

**TENDER DOCUMENTS**  
**&**  
**TECHNICAL SPECIFICATION**  
  
**FOR**  
  
**REVAMP OF HT AND LT**  
**ELECTRIFICATION SYSTEM**  
  
**OF**  
  
**INSTITUTE FOR DEVELOPMENT AND**  
**RESEARCH IN BANKING TECHNOLOGY (IDRBT)**  
  
**CASTLE HILLS, ROAD NO.1, MASAB TANK,**  
**HYDERABAD, TS.**

**PROJECT INFORMATION**

- 1.0 PROJECT : REVAMP OF HT & LT ELECTRIFICATION SYSTEM OF INSTITUTE FOR DEVELOPMENT AND RESEARCH IN BANKING TECHNOLOGY (IDRBT)
- 2.0 SITE LOCATED : CASTLE HILLS, ROAD NO.1, MASAB TANK, HYD, TS.
- 3.0 NEAREST RAILWAY STATION : LAKDI KA POOL, HYDERABAD
- 4.0 NEAREST AIRPORT : RAJIV GANDHI INTERNATIONAL AIRPORT, HYDERABAD
- 5.0 CLIENT : INSTITUTE FOR DEVELOPMENT AND RESEARCH IN BANKING TECHNOLOGY.  
Castle Hills, Road No.1, Masab Tank, Hyderabad, TS.  
Point Of Contact (POC):-  
Mr. Anurag Nanda, Administrative Executive  
04023294182
- 6.0 DEADLINE FOR RECEIPT : 05:00 PM OF 21.02.2022
- 7.0 PRE-BID MEETING : 11:00 AM OF 15.02.2022  
All bidders are requested to obtain confirmation of Scheduled date and time of the Pre-Bid meeting one day prior to the date mentioned above from the POC mentioned above.

**SPECIFICATION**  
**FOR**  
**REVAMP OF HT & LT ELECTRIFICATION SYSTEM OF IDRBT PREMISES**  
**INVITATION TO TENDER AND GENERAL INSTRUCTIONS TO BIDDERS**

**DEFINITIONS:**

The following notes shall have meanings as stated herein except where the context otherwise requires:-

CLIENT/CLIENT/EMPLOYER	Shall mean <b><u>Institute for Development and Research in Banking Technology, Hyderabad (IDRBT)</u></b> and shall include their representatives, assignees and/or successors.
CONSULTANTS	Shall mean any consultant (including their representatives, assignees and/or successors) appointed by the client for monitoring of works.
CONTRACTOR	Shall mean the successful Bidder (including his/their legal representatives, assignees or successors who is selected after scrutiny of the tenders received).
SITE	Shall mean the site of the contract works at IDRBT premises Including any building and erections thereon and any other land (Inclusively) as aforesaid allotted by the CLIENT for the Contractor's use.
THIS CONTRACT	Shall mean invitation to tender & general instructions, conditions of contract, commercial terms & conditions, the drawings, specifications, the schedule of quantities attached here to be duly executed by the authorized representative of both the parties involved.
NOTICE IN WRITING OR WRITTEN NOTICE	Shall mean a notice sent in written, typed or printed characters (unless delivered personally or otherwise proved to have been received) by registered post to registered address.

Sealed tenders are invited (in two copies) on behalf of **INSTITUTE FOR DEVELOPMENT AND RESEARCH IN BANKING TECHNOLOGY (IDRBT)** for the following works at project site (**Castle Hills, Masab Tank**), **HYDERABAD**.

- |    |                            |   |   |
|----|----------------------------|---|---|
| 1. | NAME OF WORK               | : | REVAMP OF HT/LT ELECTRIFICATION SYSTEM OF IDRBT PREMISES  |
|    | BRIEF DESCRIPTION          | : | REPLACEMENT OF TRANSFORMERS, DG SETS, ELECTRICAL PANELS (HT & LT), CABLING, ETC.  |
|    | EMD OF THE WORK            | : | 3,00,000/-<br>(i.e., 1 % of estimated cost)   |
|    | SECURITY DEPOSIT           | : | 5 % of the total final bill (inclusive of the EMD)<br>To be deducted from each progressive bill.<br>The SD shall be retained for a period of 1 year after the date of completion & acceptance of works in toto by client. |
|    | TIME PERIOD FOR COMPLETION | : | Nine months from the date of issue of Letter of Intent (LOI).   |

The envelope shall be superscribed "**TENDER FOR HT & LT ELECTRIFICATION SYSTEM**".

2. **WORK ELGIBILITY: -**

- A. The Tender will not be considered if the bidder does not possess a valid **11KV/33KV 'A GRADE' Electrical Contractor's license** issued by a competent authority of the concerned state (Government of Telangana) with a validity of minimum of 12 months from the date of issue of the Work Order.

**Experience of having successfully completed similar works during last 7 years, ending last day of the month previous to the one in which applications (31.12.2021) are invited, should meet any one of the following criteria:**

SN	WORK ELIGIBILITY CRITERIA
	<b>Electrical</b>
1	Three similar completed works with each work costing not less than the amount of Rs. 1.56 Cr
2	Or
	Two similar completed works with each work costing not less than the amount of Rs. 1.95Cr
3	Or
	One similar completed work with each costing not less than the amount of Rs. 3.1 Cr

- B. **SIMILAR WORK SHALL MEAN:** All qualitative successful completion of electrical works undertaken for Central Govt. Dept./State Govt. Dept./Semi Govt. Dept./PSU/Public Sector Banks/Airport Authority of India & works in Auditoriums/Theatres/Offices for reputed clients including the above.

- C. Civil construction works, loose furniture, modular furniture works & residential work will not be considered for evaluations.

- D. **TURNOVER REQUIREMENT:** Should not be less than **Rs. 300 lakhs** during the last financial year (2020-21) and not to be less than **Rs. 250 Lakhs** each in FY 2018-19 & FY 2019-20 as per the audited balancesheet. (Supporting documents to be submitted)
- E. **PROFIT/LOSS:** Bidder should have earned surplus/profit in at least 3 financial years out of the previous 5 financial years .(supporting documents to be submitted)
- F. The Bidder must have a valid class “A” Electrical Contractor’s License valid till 6 months after the date of opening of tenders.

3. **EARNEST MONEY DEPOSIT**

Every tender shall be accompanied by earnest Money for Rs. 3,00,000/- in the form of Demand Draft in favour of **INSTITUTE FOR DEVELOPMENT AND RESEARCH IN BANKING TECHNOLOGY, HYDERABAD** or Bank Guarantee issued by any scheduled bank, valid for Six Months for the equivalent amount. Any tender received without Earnest Money is liable to be rejected.

4. **VALIDITY OF TENDER**

- a) The rates quoted by the bidders shall hold good at least for 6 months from the last date of receipt of tenders and if accepted, the rates should continue to hold good till the completion of the work.
- b) The rates should be quoted in both words and figures without any difference between figures and words.
- c) If there is any difference in rate quoted between the two copies of tender documents, the lower rate will be taken into consideration.
- d) Each page of the schedule of quantities and tender document shall be signed/initialed with rubber stamp by the bidder and corrections in the tender document, if any, shall also be counter signed.
- e) The rates quoted shall be inclusive of all taxes, duties, packing, forwarding freight, insurance, handling charges, supervision and establishment charges and the rates must be quoted as indicated in the BOQ.

5. **TENDER FORMS**

- a) No corrections or alterations in the form shall be made nor any conditions stipulated therein.
- b) Tender documents will be hosted at IDRBT website in the link <https://idrbt.ac.in/tenders.html>
- c) Bidders must submit the tender in two copies. Wherever drawings are issued along with the tender documents, they shall form part of the tender submitted.
- d) Sealed tenders duly completed in all respects shall be submitted in the office of “**INSTITUTE FOR DEVELOPMENT AND RESEARCH IN BANKING TECHNOLOGY.**” HYDERABAD **on or before 5 P.M. on 21.02.2022.** Tenders submitted beyond this time shall be outright disqualified.

6. **TENDER COVERS**

Tenders shall be submitted in sealed covers subscribed as “TENDER FOR REVAMP OF HT & LT ELECTRIFICATION SYSTEM (TECHNO-COMMERCIAL) – PART-I”, and “TENDER FOR REVAMP OF HT & LT ELECTRIFICATION SYSTEM (PRICE BID) – PART-II”.

7. **OPENING OF TENDERS**

The tenders will be opened in the office of **INSTITUTE FOR DEVELOPMENT AND RESEARCH IN BANKING TECHNOLOGY (IDRBT).** HYDERABAD on a day notified by IDRBT.

8. **RESERVATION OF THE RIGHT OF ACCEPTANCE OF TENDERS**

**IDRBT reserves the right to accept or reject any or all tenders received without assigning any reasons thereof.**

**9. INTIMATION OF ACCEPTANCE OF TENDER**

The successful bidder (contractor) shall be intimated by IDRBT through issuance of Letter of Intent (LoI) upon completion of the evaluation.

**10. AGREEMENT**

The successful bidder, hereinafter may be referred to as “contractor” shall execute, within 15 days from the date of issue of the intimation of acceptance of this tender/ letter of intent, an agreement in the prescribed form on a stamped paper. All expenses relating to the agreement shall be borne by the contractor.

**11. TIME LIMIT FOR THE COMPLETION OF WORK**

The work shall be completed in all respects within a period of Nine months from the date of issue of Letter of Intent.

**12. SCHEDULE OF QUANTITIES**

The schedule of probable quantities in respect of the work along with specifications is enclosed with those terms and conditions. The schedule of quantities is liable to be revised for any omissions, deductions or additions at the discretion of the CLIENT. The rates quoted however shall remain unaltered for any changes in quantities / deletion of terms.

**13. STATUTORY APPROVALS**

The contractor shall be responsible for obtaining statutory approvals, if any, relating to the entire project from the start of project until completion of the project and handover of the same with all the compliances. Any official fees towards this shall be paid by the contractor and the same shall be reimbursed by the client upon production of documentary proof of payment. Other expenses, if any, shall be borne by the Contractor.

**14. LIAISON WORK**

The Contractor shall be responsible for all liaising work with Electricity Board, CEIG or any other Statutory Authority for expediting power connection and obtaining permits, certifications, etc. IDRBT shall only provide necessary paperwork and only reimburse/pay statutory fees, if any on submission of proof of payment.

**15. CIVIL WORK**

All Civil Works Related to Electrical Works such as:

- 1) Earthing
- 2) Cable Trench Routing.
- 3) Transformer & DG Yard Plinth & Foundation.
- 4) Making of opening and closing inside/outside of the building.
- 5) Digging, laying and road crossing including placing hume pipes and manholes below the roads.
- 6) PCC concreting wherever necessary.

A) Any other civil works required for the completion of the electrical services are included in the electrical contractor’s scope and all the other civil works, which are not specified (in the client’s scope), are also in the electrical contractor’s scope.

B) Client scope is limited to official paperwork & if required payment of deposits / any other statutory payments only. If at all, there are any other statutory requirements from the client’s side to be complied to; they are required to be intimated by the bidder in writing along with the tender.

C) The bidder needs to take into consideration above factors while submitting the tender.

16. **CONDITIONS OF CONTRACT**

The bidders shall go through all the general and special conditions supplied along with the blank tender form carefully before submitting the tender. Those shall form a part of the contract agreement.

17. **COMMERCIAL TERMS & CONDITIONS**

The bidder shall study the commercial terms and conditions specified in the tender and a written acceptance of all the terms and conditions needs to be furnished by him in this regard.

18. **GENERAL GUIDELINES FOR CONTRACTORS.**

The contractor shall be responsible for ESI insurance for the labour/working persons on the project. All the insurances like ESI /PF/MEDICAL as per the labour department acts and the project directory to be submitted to the client for any verification from any departmental person during execution & until the project completion. A workmen compensation policy must be obtained and a copy submitted, which is valid for the entire duration of works.

All safety measures and accessories like helmets/jackets, gloves first aid box kit, as applicable need to be arranged & implemented by the contractor during the execution /completion of the project.

Any accidental injuries to the workers deployed by the contractor at the site shall be the contractor's responsibility and need to be treated/compensated at their own cost.

19. In case of any ambiguity in tender conditions/technical specifications, the decision/interpretation of IDRBT will be final and binding on all bidders.

20. In view of the Covid Pandemic, Covid protocols like wearing of masks, usage of sanitizers, regular temperature checks has to be ensured of all the persons entering the worksite. Arrangements in this regard are in the Contractor's scope. In case of suspension of works due to guidelines of various authorities from time to time, the contract period shall be extended by the period of suspension of works.

20. All the As-built drawings, workshop drawings in coordination with other services & site conditions needs to be submitted to the client for the approval. All operating manuals guarantee/warranty certificates including 3 sets of as-built drawings needs to be submitted.

21. All pages of the tender document must be signed and stamped by the authorized representative of the Bidder.

22. It is advisable that the bidders visit the site on the pre-bid meeting day and clarify all the queries they might have before they quote the tender. It shall be the responsibility of the bidder to get all clarifications obtained before submitting the tender. The submission of tender by a bidder shall be construed as the bidder is well aware of the scope of entire work and has quoted all rates keeping in mind all tangible/ intangible/ known/unknown factors involved in completion of the project in toto.

23. The payment shall be released as progressive Running Account (RA) bills whenever bill value of Rs. 15 Lakhs is admissible subject to the following:

- (i) Only completed items of Supply and Installation may be claimed in any RA bill.
- (ii) Security deposit will be deducted from each progressive bill @ 5% of bill value (Inclusive of all taxes)
- (iii) Payment for items to be measured shall be done only on actual measurement basis after due verification of quantities executed.
- (iv) Only one RA bill can be accepted in a month.
- (v) Taxes if & as applicable will be deducted from the bills.

24. IDRBT has appointed a consultant for the said project. A periodical meeting (Once in a fortnight/ month) to review the progress of works will be called. The Representatives from Contractor, Consultant & Client are required to be present in the review meetings.

25. The Contractor must have a Site in charge for the project who shall be the Single point of Contact (SPOC) for IDRBT officials for all matters related to this project. The Contractor must also ensure deployment of qualified electrical engineer & safety engineer at site to monitor the works. It is preferred that a local office/ site office of the contractor is functional in the city of Hyderabad.

26. A PERT chart/schedule of activities must be submitted at the initial kickoff meeting and the same may be reviewed periodically based on actual progress of works at site.

27. Time & quality in execution is the essence of the contract. It's the contractor's responsibility to take utmost care towards completion of the entire project on time. A penalty of 0.5% of the total work value per week of delay up to a maximum of 5 % of the total work value may be levied for delays beyond the stipulated completion period of the project. Further, care should be taken to complete all the works in a qualitative manner.
28. Supreme standards of quality has to be maintained in all works carried out in the project. The officials of the client shall be at liberty to reject works of poor quality and the contractor is bound to replace/rectify such works at their own costs. Any damage to IDRBT's property due to the contractor's activity during the course of this project shall have to be made good by the contractor at his or her own costs.
28. HOD of Estate Department of IDRBT shall be the appellate authority for any dispute at site and his/her resolution in any dispute shall be final and binding upon the contractor. Any dispute pertaining to the said project, which cannot be resolved amicably, shall be limited to the jurisdiction of the courts of Hyderabad only.
29. The Contractor must obtain all necessary insurances for transportation and storage of items at site and the copy must be submitted to the client for records.
39. All rates quoted in the BOQ shall deemed to be inclusive of cost of all insurances, transportation costs, incidental costs etc. and no additional payment shall be made under these heads.

**SCHEDULE OF TOOLS AND TACKLES**

The contractor shall be required to maintain the following tools and tackles at site during the execution of the work. The list given below covers the minimum requirements, and additional tools, tackles and testing equipment required shall be made available at site at appropriate time :

S.No.	Name of the Party	Qty.	Remarks
1.	500 V Meggar	2 No.	To be brought as and when required.
2.	Continuity Tester	2 Sets	
3.	Earth Meggar	1 No.	
4.	Welding Machine	2 Nos.	
5.	Electrician's Tool Kits	2 Set per Gang	
6.	Hand drill	2 Nos.	
7.	Conduit bending machine	1 No.	
8.	Set of General tools & tackles Such as spanners, files, hammers, Screw drivers, cutting pliers, Chisels etc.	1 lot	
9.	Primary / Secondary injection kit	1 Set	

Signature of the Contractor

## **CONDITIONS OF CONTRACT**

### **1.0 SCOPE OF ENQUIRY**

- 1.1 The scope of specification covers the design, manufacture, inspection and testing at vendors / sub vendors works, packing, transportation from place of manufacture to site, unloading and storing at site, complete erection, testing and commissioning of various electrical equipment required for operation of 11KV HT & 1.1KV LT External /Internal electrification for the Premises of IDRBT.
- 1.2 The design, material, construction, manufacture, inspection, testing and performance of all equipment shall comply with all currently applicable standards, statutory regulations and safety codes in the locality where the equipment will be installed.
- 1.3 The extent of scope under this contract includes all items shown in the appropriate sketches and drawings notwithstanding the fact that such items may have been omitted from the specifications or schedules.

### **2.0 INSTRUCTIONS TO BIDDERS**

- 2.1 Bidders shall submit all technical information and duly filled in data sheets / schedules in soft form along with the bid. Any deviation taken shall be specifically brought out in the schedule of deviations. In the absence of this, it will be presumed that bidder's offer is completely in line with the specification requirements.
- 2.2 Bidder is advised to visit the site and obtain all the data required and other relevant details of existing facilities prior to submission of bid. Ignorance of site conditions shall not be accepted as basis for any claim for compensation.
- 2.3 All necessary coordination with regard to sub contracted equipment shall be carried out by the CONTRACTOR. CLIENT will communicate only with the Contractor for all matters pertaining to this contract.
- 2.4 All meters, instruments, gauges and other reference devices used for testing/inspection shall have valid calibration certificate and the accuracy shall be traced to national standards. Inspection by CLIENT will not be carried out unless Vendor confirms that calibrated equipment is ready for proceeding with the tests.
- 2.5 The CONTRACTOR must keep provision for a Third Party factory testing of all large equipment like DG Tests, Transformers, Panels etc. The cost, if any for this test is deemed included in the rate quoted. At least one representative of the CLIENT (and/or their CONSULTANT), CONTRACTOR & the Third Party testing agency shall be present at the Manufacturer's Location where the unit is manufactured for testing as per the tender specifications.
- 2.6 Bidders shall note that the design ambient temperature for all electrical equipment is 50°C.

**TECHNICAL SPECIFICATION**  
**FOR**  
**ELECTRICAL WORKS**  
**FOR THE IDRBT CAMPUS**  
**AT**  
**MASAB TANK, HYDERABAD,**  
**TELANGANA STATE**

# ELECTRICAL GENERAL PROVISIONS

## 1.0 ELECTRICAL GENERAL PROVISIONS

### 1.1 GENERAL

#### 1.1.1 Work Description

The scope of works for all electrical works and system comprises of design, engineering, supply, delivery, installation, testing and commissioning, handover, training, maintenance and warranty all as described or reasonably implied in the Contract. The ELECTRICAL Contractor is obliged to provide fully functioning works and systems in conformance with the requirements of the Contract and approved design and development documents prepared by the ELECTRICAL contractor.

In the event certain items are not fully described or indicated in the Contract, but deemed essential by the ELECTRICAL contractor for the performance of the works and systems then the provision of such items shall form part of the ELECTRICAL Contractors scope of works at no additional cost to the Owner.

The drawings and documents from consultant shall be used as guidance for the ELECTRICAL contractor in producing his detail design and shop drawings for carrying out works at site.

The ELECTRICAL Contractor shall be responsible to co-ordinate the equipment and services and shall produce and properly co-ordinate shop drawings to demonstrate the installation comply with the performance requirement with shop drawings, calculations and details. The Consultant shall monitor the process of shop drawings and document preparation.

Shop drawings shall take into account actual measurement and setting out dimensions/levels obtained and determined by the ELECTRICAL Contractor on site, actual equipment / material used, actual routing of services, co-ordination with all installation, and site conditions/constraints.

#### 1.1.2 Scope of Work:

The Electrical HT, LT and ELV installation shall generally include the following:

1. Common Services:
  - a. Liaison with Client to obtain and coordinate provision of incoming electricity supply.
  - b. Design, Supply, Installation, testing & commissioning of complete 33KV HT distribution system including 33KV incoming electricity supply feeder from TSEB intake point , 33KV HT Meter Room, 33KV main switchboard, 33KV cabling to 33KV HT switchboards, 33KV cabling to 33/433KV distribution transformer, LT main distribution system and associated accessories till final distribution. In conjunction with TSEB acceptance upon completion.
  - c. Complete Earthing systems for connection with component electrical systems as per latest applicable IS/IEC Norms.
2. Internal Services:
  - a. Complete LT distribution system including main LT switchboard, automatic power factor correction devices, sub-boards and distribution boards, UPS and associated distribution main and sub-main cabling and associated accessories.
  - b. Complete lighting and power installation including all final circuiting work and associated accessories.
  - c. Normal and emergency lighting supply and installation and associated accessories.
  - d. Complete earthing system.
  - e. Complete lightning protection system and associated accessories.

- f. Complete telephone cabling system and associated accessories.
- g. Complete wiring work to external/landscape and public area architectural/special lighting and dimming systems as per lighting design and associated accessories.
- h. Complete internal cable system and outlets for Telephone and MATV system and associate works.
- i. Wiring for complete Security systems
- j. Miscellaneous works like providing and fixing of rubber mats, fire buckets, first aid box, fire extinguishers, etc.
- k. All associated interfacing power supply work to other mechanical installations.
- l. Fire Alarm & Voice evacuation System
- m. Voltage drop, transformer losses, power factor and other parameter shall be as per ASHRAE 90 and GRIHA requirement.
- n. Lighting density shall be furnished through energy simulation carried out for GRIHA rating 4 Star Building.
- o. All MEP equipment shall be controlled and monitored through BMS like Chiiler, Cooling Towers, DG Sets, HSD tanks, Lighting, Plumbing and Fire Fighting equipment etc.
- p. All associated interfacing works with other M&E installations.
- q. Other works as shown on the Drawings and described elsewhere in the Contract documents.

All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration.

ELECTRICAL Contractor shall co-ordinate with all other agencies working at site for interconnection and safety aspects.

Also the ELECTRICAL Contractor shall furnish combined guarantee minimum for 1 year from the date of successful commissioning from the manufacturer. In case there is any defect, the free replacement of any part or in whole will be made immediately at no extra cost to Owner.

#### 1.1.3 Fee, Permits & Tests:

The ELECTRICAL contractor shall obtain all sanctions and permits required for the above said works from all the relevant authorities. On completion of the work, the ELECTRICAL Contractor shall obtain N.O.C from concerned authorities including, Chief Electrical Inspectorate of State. The original of the same shall be delivered to the Owner through Consultant.

The Owner shall have full power regarding the equipments/ materials get tested by authorized/ recognized independent agency at the ELECTRICAL contractor's expense in order to prove their soundness and adequacy. The ELECTRICAL contractor will rectify the defects/ suggestions pointed out by independent agency through Owner at ELECTRICAL contractor's expense.

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 (for F.F. etc.) as amended up to date, there under and special requirements, if any, of the State Electricity Boards etc. The ELECTRICAL contractor shall be 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.

1.1.4 Codes & Standards:

The design, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (BS), International Electro Technical Commission (IEC) publication, NEMA & VDE Standards amended up to date.

The design engineering, manufacturing and the installation shall be in accordance with established codes, sound engineering, practices and specifications. Further, the same shall conform to the statutory regulations applicable in the country. ELECTRICAL Contractor shall obtain all approvals from statutory authorities, e.g. electrical inspector, SEB or any other agency as applicable before commissioning of electrical system if required.

Some of the relevant Indian and British Standards are listed below.

1. Indian Electricity Act.
2. Indian Electricity Rules.
3. Factory Act.
4. NBC 2016.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

In case of any deviation/conflict with the codes & standards, the following order of precedence shall govern

1. Recommended Design guidelines of consultant
2. International standards & requirements.
3. Local codes of practice
4. Approved design development documents

1.1.5 Design:

The ELECTRICAL Contractor shall be fully responsible for the complete design of all works for the Contract, including all temporary works.

It is the responsibility of the ELECTRICAL Contractor to ensure that his design does not compromise the design intents of the consultant's approved design development documents, all authorities compliances and approvals.

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

Any materials or accessories, which may not have been specifically mentioned, but which are usual and necessary for the completion of the system and satisfactory & trouble free operation and maintenance of the equipment shall be provided without any extra cost to the Owner. This shall also include spares for commissioning of the equipment.

This specification defines the basic guidelines to develop a suitable electrical system as necessary for the Complex. All data required in this regard shall be taken in to consideration to develop a detailed engineering for the system. Site conditions as applicable are mentioned elsewhere.

1.1.6 ELECTRICAL contractor shall be responsible for:

1. Detailed co-ordination with other services, shop drawings for various electrical layouts such as equipment layout, cabling layouts, earthing layouts, including equipment installation and cable termination details etc. prior to start of work.
2. Preparation of bill of materials for electrical works.
3. Protection co-ordination drawings/ tables for complete power system.
4. Shop inspection and testing procedures.
5. Field-testing and commissioning procedures.

6. Preparation of as built drawings.

ELECTRICAL contractor shall also be responsible for:

Any other work/activity which is not listed above however is necessary for completeness of electrical system.

1.1.7 Date of Commencement and Completion Period:

The ELECTRICAL contractor shall be allowed admittance to the site on the date of commencement as described in the General Conditions and he shall thereupon and forthwith begin the works and shall regularly proceed with and complete the same on or before the date of completion subject, nevertheless to the provisions for the extension of time. The time being the essence of the contract, the ELECTRICAL Contractor will adhere to the time, progress chart and project schedule and will give proportional output/progress in proportional time.

1.1.8 Schedule and Manner of Operations:

Time being the essence of this Contract, the ELECTRICAL Contractor will be expected to furnish all labor and materials in sufficient quantities and at appropriate times, expedite and schedule the work as required and so manage the operation that the work will be completed within the time stated in the Contract.

1.1.9 Design Conditions:

Design ambient: temperature summer 43 Deg. C dry bulb temperature & 24 Deg. C wet bulb temperature, Winter 7 Deg. C dry bulb temperature & 5 Deg. C wet bulb temperature

Relative Humidity: 95% maximum

1.1.10 Coordination of Work

Contract documents establish scope, materials and quality but are not detailed installation instruction.

Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.

The drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other divisions will permit. Provide off-sets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings of other divisions to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.

The locations of thermostats, switches, panels and other equipment indicated on the drawings are approximately correct. Exercise particular caution with reference to the location of panels, thermostats, switches, etc., and have the precise and definite locations accepted by the Engineer before proceeding with the installation.

The drawings show only the general run of services and approximate location of equipment, outlets, panels, etc. Any significant changes in location of equipment, outlets, panels, etc., necessary in order to meet field conditions shall be brought to the determine attention of the Consultant for review before such alterations are made. Modifications shall be made at no additional cost to the Contract.

Carefully check space requirements with other division works to ensure that equipment can be installed in the space allotted.

Wherever work interconnects with work amongst different installation, coordinate with other trades to insure that they have the information necessary so that the ELECTRICAL Contractor may

properly install the necessary connections and equipment. Identify items requiring access in order that the Ceiling Trade will know where to install access doors and panels.

Furnish and set sleeves for passage of risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each riser passing through building surfaces.

Provide fire stopping around all pipes, conduits, ducts, sleeves, etc, which pass through fire compartments.

Provide required supports and hangers for equipment suitably so as not to exceed allowable loading of structures.

Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion include a set of these drawings with each set of record drawings.

Coordinate with the local utility companies/authorities for their requirements for service connections and provide all necessary provisions, grounding, materials, equipment, labor, testing, and appurtenances.

Before commencing works, examine adjoining works on which this work is in any way affected and report conditions which prevent performance of the works. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

The ELECTRICAL Contractor is responsible to any modifications required due to service not properly coordinated.

#### 1.1.11 Electrical Power Supply Interfaces

The ELECTRICAL Contractor shall provide power supply points/isolators at certain designated locations within the development for all mechanical and electrical installations as indicated on the drawings. It is the responsibility of the Contractor to coordinate and make connections to these power supply points/isolators and to provide all the necessary 'down-stream' power supply distribution board/network to the mechanical system's control panels, equipment, sensors, field devices, etc.

#### 1.1.12 interfacing With All Services and Systems

##### **General**

1. The ELECTRICAL Contractor shall provide all necessary provisions for interfacing amongst installation, services, and equipment. All necessary sensors, current/voltage transformers, voltage-free contacts, relays, auxiliary contacts, terminals, transducers etc. for interfacing works shall be provided by the ELECTRICAL Contractor.
2. All control/monitoring wiring from sensors, equipment, and components for the interfacing shall be terminated at a separate interfacing compartment located at the respective equipment/system's switchboard or control panel. The interfacing compartment shall be completed with all necessary connectors, terminals, and with proper identifications to allow interfacing works to be easily carried out. The compartment shall clearly indicate "Extra Low Voltage Cable Only. No Power Cable Connection". Where there is no equipment/system switchboard or control panel involved, the ELECTRICAL Contractor shall provide separate interfacing panels with provisions same as the interfacing compartment as described above. The locations of the switchboard/control panels and the interfacing panels shall be properly coordinated.
3. Wiring and cables for interfacing with the fire alarm system and other fire protection and life safety systems shall be fire rated to comply with Local Fire Department .

4. The ELECTRICAL Contractor shall provide and make all power cable connections from mechanical equipment, local control panels, and distribution boards to the electrical isolators or power points (including cable termination) provided under Division 16 works. Location of power supply isolators and power points shall be properly coordinated.
5. In addition to the interfacing requirements shown on the Drawings, interfacing provisions as described below shall also be provided and included in the Contract.

#### **Electrical Installation**

The Electrical Installation shall provide the following:

- Electrical installation shall include direct power cable connections from the source (Panel feeder) to final loads.
- Earthing terminal should be adequate and complete in all respect.

#### **1.1.13 Examination of Site**

Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.

The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work, based on examination of the site or other information. Failure to examine the drawings or other information does not relieve the ELECTRICAL Contractor of responsibility for satisfactory completion of the work.

#### **1.1.14 Excavation and Backfill**

Where ever required provide trenches details, duly approved by the consultant with all relevant section etc. as per IS codes, minimum before 1 month of laying the pipes, etc. Co ordinate with during the excavation, and ensure that the excavation and backfilling is being properly done as per requirement.

Where ever it is asked by the Owner/ Consultant for providing trenches in ELECTRICAL Contractor's scope. It is deemed that the cost of the pipe is inclusive of trench digging and backfilling. The following points needs to be taken care of while making the trenches.

The trench shall be of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum over depth of four inches below the trench depths indicated on the drawings or required. Backfill over depths in the rock excavation and unauthorized over depths with loose, granular, moist earth, thoroughly machine tamped to a compaction level of at least 95% to standard proctor density or 75% relative density or as specified by the Engineer. Wherever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.

Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade as required by local authorities.

Trenches should not be placed within 3meters of foundation or soil surfaces which must be resist horizontal forces.

Do not backfill until all required tests have been performed and installation observed by the Engineer. Comply with the requirements of other sections of the specifications. Backfill shall consist of non-expansive soil with limited porosity. Deposit in 15 cm layers and thoroughly and carefully tamp until the work has a cover of not less than 30 cm. Backfill and tamp remainder of trench at 30 cm intervals until complete. Uniformly grade the finished surface.

#### 1.1.15 Cutting and Patching

All kinds of cutting and repairing of brick Walls or Partitions, etc. for the proper routing of pipe, cutting and repairing of RCC wall, or ceiling shall be in the scope of the ELECTRICAL contractor.

Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc., using skilled trade people of the trades required at no additional cost to the Contract.

Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Contract.

#### 1.1.16 Sealing of Penetrations

##### **Air Tight Seals**

- All penetrations through the building fabric subject to suction or pressurization shall be sealed airtight.

##### **Holes in Roof**

- Roof penetrations for passage of conduits or circular PVC and PVC Cables shall be sealed watertight using a flexible polypropylene conical sleeve manufacturer to seal the cable to the roof structure, regardless of the roof profile.
- All sharp metal edges, which may come in contact with the cable, shall be suitably bushed.

##### **Fire Rated Penetrations**

- Where services penetrate any fire rated barrier, the ELECTRICAL Contractor shall seal the penetration with the use of an appropriate material to ensure the integrity of the fire barrier.
- The ELECTRICAL Contractor shall seal the cable enclosures through fire rated barriers to ensure the integrity and rating of the fire barrier.

##### **Acoustic Penetrations**

- Where services penetrate acoustic barriers, sealant shall be supplied and installed to maintain the acoustic separation at least equal to the barrier penetration.

#### 1.1.17 Mounting Heights

Verify exact locations and mounting heights with the Engineer before installation.

#### 1.1.18 Supports

Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.

Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and equipment room.

Provide supporting frames or racks for equipment which is installed in a free standing position.

Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workman like arrangement of all equipment mounted on them.

Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on ducts, pipe, electric conduits, raceways, or cables for support.

Equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splinters, runners, bars and the like in the plane of the ceiling). Provide independent support of equipment. Do not attach to supports provided for ductwork, piping or work of other trades.

Provide required supports and hangers for equipment so that loading will not exceed allowable loading of structure. Equipment and supports shall not come in contact with work of other trades.

#### 1.1.19 Fastenings

Fasten equipment to building in accordance with the best industry practice.

Where weight applied to the attachment points is 45kg or less, conform to the following as a minimum:

1. Wood : Wood screws
2. Concrete and solid masonry : Dash Fastener of appropriate ratings -HILTI/FISHER
3. Solid metal : Machine screws in tapped holes or with welded studs

Where weight applied to the building attachment point exceeds 45 kg, but is 135 kg or less, conform to the following as a minimum:

1. At concrete slabs provide 60cm x 60cm x 13cm steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top slabs screed line, where no fill is to be applied.
2. At steel decking or sub-floor for all fastenings, provide through bolts and threaded rods. The tops of bolts and rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.

Where weight applied to building attachment points exceeds 135 kg, coordinate with and obtain the approval of Consultant and conform to the following as a minimum:

1. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall suitably weld or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

For items which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.

Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars.

#### 1.1.20 Identification

Identify equipment with permanently attached black phenolic nameplates with 13 mm high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates shall be attached with cadmium plated screws; peel and stick tape or glue on type nameplates is unacceptable.

Services runs shall be properly identified as per the requirements in the Contract.

See individual section for additional identification requirements.

#### 1.1.21 Prohibited Labels and Identifications

In all public areas, tenant areas, and similar locations within the project, the inclusion or installation of any equipment or assembly which bears on any surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor or other source(s) from which such object has been obtained is prohibited.

