.

During construction, the PMC/Engineer in charge shall have the absolute right to have any deficient products or materials rectified or replaced at the Contractor's expense in order to achieve the expected life as stated in these documents. The Contractor will under no circumstance enter into a claim or variation for correction of a product or installation by virtue of the product or material being unfit for its intended purpose.

All materials which are exposed to sunlight, including materials exposed through glass, shall not be affected due to exposure to heat or ultraviolet radiation such that the material can no longer perform as intended, for the aforementioned period.

Note: LM 79, LM 80 report and BIS certificate for driver & luminaire shall be provided by the Contractor /vendor along with type test reports.

17.6 Installation

Fixtures shall be installed at mounting heights as detailed on the drawings or as instructed on site by the PMC/Engineer in charge.

Pendent fixtures within the same room or area, shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation. Flush mounted recessed fixtures, shall be installed so as to completely eliminate leakage of light within the fixture and between the fixture and adjacent finish.

Fixtures mounted outlet boxes shall be rigidly secured to a fixture stud in the outlet box. Hickeys or extension pieces shall be installed where required to facilitate proper installation. Fixtures located on the exterior of the building shall be installed with non-ferrous metal screws finished to match the fixtures.

All light fittings shall be supported with appropriate fixing accessories such as clips, supporting brackets, suspension sets, nuts, washers, screws etc. for their proper installation on different types of ceiling panels. Suspension sets shall be of adjustable type suitable to carry the weight of the lighting fittings unless otherwise stated or indicated on drawings. The suspension sets shall be generally of 900 mm length. Exact lengths required shall be provided to suit the site requirement.

Testing: Type Tests:

Type tests shall be carried out to prove confirmation with the requirement of specification and general quality/design features of the unit by the firm on particular models of the luminaire. Necessary type test reports from NABL and ISO accredited Laboratory shall be submitted to SBI.

Acceptance Tests:

These tests shall be carried out in the presence of Client, SBI/ SBI/PMC in charge representatives at the Contractor's premises on random sample drawn from a lot, for the purpose of acceptance. The luminaries shall be selected from the lot at random. Sample size shall be as per mutual agreement between Contractor and the client,SBI/PMC in charge.

17.7 Simulation:

Color Simulation of façade lighting shall be submitted to SBI for approval prior to commencement of Facade Lighting works at site.

17.8 Power cabling for External illumination:

The power shall be fed to Street Light Poles, High Mast Poles, Solar Street Light Poles, Bollards, Post Top lanterns, Gate Lights, Façade Lights, walk way lights etc. through suitable size aluminium armored XLPE insulated power cables, laid underground as per CPWD Specifications. Suitable Feeder Pillars shall be provided to feed various circuits of street lights.

17.9 Street Light Pole Height & distance between poles:

Street Light Poles, High Mast Poles, Hybrid Solar Street Light Poles, Bollards, Post Top Lanterns of suitable height shall be provided to achieve illumination with required Lux levels in the external areas as per CPWD, NBC 2016 & ECBC norms. Distance between street light poles shall be as per CPWD, NBC 2016 & ECBC norms as applicable.

Inspection: Street Light Poles, High Mast Poles, Hybrid Solar Street Light Poles etc. shall be offered for inspection by SBI/PMC at manufacturer's works before final dispatch to site as per terms of the contract.

Drawings: Site Layout drawings and Single Line diagrams shall be prepared and submitted for approval of SBI/PMC by the Contractor for the Street Light Poles, High Mast Poles, Hybrid Solar street Light Poles, Bollards, Post Top lanterns, Gate Lights, Façade Lights, Walk Way lights etc. The drawings shall be got approved from SBI/PMC before commencement of works at site.

17.10 Applicable IEC Standards:

i. IEC 61215 latest: Solar Panel
ii. IEC 61347-2-13: LED driver safety
iii. IEC 62384: LED driver performance
iv. CISPR 15: Radio disturbance characteristics
v. IEC 61547: EMC immunity requirements
vi. IEC 60598: General requirements and tests

18 AUTOMATIC TRANSFER SWITCHING EQUIPMENT - ATS

18.1 GENERAL – STANDARDS

a. The ATSE shall comply with IEC 60947-6-1: (Low-voltage switchgear and control gear - Multiple function equipment – Transfer switching equipment) and with IEC 60947-3: (Low- voltage switchgear and control gear – Switches, disconnectors. ATSE shall also confirm to relevant IS Codes, latest as amended.

b. The ATSE product shall have 4-Pole suitable for operation on 415 Volts, 3-phase, 50 Hz supply and must be duly tested in an accredited laboratory.

18.2 PRODUCTS - GENERAL CONSTRUCTION

The ATSE shall be composed of:

- An open transition break before make architecture (I – 0 – II), with two back to back, fully rated, IEC 60947-3 compliant, load break switch disconnects, with clear switch position indication (I – 0 – II), on the motorization module.
- A maintenance free switch design that includes self-cleaning contacts on all poles with fully integrated robust mechanical interlock between both switches.
- An independent switching mechanism free from external factors during transfer.
- Mounting lugs fit onto the switches (power section) independent of the motorisation.
- A wide band (control voltage of 50/60Hz, 166-332V AC) motorization module fit directly to the switching mechanism.
- An integrated ATS controller with dual power supply (DPS) and 3-phase sensing on both source supplies. ATS shall have Monitoring device and control module - MDCM.
- An easy to remove motorization & control module with no disturbance to the load. It shall be possible to remove the ATSE motor even while the ATSE is in operation on fully loaded condition.
- Dual emergency manual operation, with the Manual handle possible to mount directly on the ATSE body. It shall be possible to operate the ATSE in fully loaded condition, in the Manual mode.
- Padlocking in the zero position with the use of up to 3 X 8 mm padlocks or as per OEM specifications.
- The ATSE shall be fully integrated in one device. Besides customer I/O, no additional wiring between functional units other than the power connections and voltage sensing shall be necessary to allow the proper functioning of the ATSE. The fully integrated Controller design will not have any External wiring connection or wiring harness between the ATSE and the Controller.
- The ATSE should include dual “Product Available Outputs” (one on the motorisation and one on the ATS controls). The product should analyze / test its condition periodically and communicate through dry contacts to report the ability of the transfer switching equipment to operate.

18.3 DESIGN REQUIREMENTS:

- For ease of termination and ergonomic placement, complete Line Load side reversibility shall be possible on the ATSE.
- Dual emergency manual operation shall be provided using an insulated handle directly

through the motorisation and on the switch mechanism with the motorisation removed.

- The ATSE shall have a distinct manual / automatic mode selectable by turning a rotary switch or a removable key switch located on the motorization module. The Auto/Manual selector switch shall be mounted on the ATS body.
- The neutral pole of the ATSE switches shall be fully rated with left or right configuration.
- The ATSE shall have no power consumption while in a stable position other than that required for the ATS control unit.
- ATSE motor operation band shall be a wide band having, operational range 166-332 V AC.
- The 4-poles shall switch simultaneously with a time gap of less than 1ms to avoid potential floating neutral issues during switching
- There shall be a fully isolated ZERO position.
- Settings of various parameters shall be possible via Keypad on the product and also through communication.

18.4 SAFETY REQUIREMENTS & FEATURES:

- All operating modes shall be inhibited when the product is padlocked.
- Padlocking shall only be possible with the mode selector switch in manual position.
- The ATSE should allow manual switching I-0-II at full load without damage to the contacts.
- There shall be an integrated Watchdog relay to confirm product availability status.
- Potential free contacts shall be available.

18.5 BASIC OPERATION:

- The auxiliary power of the ATSE shall be supplied by any one of the available supplies through a built-in dual power supply (DPS).
- An automatic retransfer function should be included with the facility to inhibit retransfer locally or remotely through dry contacts.
- The ATSE shall have the facility to inhibit the ATS controller and electrically change the switch state to any position (I – 0 – II) through dedicated inputs and dry contacts.
- The ATSE shall include a priority input to force the switch to the 0 position and inhibit the automation of the ATS controller.

18.6 ATS CONTROLS

- The ATSE shall have a fully integrated ATS Controller fixed directly on the motorisation.
- The controller shall include an LCD display, LED's and a keypad with front access.
- Electrical motorised control (position I, O, II) should be available locally through the keypad, remotely through dry contacts and optionally through communication.
- Main Parameters:
  - The ATS controller shall include 3-phase and neutral sensing for the monitoring of voltage and frequency on both source supplies.
  - Voltage settings shall be field adjustable in increments of 1%.
  - Frequency settings shall be field adjustable in 0.1% increments.
  - Setting configuration shall be adjustable through software as well as from the keypad.
  - The ATS Controller shall have phase sequence detection and allow the user to

choose the desired sequence (ACB or ABC).

- Changeover shall be forbidden if the supply phase sequences are different.
- The ATS Controller is to include an Auto-Configuration function for configuration of the source supply voltage, frequency, phase rotation and neutral position.
- The ATS Controller shall have the possibility to select the network type.
- The ATS Controller shall allow the setting of the source priority.
- The ATS controller shall be able to measure phase unbalance.
- The ATS shall include 3-phase current transformer inputs for measurement of voltage, currents, frequency, PF, power (apparent, positive & negative, active and reactive energy). These inputs are to allow for 5A /1A CT configurable in ATS Controller settings.
- The ATS shall have provision to swap the power cables so as to facilitate for source power cable inversion in the panel. (Software config)

18.7 COMMUNICATION

The ATSE shall have the provision to plug in optional communication module with RS-485 port.

18.8 TIMER SETTINGS:

- Two adjustable timers of 0 to 60 seconds shall be provided to detect source 1 or source 2 failures, and to override any transient outages of the normal supply. (Source 1 Failure Timer, 1FT and Source 2 Failure Timer, 2FT).
- A timer of 0 to 60 seconds shall be provided for source 2 available so as to ensure stability of the alternative network before transfer. (Source 2 Available Timer, 2AT).
- A possibility to stay in switch position I or II shall be provided with an adjustment of 0 to 10 seconds prior to return to the 0 position. (0 Timer, 1OT, 2OT). It must be accessible with parameter RETURN to 0 activated.
- An adjustable timer of 0 to 60 minutes shall be provided to detect priority network return to normal so as to override any incorrect availability of the normal supply. (Main Return Timer, 1RT, 2RT).
- Zero position timer, settable up to 20 second
- An adjustable timer of 0 to 10 minutes shall be provided to allow the generator to cool down after the load retransfer from alternative back to the normal supply. (Cool Down Timer, 2CT accessible in Mains – Gen applications)

18.9 ON LOAD / OFF LOAD TESTS

The ATSE shall include for On-Load as well as Off Loads tests associated with Mains – Gen applications. The test will as a minimum start the Genset for a determined period of time. These tests should be operable manually through the keypad, through remote inputs, through MODBUS communication.

18.10 ONLINE MAINTENANCE

- Replacement of the electrical parts (motorization or ATS controller) shall be possible on-load without removal of or disturbance to the power section and load.
- Once the motorisation module is removed the transfer switch shall remain functional as an on- load manually operated transfer switch. The switching mechanism shall be

independent of the operator switching speed.

18.11 EXECUTION & TESTING:

- The ATSE shall be declared compliant to the IEC standards listed above by a testing laboratory having delegation or working under contract for certification to UL and IEC standards under the IEC Electro technical Equipment (IECEE) certification body scheme.
- After installation of the equipment, a test report shall be submitted to client stating that the ATS equipment has been installed and commissioned in accordance with the manufacturer's instructions.

19 TECHNICAL SPECIFICATIONS FOR OUTDOOR PACKAGE SUBSTATION

19.1 Scope and Major Components

19.1.1 Scope of Supply

This specification covers the design, engineering, manufacture, type testing, factory testing, supply, delivery, installation, testing, and commissioning of a fully integrated, factory-assembled outdoor package substation. The unit shall be supplied as a single, structurally unified, transportable package engineered for seamless network installation upon delivery.

Compact Substation (CSS) should be with dry type transformer conforming to IS 2026 and loss level as per IS 1180 Level – 2/ ECSBC compliant required for IGBC Platinum Rating.

19.1.2 Component Checklist

The integrated assembly shall include the following major functional subsystems:

- **High-voltage switchgear compartment:** One 11/22/33 kV fixed-type vacuum circuit breaker (VCB) or SF6 switchgear panel. Ring Main Unit (RMU) loop switches are excluded from this scope.
- **Transformer compartment:** One 11/22/33 kV / 433 V dry-type, Energy Efficiency **Level-3** distribution transformer rated to the specific project capacity requirements.
- **Low-voltage switchboard compartment:** One multi-cubicle 433 V switchboard complete with a motorized air circuit breaker (ACB) sized to match the transformer secondary current, specialized outgoing molded case circuit breakers (MCCBs), and busbar paths.
- **Power factor correction cubicle:** One inbuilt, real-time automatic power factor correction (APFC) panel sized appropriately for the transformer rating, complete with thyristor/capacitor-duty switching elements and detuned harmonic reactors.
- **System integration elements:** Internal earthing networks, structural base frames, intra-compartment power connections, control wiring, and secondary interfaces mapped to the Integrated Building Management System (IBMS) through RS485 open protocol.

19.2 Enclosure and General Construction Requirements

19.2.1 Enclosure Structure and Modular Layout

- **Fabrication:** The enclosure shall be manufactured from high-quality, cold-rolled galvanized iron sheet steel of adequate thickness to ensure permanent structural rigidity. The complete assembly shall be mounted on a heavy-duty, hot-dip galvanized steel channel base frame designed to distribute structural load evenly.
- **Finishing:** All sheet-steel surfaces shall undergo industrial multi-tank chemical pre-treatment, including degreasing, derusting, and phosphating, before electrostatically baked powder coating. The final exterior finish shall be light grey, RAL 7035 or equivalent.
- **Compartmentalization:** The internal layout shall be divided into independent, metal-walled, fire-segregated compartments to isolate high-voltage, low-voltage, power factor, and thermal zones.

19.2.2 Environmental Integrity and Ingress Protection

The enclosure and its compartments shall comply with the following ingress protection ratings:

Area / Compartment	Minimum IP Rating
Overall substation assembly	IP55 or better

HV and LV switchgear compartments	IP54 or better
APFC enclosure cubicle	IP54 or better
Transformer compartment, dry type	IP23, optimized for natural ventilation while limiting heavy dust, wind-driven moisture, and vermin entry.

Vandal and weather protection: To prevent unauthorized access, no assembly bolts, rivets, or fastening hardware shall be accessible from the exterior periphery. All access doors shall be fitted with heavy-duty continuous EPDM rubber profiles and robust three-point padlocking handles to prevent sagging, bending, and water ingress during driving rain.

19.2.3 Ventilation, Lighting, and Power Links

- **Thermal management:** The transformer compartment shall include engineered louvers or apertures sized to support natural air convection cooling.
- **Illumination:** Each compartment shall be equipped with an industrial-grade internal LED utility lamp operated automatically by heavy-duty door-limit switches.
- **HT-to-transformer connection:** High-dielectric, safely routed aluminium XLPE flexible cable connections shall be provided.
- **Transformer-to-LV incomer connection:** Fully rated, high-conductivity, 4-pole, color-coded, PVC-sleeved aluminium or copper busbar runs shall be provided and sized for continuous full-load operating temperatures.

19.2.4 Mechanical and Electrical Safety Interlocks

- **Door interlocking:** The main HV compartment door shall include a mechanical or electrical interlock that prevents opening whenever the primary incoming supply is ON.
- **Breaker interlocking:** The HT switchgear shall be interlocked with the associated cable isolator, circuit breaker module, and integrated earthing switch to prevent out-of-sequence operation.
- **Operator safety:** A dedicated back-charging protection scheme shall prevent high-voltage feedback and protect personnel working on incoming cable terminations.
- **Signage:** Permanent high-visibility DANGER notices and single-line schematics shall be securely fixed to the exterior of all compartment doors.

19.3 Distribution Transformer Specifications

The integrated power transformer shall be a dry-type cast-resin or vacuum pressure impregnated unit meeting Energy Efficiency Level-3 performance requirements under the latest applicable amendments of IS 1180 (Part 1).

19.3.1 Technical Design Matrix

Parameter	Technical Requirement
Transformer architecture	Dry type, cast resin or VPI
Rated capacity	As per specific project requirements
Voltage configuration	HV: 11/22/33 kV; LV: 433 V
Rated full-load current	HV and LV: As applicable for the specified rated capacity

System frequency	50 Hz ± 5%
Phase / vector group	3-phase / Dyn11
Cooling profile	Air Natural (AN)
Insulation classification	Class F or Class H, as offered, with winding temperature rise within applicable standard limits over 50°C ambient.
Efficiency compliance	Energy Efficiency Level-3 or better as per IS 1180 guidelines.
System earthing	LV neutral solidly earthed through a dedicated copper bar.
Operational duty cycle	Continuous 24/7 full-load rating.
Off-circuit tap configuration	+5% to -5% in steps of 2.5%, adjusted on the HV side.
Tap changer equipment	Off-circuit manual tap switch with integrated padlocking arrangement.
Reference standards	IS 1180 (Part 1), IS 2026, and corresponding IEC standards.

19.3.2 Standard Accessories and Fittings

- Dual-channel digital winding temperature indicator wired with independent alarm and trip dry contacts.
- Two dedicated perimeter frame earthing terminals.
- Laser-etched stainless steel rating and schematic vector plate.
- High-tensile structural lifting lugs or eyelets suitable for lifting the complete substation block or replacing the transformer independently.

19.4 HT Vacuum Circuit Breaker / SF6 Switchgear Panel

The primary high-voltage protection interface shall be a fixed-type 11/22/33 kV metal-clad switchgear compartment housing a VCB or SF6 breaker module conforming to IS 13118 and IS / IEC 62271-1.

19.4.1 Technical Design Matrix

Parameter	Technical Requirement
Nominal system voltage	11/22/33 kV rms
Maximum operating voltage	11/22/33 kV rms
Rated continuous current	Optimized to safely accommodate the rated transformer parameters.
Power-frequency withstand	75 kV rms for 1 minute

Lightning impulse withstand	170 kV peak, 1.2 / 50 µs wave profile
Short-time break current	20 kA rms for 3 seconds
Short-circuit making capacity	40 kA peak
System protection control	Microprocessor-based programmable numerical relay with instantaneous / inverse overcurrent and earth-fault protection functions.

19.5 LT Switchgear Specifications

The low-voltage section shall comprise a robust, multi-compartment indoor switchboard fabricated from high-grade cold rolled close annealed sheet steel conforming to IS 13947 and IS / IEC 60947-2.

19.5.1 Motorized Incomer Air Circuit Breaker with IBMS Integration

The primary low-voltage incomer shall be a fully motorized smart air circuit breaker configured for automated remote control and real-time network integration.

19.5.2 ACB Technical Design Matrix

Parameter	Technical Requirement
Approved manufacturers	Siemens, L&T, ABB, Legrand, Schneider Electric, C&S, GE, or Kirloskar
Breaker type and charging mechanism	Fixed-type design with 230 V AC spring-charging motor, shunt trip coil, and electrical closing coils.
Operating ratings	433–440 V AC
Number of poles	3-pole configuration with dedicated full-rated neutral link / bar, or optional 4-pole configuration as specified.
Rated continuous current	Sized to match the transformer secondary full-load current, with ±10% calibration margin adjustment.
Ultimate breaking capacity	50 kA rms at 415 V AC
Smart trip release module	Microprocessor-based true-RMS trip unit providing overload, short-circuit delay, instantaneous, and earth-fault protection.
Automation interfacing	Native RS485 Modbus RTU interface for two-way communication of real-time metering values, open / closed / tripped status, and remote-control commands to the central IBMS.

19.5.3 Downstream Outgoing Feeders

The distribution block downstream of the motorized ACB shall include MCCB outgoing feeders conforming to IS / IEC 60947-2.

- **Feeder configuration:** The quantity, frame sizes, and ratings of outgoing adjustable thermal-

magnetic or microprocessor-based MCCBs, in 3-pole or 4-pole configuration, shall be engineered to support the specific load schedule.

- **Short-circuit capacity:** All MCCBs shall have an appropriate short-circuit breaking capacity, with a minimum of 35 kA or as otherwise specified based on system fault levels.

