

TENDER DOCUMENT
FOR
11KV HT PANELS AND 415 LT PANELS

SL.NO.	CONTENTS	PAGE NO.
1)	SPECIAL & COMMERCIAL CONDITIONS OF CONTRACT	2
2)	TECHNICAL SPECIFICATION	12
3)	LIST OF APPROVED MAKES	Add file
4)	BOQ- HT Panel (RMU), LT Panel and Cable work	Add file
5)	Singal Line Diagram (SLD)	Add file

SPECIAL AND COMMERCIAL CONDITIONS FOR TEDER.**NAME OF PROJECT : UCO BANK BUILDING. 5 SANSAD
MARG NEW DELHI-110001**

CONSULTANT: - RAVI BHUSHAN AGARWAL, Noida

1. SCOPE OF WORK :-

The scope of external electrification work in this contract is include the design, engineering, manufacture, assembly, testing, delivery, erection and commissioning of electrical system. It means SITC. The scope also covers the detailed engineering and calculations of the various equipment's / system mentioned hereunder and the same shall be approved by the Owner prior to execution of the job

- Main L T Panels, meter board and external cable connection.
- HT / LT / control cables and terminations.
- Capacitor and capacitor control panels
- Battery and battery charger.
- Sub and branch distribution boards, circuit breakers etc.
- Mains and Sub mains between various panels, meter boards and distribution boards.
- Under ground and above ground LT / HT Cables and other allied works.
- Safety to personnel and equipment during both operation and maintenance.

All the above work shall be complete in all respects up to the satisfaction of architect, consultant, Client and Engineer in charge as per the details mentioned in Bill Of Quantities and drawings supplied time to time.

All the bidder has to include the cost of below items in tender cost, unless otherwise it is specified in the tender.

- a) Providing all labour, (skilled and unskilled), supervisory and administrative personnel if required, erection tools and tackles, testing equipment, implements, supplies, all type of consumables for removing the old equipment's and hardware for timely and efficient execution of the erection work.
- b) Transport Material to site, unloading at site, shifting to location and completing Installation and commissioning.
- c) Complete erection and connection, testing and commissioning, putting into successful and satisfactory commercial operations of above equipment.

All work to be performed and supplied shall be as a part of contract require specific approval/review of Owner or his authorized representative. Major activities requiring approval/review shall include but not to be limited to the following:

2. BIDDERS SHALL BE RESPONSIBAL FOR: -

Contactor / Bidder has to take approvals of following items prior to start of work

- RMU All drawings and operational & Maintenance Manual.
- GA, SLD and Schematic Drawing for Electrical Panels.
- HT and LT Cabling layouts, Cabling terminations and Jointing specifications.
- Earthing Types and layouts, including equipment installation.
- Time Schedule for all Items Supplies, Installation and commissioning.
- Pre-Commissioning testing, Govt Approvals for Energization of Electrical system final commissioning etc.
- Preparation of "As Built Drawings".
- Any other work/activity which is not listed above, however is necessary for completeness of electrical system.

3. COMPLETENESS OF TENDER: -

This tender document, comprising of Notice Inviting Tender, General Conditions of Contract, Special Conditions of Contract, Technical Specifications, Schedule of Quantities and Tender Drawings, shall form part of the contract Agreement after award of contract. Work under this contract shall be executed at contract rates as per conditions and specifications stipulated in this tender document excepting in respect of deviations specifically agreed to before the award of the contract and incorporated in the contract Agreement. In addition, components/materials, which may not be specifically stipulated in the tender document, but which are necessary for satisfactory installation and/or operation of any portion of the work, shall also be provided within the contract rates without any extra cost. Contractor shall carry out and complete the work in all respects to the satisfaction of Owners as per the contract Agreement and as directed by Owners/Architects and as required.

All sundry fittings, assemblies, accessories, hardware items, foundation bolts, termination lugs for electrical connections as required, and all other sundry items which are useful and necessary for proper assembly and efficient working of the various components of the work shall be deemed to have been included in the tender, whether such items are specifically mentioned in the tender documents or not.

CIVIL WORK for foundation of equipment's is included in the Bill of quantities. These civil works may be performed by other agency but prime responsibility will be of main electrical contractor.

4. RATES :-

- a) The rates tendered shall be for complete items of work inclusive of Cost of material, erection, connection, testing, labour, supervision, tool & plants, storage, contingencies, breakage, wastage, execution at any level & height , all taxes (including works contract tax, if any), GST and all charges for items contingent to the work, such as, packing, forwarding, insurance, freight and delivery at site for the materials to be supplied by the contractor.
- b) The price quoted for erection & commissioning shall include cost of all consumables, taxes & duties. (if any). No additional taxes/duties shall be payable by Owner.
- c) Contractor shall furnish prices separately for spare parts for two (2) year's trouble-free operation of the equipment post warranty period and shall furnish the list of the same. Contractor will Provide offer for Maintenance for next 04 years post warranty period.
- d) The work contract tax will be deducted from the bills of contractor as applicable in the state in which the work is carried out, at the time of payment, at prevalent rate.