Required test lab certification labels shall neither be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

#### 1.1.22 Equipment Pads and Anchor Bolts

Provide all details with proper sections for the equipment pads and anchor. The equipment pads casting and making provision for anchor fastening shall be as per the final UNALTERED drawing duly approved by the Consultant, shall be in the scope of ELECTRICAL contractor.

All equipment pads for all vibrating equipments shall have cork vibration pads sandwiched between the finish surface and the bottom surface of required thickness suggested by the ELECTRICAL contractor to ensure that the minimum vibration can travel below.

Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.

Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an attached to 15 cm square, galvanized metal back plates which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not acceptable.

#### 1.1.23 Miscellaneous:

A site order book will be maintained at site, which will be in the custody of the Owner, or his representative and all instructions given to the ELECTRICAL contractor will be recorded in the site order book and the same has to be signed by the ELECTRICAL contractor to comply with the instructions given therein.

After completion of the work the whole installation shall be tested by the ELECTRICAL contractor. The tests shall comply the following I.E.E. Regulations and shall be submitted along with the final bill:

1. The result of the insulation test shall comply with the I.E.E. Regulations 1101 to 1108A and 1008B as may be applicable.
2. Test shall be carried out to ascertain that all the non-linked SP switches have been connected to the phase conductor.
3. The continuity test of the earthing system shall comply with I.E.E. Regulations 1108 to 1109 to the latest addition.

If the result of the above tests does not comply with the I.E.E. Regulations, the ELECTRICAL contractor shall be bound to rectify the faults so that the required results are obtained.

The ELECTRICAL contractor shall be responsible to provide all the necessary test certificates of testing instruments, such as megger insulation tester, earth tester multi-meter, AVO meter etc for carrying out the above tests.

The work will not be considered as complete and taken over by the Owner till all the components of the work after being completed at site in all respects have been inspected/ tested by the Consultant/Owner to his entire satisfaction and a completion certificate issued by the Owner/Consultant to this effect.

Shop drawing for electrical work e.g. equipment, cable earthing and conduit layout for all systems shall be prepared by the contractor and got approved before starting of the work.

At the completion of the work and before issuance of certificate of virtual completion, the ELECTRICAL contractor shall submit 6 sets of drawing and two tracing of each drawing to Owner of each layout drawings drawn at approved.

ELECTRICAL Contractor's Superintendence:

1. The contractor shall provide all necessary superintendence during the execution of the works and as long as there is necessity. The contractor or his competent and authorized agent or representative approved of in writing by the owner (which approval may at any time be withdrawn) is to be constantly on the works and shall give his whole time to the superintendence of the same. Such authorized agent or representative shall receive on behalf of the contractor, directions and instructions from the Engineer-in-charge or his representative.
2. The contractor shall provide detailed organization of the execution team deployed for the works with names and CV's, of all key staff before the commencement of work and get it approved of in writing by the Owner/ Consultant. Contact telephone or pager numbers for emergency and/or twenty-four (24) hour call shall also be included.
3. If in any case of withdrawal of any worker/ technician/ Engineer from the execution team, the replacement of the same shall be done with equivalent qualification, and shall be approved in writing by the Owner/ Consultant.

## 1.2 PRODUCT, TESTING & COMMISSIONING

### 1.2.1 Design Criteria

#### **Electrical Details for Incoming Supply:**

- Supply Voltage: Multiple 33kV
- Fault Level (Sym.) at supply point (Designated): 1500 MVA Neutral: Grounded
- Voltage Regulations: as per IS.
- Frequency Regulations: As per IS.
- Combined Regulations: As per IS.

#### **33KV HT Power Distribution System:**

- Voltage: 33 KV
- Frequency: 50 Hz
- Neutral: Grounded
- Short Circuit Fault withstand capacity: as per calculations

#### **LT Power Distribution System:**

- Voltage: 415 V
- Frequency: 50 Hz
- Neutral: Grounded

- Short Circuit Fault withstand capacity: 10kA to 65kA for 1Sec., as per calculations

**Control supply for Electrical System:**

The various supply voltage to be used in the control panels for the main equipment shall be as under:

- Spring charge motor : 230V, AC or 24V DC (Universal Motor)
- Closing/ Trip Coil : 24V, DC
- Alarm/ Indication/ Relays : 24V, DC
- Heaters : 230V, AC

**Painting of Panels:**

Powder coating of approved shade as per Specification. (Refer clause of painting)

**Painting of Cable Trays and Structural steel:**

Powder coating of approved shade as per Specification. (Refer clause of painting)

**Cable Details:**

- LT Control Cables: Copper conductor armoured PVC insulated 1.1 KV grade.
- LT Power Cables: Aluminium conductor armoured XLPE insulated.
- Grounding Conductors: Copper/ G.I. as per specifications

1.2.2 Drawings

The Tender drawings are enclosed along with this specification. These drawings are meant to give general idea to the ELECTRICAL contractor regarding the nature of work covered by these specifications.

Any information/data shown/not shown in these drawings shall not relieve the ELECTRICAL contractor of his responsibility to carry out the work as per the specifications. Additional information required by the bidder for successfully completing the work shall be obtained by him.

1.2.3 Shop Drawings

The ELECTRICAL contractor shall prepare detailed coordinated electrical shop drawing indicating Panel layout, with other relevant services. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. Control and Relay Panel and fixing details for the above mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings do not relieve the contractor of his responsibility for providing maintenance free and full proof system including any missing component/accessories to meet with the intent of the specifications. Contractor will submit 2 (two) prints for preliminary approval and finally 6 (six) prints for distribution.

1.2.4 Manufacturer's Instructions

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

1.2.5 Completion Documents and Drawings

Three copies of operation manuals/catalogues of all standard equipment are to be furnished by the contractor immediately after commissioning of plant.

Three copies of write up on preventive maintenance, trouble shooting and operating instructions of the system along with as-built drawings are to be supplied by the Contractor at the time of commissioning.

On completion of the work in all respects, the Contractor shall supply five portfolios (300x450 mm), each containing complete set of drawings on approved scale, clearly indicating complete layouts, location; wiring and sequencing of automatic controls, location of all concealed wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The Contractor shall frame under glass, in the Panel rooms, one set of these consolidated control diagrams.

#### 1.2.6 Materials and Equipment

All the materials and equipments shall be of the approved make and design. Unless otherwise called from Consultant, only the best quality materials and equipment shall be used.

##### **Space Heaters:**

Suitable number of 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.

##### **Fungi static 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 cabinet, junction boxes and marshalling boxes, panels etc to be installed shall provide degree of protection as detailed here under.

- |  |   |       |
|--|---|-------|
| 1. Installed Outdoor   | : | IP-55 |
| 2. Installed indoor in air-conditioned area  | : | IP-31 |
| 3. Installed in covered area   | : | IP-42 |
| 4. Installed indoor in non air-conditioned area where possibility of entry of water is limited | : | IP-41 |
| 5. For LT Switchgear (AC and DC distribution boards)   | : | IP-42 |

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.

##### **Rating plates, Name plates and Labels:**

LT panel and auxiliary items installed in the building is to permanently attach to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of loading conditions of equipment in question has been designed to operate and such diagram plates as may require by the owner. The rating plate of each equipment shall be in accordance with IEC requirement.

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

**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 the Owner's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Owner after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

1. His organization structure for the management and implementation of the proposed quality assurance programme.
2. Documentation control system.
3. Qualification data for bidder's key personnel.
4. The procedure for purchases of materials, parts components and selection of services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
5. System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
6. Control of non-conforming items and system for corrective actions.
7. Inspection and test procedure both for manufacture and field activities.
8. Control of calibration and testing of measuring instruments and field activities.
9. System for indication and appraisal of inspection status.
10. System for authorizing release of manufactured product to the Owner.
11. System for maintenance of records.
12. System for handling storage and delivery.

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

**Quality Assurance Documents**

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

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

1.2.7 Inspection, Testing and Inspection Certificates

The Owner and the Consultant or duly authorized representative shall have at all reasonable times free access to the ELECTRICAL Contractor'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 ELECTRICAL Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the ELECTRICAL Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Owner and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The ELECTRICAL Contractor shall intimate the Owner/Consultant the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test were pending payment would be made on successful completion of type/routine test(s) actually carried out as per Consultant/Owner instructions.

The ELECTRICAL Contractor shall give the Consultant/Owner thirty (30) days written notice of any material being ready for testing. Such tests shall be to the ELECTRICAL Contractor's account. The Consultant /Owner unless witnessing of the tests is virtually waived 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 Owner/ Consultant and he shall forthwith forward to the Consultant duly certified copies of tests in triplicate.

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

When the factory tests have been completed at the Contractor's or Sub-contractor's works, the Consultant/Owner shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Consultant/Owner, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Consultant/Owner. 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 Owner 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 material inspection clearance certificate by the Owner.

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 labor, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by Owner/Consultant or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

The inspection by Owner/Consultant and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

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

The Owner/Consultant 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 equipments for these tests shall be provided by the Contractor.

#### 1.2.8 Tests

##### **Charging (Pre-commissioning tests):**

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/Consultant 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. / vendor/ bidder submittal and as included in the Contractor's quality assurance programme

**Commissioning Tests:**

1. 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, immeasurable 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.
2. All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
3. Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.
4. The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimburse by Owner on production of requisite documents.

1.2.9 Packaging

All the equipments 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. Owner takes no responsibility of the availability of any special packaging/transporting arrangement.

1.2.10 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 piping 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.

1.2.11 Finishing Of Metal Surfaces

**General:**

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

**Painting:**

1. All sheet steel work shall be degreased, pickled, and phosphated in accordance with the IS-6005 "Code of practice for Phosphate 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 swab 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.

2. After Phosphate process thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be “flashing dried” while the second coat shall be stoved
3. Powder coating/electrostatic painting of approved shade shall be applied.
4. The exterior color of the paint shall be as per IS-5 or as approved by Consultant. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.
5. In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for Owner’s review and approval.

#### 1.2.12 Handling, Storage and Installation

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

Contractor shall follow the site procedure for transporting of materials, unloading, and safe storage. The equipments after collection from store shall be erected, tested and commissioned as per contract specification, manufacturer guidelines and Engineer-in-charge instruction.

In case of any doubt/misunderstanding as to the correct interpretation of manufacturer’s drawings or instructions, necessary clarifications shall be obtained from the Owner/Consultant. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer’s drawings/instructions correctly.

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

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

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

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

The words ‘erection’ and ‘installation’ used in the specification are synonymous.

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

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

1.2.13 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.

The Contractor shall also conform to the general regulations governing personnel on the site and must keep to the working space allocated for their use.

The contractor shall be responsible for any kind of mishap, etc. happened with personnel. The Owner shall not take the responsibility for any of such kind.

1.2.14 Tools and Tackles

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

**END OF SECTION**

## **CONDUIT SYSTEM, CABLE TRAY, CABLE LADDER AND TRUNKING INSTALLATION**

## 2.0 CONDUIT SYSTEM, CABLE TRAY, CABLE LADDER AND TRUNKING INSTALLATION

### 2.1 GENERAL

#### 2.1.1 Work Description

This section describes the supply and installation of wiring facilities systems include conduits, cable trays, cable ladder and Trunking system, c/w associated fittings and accessories.

All cables running above the suspended false ceiling, columns, or on surface shall be supported by proper clamps, on cable tray or cable ladder system. No free hanging of cable is allowed.

The cable routes shown in the drawings shall be used as a guide only. The cable routes may be physically examined and coordinated with other services before undertaking the installation work in hand.

Uncoordinated and inaccessible routes after other services are installed, shall be relocated at the expense of the Contractor.

All conduits, trunking, cable trays and cable ladders shall be earthed in accordance to IS: 4043.

#### 2.1.2 Standards

The complete wiring facilities system shall be manufactured, supplied, installed and tested in accordance with the latest revision of the Indian standards and the appropriate BS / IEC include:

- |  |   |
|--|---|
| 1. Steel Conduit and Fitting Accessories | IS:9537 (Part-II)/ BS4568 & BS731       |
| 2. PVC Conduit and Fitting Accessories   | IS-9537/1983 (Part-III)/BS6099 & BS4607 |
| 3. Cable Tray                            | BS729                                   |
| 4. Cable Ladder                          | BS729                                   |
| 5. Cable Trunking                        | BS4678                                  |

The complete wiring facility system shall conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in the approved specification and drawings.

#### 2.1.3 Submissions

All technical submissions shall be approved by the ELECTRICAL contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

Routing of installation

Sample of proprietary factory-made accessories, elbows, risers, reducers, tees, crosses, etc.

### 2.2 PRODUCTS

#### 2.2.1 Steel Conduit and Accessories

##### **Steel Conduit:**

1. All conduits shall be of heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet up to 32mm dia and 14 (2 mm) gauge for sizes above 32mm.
2. Both inner and outer surfaces shall be smooth without burrs, dents and kinks.

3. Conduits shall be black stove enameled inside and outside. The cross section of conduit shall be uniform throughout.
4. The welding shall be uniform such that welded joints do not yield when subjected to flattening test. Welded joint shall not break when threaded or bent at an angle.
5. Conduit shall conform to specifications of IS: 9537 (Part-II) and the capacity of conduits shall be in accordance with the standards
6. The minimum size of the conduit shall be 19/20mm diameter.
7. Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit is used.

#### **Fittings**

1. Samples of conduit fittings shall be submitted for approval prior to use on work.
2. Fittings shall be those intended for use with screwed conduits and shall comply with IS 9537. However, bends, elbows and tees shall not be installed.
3. Boxes and cover plates installed outdoors shall have fixing lugs exterior to the box so that fixing screws do not enter the box interior.
4. Adaptors used with flexible conduits shall conform to IS: 9537.

#### **Circular Boxes**

Circular boxes shall be of malleable cast iron, galvanized and of standard pattern with spout(s). When used for connecting lengths of conduits, circular boxes shall be provided with cover plates of similar make that are complete with brass fixing screws.

#### **Rectangular Boxes**

Rectangular boxes (adaptable boxes) shall be of mild steel not less than 2.4 mm gauge and galvanized. When used as junction boxes, lids of the same gauge with brass fixing screws shall be used.

#### **Boxes for Accessories**

Boxes for accessories shall be suitable for surface mounting or recessed mounting according to the requirements. Surface mounted boxes and accessories shall be metal clad pattern. Recessed boxes and accessories shall be complete with insulated molded type cover plates conforming to IS: 5133 Part I-1969.

#### **Covers**

All covers for boxes, etc shall be made of galvanized steel of 1.2mm thickness.

### 2.2.2 PVC Conduit and Accessories

#### **PVC Conduit**

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

#### **PVC Conduit Accessories**

1. Accessories used for conduit wiring shall be of an approved type conforming to IS: 3837-1966.
2. All accessories used shall be of standard white or black color, identical to conduit used.
3. Plain conduits should be jointed by slip type of couplers with manufacturer's standard sealing cement.
4. All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and male bushes screwed.
5. PVC-switch and socket boxes with round knockouts are to be used. The colors of these boxes and the conduits shall be the same.
6. Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.
7. Samples of accessories shall be submitted for approval prior to installation.
8. All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

### 2.2.3 Conduit Installation

#### **Layout**

1. The conduit layout and conduit routes shall be submitted for approval. Allowance for adjustments due to site conditions shall be made at no extra cost.
2. Conduit routes shall be chosen for easy, straight runs with minimum bends and crossings. Generally they shall follow the structure of building, running at right angles or in parallel to floors and ceilings. Conduits shall be kept within 300 mm of floors and ceilings when running parallel to them.
3. Outlet boxes for housing accessories shall be used as draw boxes. The total number of draw boxes shall be kept to a minimum and shall be provided so that conduit runs do not exceed 12 m or have more than two right angle bends.
4. All conduits shall be kept clear of gas and water pipes. In particular, conduits shall be at least 150 mm away from gas pipes. Where proximity to these pipes is unavoidable, they shall be effectively segregated e.g. using rubber or other insulating material to prevent appreciable voltage differences at possible points of contact. Segregation from extra low voltage circuits and telecommunication circuits shall also apply unless these are wired to the same voltage requirements as lighting and power circuits.
5. Conduits from different distribution boards shall not be connected to the same junction box. Each run of conduit shall be assembled complete with draw-in-wires.

#### **Joints and Terminations**

1. Electrical and mechanical continuity shall be maintained throughout all conduit joints and terminations. Conduit threads shall be thoroughly cleaned and tightly screwed. The conduit system shall be watertight after installation.
2. Conduits shall be connected using couples or via boxes. With a coupler, the ends of the conduit shall butt close together and the running coupler is screwed tightly on and tightened by a locknut.
3. Conduits terminating into boxes provided with spouts shall be threaded so that there are no exposed threads. For boxes with no spouts, the termination shall be made using a brass bush and a coupler. The conduit is pushed through the knockout or drilled entry and the

bush is screwed tightly onto its end. The coupler is screwed to butt firmly against the exterior wall of the box.

4. Where conduits are not jointed or terminated in boxes, they shall be terminated in a screwed brass bush.
5. In all joints and terminations, conduit threads shall not be exposed. Where this cannot be avoided as in a running coupler, the exposed threads shall be coated with red lead paint to seal against the ingress of water.

#### **Bends**

1. Conduits shall only be bent cold with an approved type of bending block or bending machine, without altering the dimensions of their sections.
2. All conduit bends shall be such as to permit compliance to the requirements for bends in cables to as stated in the BS 7671.
3. Bends shall be made with as large a radius as the position of the conduit within the building permits. Where the bend is more than 90 degree, circular or rectangular junction boxes are to be used for connecting conduits.

#### **Cabling**

1. The conduit system must be installed free of obstructions and sharp corners before any cables are drawn in. Conduits shall be thoroughly swabbed to remove moisture and dirt immediately prior to the drawing in of cables.
2. Cables shall be drawn without crossing each other and shall not be pulled against the walls of the draw boxes. Slack cables shall left in all draw boxes.
3. Cables shall be continuous throughout conduit lengths and no joints are permitted. There shall be no kink in cables, neither any cut, abrasion or chink in the cable insulation.
4. The same conduit shall carry the lead and return conductors bunched together. However, the same conduit shall not house cables from different distribution boards.
5. Cables for power and lighting circuits and extra low voltage systems shall not be drawn into the same conduit. Lighting and power circuits shall run in separate conduits except, where an adopter box is employed as final distribution point, a number of final circuits are grouped together in larger conduits between the distribution board and the adopter box provided that all final circuits in one conduit are of the same phase. In the case of three phase circuits, all three phases including neutral, if any, shall be drawn into the same conduit.
6. Conduits shall not constitute the earth continuity path for the electrical circuit. A separate circuit protective conductor shall be installed within the conduit. The whole conduit system shall be effectively earthed.
7. Flexible conduits shall have a separate earthing conductor installed within the tubing and connected at conduit ends. Flexible conduits in general shall not be used for more than 3m length.
8. Maximum number of PVC insulated 650/1100V grade/copper conductor cable conforming to IS:694-1990

Nominal	20mm	25mm	32mm	38mm	51mm	64mm
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Cross-Sectional area of Conductor in Sq.mm												
	S	B	S	B	S	B	S	B	S	B	S	B
1.0	2	3	4	5	6	7	8	9	10	11	12	13
1.5	5	4	10	8	18	12	-	-	-	-	-	-
2.5	5	3	8	6	12	10	-	-	-	-	-	-
4.0	3	2	6	5	10	8	-	-	-	-	-	-
6.0	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	5	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

**Notes:**

- i. The above table shows the maximum capacity of drawing in of cables in conduits
- ii. The columns Head 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight run by an angle of more than 15 degrees. The columns heads 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
- iii. Conduit sizes are the nominal external diameters.

**Access and Drainage**

1. The conduit system shall be rewirable, that is, draw boxes must be accessible for the purpose. Where boxes are concealed, their covers shall be flushed with the finished surface.
2. The need for accessibility notwithstanding, the conduit system shall be protected against the ingress of water and impurities. When installed, conduits shall be kept dry and free of debris with approved pipe plugs or caps. Such plugging is especially essential prior to pouring concrete for concealed installation. As for boxes, they shall be covered by steel plates prior to concreting.
3. When installed outdoor, and in situations liable to condensation of moisture, conduits shall be arranged to be self draining, so that water may drain to low points which are fitted with a drain plug. Conduits laid under concrete floors shall have watertight floor-traps of approved detail for access of these drainage points.
4. Conduits run on surfaces other than structural steel members shall be secured using galvanized space bar saddles and brass fixing screws. Spacing of saddles shall not exceed 1.2 m for conduit sizes up to and including 25 mm and 1.8 m for sizes 32 mm and above.
5. Conduits run on structural steel shall be secured using girder clips or an approved clamp. These conduits and those run in the vicinity of structural steel shall be bonded to the steelwork using an efficient and permanent metallic connection. The conduits shall not in any way be under mechanical stress.

6. All conduit boxes except loop-in patterns shall be fixed direct to the building structure in addition to the support provided by the conduits.
7. Conduits terminating into surface boxes shall be secured by a minimum of 3 saddles at not less than 32 mm, 150 mm and 300 mm respectively from the box.
8. Conduits shall be painted with an approved paint to blend with visual environment. A zinc rich undercoat shall be provided before painting the final coat.

**2.2.4 Cable Tray/ Cable Ladder**

Cable Tray and Cable Ladder systems are intended for the support and accommodation of cables and possibly other Electrical equipment in Electrical/Instrumentation/Communication systems.

The cable trays / ladders shall be fabricated according to the design specified by IEC 61537 and should be tested for Safe Working Load (SWL). The relevant details of SWL and the load chart with respect to SWL, supporting distance and the deflection should be according to the following chart.

Safe Working Load (SWL) with a span length up to 5 meters								
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)					
			1.5m	2m	2.5m	3m	4m	5m
			Permitted Load (in kg/meter)					
Perforated tray	60	100-500	150	100	50	-	-	-
	85	100-500	175	110	50	-	-	-
	100	150-500	185	130	75	60	-	-
Cable Ladder	60	200 - 600		225	150	110	45	-
	110	200 - 600		310	-	140	65	50

Safe Working Load (SWL) with a span length up to 10 meters									
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)						
			4m	5m	6m	7m	8m	9m	10m
			Permitted Load (in kg/meter)						
Perforated Cable Tray for long span distance	110	200 - 300	160	110	75	-	20	-	-
		400 - 600	200	150	100	-	40	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
Cable Ladder for long span distance	110	200 - 300	160	110	80	40	-	-	-
		400 - 600	210	150	100	70	-	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
	200	200 - 600	-	-	300	250	200	140	100

Fabrication of Tray / Ladder and accessories at site and welding is not permitted. In unavoidable circumstances, If any cut or holes are made in the trays/Ladder/accessories, zinc spray need to be applied over the surface. The metal edge has to be protected by edge protection sleeves to avoid cable damage. Edge of the supports has to be protected with plastic END caps. Screwed connections and internal fixing Devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections.

**Cable Tray:-**

The cable tray and all accessories shall be fabricated from sheet steel and has to be galvanized against corrosion confirming to EN10346 / ISO1461-1999 for installations in indoor and outdoor applications respectively. The cable trays shall be supplied in standard lengths of 3000 mm and the width of the tray shall be as follows.

Width: 100, 150, 200, 300, 450, 600.

All the cable tray accessories like Bend's, TEES's, Cross over's etc should be designed in accordance with IEC 61537 and shall be factory fabricated. The accessories shall be from the same material as of the tray and modular type, it should be connected with the trays by using fasteners. Typical details of trays, fittings and accessories.etc are shown in the enclosed drawings.

For Cable trays designed, tested and confirming to IEC 61537, thickness of cable tray should be according to the manufacturer's catalogue. For locally fabricated and non tested tray, thickness should be 2 mm up to span length of 1.5 meter, 2.5 mm for span length between 2 to 3 meter and 3 to 4 mm for span length between 4 and 10 meter

**Cable ladder:-**

The cable Ladder and all accessories shall be fabricated from sheet steel and has to be galvanized against corrosion confirming to EN10346 / ISO 1461-1999 for installations in indoor and outdoor applications respectively. The cable ladders shall be supplied in standard lengths of 3000 mm and the width of the ladder shall be as follows.

Width: 200 to 600 mm in multiples of 100 mm

Maximum rung spacing in the ladder shall be 300mm. The rung's should be made of C profiles suitable to fix cables by special metal clamps according to the drawing. The ladder shall be of riveted and foldable type for easy transportation and to avoid damage during transportation and storage. All the ladder accessories like Bend's , TEES's, Cross over's etc should be designed in accordance with IEC 61537 and shall be factory fabricated . The accessories shall be made from the same material as of the ladder and modular type, it should be connected with the ladder by using fasteners. The details of ladders, fittings and accessories..etc. are shown in the enclosed drawing.

For Cable Ladders designed, tested and confirming to IEC 61537, thickness of cable Ladder should be according to the manufacturer's catalogue. For locally fabricated and non tested Ladder, thickness should be 2.5 mm up to span length of 1.5 to 2 meter, 3 mm for span length between 2.5 to 4 meter and 3 to 4 mm for span length between 5 and 10 meter

**Mounting Accessories (supports and Brackets):-**

The mounting accessories shall be fabricated from steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications and should be of completely modular type.

All supports and Brackets should be factory made, hot dip galvanized after completing welding, cutting, drilling, other machining operations and tested according to IEC 61537 according to the arrangements in the enclosed drawing. The system shall be designed such that it allows easy assembly at site by using Bolts and Nuts. The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hard ware etc to form various arrangements required to support the cable trays. Welding of the components at the site shall not be allowed.

**Corrosion Protection:-**

The cable tray / ladder/accessories shall be Galvanized according to EN10346 / ISO 1461-1999 for installations indoor and corrosive outdoor applications respectively. Sample tray / ladder / accessories / mounting accessories and supports should be salt spray tested according to ISO

9227 for > 150 hours & 500 hours. (\*155 hours according to class 3 for pre-galvanized surface and 550 hours according to class 6 for Hot dip Galvanized surface as per ISO)

**Testing and Certification:-**

Cable tray / Ladder, bend, T Bend, cross, and all supports are to be tested for Safe Working Load (SWL), deflections, Impact resistance, Salt Spray & Electrical continuity test according to IEC 61537. The cable tray/ladder should not deflect more than 1/100th of the span length at SWL in Mid span and the transverse deflection of all mounting accessories at SWL shall not exceed 1/20th of the length. The cable tray / cable ladder should be tested up to 1.7 times SWL at minimum and maximum room temperature. The temperature classification of cable tray system should be - 5 to + 150°C.

2.2.5 Cable Trunking

Cable trunking shall be manufactured from 1.6 mm minimum electro-galvanized mild sheet steel to BS4678 finished in oven-baked electro statically coated epoxy powder coating with color.

All trunking shall have removable lids extending over their entire lengths. Lids shall be fixed at interval not exceeding 1 meter by means of brass steel screws which and protected against corrosion by a finish of zinc coating or equivalent to zinc coating.

Factory-made bends, joints, elbow, riser, tee, reducer and accessories with same material shall be provided throughout the installation for trunking.

Trunking space factor shall be in compliance with latest IS standards.

Copper earth link bar shall be fixed at every joint of the cable trunking run.

**Note:** All items mentioned in this section shall be manufactured to comply with the specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA).

**END OF SECTION**

## WIRES AND CABLES

## 3.0 WIRES AND CABLES

### 3.1 GENERAL

#### 3.1.1 Work Description

The design, manufacturing, testing and supply of single core PVC insulated 1.1 KV grade stranded twisted wires shall comply with following standards with update amendments under the specifications.

- IS-3961: Current rating for cables.
- IS-5831: PVC insulation and sheath of electric cables.
- IS-694: PVC insulated cables for working voltage up to and including 1100 volts.
- IEC-54 (I): PVC insulated cable.

Copper / Aluminum stranded twisted conductor PVC insulated wires shall be used in conduit as per item of work. Aluminum wires for power cables and copper wires for control cables shall be used.

The wires shall be color coded - (red, yellow, blue) for Phases, black for Neutral and green for Earth.

Progressive automatic in line indelible, legible and sequential marking of grade, voltage, capacity and length in meters shall be embossed at every meter on the outer sheath of cable.

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

- IS: 8130: Conductors for insulated electric cables and flexible cords.
- IS: 5831: HRPVC / HR PVC insulation and LSZH sheath of electric cables.
- IS: 3975: Mild steel wires, strips and tapes for armoring cables.
- IS: 3961: Current rating of cables.

The routing and minimum rated current carrying capacity of the LV power cables shall be indicated on the Drawing. The Contractor shall consider the manufacturer data and engineering for cable sizing and to ensure that it meets the conditions of grouping, ambient temperature etc.

All LT cables for normal power/control circuits within buildings shall be XLPE insulated and PVC sheathed Aluminum conductor and control cables shall be PVC insulated and PVC sheathed copper conductor respectively.

All LT cables, for emergency power circuits serving emergency light, Building Management System (BMS), Fire Protection System, Security Systems, emergency communication systems, and sump pump system and fire lifts etc. with back-up from UPS systems or incoming and outgoing from the Emergency Main Switchboard, shall be fire resistant as required.

Cables in service duct, open trench, direct-laid underground in soil shall be by means of armoured cables. Non-armoured cables shall only be laid in conduits, trunkings or tray/ladder for mechanical protection.

#### 3.1.2 Standards

All cables shall be manufactured and constructed in accordance of the following standards with the latest revision:

1.	IS: 694	:	HRPVC/XLPE insulated (heavy duty) electric cables for
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			working voltage up to and including 1100 volts.
2.	IS: 424-1475(F-3)	:	Power cable-flammability test.
3.	IS: 7098(I)	:	Specification for cross-linked polyethylene insulated LSZHPVC sheathed cable for working voltage up to 1.1 KV.
4.	IS: 1554	:	Specification for PVC insulated (heavy duty) electric cables
			for working voltages up to and including 1100 volts.
5.	ASTM-D: 2863	:	Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).
6.	ASTM-D: 2843	:	Standard test method for measuring the density of smoke from the burning or decomposition.
7.	IEEE: 383	:	Standard for type of tests Class-IE, Electric cables, field splices and connections for power generation station.
8.	ASTME: 662/ IEC: 754(x)	:	Standard test method for specific optical density of smoke generated by solid materials
9.	IS: 10418	:	Cable drums.
10.	IS-10810	:	Testing method of cable.
11.	IS-6121	:	Cable glands.
12.	IS-9537	:	Rigid steel conduit.

The manufacturing of the cable shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in the approved Specification and Drawings of ELECTRICAL contractor. Only more stringent specification shall be followed.

### 3.1.3 Submission

All technical submissions shall be approved by the ELECTRICAL contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

As a minimum requirement, the submission shall include the following:

1. Equipment submission with manufacturer’s data
2. Sample submission
3. Shop Drawings of the cable route showing the co-ordinated routing of cables, arrangement on cable trays, methods of fixing of cable trays and cables, etc. All conduits including concealed conduit routing drawings shall also be included
4. Cable test reports and IS Certification
5. Cable schedule indicate the following data include:
  - a. Cable code and type and installation method
  - b. Cable feed from and serve to
  - c. Cable route length and voltage drop
  - d. Cable capacity and
  - e. Upstream protection breaker rating

The cable schedule shall be prepared in accordance to the cable manufacturer’s data.

## 3.2 PRODUCT

### 3.2.1 LT Cables

1. The cables shall be suitable for laying in racks, ducts, trenches conduits and under-ground buried installation with uncontrolled back fill and chances of flooding by water.
2. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.
3. The aluminum / copper wires used for manufacturing the cables shall be true circular / sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.
4. The cable should withstand 2.5 kA for 1 Sec. with insulation armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration.
5. The fillers and inner sheath shall be of non-hygroscopic fire retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.
6. Progressive automatic in line indelible, legible and sequential marking (grade, voltage, capacity, length - in meters) shall be embossed at every meter on the outer sheath of all cables and at every 5 meter 'LSZH marking in case of 'LSZH cables.
7. IS: 3975 method (b) for strip / wire armouring shall only be acceptable. For single core cable aluminium wire armouring shall be used.
8. Allowable tolerance on the overall diameter of the cables shall be + 2mm.
9. The normal current rating of all HRPVC/XLPE insulated cables shall be as per IS: 3961.
10. A distinct inner sheath shall be provided by pressure extrusion process for all multi cores armoured and unarmoured cables as per IS: 5831.
11. Outer sheath shall be provided by extrusion process as per IS: 5831.
12. The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.
13. In plant repairs to the cables shall not be accepted.
14. All the cables shall be supplied in non-returnable drums as per IS: 10418.
15. Fire Survival Cables
  - Multi core Al / Cu Conductor XLPE/ Cross linkable Low Smoke Halogen Free insulated with Fire rated Glass Mica Tape, LSZH inner and outer Sheathed, Armoured with GI Strip/ Wire Fire Survival Cable.
  - Basic design shall be as per BS:7846-2009,
  - Fire resistance of the cable shall be as per BS:8491-2008 & 8434-2:2003

#### **Inspection**

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

#### **Joints in Cables**

Cable drum length and sizes of cable lengths required may be checked carefully before cutting the cables from drum. The contractor shall take care that the cables received at site are distributed to various locations in single length as far as possible to ensure maximum utilization. Where the joints are unavoidable, the same is to be done with approval from the Owner/Consultant. The joints

shall be done by qualified jointer strictly in accordance with manufacturer's instruction / drawings in presence of Engineer-in-charge.

#### **Joint Boxes for Cables**

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

#### **Cable Joints**

1. All cable joints materials shall be of standard make and suitable to requirement. On jointing of cables in the joint box the cable compound shall be filled in accordance with manufacturer's instructions and in approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.
2. End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.
3. All washers and hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.
4. Cable lugs shall be tinned copper / aluminium solder less crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.
5. Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.
6. Fire resistant paint has to be applied 1 Meter on either side of cable joint.
7. The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison; no extra cost shall be incurred by the client.

#### **3.2.2 XLPE HT Cables (Upto 33KV)**

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

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

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

After laying and jointing work is completed High Pot test shall be performed in presence of Engineer-in-charge and test results submitted for approval in order to ensure that they have not been damaged during or after the laying of cables. In case, the test results are unsatisfactory, the

cost of all repairs and replacement and all extra work of removal and relaying will be made good by the contractor without any extra cost.

**Note:** All other procedure will be followed as per L.T. cables.

### 3.3 EXECUTION

#### 3.3.1 Erection of Cables

Notwithstanding the cable routes indicated on the Drawings the Contractor shall be entirely responsible for the supply of correct lengths of the cables to be installed and for all allowances for connecting and terminating the cables to the switchgears and transformers respectively

The Contractor shall submit proposed cable routes including details of supports for the cables for approval before installation. The cable shall not be run in places other than corridor, passageway, electrical riser or other designated areas subject to the Engineer's approval. The cost of support shall be deemed to have included in the Contract.