19.6 Integrated Real-Time Automatic Power Factor Correction Panel

19.6.1 System Scope and Placement

The low-voltage compartment shall integrate an inbuilt, real-time automatic power factor correction (RTAPFC) panel within an independent, thermally isolated cubicle. The panel shall be factory-wired, bus-connected to the main incoming LT network, and designed to maintain the system power factor at 0.99 lagging or better.

19.6.2 Standardized Sizing and Step Hierarchy

In accordance with IS 13340 and IEC 60831 for the specified system capacity, the APFC layout shall provide a standardized net capacity configured with fine step resolution for varying load profiles.

- **Total reactive capacity:** Scaled proportionately to match the transformer's maximum reactive load compensation requirements.
- **Capacitor step configuration:** Sub-divided into fine-tuning stages, intermediate balance stages, and core inductive load blocks to ensure seamless curve tracking.
- **Control unit architecture:** Microprocessor-based real-time APFC controller with minimum 8 to 12 target output stages and intelligent cyclic switching to equalize capacitor cell wear.

19.6.3 Capacitor and Switching Element Specifications

Feature / Component	Technical Requirement
Capacitor architecture	Heavy-duty metallized polypropylene or advanced polypropylene cells with self-healing, gas-filled or dry-resin design and internal overpressure disconnectors.
Voltage over-rating	Rated for continuous operation at 525 V to provide safety margin against voltage spikes, harmonics, and resonance effects.
Switching control technology	Real-time thyristor-switched modules with zero-cross switching logic, or heavy-duty capacitor-duty contactors with early-make damping resistors to limit transient inrush current.
Stage protection	High-rupturing-capacity fuse bases or dedicated motor protection circuit breakers for each capacitor stage.
Harmonic suppression	Each switching stage shall be coupled with a 7% detuned copper or aluminium series reactor, tuned to 189 Hz, to prevent parallel resonance and protect capacitor cells from harmonic amplification.

19.6.4 Automation, IBMS Interfacing, and Thermal Control

- **Telemetry data points:** The digital controller shall calculate and display real-time values, including target and current power factor, voltage and current total harmonic distortion, current per step, and required reactive power in kVAr.
- **Network integration:** The APFC digital interface shall include a native RS485 Modbus RTU port

mapped to the primary LT Modbus network daisy chain, transmitting tracking data and stage alarms to the centralized IBMS platform.

- **Forced climatic cooling:** Due to heat generated by 7% detuned reactors, the APFC compartment shall include dual thermostat-controlled, heavy-duty exhaust fans with IP54-rated protection to maintain safe internal operating temperatures.

19.7 Secondary Accessories and Auxiliary Equipment

- **Foundational framework:** Rugged mild-steel channel / angle stand assembly for secure ground anchoring.
- **Smart digital metering suite:** Multi-function digital energy meters, accuracy class 0.5S or better, mounted on the LV panel fascia to log phase voltages, currents, kW, kVA, total harmonic distortion, and frequency.
- **Instrument transformers:** Cast-resin encapsulated current transformers of suitable ratio, accuracy class, and burden for protection and revenue-grade metering, along with fixed-type potential transformers equipped with primary and secondary protection fuses.
- **Audible system alarms:** Industrial electronic hooters or buzzers linked to numerical fault protection relays to alert operational staff during critical system trips.

19.8 Inspection, Testing, and Compliance Quality Standards

19.8.1 Type-Testing Certification

The complete integrated package substation shall be type-tested in accordance with IEC 62271-202 or equivalent IS standards. The manufacturer shall submit validated type-test certificates from an independent accredited testing laboratory, such as CPRI, ERDA, or equivalent, confirming compliance with short-circuit, internal arc classification, temperature rise, and degree-of-protection requirements.

19.8.2 Factory Acceptance Testing

Before final packing and delivery to site, the following components shall undergo all applicable routine tests at the manufacturer's facility in accordance with their respective reference standards:

- **Dry-type transformer:** Insulation resistance, winding resistance, voltage ratio, vector group verification, no-load loss / current tests, and short-circuit impedance verification as per IS 2026 / IS 1180.
- **HT switchgear:** Power-frequency voltage tests, mechanical operation checks, and secondary wiring insulation checks as per IS / IEC 62271-1.
- **LT switchboard and APFC:** Dielectric testing, motorized ACB functional simulation, RS485 Modbus telemetry node checks, phase-sequence checks, and operational tests on thyristor capacitor steps as per IS / IEC 60947-2 and IS 13340.

20 TECHNICAL SPECIFICATIONS FOR CPCB IV+ COMPLIANT SILENT DIESEL GENERATOR SET

20.1 General Scope and Operating Conditions

The scope covers the supply, installation, testing, and commissioning (SITC) of a prime-duty, silent-type diesel generator (DG) set. The system shall comply with the latest Central Pollution Control Board (CPCB IV+) emission norms and Central Public Works Department (CPWD) guidelines.

All DG sets shall be BEE 5 star rated silent type with acoustic enclosure.

- **System rating:** Prime power rating as specified in kVA; 415 V, 3-phase, 4-wire, 50 Hz.
- **Operating speed and power factor:** 1500 RPM at 0.8 lagging power factor.
- **Environmental design parameters:** Engineered for a 0.85 continuous load factor, 40°C ambient temperature, 50% relative humidity, and operating altitudes up to 1000 m above mean sea level.
- **Traceability:** The unit shall include a permanent, laser-etched QR code on the rating plate, providing direct access to as-built drawings, schematics, OEM manuals, factory test reports, and geotagged manufacturing data.

20.2 Manufacturing Standards and Material Specifications

All equipment shall be manufactured in accordance with the latest applicable IS, ISO, and IEC standards to ensure structural integrity, electrical safety, corrosion resistance, and long service life.

- **Acoustic enclosure fabrication:** CRCA (Cold Rolled Close Annealed) steel sheets, minimum 1.6 mm / 16 SWG thickness.
- **Surface treatment and painting:** Nine-tank pre-treatment followed by UV-resistant pure polyester powder coating with a minimum thickness of 70 to 90 microns for corrosion protection.
- **Acoustic insulation:** Fire-retardant, high-density acoustic material, such as Rockwool or PU acoustic foam, covered with perforated tissue or fiberglass cloth and designed to limit sound levels to 75 dB(A) at 1 meter.
- **Hardware and gaskets:** Stainless steel or high-tensile zinc-passivated hardware, with heavy-duty EPDM rubber gaskets on doors to maintain IP65 ingress protection.

20.3 Core Equipment Specifications

20.3.1 Prime Mover: Diesel Engine

- **Type:** Turbocharged, 4-stroke, water-cooled, multi-cylinder diesel engine with dynamically balanced flywheel.
- **Overload capacity:** 10% overload permissible for 1 hour within any 12 hours of continuous operation without thermal degradation.
- **Governor:** Digital electronic governor with precise speed control, complying with ISO 8528 Part 5, Class G3.
- **Emission control:** Integrated advanced emission-control systems, including Exhaust Gas Recirculation (EGR) or Selective Catalytic Reduction (SCR), along with a catalytic converter to meet CPCB IV+ standards.
- **Filtration:** Two-stage dry-type air cleaner with digital restriction or service indicator.
- **Applicable codes:** ISO 3046, ISO 8528, BS 5514, and IS 10000.

20.3.2 Alternator

- **Type:** Synchronous, brushless, self-excited, self-regulated, continuous-duty machine.
- **Voltage regulation:** Solid-state automatic voltage regulator (AVR) ensuring voltage regulation within ±1%.
- **Insulation and protection:** Class H insulation with Vacuum Pressure Impregnation (VPI) for enhanced dielectric strength. The enclosure shall be Screen Protected Drip Proof (SPDP) with a minimum IP23 rating.
- **Rotor:** Dynamically balanced to eliminate vibration at 1500 RPM.
- **Applicable codes:** IS 13364, IS 4722, and IEC 60034-1.

20.4 Support Systems and Ancillaries

Component	Engineering Requirement
Base frame	Heavy-duty rigid MS channel or box-section frame, fully welded and common to both engine and alternator, with lifting lugs and grounding studs.
Vibration isolation	High-efficiency anti-vibration mounts (AVM) positioned between the engine / alternator feet and the base frame to achieve more than 90% vibration isolation.
Fuel system	Daily service tank fabricated from 3 mm MS sheet, integrated into the base frame or provided as a stand-alone arrangement as per CPWD specifications. The tank shall include a breather, drain plug, mechanical or digital level indicator, and Class C MS piping.
Starting system	12 V or 24 V DC electric starting motor with heavy-duty lead-acid sealed maintenance-free (SMF) batteries of minimum 180 AH, housed in a customized FRP or MS battery tray.

20.5 Control & Automation

The control panel shall manage automated power transfer, machine protection, and remote monitoring. It shall be floor-mounted, fabricated from 2 mm CRCA sheet, and engineered to IP42 for indoor installation or IP54 for outdoor installation, in compliance with IEC 61439.

- **Switchgear:** 4-pole, motorized, draw-out type ACB for higher kVA ratings or MCCB as applicable, equipped with microprocessor-based trip units for overcurrent, short-circuit, and earth-fault protection.
- **Microprocessor controller / PLC:** Deep Sea Electronics (DSE), ComAp, or equivalent DG controller to manage the three-impulse auto-start sequence, failure-to-start lockout, and automated breaker sequencing based on mains sensing.
- **BMS integration:** Built-in communication gateways supporting RS485 (Modbus RTU), Ethernet (Modbus TCP/IP), and SNMP protocols for seamless Building Management System integration.
- **Metering:** Class 1.0 digital multi-function meter displaying V, A, Hz, kW, kVA, kVAr, kWh, and power factor. Current transformers shall be cast-resin type, with Class 1.0 accuracy for metering and Class 5P10 accuracy for protection.
- **Battery charger:** Solid-state automatic float-and-boost battery charger with voltage and current limiting capability.
- **Protections and annunciations:** Audio-visual alarms and automatic trips for high coolant temperature, low lube oil pressure, engine overspeed, over / under voltage, over / under frequency, and reverse power.

20.6 Testing, Commissioning, and Handover

- **Factory Acceptance Testing (FAT):** Routine testing and load-bank testing shall be conducted at the manufacturer's facility prior to dispatch.
- **Site Acceptance Testing (SAT):** The SITC contractor shall provide the load bank, fuel, and required instrumentation to demonstrate continuous operation at 50%, 75%, and 100% load at the installation site.

20.7 Technical Compliance Matrix

Specification Category	Parameter	Required Engineering Standard	Bidder Offered Specification	Deviation, If Any
Regulatory	Emission and noise norms	CPCB IV+; less than 75 dB(A) at 1 meter		
Engine	Speed control / governor	Electronic, ISO 8528 Class G3		
Alternator	Insulation and ingress protection	Class H, VPI treated; IP23		
Enclosure	Weatherproofing and paint	IP65, CRCA steel, minimum 70-micron powder coating		
Automation	BMS protocols	Modbus RTU / TCP and SNMP		
Digital twin	Traceability	Laser-etched QR code on rating plate		

21 TECHNICAL SPECIFICATION FOR BUILDING MANAGEMENT SYSTEM

21.1 GENERAL - SCOPE OF WORK

- **Contract Scope:** The general character and scope of work are illustrated in the Drawings, Specifications, I/O Summary, and Schedule of Quantities. The Contractor shall execute the work in full conformity with the contract documents and Engineer directives.
- **Contractor Responsibilities:** The Contractor shall furnish all labor, materials, devices, transportation, and incidental components necessary for the Supply, Installation, Testing, Commissioning (SITC), final testing, operation, and handing over of the complete Building Management System (BMS).
- **Operational Readiness:** The BMS Sub-Contractor shall make the system fully operational for its intended use. Any additional components specific to the proposed make/model required for full functionality must be included at no additional cost, even if not explicitly listed in the tender.
- **System Architecture:** The BMS shall be based on a cloud-hosted, open, interoperable, and integrated architecture. It must be a peer-to-peer networked, stand-alone, distributed control system.
- **Integration and Protocols:** The system shall integrate diverse utilities (HVAC, Fire Fighting, Plumbing, Electrical, and ELV systems) using international standards (ANSI/ASHRAE) and communication protocols such as BACnet/MSTP, BACnet/IP, RS485, HTTP, and MQTT.
- **User Interface (UI):** The integrated platform shall feature a Single Log-on URL, Building Portfolio Landing Page, Nine-dot Menu for module navigation, drag-and-drop data cards, unified workflow across disciplines, English-language support, and seamless third-party system integration.
- **Architecture Levels:** The system shall be completely modular and freely expandable, structured across three tiers:
  - **Management Level (Software):** Includes the cloud server, processing, encryption, security, visualization, data analysis/reporting, alarm notifications, and data exchange. Communication must flow in all directions across networks.
  - **Automation Level (Controller):** Redundant processing based on built-in logic within the Direct Digital Controller (DDC). DDCs shall feature dual-mode Wi-Fi and IP communication. Data exchange to the server shall occur via Wi-Fi or LAN-enabled internet (HTTP) via MQTT brokers. Peer-to-peer communication is reserved for master-slave data exchange.
  - **Field Level (Expansion/Slave):** Individual expansion/slave controllers for monitoring and control based on application-specific logic residing on the master controllers.
- **Software Package:** The Contractor shall supply the complete, fully licensed cloud software package (OEM originals) including necessary modules, cloud databases, and cloud-based anti-virus. The system shall not require any user or point-capacity licensing.
- **Response Time:** The maximum acceptable response time from any alarm occurrence to the point of annunciation on user interfaces shall not exceed 2 to 5 seconds.

21.2 IBMS CLIENT

The Integrated Building Management System (IBMS) shall support cloud-based clients accessible via web browser URLs on PCs and tablet devices. It must support an unlimited number of concurrent operator workstation connections via provided IDs and passwords without requiring Native SNMP enablement.

The IBMS client shall support the following minimum functions:

- **Secure Access:** User log-on identification and password are required. Unauthorized access attempts must trigger an error pop-up.
- **Web-Based Graphics:** Graphical screens developed for the GUI shall mirror those used on the web browser client, including all animated graphical objects. No HTML programming shall be required to display system graphics or text.
- **Cloud Storage:** All graphical screens shall be stored on the IBMS cloud server. Local storage of graphics on client workstations is strictly unacceptable.
- **Real-Time Updates:** Real-time values on web pages shall update automatically with recent time stamps, requiring no manual page refresh.
- **Administrator Privileges:** Users shall have administrator-defined access to modify common application objects (schedules, calendars, setpoints) graphically.
- **Command Execution:** Starting and stopping binary objects shall be executed via an override pop-up button on the selected object's data card. Text entry shall not be required for commands.
- **Data Viewing:** Users shall be able to view logs, charts, and acknowledge alarms.
- **Custom Home Pages:** The system shall allow administrators to assign specific home pages based on user ID and optionally restrict users from modifying them.
- **Hyperlinking:** Graphic screens shall support hypertext links (URLs) to other internet or intranet locations.

21.3 CODES AND STANDARDS

All equipment and systems shall conform to the latest editions and amendments of the following codes and standards:

- **CE Certification:** European health, safety, and environmental protection standards.
- **ASHRAE 135:** BACnet communication protocol standard.
- **ISO/IEC 20922:** MQTT standard for IoT messaging.
- **IEEE 802.11:** Wi-Fi communication standards.
- **IEEE 802.3:** Ethernet local area network standards.

21.4 SYSTEM DESCRIPTION

The IBMS shall utilize Wi-Fi and BLE-enabled, interoperable, stand-alone IP digital controllers communicating over the MQTT protocol. Beyond HVAC, the system must integrate with third-party systems such as energy metering, electrical, plumbing, access control, and fire-life safety systems.

Microcontroller/Microprocessor-based DDC Functions:

- Individual I/O point scanning, processing, and control.
- Centralized operation and remote control of services.
- Dynamic color graphics detailing building services.
- Energy Management via optimization of all connected mechanical and electrical plants.
- Early fault recognition and alarm detection.
- Time, event, holiday, and temporary scheduling.
- Prevention of unauthorized access.
- Suggestive preventive maintenance and internal error diagnosis.
- Building maintenance reporting and data visualization.

Controller Specifications:

- **Stand-alone Capability:** Controllers must function independently if communication with the Cloud Server is lost.
- **Advanced Logic:** Capable of Proportional + Integral + Derivative (PID) control, conditioned-based On/Off commands, and time/event-based logic.
- **Hardware Inputs:** DDC controllers shall feature a minimum 12-bit A/D resolution on analog inputs.
- **Protocols:** On-board Ethernet connectivity must support BACnet/IP, Modbus/IP, and Modbus/RTU over RS485.
- **Peer-to-Peer:** Controllers must communicate directly with each other without relying on supervisory servers. Integration routing must occur via subnets, strictly avoiding proprietary LAN/WAN.

Operator Station Requirements:

- Operation must utilize a standard web browser without server/client architecture dependencies.
- No specific server-class PCs or special software installations are required locally.
- Local database management systems, local anti-virus packages, and local software suites are not required due to the Native Cloud architecture.

21.5 MONITORING STATION SOFTWARE AND HARDWARE

21.5.1 Integrated Building Management Software

- **Cloud Architecture:** A native cloud-based central IBMS server shall be provided, supporting all routers and BACnet broadcast management devices (BBMDs) connected via Ethernet LAN or remote broadband.
- **MQTT Broker Access:** All controllers shall be accessible via a single internet (HTTP) connection to the IBMS cloud server MQTT Broker.
- **Graphic Capabilities:** Must support SVGZ graphics, 3D styling, AutoCAD PDF imports, multi-layer native editing, and embedded symbol libraries.
- **Reporting Engine:** Must feature a robust engine for scheduling and customizing reports (bar, scatter, line charts) with export capabilities to PDF and Excel.
- **Automated Discovery:** The system must automatically discover devices on the MQTT network via internet routers.
- **Protocol Flexibility:** Must support open protocols (BACnet, Modbus, Lontalk) without requiring software configuration changes, additional drivers, or licenses upon addition/deletion of integrations.
- **Alarm Management:** Must forward alarms to predefined email/SMS accounts and feature automatic alarm escalation without physical Auto-Dialer modem connectivity.
- **Time Synchronization:** Must include an IST clock service to synchronize all devices with the cloud server.
- **Global Scheduling & Demand Limiting:** Capable of scheduling third-party devices and operating demand-limiting programs across all BBMD/B-AAC devices, supporting multiple meters and shed lists.
- **Data Archiving:** Connected devices must archive log data locally for 2-5 days during internet failures, which the cloud server will retrieve automatically (First-In-First-Out) once reconnected.

21.5.2 Cloud Server Requirements

- **Performance:** Supply, installation, testing, and commissioning of a Cloud-Deployed Server featuring on-demand auto-scaling via orchestration tools, ensuring 99.95% uptime through distributed architecture.

- **Security:** Highest level built-in SSL security and 256-bit encryption (Digicert certified). End-to-end encrypted data transceivers.
- **Capabilities:** Must include AI and Machine Learning capabilities for energy optimization. Must feature cloud data optimization, a state-of-the-art logic engine, and API integration capabilities.
- **Maintenance:** Upgrades must happen seamlessly in the cloud without license purchases, software change fees, or server downtime.

21.5.3 System Programming

- **Cloud-Based Engineering:** The Graphical User Interface (GUI) and database engineering shall be executed via a cloud-based backend platform using a comprehensive library of control and graphic objects.
- **Graphical Linking:** Object linking must support one-to-one, many-to-one, or one-to-many relationships via graphical mapping. Object configuration shall utilize fill-in-the-blank fields and drop-down menus; custom scripting or procedural programming languages are unacceptable.
- **Commissioning Tools:** Control strategies and schedules shall be programmable through the cloud backend, allowing users to commission and monitor controller parameters seamlessly.
- **API Mirroring:** System object mirroring within a customer's cloud database must occur strictly through API integration; mirroring via MQTT brokers is prohibited. Local offline database creation shall be permissible on-site strictly through the provided Configuration Tool.

22 TECHNICAL SPECIFICATIONS FOR TELECOMMUNICATION AND IN-FLAT WI-FI NETWORK

Section: Telecommunication and Wi-Fi Network (FTTH)
Application: Residential Multi-Dwelling Units (MDUs)

22.1 General Requirements and Scope of Work

The EPC Contractor shall design, supply, install, test, and commission a complete Fiber-to-the-Home (FTTH) Gigabit Passive Optical Network (GPON) infrastructure. The system shall serve as the primary data backbone for the residential development and shall terminate within each flat.