#### 3.3.2 Cable Pulling

Winching of cables through ducts / pipes shall only be carried out with the approval of the Engineer-in-charge in which event a pulley eye shall be attached to the conductors. Cable shall be run in neat and orderly manner to allow space for future cabling and maintenance. Under any circumstances the cable shall not run diagonally across a room, cable basement, corridor, etc.

A cable sheath stocking may be employed or cables where no undue stress in the sheath is likely to occur.

Care shall be taken to ensure that the draw strain is applied to the armouring and protected during drawing against damage.

#### 3.3.3 Cable Laying

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

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

In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200 mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 20 times the dia meter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever less is. Minimum 3 meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.

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

Cables laid in trenches in single tier formation, 10 cms all-around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30 cm of sand cushion is provided over the initial tier. The cable shall be protected by 2nd class brick of size not less than 230 x 115 x 75mm, stone tiles / RCC curved channel be placed on top of

the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the brick shall cover all cables and project at least 8 cms over the outer sides of the end cables.

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

PVC pipe shall be provided on all road crossing. The size of the pipe shall be above the size of the cable. Minimum 100mm dia. pipes are to be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting of 1:5:10 shall be provided as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Cable route markers at interval of 30 meters and at the point of direction change shall be provided to indicate cable path. Aluminum strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

Where the cables are laid in ducts (pucca trenches) in side the building, they will be laid on MS rack / cable trays grouted on trenches walls. Cables passing through floors shall be protected from mechanical damage by steel channel to a height of one meter above the floor. Sleeve shall be provided in the wall for crossing of cables.

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

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

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

#### 3.3.4 Internal Wiring

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

Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the Consultant. No reduction of strands is permitted at terminations. No wire smaller than 1.5 sq.mm shall be used. Wherever wiring is run through trunkings or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals. Identification ferrules indicating the circuit and DB number shall be used for sub main sub-circuit wiring. The ferrules shall be provided at both end of each sub main and sub-circuit.

Where single phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same phase of the supply. Circuits fed from

distinct sources of supply or from different distribution boards or through switches or MCBs shall not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single phase switches connected to different phase shall be mounted within two meters of each other.

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

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

### 3.3.5 Fire Seal System

All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.

The fire proof sealing system shall fully comply with the requirements of relevant IS/BS: 476 Part-B. The fire proof seal system shall have minimum one hour fire resistance rating.

The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, antirodent and anti-termite.

The material used in fire proof seal system shall be non-toxic and harmless to the working personnel.

Type of fire proof seal system shall be foaming type or flamemastic type compound or approved equivalent.

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

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

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

1. HT Cable (33 KV)	- HV Cable (33 KV)	50 mm
2. ELV & LT 230 V/433 V	- ELV & LT cable 230 V/433 V	50 mm
3. HT cables (33 KV)	- ELV & LV cables 230 V/433 V	300 mm
4. LT cables 433 V	- Telephone/Instrument cable	350 mm
5. All cables	- All hot pipe work	200 mm

### 3.3.6 Factory Tests

Each type of cable specified shall be fully type tested according to IEC 502 and the appropriate British Standards. The types and sizes of cables required are shown on the Drawings.

Should the Engineer require it, the Contractor shall submit reports issued by a national or international testing authority on type test that have been successfully performed on the cable for his approval.

The type test shall include the following test:

1. Partial discharge test;
2. Bending test, plus partial discharge test;

3. Tan  $\delta$  measurement as a function of the voltage and capacitance measurement;
4. Tan  $\delta$  measurement as a function of the temperature;
5. Heating cycle test plus partial discharge test ;
6. Impulse withstand test, followed by a power frequency voltage test;
7. Medium-voltage alternating current test;
8. Type test (non-electrical) as stipulated in IEC 502, Table VI.

Cable routine test shall be conducted at factory in accordance with IEC 502 for the following tests:

Measurement of the electrical resistance of conductors

Partial discharge test,

4-hour HT test

#### 3.3.7 Site Acceptance Test

The Contractor shall supply all necessary testing equipments for site testing. When required, these testing equipments shall be calibrated at the expense of the Contractor at a recognized national laboratory.

The Contractor shall engage an Authorised Medium Voltage Testing Engineer who is recognized by SEB to perform all site tests.

In addition to SEB's requirements and those recommended by the manufacturer, the following tests shall be carried out:

1. Continuity test
2. Earth test
3. Polarity test
4. Insulation resistance test
5. DC high voltage test. The test voltage shall be in accordance with SEB's requirements and Engineer's approval.

**END OF SECTION**

## **WIRING DEVICES**

## 4.0 WIRING DEVICES

### 4.1 GENERAL

#### 4.1.1 Work Description

The drawings for the lighting and power points indicate approximate position of all lighting fittings, switches, power outlet points, isolating switch points etc. The actual position of all fittings, switches, the wiring details and cable routes shall be co-ordinated with other trades at site and submitted for the approval of the Engineer- in-charge. All time and cost required for adjusting the layout or complete installation to suit site requirement is included.

To determine the exact positioning of lighting and power points due consideration shall be given, for selection of the most accessible routes for wiring, convenience of switching and operational requirement of the installation.

No extra cost will be paid should the final positions be relocated within the same room.

For the purpose of specification and related drawing, each lighting & power point circuit shall be coded with a prefix to indicate the corresponding distribution board number.

The electrical equipment/system may develop sudden changes due to low frequency or direct electric current components such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS: 800 "Limits of Radio Interference".

This section included the specification of the following:

1. Distribution boards
2. Miniature circuit breakers
3. Earth leakage circuit breakers
4. 6A Switch Socket Outlet
5. 16A Switch Socket Outlets
6. Isolating Switches
7. Conduit Boxes
8. Contactors
9. Dimmers Switch
10. Time Switch
11. Cooler Control Units
12. Water Heater Switches
13. Bell Push Switches

#### 4.1.2 Standards

The complete wiring installation shall be engineered according to manufacturer data and constructed in accordance with the latest revision of the IS and the appropriate BS/IEC

In the adoption of standards and requirements, the Contractor shall take the following precedence:

1. Engineer's decision
2. Local codes of practice
3. Drawings
4. Specification
5. International standards and requirements

#### 4.1.3 Submission

All technical submissions shall be approved by the ELECTRICAL contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

The submission shall include the following as a minimum requirement,

1. Equipment catalogues submission with manufacturer's data
2. Sample submission include all wiring accessories
3. Shop Drawings of the lighting and power positions, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included.
4. Drawings showing the installation details
5. Labeling system
6. Builder's works requirement.

## 4.2 PRODUCT

#### 4.2.1 Lighting Point Installation

The various types of light fittings to be supplied and installed are described in the Schedule of Lighting Fittings on Drawing

Surface mounted light fitting shall terminate at junction box having entries appropriate to the run of conduit. This shall be complete with porcelain / PVC connector suitable for the size and number of connections and wiring points to be connected with the specified fitting. Wiring to the light fittings within the false ceiling space shall be by means of heat resistant (butyl or silicon rubber insulated to BS 6500) cables i.e. between the junction box and the lamp holder/terminal blocks, in flexible conduits.

At every light fitting an approved type earth terminal shall be provided for connection of the circuit protective conductor of the final circuit.

Ferrous metal work shall be of minimum of 1mm thickness and treated against corrosion by galvanizing after welding or lead primer or other approved process. Metal work shall be painted with one priming coat, one under-coat and two final coats with stove-enamelled matt white paint unless otherwise specified.

Cables used for internal wiring of the lighting fittings shall be with appropriate type and size, number with conductor of size not less than 1.5 sq mm single core. The insulation of the cables shall withstand the maximum temperature throughout the life of the fitting. It will be subject to normal use without deterioration which could affect the safety of the fitting.

Cables within the lighting fittings shall be neatly bundled by nylon self-locking cable ties. Wiring shall be properly routed and secured away from control gear etc. wherever possible.

All cable terminations within the light fittings shall be suitably shrouded.

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 900mm length. Exact lengths required shall be provided to suit the site requirement.

All lamps in operational condition with proper control gear shall be provided together with the light fittings as required and specified.

#### 4.2.2 Switches

Lighting switches unless otherwise specified, shall be single pole, quick make and break, silent action type with solid silver alloy contacts and totally enclosed for flush or surface mounting as required.

Lighting switches shall be suitable for indoor or outdoor service according to location housed in standardized purpose manufactured galvanized steel boxes completed with conduit knockouts made up into single or multi-gang units employing a grid switch system of fully interchangeable components at standardized fixing centers of matching switches of different types and ratings but of identical dimensions, push buttons, neon indicator lamps, blanking units, grids, steel boxes and plates all capable of integration into standard composite assemblies in any combination as required.

Grids shall be adjustable for variation in depth of plaster and for squaring errors and of the same type for surface or flush mounting. Switches in mechanical plant rooms and electrical sub-stations and switch rooms shall be of the metal clad type approved by the Engineer-in-charge mounted in flush or surface conduit boxes as specified.

Switches located on brick or concrete walls shall be mounted in horizontal arrangement in plaster depth steel boxes or in galvanized steel boxes using box suspension straps and cover plates. Countersunk screws shall be provided for fixing to the conduit boxes.

Switches for external use shall be of weatherproof construction with IP-65 rating unless otherwise specified. Samples of all switches, conduit boxes and plaster depth boxes shall be submitted to the Engineer for approval prior to installation.

Switches shall be rated for 6Amps (minimum light switch rating 6Amps), 16Amps or 20Amps (as determined by circuit load). Inductive lighting circuit shall be assessed at twice the steady state connected load current. One or two ways switch as indicated on the drawings be fixed generally at a height of 1200mm from floor level in rooms. The switch shall possibly be located inside the room on the handle side of the door as close as practicable.

Earth continuity terminal shall be provided and connected to the circuit protective conductor at every lighting switch position. Single pole switches shall be connected to break the phase wire of the supply. The neutral wire shall not be routed through switch boxes.

Switches which are mounted in the same location shall be of multi-gang type, of the maximum number of gangs available. All switches used shall be of approved or prescribed items as required by local Authorities. Circuit from different phase and circuit from emergency power should have separate switch plate.

#### 4.2.3 Isolation Switch

Isolating switches shall be of the current ratings and number of poles (generally double pole for single phase and 4-pole three phases) as indicated on the Drawings.

Isolating switches shall be of the totally enclosed pattern, metal-clad or polycarbonate with positive quick-make and quick-break action.

Switches shall be capable of passing and interrupting their full rated current safely and without damage.

Ferrous materials shall be galvanised, switch handles shall be interlocked to prevent opening the cover with the switch "ON".

#### 4.2.4 6AMP Switch Socket Outlets

Switch socket outlets shall be as per BS: 1363 single pole 6Amp 3round pin shuttered outlets, one or two gang for indoor service except otherwise specified and suitable for surface or flush mounting according to location.

Switches shall be of the quick-make and break type silent action totally enclosed with solid silver alloy contacts. Switched socket outlets for indoor use shall be housed in suitable galvanized steel boxes as per BS: 4662 with conduit knockouts. Types and finishes of socket plates shall match those for the lighting switches.

Generally switch socket outlets shall be positioned 300mm above floor level except in plant rooms, kitchen, etc. where they shall be positioned 1400mm above floor level or 150mm above counters or benches as per requirement.

Switch socket outlet in all mechanical plant rooms, electrical switch rooms shall be of the metal clad type, with recessed or protected switch dolly, mounted in flush or surface conduit boxes as specified.

All switch socket outlets used shall be of an approved quality.

#### 4.2.5 16 AMP Switch Socket Outlets

16Amp switch socket outlets shall be 3pin round type to BS: 546 shuttered, of finished similar to 6Amp switch socket outlets and flush mounted in galvanised steel conduit boxes to BS: 4662 requirements.

#### 4.2.6 Weatherproof Isolator

Weatherproof enclosure shall be of the high impact, water resistant to IP-65. The isolator provided shall complete with lockable device. Isolators shall be 2-pole, 4-pole as specified.

#### 4.2.7 Floor Box-Access Outlet.

All plates shall be made from stainless steel or equal approved, heavy duty trap cover. All plates are to be mounted flush with surface and are to be aligned correctly. Access Outlet should carry service plates for providing services i.e. Power, Data & Telecom. The system must comply the relevant specification & IEC 61084 standards. The system should have Positive Double Earthing connections.

#### 4.2.8 Lighting Dimmers Switch

Lighting dimmer switch shall be solid state, variable load and thyristor controlled type suitable for controlling fluorescent or incandescent lighting circuits operating at 230V  $\pm$  6%, 50Hz single phase AC supply.

Dimmer switch shall be manufactured to eliminate TV and radio frequency interference in compliance with IS.

The ratings of the dimmer units shall be suitable for lighting circuit specified on Drawing.

#### 4.2.9 Time Switches

Time switches shall be self- contained unit suitable for mains operation. All units shall have self-starting synchronous motor with single-pole fuse in the motor circuit, 3-way terminal block and thirty-six (36) hours spring reserve complete with an automatic solar dial.

The solar dial shall be capable of switching ON The lighting at sunset and OFF at sunrise throughout the year by control of a secondary calendar dial with month and day settings. The automatic switching time shall be adjustable.

Time switches shall be encased in dust-tight metal casing having hinged front cover with clear Perspex window. The casing shall be effectively earthed.

A manual bypass switch shall be incorporated with the time switch to facilitate maintenance of the latter.

#### 4.2.10 Miniature Circuit Breaker

The MCB shall be suitable for manual closing, opening and automatic tripping under overload and short circuit. The MCB shall also be trip free type.

Single pole / three pole versions shall be furnished as required.

The MCB shall be rated for 10KA fault level.

The MCB shall be suitable for housing in the lighting boards and is suitable for connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.

The terminal of the MCB and their open and close conditions shall be clearly / indelibly marked.

The MCB shall generally conform to IEC/ IS: 60898

#### 4.2.11 Earth Leakage Circuit Breaker

ELCB shall be 4 pole 415 volts 50Hz, 30-300mA sensitivity. These shall be of approved make. The rating of the ELCB shall be as required. These shall be suitable for manual closing and opening and for automatic tripping under earth fault circuit of 30-300 mA as specified in item of work.

The enclosure of the ELCB shall be moulded from high quality insulating material. The material shall be fire retardant, anti tracking, non-hygroscopic, impact resistant and shall with stand high temperature.

All parts of switching mechanism shall be non-greasing, self lubricating material so as to provide consistent and trouble free operation.

Operation of ELCB shall be independent of mounting position and trip free type.

#### 4.2.12 Lighting/Small Power Distribution Boards

Distribution boards shall be of standard make with MCBs as per approved make given. Distribution boards shall be of steel sheet construction double door all welded enclosure of IP42 protection and powder coated painted.

Ample clearance between the conductors of opposite pole and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduits entry plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements.

Additional / separate adopter box of suitable size shall be provided to accommodate wires, cables and No. of conduits etc. at no extra cost.

The MCB shall be mounted on high grade rigid insulating support and connected by electrolytic copper bus bars.

Each incoming MCB isolator shall be provided with solder-less cable sockets for crimping.

Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.

Distribution boards shall be recessed in wall or mounted on surface of wall with necessary mounting arrangement.

The mounting height shall not exceed 1200mm from finished floor level. Distribution board shall be provided with proper circuit identification name plate and danger sticker/plate as per requirement.

All the distribution boards shall be provided with engraved name plates with 'lighting', 'power' or 'UPS' with DB Nos., as the case may be.

Each DB shall be provided with circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number & phase.

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

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

#### 4.2.13 Telephone Outlets

Telephone outlets where called for shall be single or twin flush mounted type suitable to receive the plug- in telephone cable lead to the approval of the Telecom. The finish of the telephone outlet plates at various areas shall be as specified for lighting switches.

#### 4.2.14 Water Cooler Drinking Fountain Switches

Flush-mounted double pole AC switch of 20Amps rating shall be provided for water cooler and marked "water cooler".

Associated connector units shall be provided next to the water cooler.

The switches and the connector shall be IP-65 waterproof rating.

#### 4.2.15 Bell Push Switches

Bell push switches shall be flush-mounted having single-pole AC switch of 6Amps rating and marked with bell symbol.

#### 4.2.16 Shaver Outlets

Shaver outlets shall comprise a 20VA continuously rated double wound isolating transformer to provide an earth-free AC supply at mains frequency, complete with self resetting thermal overload device fitted in the primary circuit an insulated voltage selector switch to provide either 115 or 230volt output, one ON-OFF switch and one universal socket outlet suitable for British, American, Continental and Australian razor plugs, all contained in recessed sheet steel box with insulated moulded front plate suitable for flush, mounting and suitably inscribed to give clear indication of the voltages available at the outlet and the service of the outlet.

#### 4.2.17 Cooler Control Units

Cooler Control Units shall be flush mounted double pole AC switch of rating 30Amps complete with pilot indicating lamps and with self adhesive plastic identification label mounted on a removable chassis contained within steel box finished aluminium stove enamel provided with conduit knockouts and earthing terminals. The cover plates shall be of the same finish as those specified for the lighting switches.

Associated connector units shall be provided adjacent to the cooler units.

Wirings between the cooler control units and associated connector units shall be provided in concealed conduits.

4.2.18 Water Heater Switches

Water heater switches shall be flush mounted having double pole AC switch rated at 20amps fitted with pilot lamp and marked “water heater”. The cover plates shall be of the same finish as those specified for the other switches. Associated connector units shall be provided next to the water heater units.

4.2.19 Power Supply for Lighting at Wet Condition

Residual Current Circuit Breakers shall be provided individually for each circuits serving lighting subject to wet condition.

**END OF SECTION**

## LT PANEL BOARDS

## 5.0 LT PANEL BOARDS

### 5.1 GENERAL

#### 5.1.1 Scope

The section covers the detailed requirements of medium voltage switch panel for 433 volts, 3 phases, 50 HZ, 4 wire systems. These shall be branded and or / assembled / fabricated of factory of repute. All switchgears shall be fully rated at an ambient of 40 deg C.

#### 5.1.2 Type Of Panel

The medium voltage switch board panel shall comprise of any of the following types of switchgears or combination thereof as specified:

- Air circuit breakers draw out type or fixed type
- Switch Disconnecter Fuse Units fixed type, MCCBs of suitable lcs ratings. MCCBs shall invariably be current limiting type. Features like Double Break, positive isolation functions shall be preferred.

This specification covers the 'General Requirement' for the design, manufacture, supply performance, inspection, testing and commissioning including supply of indoor type low voltage switch boards panels up to 1100V including necessary termination cabling and bus work required for satisfactory operation .

The Panel boards including distribution boards and control panels shall be built in accordance with IEC-60439 "Factory Built Assemblies for Low Voltage" or BS-5486 "Factory-built Assemblies of Switchgear and Control Gear for Voltage up to and including 1000V AC and 1200V DC.

Specific requirements shall be in accordance with single line diagram / specification.

The technical parameters of switchgear equipments, transformers etc. shall be referred.

#### 5.1.3 Standards

All equipment material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where equipments are to be installed should be followed.

The equipment offered complying with other standards shall be submitted with copies of standard followed and full details indicating merits of adopted standard over to specified standards.

The Panel boards shall be engineered and constructed in accordance with the latest revision of the following Indian and British standards:

- |   |          |   |
|---|----------|---|
| 1 | IS 13947 | : A.C. Circuit Breakers   |
| 2 | IS 3427  | : Metal enclosed Switchgear & Control Gear                      |
| 3 | BS 162   | : Safety Clearances   |
| 4 | IS 2705  | : Current Transformers  |
| 5 | IS 3156  | : Voltage Transformers  |
| 6 | IS 3202  | : Code of Practice for climate proofing of electrical equipment |

- |    |                    |  |
|----|--------------------|--|
| 7  | IS 375             | : Marking & Arrangement for Switchgear Bus Bars, main connections and auxiliary wiring.  |
| 8  | IS 722             | : A.C. Electric Meters   |
| 9  | IS 1248            | : Direct acting Electrical Indicating Instruments  |
| 10 | IS 3231            | : Electrical Relays for Power System Protection  |
| 11 | IS 2544            | : Epoxy Cast Resin Insulators  |
| 12 | IS 5082            | : Electrolytic Copper/ Aluminium   |
| 13 | IS 5792            | : High Voltage HRC fuses   |
| 14 | BS 88              | : Cartridge fuses for voltages up to and including 1000V AC and 1500V DC.  |
| 15 | BS 89              | : Direct acting electrical indicating analogue electrical measuring instruments and their accessories.   |
| 16 | BS 142             | : Electrical protective relays   |
| 17 | BS 159             | : Bus-bar and Bus-bar connection   |
| 18 | BS 1433            | : Copper for electrical purposes. Rods and bars.   |
| 19 | BS EN 60898:       | Circuit-breakers for over current protection for household and similar installations.  |
| 20 | BS 3938            | : Current transformers   |
| 21 | BS EN 60947-2      | : Low-voltage switchgear and control gear, Part-2 circuit-breakers.  |
| 22 | BS 4794            | : Control switches (switching devices, Part-1 including contactor relays, for control and auxiliary circuits, for voltages up to and including 1000V AC and 1200V DC). General requirements. |
| 23 | BS 5419            | : Air-break switches, air-break disconnectors, and fuse combination units for voltages up to and including 1000V AC and 1200V DC.  |
| 24 | BS 5420            | : Degrees of protection of enclosures of switchgear Part-I and control gear for voltages up to and including 1000V AC and 1200V DC.  |
| 25 | BS 5424            | : Control gear for voltages up to and including 1000V AC and 1200V DC-Part-1 Contactors.   |
| 26 | BS 5486            | : Low-voltage switchgear and control gear Part 1 assemblies. Part I: Requirement for type tested and partially type tested assemblies.   |
| 27 | BS 5685            | : Electricity meters-Part-I: Class-0.5, 1 and 2 single phase and poly phase, single-rate and multi-rate watt-hour meters.  |
| 28 | BS 5992            | : Electrical relays  |
| 29 | BS 6004            | : PVC insulated cables, (non-armoured), for electric power and lighting.   |
| 30 | BS 6231            | : PVC insulated cables for switchgear and control gear wiring.   |
| 31 | IS 3043/<br>BS7430 | : Earthing   |

BS / IEC or IS standards not specifically mentioned above but applicable to the installation shall also apply.

#### 5.1.4 Submission

All technical submissions shall be approved by the ELECTRICAL contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

Detailed co-ordination with other services shop drawings for various electrical layouts such as equipment layout and earthing layout including equipment installation and cable termination details etc. prior to start of work.

Such drawings shall show the proposed method of construction of the cubicles, equipment, bus bar layout, method of supporting equipment and Bus bar electrical control wiring diagrams, equipment weight, colors, and surface treatment.

The drawings shall also incorporate full list of proposed materials. The construction shall not commence until the drawings are approved for construction.

Factory and site testing procedures and report formats shall also be included.

Preparation of bill of materials for different Items as mentioned in Schedule of Quantities.

Lighting / power panel schedule.

Interconnection drawing.

Protection co-ordination drawings/tables for complete power system.

Shop inspection and testing procedures.

Field testing and commissioning procedures.

Preparation of as built drawings for the services rendered by the contractor.

Any other work or activity not listed above but necessary for completion of electrical system shall form part of the specification.

## 5.2 PRODUCTS

### 5.2.1 Panel Board

The switch boards shall be floor mounted free standing cubicle type totally enclosed and extensible type. The switch board shall be dust and vermin proof offering degree of protection not less than IP-42 and suitable for climatic conditions specified.

The design shall include all provisions for safety of operation and maintenance personnel. The general construction shall conform to IS 8623/1993 for factory assembled switch board.

All factories built assemblies subject to rain or wet conditions or located outside electrical switch room shall be of weatherproof construction conformation to IP 65 and able to withstand high impact strength of 60KN/m<sup>2</sup> (min.) temperature resistant, flame retardant and corrosion resistant.

The switchgear cubicles shall be rigid and robust in design and construction fabricated out of CRCA sheet steel not less than 2mm thick. Where ever necessary, such sheet steel members shall be stiffened by angle iron frame work

General construction shall employ the principle of compartmentalization and segregation for each circuit. Unless otherwise approved, incomer and bus section panels or sections shall be separate and independent and shall not be mixed with sections required for feeders. Each section of rear accessible type panel shall have hinged access door at the rear. Overall height of the panel shall

not exceed 2.4 Meters. Operating levers, handles etc of highest unit shall not be higher than 1.7 Meters.

Multi tier mounting of feeders is permissible. The general arrangement for multi tier construction shall be such that the horizontal tiers formed present a pleasing and aesthetic look. General arrangements shall be approved before fabrication.

Cable entries for various feeders shall be either from Top or Bottom of the panel. Through cable allies may be located in between two circuit sections either in the rear or in front of the panels.

All cable entries shall be through gland plates. There shall be separate gland plate for each cable entry so that there will not be dislocation of already wired circuits when the new feeders are added. Cable entry place therefore shall be sectionalized. The construction shall include necessary cable supporters for clamping the cable in the cable alley or rear cable chamber.

Cubicle panels with more than 1000Amps bus shall be made of tested structural modular sections.

All panels shall be of same height, width and depth. Panels shall be bolted together to form continuous flush front switch board suitable for front of board operation. .

All doors, panels, removable covers shall be provided with non deteriorating (neoprene) gaskets all around the perimeter.

Floor mounted cubicles shall be provided with a 75mm high channel base frame. The total height of the cubicle shall not exceed 2400mm keeping in view the operating height of top switch should not exceed 1750mm from FFL including base channel.

#### 5.2.2 Bus-Bars & Bus-Bar Chamber

##### **Rating**

Bus bars shall be made of wrought aluminium or aluminium alloy, or electric grade copper, confirming to relevant Indian standard, as specified.

##### **Current density**

The bus bars shall be of sufficient cross section so that a current density of 130A/Sqcm (800A/ Sq inch) is not exceeded at nominal current rating for Aluminium Bus Bars 160A/Sqcm (1000A /Sq inch) for copper bus bars.

##### **Cross Section of Bus Bar**

The cross section of the Neutral Bus bar shall be same as of the phase bus bar for the bus bars of capacities up to 200 A ; for higher capacities, the neutral bus bar must not be less than half the cross section of that of the phase bus bar.

##### **Insulation**

Each bus bar shall be suitably insulated with PVC sleeves / tapes in approved manner

##### **Bus Bar Supports**

Bus bar Support insulators shall be Class F insulators made of non –hygroscopic, non combustible, track resistant and high strength FRP / SMC / DMC material, and shall be of suitable size and spacing to with stand the dynamic stresses due to short circuit currents. The spacing between two insulators should not exceed 250mm.

##### **Bus Bar Clearances**

The minimum clearance to be maintained for enclosed indoor air insulated bus bar for medium voltage application shall be as follows:

**Between**

**Min clearance**

Phase to Earth	26mm
Phase to Phase	32mm

**Note:** For strip connection from bus bar to switch gear, the above clearances do not apply.

Bus bar Joints shall be thoroughly cleaned and suitable oxidizing grease shall be applied before making the joint.

High tensile bolts, plain and spring washers shall be provided to ensure good contacts at the joints.

The overlap of the bus bar at the joints shall be not less than the area of cross section of bus bars.

Bus bars & bus bar connections shall be of uniform cross section shall be suitable for carrying rated current continuously and short circuit current for specified duration without overheating. Normal operating temperature for bus bars shall be 85 Deg C. Short circuit rating of the bus bars shall be 20 to 50KA for 1sec as per calculations.

Direct access to accidental contact with bus bars and primary connections shall be avoided by providing shrouds. All apertures and slots shall be protected by barriers to prevent accidental short circuiting of bus bars. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle into another.

All bus bars shall be color coded as per IS: 375.

#### 5.2.3 Current Transformers (CT'S)

Accommodation shall be provided in the circuit breaker panel to mount one set of three number dual core ratio CT's for metering and protection purposes. Access to the CTs for cleaning, testing or changing shall be from front, back or top of the panel.

Current transformers ratings shall be dual core and dual ratio CTs of suitable burden (but not less than 15 VA) shall be preferred with 5 Amp secondary.

Secondary terminals of CT shall be brought out suitably to a terminal block which will be easily accessible for testing and terminal connections.

The protection CTs shall be of accuracy class 5 P 10 of IS 2705 – Part – III -1992.

The Metering CTs shall conform to the metering ratio and accuracy class 0.5 of IS 2705 – 1992.

Current transformers shall conform to latest edition to relevant standards. The Current transformers shall be epoxy resin cast with bar Primary or ring type.

The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses due to the maximum short circuit current of the circuit.

CT core laminations shall be of high grade silicon steel.

Rating plate details and terminal markings shall be according to the latest edition of relevant Indian Standard specification.

Current transformers (core) shall be used for metering and protection.

#### 5.2.4 Potential Transformers (PT'S)

Potential Transformers shall conform to latest edition of relevant standards.

Potential transformers shall be dry, cast epoxy resin type. The PTs shall be of single phase construction.

The PT'S shall be capable of operating continuously at 110% of the rated voltage without any damage. When star - star connection is required in non-effectively or ungrounded system, the PT'S shall be suitable for continuous operation with a persistent phase to ground fault.

Maximum temperature rise of the transformer at rated burden and with rated primary voltage and frequency shall not exceed 40 Deg's above an ambient of 45 deg C

Voltage transformer of burden not less than 100 VA and of the proper ratio and of proper ratio as specified shall be provided at the incoming panel. The accuracy class for the VT shall be class 0.5 as per IS 3156 Part-I to III for incomer and class 1 for outgoing panels.

The transformer shall be of cast epoxy resin construction. It shall be fixed/ withdraw able type. HRC fuses/MCBs shall be provided on both HV & LV side. It shall be possible to replace PT fuses easily without having to de-energies the main bus bars. Prospective interrupting current rating of the fuses shall be same as the system fault level.

Voltage transformer ratio, output and class shall be as specified in the drawing & BOQ. Name plate as per relevant standards shall be provided on the PT.

#### 5.2.5 Protective Relays

Relays type and numbers shall be in accordance with the protective scheme specified or as per drawings and schedule of quantities.

Relays shall be enclosed in rectangular shaped cases suitable for flush mounting dust tight covers projecting from the front cover panel. The case shall be dust tight, damp proof and tropicals.

Relays shall be accessible for setting from the front. Access to setting devices shall be possible only after removal of front cover.

Protective relays shall be draw-out type. Where it is not possible to provide protective relays of the draw out pattern fixed type relays with facilities for plugging in a portable test plug shall be provided. Necessary test plugs shall be furnished along with the relays.

Relays shall be provided with positive action self reset type with indicator. The indicators shall be visible from the front.

Relays conform to relevant standards in all respects.

Relays shall be provided with minimum two pairs of self or hand reset type contacts as specified. Auxiliary relays shall have the number of NO and NC contacts as specified in data sheet.

#### 5.2.6 Incomer / Termination

Incomer termination shall be suitable for receiving bus trunking / underground cables. Cable shall invariably be through terminal blocks (Polyamide or Superior) or brought out solid terminals.

The housing material shall have unbreakable and fire retardant characteristic. All the metal parts shall be made up of copper alloy including the screws. Mounting shall be DIN or G-Rail type. Screws shall be captive type. No protection cover is required and the block shall be touch proof.

#### 5.2.7 Instrument / Indication Lamp

All Voltmeters and Ammeters shall be flush mounted of size minimum 96mm conforming to class 1.5 of IS:1248 for accuracy. All voltmeters shall be protected with MCB.

Multi function meter of CL 1.0 accuracy with RS 485 port shall be provided.

On all the incomers of HT panels, ON/OFF indication LED lamps shall be provided and shall be suitable for operation on AC supply. Phase indicating lamps shall be associated with necessary ON / OFF toggle switch.

LED type indicating lamps shall be provided everywhere except where low voltage filament type with series resistor called for.

Lamp covers shall be provided with interchangeable colored lenses of Perspex or equivalent unbreakable material. The lenses shall not discolor in course of time due to heat of the lamp.

Bulbs and lenses shall be interchangeable and replaceable from the front.

Following colors shall be used for the function indicated:

Red	-	Circuit Breaker 'ON'
Green	-	Circuit Breaker 'OFF'
White	-	Continuous trip supply supervision
Amber	-	Auto trip
Blue	-	Spring charged
R, Y, B	-	Potential indication

### **Push Buttons**

1. All push buttons shall be push to actuate the contact type.
2. Start & Stop push buttons shall be colored green and red respectively. Reset push buttons shall be yellow in color and test push buttons shall be blue in color. All other push buttons shall be black in color.
3. Emergency stop push buttons shall be lockable in the operated position, i.e. push to operate and key to release type. Push buttons for emergency stop shall be recessed/shrouded type to avoid accidental operation.

### **Control & Selector Switches**

1. Control and Selector switches shall be of rotary type, having enclosed contacts accessible only after removal of cover.
2. All control and selector switches for circuit breakers and instruments shall be mounted on the front of the panel. Control switches for space heater/s and control supplies shall be mounted inside the panel.
3. Circuit Breaker control switches shall be provided with pistol grip handles. Selector switches shall be provided with round, knurled handles. All handles shall be black in color. Properly designated escutcheon plates clearly marked to show the operating positions shall be provided on all switches.
4. Circuit breaker control switches shall normally have three position close - Normal - Trip with spring return to normal position. Switch operating mechanism shall prevent the switch from being operated twice successively in the same direction. Circuit breaker control switch shall have one NO-NC contact along with other contacts as required.
5. All other instruments and selector switches shall have stay put contacts.
6. Contacts of all control and selector switches shall be rated for 10Amps at 240V, AC or 20Amps at 220V DC (inductive break). Switch for space heater supply and control voltage supply shall normally be two pole rated for 25A, AC.

### **Control Terminal Block**

1. Box - clamp type, 650V grade line up terminals of minimum 2.5 sqmm size shall be provided. Connection to terminals shall be from front.

2. Not more than one wire on each side shall be connected on any terminal. Where duplication of terminals block/s is necessary, suitable solid bonding links shall be incorporated.
3. Terminal blocks at different voltage shall be segregated into groups and distinctly labeled.
4. Current transformer secondary leads shall be brought to terminal blocks having facility for short circuiting and grounding the secondary.
5. Terminals shall be numbered for identification and grouped according to function. Engraved back on white PVC labels shall be provided on the terminal blocks describing the function of the circuit.
6. Separate terminal stems shall be provided for internal and external wiring.
7. Control terminal blocks shall be so located that control cables are fully segregated from power cables. Suitable insulated or earthed metal race ways shall be provided for control wiring. Separate unrolled removable gland plate shall be provided for the control cables at the bottom of each panel.
8. Minimum 10% of total number spare terminals shall be provided for future use.