- Provide the Main Distribution Frame (MDF) in the ground-floor or basement central telecom room.
- Install vertical optical fiber risers through dedicated telecom shafts.
- Provide Intermediate Distribution Frames (IDFs) and Fiber Distribution Boxes (FDBs) on the respective floors.
- Install last-meter fiber drop cables from the floor FDB to each residential flat.
- Provide in-flat smart panels and Cat 6 horizontal copper cabling for local data distribution from the proposed router to bed rooms & living rooms.
- Test and certify all passive optical fiber links and copper cabling links prior to handover.

22.2 Applicable Codes and Standards

All materials, workmanship, installation practices, testing, and documentation shall comply with the latest applicable editions of the following standards:

- **ITU-T G.652.D / G.657.A2:** Characteristics of single-mode optical fiber and cable.
- **ITU-T G.984.x:** Gigabit-capable Passive Optical Networks (GPON).
- **TIA/EIA-568-C.3:** Optical Fiber Cabling Components Standard.
- **TIA/EIA-568-C.2:** Balanced Twisted-Pair Telecommunications Cabling and Components.
- **TIA/EIA-570:** Residential Telecommunications Cabling Standard.
- **IEEE 802.11ax:** Wireless LAN Medium Access Control and Physical Layer Specifications for Wi-Fi 6
- **ISO/IEC 11801:** Information Technology — Generic Cabling for Customer Premises.

22.3 Passive Optical Infrastructure Specifications

22.3.1 Main Distribution Frame (MDF) / Central Telecom Room

- **Optical Distribution Frame (ODF):** High-density, 19-inch rack-mounted ODF fabricated from cold-rolled steel with anti-corrosive powder coating, complete with splice trays, routing guides, and LC/APC or SC/APC adapters.
- **Equipment racks:** Standard 42U, 19-inch floor-standing racks rated IP20, complete with vertical cable managers, heavy-duty castors, roof-mounted cooling fans, and dual Power Distribution Unit (PDU) strips.

22.3.2 Vertical Backbone / Riser Cabling

- **Cable type:** Multi-core single-mode optical fiber (OS2) with Low Smoke Zero Halogen (LSZH) outer jacket.
- **Core sizing:** Fiber core count shall be calculated based on flat density per floor and shall include a minimum 20% reserve dark fiber capacity for future scalability and redundancy.
- **Routing:** Riser cables shall be laid in designated GI perforated cable trays with a minimum physical separation of 300 mm from high-voltage electrical distribution cables.

22.3.3 Floor Distribution / Telecom Shafts

- **Fiber Distribution Box (FDB):** Wall-mounted, lockable enclosure rated IP55 minimum, fabricated from metal or heavy-duty polycarbonate material.
- **Optical splitters:** Passive Planar Lightwave Circuit (PLC) splitters, such as 1:8 or 1:16, shall be provided as per network design. Operating wavelength shall be 1260 nm to 1650 nm.
- **Splicing:** All fiber core connections within the FDB shall be completed by fusion splicing. Mechanical splices shall not be used in the backbone network.

22.4 In-Flat Infrastructure

22.4.1 Fiber Drop Cable

The connection from the floor FDB to the in-flat smart panel shall be made using a 2-core or 4-core bend-insensitive single-mode fiber drop cable complying with ITU-T G.657.A2. The cable shall be routed through concealed PVC conduits.

22.4.2 Smart Panel / Home Distribution Box

A recessed, wall-mounted smart panel shall be installed in a centralized and accessible location within each flat, such as a hallway or utility area. The panel shall serve as the residential integration hub for fiber termination, router placement, and localized data distribution.

- **Construction:** CRCA sheet steel or high-impact ABS plastic enclosure with adequate ventilation and an aesthetically finished flush-mounted door.
- **Housed components:** Fiber rosette or optical wall outlet, space for ISP Optical Network Terminal (ONT) and Wi-Fi router, and minimum two 5 A / 15 A standard electrical sockets for active equipment.

22.4.3 Internal Copper Cabling / Data Points

- **Cable standard:** 4-pair Category 6 UTP cable with 23 AWG solid bare copper conductors and LSZH jacket.
- **Topology:** Cat 6 cabling shall originate from the router location inside the smart panel and terminate at RJ-45 keystone jacks mounted on flush faceplates in the living room, master bedroom, and other designated locations.

22.5 TESTING, COMMISSIONING, AND HANDOVER

The EPC Contractor shall complete testing and commissioning for all optical and copper links and shall submit comprehensive digital and hard-copy test reports prior to project handover.

- **Optical link testing:** 100% of fiber links from the MDF to the in-flat fiber rosette shall be tested using an Optical Time-Domain Reflectometer (OTDR) and optical power meter at 1310 nm and 1550 nm. Total end-to-end insertion loss shall comply with standard GPON link budgets, typically less than 28 dB.
- **Copper testing:** 100% of in-flat Cat 6 links shall be certified using a calibrated Level III cable analyzer, such as a Fluke DSX series or equivalent, for wire map, NEXT, return loss, and insertion loss.
- **Handover deliverables:** The Contractor shall submit complete as-built drawings in DWG and PDF formats, port mapping and labeling schedules compliant with TIA-606, test reports, and OEM warranty certificates.

23 TECHNICAL SPECIFICATIONS FOR TV & TELEPHONE CABLING IN FLATS

23.1 TV CABLING IN FLATS

23.1.1 Network Architecture: Building and Shaft Distribution

The EPC scope shall provide TV cabling from individual flats to terrace of the residential towers using coaxial cable, conduiting, flatwise termination and final termination at terrace with suitable connectors, enclosure etc.

23.1.2 In-Flat Cabling and Conduit Specifications

The contractor shall supply, lay, test and commission the complete concealed TV cabling network for all residential flats. The scope of work shall include laying of 75 Ohm RG-6 FRLS coaxial cable from the terrace TV termination point to floor-wise splitter locations and from the splitters to the TV outlet point(s) inside each flat (all bedroom and living room) design as approved by PMC & SBI. The work shall also include the supply and installation of floor-wise splitters, termination of cables at the terrace and splitter locations, F-type connectors, junction boxes, and all accessories required for a complete TV cabling network. The active equipment such as dish antenna, head-end equipment, amplifiers, set-top boxes, etc., is not included in the scope.

Cable routes shall be coordinated with the apartment interior layout and concealed wherever possible.

Material / System	Specification for Inside Flats
TV / DTH cable	RG-6 quad-shield coaxial cable with FR-PVC jacket, sweep-tested up to 3000 MHz to support high-quality satellite and 4K TV signals.
Conduiting	Minimum 25 mm FRLSH PVC conduits, embedded in the concrete slab during casting or chased into brick/block walls before plastering.

23.1.3 User Terminal Outlets and Faceplates

Wall plates behind TV and data locations shall be specified to support modern entertainment, streaming, and connectivity requirements. Final outlet quantities shall be coordinated with the approved apartment layouts.

- **Living room:** Provide a minimum of two RJ-45 Cat 6 data ports and one F-type coaxial outlet behind the main TV unit.
- **Bedrooms:** Provide a minimum of one RJ-45 Cat 6 data port and one F-type coaxial outlet at each designated bedroom TV location.
- **Faceplate finish:** All ELV faceplates shall match the brand, color, finish, and modular style of the electrical switches used in the flat, including polycarbonate or glass finish where applicable.

23.2 TELEPHONE CABLING IN FLATS

The contractor shall supply, lay, test and commission the complete telephone cabling network from each residential flat to the Security Cabin to facilitate internal communication over the local telephone network. The work shall include laying of Category-5e UTP cable through concealed heavy-duty ISI-marked PVC conduits, complete with telephone outlets, junction boxes, terminations at the flat and Security Cabin, MDF complete with Krone termination box/modules, patching, tagging, ferruling, and all accessories required for a complete and functional telephone

cabling system. The MDF shall be installed at the designated location in the Security Cabin with all incoming cables from the flats neatly terminated on Krone modules for ease of identification and maintenance. The scope is limited to passive cabling only and excludes the supply and installation of EPABX/IP-PBX systems, telephones, switches, routers, or any other active communication equipment.

The cabling shall be installed without intermediate joints, properly identified at both ends, and adequately separated from power cables to prevent electromagnetic interference. All terminations shall be carried out using suitable modular RJ-11 sockets and termination modules, as applicable. The contractor shall test each cable for continuity, insulation, polarity, and end-to-end connectivity before handing over the installation. The quoted rate shall be inclusive of all cables, conduits, outlets, terminations, labour, testing, commissioning, transportation, tools and tackles, and all incidental items necessary for the satisfactory completion of the telephone cabling work.

24 TECHNICAL SPECIFICATIONS FOR ELECTRIC VEHICLE (EV) CHARGING STATION INFRASTRUCTURE

24.1 GENERAL SCOPE OF WORK

The scope of work covers the supply, installation, testing, and commissioning (SITC) of Electric Vehicle (EV) charging stations for the project. The installation shall comply with the Energy Conservation Building Code (ECBC), National Building Code of India (NBC), Indian Green Building Council (IGBC) guidelines, Government of India (GoI) directives, applicable Indian Standards (IS), local discom requirements, and project-specific electrical safety requirements.

24.2 CODES AND STANDARDS COMPLIANCE

All equipment, materials, installation methods, testing procedures, and documentation shall comply with the latest applicable editions of the following codes and standards:

- **IS 17017 Series:** General requirements for EV conductive charging systems.
- **IS 17017-2:** Plugs, socket-outlets, vehicle connectors, and vehicle inlets.
- **IS 17017-22-1:** Specific requirements for DC EV charging stations.
- **IS 60309:** Plugs, socket-outlets, and couplers for industrial applications.
- **IS 13252 (Part 1): 2010:** Safety requirements for information technology equipment, including telecommunication ports.
- **IEC 62262:** Degrees of protection provided by enclosures against external mechanical impacts (IK Code).

24.3 TECHNICAL SPECIFICATIONS

24.3.1 Power Input and Output Requirements

Charger Type	Input Supply	Output Specification
7 kW AC charger	Single-phase 230 V AC (+10%), 50 Hz (±3%).	230 V AC output.
11 kW / 22 kW AC charger (Level 2)	Three-phase 415 V AC (-40% to +20%), 50 Hz (±5%).	240 V AC output, as applicable to the charger design and OEM configuration.
≥ 24 kW DC charger (Level 2)	Three-phase 415 V AC (-40% to +20%), 50 Hz (±5%).	DC output voltage and auxiliary supply shall be as per the specific OEM design requirements.

24.3.2 Environmental and Operating Conditions

The EV charging infrastructure shall be designed for reliable operation under the following environmental conditions:

- **Outdoor operating temperature:** -25°C to 55°C.
- **Indoor operating temperature:** -5°C to 55°C.
- **Relative humidity:** Up to 95%, non-condensing.

24.3.3 Enclosure and Mechanical Design

All charging equipment enclosures shall provide suitable protection against environmental exposure, unauthorized access, and mechanical impact.

- **Ingress protection:** Minimum IP41 for indoor installations and minimum IP44 for outdoor installations.

- **Mechanical impact protection:** Minimum IK08 rating in accordance with IEC 62262.
- **Charging cable:** Each charging unit shall be supplied with an integrated charging cable of 7.5 m length.

24.4 INTERFACES, CONNECTORS, AND SOCKETS

Each charging unit shall be equipped with one charge-point plug or socket compliant with IS 60309 and IS 17017-2. Vehicle inlets or connectors shall be provided in accordance with the applicable EV manufacturer requirements.
The system shall support efficient charging of two-wheelers and four-wheelers, as applicable to the approved charger type and project deployment plan.

24.5 PROTECTION AND SAFETY FEATURES

The EV charging system shall incorporate the following mandatory safety provisions to support safe and reliable operation:

- **Overload and short-circuit protection:** Integrated MCBs or breakers shall isolate faults safely and promptly.
- **Insulation resistance:** Insulation resistance shall be greater than 1 MΩ.
- **Earth leakage protection:** Residual Current Devices (RCDs) with residual operating current not exceeding 30 mA shall be provided. Individual RCD protection shall be provided for each output.

24.6 COMMUNICATION AND TELEMETRY

The charging system shall support smart charging integration, real-time monitoring, and future-ready communication capability.

- **EV–EVSE communication:** Charging equipment shall conform to relevant IS communication requirements and include Bluetooth Low Energy (BLE) compatibility where specified.
- **Network protocol:** The system shall fully support Open Charge Point Protocol (OCPP) 1.6J. Firmware and hardware shall be natively upgradeable to OCPP 2.0.
- **Telecommunication port:** Communication ports shall comply with IS 13252 (Part 1): 2010.

24.7 CONTRACTOR RESPONSIBILITIES

The Contractor shall verify site conditions before installation and ensure that all EV charging works comply with local discom regulations, applicable IS codes, electrical wiring requirements, earthing practices, and project safety requirements.

25 TECHNICAL SPECIFICATIONS FOR VENTILATION SYSTEM

25.1 GENERAL :

The ventilation fans shall be complete in all respects and shall generally comply with the following specifications given below:

25.2 EXHAUST FANS (AXIAL FLOW TYPE) :

- The exhaust fans shall be Axial flow type with steel hub and blades, mounted directly on the shaft of a totally enclosed motor.
- The fan blades shall be of pressed steel of aerofoil design for high efficiency and static pressure.
- The mounting frame shall be of cast/sheet steel with steel brackets to connect the frame with the fan/motor assembly. Rubber mounts shall be provided between the mounting frame and the mounting brackets.
- The fan motor shall be to totally enclosed Class “H” insulation and shall be IE-3 Type.
- The fan shall be completely rated for fire @250°C for 2 Hours.Note Fan shall be AMCA Certified.
- The fan shall be selected for lowest noise level and it shall not exceed more than 80 db(A) at a distance of 1 m around the equipments.

25.3 FRESH AIR / PRESSURIZATION FANS (AXIAL FLOW TYPE) :

- The exhaust/ fresh air / pressurization fans shall be Axial flow type with steel hub and blades, mounted directly on the shaft of a totally enclosed motor.

- The fan blades shall be of pressed steel of aero foil design for high efficiency and static pressure.

- The mounting frame shall be of cast/sheet steel with steel brackets to connect the frame with the fan/ motor assembly. Rubber mounts shall be provided between the mounting frame and the mounting brackets.

- The fan motor shall be to totally enclosed **Class “F” insulation and shall be IE-3 Type**.

- The fan shall be selected for lowest noise level and it shall not exceed more than 80 db(A) at a distance of 1 m around the equipment’s.

25.4 FAN SECTIONS:

- The scope of this section comprises the supply, installation, testing and commissioning of ventilation fan sections double skin Type conforming to these specifications and in accordance with the requirement of drawings and DBR. Fan Outlet velocity shall not exceed 610 meters per minute.
- The Double Skin Ventilation fan sections shall be complete with Centrifugal Fans, belt driven fans complete with motor drive and housing with weatherproof cowl.
- The housing shall be fabricated out of 16 gauge steel sheet and shall have flange to be connected to duct. The discharge cowl shall be hinged along one edge for easy access to

motor and drive, for inspection and maintenance. The entire assembly shall be weatherproof and provided with 18 gauge galvanized steel mesh bird screen of 6 mm size on all discharge cowls around the outlet areas. Shaft shall be constructed of steel, turned, ground & polished.

- Fan shall be forward / backward inclined wheel type designed for maximum efficiency, minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced. Fan shall conform to specifications as given in specification No.SPC/CF – PF/01
- Motors shall be suitable for 415 +- 10% volts, 50 CPS, 3 Phase AC supply totally enclosed fan cooled motor provided with class ‗F' insulation& IE-3 class efficiency. Motor shall be designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be through belts.
- Back draft Damper Where called for in as per instruction of Cosultant / Client the ventilation fan section shall be provided with a rattle free back draft damper to prevent air from re-entering the fan when fan is not in operation, thus sealing completely in closed position. Damper shall be chatter proof under all conditions.
- The motor and fan assembly shall be isolated from base through vibration isolators.
- All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.
- Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.
- The Fans shall be AMCA certified. Also, it should be UL & FM/EN approved. Sound attenuators with/without baffles to reduce noise generated at source itself wherever feasible.

25.5 AXIAL FLOW FANS

25.5.1 SCOPE

This section covers the technical requirements for manufacture, testing at works, delivery at site, testing after installation, commissioning of axial flow fan equipments for ventilation and exhaust system. Their location shall be as given in DBR and drawings.

The fans shall be complete with all the accessories required for proper installation and performance consisting mainly of the following: -

a. Suction and discharge side flanges and counter flanges suitably drilled, complete with bolts & nuts, direct driving electric motor, suspension hangers (for ceiling hung fans only) for vibration isolation (rubber in shear type). Any structural steel and hardware required for assembly, installation, supporting of fan or accessories. 2 mm thick flexible connectors, fire resistant type at suction and discharge end, Foundation bolts and vibration isolators (in case of floor mounting only).

b. Gravity louvers

25.5.2 APPLICABLE SPECIFICATIONS STANDARDS AND CODES.

Documents listed below should be read along with the technical data given in the DBR and shall be applicable to the material, manufacture, testing and installation of axial flow fans and

accessories.

a. I.S.S.: 3588 – 1986; specifications for electric axial flow fans.
b. ANSI/ASHRAE: standard 51
c. ANSI/AMCA: standard 210 & 300 for preparing performance curves, charts and testing of fans for air and sound performnace
d. IS-2312 – Propeller type A.C ventilation fans
e. BS – 848/ ACMA Tested – Methods of performance test for fans

25.5.3 DESIGN & MANUFACTURING

i. **Fan and Components**

a. The fan shall be designed to handle the quantity of air against the static pressure and at conditions indicated in the technical data. The fan shall have 70% efficiency at operating conditions and shall have performance characteristics to match the approved performance curves.

b. The unit shall be factory built to the highest standards to ensure rigidity, maximum mechanical and electrical reliability, quite, stable and vibration free operation at the prescribed conditions of flow, static and speed.

c. The casing shall be fabricated from heavy gauge sheet steel with suction and discharge ends flanged and complete with counter flanges, G.I. nuts and bolts. The flanges and counter flanges shall be matched and drilled suitably to receive flexible PVC connections. An inspection door with handle and neoprene gaskets shall be provided. Support brackets for ceiling suspension shall be bolted to the casing for connection to hanger bolts.

ii. **Impeller & Blades**

The impeller shall be cast aluminum; aerofoil type with well-balanced blades made from cast aluminum alloy or cast steel construction.

25.5.4 DRIVE

The fan hub and blades shall be directly mounted on the shaft of a totally enclosed motor, rotor of fan motor shall be well balanced. The motor shall be TEFC, squirrel cage, IP 55 0– class H/F as per use, IE-3 class efficiency preferably and suitable for 415 +- 10% V, 50 HZ 3 phase AC power supply. The motor shall be dual speed wherever called for in DBR. The maximum motor speed shall be limited to 1450 RPM. Motor conduit box shall be mounted on exterior of fan casing and lead wires from motor to conduit box shall be protected from air stream by enclosing in a flexible metal conduit.

25.5.5 TECHNICAL SPECIFICATIONS

The firm shall submit the technical data and performance characteristics with operating points duly marked for approval prior to fabrication. The supplier shall supply the test certificates of all the fans.

25.5.6 GENERAL REQUIREMENTS

a. Static, dynamic balancing and vibration: the individual fan impeller, blades, motor shall be statically and dynamically balanced independently. After assembly the entire fan motor unit shall not give rise to any vibrations. The balancing shall be as per ISO: 1940 GR 6.3.

b. NOISE LEVEL: The tendered shall indicate the noise level generated by the fan/motor unit in

terms of decibel units to be measured at 3M from the unit. This shall fall in line with best engineering standard and shall not be more than 80 db.

25.5.7 PAINTING

All fans and their accessories shall be painted with two coats of suitable enamel paint after one coat of Red Oxide primer.

25.5.8 PACKING

The fans shall be dispatched in packed condition to avoid damage during transportation to site. Transit insurance for the fans shall be included in this offer.

25.5.9 INSPECTION & TESTING

All fans shall be subjected to inspection and testing requirements as given below. The contactor shall be responsible for providing all inspection facilities and for conducting all tests at works and at site after erection. Test certificates for all fans shall be submitted, some fans at the discretion of CLIENT/ HITES may be tested at the factory in his presence.

The performance of the fan motor unit shall be tested by operating at design conditions. The following parameters will be tested vis-à-vis the approved performance curves.

a. Airflow capacity, Static head developed, BHP requirement, Vibration and noise level. The Fans shall be AMCA certified. Also, it should be UL & FM/EN approved. Sound attenuators with/without baffles to reduce noise generated at source itself wherever feasible.

25.5.10 Accessories :

All necessary accessories shall be provide for proper operation and shall also include:

a. Vibration isolators for the blowers.
b. Double canvas connections at the outlet of each fan.
c. Nuts, bolts, shims etc. as required for the grouting of the equipment.
d. Slide rails for mounting the motor and belt adjustments.

25.6 IN-LINE FANS

25.6.1 1. General

In-line fans shall be complete in all respects and shall comply with the requirements specified in this section.

25.6.2 Fan Assembly

Each fan shall be supplied as a complete assembly comprising a centrifugal impeller, direct-driven motor, timer, MCB, vibration isolators, and all required components enclosed in a weatherproof, single-skin, 18-gauge G.I. casing.

Housing

The housing shall be constructed from hot-rolled GSS sheet metal. Housing components shall be spot-welded, screwed, or riveted together. The housing shall be clearly marked with the direction of rotation, make, model, and duty conditions.

Fan Wheel

The fan wheel shall be forward-curved or backward-curved type and shall be statically and

dynamically balanced.

Ball Bearings
Ball bearings shall be maintenance-free and suitable for operation in any mounting position at the maximum indicated temperature. Bearing lubricant shall be suitable for a minimum ambient temperature of -15°C. At the maximum indicated ambient temperature, the minimum L10 life expectancy shall be 40,000 hours.

Fan Motor
Each fan shall be supplied with a built-in thermal contact (TK). At the critical high-temperature point—130°C for Class B insulation or 155°C for Class F insulation—the thermal contact shall open and interrupt the power supply to the fan. The fan motor shall have Class B or Class F insulation and IP44 or IP54 protection, as applicable.

Fan Drive
The fan shall be direct-driven type.

Finish
The complete fan assembly and all other steel components shall be either GSS construction or epoxy painted.

25.6.3 Timer

The timer shall be arranged to start the fan automatically for 10 minutes after every 10-minute rest period.

25.6.4 Test Certificates

The contractor shall submit the manufacturer's test certificate for each fan.

25.6.5 Factory Inspection and Testing

Factory inspection and testing by the owner shall be carried out in the presence of the Design Consultant, Engineer-in-Charge, and Client, where required.

25.7 PROPELLER FANS

25.7.1 Fan Arrangement

Propeller fans shall be direct-driven, three- or four-blade units mounted on a steel mounting plate complete with an orifice ring.

25.7.2 Mounting Plate and Inlet Arrangement

The mounting plate shall be fabricated from heavy-gauge sheet steel. For supply applications, it shall include a streamlined reverse venturi inlet, with dimensions suitable for the selected fan size.

25.7.3 Fan Blades and Hub

Fan blades shall be constructed from aluminium or steel. The fan hub shall be of heavy welded steel construction, with blades bolted securely to the hub.
The complete fan blade and hub assembly shall be statically and dynamically balanced at the factory.

25.7.4 Motor Requirements

Motors for small fan sizes shall be standard, easily replaceable, single-phase permanent split capacitor or shaded-pole type. Motors shall be totally enclosed, designed for quiet operation, and fitted with pre-lubricated sleeve or ball bearings.
Maximum motor speed shall be limited to 1000 RPM for fans of 31 cm diameter and larger, and 1440 RPM for fans of 31 cm diameter and smaller.
Motors for larger fans shall be suitable for 415 ± 10% volts, 50 cycles, three-phase power supply.
Motors shall be suitable for horizontal or vertical service, as indicated in the drawings or schedule of quantities.

25.7.5 Accessories

Where specified in the tender documents, propeller fans shall be supplied with the following accessories:
Inlet wire guard and outlet bird screen.
Gravity-operated louver shutters built into a steel frame.
Fan-speed regulators for single-phase fan motors.

25.8 DUCT WORK AND OUTLETS

25.8.1 SCOPE:

The scope of this section includes supply, fabrication, installation & testing of all sheet metal ducts as per specifications & drawings. Except as otherwise specified all ductwork and related items shall be in accordance with these specifications. Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners, hangers & all accessories.

25.8.2 DUCT MATERIALS:

The ducts shall be fabricated from galvanized steel sheets class VIII - Light coating of Zinc conforming to ISS: 277-1962 (REVISED) with accompanying Mill test Certificates. Galvanizing shall be 120gms/sq.m. (total coating on both sides). In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense. Only new, fresh, clean (unsoiled) and bright GI / Aluminum sheets shall be used. The Owner / Consultants reserve the right to summarily reject the sheets not meeting these requirements. Fabrication of ducts shall be through Lock forming machines. In case of factory fabricated duct the G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.

25.8.3 SPECIFICATIONS FOR SITE FABRICATED DUCTING:

All duct work, sheet metal fabrication unless otherwise directed, shall strictly meet requirements, as described in IS: 655-1963 with Amendment-I (1971 Edition) Longer size of Duct Sheet Thickness GI (MM) Type of Joints Bracing Up to 750 0.63 GI Flange - 751-1000 0.80 25x25x3 mm angle iron frame with 8 mm Dia nuts & bolts 25X25X3 MM @ 1M 1001-1500 0.80 40x40x5 mm angle iron frame with 8 mm Dia nuts & bolts 40x40x5 MM @1M 1501-2250 1.00 50x50x5 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center 40x40x3mm@ 1.2m to be braced diagonally. 2251 & above 1.25 50x50x6 mm angle iron frame with 10 mm Dia nuts 40x40x3mm @ 1.6m diagonally braced & bolts at 125 mm center Ducts larger than 450 mm shall be cross broken, duct sections up to 1200 mm length may be used with bracing angles omitted. Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 Deg. Angle from the axis of the main duct unless otherwise approved by the Engineer-in-Charge. All ducts shall be supported from the ceiling/slab by means of M.S. rods of 10 MM Dia with M.S. angle at the bottom of size 40 mm x 40 mm x 6 mm for sizes

up to 1500 mm at 3 m intervals. Above size 1500 mm upto 2250, support shall be provided with 10 mm dia. MS rod and MS angle size 50 mm x 50 mm at bottom at 2.5 m intervals. Above size 2250 mm support shall be provided with 12 mm dia MS rod and MS angle size 50 mm x 50 mm at bottom 3. INSTALLATION All ducts shall be fabricated and installed in workman like manner, generally conforming to relevant BIS codes. Round exposed ducts shall be die formed for achieving perfect circle configuration Ducts so identified on the drawing shall be acoustically lined and thermally insulated as described in the section 'Insulation' and as indicated in 'Schedule of Quantities. Duct dimensions shown in drawings are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in 'Schedule of Quantities'. Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made airtight. All exposed ducts upto 60 cm width within conditioned spaces shall have slip joints. The internal ends of the slip joints shall be in the direction of airflow. Ducts and accessories within ceiling spaces visible from air-conditioned areas shall be provided with two coats of matt black finish paint. Change in dimensions and shape of ducts shall be gradual. Air turns shall be installed in all vanes arranged to permit the air to make the turn without appreciable turbulence. Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees of ample size to keep the ducts true to shape and to prevent buckling, vibration or breaking. All sheets metal connections, partitions and plenums required to confine the flow of air to/ through the filters and fans shall be constructed of 18 Gauge GSS thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary inspection doors as required to give access to all parts of the apparatus. Doors shall be not less than 45cm X 45cm in size. Plenums shall be panel type and assembled at site. Fixing of MS angle iron flanges of duct pieces shall be with rivet heads inside i.e. Towards G.S. sheet and riveting shall be done from outside. Rubber gasket 3 mm thick shall be used between duct flanges and between duct and duct supports instead of felt in all ducting installation for complete sealing. During the construction, the Contractor shall temporarily close duct openings with sheet metal covers to prevent debris-entering ducts and to maintain opening straight and square, as per direction of Engineer-in-Charge. Great care should be taken to ensure that the ductwork does not extend outside and beyond height limits as noted on the drawings. All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be tight and shall be made in the direction of airflow. The ducts shall be reinforced where necessary, and must be secured in place so as to avoid vibration of the duct on its support. All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in I.S. specifications shall be adhered to and shall be considered as an integral part of these specifications. The ductwork shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted duct design and subject to the approval of the engineer-in-charge. The Contractor shall verify all measurements at building and shall notify the Engineer-in-Charge of any difficulty in carrying out his work before fabrication. Sponge rubber or approved equal gaskets shall be installed between all connections of sheet metal ducts to walls. Sheet metal connections shall be made to walls and floors by means of galvanized steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by Engineer-in-Charge. All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angel/channel under ducts. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the

hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles / channels shall be hung through these cleats. Wherever use of metal plates is not feasible, duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats. Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality thermo Cole around the duct prior to sealing of the opening. All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 100 mm long but not more than 200 mm, securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation. Flanges and supports are to be black, mild steel and are to be primer coated on all surfaces before erection and painted with aluminum thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified. The ductwork should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling Contractors.

25.8.4 SPECIFICATIONS FOR FACTORY FABRICATED DUCTING:

Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards (“HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995” SMACNA).

Duct Connectors and Accessories All transverse duct connectors (flanges / cleats) and accessories/related hardware are such as support system shall be zinc-coated (galvanized).

FABRICATION STANDARDS

All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory fabricated. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply. Coil lines to ensure location of longitudinal seams at comes / folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct. All ducts, transformation pieces and fittings to be made on CNC profile cutlers for required accuracy of dimensions, location and dimensions of notches at the folding lines. All edges to be machine treated using lock formers, flanges and rollers for fuming up edges. Sealant dispensing equipment for applying built-in sealants in Pittsburgh lock where sealing of longitudinal joints are specified will be used.

25.8.5 SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS :

Duct Construction shall be in compliance with 2” (500Pa) w.g. static norms as per SMACNA. All transverse connectors shall be similar to Rolamate 4-bolt slip-on flange system or equivalent of similar 4-bolt systems with built-in sealant if any to avoid any leakage additional sealant to be used. The specific class of transverse connector and duct gauge for a given duct dimensions will be 1”(250 Pa) pressure class. Non-toxic, AC -applications grade P.E. or PVC Casketing is required between all mating flanged joints. Gasket sizes should conform to flange manufacturer’s specification.

25.8.6 DUCT CONSTRUCTION

- The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.
- Dimensional Tolerances: All fabricated dimensions will be within ± 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be ± 1.0 mm per meter.
- Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.
- Ducts shall be straight and smooth on the inside Longitudinal seams shall be airtight and at comers only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.
- Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the tum without appreciable turbulence.
- Plenums shall be shop/factory fabricated panel type and assembled at site.

25.8.7 FACTORY FABRICATED RECTANGULAR GSS DUCTING:

All ducts shall be fabricated from galvanized steel / aluminum of the following thickness, as indicated as below: Rectangular Ducts G. S. External Pressure 500 Pa Duct Section Length 1.2 m (4 ft) Maximum Duct Size Gauge Joint Type Bracing Spacing 1–600 mm 24 C & SS Nil 601-750 mm 24 4 Bolt Transverse Duct Connector-E (TDC) with built in sealant Nil 751-1000 mm 22 4 Bolt TDC-E Nil 1001-1200 mm 22 4 Bolt TDC-H Nil 1201-1300 mm 20 4 Bolt TDC-J Nil 1301-1500 mm 18 4 Bolt TDC-J Nil 1501-1800 mm 18 4 Bolt TDC-J Nil 1801-2100 mm 18 4 Bolt TDC-J Nil 2101-2250 mm 18 4 Bolt TDC-J Nil 2251-2400 mm 18 4 Bolt TDC-J Nil 2401-2700 mm 18 4 Bolt TDC-J 600 'C'-cleat; 'S'-S cleat; 'SS'-Standing S cleat; 'AI' -Angle Iron in mm *Distance of reinforcement/bracing from each joint. Bracing material to be same as material used for joining duct sections.

NOTE:

a) DUCT USING LOCK FORMER MACHINE AT SITE SHALL NOT BE ACCEPTED.

b) MS FLANGES SHALL BE USED FOR DUCTS FOR THE AHU HAVING HEPA FILTERS.

- Fabrication Standard: All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the machines to provide the requisite quality of ducts. Coil lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct. All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines. All edges to be machine treated.
- Duct Construction: All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes. Ducts so identified on the Drawings shall be insulated from outside as described in the section “Insulation” and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps. Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness. All ducts up to 75cms width within conditioned spaces shall have slip

and drive (C & S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that S/SS Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint. Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence. Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing. All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size. Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside. Self adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

25.8.8 INSTALLATION

- During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.
- Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.
- All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.
- The ducts shall be re-in forced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.
- All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.
- Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.
- Flanges bracings and supports are to be sourced from the duct manufacturer. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
- Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.

- Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.
- Fire retarding flexible joints is to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-InCharge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.
- The flexible joints are to be not less than 75 MM and not more than 250 MM between faces. The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors. Duct passing through brick or masonary, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.
- The work shall meet with the approval of Consultant/customer in charge in all its parts and details All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required cross sectional area being maintained) all as per the site requirement. If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of consultant/customer in charge.
- All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle / channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners. Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Consultant / customer in charge. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor’s work in the building. All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation. Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

25.8.9 DOCUMENTATION TO MEASUREMENTS:

For each drawing, all supply of ductwork must be accompanied by computer generated detailed bill of material indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable. Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise. All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

25.8.10 TESTING:

After duct installation, a part of duct section (approximately 5% of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA- “HVAC Air Duct Leakage Test Manual: (First Edition). All duct supports, flanges, hangers and damper boxes etc shall be given 2 coats of red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost. All angle iron flanges are to be welded electrically and holes to be drilled. All the angle iron flanges are to be connected to the GSS ducts by rivets at 100 mm centers. After completion, all duct system shall be tested for air leakage. The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance of air quantity through each outlet shall be submitted to the engineer-in-charge for approval. Measured air quantities at fan discharge and at various outlets shall be identical to or less than 5% in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time.

26 IMPORTANT INDIAN STANDARDS

26.1 CODES OF PRACTICE GUIDE

SN	Standard	Title	Reaffirm Date	Amendment
(1)	IS 732:1989	Code of practice for electrical wiring installations (third revision)	March 2010	
(2)	IS 4648:1968	Guide for electrical layout in residential buildings	August 2012	
(3)	IS 8061:1976	Code of practice for design, installation and maintenance of service lines upto and including 650 V	March 2011	
(4)	IS 8884:1978	Code of practice for the installation of electric bells and call systems	August 2012	
(5)	IS 5578:1984/ IEC 60391 (1972)	Guide for marking of insulated conductors (first revision)	March 2011	
(6)	IS 11353:1985/ IEC 60445 (1973)	Guide for uniform system of marking and identification of conductors and apparatus terminals	July 2012	
(7)	IS 13234:1991/ IEC 60909: 1988	Guide for short circuit current calculations in three- phase ac systems (superseding IS 5728)	August 2012	
(8)	IS 7752 (Part 1): 1975	Guide for improvement of power factor in consumer installation: Part 1 Low and medium supply voltages	March 2011	
(9)	IS 3646 (Part 1): 1992	Code of practice for interior illumination: Part 1 General requirements and recommendations for working interiors (first revision)	March 2008	
(10)	IS 3646 (Part 2): 1966	Code of practice for interior illumination: Part 2 Schedule of illumination and glare index	March 2008	
(11)	IS 3646 (Part 3): 1968	Code of practice for interior illumination: Part 3 Calculation of coefficients of utilization by the BZ method	March 2008	
(12)	IS 4347:1967	Code of practice for hospital lighting	May 2010	
(13)	IS 6665:1972	Code of practice for industrial lighting	May 2010	
(14)	IS 2672:1966	Code of practice for library lighting	May 2010	

(15)	IS 10118 (Part 1):1982	Code of practice for selection, installation and maintenance of switchgear and controlgear: Part 1 General	March 2011	
(16)	IS 10118 (Part 2):1982	Code of practice for selection, installation and maintenance of Switchgear and controlgear: Part 2 Selection	March 2011	
(17)	IS 10118 (Part 3):1982	Code of practice for selection, installation and maintenance of switchgear and controlgear: Part 3 Installation	March 2011	
(18)	IS 10118 (Part 4):1982	Code of practice for selection, installation and maintenance of switchgear and controlgear: Part 4 Maintenance	March 2011	
(19)	IS 4146:1983	Application guide for voltage transformers (first revision)	September 2011	
(20)	IS 4201:1983	Application guide for current transformers (first revision)	September 2011	
(21)	IS 5547:1983	Application guide for capacitor voltage transformers (first revision)	September 2011	
(22)	IS 2309:1989	Code of practice for protection of buildings and allied structures against lightning (second revision)	March 2010	1
(23)	IS 3043:1987	Code of practice for earthing	March 2011	2
(24)	IS 5216 (Part 1):1982	Recommendations on safety procedures and practices in electrical work: Part 1 General (first revision)	March 2010	
(25)	IS 5216 (Part 2):1982	Recommendations on safety procedures and practices in electrical work: Part 2 Life saving techniques (first revision)	March 2010	

26.2 ELECTRIC FANS: CODES OF PRACTICE GUIDE

Sl. No	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 555:1979	Electric table type fans and regulators (third revision)	July 2010	2
(2)	IS 1169:1967	Electric pedestal type fans and regulators (first revision)	Mar 2009	6

(3)	IS 374:1979	Electric ceiling type fans and regulators (third revision)	September 2010	6
(4)	IS 2997:1964	Air circulator type electric fans and regulators	July 2010	8
(5)	IEC: 60665 (1981) IS 2312:1967	Propeller type ac ventilating fans (first revision) Draft Standard issued in wide circulation	July 2010	8
(6)	IS 3588:1987	Electric axial flow fans (first revision)	August 2009	1
(7)	IS 3963:1987	Roof extractor units (first revision)	August 2009	3
(8)	IS 4283:1981	Hot air fans (first revision)	August 2009	3
(9)	IS 6272:1987	Industrial cooling fans (man coolers) (fi rst revision)	August 2009	2
(10)	IS 4894:1987	Centrifugal fans (first revision)	August 2009	3
(11)	IS 11037:1984	Electronic type fan regulators	August 2010	3
(12)	IS 12155:1987	General and safety requirements for fans and regulators for household and similar purposes		

26.3 LOW VOLTAGE SWITCH GEAR AND CONTROL GEAR CODES OF PRACTICE GUIDE

Sl.No	Standard	Title	Reaffirm Date	ıdt.
(1)	IS 4237:1982	General requirements for switchgear and controlgear for voltages not exceeding 1000 volts ac or 1200 volts dc (first revision) [superseded by IS 13947 (Part 1):1993]		
(2)	IS 6875 (Part 1): 1973	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac & 1200 V dc: Part 1 General requirements [superseded by IS 13947 (Part 5/Section 1)]		
(3)	IS 6875 (Part 2): 1973	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac and 1200 V dc: Part 2 Push-buttons and related		

(4)	IS 6875 (Part 3): 1980	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac and 1200 V dc: Part 3 Rotary control switches [superseded by IS 13947 (Part 5/ Section 1)]		
(5)	IS 10027:2000	Composite units of air-break switches and rewirable type fuses for voltages not exceeding 650 volt ac - Specification (first revision)	March 2010	
(6)	IS 4064 (Part 1):	Air-break switches, air break disconnectors, air- break switch disconnectors and fuse-combination units for voltages not exceeding 1000 V ac or 1200 V dc: Part 1 General requirements (revised) [superseded by IS 13947 (Part 3): 1993]		
(7)	IS 2675:1983	Enclosed Distribution Fuse Boards and Cut Outs for voltages not exceeding 1000 V A.C. or 1200 V D.C.	March 2011	
(8)	IS 8828:1996	Circuit-breakers for over current protection for household and similar installations (second revision)		
(9)	IS 13032:1991	Miniature circuit breaker boards for voltage upto and including 1 000 Volt ac	March 2011	1
(10)	IS 12640 (Part 1): 2008	Residual current operated circuit-breakers for household and simililar uses: Part 1 circuit-breakers without integral over current protection (RCCBs) (First Revision)		
(11)	IS 12640 (Part 2): 2008	Residual current operated circuit-breakers for household and similar uses: Part 2 circuit breakers with integral over current protection (RCBOs) (First Revision)		
(12)	IS 2959:1985	Contactors for voltages not exceeding 1000 V ac or 1200 V dc (first revision) [superseded by IS 13947 (Part 4/Section 1)]		
(13)	IS 12021:1987	Specification for control transformers for switchgear and control gear for voltages not exceeding 1000 Volt AC	March 2010	2