#### 5.2.8 Small Wiring

All wiring for Controls, Indication, protection, alarm and indicating circuits of all equipment shall be of suitable FRLS/HFFR (Halogen free fire retardant) copper conductor cable.

All wiring shall be suitably protected with in switch board. Runs of wire shall be neatly bunched, suitably supported and clamped.

Means shall be provided for easy identification of the wires. Identification ferrules shall be used at both ends of the wires. Ferrules shall fit tight on the wires, without falling off when wire is removed. Ferrules shall be of white color with black lettering. Each wire shall be identified by letter to denote its function followed by a number to denote its identity at both ends.

Where wires are drawn through steel conduits, the work shall conform to CPWD General Specification for Electrical works Part-I-Internal)-.2005 and IS: 732 as the case may be.

All control wiring meant for external connections are to be brought out of terminal board.

All wiring shall be color coded as follows:

Instrument Transformer AC circuit	-	Red, Yellow & Blue wire associated by phases
AC Phase Wire	-	White
AC Neutral	-	Black
DC Circuits	-	Grey
Earth connections	-	Green

All unused auxiliary contacts of the circuit breaker and relays shall be wired up to terminal block

#### 5.2.9 Safety/ Protection & Interlocks / Features

Following interlocks and features shall be incorporated for equipment protection and personnel safety under mal-operation. No deviations on these interlocks and safety features are allowed. These interlocks and safety features shall be fail-safe positive and full-proof.

It shall not be possible to plug-in or isolate a closed circuit breaker. An attempt to do so shall trip the breaker. (In case of breakers with vertical isolation, this will apply to raising and lowering). There shall be a positive locking facility to prevent closing of circuit unless it is in Service or Test position.

Closing and opening operations shall be possible only in discrete, well defined Test and Service positions and not in any position midway. An extension adapter cable with plugs and sockets shall preferably be provided so that the closing and opening operation of the circuit breaker can be done in fully withdrawn position outside the cable.

Slow operation of circuit breakers shall be possible only in the circuit breaker in Test or Isolated position.

Isolating switches if provided shall be interlocked with respective circuit breakers to prevent them making or breaking the current.

1No. bus earthing truck shall be supplied with each panel to earth the out going cable of the VCB breaker.

Automatic safety shutters for all openings which will lead to access to the live parts of the switchgear upon withdrawal or any operation the switchgear components/parts shall be provided, preferably with a padlocking facility.

Spring of motor operated spring charged mechanism shall not discharge until they are fully charged and charging means are fully disconnected.

Where interlocking key is employed tripping of closed circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.

Any other interlock considered to be provided which manufacturer may deem to be required for safety and specifically specified separately required for the system shall be included.

All terminals, connections which may be live and exposed for accidental contact shall be adequately shrouded.

Components within cubicles shall be properly labeled to facilitate testing.

#### 5.2.10 Earthing

Adequate copper strip for LT panel shall be provided with proper terminations shall be provided .

All non- current carrying metal parts frames and equipment mounted in the switch board shall be bonded to earth bus.

Earthing of moving carriage of draw out equipment shall be achieved by scraping earthing device. The earthing device shall maintain positive earth continuity in all Service Test and Isolated positions.

It shall be possible to connect each circuit or set of three phase bus bars to earth either through earthing trucks or through the circuit breakers.

One earthing trolley suitable for earthing of cables & bus bars for all circuit breakers of the same type / rating shall be provided

#### 5.2.11 Name Plates and Labels

One Name plate giving designation of the MV switchboard shall be affixed prominently on top of the switch board. Details of designation will be specified.

Labels with following details shall be affixed on each feeder panel:

- i. Feeder Number.
- ii. Equipment reference Number & Description
- iii. Rating (HP/kW/kVA/Amp.)

All components whether mounted inside or on the door shall be permanently and clearly labeled with reference number / letter or their function. Rating of fuse shall be part of fuse designation. Paper labels, stickers or labels fixed with adhesives are not acceptable. All labels shall be properly fixed by screws with provision to prevent distortion due to expansion.

All labels shall be non-corroding, preferably laminated plastic or rear engraved Perspex with white letters on black background.

Labels for feeder panel designation fixed on front side shall be fitted with chrome plated, self tapping, and counter sunk head screws. These labels shall be of identical size to permit interchange.

#### 5.2.12 Space Heaters

Adequately rated anti-condensation space heaters shall be provided in each cubicle.

Space heater/s shall be trip type, rated with operation voltage of 240V, 50 Hz. AC supply.

Each space heater shall be complete with a 2P MCB, 10KA and a control thermostat.

The space heater shall be rated for maintaining the panel inside temperature 10 Deg.C above outside ambient temperature.

#### 5.2.13 Cubicle Lighting

Each cubicle shall be provided with interior lighting by means of CFL light fixture. An ON/OFF switch/door switch shall be provided. The lighting fixture shall be suitable for operation from 240V single phase, 50 Hz. A.C. supplies.

#### 5.2.14 Auxiliary Supply

Auxiliary supply for control, indication, space heater etc. shall be made available at one point on the switch board. Vendor shall provide suitable auxiliary supply in the switch board.

#### 5.2.15 Fuses

Fuses shall be HRC cartridge link type (Diaz- zed Fuses are not acceptable) and shall be provided with operation indicator which shall be visible without removal of fuses from service.

Fuses shall be pressure fitted type and shall preferably have ribs on the contact blades to ensure good line contact.

It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be provide. The fuse bases shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problems.

Mounting of fuse fitting shall ensure adequate dissipation of heat generated and shall facilitate inspection and easy replacement of fuse.

#### 5.2.16 Contactors

The contactors shall be air break type, equipped with three main contacts and minimum 2NO + 2NC auxiliary contacts. The main contacts of a particular contactor shall have AC 3 ratings for unidirectional motors & AC 4 for reversible motors.

The auxiliary contacts shall be rated for minimum 5 Amps at 240V AC and 1.3 Amps at 110V DC (Inductive load).

Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240V, (+) 10% & (-) 15% 1-Ø, AC supply. The drop off voltage of contractor shall be 15% to 65% of the rated coil voltage.

#### 5.2.17 Single Phasing Preventer (SPP)

Unless specified otherwise SPP's shall be provided in all motor starter modules with contactor rating of 200 Amps and above. The SPP shall be of the current operated type and shall operate on the principle of sensing negative sequence component of current.

In case of single phasing, the SPP shall operate after a time delay of 2 to 3Secs. The relay shall be of the hand reset type and visual indication of the relay operation shall be available.

The SPP shall be suitable for protection of the non-reversible and reversible motors. The relay operation shall be independent of the loading and RPM of the motor prior to the occurrence of single phasing.

### **5.3 EXECUTION**

#### **5.3.1 Testing and Commissioning**

All panel boards shall be inspected & tested in the presence of Engineer- in-charge / Consultant's representative. Engineer-in-charge after inspection shall issue inspection certificate for materials as per specification and commissioning the panels.

Generally such tests in the factory and repeated at site are as follows:

1. All routine tests specified in relevant Indian / British Standards shall be carried out on all circuit breakers.
2. Test for protective relay operation by secondary injection method.
3. Operation of all meters.
4. Secondary wiring continuity test
5. Insulation test with 1000Volts megger before and after voltage test.
6. HV test on secondary wiring and components on which such test is permissible (2KV for one minute)
7. Simulating external circuits for remote operation of breaker, indicating lights and other operations, if any.
8. Measurement of power required for closing/trip coil of the breaker.
9. Pick up and drop out voltages for shunt trip and closing coils.
10. CT Polarity test.
11. Power frequency voltage withstand test.
12. Earth continuity test;
13. Check of clearance and creep age distances;
14. Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications, etc.;
15. Interfacing test with BMS control function
16. All other tests required by the Engineer-in-charge to verify compliance with the Specification.

All principal test records and test certificates shall be supplied in triplicate for all the tests conducted in accordance with the Specification to the Engineer-in-charge for approval before dispatch from the factory.

All materials, instruments and, labour, etc. required for conducting the tests shall be provided by the contractor at no extra cost...

#### 5.3.2 Drawings and Information

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

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

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

The information furnished shall include the following:

1. Technical literature giving complete information of the equipment.
2. Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.
3. A comprehensive spare parts catalogue.

#### 5.3.3 Tools

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

#### 5.3.4 Spares

The manufacturer / tenderer shall be responsible for commissioning of the equipment supplied by them. During commissioning if any of the components fails the same shall be replaced with new spare part within the quoted price. Contractor shall ensure availability of commissioning spares and tools at site. The details for all such spare parts and tools shall be submitted in the tender. On commissioning of the system unutilized spares and tools shall be retained by engineer-in-charge and nothing extra shall be paid on this account. The delay in commissioning of system for want of spares shall be termed as delay in completion of contract and shall be dealt as per related terms of contract.

The contractor shall also furnish minimum recommended spare parts required for three years with their prices. Availability of spares shall be guaranteed for rated life of the equipment.

#### 5.3.5 Transportation

Panel boards are not allowed to be delivered to site until the electrical room or switch room is in clean and acceptable condition with lockable doors.

Panel boards, transported to site shall be fully covered with weatherproof covers and transportation eye bolts shall be provided for handling at site.

Panel boards, which are poorly packed and result in signs of corrosion, will be rejected.

All necessary measures to cover and protect the panel boards at site shall be provided. Such measures shall include a complete PVC blanket over the whole panel boards.

#### 5.3.6 Rejection of Panel Boards

Deviation from specification must be stated in writing at the quotation stage.

In absence of such statement, it will be assumed that the requirements of the specifications are met without expectation.

If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer. Delivery of panel boards on site without significant cable connection (Say 80%) shall not entitle progress payment certified for material delivery on site.

**END OF SECTION**

## **MULTI FUNCTION METER**

## 6.0 MULTI FUNCTION METER

### 6.1 General Provisions:

All setup parameters required by the Multifunction Meter shall be stored in non-volatile memory and retained in the event of a control power interruption.

The Multifunction Meter may be applied in three-phase, three- or four-wire systems as well as single phase

The Multifunction Meter shall be capable of being applied without modification at nominal frequencies of 45 to 65 Hz.

### 6.2 Measured Values:

The Multifunction Meter shall provide the following, true RMS metered quantities:

#### Real-Time Readings

- Current (Per-Phase)
- Voltage (L–L, L–N)
- Real Power ( Total)
- Reactive Power (Total)
- Apparent Power (Total)
- Power Factor (Total)
- Frequency

#### Energy Readings

**Signed Accumulated Energy (Real kWh\*, Signed Reactive kVArh\*, Apparent kVAh) (Absolute)**

#### Demand Readings

- Demand Current Calculations (Per-Phase):
  - (i) Present
  - (ii) Peak
- Demand Real Power Calculations (Total):
  - (i) Present
  - (ii) Peak
- Demand Reactive Power Calculations (Total):
  - (i) Present
  - (ii) Peak
- Demand Apparent Power Calculations (Total):
  - (i) Present
  - (ii) Peak

kWh and kVArh are signed net consumption values.

### 6.3 Demand

All power demand calculations shall use any one of the following calculation methods, selectable by the user:

Block interval, with optional sub-intervals. The window length shall be set by the user from 1-60 minutes in 1 minute intervals. The user shall be able to set the sub-interval length from 1-60 minutes in 1-minute intervals. The following Block methods are available:

- Sliding Block that calculates demand every 15 seconds with intervals less than 15 minutes and every 60 seconds with an interval between 15 and 60 minutes.
- Fixed Block that calculates demand at the end of the interval.

#### **6.4 Sampling**

The current and voltage signals shall be digitally sampled at a rate high enough to provide true rms accuracy to the 15th harmonic.

The Multifunction Meter shall provide continuous sampling at a minimum of up to 32 samples/cycle, simultaneously on all voltage and current channels in the meter.

#### **6.5 Current Inputs**

The Multifunction Meter shall accept current inputs from standard instrument current transformers with 5 amp secondary output and shall have a metering range of 0-6 amps with the following withstand currents: 10 amp continuous, 50 amp 10 sec per hour, 120 amp 1 sec per hour.

Current transformer primaries through 327 kA shall be supported.

#### **6.6 Voltage Inputs**

The Multifunction Meter shall allow connection to circuits up to 480 volts AC without the use of potential transformers. The Multifunction Meter shall also accept voltage inputs from standard instrument potential transformers. The Multifunction Meter shall support PT primaries through 1.6 MV.

The nominal full scale input of the Multifunction Meter shall be 277 Volts AC L-N, 480 Volts AC L-L. The meter shall accept a metering over-range of 20%. The input impedance shall be greater than 2Mohm (L-L) or 1Mohm (L-N).

#### **6.7 Accuracy**

The Multifunction Meter shall comply with ANSI C12.16 and IEC-62053-21, Class 1

- Functions performance class according to IEC 61557-12 (with CT ratio=1:1 and PT ratio=1:1) are, Class 0.2 for Voltage L-L from 30 Vac–480 Vac. Class 0.2 for Phase Current from 25% $I_n$  <  $I$  <  $I_{max}$  Class 1.0 for Total Active Power from 1%  $I_n$  <  $I$  <  $I_{max}$  and 0.5 Ind to 0.8 Cap. Class 1.0 for Total Active Energy from 0 - 9999999.9 kWh. Class-1.0 for Power Factor Vector from 0.5 Ind to 0.8 Cap. And Class 0.02 for Frequency from 45Hz - 65 Hz. (PM700)

No annual calibration shall be required to maintain this accuracy when the Multifunction Meter operates under specifications.

#### **6.8 Input/Output**

The Multifunction Meter shall be capable of operating a solid state output to provide output pulses for a user definable increment of reported energy. Minimum relay life shall be in excess of one billion operations. The standard pulse output shall operate up to 240 volt AC, 300 volt DC, 96mA max, and provide 2.41 kVrms isolation.

All meters shall communicate on Modbus RTU/IP for necessary integration wherever required.

### **6.9 Control power:**

The Multifunction Meter shall operate properly over a wide range of control power including 110-415VAC, +/-10% or 125-250VDC, +/-20%.

### **6.10 Communications:**

The Multifunction Meter shall communicate via RS-485 Modbus protocol with a 2-wire connection at speeds up to 19.2 kBaud.

It shall be possible to field upgrade the firmware in the Multifunction Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly or changing of integrated circuit chips shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

### **6.11 Display**

The Multifunction Meter display shall be back lit LCD for easy viewing, display shall also be anti-glare and scratch resistant

The Display shall be capable of allowing the user to view four values on one screen at the same time. A summary screen shall also be available to allow the user to view a snapshot of the system.

The display shall include two different modes of visualization, IEEE and IEC for all quantities.

The Display shall show 3 phase bargraphs

The Multifunction Meter display shall provide local access to the following metered quantities:

- a) Current, per phase rms
- b) Voltage, phase-to-phase, phase-to-neutral
- c) Real power, 3-phase total
- d) Reactive power, 3-phase total
- e) Apparent power, 3-phase total
- f) Signed Power factor, 3-phase total
- g) Frequency
- h) Demand current, per phase
- i) Demand real power, three phase total
- j) Demand apparent power, three phase total
- k) Signed Accumulated Energy, (kWh, kVAh, and kVARh)

Reset of the following electrical parameters shall also be allowed from the Multifunction Meter display:

- a) Peak demand current
- b) Peak demand power (kW, kVA, kVA)
- c) Energy (MWh) and reactive energy (MVARh)

Setup for system requirements shall be allowed from the Multifunction Meter display. Setup provisions shall include:

- a) CT rating
- b) PT rating (Single Phase, 2-Wire)
- c) System type [three-phase, 3-wire] [three-phase, 4-wire] [2 wire]
- d) Watt-hours per pulse (PM200P Only)
- e) Communication parameters such as address and baud rate

### **6.12 Upgrades**

It shall be possible to field upgrade the firmware in the Multifunction Meter to enhance functionality. These firmware upgrades shall be done through the communication connection and shall allow upgrades of individual meters or groups. No disassembly, changing of integrated circuit chips or kits shall be required and it will not be necessary to de-energize the circuit or the equipment to perform the upgrade.

### **6.13 Installation**

To ensure safety of goods and people, the installation category of the Multifunction Meter shall be III. The communication circuit shall be of SELV type (security extra low voltage) and shall provide a class II insulation level between distribution system connection and communication port. The meter shall withstand a Uimp of 6kV. (Uimp: impulse withstands voltage).

The Multifunction Meter shall be rated for an operating temperature range of 0°C to +60°C.

Depth of the Multifunction Meter behind panel with communication port shall be equal or less than 50mm.

### **6.14 Standard**

The multifunction meter shall comply with the following standards.

- a) IEC 62053-22 – Active Energy Class 1
- b) IEC 61557-12
- c) IEC 61010-1 – Safety

**END OF SECTION**

## **CIRCUIT BREAKER**

## 7.0 CIRCUIT BREAKER

### 7.1 GENERAL

#### 7.1.1 Scope

Circuit breaker i.e. Air-circuit breaker (ACB), Moulded Case Circuit Breakers (MCCB), Miniature Circuit Breakers (MCB) and Residual Current Circuit Breakers (RCCB / RCD) shall be provided according to the specification.

All breakers shall be capable to withstand the electrical, mechanical and thermal stress of the prospective fault level experience. The prospective fault levels of the various breakers shall be verified according to result in short circuit / co-ordination study specified in specification.

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

#### 7.1.2 Standards

All equipment, material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where equipment is to be installed shall also be followed.

The equipment offered complying with other standards, these standards shall be equal to or superior to those specified and full details of the differences shall be furnished along with the tender.

The Panel boards shall be engineered and constructed in accordance with the latest revision of the following Indian and British standards:

1. IS:13947 1993/ : Air circuit breaker/molded case circuit breaker. IEC 947-1989
2. IS: 3156 : Voltage Transformers.
3. IS: 2705 Part-I, II : Current Transformers for metering and protection with classification & III 1964 burden and insulation.
4. IS: 9224 : Low voltage fuse and protection.
5. IS: 3231 : Specification for electrical relays for power system protection.
6. IS:8623 : Specification for factory built assemblies of switchgear and control gear for voltage upto and including 1000V, AC / 1200V, DC.
7. IS: 4237 : General requirements for switch gear and control gear for voltage not exceeding gear.
8. IS: 2147 : Degree of protection provided enclosures for low voltage switch gear and control gear.
9. IS: 1018 : Switchgear and control gear selection / installation & maintenance.
10. IS: 1248 : Direct acting electrical indicating instruments.
11. IS: 375 : Arrangement for switchgear, bus bars, main connections, auxiliary wiring and marking.
12. IS: 2959 : AC contactors for voltage not exceeding 1000V.
13. IS: 5578 : Guide for marking of insulated conductors.
14. IS: 11050 : Guide for forming system of marking and identification of conductors& apparatus terminal.

- 15. IS: 1248 : Direct acting indicating analogue electrical measuring instruments and testing accessories.
- 16. IS: 6005 : Code of practice for phosphating of iron & steel.
- 17. BS EN 60898 IEC 898 : Circuit breakers for over current protection for household and similar installations.
- 18. BS EN 60947-2 : Low-voltage switchgear and control gear, Part -2 circuit breakers. IEC 947-2
- 19. BS 5419 : Air-break switches, air-break disconnectors, and fuse combination units for voltage up to and including 1000V AC and 1200 V DC.
- 20. BS 5486 : Low-voltage switchgear and control gear Part-I, assemblies. Part-II requirement for type tested and partially type tested assemblies.
- 21. BS 4293 : Residual Current Circuit Breaker

BS/IEC or other National standards not mentioned above but are applicable to this installation shall also apply.

### 7.1.3 Submission

All technical submissions shall be approved by the ELECTRICAL contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

A component list and catalogues.

Preparation of bill of materials for different Items as mentioned.

Factory and site testing procedures and report formats shall also be included.

Protection co-ordination drawings/tables for complete power system.

Shop inspection and testing procedures.

Field testing and commissioning procedures.

General Arrangement drawing of the switchboard, showing front view, plan, foundation plan, floor cutouts/trenches for external cables and elevations, transport sections and weights.

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

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

Terminal plans showing terminal numbers, ferrules markings, device terminal numbers and function etc.

Relay wiring diagrams.

Equipment List.

The information furnished shall include the following:

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

For completion of electrical system any other work/activities which are not listed above and considered necessary.

## 7.2 PRODUCTS

### 7.2.1 Air Circuit Breakers (For Main LT Panel)

#### **General:**

ACB shall comply with standards IS/IEC 60947-1 & 2.

ACB shall have a rated operational voltage of 415V AC, rated insulation voltage of 1000 volts AC, rated impulse voltage of 12kV.

ACB shall be of 3pole or 4pole (as per BOQ), air break, molded case design for longer life along with less maintenance requirement

All ACBs shall preferably be of single frame size up to 3200A to optimize requirement for spares management.

ACB shall have a Ready to close mechanism preferably having a ready to close mechanical indication on front of ACB. All EDO ACBs ready to close indication contact which shall be used to give a single indication via indicating lamps on panel door if ACB is ready to be closed, after checking all the given conditions (UV release energized, Shunt release de-energized, spring charged, Breaker is not "ON", Breaker has not tripped on fault, Breaker is not mechanically interlocked with other breaker and ACB is not racked in completely in service position) ensuring safety for user and electrical distribution. ACB shall comply with the environmental directives like RoHS .

#### **Performance:**

ACB shall have the breaking performance  $I_{cs} = I_{cu} = I_{cw}$  (1sec) =

65kA ACB shall have minimum Mechanical life of 20000 operations

The operating mechanism of ACB shall be of the Open/Closed/Open stored-energy spring type.

The closing time shall be less than or equal to 70ms, and of fast opening type with break time of breaker should be <30ms to ensure higher life of distribution cables.

#### **Accessories & Auxiliaries:**

Shunt trip and closing coil (having common AC/DC supply upto 250V) shall be continuous rated.

For Incomer ACBs delayed type under voltage release shall be used to avoid nuisance tripping during voltage surges.

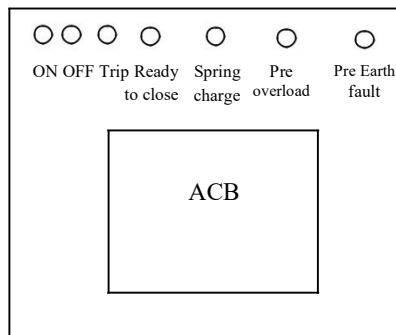
ACBs shall have minimum 4 change-over auxiliary contacts, available to be used for indication and interlocking, rated at minimum 10A 240/380V 50 Hz and shall be wired on chassis/cradle.

There should be facility to add one more set of 4 contacts if required

ACB shall be provided with two programmable contacts for fault/Alarm indications on panel door via LED lamps. It shall be possible to program the contacts for pre overload alarm and pre earth alarm. Panel builder shall wire these contacts to LED lamps on panel's front door. Pre wired Fault trip contact should be provided with Release as standard.

Indication lamps to be provided on front door of ACB feeder shall be as shown below: -

Spring charge indication required for EDO ACB only



**Safety:**

Draw-out ACBs shall preferably be provided with a mechanical latch on chassis which latches the ACB at Connected-Test-Disconnected positions while racking in and racking out the circuit breaker. This feature will help the operator in placing the circuit breaker at right position inside the chassis and can help in avoiding the accident.

**Interlocks:**

The racking handle shall be stored on the air circuit breaker in such a manner as to be accessible without defeating the door interlocking.

**Terminations:**

All air circuit breaker shall be fully tropicalized as standard & suitable for terminating copper or aluminium bus bars. Both fixed & draw-out circuit breakers shall have single pole-pitch. ACBs upto 3200A shall be provided with top horizontal and bottom vertical terminal adapters on both sides for proper cable connections/bus duct connections. Terminal orientation for top and bottom side shall preferably be possible to be changed from vertical to horizontal or vice versa on site as per cable/bus duct entry. Rest of the ACBs shall have both side vertical terminal adaptors for better heat dissipation.

**Protections:**

Air circuit breaker shall be provided with micro processor release, which should be self powered type without the need of any auxiliary power supply during normal operation of the breaker. The circuit breaker control unit shall measure the true r.m.s value of the current  
Circuit breaker trip unit shall have a display for measurement of current, voltage and energy. It shall be possible to view last 5 trip cause on trip unit. One 96x96 display unit shall be provided with each circuit breaker which displays the data inside the trip unit on a bigger display. This display unit shall be mounted on the panel door.

All trip units provided shall have thermal memory as standard

All trip units shall be EMC/EMI tested

The protection release shall have following protections as standard: -

- a. Adjustable over load current (Ir) settings from 40% to 100% of rating of ACB (In). Over load time setting (tr) from 0.5s, 1s, 2s, 4s.....24s as field selectable curves.
- b. Short circuit setting (Isd) from 1.5 to 10 times of Ir setting, Short circuit time delay adjustable from 0 to 400 msec.
- c. Instantaneous (Ii) protection with an adjustable pick-up and an OFF position.

I2t ON / I2t OFF options shall be available for short-circuit & earth fault protections which can be used to ensure discrimination with upstream circuit breaker or fuse. The trip unit shall have integral test facility to verify the healthiness and to avoid external calibration. It shall be possible to change the protection settings on line and the circuit breaker need not be switched off while adjusting the settings.

All ACBs in main LT panel shall be provided with zone selective interlocking which helps in reducing the thermal and dynamic stress on installation during short circuit and ground faults. The releases shall be suitable to communicate between incomer breaker and outgoing breakers enabling zone selective interlocking. The manufacturer shall supply all equipment like ZSI module, power supply and wiring connectors to implement ZSI.

It shall be possible to view the percentage loading of three phases at once on trip unit via LEDs or LCD display to help the user in identifying the current load balancing of the network. This will help in preventing the deterioration of loads affected by load balancing by identification of the balancing related issue.

All 4 Pole ACBs shall have fully rated neutral equal to rating of the breaker & shall be protected against over-load faults with provisions for settings neutral unprotected, neutral protection at  $0.5I_n$  and neutral protection at  $1.0 I_n$  to ensure precise neutral protection.

#### **Communication:**

The advanced communication system needed for the project shall be able to show the basic data inside the trip unit of the ACB without using any external software. This is required for two purposes

- a) Communication testing of the circuit breakers at panel builder's shop floor and generating the communication check report
- b) Basic parameters (A, V, kWh, no. of operations etc) viewing on Ethernet network from anywhere in LAN network and from any laptop, computer or smart phone
- c) Easy replacement of the Ethernet modules without the involvement of system integrators, in case the modules become faulty.

#### **Specifications for communication**

All ACBs shall be provided with individual Modbus TCP/Ethernet ports/modules for better speed of data transfer (with at least 10Mbps speed on Ethernet network). Ethernet modules provided shall be with two Ethernet ports to minimize the number of Ethernet switches required in the system. One colored touch screen display module/HMI, for not more than 8 circuit breakers, shall be provided on front door of the panel. It shall contain the following information about circuit breakers

- e. Measurements from air circuit breakers (e.g. Current, voltage and energy)
- f. Circuit breaker load profile i.e. circuit breaker has seen how much current for how many hours (e.g. Upto 70% for how many hours, Upto 90% for how many hours etc.)
- g. Circuit breaker number of ON/OFF operations and number of trip operations counter
- h. It shall be possible to control the circuit breaker from the module

Panel builder shall provide circuit break communication test report having the following data

- i. Circuit breaker communication check (Ok/Not Ok)
- j. Circuit breaker settings at the time of communication test. Settings on the circuit breaker, at the time of communication test, shall be same as recommended by the consultant.

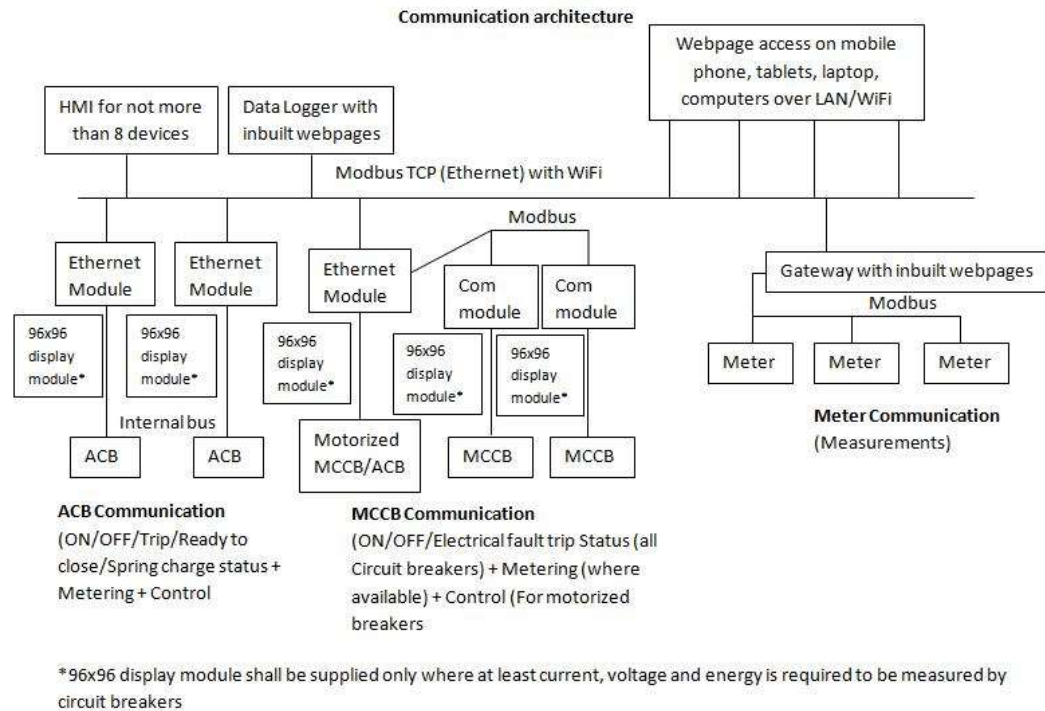
One energy data logger with below features/accessories shall be provided for the project

- k. Atleast 3 GB data storage space
- l. Modbus and Modbus TCP ports
- m. GPRS and Wifi dongle (without sim card)
- n. 2 analog and 6 digital inputs
- o. Embedded software for energy dashboards

- p. It shall be able to take the data from all Modbus or Modbus TCP meters, ACB Ethernet modules, MCCB Ethernet modules etc. and display on its webpage and store the entire data in its memory

Following data shall be available from ACB on inbuilt webpages of Ethernet module/software

- i. Current, voltage and energy data measurement
- ii. Circuit breaker number of operation measurement
- iii. Circuit breaker control (ON/OFF)
- iv. Email notifications for undesired events like circuit breaker tripping on electrical fault, circuit breaker tripping on overload/short circuit/earth fault/trip unit failure etc.
- v. It shall be possible to send the energy consumption daily reports by Email or FTP directly from inbuilt web-pages
- vi. Circuit breaker ready to close and spring charge status
- vii. Circuit breaker settings
- viii. Circuit breaker last 10 trip and event history



### 7.2.2 Moulded Case Circuit Breakers (MCCB)(MAIN LT Panel)

**General:**

MCCBs shall comply with standards IS/IEC 60947-1 & 2. The breaking capacity performance certificates shall be available for category A to the above mentioned standards.

MCCB shall have a rated operational voltage (Ue) of 415V, insulation voltage (Ui) of 690 V (AC 50/60 Hz) & impulse voltage (Uimp) of not less than 8kV.

MCCBs shall be current limiting type preferably having an encapsulated double break design having two fixed contacts, one moving contacts and two arc chutes per pole. The design is required to minimize the effects of short circuit currents i.e. limit the let through energy and improve the life of cables.

MCCB shall not have any line load bias

MCCB shall comply with the environmental directives like RoHS.

All MCCBs upto 630A in main LT panel shall be plug-in type for ease of maintenance


**Performance:**

The MCCBs shall have a rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) at 415V and as per system fault levels (refer SLD).

The limiting capacity of a circuit breaker is expressed by two curves which are a function of the prospective short-circuit current (the current which would flow if no protection devices were installed): The thermal stress ( $A^2s$ ), i.e. the energy dissipated by MCCB during fault should be as low as possible. Cable selection to be done as per Maximum permissible cable stresses for which manufacture should produce current limiting and energy limiting curves of MCCB's.

**Safety:**

For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries (ON/OFF/Trip Contact, Shunt, Under Voltage etc.). All poles shall operate simultaneously for circuit breaker opening, closing and tripping. MCCBs shall be actuated by a toggle or rotary-handle that clearly indicates the three distinctive positions: ON, OFF and TRIPPED. MCCB shall clearly indicate

the suitability for isolation in the name plate identified by the symbol . MCCBs shall be equipped with a "push to trip" button in front to test operation and simultaneous opening of all poles together.

MCCBs shall be designed to prevent access to live parts when the cover is removed, means main current path of the circuit breaker should be isolated from auxiliary section i.e. MCCB shall offer class –II front face as per IEC standards 61140 and 60664-1

The electrical life of MCCBs shall be 8,000 operations up to 250A & 4000 operations up to 630A

All MCCBs provided shall be of single frame size upto 250A to reduce the requirement of spares management.

All MCCBs shall have cross bolted type termination where bus bars or cable lugs can be terminated by crossing the bolt between the lugs/bus bars and MCCB connections, to enhance safety and reliability of the terminations. In case spreaders/rear connectors are used in between MCCB and bus bar/lugs then the spreaders shall be cross bolted with the MCCB connectors.

**Auxiliaries and accessories:**

Separate Field installable auxiliary contacts for signaling ON/OFF indication shall be provided with all MCCBs

Rotary handle shall ensure IP40 for direct type and IP 55 for extended Rotary handle.

MCCB shall have provision for Rear connection - MCCB mounting on a back plate with suitable holes enables rear connection. The rear connections are simply fitted to the device connection terminals.

**Protections requirements:**

All MCCBs upto 250A shall be thermal magnetic type with adjustable overload settings from 0.7 to 1 times  $I_n$  and fixed magnetic settings.

All MCCBs above 250A upto 630A shall be self-powered microprocessor based type to have wide range of settings and advanced information over and above thermal magnetic trip units

- a. LED indication on trip unit shall be there for trip unit ON indication
- b. Test port on trip unit shall be there for testing the trip unit
- c. Overload alarm indication LED shall be there on trip unit

- d. Overload settings adjustment from 40% to 100% shall be possible. It shall also be possible to do the fine adjustment of overload settings in at least 5 steps. e.g. if overload settings selected from dial is at 250A. It shall be possible to set it at 92% or 93% or 94% or 95% or 96% etc. of 250A for accurate settings.
- e. It shall be possible to set the overload time delay from 0.5 to 16 secs at 6xI<sub>r</sub>
- f. Short circuit settings shall be adjustable from 1.5 to 10 times I<sub>r</sub>. Fine adjustment of settings shall also be possible. Short circuit time delay shall be adjustable from 0.1 to 0.4 secs. It shall be possible to switch the I<sub>2t</sub> protection ON or OFF to achieve discrimination between upstream fuse or circuit breaker
- g. Instantaneous settings shall be adjustable from 1.5 I<sub>n</sub> to 10 I<sub>n</sub>
- h. Earth fault protection shall be adjustable from 20% to 100% or OFF. It shall be possible to switch the I<sub>2t</sub> protection ON or OFF to achieve discrimination between upstream fuse or circuit breaker

In case of 4 pole microprocessor based MCCBs neutral shall be protected & adjustable as a Neutral unprotected / Neutral protected at 0.5 I<sub>n</sub>/ Neutral protected at I<sub>n</sub>.