(14)	IS 5039:1983	Distribution pillars for voltages not exceeding 1000 volts (first revision)	March 2011	2
(15)	IS 8623 (Part 1): 1993/ IEC 60439-1 (1985)	Specification for low voltage switchgear and controlgear assemblies: Part 1 Requirements for type-tested and partially type tested assemblies (first revision).	March 2008	2
(16)	IS 8623 (Part 2):1993/ IEC 60439-2 (1987)	Specification for low voltage switchgear and controlgear assemblies: Part 2 Particular requirements for busbar trunking systems (busways)-(first revision)	March 2008	2
(17)	IS 8544 (Part 1): 1977	Motor starters for voltages not exceeding 1000 V: Part Direction line ac starters [superseded by IS 13947 (Part 4/Section 1): 1993]		2
(18)	IS 8544 (Part 2): 1977	Motor starters for voltages not exceeding 1000 V: Part 2 Star-delta starters [superseded by IS 13947 (Part 4/ Section 1): 1993]		
(19)	IS 8544 (Part 3/ Sec 1): 1979	Motor starters for voltages not exceeding 1000 V: Part 3 Rheostatic motor starters, Section 1 General requirements [superseded by IS 13947 (Part 4/Section 1): 1993]		
(20)	IS 8544 (Part 4): 1979	Motor starters for voltages not exceeding 1000 V: Part 4 Reduced voltage ac starters: two step auto-transformer starters [superseded by IS 13947 (Part 4/Section 1): 1993]		

26.4 POWER CABLE CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 694:1990/ IEC 60227-1 to 5 (1979)	PVC Insulated cables for working voltages upto and including 1100 V	February 2010	5

(2)	IS 694: 2010	Polyvinyl chloride insulated sheathed and unsheathed cables with rigid and flexible conductor for rated voltages upto and including 450/750 V: Part 1 General requirements (fourth revision)		
(3)	IS 1554 (Part 1): 1988/ IEC 60502 (1983)	PVC insulated (heavy duty) electric cables: Part 2 For working voltages upto and including 1100 V (Third revision)		
(4)	IS 3961 (Part 1): 1967	Recommended current ratings for cables: Part 1 Paper insulated lead sheathed cables	November 2011	
(5)	IS 4288:1988	PVC insulated (heavy duty) electric cables with solid aluminium conductors for voltages upto and including 1100 V (second revision) (withdrawn)		
(6)	IS 4289 (Part 1):1984/ IEC 60245-5	Flexible cables for lifts and other flexible connections: Part 1 Elastomer insulated cables (first revision)		

26.5 ELECTRIC WIRING ACCESSORIES CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 9537 (Part 1): 1980/ IEC 60614-1 (1978)	Conduits for electrical installations: Part 1 General Requirements	November 2010	(1)
(2)	IS 9537 (Part 2): 1981	Conduits for electrical installations: Part 2 Rigid steel conduits (superseding IS:1653)	May 2012	(2)
(3)	IS 3480:1966	Flexible steel conduits for electrical wiring	May 2012	(1)
(4)	IS 2667:1988	Fittings for rigid steel conduits for electrical wiring (first revision) [Superseded by IS 14768 (Part 2): 2003]	February 2008	

(5)	IS 3837:1976	Accessories for rigid steel conduits for electrical wiring (first revision)	May 2012	(1)
(6)	IS 9537 (Part 4): 1983	Conduits for electrical installations: Part 4 Pliable self- recovering conduits of insulating materials	May 2012	
(7)	IS 9537 (Part 5): 2000/ IEC 60614-2-3 (1990)	Conduits for a electrical installations: Part 5 Pliable conduits of insulating material [Superseding IS 6946]	June 2010	
(8)	IS 3419:1989 IS 14772:2000/	Fittings for rigid non-metallic conduits (second revision) Enclosures for accessories for household and similar	May 2012	
(9)	IEC 60670-1 (1989)	Fixed Electrical Installations [Superseding IS 5133 (Part 1 and 2)]	May 2010	
(10)	IS 2412:1975	Link clips for electrical wiring (first revision)	May 2012	(2)
(11)	IS 371:1999	Ceiling roses (third revision)	March 2010	(4)
(12)	IS 3854:1997/ IEC 60669-1 (1998)	Switches for domestic and similar purposes (second revision)	July 2012	(6)
(13)	IS 4615:1968	Switch-socket outlets (non-interlocking type) (Withdrawn)		
(14)	IS 4160:2005/ IEC 60884-2-6 (1997)	Interlocking switch socket outlets - Specification (first revision)	June 2010	
(15)	IS 1293:2005/ IEC 60884-1 (2002)	Plugs and socket outlets of rated voltage upto and including 250 volts and rated current upto and including 16 amperes - Specification (third revision)	June 2010	(5)

26.6 ELECTRICAL LAMPS AND THEIR AUXILIARIES CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.

(1)	IS 418:2004/ IEC 60064	Tungsten filament lamps for domestic and similar general lighting purposes (fourth revision)	March 2009	(4)
(2)	IS 2418 (Part 1): 1977/ IEC 81 (1974)	Tubular fluorescent lamps for general lighting service: Part 1 Requirements and tests (first revision)	December 2010	(8)
(3)	IS 9900 (Part 1): 1981 / IEC 188 (1974)	High pressure mercury vapour lamps: Part 1 Requirements and test [Superseding IS 2183 and IS 7023]	October 2012	(4)
(4)	IS 9974 (Part 1): 1981/ IEC 662 (1980)	High pressure sodium vapour lamps: Part 1 General requirements and tests	October 2012	(4)
(5)	IS 1258:2005/ IEC 61184 (1997)	Bayonet lamp holders (fourth revision)	June 2010	(3)
(6)	IS 3323:1980/ IEC 0400(1972)	Bi-pin lampholders for tubular fluorescent lamps	October 2012	(1)
(7)	IS 3324:1982/ IEC 400 (1972)	Holders For Starters For Tubular Fluorescent Lamps	June 2008	
(8)	IS 2215:2006/ IEC 60155 (1993)	Starters for fluorescent lamps (third revision)	Jun 2010	
(9)	IS 1534 (Part 1): 1977 / IEC 82 (1973)	Ballasts for fluorescent lamps: Part 1 For switch start circuits (second revision)	July 2011	(5)
(10)	IS 1569:1976/ IEC 566	Capacitors for use in tubular fluorescent	July 2011	(1)
(11)	IS 6616:1982/ IEC 262 (1969)	Holders For Starters For Tubular Fluorescent Lamps	July 2011	

26.7 LIGHT FITTINGS AND LUMINAIRES CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 1913 (Part 1): 1978	General and safety requirements for luminaires: Part 1 Tubular fluorescent lamps (second revision)		
(2)	*IS 10322 (Part 1):1982 / IEC 598 - 1(1979)	Luminaires: Part 1 General requirements	May 2010	
(3)	IS 10322 (Part 2): 1982 / IEC 598 - 1(1979)	Luminaires: Part 2 Constructional Requirements	May 2010	
(4)	IS 10322 (Part 5/ Sec. 2):2012	Luminaires: Part 5 Particular requirements, Sec 2 Recessed luminaires (First Revision)	March 2012	
(5)	IS 10322 (Part 5/ Sec. 3):2012/ IEC 60598-2-3 (1979)	Luminaires: Part 5 Particular requirements, Sec 3 Luminaires for road and street lighting (First revision)	March 2012	
(6)	IS 10322 (Part 5/ Sec 4):1987/ IEC 60598-2-4 (1979)	Luminaires: Part 5 Particular requirements, Section 4 Portable general purpose	May 2010	1
(7)	IS 10322 (Part 5/ Sec 5):1987/ IEC 60598-2-5	Luminaires: Part 5 Particular requirements, Section 5 Flood lights [superseding IS 1947]	May 2010	(1)
(8)	IS 3287:1965	Industrial lighting fittings with plastic reflectors		
(9)	IS 1777:1978	Industrial luminaires with metal reflectors (first revision)		
(10)	IS 2206 (Part 1): 1984	Flameproof electric lighting fittings: Part 1 Well-glass and bulkhead types (first revision)		
(11)	IS 3528:1966	Waterproof electric lighting fittings	May 2010	

(12)	IS 3553:1966	Watertight electric lighting fittings	May 2010	
(13)	IS 8030:1976/ IEC 162 (1972)	Luminaires for hospitals	March 2008	
(14)	IS 7537:1974	Road traffic signals	March 2008	
(15)	IS 9583:1981/ IEC 598-2-22	Emergency lighting units	March 2008	

26.8 ELECTRICAL APPLIANCES

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 302 (Part 1): 2008/ IEC 60335-1 (2006)	Safety of household and similar electrical appliances: Part 1 General requirements (sixth revision)		(1)
(2)	IS 2268:1994	Electric call bells and buzzers for indoor use (second revision)	March 2009	
(3)	IS 3412:1994	Electric water boilers (second revision)	March 2009	

26.9 ELECTRICAL INSTRUMENTS CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 6236:1971/ IEC 60258 (1968)	Direct recording electrical measuring Instruments	January 2010	
(2)	IS 1248(Part 1): 2003/ IEC 600 51-1 (1997)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 1 General requirements (fourth revision)	Sep 2008	
(3)	IS 1248(Part 2): 2003/ IEC 600 51-2 (1984)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 2 Ammeters and voltmeters (third revision)	Aug 2008	

(4)	IS 1248(Part 3): 2003/ IEC 600 51-3 (1984) IS 1248(Part 4):	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 3 Wattmeters and varmeters (third revision) Direct acting indicating analogue electrical measuring	Aug 2012	
(5)	2003/ IEC 600 51-4 (1984)	instruments and their accessories: Part 4 Frequency meters (third revision)	Aug 2008	
(6)	IS 1248 (Part 5): 2003/ IEC 600 51-5 (1984)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 5 Phase meters, power factor meters and synchroscope (third revision)	Aug 2008	
(7)	IS 722(Part 1): 1998	AC electricity meters: General requirement and tests		
(8)	IS 722 (Part 2): 1977	AC electricity meters: Part 2 Single-phase whole-current watt-hour meters, Class 2 (first revision)		
(9)	IS 722 (Part 3): 1988	AC electricity meters: Part 3 Three-phase whole current and transformer operated and single-phase transformer operated watt-hour meters, class 2 (second revision)		
(10)	IS 722 (Part 5): 1980	AC electricity meters: Part 5 Volt-ampere hour meters for restricted power factor range, class 3.5 (first revision)		
(11)	IS 722 (Part 7/Sec 1): 1987	AC electricity meters: Part 7 Volt-ampere hour meters for full power factor range, Section 1 General requirements (first revision)		
(12)	IS 722 (Part 8): 1972	AC electricity meters: Part 8 Single-phase 2- wire whole current watt-hour meter (class 1.0)		
(13)	IS 722 (Part 9): 1972	AC electricity meters: Part 9 Three-phase whole current and transformer operated watt-hour meters and single- phase two-wire transformer operated watt-hour meters (class 1.0)		
(14)	IS 8530: 1977 IEC 60211:1966 *IS 2992:1987	Maximum demand indicators (class 1) Insulation resistance testers, hand operated (magneto generator type) (second revision		

26.10 INSTRUMENT TRANSFORMERS CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 2705 (Part 1):1992/ IEC 60185 (1966)	Current transformers: Part 1 General requirements (second revision)	Aug 2012	(1)
(2)	IS 2705 (Part 2):1992/ IEC 60185 (1966)	Current transformers: Part 2 Measuring current transformers (second revision)	Aug 2012	
(3)	IS 2705 (Part 3): 1992/ IEC 60185 (1966)	Current transformers: Part 3 Protective current transformers (second revision)	Aug 2012	
(4)	IS 2705 (Part 4): 1992/ IEC 60185 (1966)	Current transformers: Part 4 Protective current transformers for special purpose applications (second revision)	Aug 2012	
(5)	IS 6949:1973	Summation current transformers	Sep 2011	

26.11 FUSES CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 9224 (Part1): 1979	Low voltage fuses: Part 1 General requirements superseded by IS 13703 (Part 1):1993]		
(2)	IS 9224 (Part 2): 1979	Low voltage fuses: Part 2 Supplementary requirements for fuses for industrial applications (superseding IS 2208) [superseded by IS 13703 (part 2/Section 1):1993]		
(3)	IS 2086:1993	Carriers and bases used in rewirable type electric fuses for voltages upto 650 V (third revision) [Superseding IS 8724]	Mar 2009	(1)

(4)	IS 9926:1981	Fuse wires used in rewirable type electric fuses upto 650 volts	Mar 2011	
(5)	IS 8187:1976/ IEC 269-3 (1973)	D-type fuses		

26.12 MISCELLANEOUS CODES OF PRACTICE GUIDE

Sl.No	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 2551:1982	Danger notice plates (first revision)	Mar 2010	
(2)	IS 2448 (Part 1): 1963	Adhesive insulating tapes for electrical purposes: Part 1 Tapes with cotton textile substrates	Oct 2010	(5)

26.13 ELECTROTECHNICAL VOCABULARY CODES OF PRACTICE GUIDE

Sl.No	Standard	Title	Reaffirm Date	Amdt
(1)	IS 1885 (Part 1): 1961	Electrotechnical vocabulary: Part 1 Fundamental Definitions	Jul 2012	(2)
(2)	IS 1885 (Part 9): 1992/ IEC 60050 (446):1983	Electrotechnical Vocabulary: Part 9 Electrical relays (second revision)	Jul 2012	
(3)	IS 1885 (Part 11): 1966	Electrotechnical vocabulary: Part 11 Electrical Measurements	Jul 2012	
(4)	IS 1885 (Part 16/ Sec 1):1968	Electrotechnical vocabulary: Part 16 Lighting, Section 1 General aspects	Jul 2012	
(5)	IS 1885 (Part 16/ Sec. 2):1968	Electrotechnical vocabulary: Part 16 Lighting, Section 2 General illumination, lighting fittings and lighting for traffic and signaling	Jul 2012	
(6)	IS 1885 (Part 16/ Sec. 3):1967	Electrotechnical vocabulary: Part 16 Lighting, Section 3 Lamps and auxiliary apparatus	Jul 2012	

(7)	IS 1885 (Part 17): 1979	Electrotechnical vocabulary: Part 17 Switchgear and controlgear (first revision)	Jul 2012	
(8)	IS 1885 (Part 32):1993/IEC 60050 (461):1984	Electrotechnical Vocabulary: Part 32 Electric cables (first revision)	Mar 2009	

26.14 SAFETY CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 15652 : 2006	Insulating Mats For Electrical Purposes	2016	

27 SPECIAL NOTE REGARDING SELECTION OF EQUIPMENT & FITTINGS

The following minimum requirements shall be complied with by the EPC Contractor for selection of all electrical equipment, fittings and accessories:

1. All electrical equipment, fittings, accessories and materials supplied under this contract shall be BIS/IS certified and shall conform to the relevant Indian Standards.
2. Wherever applicable, all electrical equipment shall be BEE 5-Star rated (latest applicable version) to promote energy efficiency.
3. For equipment categories where BEE Star Rating is not available, the products shall be BIS/IS certified and shall comply with the latest Energy Conservation and Sustainable Building Code (ECSBC), Indian Green Building Council (IGBC) requirements and other applicable energy efficiency guidelines. Preference shall be given to the most energy-efficient products available.
4. The make, model and technical specifications of all equipment and materials proposed by the EPC Contractor shall be subject to the approval of the Bank/PMC prior to procurement and installation.
5. Unless otherwise specified, the latest editions of all applicable Indian Standards (IS), BIS specifications, IEC Standards (where adopted), including all amendments, revisions and corrigenda issued up to the date of submission of bid, shall be deemed to form part of this tender and shall be complied with.
6. Similarly, the latest applicable versions (including amendments and revisions) of all relevant statutory codes, regulations and technical specifications, including but not limited to the following, shall be complied with:
    - National Building Code of India (NBC);
    - Central Public Works Department (CPWD) General Specifications;
    - Energy Conservation and Sustainable Building Code (ECSBC);
    - Indian Green Building Council (IGBC) guidelines/requirements;
    - Central Electricity Authority (CEA) Regulations;
    - Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations;
    - Applicable State Electricity Distribution Company regulations;
    - Any other relevant statutory codes, standards and regulations applicable to the works.
7. In case of any conflict between this tender specification and the applicable statutory codes or standards, the more stringent requirement shall prevail. Any deviation shall require the prior written approval of the Bank/PMC.
8. The EPC Contractor shall ensure that all equipment and installations comply with the above requirements without any additional cost to the Bank.

28 APPROVED MAKE OF MATERIALS

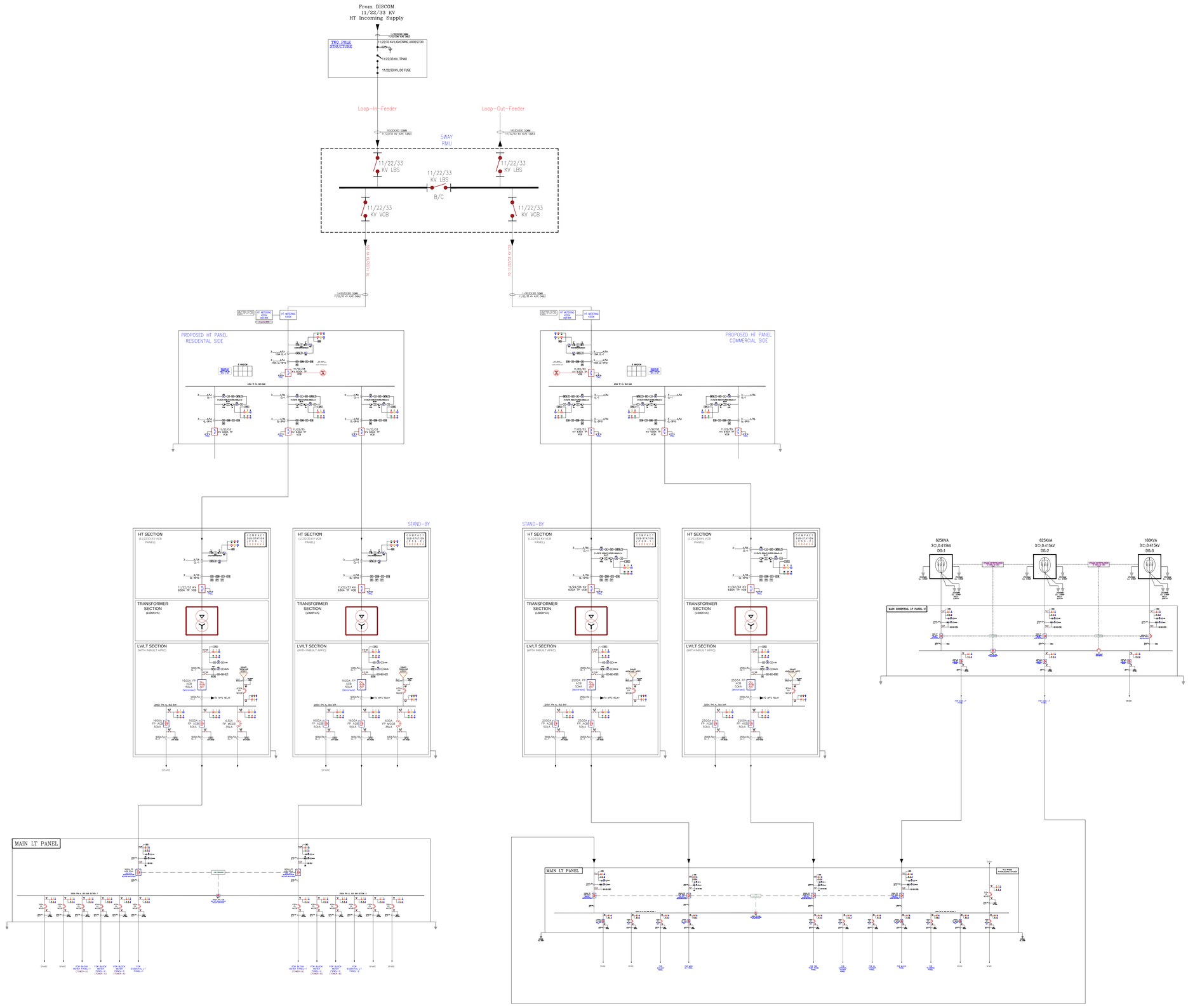
S.No.	Detail of Materials	Manufacture's Name/Make
1.	Switch, plug Socket, TV socket, telephone socket, cover plate, G.I. box e t c .	LEGRAND (MYRIUS)/MK Honeywell Blenz/ Schnieder Unica Plus
2.	FRLSH PVC insulated copper conductor stranded flexible wire (pre twisted).	POLYCAB/RR Kable / Finolex/ V-Guard
3.	Heavy Guage PVC FRLSH Conduit (ISI approved) &Heavy Duty Accessories for PVC Conduit.	Panasonic / Astral/Supreme/Prince/Polycab/ Precision
4.	RACEWAY	LEGRAND/Obo/Honeywell
5.	Lighting Fixtures	
a.	LED (Indoor)	Lighting Technology/ Philips/ Crompton/ Wipro
b.	External Lighting Fixture (LED).	Lighting Technology/ Philips/ Crompton/ Wipro
c.	Aviation Obstruction Light (LED Type).	Bajaj /Lighting Technology / Wipro /Philips
6.	BLDC Ceiling Fan/Exhaust Fan/Wall Mounting fan. (All full metal body)	Crompton/ Orient/Atomberg/Bajaj
7.	DISTRIBUTION BOARD.	Hager, Schnieder, Legrand, Siemens, LK
8.	Moulded Case Circuit Breaker (MCCB) 3 & 4 with rotary operating mechanism).	Schneider Electric NXS/ LK Dzor Dsin / Legrand DPX/ Seimens
9.	Miniature Circuit Breaker (MCB) & Distribution Boards	Schneider Electric / Hager / LK Exora /Legrand- DX3/ Panasonic/ Seimens

10.	LT Panel, HVAC Panel, plumbing panel, firefighting panel, Power Distribution Panel and Motor Control Centre /Fire panel/ Capacitor Panels/ DG Synchronizing Panel (All LT Panels)	Authorised System integrator or Channel Partner of ABB / Schneider/ Seimens / LK / legrand
11.	Rising Main/ Bus duct.	LK, Legrand, Schneider, RR Global
12.	Air Circuit Breaker(3/4Pole).	LK Omega Series /Siemens 3WL/Schneider Electric NW / Legrand DMX3
13.	Earth Leakage Circuit Breaker (ELCB)/ Residual Circuit Breaker (RCCB / RCBO's)	Schneider Electric/Hager/ LK / Legrand / Seimens
14.	Cable Trays.	Obo betterman, NPES, legrand,
15.	Polycarbonate Junction Boxes	Hensel/Spelsberg/HPL/Trinitytouch/ctmengg
16.	Terminal Blocks	ConnectWellElmex/Wago/PHOENIX
17.	Industrial Socket(Metal Clad).	Legrand/ Hager / Siemens /LK
18.	G.I. octagonal Lighting Poles.	Bajaj / Twinkle /Valmount
19.	Overload relay switch built in	Siemens/Schneider Electric/ABB/ LK
20.	Protection Relay	
a.	Numeric Type	ABB/GE/Schneider/Siemens/LK
b.	Electromagnetic Type	ABB/Schneider/LK
21.	Automatic Power Factor Correction Relay (Numeric Type)	Beluk(Germany)/Conzerv/Siemens/English Electric/ EPCOS/LK

22.	Electronic Digital Meters (A/V/PF/Hz/KW/KWH) (Networkable)/ Static Meters/Trivector Meter	Shneider/Socomec/Siemens/Conzerv/LK
23.	HT panel.	ABB /Seimens/Schneider Electric/Legrand/LK /
24.	Vacuum Circuit Breaker/RMU	Siemens/Schneider Electric/ABB/ LK (DISCOM Approved)
25.	Power/Aux.Contactor3/4pole	Siemens/Schneider Electric/ABB/ LK
26.	Off-Load/ON-Load Changeovers & ATS (Automatic transfer switch)	Siemens/Schneider Electric/ABB/ LK
27.	Selector Switch, Toggle switch	Kaycee/ Rishabh/Salzer (LK)
28.	Power Capacitor	Ducatti/Meher(LK)/Siemens(Epcos)/C&S
29.	Potential Transformers	Automatic Electric, Gilbert &Maxwell Kappa ,Matrix
30.	Current Transformer (Epoxy Cast Resin)	Kappa/Matrix/Automatic Electric/Gilbert& Maxwell
31.	Indicating Lamps LED type, Push Button	GE Power Controls Schneider Electric (MG) Siemens Ltd /C&S
32.	Compact Substation with Dry type Transformer	Voltamp/ABB/ Schneider/ SIEMENS/ Kirloskar/ CG
33.	DG Set with acoustic enclosure	Cummins / KOEL / Mahindra / Greaves (Alternator: Cummins / KOEL / Crompton Greaves (CG) / Stamford / Kirloskar Engine: Cummins/ Perkins/ Kirloskar / Mahindra /Ggreaves)
34.	Motors(Energy Efficient Class–I)	Kirloskar/Crompton/Siemens/ABB

35.	PVC insulated XLPE aluminum /copper conductor armored MV Cables upto1100Vgrade.	Polycab / KEI / RR Cable / Finolex
36.	HT Cable.	Polycab / KEI / RR Cable / Finolex
37.	LT &HT Jointing Kit/Termination	Raychem/M-Seal/Birla-3M
38.	Cable Glands Double Compression with earthing links.	COSMOS/Comet/3D/3M/TrinityTouch
39.	Bimetallic/Copper/Aluminum Cable Lug	Comet/3D/Dowell's/3M/TrinityTouch
40.	Rubber Mats(ISI mark)	Jyoti/Millars/Safevolt/Maruti Electromat/Dozz
41.	Fire Sealant	Promat/Hilti /3M / Armacell
42.	Solar panels	Waree / Adani Solar / Tata power Solar / Vikram Solar
43.	Solar Inverters	Deye / Polycab / Growatt / Sungrow / Feston
44.	Solar water heating systems	Racold / V-Guard / Supreme Solar
45.	Earthing/Earthing materials.	Ashlok/Erico/Galaxy/OBO/Valtree/BMI / JMV
46.	Lifts & Escalators	Mitsubishi/Otis/Schindler/ Johnson/Kone/ Thyssen Krupp
47.	Lighting protection.	ABB/ HAKEL/LPI / JMV
48.	Mounting Mast.	ABB/ HAKEL/LPI/ JMV
49.	OPR Lighting Flash counter.	ABB/ HAKEL/LPI/ JMV
50.	25 x 3mm copper down conductor.	ABB/ HAKEL/LPI/ JMV
51.	Test Clamp.	ABB/ HAKEL/LPI/ JMV

52.	IBMS.	Siemens/ Honeywell / Panasonic
53.	EV Charging Stations	ABB, Siemens, Tata Power, Jio-Pulse, Delta, Panasonic, Luby
54.	PIR Occupancy sensors	Legrand / Scneider / Hager
55.	Electronic Timers (24 hr)	Legrand / Hager / Schneider / LK
56.	Telephone Cables (CAT 5E) & Data cables Cat-6E (Wi-Fi)	D-Link / Finolex / Amp / Systemax
57.	RG-6 Co-axial cables (TV)	Polycab / Finolex /RR cable / V Guard
58.	OFC	Sterlite / HFCL / Polycab / Finolex
59.	Data I/O outlets	D-Link / Finolex / Amp / Systemax



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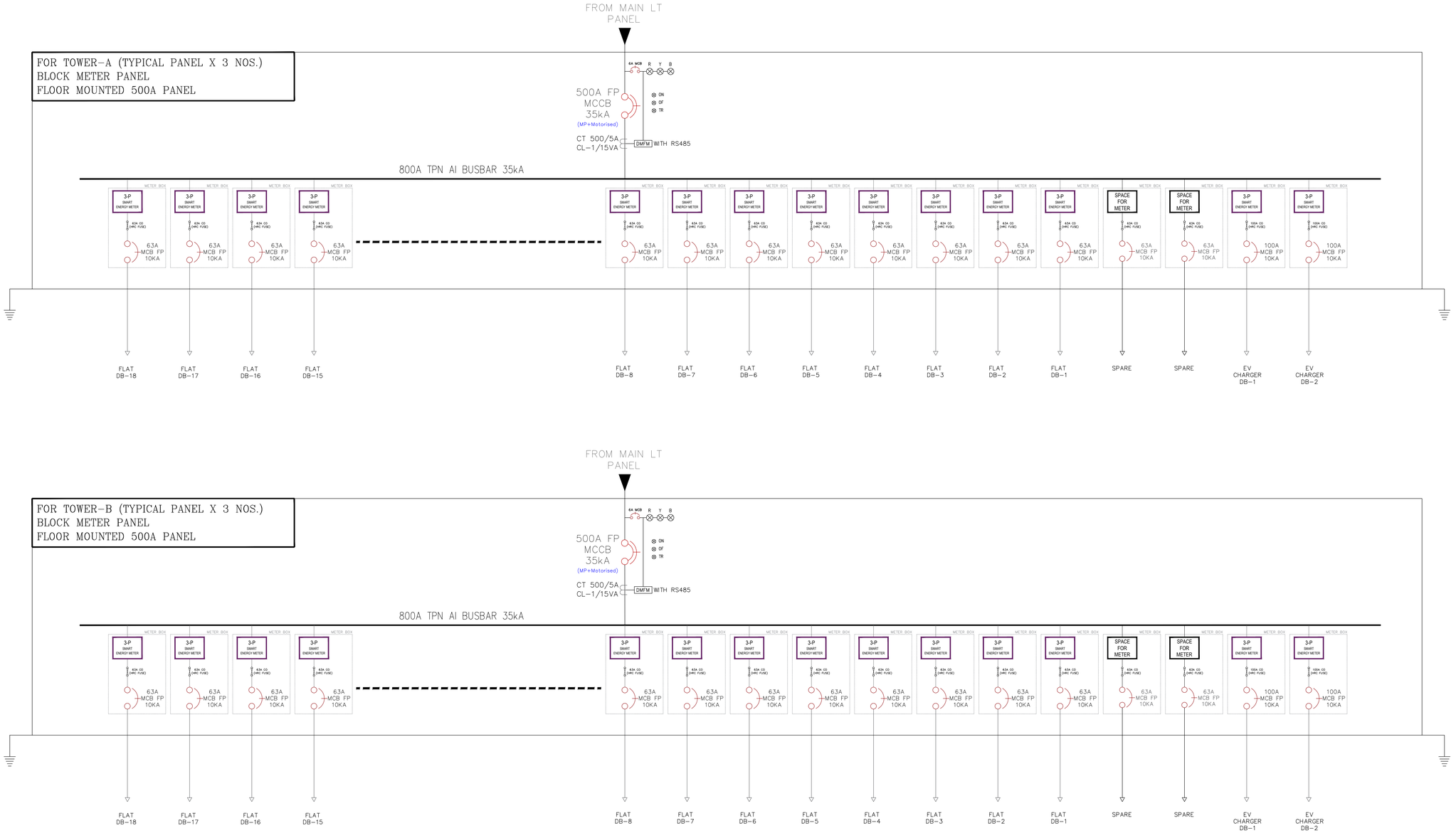

NOTE :

1. FOR EACH FLAT DB - 6 WAY TPN DB (DOUBLE DOOR) WITH 63A FP MCB INCOMER WITH 25A 30mA DP RCCB AT EACH PHASE AS SUB-INCOMER.

2. OUTGOING MCB RATING AND WIRE SIZES AS PER CPWD INTERNAL SPECIFICATION 2023.

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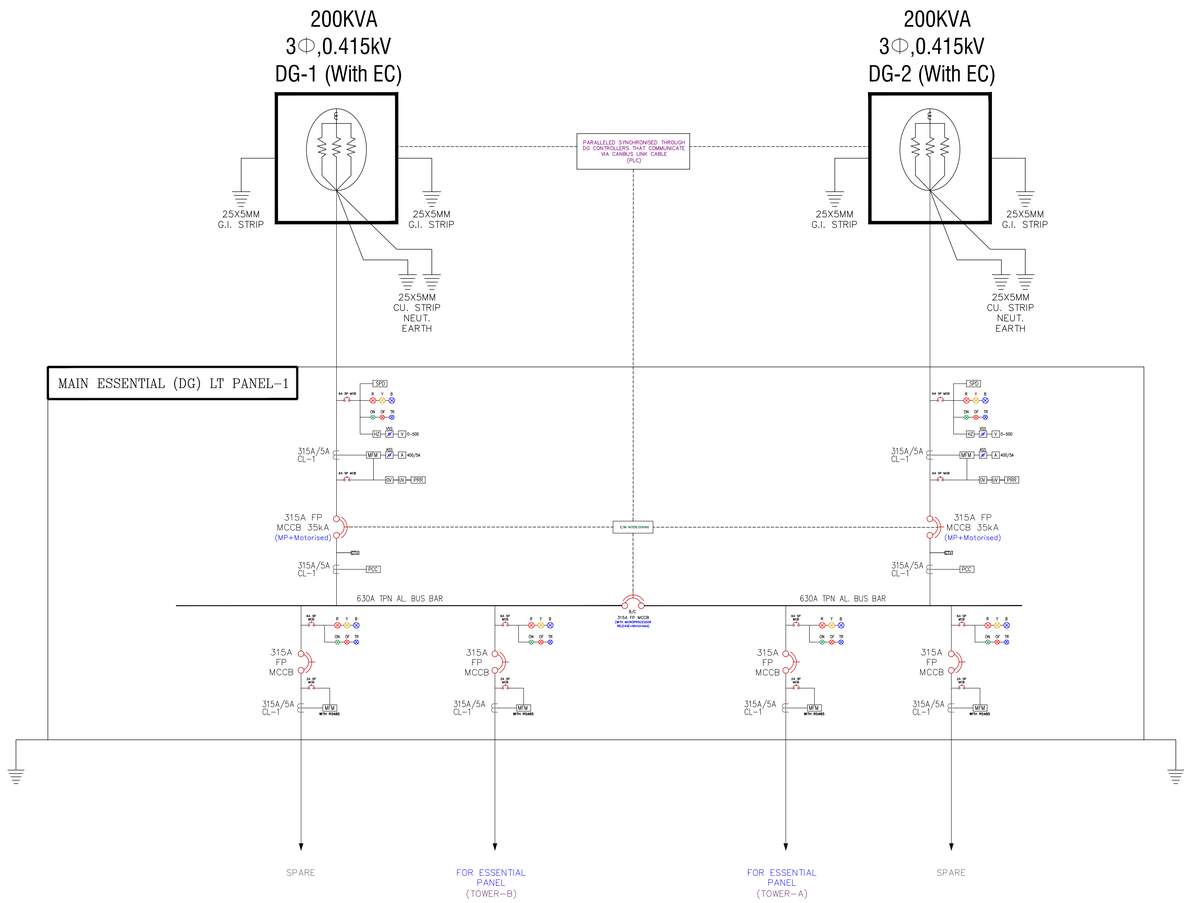

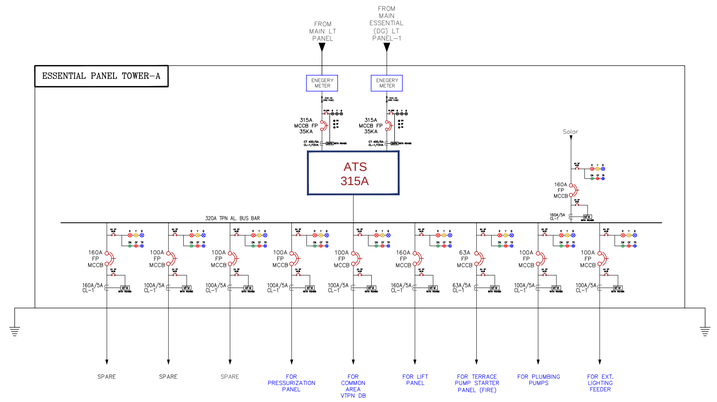

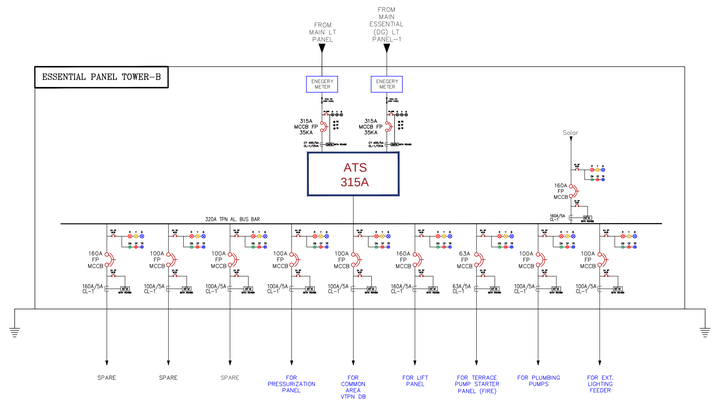

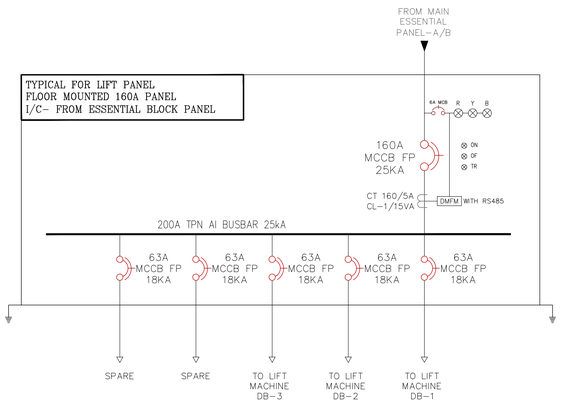

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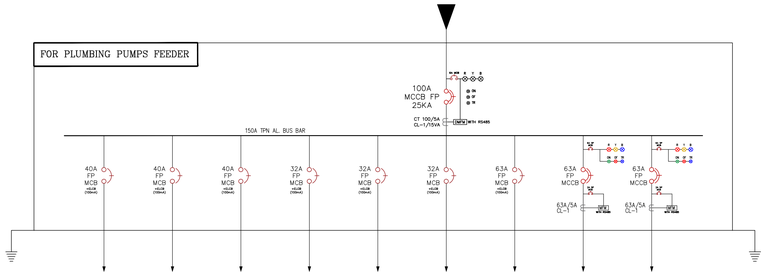