All MCCBs in main LT panel with inbuilt earth fault protection shall also be provided with zone selective interlocking feature, which helps in reducing the thermal and dynamic stress on installation during short circuit and ground faults. The releases shall be suitable to communicate with upstream ACBs enabling zone selective interlocking. The manufacturer should supply all equipment like ZSI module, power supply, wiring connectors etc. to implement ZSI.

All MCCBs with earth fault shall display the type of fault (overload, short circuit, earth fault, instantaneous tripping), the phase concerned and interrupted current value, on occurrence of fault. All MCCBs shall be provided with external power supply recommended by manufacturer, so that the display of the reason of fault shall also not switch OFF after the tripping of MCCB

All MCCBs with earth fault protection shall store last 10 trip record. The record shall be viewable on display modules or communication or shall be downloadable using MCCB test port.

#### **Communication:**

The communication system needed for the project shall be able to show the mentioned data of MCCB on a webpage without using any external software. This is required for two purposes

- a) Communication testing of the circuit breakers at panel builder's shop floor and generating the communication check report
- b) Basic parameters (ON/OFF/Trip status and number of operations) viewing on Ethernet network from anywhere in LAN network and from any laptop, computer or smart phone
- c) Easy replacement of the ethernet modules without the involvement of system integrators, in case the modules become faulty.

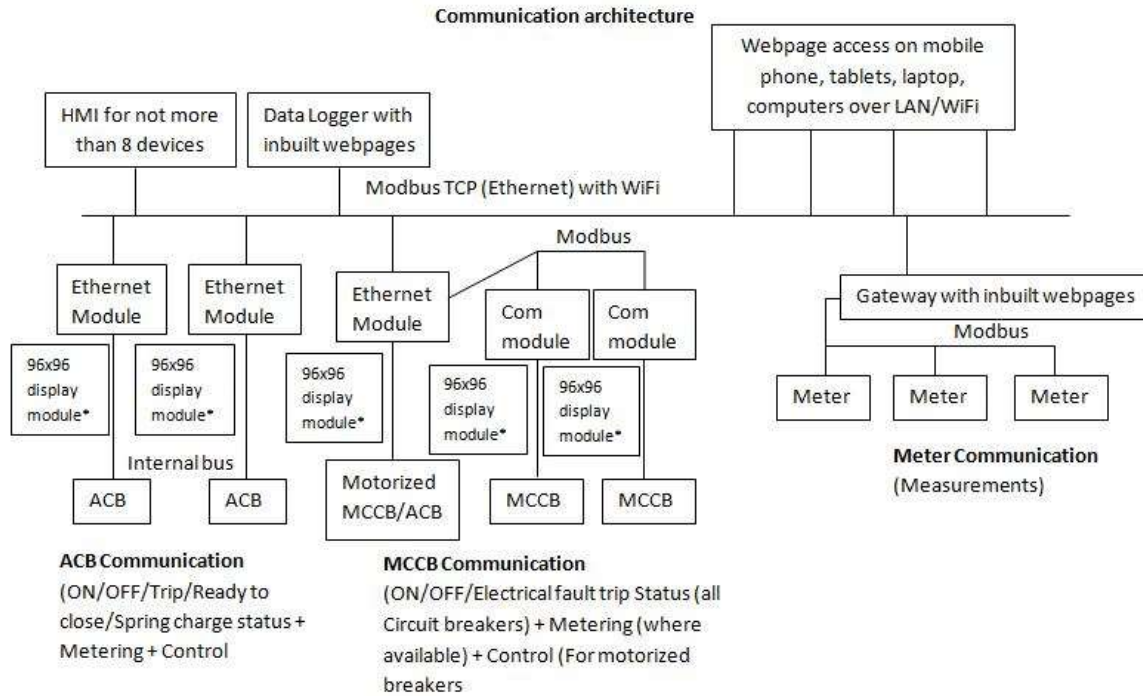
#### **Communication specifications**

It shall be possible to communicate ON, OFF and Trip status of all MCCBs over modbus TCP/ Ethernet port (with at least 10mbps speed on Ethernet network).

MCCB shall provide following information which shall be displayed on inbuilt webpages/software

- i. MCCB ON/OFF/Trip status indication
- j. Total number of ON/OFF and trip operations
- k. Total number of operating hours & % Contact wear for all MCCBs where LSIG protection is asked
- l. Email notifications for undesired events like circuit breaker tripped on overload/Short circuit/instantaneous/earth fault/trip unit failure etc. for all MCCBs where LSIG protection is asked. For all other MCCBs email notification for MCCB status change from ON to OFF and ON to Trip shall be provided
- m. Last 10 trip record of the circuit breaker with interrupted current value and phase in which the fault occurred for all MCCBs where LSIG protection is asked.

- n. It shall be possible to modify the protection settings from remote location via software for all MCCBs where LSIG protection is asked.



\*96x96 display module shall be supplied only where at least current, voltage and energy is required to be measured by circuit breakers

### 7.2.3 Air Circuit Breakers (Other than Main LT Panel)

**General:**

ACB shall comply with standards IS/IEC 60947-1 & 2.  
ACB shall have a rated operational voltage of 415V AC, rated insulation voltage of 1000 volts AC, rated impulse voltage of 12kV.

ACB shall be of 3pole or 4pole (as per BOQ), air break, molded case design for longer life along with less maintenance requirement

All ACBs shall preferably be of single frame size up to 3200A to optimize requirement for spares management.

ACB shall have a Ready to close mechanism preferably having a ready to close mechanical indication on front of ACB. All EDO ACBs ready to close indication contact which shall be used to give a single indication via indicating lamps on panel door if ACB is ready to be closed, after checking all the given conditions (UV release energized, Shunt release de-energized, spring charged, Breaker is not "ON", Breaker has not tripped on fault, Breaker is not mechanically interlocked with other breaker and ACB is not racked in completely in service position) ensuring safety for user and electrical distribution. ACB shall comply with the environmental directives like RoHS.

**Performance:**

ACB shall have the breaking performance  $I_{cs} = I_{cu} = I_{cw}$  (1sec) = 50kA  
50kA ACB shall have minimum Mechanical life of 20000 operations

The operating mechanism of ACB shall be of the Open/Closed/Open stored-energy spring type. The closing time shall be less than or equal to 70ms, and of fast opening type with break time of breaker should be <30ms to ensure higher life of distribution cables.

ON, OFF, Trip & Ready to close Data should be available on Modbus RTU.

**Accessories & Auxiliaries:**

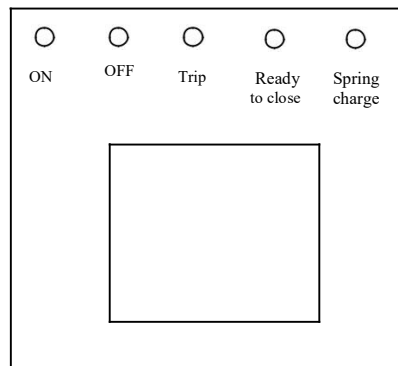
Shunt trip and closing coil (having common AC/DC supply upto 250V) shall be continuous rated. For Incomer ACBs delayed type under voltage release shall be used to avoid nuisance tripping during voltage surges.

ACBs shall have minimum 4 change-over auxiliary contacts, available to be used for indication and interlocking, rated at minimum 10A 240/380V 50 Hz and shall be wired on chassis/cradle.

There should be facility to add one more set of 4 contacts if required

Pre wired Fault trip contact should be provided with Release as standard.

Indication lamps to be provided on front door of ACB feeder shall be as shown below: -



Spring charge indication required for EDO ACB only

**Safety:**

Draw-out ACBs shall preferably be provided with a mechanical latch on chassis which latches the ACB at Connected-Test-Disconnected positions while racking in and racking out the circuit breaker. This feature will help the operator in placing the circuit breaker at right position inside the chassis and can help in avoiding the accident.

The racking handle of the breaker shall be stored on the air circuit breaker in such a manner as to be accessible without defeating the door interlocking.

**Terminations:**

All air circuit breakers shall be fully tropicalized as standard & suitable for terminating copper or aluminium bus bars. Both fixed & draw-out circuit breakers shall have single pole- pitch. ACBs upto 3200A shall be provided with top horizontal and bottom vertical terminal adapters on both sides for proper cable connections/bus duct connections. Terminal orientation for top and bottom side shall preferably be possible to be changed from vertical to horizontal or vice versa on site as per cable/bus duct entry. Rest of the ACBs shall have both side vertical terminal adapters for better heat dissipation.

**Protections:**

Air circuit breaker shall be provided with micro processor release, which should be self powered type without the need of any auxiliary power supply during normal operation of the breaker. The circuit breaker control unit shall measure the true r.m.s value of the current

Circuit breaker trip unit shall have a display for measurement of current and voltage. It shall be possible to view last 5 trip cause on trip unit.

All trip units provided shall have thermal memory as standard

All trip units shall be EMC/EMI tested

The protection release shall have following protections as standard: -

- a. Adjustable over load current ( $I_r$ ) settings from 40% to 100% of rating of ACB ( $I_n$ ). Over load time setting ( $t_r$ ) from 0.5s, 1s, 2s, 4s...24s as field selectable curves.
- b. Short circuit setting ( $I_{sd}$ ) from 1.5 to 10 times of  $I_r$  setting, Short circuit time delay adjustable from 0 to 400 msec.
- c. Instantaneous ( $I_i$ ) protection with an adjustable pick-up and an OFF position.
- d. Earth fault setting adjustable in absolute Ampere with time delay settings from 0 to 400ms.

Separately powered, individual fault trip indication LEDs (For overload, short circuit, earth fault and trip unit failure) shall be available on the trip unit which shall function even if the display fails. I2t ON / I2t OFF options shall be available for short -circuit & earth fault protections which can be used to ensure discrimination with upstream circuit breaker or fuse  
The trip unit shall have integral test facility to verify the healthiness and to avoid external calibration.

It shall be possible to change the protection settings on line and the circuit breaker need not be switched off while adjusting the settings.

All ACBs in main LT panel shall surely be provided with zone selective interlocking which helps in reducing the thermal and dynamic stress on installation during short circuit and ground faults. The releases shall be suitable to communicate between incomer breaker and outgoing breakers enabling zone selective interlocking. The manufacturer shall supply all equipment like ZSI module, power supply and wiring connectors to implement ZSI.

It shall be possible to view the percentage loading of three phases at once on trip unit via LEDs or LCD display to help the user in identifying the current load balancing of the network. This will help in preventing the deterioration of loads affected by load balancing by identification of the balancing related issue.

All 4 Pole ACBs shall have fully rated neutral equal to rating of the breaker & shall be protected against over-load faults with provisions for settings neutral unprotected, neutral protection at 0.5In and neutral protection at 1.0 In to ensure precise neutral protection.

#### 7.2.4 Moulded Case Circuit Breakers (MCCB) (Other than Main LT Panel)

##### **General:**

MCCBs shall comply with standards IS/IEC 60947-1 & 2. The breaking capacity performance certificates shall be available for category A to the above mentioned standards.

MCCB shall have a rated operational voltage ( $U_e$ ) of 415V, insulation voltage ( $U_i$ ) of 690 V (AC 50/60 Hz) & impulse voltage ( $U_{imp}$ ) of not less than 8kV.

MCCBs shall be current limiting type preferably having an encapsulated double break design having two fixed contacts, one moving contacts and two arc chutes per pole. The design is required to minimize the effects of short circuit currents i.e. limit the let through energy and improve the life of cables.

MCCB shall not have any line load bias

MCCB shall comply with the environmental directives like RoHS.

800A and above rating MCCBs - shall be microprocessor based, category B type (drawout design in main panel and fixed type in sub panels) having  $I_{cw}$  (1sec) not less than 15kA. Microprocessor trip unit shall measure current and voltage data with last 5 trip records. Microprocessor based MCCBs in main panel shall have zone selective interlocking feature. Mechanical life shall be 10000 operations

##### **Performance:**


The MCCBs shall have a rated service breaking capacity ( $I_{cs}$ ) equal to the ultimate breaking capacity ( $I_{cu}$ ) at 415V and as per system fault levels (refer SLD).

The limiting capacity of a circuit breaker is expressed by two curves which are a function of the prospective short-circuit current (the current which would flow if no protection devices were installed):

The thermal stress ( $A^2s$ ), i.e. the energy dissipated by MCCB during fault should be as low as possible. Cable selection to be done as per Maximum permissible cable stresses for which manufacture should produce current limiting and energy limiting curves of MCCB's.

##### **Safety:**

For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries (ON/OFF/Trip Contact, Shunt, Under Voltage etc.). All poles shall operate simultaneously for circuit breaker opening, closing and tripping. MCCBs shall be actuated by a toggle or rotary-handle that clearly indicates the three distinctive positions: ON, OFF and TRIPPED. MCCB shall clearly indicate

the suitability for isolation in the name plate identified by the symbol . MCCBs shall be equipped with a "push to trip" button in front to test operation and simultaneous opening of all poles together.

MCCBs shall be designed to prevent access to live parts when the cover is removed, means main current path of the circuit breaker should be isolated from auxiliary section i.e. MCCB shall offer class –II front face as per IEC standards 61140 and 60664-1

The electrical life of MCCBs shall be 8,000 operations up to 250A & 4000 operations up to 630A

All MCCBs provided shall be of single frame size upto 250A to reduce the requirement of spares management.

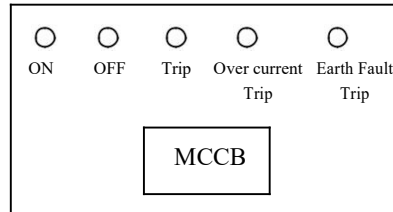
All MCCBs shall have cross bolted type termination where bus bars or cable lugs can be terminated by crossing the bolt between the lugs/bus bars and MCCB connections, to enhance safety and reliability

of the terminations. In case spreaders/rear connectors are used in between MCCB and bus bar/lugs then the spreaders shall be cross bolted with the MCCB connectors.

**Auxiliaries and accessories:**

Following separate Field installable auxiliary contacts for signaling different functions shall be provided with all MCCBs

- a. open/closed position contact
- b. trip signaling contact
- c. Electrical fault trip signaling contact



Rotary handle shall ensure IP40 for direct type and IP 55 for extended Rotary handle. MCCB shall have provision for Rear connection - MCCB mounting on a back plate with suitable holes enables rear connection. The rear connections are simply fitted to the device connection terminals.

**Protections requirements:**

MCCBs shall have thermal magnetic trip units upto 250A and microprocessor trip units above 250A. Thermal magnetic trip units shall have variable overload settings from 0.7 to 1 Ir and fixed short circuit settings

Microprocessor trip units shall have variable overload settings from 0.5 to 1 Ir and variable short circuit settings from 2 to 10Ir

In case of 4 pole microprocessor based MCCBs neutral shall be protected & adjustable as a Neutral unprotected / Neutral protected at 0.5 In/ Neutral protected at In.

MCCB's should be provided with auxiliary contacts for signaling different functions, as: open/ closed position, fault signal and shunt trip coil for remote/emergency tripping of MCCB.

Where ever it is required based on electrical distribution network need, MCCB shall have Earth Fault Protection as a provision. MCCB Earth Fault Protection should have following settings and features:

- d. Selection of Ir MCCB rating
- e. Earth fault sensitivity selection from 20% – 60% In.
- f. The time delay selection in case of Earth Fault from 0.5 to 3 Sec/ instantaneous.
- g. There shall be a separate fault differentiation indication (LED) for Over current and Earth fault. Indication for over current and earth fault tripping shall be extended to the panel door via indication lamps
- h. Separate LED shall be there to show healthiness of earth fault protection system
- i. EF protection module shall be suitable for 3P 4W system. It shall take the input from neutral for correct earth fault protection.
- j. Earth fault module shall have auxiliary contacts for earth fault signaling.

**7.2.5 Miniature Circuit Breakers (MCB)**

MCB'S shall comply with IEC 898:1995. They shall be of the current limiting type having sealed ambient temperature independent thermal magnetic tripping mechanism providing overload and short circuit protection. All MCB'S shall be of 35mm D/N symmetrical rail mounted type.

The breaking capacity of MCB'S shall be at least equal to the prospective fault level at the point installation, unless back-up by current limiting upstream breaker of the same make.

The MCB operating mechanism shall be mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short circuit and overload conditions. It shall be of the automatic resetting type.

The individual operating mechanism of each pole of a multi-pole MCB shall be directly linked within the MCB casing and not with the operating handles.

The operating handle shall be of the toggle type with possibility for mounting of padlocking facility.

Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short circuit protection.

It shall be possible to fit on site auxiliaries like shunt-trip coil, under-voltage release, ON/OFF switch or alarm switch.

#### 7.2.6 Residual Current Circuit Breakers (RCCB)

RCCB shall comply with BS 4293 and shall be of the current operated type.

The RCCB'S shall be manufactured to trip within 0.1 second for 30 mA.

The RCCB'S shall be of 2-pole construction for single phase and 4-pole construction for 3 phases.

All RCCB'S shall be complete with test buttons.

All RCCB'S shall be batch tested and bear the appropriate test label of approval meeting SEB requirement.

All RCCB'S shall be of high sensibility type as appropriate and as specified in the drawing. They shall be of surge proof manufacture to prevent nuisance tripping due to transient over voltage.

### 7.3 EXECUTION

#### 7.3.1 Testing and Commissioning

All Switch gears shall be inspected & tested in the presence of Engineer-in-charge / Consultant's representative and certified 'safe for commissioning, operation and equipment comply with the requirements of the Specification' by the installation Engineer.

All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.

1. Test for protective relay operation by primary or secondary injection method.
2. Operation of all meters.
3. Secondary wiring continuity test
4. Insulation test with 1000 Volts megger before and after voltage test.
5. HV test on secondary wiring and components on which such test is permissible (2kV for one minute)
6. Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations if any.
7. Measurement of power required for closing / trip coil of the breaker.
8. Pick up and drop out voltage for shunt trip and closing coils.
9. CT Polarity test.

10. Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications etc.
11. Interfacing test with BMS control function.
12. All other tests required by the Engineer to verify compliance with the Specification.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the test.

Required copies of test certificates for all the tests carried out along with copies of type test certificates and certificates from sub-vendor for the components procured from them are to be submitted before dispatch of switch boards.

#### 7.3.2 Tools

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

#### 7.3.3 Spares

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

#### 7.3.4 Quality Assurance

Quality Assurance shall follow the requirements of Engineer-in-charge / Consultant's as applicable.

Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to purchaser's requirements.

#### 7.3.5 Deviations

Deviation from specification must be stated in writing at the quotation stage.

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

If any of the above tests fail to comply with the requirements of the Specification in any respect whatsoever at any stage of manufacture, test, and erection or on completion at site, the Engineer-in-charge reserves the right to reject the item or defective component. Such items after replacement or repairs shall be offered for inspection / or test. All such items shall be used only after approval of Engineer-in-charge.

**END OF SECTION**

## **EARTHING SYSTEM**

## 8.0 EARTHING SYSTEM

### 8.1 GENERAL

#### 8.1.1 Work Description

This section covers design, and setting of the complete earthing network for individual earthing systems, circuit protective conductors and bonding conductors and, supply, installation, testing, commissioning of earthing system.

A complete earthing network comprising cables, copper tapes, electrodes and earth bonding of all relevant necessary non-current carrying metal parts of equipments/ apparatus shall be connected as required.

The system shall have a common earthing system as described in the specification and as shown on the drawings. Individual earthing systems as per drawing shall be provided for following:

1. HT Electrical Earthing
2. LT Electrical Earthing
3. DG Generator Earthing
4. ELV Earthing
5. Data Communication Earthing

Main HT / LT / Generator Electrical Earthing shall have two earth connections to the earthing system.

Sufficient numbers of electrodes interconnected by Cooper / GI (as per requirement) to form earthing mat so that the overall earth resistance is less than 1 ohm for each individual earthing mat.

The number of earth electrodes of the earthing mat is indicated on the drawings as minimum. The Contractor shall test the resistivity of soil at site and determine the exact number of earth electrodes to achieve the required earth resistance value with approval of Engineer-in-charge. Earth plate, earth mat detail to achieve the earth resistance value shall be included in the Contract for complete earthing installation.

The Contractor shall have approval of materials from engineer-in-charge before use on work. Execution of earthing shall be carried out only in the presence of the Engineer or the representative.

#### 8.1.2 Standards

Complete earthing system shall be designed and executed in accordance with the latest revision of the following standards and the appropriate BS/IEC:

1. IS: 3043 : Earthing
2. BS6651 : Lightning Protection System
3. IEC 61024-1-2 : Lightning Protection System

The detail of the Earthing System shall also conform to the requirements of all relevant local codes as applicable together with the additional requirements referred to in the Specification and Drawings, whichever is the more stringent and acceptable to the Engineer-in charge.

#### 8.1.3 Submission

All technical submissions shall be approved by the ELECTRICAL contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

As minimum requirement the submission shall include the following:

1. Shop Drawings and Sample Submission
2. Builder's work requirement
3. Testing procedures and report format for testing of the earth electrodes and/or earth strips
4. Soil resisting test report with calculation report for the details of the earthing system detail including quantity and layout of earth electrodes and/or earth strips to achieve the required earth resistance. The report shall be endorsed by the Contractor's Installation Engineer who supervise and endorse the installation upon completion
5. Proposed details of earthing system including quantity and layout of the earth electrodes and/or earth strips according to the calculation result.

## **8.2 PRODUCT**

### **8.2.1 General**

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

The earth loop resistance to any point in the electrical system shall not be in excess of 0.5 ohms in order to ensure satisfactory operation of protective devices.

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

1. At each electrical system ground or system neutral ground.
2. At one point each grounding system used to ground electrical equipment enclosures.
3. At one point each grounding system used to ground wiring system enclosures such as metal conduits and cable sheaths or armoured.

All earthing conductors shall be of high conductivity copper/ G.I. and able to protect against mechanical damage as per requirement. The cross-sectional area of earth conductor shall not be smaller than half that of the largest current carrying conductor. However, the contractor shall use the sizes specified in the bill of quantities of the Tender. Common earth mats of resistivity of less than one (1) ohm shall be constructed below the lowest floor structure prior to any ground work construction. The earth mats shall comprise the complete earth electrodes, earth strips/grids, earth inspection chambers, earth leads, main earth terminals, earth test link boxes at ground level, etc. Each individual earthing system shall have earth leads connecting its main earth terminal directly to an earth electrode underground as specified.

All earthing products/accessories shall be in accordance to IS standards.

The mating surface of all tapes at joints etc shall be cleaned before clamping and riveted with proper connector or exothermic welded. All connections to electrical apparatus shall be made by bolted connection in a visible and accessible position

### 8.2.2 Pipe Earth Electrode

G.I. pipe shall be of medium class 100mm dia and 3m in length.

G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other up to 2m of length from bottom.

The electrode shall be buried in the ground vertically with its top being 20cm minimum below ground level.

Clamping of the earth leads to the earth rod shall be made by earth clamp. The clamps shall be capable of providing high pressure contact between the earth rod and the earth leads to achieve low contact resistance.

When two or more electrodes are driven to form a group, the heads of the electrodes in the group shall be bonded to each other by means of a 25 mm x 3mm GI / Copper strip, laid at a depth of at least 600 mm in soil.

Recommended water seal insert sleeve approved by Engineer-in-charge shall be provided with all earth electrode penetrations through basement water proofing membranes and the installation shall be done under strict supervision.

### 8.2.3 Plate Earth Electrode

The plate earth electrode shall consist of copper plate or G.I. plate as per item of work. The plate electrode shall be buried in ground with its faces vertical and top not less than 4.5m below Ground level. The plate shall be filled with charcoal dust and common salt filling, extending 15cm around it's on all sides.

A watering pipe of 50mm dia of medium class G.I pipe shall be provided.

The top of the pipe shall be provided with a funnel and a G.I. mesh screen for watering the earth. In the case of pipe electrode a removable plug shall be provided.

The earthing lead from electrode onwards shall be suitably protected from mechanical injury by suitable dia medium class G.I. pipe in case of wire and size according to strip size.

The overlapping of strips at joints shall done in approved manner

- a. GI strips shall be riveted with rivets/ bolted and welded.
- b. Copper strips shall be riveted with rivets/ bolted brass nuts, bolts and washers and brazed.

The protection pipe within ground shall be buried at least 30 cm deep (to be increased to 60cm in case of road crossing and pavements).

The portion within the building shall be recessed in walls and floors to adequate depth.

In the case of plate earth electrode the earthing lead shall be securely bolted to the plate with two bolts, nuts, check nuts and washers.

In case of pipe electrode it shall be connected by means of a through bolt, nuts and washers and cable socket.

Main earthing conductor is taken from the earth electrode with which the connection is to be made.

No earth pit shall be fixed within 1.5 M of a wall of foundation. The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. Effort shall be made to locate them in grass lawns or near flower beds or water taps.

### 8.2.4 Earth Inspection Chamber

Earth electrode shall be fitted with a heavy-duty pre cast concrete inspection chamber / pit complete with heavy-duty cover as specified on drawings.

For earth electrodes located outside or on the apron of the building, earth inspection chambers shall extend to a depth of not less than 300 mm below finished ground level and kept free of soil. For earth electrodes located inside building, earth electrodes shall be buried not less than 100 mm below the floor slab structure. Each earth electrode shall be clearly marked '**Safety Electrical Earth Connection – Do Not Remove**'.

The chamber and cover shall be heavy duty detail to consider the traffic load at the location of installation. The cover shall be recessed cover to receive the Architectural floor finish at the location of installation.

#### 8.2.5 Earth Strip

Earth strips/grids shall be of bare GI/ Copper strips of 25 mm x 3 mm as specified.

Earth strips shall be riveted or joint with proper connector to earth electrodes underground below the floor slab structure, and shall be buried not less than 300 mm below the floor slab structure.

In order to minimize the mutual inductance between strips, earth strips shall be positioned at a distance not less than 6m apart unless otherwise specified.

### 8.3 EARTH BONDING

#### 8.3.1 Circuit Protective Conductor

Circuit protective conductor (CPC) is a system of conductors joining together all exposed conductive parts and connecting them to the main earth terminal.

The purpose of circuit protective conductor is to provide a path for earth fault circuit so that the protective device will operate to remove dangerous potential differences during a fault condition.

The circuit protective conductors shall take the form of separate cable with a sheath in green/yellow color or copper tape of minimum size 25mm x 3mm.

All exposed non-current carrying metal parts of light fittings, switchgears, motors, enclosures, etc. shall be effectively earthed by circuit protective conductors for earth continuity protection.

For equipment where an earth terminal is provided, the earth continuity wire shall be firmly clamped. Where no earth terminal is provided, the exposed metal part shall be cleaned of paint and surface rust before welding the earth continuity lead.

The minimum size of the principal protective conductors shall be in accordance with to the current edition of IS: 3043/ BS7671 and BS7430.

The external earth terminal on the outside of the end panel of any switchboard shall be connected to the main earth bar provided in two independent points.

Circuit protective conductors shall be provided in electrical and mechanical rooms and along the routes for the bonding of all exposed conductive parts and extraneous conductive parts. A suitably sized earth terminal shall be provided at each zone of the building for this purpose.

All exposed conductive parts shall be effectively connected in an approved manner to the principal protective conductors. The circuit protective conductors shall be single core copper cables or high conductivity annealed copper tapes specified. Unless otherwise specified, the minimum cross-sectional area of the circuit protective conductors shall be selected in accordance with IS: 3043/ BS7671.

**END OF SECTION**

# **LIFE SAFETY/FIRE DETECTION, DIGITAL VOICE EVACUATION SYSTEM**

## 9.0 LIFESAFETY/ FIRE DETECTION, DIGITAL VOICE EVACUATION SYSTEM.

### 9.1 GENERAL DESCRIPTION

Provide Fire Detection and Alarm System in accordance with NFPA 72 (Latest edition) and requirements of the Contract Documents. Provide a complete operable and intelligent analog addressable Fire Alarm and Detection System with associated communication and notification systems. The system shall include interfaces for foreign systems, as described herein and in accordance with the Contract Documents, and all applicable Codes, Standards.

All Plant furnished shall be new and the latest state- of-the-art, products of a single Manufacturer engaged in the manufacturing of analog fire detection devices for at least 5 years.

All software licenses shall be supplied as part of the contract (If applicable). Renewable & subscription license are not acceptable.

The system shall be supplied, installed, tested, and approved by Consultant, and turned over to the Contractor in an operational condition.

The subcontractor shall contract with a single supplier for the fire alarm Plant, engineering, programming, inspection and tests, and shall provide a “UL Listing Certificate” for the complete system.

Drawings: The Drawings shall serve to indicate the general arrangement of the various Plant and their generic functional interconnections. However, layout of Plant, accessories, specialties, conduit system and wiring, are diagrammatic and do not necessarily indicate every required device, fitting, etc., required for the complete installation.

### 9.2 SCOPE

A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance to the project specifications and drawings.

#### **Basic Performance:**

Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 6 (Class A) Signaling Line Circuits (SLC).

Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.

Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.

On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone which ever is greater.

Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.

NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.

Two-way telephone communication circuits shall be supervised for open and short circuit conditions.

### **9.3 DRAWINGS & TECHNICAL SUBMITTALS**

#### **9.3.1 General**

Two copies of all submittals shall be submitted to the Architect/Consultant for review.

All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.

For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

#### **9.3.2 Shop Drawings**

Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.

Show annunciator layout, configurations, and terminations.

#### **9.3.3 Manuals**

Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.

Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.

Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

#### **9.3.4 Software Modifications**

Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.

Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site.

#### **9.3.5 Certifications**

Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

### **9.4 WARRANTY**

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

## **9.5 POST CONTRACT MAINTENANCE**

Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.

As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

Maintenance and testing shall be on a semiannual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The schedule shall include:

Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, and water flow switches and all accessories of the fire alarm system.

Each circuit in the fire alarm system shall be tested semiannually.

Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7.

## **9.6 POST CONTRACT EXPANSIONS**

The contractor shall have the ability to provide parts and labor to expand the system specified, if so requested, for a period of five (5) years from the date of acceptance.

As part of the submittal, include a quotation for all parts and material, and all installation and test labor as needed to increase the number of intelligent or addressable devices by ten percent (10%). This quotation shall include intelligent smoke detectors, intelligent heat detectors, addressable manual stations, addressable monitor modules and addressable modules equal in number to one tenth of the number required to meet this specification (list actual quantity of each type).

The quotation shall include installation, test labor, and labor to reprogram the system for this 10% expansion. If additional FACP hardware is required, include the material and labor necessary to install this hardware.

Do not include cost of conduit or wire or the cost to install conduit or wire except for labor to make final connections at the FACP and at each intelligent addressable device. Do not include the cost of conventional peripherals or the cost of initiating devices or notification appliances connected to the addressable monitor/control modules.

Submittals that do not include this estimate of post contract expansion cost will not be accepted.

## **9.7 APPLICABLE STANDARDS AND SPECIFICATIONS**

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

National Fire Protection Association (NFPA) - USA:

NFPA 13	Sprinkler Systems
NFPA 16	Foam/Water Deluge and Spray Systems
NFPA 17	Dry Chemical Extinguishing Systems
NFPA 17A	Wet Chemical Extinguishing Systems
NFPA 2001	Clean Agent Extinguishing Systems
NFPA 70,	National Electrical Code
NFPA 72	National Fire Alarm Code
NFPA 76	Telecommunication Facilities
NFPA 318	Clean Room Applications
NFPA 101	Life Safety Code
NFPA 90A	Air conditioning & ventilation system

Underwriters Laboratories Inc. (UL) - USA:

UL 268	Smoke Detectors for Fire Protective Signaling Systems
UL 864	Control Units for Fire Protective Signaling Systems <b>9<sup>th</sup> Edition Listed</b>
UL 268 A	Smoke Detectors for Duct Applications
UL 521	Heat Detectors for Fire Protective Signaling Systems
UL 464	Audible Signaling Appliances
UL 38	Manually Actuated Signaling Boxes
UL 346	Water flow Indicators for Fire Protective Signaling Systems
UL 1971	Visual Notification Appliances
UL 228	Door Holders

NATIONAL BUILDING CODES

IS CODES

The Video Display Terminal (VDT) shall comply with Swedish magnetic emission and X-radiation guidelines MPR 1990:10.

APPROVALS:

The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL Underwriters Laboratories Inc (**9<sup>th</sup> Edition**)

The fire alarm control panel shall meet UL Standard 864 9<sup>th</sup> Edition (Control Units)

**The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of high and low pressure gases.**

# TRANSFORMER



#### **4. CORE AND COILS**

- 4.1 The Transformer may be of core type. The core shall be built up with high grade, non-ageing, low loss, high permeability grain oriented cold rolled silicon steel laminations especially suitable for core material.
- 4.2 The coils shall be manufactured from electrolytic copper conductor and fully insulated for rated voltage.
- 4.3 Insulating material shall be of proven design. Coils shall be so insulated that impulse and power frequency voltage stresses are minimum and to withstand designed temperature fluctuation.
- 4.4 All leads from the winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short-circuit stresses.
- 4.5 The core and coils assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer or under short-circuit stresses.
- 4.6 The neutral of star-connected winding shall be brought out to a separate bushing shall be provided on the tank side to facilitate lead the earth conductor down to the ground level.

#### **5. BUSDUCT TERMINATION**

The LV side of the Transformer will have provision for Bus duct Termination for 1600KVA Transformer.

#### **6. MARSHALLING BOX**

- 6.1 The marshalling box shall be tank mounted, Outdoor, Weather proof, sheet steel (2mm thick) enclosed, with hinged door having padlocking, facility and painted as per IS. All doors, covers and plates shall be fitted with neoprene gaskets. Bottom shall be at least 600mm from floor level and provided with gland plate and cable glands as required. Top surface shall be sloped.
- 6.2 All contacts for alarm, trip and indication circuits shall each be electrically free, wired for auxiliary D.C. supply as specified and brought out to separate terminals at the terminal blocks in the marshalling box. Terminals shall be rated for 10A. Wiring shall be with stranded, copper conductor size not smaller than 1.5 Sq.mm for control and 2.5mm for C.T. circuits, C.T. terminals shall be provided with shorting facility.

#### **7. ELECTRICAL PERFORMANCE REQUIREMENTS**

- 7.1 Transformers shall operate without injurious heating at the rated KVA at any voltage within  $\pm 10\%$  of the rated voltage of that particular tap.
- 7.2 Transformers shall be designed for 110% continuous over fluxing withstand capability.
- 7.3 Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by equipment shall apply.
- 7.4 The neutral terminal of windings with star connection shall be designed for the highest over current that can flow through this winding.
- 7.5 Every care shall be taken to ensure that the design and manufacture of the transformers shall be such as to reduce noise and vibration to the level obtained in good modern practice. The VENDOR shall ensure that the noise level shall not be more than 80 db.
- 7.6 For Transformers with tappings, full power tappings shall be provided.

#### **8. WIRING**

- 8.1 All control, alarm and indication devices provided with the transformer shall be wired up to the terminal blocks.
- 8.2 Wiring shall be done with PVC wires in conduit or PVC armoured cable. Minimum wire size shall be 2.5sq.mm stranded copper. Not more than two wires shall be connected to a terminal. Ten percent spare terminals shall be provided.
- 8.3 All devices and terminal blocks within the marshalling box shall be identify by numbers corresponding to those used in the applicable schematic or wiring diagram.
- 8.4 Ferrule numbers to be provided on both sides of the control wires termination as per the approved drawings.

## 9. PAINING

- 9.1 All steel surfaces shall be thoroughly cleaned by sandblasting and/or chemical agents as required, to produce a smooth surface free of scales, grease and rust.
- 9.2 The external surfaces, after cleaning shall be given a coat of high quality red oxide or yellow chromate primer followed by filler coats.
- 9.3 The Transformer shall be finished with two coats of synthetic enamel paint, battleship gray.
- 9.4 The paints shall be carefully selected to withstand tropical heat, rain etc. The paint shall not scale off, crinkle, or be removed by abrasion due to normal handling.

## 10. ON-LOAD TAP CHANGING GEAR (OLTC)

The OLTC gear shall comply with the following requirements:

- 10.1 On Load Tap Changer shall be of Outdoor design, weather proof, non-inductive transition resistor type, employing snap switches, combining both selector and diverter duties housed in a self contained single compartment and suitable for mounting externally on a port flange provided on the transformer tank. The tap changer will be suitable for connection to tapings brought out from HV winding covering a range from +10% to -10% insteps of 1.25%

The tap changer shall be supplied with the following components in the driving mechanism cubicle.

- 10.1.1 High torque electric motor suitable for 415V, 3Ph, 50Hz, AC supply.
- 10.1.2 Motor drive and energy accumulator.
- 10.1.3 Motor isolating device with over load protection.
- 10.1.4 Contactors for forward and reverse operation of motor
- 10.1.5 'Raise/Lower' control for local operation.
- 10.1.6 'Local/Remote' control selector switch.
- 10.1.7 'Raise/Lower' limit switches.
- 10.1.8 Anti-condensation heater with switch.
- 10.1.9 Interlock between manual and electrical operation.
- 10.1.10 Handle for manual operation.
- 10.1.11 Auxiliary isolating switch.
- 10.1.12 A set of MCCBs with suitable rating.
- 10.1.13 Mechanical tap position indicator.
- 10.1.14 Tap changing operation indicator.
- 10.1.15 Stoppers to prevent over travelling of mechanism.
- 10.1.16 Auto/manual selector switch
- 10.1.17 Retainer switch.
- 10.1.18 Stepping relay.
- 10.1.19 Rating plate.
- 10.1.20 Driving mechanism chamber locking arrangement.
- 10.1.21 Terminal strips.
- 10.1.22 Lubrication chart.
- 10.1.23 Potentiometer for remote tap position indicator.
- 10.1.24 Pygmy lamp for internal illumination with local switch.
- 10.1.25 Potential free contacts for Overload, Tap position, Local remote position, Selector switches, Tap change in progress, Winding temp.suitable for SCADA.
- 10.2 An Indoor floor mounted remote control cubicle (RTCC) with AVR having rear access door, wiring and with the following components:
  - 10.2.1 Remote tap position indicating meter or digital meter.
  - 10.2.2 Tap change in progress' signal lamp.
  - 10.2.3 'Raise/Lower' push buttons for remote operation.
  - 10.2.4 Cubical illuminating lamp with door switch with fuse.
  - 10.2.5 Terminal strips.
  - 10.2.6 Supply 'ON' signal lamp.
  - 10.2.7 Un-drilled gland plate for cable entry.

## 11. BUSHINGS

- 11.1 Bushings shall be rated for 33KV for HT termination box and shall be of the oil-filled condenser type with a central tube and draw-in conductor which shall be connected to the connector housed in the helmet of the bushings. The pull through lead shall be fitted with a gas bubble deflector. Condenser type bushings shall be equipped with following:
- 11.1.1 Provision for power factor testing without disconnecting main leads.
  - 11.1.2 Stress rings and lower end shields.
  - 11.1.3 Current transformers shall be provided, if specified and the bushing shall be so arranged that it can be removed without disturbing the current transformers and secondary terminals.
- 11.2 Bushings rated for 400A and above shall have non-ferrous flanges and hardware.
- 11.3 Fittings made of steel or malleable iron shall be galvanised.
- 11.4 Bushings shall be so located on the transformers that full flashover strength will be utilized and minimum clearances as required for the BIL shall be realized between live parts and live parts to earthed structures.

## 12. BUSHING CURRENT TRANSFORMERS

- 12.1 Current transformers shall comply with relevant standards.
- 12.2 It shall be possible to remove turret mounted CT's from the transformer tank, without removing the cover.
- 12.3 All secondary leads, including tapings, shall be brought to a weatherproof outlet box near the bushing. The VENDOR shall arrange conduit wiring from this outlet box up to the transformer-marshalling box or control cabinet.
- 12.4 Bushing current transformer nameplate shall be mounted on the equipment tank adjacent to the terminal box.

## 13. FITTINGS & ACCESSORIES:

For Oil Filled Transformers, following fittings shall be provided:

- 13.1 Bushing Terminals complete with connectors for the Purchaser's external conductors or cable boxes.
- 13.2 Neutral bushing terminal complete with connector for the Purchaser's external conductors or cable boxes.
- 13.3 Inspection cover (for transformers 1000 KVA and above).
- 13.4 Rating and terminal marking plates.
- 13.5 Two earthing terminals.

## 14. LIFTING LUGS FOR:

- 14.1 Lifting complete transformer.
- 14.2 Lifting core and coils

The Transformer Fin plates shall be welded with connector plates for equal distribution of the load under vibration.

The under base provided with channels for fixing on a platform or plinth.

Four plain rollers in place of fixing channels.

## 15. VALVES:

- 15.1 One (1) top filter valve with blanking plate.
- 15.2 One (1) bottom filter valve with blanking plate.

#### **16. TESTS:**

The first three tests listed below shall be carried out and shall be deemed to be included in the BIDDER'S scope.

- 16.1 Routine tests as per applicable standards.
- 16.2 2KV withstand test for all wiring.
- 16.3 Zero phase sequence impedance test.
- 16.4 Impulse test on any one phase of the HV winding of any one transformer.
- 16.5 Temperature rise test.
- 16.6 Short circuit test.
- 16.7 All routine/type test certificates shall be submitted to the client/consultant for approval during inspection or before dispatch of the Transformer.

#### **17. LOSSES:**

Should the losses as measured on the transformer after manufacture be found in excess of the values of the guaranteed losses with plus tolerance indicated in the proposal, VENDOR shall pay penalty to the PURCHASER.

#### **18. REJECTION:**

PURCHASER may reject any transformer if during tests or service any of the following conditions arise:

- 18.1 No load loss exceeds the guaranteed value by 20% or more.
- 18.2 Load loss exceeds the guaranteed value by 20% or more.
- 18.3 Impedance value differs the guaranteed value by  $\pm 10\%$  or more.
- 18.4 Winding temperature rise exceeds the specified value by 5°C.
- 18.5 Transformer fails on impulse test.
- 18.6 Transformer fails on power frequency voltage withstand test.
- 18.7 Transformer is provided to have been manufactured not in accordance with the agreed specification.
  
- 18.8 The PURCHASER reserves the right to certain the rejected transformer and take it into service until the SELLAR replaces, at no extra cost to PURCHASER, the defective transformer by a new acceptable transformer.
- 18.9 The BIDDER shall repair or replace the transformer within a reasonable period to the PURCHASER'S satisfaction at no extra cost to the PURCHASER.

#### **19. TERMS & CONDITIONS:**

The Bidder should submit his offer as per the enclosed specification and enclosed Annexure of Terms & Conditions.

#### **20. SPARES:**

The BIDDER shall quote itemized prices for his recommended spares.

#### **21. DRAWINGS:**

The following drawings shall be submitted to Engineer-in-charge for approval in the stipulated time.

Weeks after award of contract

- 20.1 General outline drawings showing plan, front

	elevation, rear elevation, cable boxes / disconnecting chamber section views, location & dimensions of cable entries, terminals foundation floor fixing details and weights.	1
20.2	Bushings: Plan, elevation terminals details, mounting details make and type number, current and voltage rating, creepage distances and principal characteristics.	1
20.3	Rating and diagram plate	1
20.4	Marshalling box terminal connections, wiring diagram	2

## **22.0 TEST REPORTS**

Test results shall be corrected to a reference temperature of 75 °C.

- 22.1 Two copies of test results shall be submitted for the Owner's/Consultants approval before despatch of transformer.
- 22.2 Additional bound copies, as required by the Owners/Consultants contract, of complete test results including all tests on transformer, bushing, current transformer (if provided), shall be furnished with the transformer.

### 23. TECHNICAL SPECIFICATION OF TRANSFORMER

The Transformer shall be designed and manufactured as per IS: 1180 and shall supplied with first filling of oil.

S.No.	ITEM	PARTICULARS
1.	Manufacturer	:
2.	Transformer application/ designation	: Power
3.	Quantity required	: 2Noof500KVA
4.	Full Load Rating	:
5.	Type of Winding	: Copper
6.	Number of Phases	: Three
7.	Rated no-load Voltages	
	7.1 HV with OLTC	: 11 KV
	7.2 LV	: 0.433 KV
8.	Type of cooling	: ONAN (OIL FILLED)
9.	Rated percentage impedance	: 5 % ( Or As per Standard)
10.	Rated Frequency	: 50 Hz
11.	Installation	: Outdoor
12.	Winding connections	
	12.1 HV with OLTC, RTCC & AVR	: ±10% in step of 1.25% with RTCC & AVR
	12.2 LV	:
	12.3 Vector Group	:
	12.4 Primary connection	:
	12.5 Secondary connection	:
13.	Terminal arrangement	
	13.1 HV	: H.T. Cable Box arrangement suitable for 3C, XLPE
	13.2 LV	: Suitable for Bus Duct / LT cable box / LT cable box arrangement.
	13.3 LV	: One separate Neutral Terminal for earthing.
14.	Highest system voltage for which Transformer windings are suitable	:
	14.1 HV	:
	14.2 LV	:
15.	Tappings of winding	:

- 15.1 ON load taps :
- 15.2 Total tapping range :
- 15.3 Tapping steps :
- 15.4 On HV/LV windings :
- 16. Maximum temperature rise of :
- 16.1 By Thermometer :
- 16.2 Windings by resistance method :
- 17. Load loss at rated current at 75°C :  
Winding temperature (guaranteed,  
Subject to plus tolerance as per Applicable standard)
- 18. No-load losses (core less and dielectric :  
Loss) at 100% rated voltage and  
Frequency as per applicable standard
- 19. Magnetization current at rated :  
voltage & frequency in perfect of full load current.
- 19.1 Weight (approx) :
- 19.2 Winding Kg. :
- 19.3 Core Kg. :
- 19.4 Total (19.1 to 19.3) Kg. :
- 20. Efficiency at 75°C full % load (UPF) :
- 21. Maximum flux density
- 21.1 At rated voltage Wb/m :
- 21.2 At 110% of rated voltage Wb/m :
- 22. Fittings and Accessories
- 22.1 Rating and Terminal marking plate :
- 22.2 Earthing Terminals :
- 22.3 Lifting Lugs :
- 22.4 ON circuit tap changing switch :
- 22.5 Dehydrating silica gel breather :
- 22.6 Thermometer pocket :
- 22.7 Marshalling box with wiring :
- 22.8 List of routine tests to be carried out  
As per IS:2026.
- 22.8.1 Pressure Test.
- 22.8.2 Measurement of IR values.
- 22.8.3 Measurement of turns ratio.
- 22.8.4 Identification of Vector group.
- 22.8.5 Measurement of winding resistance.
- 22.8.6 Measuring of No Load Losses and No Load Current.

- 22.8.7 Measuring of Full Load Losses and Impedance Voltage.
- 22.8.8 Checking of Insulation capability for live parts to other
- 22.8.9 Windings to earth.
- 22.8.10 Checking of Insulation strength between turns, between Coils between phases, between leas and live parts to earth.
- 22.8.11 Measurement of Magnetic balance.
- 22.8.12 Measurement of Zero sequence impedance test.

**END OF SECTION**

# ENERGY MANAGEMENT SYSTEM

## **11 EMS SOFTWARE**

### **11.1 ENERGY & POWER MANAGEMENT SOFTWARE—GENERAL**

The Energy and Power Management Software (EPMS) platform shall facilitate applications in the broad categories of (a) energy performance, (b) power availability, quality and reliability, and (c) sustainability performance. At a level, the feature-set shall provide functions in:

- a. Real-time monitoring.
- b. Alarming and event management.
- c. Energy cost analysis.
- d. Energy, power, and sustainability data analytics and visualization.

The software platform shall be certified for use as a part of an ISO50001 program and verifiably support compliance. In addition, the functionality shall support ongoing ISO50001 programs per the following areas of Section 4 of the ISO standard:

- a. Energy review.
- b. Energy baseline.
- c. Energy performance indicators.
- d. Monitoring, measurement, and analysis.
- e. Input to management review.

The EPMS shall verifiably support compliance with EN 16247-1 for energy audits. The EPMS shall include Modular, licensable optional applications to expand the basic functionalities of the core platform

### **11.2 POWER MANAGEMENT SOFTWARE—REAL TIME MONITORING**

The Energy & Power Management Software (EPMS) shall provide a graphical monitoring and analysis application for power users (trained administrators, power system engineers, energy managers, facility managers, technicians, etc.) that provide tools for energy analysis, Power Quality analysis, power system monitoring and control.

The graphical monitoring and analysis application shall be able to create a comprehensive set of linked hierarchical graphical diagrams showing all devices and their associated device specific diagrams in the power monitoring network WITH A SINGLE MOUSE CLICK (auto-diagram creation).

The graphical monitoring and analysis application shall support custom graphics/images and provide the ability to create graphical diagrams of the Power Monitoring system, including electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations and mimic displays.

The graphical monitoring and analysis application shall be capable of writing to device registers for applications such as resetting, triggering, toggling, switching, manual waveform capture, controlling remote devices and equipment, including breakers.

The graphical monitoring and analysis application shall allow application and HMI design engineers to create custom diagrams with linkages to device registers.

Web-enabled real-time tables: The system shall have the following capabilities for interactive side-by-side visualization of real-time measurements:

- a. Display a tabular view to compare device readings from multiple meters in the power monitoring network quickly.
- b. Permit users to create, modify, view and share table views through a browser without the need for a separate software application.
- c. Have built-in functions that allow users to easily and instantly filter out measurements when viewing a table.
- d. Support both physical and virtual devices defined in the system.
- e. Support exporting real time tabular data into Excel formats.

Power monitoring trending: The EPMS shall include graphical charts for real-time trending of power usage (kW, Volt, Amp, and kWh) or any measurement supported by metered equipment such as generators and MV/LV switchgear. These trends shall include the capability to:

- a. Trend up to 14 measurements on the same chart (limit may be increased if desired).
- b. Customize attributes such as color, line thickness, overlays, display name, and display units for each data series.
- c. View the trend using an auto-scaling or manual chart axis.
- d. Adjust the desired time viewing window for the trend.
- e. Inspect the trend by zooming and panning to focus in on key areas of the trend.

- f. Provide drill-down detail for the highlighted trend data point to help identify root causes of concern.
- g. Trend measurements with different units on the same chart using two different axes.
- h. Provide calculated values of minimum, maximum, and average values for a trend.
- i. Configure a target threshold line for comparison against actual measurements.
- j. Configure up to two target bands with visual indicators to identify when a measurement is outside specified limits.
- k. Display real-time data and/or historical data per data series, with optional back-filling of the real-time data using historical data.
- l. Export trend data to .CSV/Excel format.
- m. Access trend data from a web browser or mobile environment.
- n. Save specified trends in a library for later use.
- o. Share trends with other users or restrict use.
- p. Simultaneously view multiple trend charts, or alternatively maximize a selected trend to display it in full screen mode.

### 11.3 POWER MANAGEMENT SOFTWARE—ALARM AND EVENT ANALYSIS AND NOTIFICATION

The Power Management Software (EPMS) shall provide alarm and event annunciation features that include the following:

An alarm viewer that provides a summary of the active alarms shall be provided. The viewer shall:

- a. Be visible in any screen when logged into the web interface of the system.
- b. Display the total number of unacknowledged alarms, and the breakdown of how many of those alarms are high priority, medium priority and low priority.
- c. Provide an audible alarm and a simple means for muting the alarm.
- d. Allow a simple mechanism to acknowledge alarms for users with appropriate user privileges.
- e. Allow a mechanism to sort and group alarms.
- f. Allow a mechanism to set configurable alarm thresholds, for example, high, medium, and low.
- g. Allow a mechanism to create user defined alarm views that fit user defined criteria.
- h. Provide an active alarms view to show alarms currently in the active state.

The EPMS shall provide an alarm notification system.

The alarm evaluation and notification system shall ensure that appropriate staff members are notified of power system events. The system shall collect data, evaluate alarm conditions, and annunciate the alarms to specified users through email. The alarm evaluation and notification system shall include:

- a. An alarm evaluation engine.
- b. An alarm notification/annunciation engine that supports annunciation through email and SMS text message.
- c. Flexible alarm scheduling capabilities.
- d. Web-based configuration tools for notification configuration, log viewing, and filtering.
- e. The ability to control alarm flooding by intelligent aggregation through alarm filtering and consolidation.
- f. Message delivery mechanisms such as:
  - Electronic mail (Email)
  - Text messaging for cell phones (GSM Modem)
  - Simple Network Management Protocol (SNMP)

### 11.4 POWER MANAGEMENT SOFTWARE—DATA ANALYTICS AND VISUALIZATION

The Power Management Software (EPMS) shall provide web-enabled dashboards.

The system shall have a web client interface that presents interactive auto-updating dashboard views that may contain energy summary data, historical data trends, images, and content from any accessible URL address.

Users shall be able to create, modify, view, and share their dashboards (including graphics, labels, scaling, measurements, date ranges, etc.) using only a browser and without a separate software application.

Users shall be able to create with configurable drag and drop gadgets to show the following data: Images from any web-based content

- a. Energy consumption
- b. Energy cost
- c. Energy comparison
- d. Energy savings
- e. Emissions
- f. Trends

The system shall facilitate kiosk displays by assigning individual dashboards to slideshows to run in unattended mode, scrolling through designated dashboards at a configurable time interval.

The system shall permit users to create, save, and share an unlimited number of dashboards and slideshows.

The system shall provide a web-enabled reporting platform.

The system shall provide a web-enabled reporting tool to view historical data in pre-formatted or user-defined report templates.

The system shall support reporting on all supported physical devices and virtual (or calculated) meters as defined in the device hierarchy.

Users shall be able to create, modify, view and share their reports in the web reports interface.

The reporting tool shall provide standard pre-formatted report templates for:

Energy cost

- a. Load profile
- b. System-wide interactive power quality with CBEMA/ITIC evaluation.
- c. EN50160 compliance
- d. EN50160 Edition 4 compliance
- e. Harmonics compliance (IEEE519-1992)
- f. IEC61000-4-30
- g. 100 ms. power quality
- h. Energy Usage: period-over-period, by shift, single and multi-device comparison
- i. Tabular, trend and multi-trend
- j. Alarm and event history
- k. System configuration
- l. Hourly usage report
- m. Single and multi-device usage reports

The reporting tool shall support exporting to the following output formats: .HTML, .PDF, .TIFF, .Excel, and .XML.

The reporting tool shall be capable of subscriptions to facilitate automatic distribution of reports according to a configurable schedule by saving to network locations, email, or print.

The system shall support the ability to trigger the generation and delivery of a pre-configured report based on pre-specified event criteria. The system shall be capable of configuring event monitoring detection filters criteria.

The reporting tool shall have a framework to support:

Simple customizations to reports such as colors, image inclusions, turning report sections on/off, and logo changes without programming.

Additional more complex report customization through a programming kit.

The reporting tool shall be capable of subscriptions to facilitate automatic distribution of reports according to a configurable schedule by saving to network locations, email, or print.

### **11.5 APPLICATIONS—POWER QUALITY MONITORING, COMPLIANCE AND ANALYSIS**

Power Quality Monitoring: The Power Management Software (EPMS) shall provide power quality specific screens and reports as follows.

Device Level Power quality summary screen—the data collected by any compliant PQ-capable metering device shall be summarized to show:

Voltage disturbances, including the date and time of the last disturbance, the count of the number of transient events, and the count of the number of sag/swell events.

- a. Harmonic measurements, including a link to the harmonics log for the particular device. Additionally, there shall be a link to another screen that shall show the real-time Total Harmonic Distortion (THD) content and the maximum THD.
- b. Logged events, including a link to the event log for the particular device.
- c. Waveform logs, including a link for waveforms captured during transients and sag/swell events.
- d. Further detailed waveform analysis using a tool shall be provided.

System Level Power Quality summary screen—the power quality report shall display all power quality events collected in the EPMS for one or more measuring points for a given period of time.

The report shall show a summary table of all the events in a given time period and provide the means to see further details (power quality details report) for any given event.

The summary report shall contain a plot of the Information Technology Industry Council (ITI) (also known as ITIC or CBEMA) curve that displays the worst disturbance from each event listed in the summary table. The summary table shall contain the following components for each event:

- a. Event identifier
- b. Source.

- c. Event timestamp.
- d. Phase identifier for the worst disturbance during this event (ex., "V1").
- e. Voltage magnitude for the worst disturbance during this event in % of nominal (for example, "68.80%")
- f. Voltage magnitude maximum and minimum on phases V1, V2 and V3 for the worst disturbance during this event in % of nominal.
- g. Duration for the worst disturbance during this event in seconds (for example, "0.084s").
- h. Disturbance type for the worst disturbance during this event (for example, "sag").
- i. ITI (ITIC, CBEMA) tolerance curve violations (for example, "outside tolerance").
- j. Link to the details report for this event.
- k. Link to waveform report for the worst disturbance during this event.

Each entry in the summary table shall include a link that provides further details for the given event.

The details to be shown are:

Disturbance event timestamp.

Phase identifier.

Voltage magnitude in % of nominal (for example, "68.80%")

Voltage magnitude maximum and minimum on phase V1, V2 and V3 in percentage of nominal.

Duration in seconds.

Disturbance type.

ITI (CBEMA) tolerance curve violations (for example, "outside tolerance").

Link to waveform report.

Each entry in the summary table shall include a link that shows the waveforms of the given event (if any exist). The waveforms shown shall be for both the voltage and current readings of the measuring point.

One hundred (100)-millisecond Power Quality Report

This report shall display data recorded at 100 millisecond intervals, with a data table for the measured point and selected measurement containing columns labeled: Timestamp, Source Label, Measurement Label, Measurement Unit, and Data Value.

IEEE1159.3 Power Quality Data Interchange Format (PQDIF) Support

The system shall provide a mechanism to export power quality data to the non-proprietary standard PQDIF format with support for the following default templates:

Sag/Swell: Sag/swell disturbance data for voltage inputs, including minimum, maximum and average values.

Sag/Swell Waveforms: Waveform data for voltage sag/swell.

Steady-state: Steady-state (RMS) data for trending.

Steady-state Waveforms: Waveform data for steady-state data.

Disturbance Direction Detection

For power quality compliant devices, the system will indicate the direction of the disturbance within the electrical distribution system in event logs, with associated confidence or certainty rating (for example, "Upstream: Confidence Rating - High", or "Downstream: Confidence Rating – Medium" etc.).

Power Quality Compliance Reporting

EN50160 Edition 4 compliance report

The EN50160 voltage characteristics of public distribution systems compliance report shall display a summary of EN50160 compliance for a set of measuring points in the system for a given time period for the following components:

- a. Power frequency.
- b. Supply voltage variations.
- c. Flicker severity.
- d. Supply voltage unbalance.
- e. Harmonic voltage.
- f. Inter-harmonic voltages.
- g. Mains signaling voltages.
- h. Interruptions of supply voltage.
- i. Supply voltage dips and swells.
- j. Additionally, the report shall allow for detailed drill-down for a given measuring point and measurement period.

IEC61000-4-30 report

The IEC61000-4-30 compliance report shall display a summary of the IEC61000-4-30 compliance for a set of measuring points in the system for a given period. The report shall:

- a. Include the following IEC61000-4-30 components: frequency, supply voltage magnitude, flicker, supply voltage unbalance and supply voltage THD.
- b. Provide a means to manually enter a baseline value for each component.
- c. Display a series of trends for each component listed with each component's manually entered baseline.
- d. Include a data table that displays all the power quality-related events for the given report period including voltage dips, voltage swells, and voltage interruptions.

IEEE 519 Harmonics Compliance report

The IEEE519 harmonics compliance report shall have the following capabilities:

- a. Provide a mechanism to report on IEEE519 limits.
- b. Provide a mechanism to report on user defined limits.
- c. Ability to determine voltage and  $I_{sc}/I-I$  ratio directly from the device, where  $I_{sc}$  is the maximum short circuit current at the point of common coupling (PCC), and the  $I-I$  is the maximum fundamental frequency demand current.
- d. For both individual and total harmonic voltage distortion, display the following:
- e. The allowable IEEE519 limits.
- f. The % time out of compliance.
- g. The number of non-compliant three-second intervals.
- h. The number of total measured intervals.
- i. Number of missing or invalid intervals.
- j. Compliance levels of Warning, Out of compliance, or Compliant.
- k. A maximum value with a time-stamp of when that distortion was measured.
- l. For both individual and total harmonic distortion for current, display all the values specified in the previous section for every range of harmonic orders.

For each phase, voltage, and current provide a graphical plot of THD versus time stamp. On the same plot, plot the allowable limit to allow for visual comparison of compliance.

Provide a graphical plot of "average value of voltage per harmonic" and "average value of current per harmonic" as a percentage of fundamental frequency, versus harmonic order to allow for visual identification of the worst harmonic problems.

For each phase voltage and current, provide a graphical plot of harmonic content versus time stamp with simultaneous plot lines for a set of harmonic orders (for example,  $h \leq 11$ ). This allows the user to identify the harmonic orders associated with the worst problems to enable mitigation measures such as active filtering.

## 11.6 POWER MANAGEMENT SOFTWARE—TECHNICAL INFRASTRUCTURE

The Power Management Software (EPMS) shall provide the following operating system and browser support:

All associated core components of the EPMS software operate as Windows operating system services.

The web client interface shall support multiple browsers.

The EPMS shall provide the following data management support:

Microsoft SQL Server database engine per supported configurations.

All network configuration settings relating to device routing and addressing, communication gateways, distributed I/O servers, and load-distributing application servers shall be stored in the EPMS databases.

Archiving, trimming, and on-demand or scheduled capabilities shall be supported.

The capability to view historical data from archived databases shall be included.

The EPMS shall be capable of retrieving data from devices in the monitoring network and provide the following abilities:

- a. Interrogate and download logs of interval, waveform, and alarm data stored onboard metering devices and related circuit breaker trip units.
- b. Interrogate and download logs of interval data generated by the software system (software-based logging).
- c. Interrogate and download logs of alarm and event data generated by the software system (software-based alarming).
- d. Automatically re-arm the waveform recorders upon upload of information.
- e. Detect unknown measurement quantities provided by devices in the network, and automatically generate appropriate database references for those quantities without user intervention.

The EPMS system shall include an Administrative interface with the following management functions:

Security: administer groups and user accounts with role based privileges.

Database: initiate backup, archiving, and trimming tasks.

Devices: Add or rename devices, map measurements, and communication settings.

Connections: Configure connection schedules and manage modem connections.

Events: View and manage software system events.

The EPMS system shall function without disruptions (including communications, logging, and alarming) and shall remain online during all system administration functions such as adding, modifying, or removing devices in the system; creating, modifying, or removing graphical diagrams, dashboards, tables, and reports; creating, modifying, or removing application logic programs in the application logic engine

The EPMS shall support the following device support and management features:

The system shall include factory-tested native driver support for various electrical distribution devices (energy and power meters, protection relays, circuit breakers, PLCs, etc.)

Native comprehensive device support shall include:

Pre-engineered, interactive graphical display screens for viewing and analyzing real-time and historical device data.

All registers pre-mapped to standard measurement names without additional mapping of internal device registers.

Automatic upload of time-stamped onboard data logs, event strings, and waveform captures without additional configuration.

Automatic time synchronization.

The system shall support integration with other third party intelligent electronic devices (IEDs) not directly supported natively.

The system shall support logical device definitions for user-friendly device and measurement names for inputs/outputs or channels on devices that represent a downstream device (in the case of PLCs and auxiliary inputs) or an individual circuit (in the case of multi-circuit devices). Bulk-import capability to create large numbers of logical devices without manual single-device configuration shall be supported.

The system shall support the concept of hierarchies to organize devices structurally into various levels. Examples include Tenants/Racks/Circuits, PDUs/RPPs/Panels, or Buildings/Floors/Rooms.

The system shall include the ability to:

Aggregate data at any location in the hierarchy.

Track hierarchy configuration changes over time.

Allow administrators to update names in a given hierarchy at any time (even in the past) to ensure accurate reporting of associated data points (for example, report on energy consumption for a Tenant who has re-located, expanded, added, or removed circuits during the billing period).

Export the hierarchy structure to Excel format.

Bulk-import capability to create and edit large hierarchies without manual per-device setup.

The system shall support extensibility in the following ways:

Provide a graphical, object-oriented application logic engine to create system-wide logic modules with arithmetic, XML data import, PC-based alarming, and logging capabilities.

The application logic engine shall have a comprehensive set of functions to create customized applications programs for functions such as weather or real-time price import, KPI calculations, energy units conversion, data aggregation, data normalization, data comparison, power loss calculations, power factor control, load shedding, etc.

The EPMS system shall support system integration in the following ways:

Device-level Modbus interoperability.

The system shall be capable of supporting Modbus communicating devices and be capable of functioning as a Modbus master to read/write registers in Modbus devices for monitoring and control applications.

The system shall be capable of Modbus device definition (device drivers) creation to enable integration of third-party Modbus protocol devices.

System-level OPC interoperability.

The system shall be OPC DA 2.0.1 compliant (as per the OPC Foundation Compliance Testing process) for OPC Server and OPC Client data sharing applications amongst OPC compliant systems.

The system shall provide default OPC Server tag mappings for all natively supported device types without the need to select, configure, or program the mapping of device registers to OPC tags.

The system shall provide a flexible means to add or change OPC mappings and shall support the ability to add custom measurements.

Data-level interoperability.

The system shall support the Extract, Transform, and Load (ETL) data log file transfer mechanism to import and export data log files to integrate functions such as manual data entry, offline device data import, push data to the cloud, or to other systems.

The system shall include a mapping application for specifying log data file import-export mappings and import schedules to facilitate import/export in formats such as .CSV, .XML, etc. Web application level integration.

The system shall include:

The capability to supply content such as dashboards, reports, trends and diagrams to other external web applications through addressable URLs.

The EPMS shall support system configuration and advanced analysis tools in the following ways:

The system shall include a monitoring and analysis application with a rich set of power tools energy analysis, power quality analysis, power system monitoring and control, and include the following capabilities:

Auto-diagram creation capability to create a comprehensive set of linked hierarchical graphical diagrams showing devices and their associated device specific diagrams in the network.

Ability to import custom graphics or images to create electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, and mimic displays. Support for power quality analysis.

Plot PQ events on an ITIC/CBMEA curve or SEMI F47 curve.

Manual waveform capture.

Visualization or analysis tools for sinusoidal electrical waveforms including waveform overlay, zooming, and calculations for RMS, peak, delta, harmonics spectrum bar charts, and phasor diagrams.

Ability to write to device registers for applications such as resetting, triggering, toggling, switching, manual waveform capture, controlling remote devices and equipment, including breakers.

Ability to develop custom graphics screens and application logic programs with the devices being offline or disabled to allow for project development in disconnected mode. The system communications infrastructure shall support the following:

Multiple communications network topologies including Ethernet/TCP, serial RS-485/RS-232, and Modem dial-up connections.

The capability to provide time-synchronization signals over an Ethernet network with 16ms accuracy or better.

The capability to communicate simultaneously with multiple devices, including devices on different physical communications channels.

The ability to automatically retrieve logged data (interval data, event data, and waveform data) from natively supported devices without additional configuration.

The ability to accept or reject duplicate data entries into the database.

## 2 ENERGY METERS.

### 11.7 FOR HT INCOMERS / MAIN LT PANEL INCOMERS

Power Quality Analyser - High end power quality analyser with Class 0.2 active energy Accuracy with **Sag/Swell - Waveform capture and Individual harmonics monitoring upto 63rd**. Power Quality analyser needs to be capable of **Disturbance direction detection with onboard dual ethernet Port** communication.