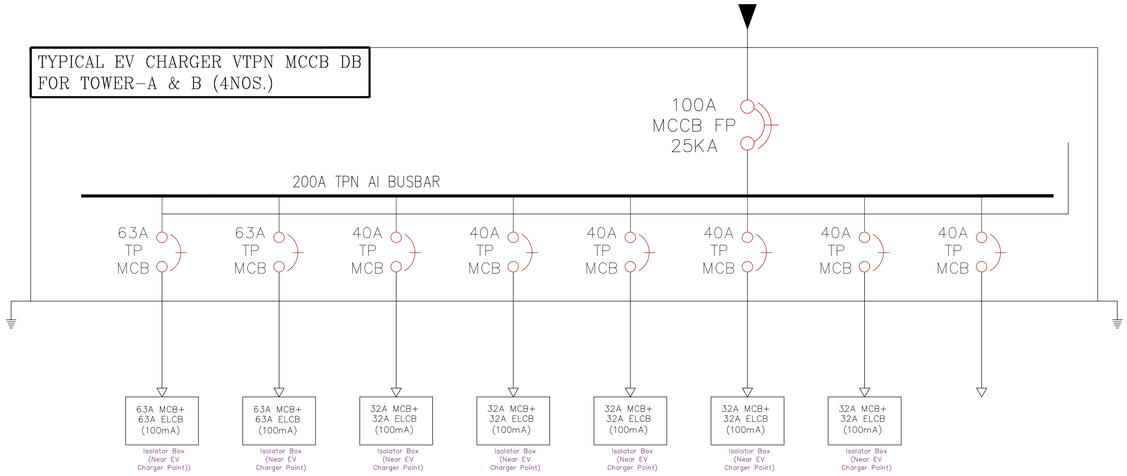

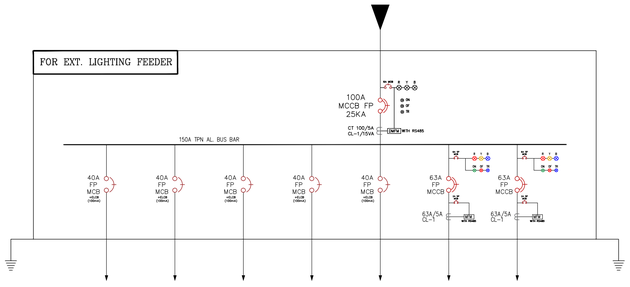

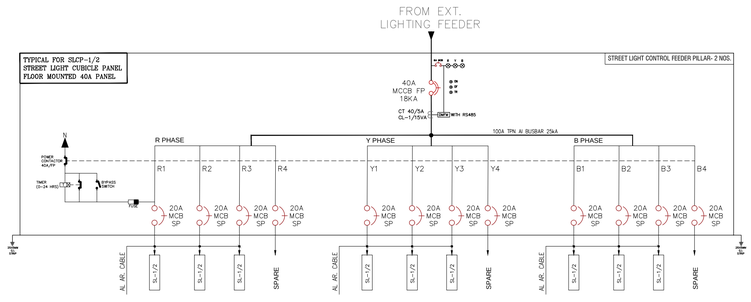

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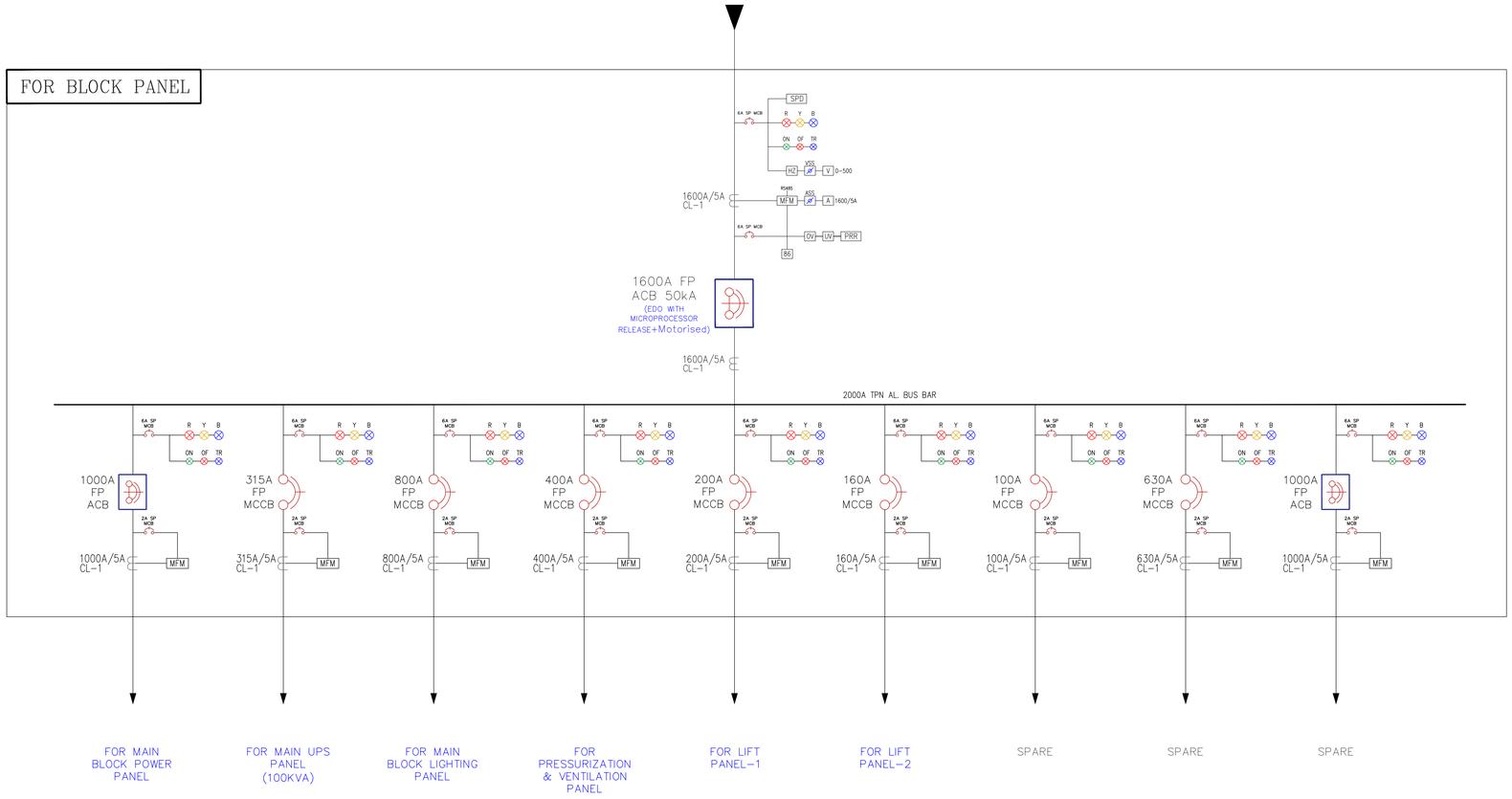

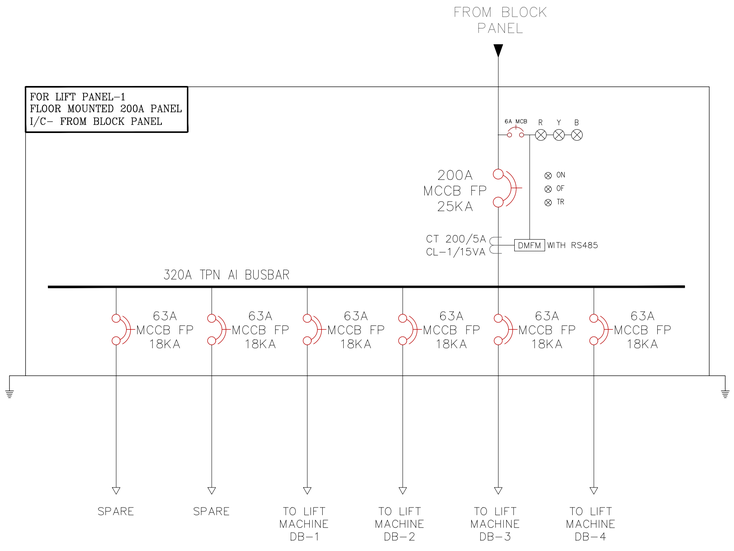

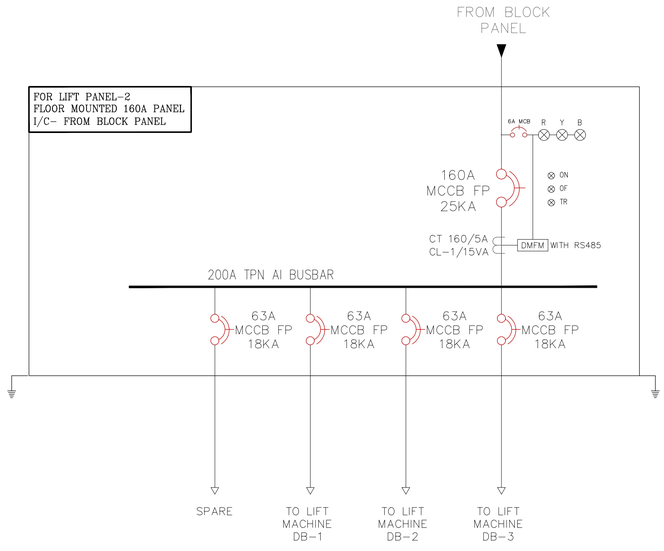

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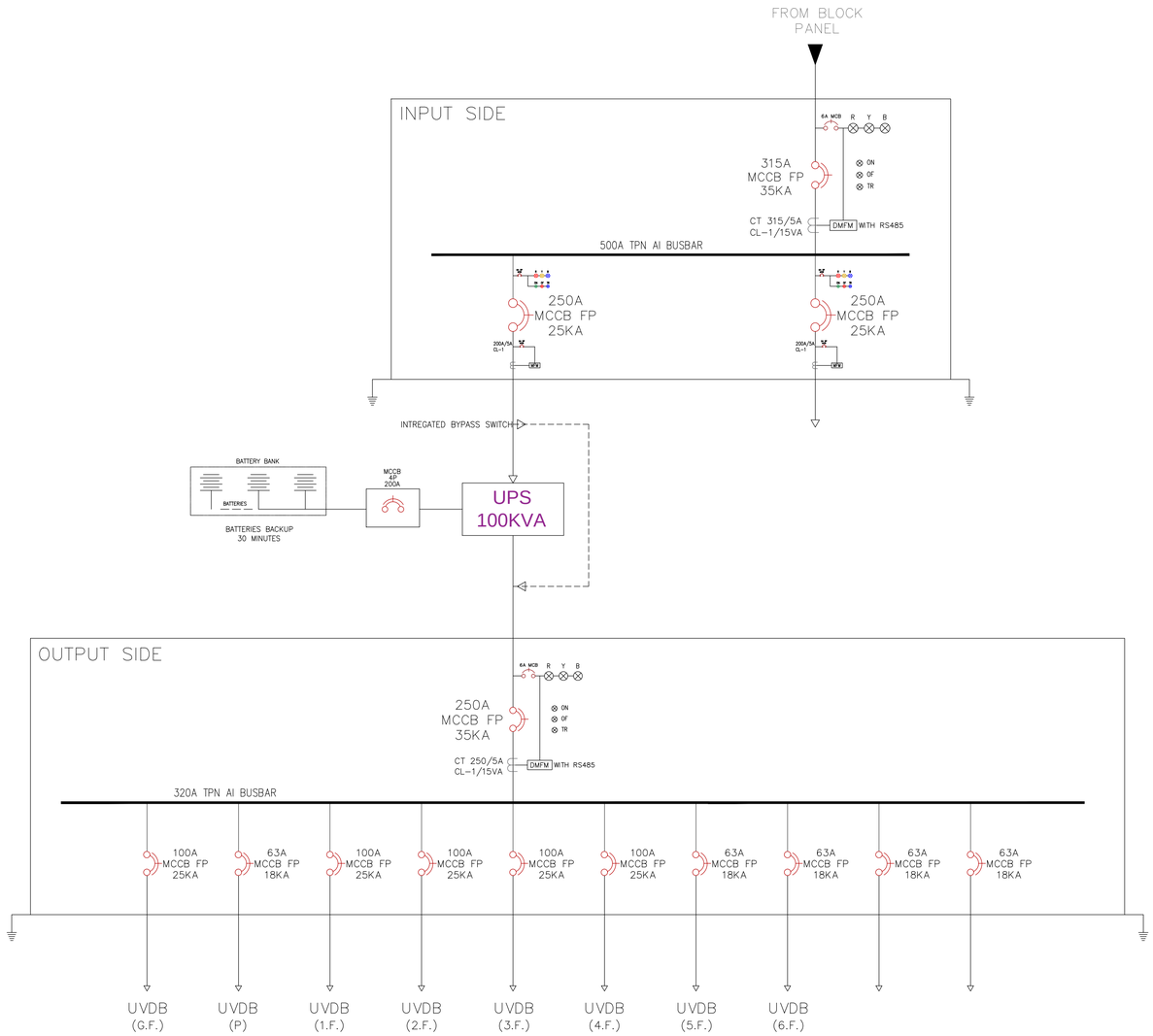

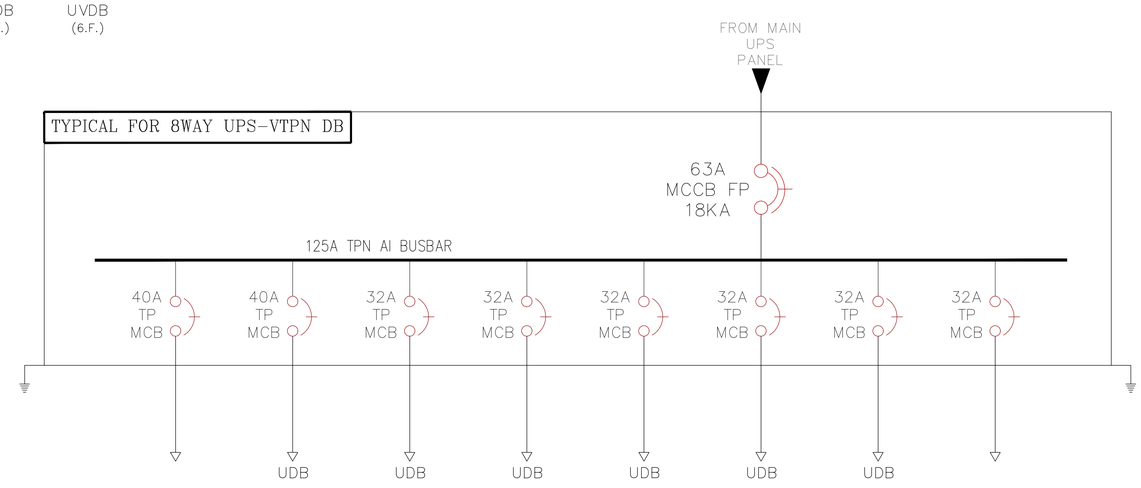

NOTE :

1. UVDB - 6 WAY VTPN MCCB DB (DOUBLE DOOR) WITH 100A TPN MCCB INCOMER AT EACH FLOOR-FOR 100A FEEDER.
2. UVDB - 6 WAY VTPN MCCB DB (DOUBLE DOOR) WITH 63A TPN MCCB INCOMER AT EACH FLOOR-FOR 63A FEEDER.
3. OUTGOING MCB RATING AND WIRE SIZES AS PER CPWD INTERNAL SPECIFICATION 2023.

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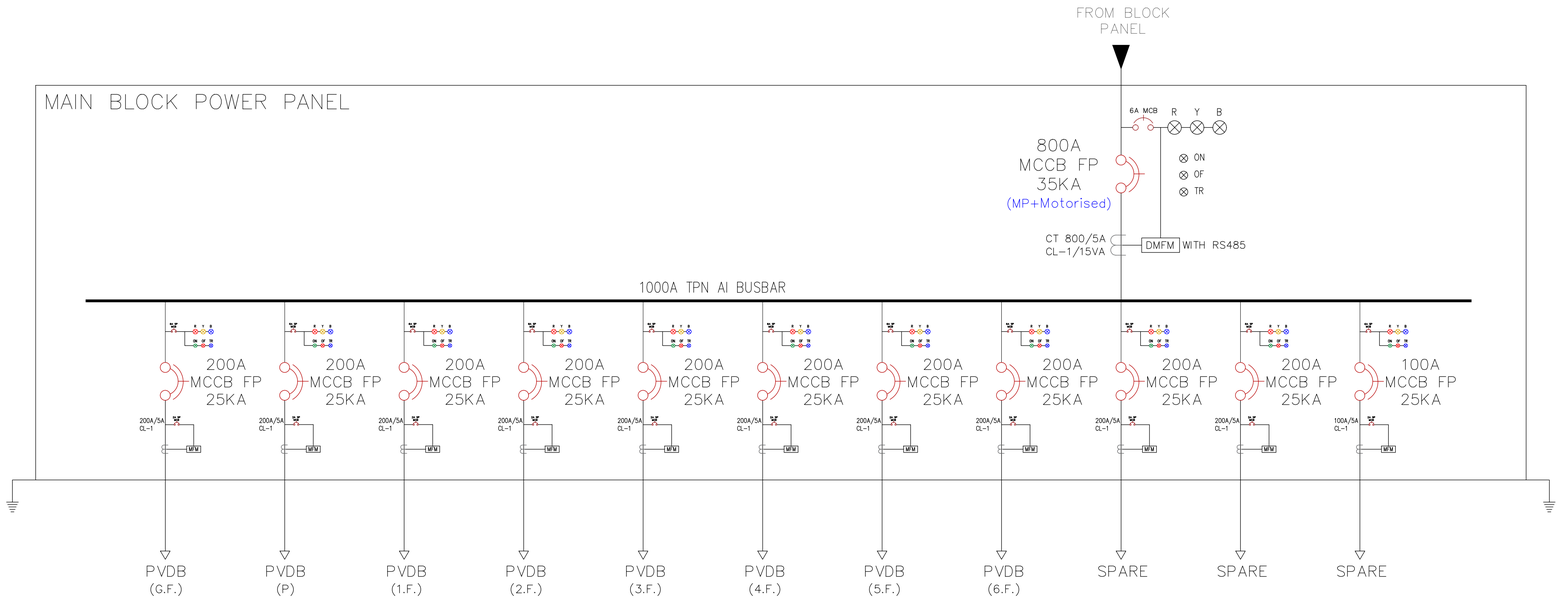

NOTE :

1. PVDB - 8 WAY VTPN MCCB DB (DOUBLE DOOR) WITH 160A FP MCCB INCOMER AT EACH FLOOR.
2. LVDB - 6 WAY VTPN MCCB DB (DOUBLE DOOR) WITH 100A FP MCCB INCOMER AT EACH FLOOR.
3. OUTGOING MCB RATING AND WIRE SIZES AS PER CPWD INTERNAL SPECIFICATION 2023.
4. FOR DOWNSTREAM DETAILS OF HOSTEL AREA REFER TO DBR.