Power Quality Analyser - High end power quality analyser with Class 0.2 active energy Accuracy with <b>Sag/Swell - Waveform capture and Individual harmonics monitoring upto 63rd</b> . Power Quality analyser needs to be capable of <b>Disturbance direction detection with onboard dual ethernet Port</b> communication.	
Basic Parameters	<ul style="list-style-type: none"> <li>* Current, voltage, frequency</li> <li>* Active, reactive, apparent power Total and per phase</li> <li>* Power factor Total and per phase</li> <li>* Current measurement range (autoranging) 0.05 - 10A</li> </ul>
Energy Parameters	<ul style="list-style-type: none"> <li>* Active, reactive, apparent energy</li> <li>* Settable accumulation modes</li> </ul>
Demand Parameters	<ul style="list-style-type: none"> <li>* Current Present and max. values</li> <li>* Active, reactive, apparent power - Present and max. values</li> <li>* Predicted active, reactive, apparent power</li> <li>* Synchronisation of the measurement window</li> </ul>

	* Setting of calculation mode - Block / sliding
Power Quality Parameters	* Total Harmonic distortion Current and voltage * Individual harmonics - Upto 63rd * Waveform capture * Detection of voltage swells and sags * Disturbance Direction detection
Sampling Rate / Cycle	Minimum 256 Samples / Cycle
Data Recording	512MB of standard non-volatile memory. 10 MB of standard nonvolatilememory dedicated to capture billing data, events, and waveforms.Logs of Min/max of instantaneous values, Event logs,Trending/ forecasting, SER (Sequence of event recording).
Class Accuracy	Active Energy - Class 0.2S IEC 62053-22 , Reactive Energy Class -0.5S IEC 62053-24, Power Factor - Class 0.5 as per IEC 61557-12
PQ Standards	PQ compliance reporting as per IEC 61000-4-30 Class S, - IEC 62586 PQI-S
Communication	Onboard Dual ethernet port for daisy chaining over ethernet. Meters need to have Modbus Mastering capability by connecting Slave devices over RS485 port
Time Synchronisation	GPS clock (RS485) or IRIG-B (digital input) to +/- 1 millisecond.
Digital IO	Standard : 3 digital status inputs for Breaker ON/OFF/ Trip monitoring& 1 KY (form A) energy pulse output for interfacing with other systems.Expandable DI/DO, ADI/ADO capability
Display	Bright LCD colour display with meter dimension 96 X 96 mm only

Multifunction Meter - Multifunction meters with Power and harmonics monitoring capturing abnormalities in the system with date and time stamp.

### 11.8 FOR LT PANEL AND OTHERS

Multifunction Meter - Multifunction meters with Power and harmonics monitoring capturing abnormalities in the system with date and time stamp	
Basic Parameters	* Current - Average line current of 3-phase, per-phase, and calculated neutral current * Voltage Average voltage of L-L, L-N parameters, and per-phase * Frequency * Displacement power factor Average and per-phase signed * True power factor Average and per-phase signed * % unbalance among the phase for I, V L-N, V L-L
Energy & PowerParameters	* Real, reactive, and apparent power Total and per-phase value * Accumulated Active, Reactive and Apparent Energy, Received and Delivered registers , Net and absolute energy values, time counters
Demand Parameters	* Current average, Active power, Reactive power, Apparent power -Present, Last, Predicted, Peak, and Peak Date Time * Demand sync methods Thermal, Timed, Command Sync,and Clocked Sync * Demand calculation mode Sliding, fixed and rolling block * Demand intervals - settable from 1 to 60 minutes
Power Quality Parameters	THD as per IEC 61557-12 for THD and individual harmonics

	up to 15th over communication
Sampling Rate / Cycle	Minimum 64 Samples / Cycle
Class Accuracy	Active energy - Class 0.5S as per IEC 62053-22
Communication	RS 485 port Modbus RTU and disabling RS485 port against unauthorized access.
Calibration LED	configurable from 1 to 9999000 pulses/k_h (kWh, kVAh, or kVARh)
Min/Max values	instantaneous parameters with timestamp
Display	Bright red colour LED display with meter dimension 96 X 96 mm only

**END OF SECTION**

## LIGHTNING PROTECTION SYSTEM

## 12.0 LIGHTNING PROTECTION SYSTEM

### 1.0 GENERAL

#### 12.1 Work Description

This section comprises the engineering, supply and installation, testing necessary for the Lightning Protection System for all buildings and of open areas (storage, leisure, office areas etc) It includes the protection against the electrical consequences due to the lightning current flow through the lightning protection system.

Notes:

1. This standard does not cover the protection of electrical equipments or system against voltage surges of atmospheric origin which are transmitted by networks entering the structure.
2. Other standards describe lightning protection systems using simple rod lightning conductor, stretched wires and meshed conductors.

The Lightning Protection System shall be installed generally in accordance with IS / IEC 62305-3 & IS 3043 and additional requirements of this specification. The system shall consist of air terminations, down conductors, joints and bonds, testing joints, earth terminations and earth electrodes. The general arrangement shall be as indicated on the drawings.

The lightning protection system shall comprise:-

1. Air terminal (as per rolling sphere or mesh or protective angle method or any combination thereof.)
2. Down Conductors
3. Joints and Bonds
4. Test Links
5. Maintenance free earthing system based on chemical earth compound

Lightning protection system employing steel structural and reinforcement system as part of the down conductors shall be adopted as per Drawing specified. All requirements in the specification included cast-in re-bar down conductors shall be applied unless otherwise specified.

#### 12.2 Standards

Complete supply and installation of the lightning protection system shall be followed for engineering, construction and installation in accordance of the following standards and with the latest revision with update amendments:

IS / IEC 62305-3 & IS 3043	lightning arrester air terminals
IS/ IEC 62561	Lightning and Earthing Material

The detail of the lightning protection system shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.

In the adoption of standards and requirements, the Contractor shall take the following precedence:

1. Engineer's decision
2. Local codes of practice

3. Drawings
4. Specification
5. International standards and requirements.

### **12.3 Submission**

All technical submissions shall be approved by the ELECTRICAL contractor prior to the respective stages of construction with respect to the approved design and development documents. In case of major deviations, it shall be brought under the notice of consultant for its review and approval.

A prior survey may be conducted to determine the protection level to be considered, the ESE lightning conductor location(s), the down –conductor path(s), the earth termination system location(s) and type(s). All technical submissions shall be approved by the Engineer prior to the respective stages of construction.

Architectural constrains may be taken into account in the lightning protection system design and the design shall be based in a manner so that there is no reduction in the lightning protection system effectiveness.

As a minimum requirement, the submission shall include the following:

1. Equipment submission with manufacturer's data;
2. Sample submission;
3. Shop Drawings showing the co-ordinate routing of air terminations, down conductors bonding to re-bar and foundation earth terminations, methods of fixing etc.
4. Builder's works requirement.
5. Proposal on testing procedures and report format for testing of the Lightning Protection System.
6. Detail of the Contractor's installation Professional Engineer who supervise and endorse the installation for occupation permit application.

#### **a. PRODUCT**

### **12.4 AIR TERMINAL**

#### **1.0 General**

Lightning Protection System shall be in accordance with IS / IEC 62305-3 & IS 3043

#### **2.0 Zone of Protection**

The zone of protection of a lightning conductor defines the space within which Air Terminal provides protection against a direct lightning strike with probability of protection as per LPL.

#### **3.0 LPL (Lightning Protection Level)**

LPL is a number associated with a set of lightning current parameters relevant to the probability that the associated minimum & maximum values do not exceed the normally occurring lightning. LPL can be determined by Risk analysis as explained in IS / IEC 62305-2.

**LPL levels and probability of protection:**

Lightning protection Class	Lightning current peak value MINIMUM	Lightning current peak value MAXIMUM	Interception probability
LPL 1:	3 kA	200 kA	98%
LPL 2:	5 kA	150 kA	95%
LPL 3:	10 kA	100 kA	88%
LPL 4:	16 kA	100 kA	81%

**Components of External LPS**

- 1.) Air terminal (as per rolling sphere or mesh or protective angle method or any combination thereof.)
- 2.) Down conductor
- 3.) Earthing

**3.1 Air termination system:**

No drilling is allowed in the terrace for fixing the air terminal, if the roof is made of concrete. Parapet wall is exception to this.

**Values of Rolling sphere radius, Mesh size and protection angle as per Class of LPL/LPS.**

Class of LPL/LPS	Rolling sphere radius(m)	Mesh size (m)	Protection angle
1	20	5*5	Refer figure 1
2	30	10*10	Refer figure 1
3	45	15*15	Refer figure 1
4	60	20*20	Refer figure 1

**3.1.1 Material and Dimensions**

Material of air terminal, down conductor, earth termination etc. shall be as below:

Material	May be destroyed by galvanic coupling with
Copper(Solid)	GI and Aluminium
Hot galvanized steel(Solid)	Copper
Stainless steel(Solid)	.....
Aluminium (Solid)	Copper

Dissimilar metals (eg. Copper with Aluminium) must be connected only by using bimetal connectors.

**Minimum thickness of metal in air termination system for LPL /LPS**

Material	Thickness (a) in mm	Thickness (b) in mm
Galvanized steel	4	0.5
Stainless steel	4	0.5
Copper	5	0.5
Aluminium	7	0.65

**Material, Configuration and Minimum cross sectional area of air terminal & down conductors**

Material	Type	Minimum cross section area	Remarks
Copper	Solid tape	50 sq mm	2mm min thickness
Copper	Solid round	50 sq mm	8mm dia
Aluminum	Solid tape	70 sq mm	3 mm min thickness
Aluminium	Solid round	50 sq mm	8 mm dia
GI	Solid tape	50 sq mm	2.5 mm min thickness
Stainless steel	Solid tape	50 sq mm	2 mm min thickness

**3.1.2 Air terminal holder:**

**Concrete Roof structure:** Conductors shall be securely fixed on the terrace by means of airterminal holder which is fixed on the roof by adhesive of good quality taking care of varying weather conditions. Air conductor holder is an insulator & should be of minimum 50 mm height so that even small amount of water logging on terrace is below the level of conductor holder.

**Metal Roof structure:** Conductors shall be securely fixed on the terrace by means of air terminalholder which is fixed on the roof by metal conductor holder of good quality which is tested for lightning current as per IEC standard. Vendor need to give proof. As metal roof structures are normally tapered at an angle, there is no min. height criteria for metal conductor holder.

**3.1.3 Recommended distance between air terminal holders:**

Arrangement	Recommended distance for SOLID TAPE	Recommended distance For ROUND conductors
Horizontal conductor on horizontal surface	500 mm	1000 mm
Horizontal conductor on vertical surface	500 mm	1000 mm
Vertical conductor from Ground to 20m height	1000 mm	1000 mm
Vertical conductor above 20m height	500 mm	1000 mm

If antenna, air cooler or any other electrical equipment is present above terrace level, the same have to be protected by using vertical air terminal after calculating the safety or separation distance. The vertical air terminal has to have suitable supports to hold it. Wind speed need to be taken into account. Vertical air terminal must be connected to horizontal air terminal by using suitable connectors.

At the crossings of the horizontal air terminals, suitable Cross connector has to be used for secure connection which is tested for lightning current as per IEC standard. Vendor has to provide proof.

**3.1.4 Safety or Separation distance:**

It is must to calculate safety or separation distance in order to avoid flash over to the electrical equipment when the lightning current is passing through the vertical air terminal.

**3.1.5 Safety/Separation distance (S) in m = (ki \* kc\*L) / km**

Coefficient ki depends on class of LPL/LPS

- ki = 0.08 for LPL1,
- ki = 0.06 for LPL 2,
- ki = 0.04 for LPL3 and 4.

Coefficient kc depends on no of down conductors:

- kc = 0.66 for 2 down conductors
- kc = 0.44 for 3 or more down conductors

Value of coefficient km = 1

Value of L is the total distance between the equipment to be protected (for e.g. Antenna) to the equi-potential bonding bar situated just above the ground.

**3.1.6 Expansion piece**

In order to take care the expansion of the metal in summer and contraction of the metal in winter, expansion piece with suitable connectors have to be used at every 20m distance of horizontal air terminal.

**3.1.7 Joints and Bonds**

The lightning protective system shall have few joints as far as possible & air terminal & down conductor have to be straight. Where it is not possible, it should NOT be bent at 90 degree (right angles) & should have a curved path of 45 degree bend.

**3.2 Down conductor system**

In order to reduce the probability of damage to electronic/electrical equipment, the down conductors shall be arranged in equi distance in such a way that from the point of strike to earth, several parallel current paths should exist & length of the current path should be minimum. Down conductors can be installed separately or more wisely it can be part of natural components of the building. Examples are steel reinforcement in RCC columns, metal facades, profile rails, metal doors & windows. Down conductors should be installed at each exposed corner of the structure as a minimum.

**Value of distance between down conductors as per Class of LPL / LPS**

Class of LPL/LPS	Typical distance (m)
1	10
2	10
3	15
4	20

**3.2.1 Test joints:**

At the connection of the earth terminal, a test joint should be fitted on each down conductor at a height of 1 m from the ground, except in the case of natural down conductors combined with foundation earth electrode. The purpose of test joint is to measure the earth resistance value. The remaining portion of down conductor (i.e., after the test joint should be mounted inside a plastic pipe of minimum 3 mm thickness.)

### 3.2.2 Earth Terminations

Earth mat is most preferable. Where earth mat is not possible, ring earthing is the next best method. Ring earthing must be 1 meter away from the building and 0.5m below the ground level. The resistance of earthing system shall not exceed 10 ohm as per IEC 62305. Lower earth resistance is more preferable

For earth termination system, 2 basic types of earth electrode arrangements are applicable.

Type A & Type B arrangement.

**Type A arrangement:** Comprises of horizontal or vertical earth electrode installed outside the structure to be protected connected to each down conductor.

In type A arrangement, the total number of earth electrodes shall not be less than two.

Type A arrangement is suitable in places where electronic equipment are not located.

**Type B arrangement:** This type of arrangement comprises either a ring conductor external to the structure to be protected, in contact with the soil for at least 80% of its total length or a foundation earth electrode. Such earth electrodes can also be meshed. For structures with extensive electronic systems or with high risk of fire, type B earthing is most preferable method. Corrosion proofing band has to be used wherever down conductor is connected to earth termination system. Bitumen has to be applied at the point of inter-connection. In potentially corrosive areas, Stainless steel must be used.

### 3.2.3 References:

IS / IEC62305 – PROTECTION AGAINST LIGHTNING:

Part 1: General Principles

Part 2: Risk Management

Part 3: Protection of structures

Part 4: Protection of Electrical & Electronic equipment within structure

IS3043: 1987: Code of practice for Earthing.

### b. TESTING & COMMISSIONING

The contractor shall conduct his own inspection and test reports certified by their engineer shall be submitted to the Engineer-in-charge for his approval and submit a request for joint inspection.

Joint inspection shall be carried out by the engineer-in charge or his authorized representative. Test results shall be checked and compared with the report submitted. All equipment, transportation, manpower and other necessary costs for the joint inspection shall be borne by contractor.

The system shall be tested once in every month intervals for earth resistivity, resistance to earth of the electrodes and electrical continuity of the system. The record of readings / results of these tests shall be maintained by contractor during defect liability period by the contractor and after that by Engineer-in charge.

The contractor shall supply one set of portable Air terminal test meter suitable for operation on batteries for maintenance and check of system. The meter should be suitable:

- To test the individual charge sensor
- To test the individual triggering terminal
- To identify the faulty air terminal
- To give alarm in case test meter is defective.

The Contractor shall submit a detailed layout drawing showing the positions of testing carry out on site.

**END OF SECTION**

**RISING MAINS/BUS DUCT 433  
VOLTS, 3-PHASE, 4-WIRE**

## 13.0 BUS DUCTS/RISING MAINS (SANDWICHED CONSTRUCTION)

### 13.1 SCOPE:

The specification covers design, manufacturing, supply, installation, testing and commissioning of Sandwich type bus bar trunking for use as feeder bus bars for interconnection between separate electrical equipment / load centers, and for use as plug in bus bar risers and it should be suitable for 1000 Meter MSL.

### 13.2 GENERAL:

Bus bar Trunking shall be sandwich type construction. It shall be 3 Phase with 100% Neutral and PE conductor enclosed in GI / all sheet steel (CRCA) housing.  
Bus bar Trunking shall be rated for operational voltage of 690V with insulation voltage of 1000V, Rated Impulse Voltage withstand-8Kv and shall be suitable for 50Hz frequency.  
Sandwich type bus bar shall be suitable for distribution application from 250A to 4000A copper/Al conductor.

Range shall be suitable for horizontal and riser application and should be complete with feeder/plug in and all accessories like expansion joints, reducers, end terminal covers etc. as recommended by the manufacturers. Standard length of bus bar shall not be less than 3000mm & plug in opening shall be provided at regular intervals with safety shutters. Special length shall be designed to connect the end piece and some special requirements.

The Plug in Busway shall be suitable for vertical and/or horizontal installation.

All indoor application shall use IP54 and for outdoor application IP65 with canopy should be used.

Busduct /Rising Main shall have mounting Brackets welded to the housing of Bus duct/Rising Main for installation of External earth Busbar on both the size, the earthing Contractor shall be installed in the rising main with proper Hardware and star washer so that paint on bracket is peeled off and proper contact of earthing bus bar is insured with housing of rising mains.

### 13.3 SHORT CIRCUIT AND TYPE TEST:

Bus way system shall comply with following standards:

IEC 61439-1&6

All type test certificates according to above standards shall be of International Lab of repute such as CPRI/DEKRA/LOVAG /KEMA or equivalent.

Type test certificate shall be produced for validation before ordering for Rated Short Circuit breaking capacity for 1sec.

Type Test certificates confirming Mechanical Operation and Temp. Rise of Tap Off Box of similar design in accordance with IEC-61439 are must. Busway manufacturer shall produce a Type Test Report determining Rating of Busway at Ambient Temp. with no deration. Failure to submit such reports will disqualify the manufacturer.

A Type Test report confirming Degree of Protection in accordance with IEC 60529 is must.  
The type test for IEC-60068 of seismic with acceleration of 0.4g. certificate of green premium product from independent test house is a must.

### 13.4 HOUSING:

The bus bar trunking housing shall be constructed of 1.6 mm thick (sheet steel, CRCA housing), IK-10 on all the sides. It shall be provided with a suitable protective finish of epoxy resin paints.  
Housing shall be light in weight for ease of installation and maintenance. The bus bar trunking housing shall be totally enclosed non-ventilated, for protection against mechanical damage and dust accumulation.

Modifications of bus bar trunking to make it totally enclosed by other than the bus bar trunking

manufacturer voids the manufacturer's warranty.

For outdoor/Higher IP protection the housing made by the manufacturer shall be considered based on adequate type test reports ratifying their use in desired conditions/locations alongside a confirmation meeting the requirement of basic IP Protection sought above. Housing shall be non-corrosive and shall be able to withstand 1000 hours of salt spray test.

### **13.5 BUS BARS:**

Bus bar conductors shall be high conductivity Aluminium Alloy. Each bus bar shall be individually insulated Class B (130 Deg C) insulation with multilayer of reputed make UL certified insulation insulating film (Certified Insulation Material as per standards), epoxy ormica insulation not allowed. Both feeder and plug-in bus bar trunking for all ratings shall be of sandwich construction, with no air gap between bus bars except at plug-in openings.

### **13.6 NEUTRAL BUS BAR:**

Internal neutral conductor shall be 100%, which can meet with the requirements of various power systems in the installations.

### **13.7 PLUG IN OPENINGS:**

On plug-in bus bar trunking there shall be three dead front, hinged cover type plug-in openings on each side of standard three meter lengths.

All openings shall be usable simultaneously.

All contact on joint and plug-in opening should be silver plated copper.

It shall be possible to inspect the plug-in opening and bus bars prior to the installation of the plug-in unit.

### **13.8 PLUG-IN UNITS:**

Plug-in Units circuit breaker type shall be operated with visible rotary quick make and quick-break mechanism.

All plug in units shall have MCCBs of suitable breaking capacity as per design. MCCB and bus bar system shall be of same manufacturer. It should also be type tested as per IEC 61439-1&6.

### **13.9 PLUG-IN UNIT SAFETY DEVICES:**

Plug-in unit enclosures shall make positive earth connection with the earth bus before the jaws make contact with the phase bars.

The Earthing method shall be such that it cuts through painted surfaces to make the positive earth connection.

Plug in box unit shall have an protection of IP 54 along with the housing so that there is no access to live bus bars once connected.

The plug is provided with internal interlocking mechanism to prevent the plug door being opened whilst energized, ensuring operational safety.

Plug in Boxes shall be suitably Type Tested / as per IEC 61439.

### **13.10 JOINT:**

The bus bar trunking joint shall be of the on-bolt type which utilizes a high strength steel bolt(s) and washers to maintain proper pressure over a large contact surface area.

The bolt shall be two-headed design to indicate when proper torque has been applied and require only standard long handle wrench to be properly activated.

Access shall be required to only one side of the bus bar trunking for tightening joint bolts.

On bus bar trunking, it shall be possible to remove any joint connection assembly to allow electrical isolation or physical removal of a bus bar trunking length without disturbing adjacent bus bar trunking lengths.

### **13.11 SUPPORT OF BUS BAR TRUNKING:**

Hanger spacing shall be noted on layout drawings and shall not exceed manufacturer's recommendations. Indoor Feeder and plug-in bus bar trunking shall be approved for hanger spacing of up to two meters' for horizontally mounted runs and four meters' for vertically mounted runs. Outdoor feeder bus bar trunking shall be approved for spacing of up to 1.2 meters' for horizontally or vertically mounted runs.

### **13.12 VOLTAGE DROP:**

The voltage drop (input voltage minus output voltage) specified shall be based on the bus bar trunking operating at full rated current and at stabilized operating temperature.

### **13.13 INSTALLATION:**

The bus bar trunking construction should be such that no two consecutive pieces be installed successive TOP and BOTTOM, i.e., there should be a clear mechanical preventer to prevent installation of (TOP) RYBN and (BOTTOM) NBYR.

**END OF SECTION**

## HT PANEL BOARDS

## 14.0 HT PANEL BOARDS

### 14.1 SCOPE

This specification covers design, engineering, manufacture, shop testing, delivery at site, erection, testing and commissioning of type tested 12 KV, 3 phase, metal clad indoor, Horizontal draw out type, Vacuum Circuit Breaker (VCB) Switchboard with all accessories and protective devices mounted and wired up.

### 14.2 CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of the Switch Board offered shall comply with all currently/latest applicable standards (including amendments thereto), regulations and safety codes in the locality where the equipments will be installed. Nothing in this specification shall be construed to relieve the Supplier of his responsibility. Where no standards are available, the supply items shall be of good quality and workmanship and backed by test results. Other National Standards are acceptable if they are established to be equivalent to or superior to the listed standards.

Standards	
1.	IEC: 62271 - 1 High-voltage switchgear and control gear - Common specifications.
2.	IEC: 62271 - 100 High-voltage switchgear and control gear - Alternating current circuit-breakers.
3.	IEC: 62271 - 200 High-voltage switchgear and control gear - AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV.
4.	IEC: 600441-1 Current Transformers
5.	IEC: 600441-2 Voltage Transformers
6.	IEC: 60529 Classification of degrees of protection provided by enclosures
7.	IEC: 60038 Standard Voltages
8.	IEC: 60255 Measuring relays and protection equipment - Part 24: Common format for transient data exchange (COMTRADE) for power systems.
9.	ANSI IEEE C 37/20 Switch gear assemblies including metal enclosed bus.

### 14.3 CIRCUIT BREAKER

The circuit breaker shall be mounted on a withdrawable truck which shall roll out horizontally from service position to isolated position with ease and it shall also be possible to take out the breaker truck from cubicle smoothly on to the floor without use of any separate handling equipment. It is preferable to provide three point guide for withdrawal and insertion of truck into the cubicle with ball bearing arrangement on the top of the truck. Circuit breaker shall be of vacuum only and the truck shall have distinct 'SERVICE' and 'TEST' position. Isolated position by defeating the interlock shall also be inside the cubicle so that the front door of breaker compartment can be closed even in breaker isolated position. Special more than three point hinged locking arrangement shall be provided to prevent opening of door in the event of internal arc in breaker compartment. Isolation shall be horizontal.

All the three interrupters of individual phases shall be mounted on a common phase segregated epoxy body mounted on a truck for better insulation and avoidance of non-simultaneity of poles. Circuit breaker shall be vacuum type only. Bidders should be the manufacturer of vacuum interrupter as pre requisite for qualifying .Interrupter mounted on the conventional individual insulators will not be accepted. No separate fiberglass sheet barrier to be used.

It shall be operated through a common motor wound spring charged mechanism with electrical release coil for closing and shunt trip coil for tripping. Operating mechanism must have manual charging, closing and tripping facility with the provision locking facility in push to close & push to trip mechanical push button.

The mechanism shall be such that motor will automatically recharge the mechanism springs after a closing operation enabling breaker to perform OCO operation. The charging time of motor shall be less than 15 secs making it suitable for rapid auto reclosing duty. Emergency mechanical push to trip button shall be provided for emergency manual tripping with front door closed. All the 'MS' components of circuit

Breaker mechanism shall be treated with zinc plating with olive green passivation for longer life even in adverse climatic condition. Yellow passivation shall not be acceptable. All mechanism springs shall be powder coated. Plating on mechanism spring is not acceptable. The normal current rating of circuit breaker shall be in panel rating without fan.

There shall be minimum 4NO and 4NC contacts in breaker auxiliary switch. In case of Additional contacts the same can be multiplied through latched type contactors. Auxiliary plug and socket shall be of minimum 24 pin plug type and shall have scrapping earth feature. Auxiliary contacts shall be suitable for continuous thermal current rating of 10A.

#### **14.4 INTERLOCKS**

Circuit breaker can be inserted only in open position. Likewise circuit breaker in closed position cannot be withdrawn. Attempt to draw out closed breaker shall not trip the breaker.

The circuit breaker shall operate only in one of the three defined positions i.e. service, test and isolated. The breaker shall not close in any of the intermediate positions. The circuit breaker cannot be inserted into service position till auxiliary contacts are made. Similarly interlock prevent auxiliary contacts from being disconnected, if circuit breaker is in service position.

It will not be possible to rack out the withdrawable part from Service to Test position when the switching device is switched ON. Similarly, it will not be possible to rack in the withdrawable part from Test to Service position, if the switching device is switched ON.

Any attempt to rack out withdrawable part from Service to Test position will not result in switching OFF of the Circuit Breaker instead the Service position will be locked till switching device is 'ON'.

It will not be possible to rack in or rack out withdrawable truck when the front high voltage door is open. However, a suitable defeat interlock mechanism is provided for emergency purpose.

It will not be possible to rack in the withdrawable truck from test to service position when the low voltage control plug is not in position and locked on the truck itself.

It will not be possible to close the door if the low voltage control plug is not engaged

#### **14.5 BUSBARS**

Bus bar material shall be Electrolytic Copper.

All bus bars shall be insulated with heat shrinkable PVC sleeves. Joints shall be insulated with shrouds in busbar chamber and interphase barrier shall be provided in cable chamber.

Phase identification shall be made at the end by coloured tape.

Bus bars shall be mounted on integral seal off bushings while passing from one compartment to another except busbar compartment.

Busbar shall run throughout the switchgear without interruption so in case of any arc, arc shall travel and cause minimum damage to the switchgear.

Temperature Rise of busbar along with other parts of switchgear shall be governed by IEC 60694, Table III.

#### **14.6 CUBICLE CONSTRUCTION**

The switchgear panel shall be of sheet steel construction with ALUZINC not less than 2.5mm thickness for load bearing section and not less than 2 mm thickness for non-load bearing and shall totally dust and vermin proof. The panels shall be rigid without using any external bracings. The switchboard panels should comply with relevant IS/IEC and revision thereof and shall be designed for easy operation maintenance and further extension. Bus bar, metering circuit breaker chamber, cables and cable box chamber should have proper access for maintenance, proper interlocks should be provided. All instruments shall be non-draw out type and safe guard in every respect from damages and provided with mechanical indicator of connection and disconnection position. The switchgear shall be completed with all necessary wiring fuses, auxiliary contacts terminal boards etc.

Width of cubicle is 600mm up to 1250A and 800 mm above 1250A.

Joints for All front door shall be provided with neoprene or cross linked poly ethylene gaskets self adhesive type

All the high voltage compartments must have pressure discharge flap for the exit of gas due to internal arc to insure operator safety. All the HV compartment design i.e. Busbar compartment, VCB compartment and Cable compartment should ensure conformity to IEC 62271-200 and must be type tested individually for Internal Arc Test for AFLR 26.3kA for 100ms. The switchgear panels shall be suitable for loss of service continuity LSC 2B. Safety shutters complying with IEC-62271-200 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to ISOLATED position.

Safety shutters shall be metallic and shall be provided to cover up the fixed High voltage contacts on bus bar and cable sides when the truck is moved to Test / isolated position. The shutters shall move automatically, through a Linkage with the movement of the truck and shall be of gravity fall type only. It shall be possible to padlock shutters individually.

Switch gear cubicle shall have seal off bushing arrangement between the circuit breaker compartment and bus bar / C.T. cum cable compartment, i.e. the fixed isolating contacts shall be embedded in epoxy cast bushing so these act as seal off bushing to prevent transfer of arc from one compartment to the other in the event of internal arc within the cubicle & must be tested for internal arc in all three HV compartments as per new IEC 62271-200.

Louvers can be provided for higher normal current rating however, same shall be backed up by fine wire mesh.

Joints for All front door shall be provided with neoprene or cross linked poly ethylene gaskets self adhesive type. For Compressibility step type channel base shall be provided for easy compressibility. It shall be preferable to provide cross linked poly ethylene type. It shall be preferable to supply cubicle with gaskets between all metal to metal proper vermin proof. Minimum degree of protection shall be IP4X.

#### **14.7 LOW VOLTAGE COMPARTMENT**

Low voltage compartment shall be mounted at the front on the top of breaker compartment and shall also have hinged type of door.

All wiring shall be routed through PVC ducts and shall be terminated on to stud type terminal with plastic cover.

For current transformer terminal shall be disconnecting link type only.

The wire shall be of 1.1KV grade and suitable for 2KVrms for 1 minute power frequency high voltage.

#### **14.8 CABLE COMPARTMENT**

It shall be at the rear side with rear bolted box type back covers. There shall be an inspection window at the rear back cover enabling operator to have visual inspection without opening back cover in live condition. Viewing window at the rear side shall be of poly carbonate only and shall be tested for internal arc.

The gland plate of cable chamber shall be of minimum 3mm thickness MS sheet in two halves section with built in adjustable cable holding clamp. In case of single core cable it shall be supplied with non magnetic gland plate. Cable box shall accommodate 2-3Core 630 sq. mm. Cables or 6-1C cables. Addition rear extension box of minimum 500 mm depth shall be provided for cables more than the quantity mentioned above.

Sufficient headroom shall be provided for cable termination. The distance between gland plate and terminal shall be minimum 600mm.

Control cable entry shall be from front and there should be a possibility of terminating to LV chamber from both right hand and left hand side. Power cable entry shall be from rear bottom. Provision shall be available for entry of power cable or bus duct from rear bottom or rear top.

## 14.9 EARTHING

There shall be a continuous copper earth bus of size 30x6 sq. mm running at the bottom of the panel. Earth bus shall be robust and shall be capable of carrying full short circuit current for 1 second. Doors, covers and all non-current carrying metallic parts shall be earthed through flexible copper wires. This also includes instrument casing and cable armour which are also connected to the earth bus. Earth bus must be tested for 26.3KA for 1 sec

Separate earthing truck shall be provided for bus earthing and cable earthing. The earthing truck shall be so designed that it is impossible to earth a live. It shall be provided with capacitive voltage divider and complete with audio visual annunciation.

In addition to scrapping earth in auxiliary plug and socket proper arrangement should be made so that during engagement of the breaker in service condition earthing contacts is made first before isolating power contacts are engaged.

## 14.10 CURRENT AND POTENTIAL TRANSFORMER

Current transformers shall be double core window/bar primary for higher rating or wound primary for lower rating. Maximum VA burden shall be of 15 VA and shall be rated for full short circuit current for 1 second. Differential /REF CTs can be in one mould. In case of numerical relays 10VA burden shall be sufficient. CT shall be of a minimum accuracy of class 0.5/5P10 and CT Secondary rating shall be 1A unless otherwise specified.

Potential transformer shall be 3phase 3 limb type with 50VA per phase of class 0.5/3P accuracy and shall be mounted on incomer breaker truck.. For bus connected P.T the same shall be mounted in a separate withdrawable truck in a separate vertical panel.

## 14.11 PROTECTION RELAYS

The Protective IDMT O/C, E/F relays should be of numerical type with the same Technical specification. The relay should have feature for storing fault data, should have site selectable CT secondary relay currents i.e -/5 Amps or -/1 Amps. Should have LED/LCD for each function element of a relay to enable to identify the type of fault condition.

All the switchgears shall be provided with microprocessor based numerical protective relays of ASEA BROWN BOWERI/ SIEMENS/SCHNIEDER designed to disconnect faulty circuit with speed and discrimination and shall conform to latest revision of relevant standards regarding accuracy and other feature. Composite relay unit having O/C, E/F, O/V, U/V etc shall be preferred. The numerical relays shall be communicable type and shall communicate on MODBUS protocol. Use of communication protocol converter is not acceptable. Min 10 DI/DO has to be provided.

**Every Panel Should have Arc Flash Protection in Cable and BusBar Chamber.**

Protection of Various type of feeders as follows:

### Incomer:

- a. 1 No of SCADA Compatible Feeder Protection Relay 50/51(3 phase overcurrent) , 50/51N ( Earth overcurrent) , 67P (3 phase directional overcurrent), 67N (Earth fault directional overcurrent) , 51V ( Voltage controlled overcurrent) , 37 ( 3 phase undercurrent) , 46 ( Negative phase sequence overcurrent) , 59N ( Residual over voltage) , 32 (Directional Power protection (Under/Over active/reactive power)) , 81U/O (Under/over frequency) , 49 (Thermal overload), 79 ( Autoreclose), 50BF ( Circuit breaker failure detection) , Cold load pick up, Inrush blocking. Relay will be on Modbus Protocol Make : AREVA ( Micom P127) / ABB ( REF 541) /Siemens (7SJ62)
- b. Master Trip Relay

### Buscoupler:

- a. Master Trip Relay
- b. DC Supervision Relay

### Outgoing Transformer Feeder

- a. 1 No of SCADA Comaptble Feeder Protection Relay 50/51(3 phase overcurrent) , 50/51N ( Earth overcurrent) , 67P (3 phase directional overcurrent), 67N (Earth fault directional overcurrent) , 51V ( Voltage controlled overcurrent) , 37 ( 3 phase undercurrent) , 46 ( Negative phase sequence overcurrent) , 59N ( Residual over voltage) , 32 (Directional Power protection (Under/Over active/reactive power)) , 81U/O (Under/over frequency) , 49 (Thermal overload), 79 ( Autoreclose), 50BF ( Circuit breaker failure detection) , Cold load pick up, Inrush blocking. Relay will be on Modbus Protocol Make : AREVA ( Micom P127) / ABB ( REF 541) /Siemens (7SJ62)
- b. Master Trip Relay
- c. Transformer Fault Alarm/Trip Aux. Relay. For Transformer Feeder only

#### **Outgoing Motor Feeder**

- a. 1 No of SCADA Comaptble Motor rotection Relay 50/51 ( Short Circuit) , 50N/51N ( Earth Fault ) , 50BF ( Breaker Failure) , 66 ( Number of starts limitation) , 37 ( Loss of load / Underpower) , 46 (Negative Sequence Overcurrent) , 49 (Thermal Overload) , 27/27LV/59 (Undervoltage / Overvoltage / Re-acceleration) , 86 (Latching of output relay) ,48/ 51LR (Start / Stalled protection / Motor Re-acceleration),51S (Locked rotor during start-up) , 14 (Speed switch input) , Emergency Restart.Relay will be on Modbus Protocol Make : AREVA ( Micom P225) / ABB ( REM 615) /Siemens (7SJ62)
- b. Master Trip Relay

#### **Outgoing Tie Feeder**

- c. 1 No of SCADA Comaptble Feeder Protection Relay 50/51(3 phase overcurrent) , 50/51N ( Earth overcurrent) , 67P (3 phase directional overcurrent), 67N (Earth fault directional overcurrent) , 51V ( Voltage controlled overcurrent) , 37 ( 3 phase undercurrent) , 46 ( Negative phase sequence overcurrent) , 59N ( Residual over voltage) , 32 (Directional Power protection (Under/Over active/reactive power)) , 81U/O (Under/over frequency) , 49 (Thermal overload), 79 ( Autoreclose), 50BF ( Circuit breaker failure detection) , Cold load pick up, Inrush blocking. Relay will be on Modbus Protocol .Make : AREVA ( Micom P127) / ABB ( REF 541) /Siemens (7SJ62)
- d. Master Trip Relay

#### **14.12 METERING**

- a. Ammeter & voltmeter selector switches shall be four position type. Ammeter selector switches shall have make before break feature to prevent open circuiting of CT secondary. Selector switch shall be suitable for semi flush mounting with only switch front plate and operating handle projecting out.
- b. Multifunction meter: Digital type (Displaying A, V, PF, Hz, KVA, KW, KVAR, KWh, KVARh e.t.c.) Class 0.5 with RS485 port for communication in Modbus protocol.Make : Schneider EM 6400 or equivalent shall be provided in all incomers and outgoing feeders

#### **14.13AUXILIARY/CONTROL WIRING**

Control supply for closing and tripping shall be 220 or 110Volts D.C. through external battery source. 230 Volts single phase A.C. supply shall also be available for the operation of spring charging motor and cubicle space heater. Wattage of closing and tripping coils shall be within 250 watts. Aux supply shall be suitably distributed along with switchgear in loop in loop out fashion.