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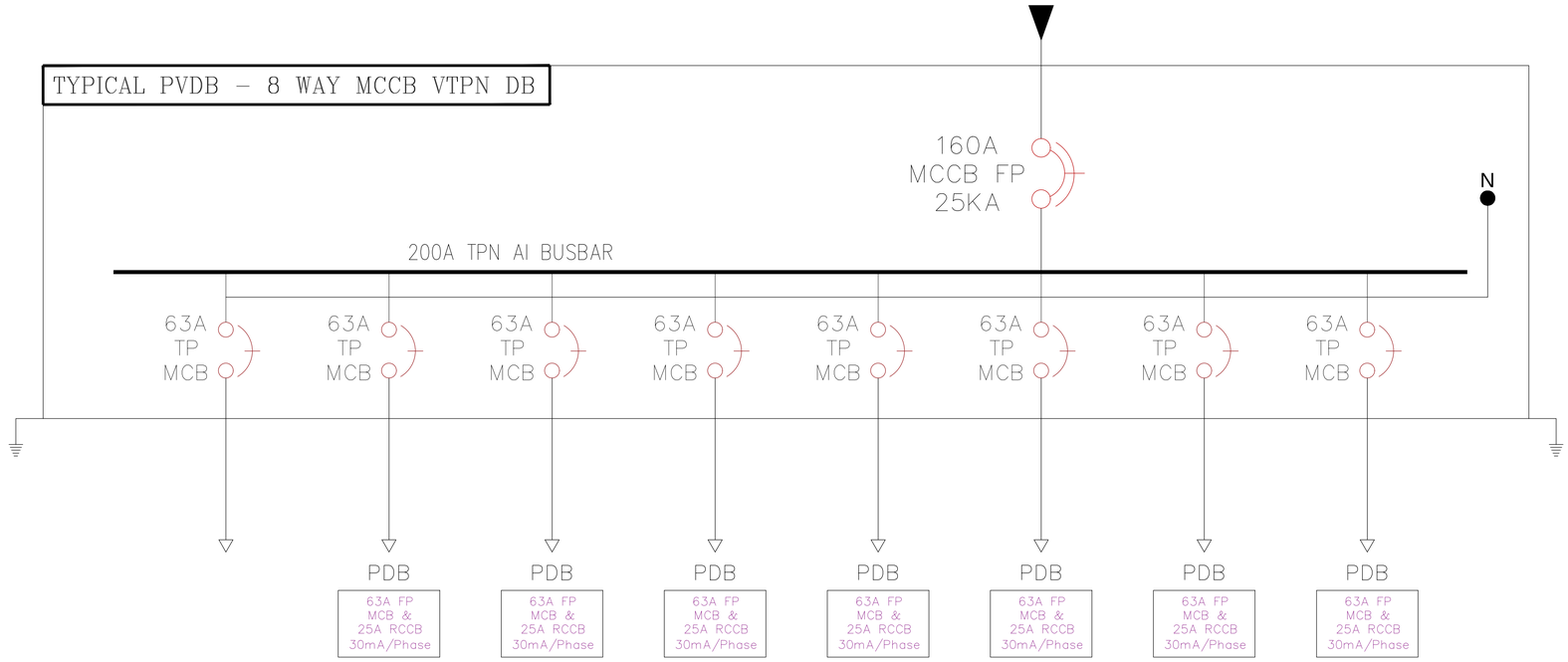

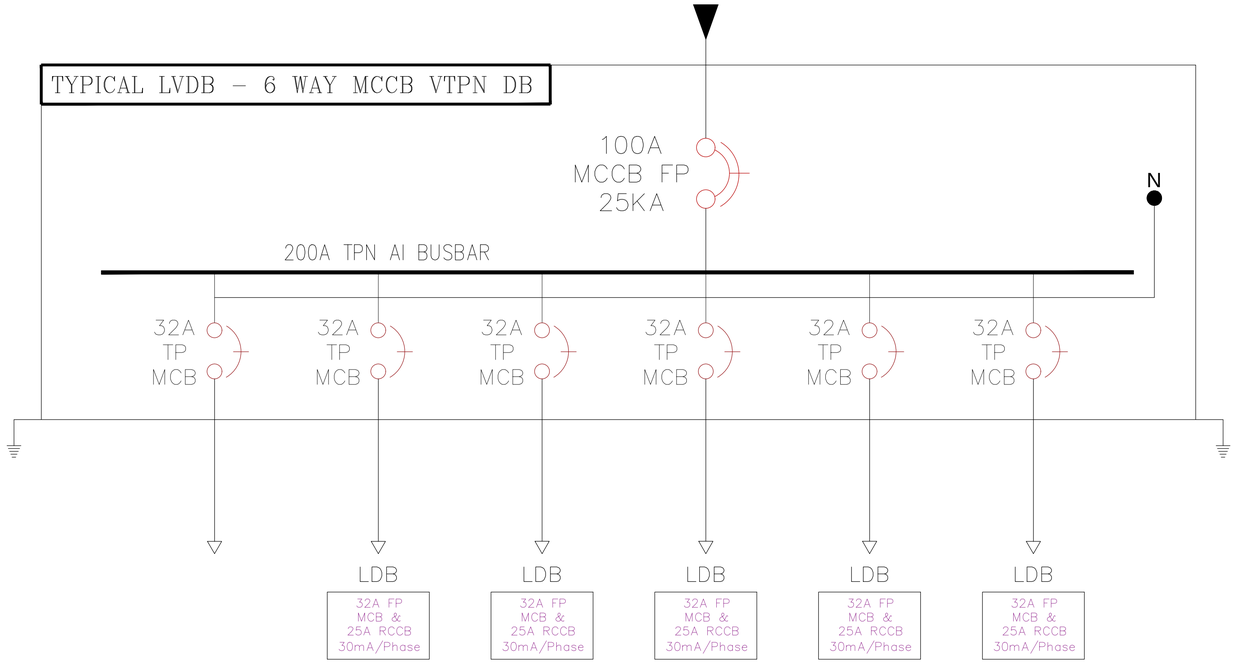

NOTE :

1. FOR EACH LDB - DB (DOUBLE DOOR) WITH 32A FP MCB INCOMER WITH 25A 30mA DP RCCB AT EACH PHASE AS SUB-INCOMER.
2. FOR EACH PDB - DB (DOUBLE DOOR) WITH 63A FP MCB INCOMER WITH 25A 30mA DP RCCB AT EACH PHASE AS SUB-INCOMER.
3. OUTGOING MCB RATING AND WIRE SIZES AS PER CPWD INTERNAL SPECIFICATION 2023.

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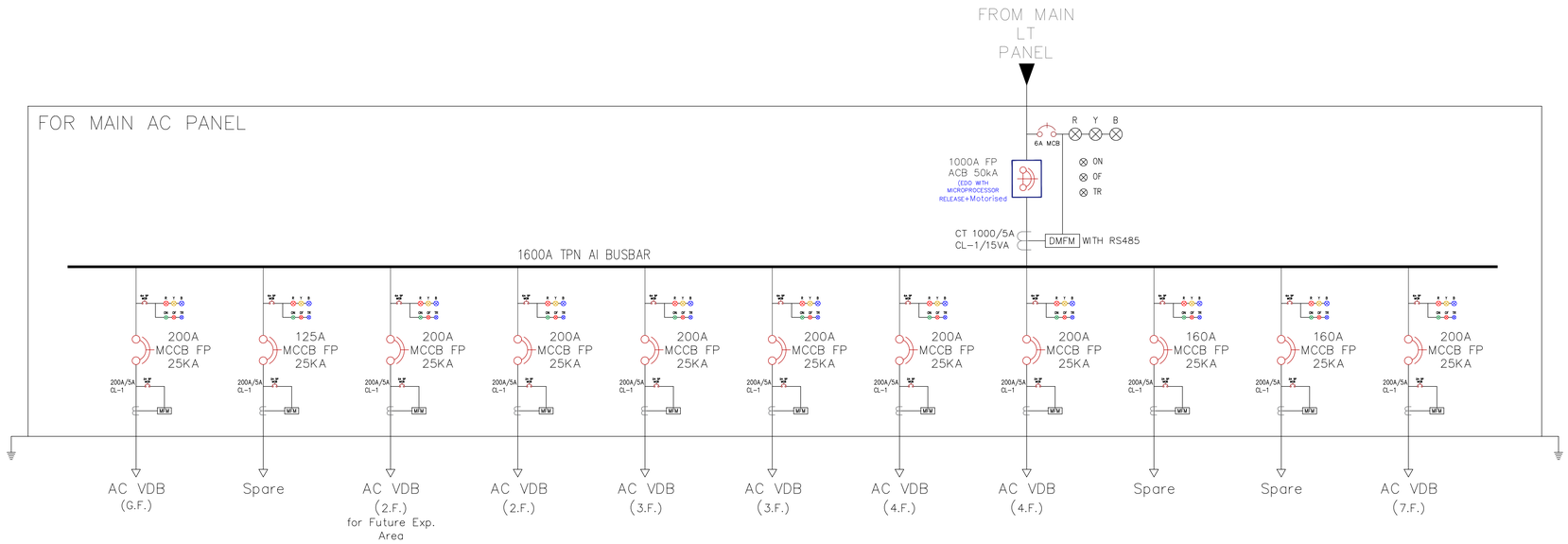

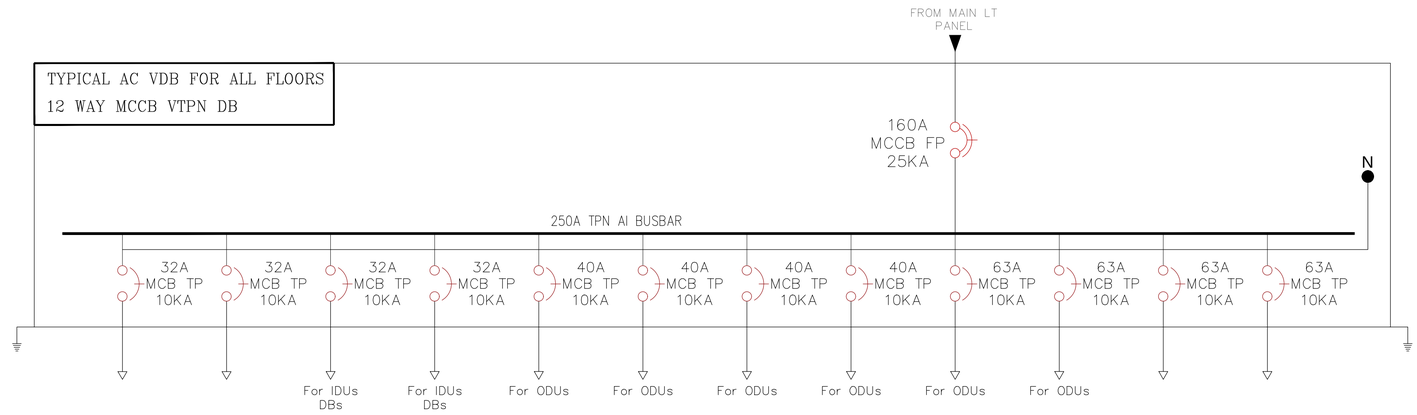

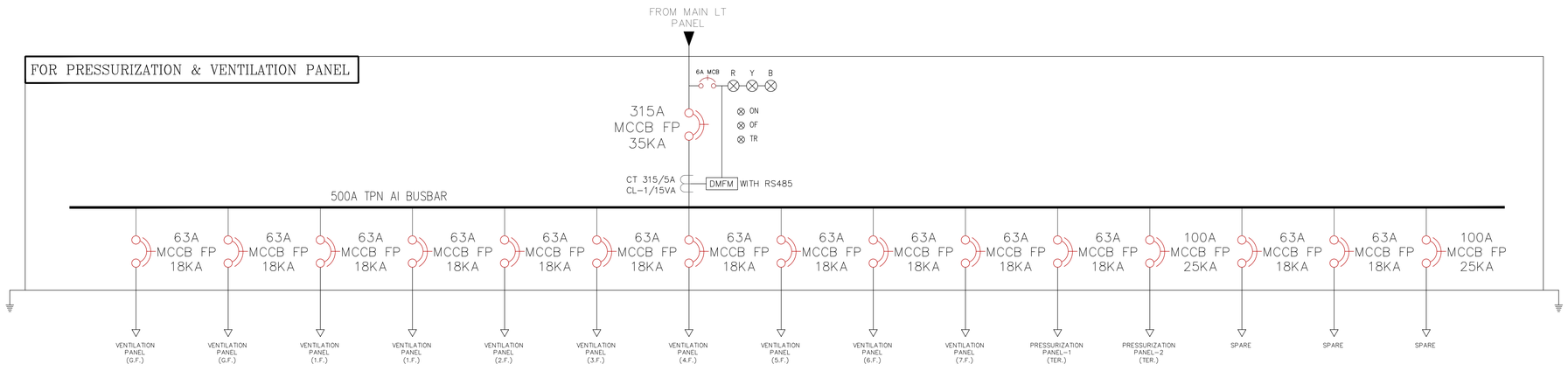

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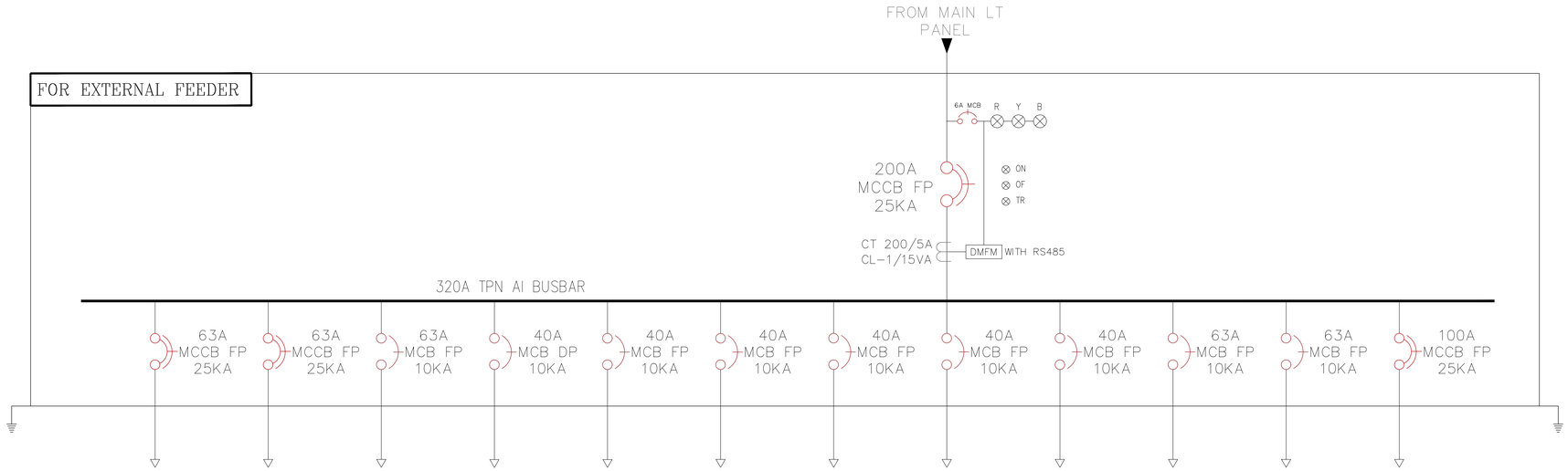

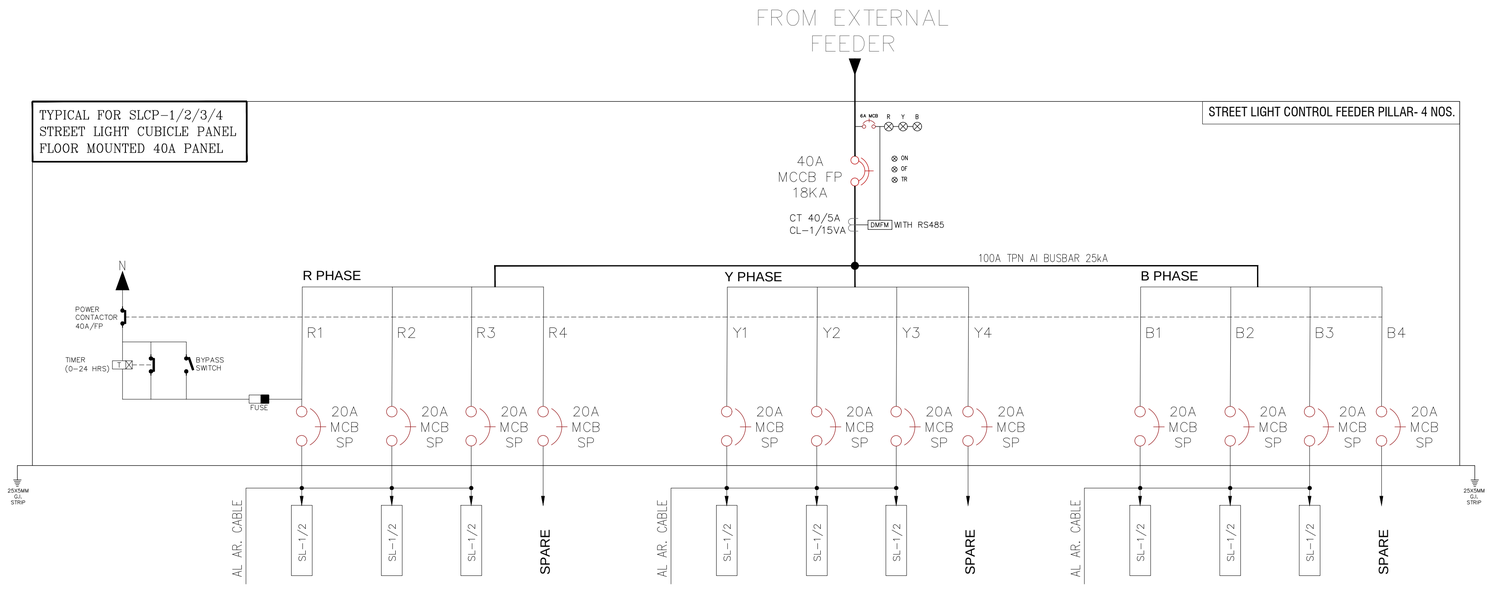

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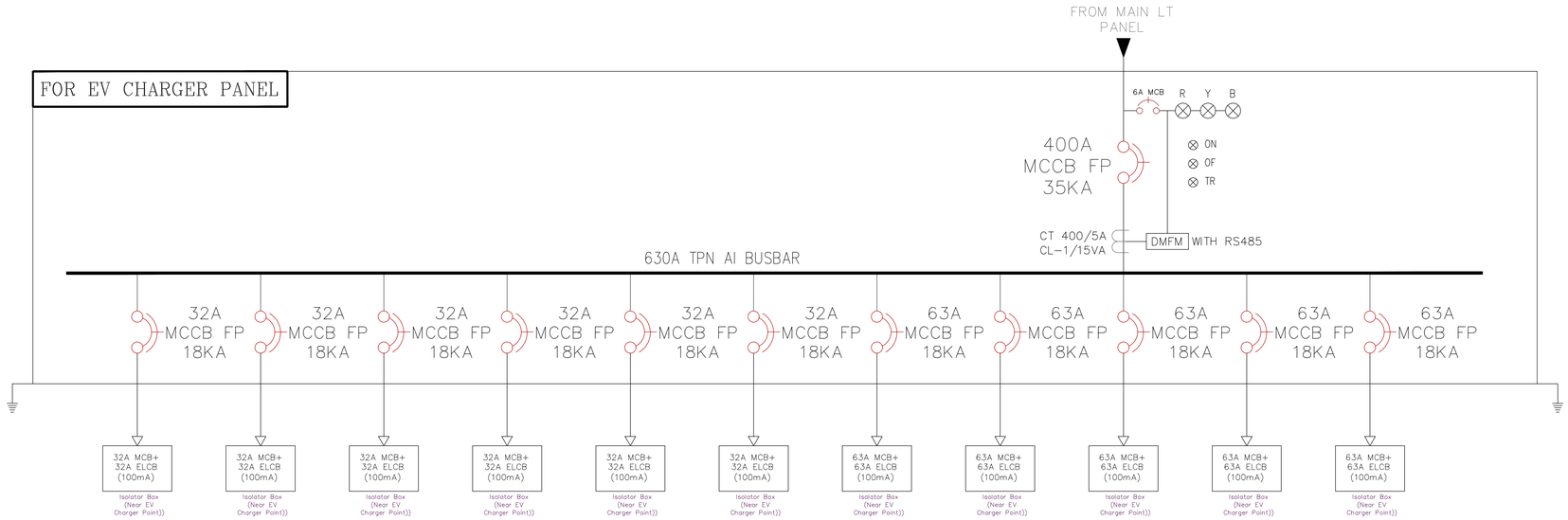

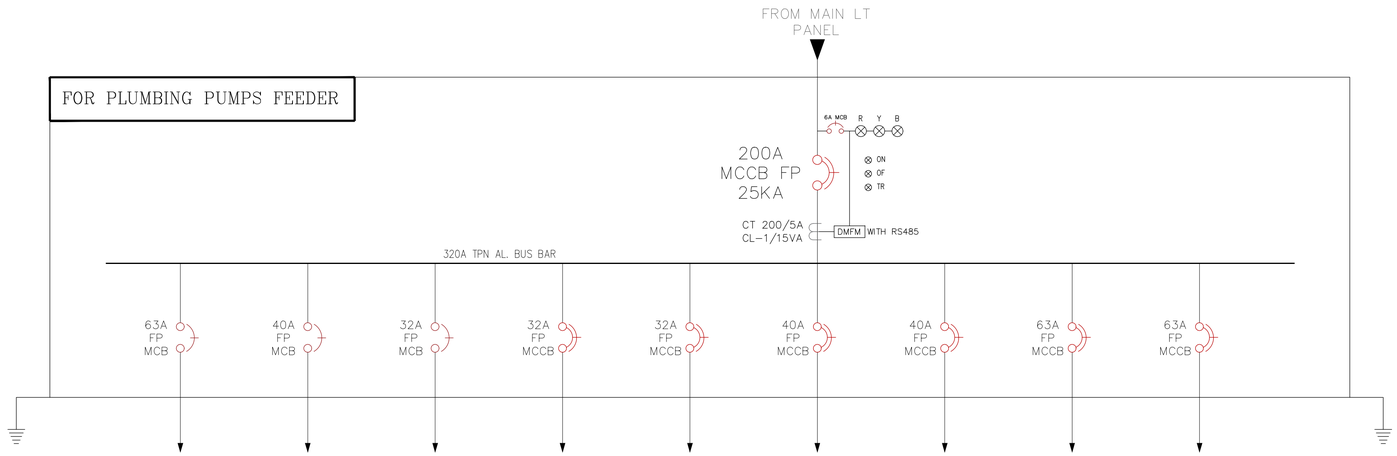

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