All Switchgear panels shall be supplied completely wired internally upto the terminal block ready to receive external cabling.

All the secondary wiring in the panel shall have high quality PVC insulation and the same shall have conductor size of not less than 1.5 mm<sup>2</sup> of copper.

Colors of the secondary/auxiliary wiring should confirm to IS 375/1963 and latest amendment thereof if any. All wiring shall be neatly run and group of wiring shall be securely fixed by clips so that wiring can be checked without necessity of removing the clamps. Wiring between fixed and moving portion of the panel.

shall be run in flexible tubes and the same shall be so mounted to avoid any damage to them due to mechanical movements. Ferrules with number shall be provided on both end of the wiring.

All wires directly connected to trip the circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule

#### **14.14PRE TREATMENT AND PAINTING**

Switchgear front and rear covers shall be painted for aesthetic purposes and Paint shade shall be RAL 7032.

#### **14.15 NAME PLATE AND DIAGRAM PLATES**

All equipment shall have weather proof and non corrosive metal plates fixed in suitable position with full particulars engraved thereon with white letters against black background.

The firm shall affix a name plate on each Switchgear panel having following information:

- a. Manufacturer's name
- b. Type of Panel.
- c. CT Ratio.
- d. Rated Voltage.
- e. Rated Insulation Level
- f. Rated Frequency
- g. Rated Normal Current
- h. Rated Short Circuit Breaking Current.
- i. Order No. and Date
- j. Year of supply.

#### **14.16 TESTS**

The design of circuit breaker shall be proven through all the routine and type tests in accordance with IS IEC 62271-200 and any amendment thereof. Photocopy of all the test reports must be enclosed with the tender. Type test report earlier than 5 years from the date of tender opening shall not be acceptable.

The Bidder shall submit the type test reports of following type tests for approval of the Purchaser

- a. Short circuit duty test on circuit breaker, mounted inside the panel offered.
- b. Short time withstand test – on circuit breaker, mount inside panel offered.
- c. Power frequency withstand test on breaker and panel.
- d. Lightning impulse withstand test on breaker and panel.
- e. Temperature rise test on breaker and panel together.
- f. Measurement of resistance of main circuit.
- g. Mechanical endurance test on breaker.
- h. Mechanical operation test.
- i. Internal arc current (IAC) test on individual compartments i.e. Busbar, VCB and cable compartment.

#### **14.17 QUALIFYING REQUIREMENT.**

Having supplied minimum **3000 nos.VCB of minimum 25KA fault rating.**

Bidder is a manufacturer of vacuum circuit breaker for **past 10**

**Years** Minimum turn over should be **300 crores.** Bidders must meet

the above **Type Test Criteria.** Bidder should be the **manufacturer**

**of Interrupter.**

**END OF SECTION**

## 15. ELECTRICAL PERFORMANCE SPECIFICATIONS

S.NO	PARAMETERS		REQUIREMENTS
(1)	<b>ELECTRICAL GENERAL PROVISIONS</b>	1	System has to be complete in all respect adhering to latest applicable norms.
		2	Trenches not to be placed within 3 meters of foundation or soil surfaces
		3	Electrical Details for Incoming Supply: Supply Voltage: Single 33kV Fault Level (Sym.) at supply point (Designated): 1500 MVA Neutral: Grounded Voltage Regulations: As per Latest IS/Norms. Frequency Regulations: As per Latest IS/Norms. Combined Regulations: As per Latest IS/Norms
		4	33 KV HT Power Distribution System: Voltage: 33 KV Frequency: 50 Hz Neutral: Grounded Short Circuit Fault withstand capacity: as per calculations
		5	LT Power Distribution System: Voltage: 415 V Frequency: 50 Hz Neutral: Grounded Short Circuit Fault withstand capacity: 10kA to 65kA for 1Sec., as per calculations
		6	Control supply for Electrical System: Spring charge motor : 230V, AC or 24V DC (Universal Motor) Closing/ Trip Coil : 24V, DC Alarm/ Indication/ Relays : 24V, DC Heaters : 230V, AC
		7	Cable Details: LT Control Cables: Copper conductor armoured PVC insulated 1.1 KV grade LT Power Cables: Aluminium conductor armoured XLPE insulated Grounding Conductors: Copper/ G.I. as per specifications
		8	Degree of Protection: 1. Installed Outdoor : IP-55 2. Installed indoor in air-conditioned area : IP-31 3. Installed in covered area : IP-42 4. Installed indoor in non-air-conditioned area where possibility of entry of water is limited : IP-41 5. For LT Switchgear (AC and DC distribution boards) : IP-42 Degree of protection shall be in accordance with IS: 13947 (Part-I) IEC-947 (Part-I)
		9	Steel conductors for Earthing /grounding (above ground level) to be galvanized according to IS: 2629
		10	Sheet steel work to be degreased, pickled, and phosphated in accordance with the IS-6005 "Code of practice for Phosphate iron and sheet".
			All conduits, trunking, cable trays and cable ladders shall be earthed in accordance to IS: 4043
(2)	<b>CONDUIT SYSTEM, CABLE TRAY, CABLE LADDER AND TRUNKING INSTALLATION</b>	1	Heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet up to 32mm dia and 14 (2 mm) gauge for sizes & above 32mm
		2	Minimum size of the conduit shall be 19/20mm diameter
		3	Fittings to be used with screwed conduits and comply with IS 9537
		4	Adaptors used with flexible conduits shall conform to IS: 9537
		5	Recessed boxes and accessories complete with insulated moulded type cover plates conforming to IS: 5133 Part I-1969
		6	Conduits to be high impact rigid 2mm thickness PVC heavy duty type and comply with I.E.E. regulations for non-metallic conduit as per IS-9537/1983 (Part-III)
		7	Accessories used for conduit wiring to be of an approved type conforming to IS: 3837-1966

		8	Conduits to be kept within 300 mm of floors and ceilings when running parallel
		9	Conduits shall be kept clear of gas and water pipes. In particular, conduits shall be at least 150 mm away from gas pipes
		10	Conduit bends to permit compliance to the requirements for bends in cables to as stated in the BS 7671. Where the bend is more than 90 degree, circular or rectangular junction boxes are to be used for connecting conduits
		11	Flexible conduits in general shall not be used for more than 3m length
		12	Maximum number of PVC insulated 650/1100V grade/copper conductor cable conforming to IS:694-1990
		13	Conduits run on surfaces other than structural steel members to be secured using galvanized space bar saddles and brass fixing screws. Spacing of saddles not to exceed 1.2 m for conduit sizes up to and including 25 mm and 1.8 m for sizes 32 mm and above
		14	Conduits run on structural steel to be secured using girder clips or an approved clamp
		15	Cable tray to be perforated type and construction with minimum 2.0 mm hot dipped galvanized mild steel for outdoor damp condition, and epoxy coated electro-galvanized mild steel for indoor installation
		16	Cable trays exposed to the weather, a hot-dip galvanized cover of 1.5mm gauge steel, flush fixing type with gasket, to be installed on top of the tray
		17	Cable ladder to have a 150 mm high longitudinal side member for ladders width of 800 mm or above and 120 mm high longitudinal side member for ladder width less than 800 mm
		18	Separate flexible earth continuity connectors of at least 16mm <sup>2</sup> copper jumpers to be installed between the ladder sections
		19	Cable trunking to be manufactured from 1.6 mm minimum electrogalvanized mild sheet steel to BS4678 finished in oven-baked electro statically coated epoxy powder coating with color
		20	Design, manufacturing, testing and supply of single core PVC insulated 1.1 KV grade stranded twisted wires shall comply with: IS-3961: Current rating for cables IS-5831: PVC insulation and sheath of electric cables IS-694: PVC insulated cables for working voltage up to and including 1100 volts IEC-54 (I): PVC insulated cable
<b>(3)</b>	<b>WIRES AND CABLES</b>	1	IS: 8130: Conductors for insulated electric cables and flexible cords IS: 5831: HRPVC / HR PVC insulation and LSZH sheath of electric cables IS: 3975: Mild steel wires, strips and tapes for armouring cables IS: 3961: Current rating of cables
		2	Cables in service duct, open trench, direct-laid underground in soil to be by means of armoured cables
		3	Non-armoured cables to be laid in conduits, trunkings or tray/ladder for mechanical protection
		4	Conductor used in manufacture of the cable to be of H2 grade
		5	Cable should withstand 2.5 kA for 1 Sec. with insulation armour insulated at one end
		6	IS: 3975 method (b) for strip / wire armouring to be acceptable. For single core cable aluminium wire armouring to be used
		7	Allowable tolerance on the overall diameter of the cables to be + 2mm
		8	Normal current rating of all HRPVC/XLPE insulated cables to be as per IS: 3961
		9	Distinct inner sheath to be provided by pressure extrusion process for all multi cores armoured and unarmoured cables as per IS: 5831

		10	Outer sheath to be provided by extrusion process as per IS: 5831 with oxygen index of not less than 29
		11	Cables to be supplied in non-returnable drums as per IS: 10418
		12	Cable to pass the fire resistance test as per SS: 42, 41, and 475 (I) and flammability test as per EEE: 383
		13	End terminations of cables more than 1.1 KV grade to be done with epoxy mould boxed and epoxy resin & glands be 1.1KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished
		14	Cable lugs to be tinned copper / aluminium solder less crimping type conforming to IS: 8309 suitable for aluminium or copper conductor
		15	Fire resistant paint to be applied 1 Meter on either side of cable joint
		16	Cross linked polyethylene (XLPE) cable to be aluminium conductor PVC outer sheath steel strip armoured over inner sheath construction & conform to testing in accordance with IS: 7098 (Part-I) 1977 and (Part-II) 1973
		17	HT cable to be laid at least 1200mm for cable up to 33 KV (E) below the ground level in a trench 450mm wide
		18	Cable of 1.1KV grade be laid not less than 750mm below ground level in a 375 mm wide trench (throughout)
		19	PVC pipe minimum 100mm dia. to be provided on all road crossing
		20	Clamps for multi core cables to be fabricated of 25x3 GI flats
		21	Single core power cable to be laid in trefoil formation & clamped with trefoil clamps made of PVC/fiber glass
		22	Wiring installation to be as per IS: 732 for sub-circuit runs from the distribution boards to the points and pulled into conduits to be twisted copper conductors with thermoplastic insulations of 1100 volts grade & no wire smaller than 1.5 sq.mm to be used
		23	Fire proof sealing system fully comply with the requirements of relevant IS/BS: 476 Part-B
		24	Cables for use on low and medium voltage system (1.1KV grade cables) should withstand for 15 minutes a pressure of 3000V, DC applied between conductors and also between each conductor and sheaths
		25	Cable shall be installed so that separations: 1. HT Cable (33 KV) - HV Cable (33 KV) 50 mm 2. ELV & LT 230 V/433 V - ELV& LT cable 230 V/433 V 50 mm 3. HT cables (33 KV) - ELV& LV cables 230 V/433 V 300 mm 4. LT cables 433 V - Telephone/Instrument cable 350 mm 5. All cables - All hot pipe work 200 mm
		26	At light fittings, earth terminal to be provided
<b>(4)</b>	<b>WIRING DEVICES</b>	1	One or two ways switch to be fixed generally at a height of 1200mm from floor level in rooms
		2	Switch socket outlets to be positioned 300mm above floor level except in plant rooms, kitchen, etc. where they shall be positioned 1400mm above floor level or 150mm above counters or benches as per requirement
		3	Lighting dimmer switch to be solid state, variable load and thyristor controlled type suitable for controlling fluorescent or incandescent lighting circuits operating at 230V ± 6%, 50Hz single phase AC supply
		4	Time switches to be self-contained unit suitable for mains operation with self-starting synchronous motor with single-pole fuse in the motor circuit, 3-way terminal block and thirty-six (36) hours spring reserve complete with an automatic solar dial
		5	Shaver outlets to comprise a 20VA continuously rated double wound isolating transformer to provide an earth-free AC supply at mains frequency, complete with self-resetting thermal

			overload device
		6	MCB to be rated for 10KA fault level and conform to IS: 8828
		7	ELCB to be 4 pole 415 volts 50Hz, 30-300mA sensitivity
		8	DB mounting height not to exceed 1200mm from finished floor level
		9	Cooler Control Units to be flush mounted double pole AC switch of rating 30Amps
		10	Flush-mounted double pole AC switch of 20Amps rating to be provided for water cooler along with associated connector units
		11	Water heater switches to be flush mounted having double pole AC switch rated at 20amps fitted with pilot lamp
		12	Bell push switches to be flush-mounted having single-pole AC switch of 6Amps rating
		13	Medium voltage switch panel for 433 volts, 3 phases, 50 HZ, 4 wire systems, fully rated at an ambient of 40 deg C
<b>(5)</b>	<b>LT PANEL BOARDS</b>	1	General construction to conform to IS 8623/1993 IEC 60439 for factory assembled switch board
		2	There Should be Provision of Clean Gas Based Fire Suppression System fully integrated to EMS, BMS, FAS system in HT Panel, Main LT Panel and Lift Panels.
		3	Height of the panel not to exceed 2.4 meter & operating levers, handles etc. of highest unit not to be higher than 1.7 Meters
		4	Cubicle panels with more than 1000Amps bus to be made of tested structural modular sections
		5	Floor mounted cubicles to be provided with a 75mm high channel base frame with height not exceeding 2400mm keeping operating height of top switch should not exceed 1750mm from FFL including base channel
		6	Bus bars to be of sufficient cross section with current density of 130A/Sqcm (800A/ Sq inch) is not exceeding at nominal current rating for Aluminium Bus Bars 160A/Sqcm (1000A /Sq inch) for copper bus bars
		7	Normal operating temperature for bus bars to be 85 Deg C & Short circuit rating of the bus bars to be 20 to 65KA for 1sec as per calculations
		8	Current transformers ratings to be dual core and dual ratio CTs of suitable burden (but not less than 15 VA) with 5 Amp secondary, accuracy class 5 P 10 of IS 2705 – Part – III -1992, metering conforming to the metering ratio and accuracy class 0.5 of IS 2705 – 1992
		9	PT'S to be capable of operating continuously at 110% of the rated voltage
		10	Maximum temperature rise of the transformer at rated burden and with rated primary voltage and frequency not to exceed 40 Deg's above an ambient of 45 deg C. Voltage transformer of burden not less than 100 VA and of the proper ratio and of proper ratio as specified to be provided at the incoming panel having accuracy class for the VT shall be class 0.5 as per IS 3156 Part-I to III for incomer and class 1 for outgoing panels
		11	Protective relays to be draw-out type
		12	Voltmeters and Ammeters to be flush mounted of size minimum 96mm conforming to class 1.5 of IS:1248 for accuracy. Multifunction meter of CL 1.0 accuracy with RS 485 port to be provided
		13	Control and selector switches to be rated for 10Amps at 240V, AC or 20Amps at 220V DC (inductive break). Switch for space heater supply and control voltage supply normally be two pole rated for 25A, AC
		14	Where wires drawn through steel conduits, the work to confirm to CPWD General Specification for Electrical works Part-I-Internal).2005 and IS: 732
		15	2 Nos 20 x 3 mm copper strip for LT panel up to 400 Amp and

			20 x 5 mm copper strip for LT panel of higher capacity to be provided all around the panel connected to 2 Nos earth bus copper strips connected to incoming conductor.
		16	Space heater/s to be trip type, rated with operation voltage of 240V, 50 Hz. AC supply completed with a 2P MCB, 10KA and a control thermostat & rated for maintaining the panel inside temperature 10 Deg.C above outside ambient temperature
		17	Fuses to be HRC cartridge link type (Diaz- zed Fuses are not acceptable) with operation indicator
		18	Contactors to be air break type, equipped with three main contacts and minimum 2NO + 2NC auxiliary contacts. The auxiliary contacts to be rated for minimum 5 Amps at 240V AC and 1.3 Amps at 110V DC (Inductive load) & coil of suitable for operation on 240V, (+) 10% & (-) 15% 1-Ø, AC supply. The drop off voltage of contractor shall be 15% to 65% of the rated coil voltage.
		19	Multifunction Meter to be capable of being applied without modification at nominal frequencies of 45 to 65 Hz
<b>(6)</b>	<b>MULTI FUNCTION METER</b>	1	Multifunction Meter to provide continuous sampling at a minimum of up to 32-256 samples/cycle, simultaneously on all voltage and current channels in the meter
		2	Current Inputs: metering range of 0-6 amps with withstand currents: 10 amp continuous, 50 amp 10 sec per hour, 120 amp 1 sec per hour & Current transformer primaries through 327 kA to be supported
		3	Voltage Inputs: Nominal full scale input of the Multifunction Meter shall be 277 Volts AC L-N, 480 Volts AC L-L & meter to accept a metering over-range of 20%. Input impedance to be greater than 2Mohm (L-L) or 1Mohm (L-N)
		4	Multifunction Meter to comply with ANSI C12.16 and IEC-6205321, Class 1
		5	TMultifunction Meter to operate control power including 110/115VAC, +/-10% or 125-250VDC, +/-20%
		6	Multifunction Meter to communicate via Modbus RTU/IP protocol.
		7	Multifunction Meter to be rated for an operating temperature range of 0°C to +60°C
		8	Air circuit breaker moulded case, flush mounted, horizontal draw out isolation, air break type shall have short Circuit rated service Breaking Capacity (Ics) of: minimum 65 kA RMS at 415V AC for substation having 2500 kVA transformer.
<b>(7)</b>	<b>CIRCUIT BREAKER</b>	1	ACB should be rated for service voltage up to 690 or higher volt, 3 phases, 50/60HZ, AC supply with rated insulation voltage should be 1000 volt AC supply
		2	Rated impulse withstand voltage to be equal to 12 kV for main circuit and 8kV for auxiliary circuit
		3	Air circuit breaker to be designed for an ambient temperature of 45Deg C and be able to withstand to operating temperature of 50Deg C
		4	Breaker data should be available over communication as per technical specification.
		5	Incoming air circuit breakers (ACBs) to be of electrically operated draw-out type (EDO) and out going ACBs shall be manually draw out (MDO)
		6	MCCB to be preferably used for loads below 800 Amps
		7	MCCB to be current limiting type with trip time of less than 10 millisecc under short circuit conditions & should be either 3 or 4 poles as specified
		8	MCCB'S for sub station panels to have double break, positive isolation current limiting, load line reversibility and Horizontal cum vertical mounting features
		9	Automatic change over MCCB's to be of the motorised type, fully withdraw able, with both mechanical and electrical interlock

			& transfer operation to be controlled by an adjustable time delay of 0.1 to 30 sec
		10	MCB'S to be of 35mm D/N symmetrical rail mounted type
		11	RCCB'S to be manufactured to trip within 0.1 second for 30 mA & to be of 2-pole construction for single phase and 4-pole construction for 3 phases
		12	Electrodes interconnected by Cooper / GI (as per requirement) to form earthing mat so that the overall earth resistance is less than 1 ohm for each individual earthing mat
<b>(8)</b>	<b>EARTHING SYSTEM</b>	1	Earth loop resistance to any point in the electrical system not to be in excess of 0.5 ohms
		2	Resistance between earthing system and the general mass of earth not to be greater than 1 ohm
		3	G.I. pipe to be of medium class 100mm dia and 3m in length & electrode to be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other up to 2m of length from bottom & to be buried in the ground vertically with its top being 20cm minimum below ground level
		4	Plate electrode to be buried in ground with its faces vertical and top not less than 4.5m below Ground level & watering pipe of 50mm dia of medium class G.I pipe to be provided
		5	Protection pipe within ground to be buried at least 30 cm deep (to be increased to 60cm in case of road crossing and pavements)
		6	No earth pit to be fixed within 1.5 M of a wall of foundation
		7	Earth strips/grids to be of bare GI/ Copper strips of 25 mm x 3 mm as specified
		8	NAC speaker circuits to be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone
<b>(9)</b>	<b>LIFE SAFETY/ FIRE DETECTION, DIGITAL VOICE EVACUATION SYSTEM</b>	1	FACP hardware to be provided: 1. Power Limited base panel with Platinum / Red cabinet and door, 240 VAC input power. 2. 2,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
		2	Fire Alarm Control Panel is able to connect per loop 250 devices Detector or Module in any combination
		3	Eight channel digitally multiplexed audio for systems that require more than two channels of simultaneous audio on either a style 4 or style 7 twisted pair
		4	Fire alarm input to be 600-Ohm impedance
		5	Smoke Control System which is UL 864 (UUKL product category) listed to provide automatic operation of smoke exhaust fans, makeup air fans, air handling units, and dampers & located in the fire command center. Smoke control relays to be provided within 3 feet & provision of addressable modules to monitor status/operation
		6	Fire Fighters' Telephones to have a dynamic receiver and a carbon transmitter, operating on 24VDC
		7	Capacity to annunciate 12,000 network points and/or point lists
		8	Addressable Manual Pull Stations horn to provide 85dB at 10 feet and to be powered by a 9 VDC battery
		9	Addressable Photo Electric Smoke Sensors With Base Operating Voltage: 24 VDC, nominal
		10	Addressable Photo Thermal Smoke Sensors With Base Operating Voltage: 24 VDC, nominal, photo sensor sensitivity from 0.2% to 3.7% / ft obscuration and thermal fixed temperature range is 57.2° C / 68° C or rate-of-rise temperature range is 18.3° C / 11.1° C
		11	Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixedtemperature setting except as indicated
		12	Sensor fixed temperature sensing to be independent of rate-of-

			rise sensing and programmable to operate at 135-deg F or 155-deg
		13	Sensor to have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.
		14	Laser COMPACT air sampling smoke detection system for areas up to 8000 sq. ft & LaserPLUS air sampling smoke detection system for areas up to 20000 sq. ft
		15	Aspiration unit with pre-installed addressable sensor is designed to cover areas up to 1800 to 3600 square feet based on the number of sensors with sensitivity Range - 0.5% to 3.0% / foot obscuration
		16	3 phase 50Hz 33/4.33 KV Indoor type (dry type) transformer
(10)	<b>MAINS FAILURE STANDBY GENERATING SYSTEM FOR PRIME POWER APPLICATION (D.G. SETS)</b>	1	Generating set to have minimum 50% single step loading capacity and to be able to take full load in less than 25 seconds from the time of start
		2	Engine to be heavy-duty four strokes, turbo charged after cooler 'V' construction, electric start. Engine to have minimum lube oil change period of 300 hrs
		3	Total harmonics contents to be less than 3%
		4	Diesel Engine to be multi-cylinder, 4-stroke, air cooled with engine mounted heat exchanger (not motor driven), totally enclosed, continuous duty, direct fuel injection, turbo charged, compression ignition, inter cooled oil engine or with individual cylinder head with provision to measure exhaust temperature
		5	Day tank to be suitably located to avoid gravity feed to the engine, shaft driven fuel oil pumps and completed with gauges, glasses, filling, draining and vent connection with valves and level switch for auto filling of tank and for alarm in case oil level goes beyond specified limit
		6	Externally mounted hardware to be high tensile steel only & engine to be fitted with an exhaust gas driven turbo charger of air/ water cooled type complete with its own self-contained lubricating system
		7	Starting of the Diesel Engine to be done by electric starting system
		8	Lube oil system to be provided with full flow duplex lube oil cartridge filters & minimum lube oil change to be after 300 hrs of operation
		9	Engine emission exhaust system to be residential type & silencer ducting, bends, hood/canopy, thermally insulated aluminium clad exhaust piping etc.
		10	System should come in operation after sensing of Grid Failure and/ or the voltage drops below preset value for which NB-2 or equivalent "Engine Control & Automatic Mains Failure Stand by System" to be provided
		11	Alternator to be brushless synchronous and suitable for 3 phase 415V, 3 wire, 50 Hz, 0.8 p.f., 1500 RPM(Prime Duty)
		12	Rated output of alternators at specified site condition at 0.8 lagging power factor to be for 2000 KVA DG Set at 415V & each DG set to be suitable for sustaining a 10% overload for 1 hour in any 12 hour period
		13	Diesel generating set to be able to start motor of 30% capacity of D.G. set with a 20% base load
		14	Alternator to withstand an over speed of 20% for a period of 3 minutes
		15	Alternator to be capable to withstand 3-phase short circuit at its terminals for 3 seconds when operated at rated KVA and power factor at 5% over voltage with fixed excitation (3 times the line

			current for 10 Sec)
		16	Voltage regulation and steady state modulation to be within $\pm 1\%$ of the line voltage and with manual voltage adjustment capability within $\pm 5\%$ . from hot to cold at unity power factor and from 0.8 to 0.99 power factor with 4% speed regulation of the engine
		17	Synchronization facility to be available both for 'Auto & manual' mode
		18	Cable ladder to have a 150 mm high longitudinal side member for ladders width of 800 mm or above and 120 mm high longitudinal side member for ladder width less than 800 mm & rugs to be at least 50 mm wide, with slots of 25 mm x 10 mm at 25 mm intervals covering the length of the rugs & spaced 300 mm apart along straight lengths of the ladder
		19	Cable tray to be perforated type and construction with minimum 2.0 mm hot dipped galvanized mild steel for outdoor damp condition, and epoxy coated electro-galvanized mild steel for indoor installation
<b>(13)</b>	<b>RISING MAINS : 433 VOLTS, 3-PHASE, 4WIRE</b>	1	Rising mains to be insulated to Class B i.e. 85 deg C temperature rise above ambient temperature of 40 deg C but maximum operation temperature not to exceed 95 deg C
		2	Rising mains and the associated fittings to be minimum IP54 rating within Electrical room and Electrical riser & at car park, outdoor or plant room areas to be weatherproof type to IP 65 in accordance to IEC 529
		3	Manufacturers recommended hanger/support to be provided for every run of rising mains
		4	Rising mains to have rated insulation voltage and rated operating voltage of 1000V respectively
		5	Current density of bus bars to be considered as 0.8 Amps/ Sq.mm for Aluminium conductor and 1.4 Amps/ sq.mm for Copper Conductor
		6	Rising mains to be provided with wall straps for fixing the duct along wall at 1 metre interval regularly
		7	Fire barrier to be provided at every floor and to be able to withstand fire hazard for 2 hours
		8	Poles to be manufactured from electric resistance welded tubes as per IS: 2713-1980 , buried 1/6th of the pole size underground in cement concrete foundation
<b>(14)</b>	<b>EXTERNAL LIGHTING</b>	1	Earthing stud with copper lugs for connecting 8SWG GI wires for earthing to be provided on the pole
		2	GI pole to be supplied in 3M length
		3	Octagonal Poles to be designed to withstand maximum wind speed as per IS 875
		4	Welding of pole shaft to be done by Submerged Arc Welding (SAW) process & Octagonal Poles to be in single section (upto 11 mtr)
		5	Lux level for lighting: Public Parking 40-50 Internal Roads (10mtrs) 18-20 Main Approach Roads (12mtrs) 20-25 Piazza Lights 38-40 Security lights 20
		6	Normal operating temperature for bus bars to be 90 Deg C. Short circuit rating of the bus bars to be 1500 MVA at 33KV.
<b>(15)</b>	<b>HT PANEL BOARDS</b>	1	Spring/Lock washers to be provided to ensure good contact on the joints
		2	Circuit breakers to be vacuum type horizontal draw out pattern
		3	Protection CTs to be of accuracy class 5 P 10 of IS 2705 – Part – III -1992
		4	Metering CTs to conform to the metering ratio and accuracy class 0.5 of IS 2705 – 1992
		5	PT'S shall be capable of operating continuously at 110% of the rated voltage
		6	Voltage transformer of burden not less than 100 VA and of the

			proper ratio and of proper ratio as specified to be provided at the incoming panel
		7	Accuracy class for the VT shall be class 0.5 as per IS 3156 Part-I to III for incomer and class 1 for outgoing panels
		8	Over current Relays to have adjustable setting for current from 50% to 200% and earth fault from 10% to 40% or 20% to 80%
		9	Voltmeter of class 1.5 accuracy as per IS-1248 at each incomer panel, with selector switch
		10	Energy meter of class 1.0 conforming to IS 722 (Part IX) and power factor meter of class of accuracy of 2 to be provided
		11	Ammeter of specified ranges of class 1.0 accuracy as per IS - 1248 to be provided at both incomer and outgoing panels along with necessary selector switch
		12	Small wiring for control, protection, alarm and indicating circuits on all equipment to be carried out with minimum 1.5 Sqmm FRLS / HFFR insulated copper conductor cables
		13	CT wiring to be done with minimum 2.5 Sqmm wires
		14	Space heater/s to be trip type, rated with operation voltage of 240V, 50 Hz. AC supply completed with a 2P, MCB, 10KA and a control thermostat at a rated temperature 10°C
		15	Contactors to be vacuum break type, equipped with three main contacts and minimum 2NO + 2NC auxiliary contacts
		16	Auxiliary contacts to be rated for minimum 5 Amps at 240V AC and 1.3 Amps at 110V DC (Inductive load)
		17	Complete Panel to be tested with 5000 Volts megger for insulation between Poles and Poles to earth. Insulation test of secondary of CTs and VT to earth to be conducted using 5000V megger

**ELECTRICAL WORKS LIST OF RECOMMENDED MAKES**

S. No	Details of Equipment/ Material	Makes

<b>A) Internal Electrical Works</b>		
1)	PVC Conduit & Accessories	Astral/Anchor/Sudhakar
2)	Switch Socket Accessories	Hager (insysta) /Legrand (Myrius)/ Schneider (OPAL)/ Anchor (Vision)/Havells (Verona)
3)	Copper conductor PVC insulated wires (FRLS)	Havells/KEI/Polycab/Bonton/Anchor
4)	Automatic Transfer Switch	Socomec/L&T/Siemens
5)	MCB/RCBO/RCCB/DB	Legrand/ /L&T/Hager/
6)	Light Fixtures	Bajaj/ Philips/ Havells/Panasonic/Crompton Greeves/Lighting Technologies
7)	Ceiling/Exhaust Fans	Crompton Greaves/Panasonic/Bajaj
<b>B) External Electrical Works</b>		
8)	HT Panel Boards (OEM Only)	Siemens/ Schneider/ABB
9)	Transformers (Distribution)	Transformer & Rectifier/Voltamp/Kirloskar/Crompton Greaves
10)	Relays	L&T/ Schneider/Siemens
11)	HT XLPE 33 KV Cable	Polycab/ Havells/ KEI
12)	HT Cable Termination/ Jointing Kit	Raychem/Birla 3M/Densons/M-seal
13)	L.T. Panel Boards/Sub-Panel/ Feeder Pillar/ Meter Boards	L&T/Schneider/Hager/
14)	ACB	Schneider (MVS)/ L&T (U Power)/Legrand//Siemens
15)	MCCB	Schneider (CVS)/ L&T (D-Sine)/Legrand/Indo Asian/Hager/Mitsubishi
16)	Capacitor	L&T/Epcos/Schneider
17)	Terminal Blocks	BCH/Industrial Control/ L-Mak/ Jainson
18)	Change Over Switch	L&T/Socomec
19)	Bus Duct/Rising main (Sandwich)	L&T (Henikwon)/ Schneider/Legrand
20)	Bus bar	Jindal/Indalco/Century
21)	PLC	Allen Bradley /Siemens/ Schneider
22)	Copper Bonded Earthing Pits	Remedies/Cape
23)	Conventional Earthing	Earthplus/Remedies
24)	Timers & Contactors	L&T/Siemens/ Schneider

25)	MV Contactors/Timer/ Starters	L&T/Siemens/ Schneider
26)	Protective Relays	ABB/L&T/ Schneider
27)	kWh Meters (Electronic Digital type)/ Multifunction Meter/Ammeter/Voltmeter /Load Manager	L&T /Secure/Elmeasure
28)	LT Cables(FRLS ,XLPE INSULATED ,AL,AR)	KEI/Polycab/ Havells
29)	Indication Lamps/Push Button	L&T/GE
30)	Cable Trays	OBO/Legrand/Yelavarthi
31)	Polycarbonate Junction Boxes	Scame/Cape
32)	Energy Management System	Schneider/ L&T
33)	Control Cable	Polycab/Havells/KEI
34)	Selector Switch	Rishab /L&T/C&S
35)	CT/PT	C&S/Kappa/Kalpa
36)	Lightning Protection System	Cape/Remedies/Dehn
37)	Surge Arrestor	Cape/Remedies
38)	Annunciation Panel	Crompton/ Schneider/ Kirloskar/ ABB/ Siemens
39)	APFCR	L&T/ Schneider/EPCOS/P2 Power
40)	DG Set	Engine: Cummins/Kirloska/Caterpillar Alternator: Stamford/Kirloskar/Crompton Greaves