5. ELECTRIC POWER SUPPLY AND WATER SUPPLY: -

Unless and otherwise specified, power supply and water supply as may be required shall be arranged by the contractor for installation and testing of the entire work at the site of work.

6. PROVISIONS AGAINST ACCIDENTS AND SAFETY MEASURES

- a) All safety rules and codes as applicable to work including rules applicable as per factory inspector shall be followed during execution of above work.
- b) All safety appliances and protective devices including hand gloves, aprons, helmets, shields, goggles, belts etc. shall be provided by Contractor for his personnel.
- c) The Contractor shall arrange to provide guards and prominent display caution notices if access to any equipment / area is considered unsafe and hazardous.

7. SPECIFICATIONS

In the absence of specifications for any work or materials, relevant Indian Standard Specifications shall be applicable. If such codes for a particular subject have not been framed, the decision of the Owner / Consultant will be final and binding and no extra will be paid to the contractor.

8. VARIATION IN QUANTITY

- a) The Owner shall have right to delete or increase / decrease quantity specified in this specification as specified in preamble to Bill Of Materials.
- b) Quantities indicated in Bill of Materials are based on engineering status of the project as on date. It is necessary that proper engineering is carried out by the contractor before procurement of material.
- c) For procurement of any material & sequential delivery at site from point of view of erection etc. Contractor shall take prior approval from the employer.
- d) All left over material for which payment has been made by the employer, has to be taken back by the contractor. Necessary deduction shall be made from the bills of contractor by the employer.

9. SITE VISIT

It is recommended that contractor shall visit site before submission of his offer. Time and date shall be fixed with Owner/Consultant.

10. TOOLS FOR HANDLING AND ERECTION :-

All tools and tackles required for handling of equipment and materials at site of work as well as for their assembly and erection and also necessary test instruments shall be the responsibility of the contractor.

11. CARE OF BUILDINGS :-

Care shall be taken by the contractor to avoid damage to the building during execution of his part of the work. He shall be responsible for repairing all damages and restoring the same to their original finish at his cost. He shall also remove at his cost all unwanted and waste materials arising out of his work from the site, from time to time as designed by the Engineer-in-charge.

12. STRUCTURAL ALTERATIONS TO BUILDINGS :-

- i. No structural member in the building shall be damaged/altered, without prior approval from the competent authority through the Engineer-in-charge.
- ii. Structural provisions like openings, cutouts if any, provided by the client for the work, shall be used. Where these require modifications, or where fresh provisions are required to be made, such contingent works shall be carried out by the contractor at his cost after written approval from the engg-in-charge.
- iii. All such openings in floors provided by the client shall be closed by the contractor after installing the cables/conduits/rising mains etc. as the case may be, by any suitable means as approved by the Engineer-in-charge without any extra payment.
- iv. All chase required in connection with the electrical works shall be provided and filled by the contractor at his own cost to the original architectural finish of the buildings.

13. STATUTORY REGULATION AND APPROVALS :-

All electrical works shall be carried out only by those Contractors who are licensed by the concerned local authorities to execute this type of work. Only "A" Class government approved electrical contractor shall execute the job.

The contractor shall obtain all sanctions, approval / Intimation of modification in drawing / Electrical Substation from the concerned authorities / electrical safety and permits required for the electrical installation work. All actual fee payable in this regard will be reimbursed against receipt/documentary evidence. On completion of work, the contractor shall obtain NOC from Electricity Authorities & Chief Electrical Inspector, a copy of the same shall be delivered to the Owner through consultant.

The Owner/ Consultant shall have full power regarding the materials or work got tested by independent agency at the electrical contractor's expenses in order to prove their soundness and adequacy. The contractor will rectify the defects/suggestions pointed out by independent agency through Owner / consultant at his own expenses.

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

14. STANDARDS AND CODE OF PRACTICE :-

The work shall be carried out as per the enclosed Specifications of work and the construction drawings to be issued from time to time. These specifications shall be read in conjunction with National Building Code, National Electrical Code, Relevant Codes of Practices and Standards as issued by ISI and Indian Electricity Rules, Indian electricity act, factory act, CPWD specifications for electrical works (all with the latest amendments). The installation shall confirm in all respects to Indian Standard code of Practices. Following BIS codes shall be referred -

- a) National Electrical Code
- b) IS : 732 -1989 : Electrical wiring installation
- c) IS : 1225 -1938 : Installation and Maintenance of power Cables up to and including 33 KV Rating
- d) IS : 1554 (Part-1) : PVC insulated heavy duty electrical cables.
- e) IS : 1860 : Installation operation and maintenance of passenger and goods elevator.
- f) IS : 2309 -1989 : Protection of building and allied structures against lightning.
- g) IS : 2705 : CT for metering and protection
- h) IS : 2834 : Capacitors
- i) IS : 2959 : Contactors
- j) IS : 3043 -1987: Earthing
- k) IS : 3231 : Electrical relays for power system protection

- l) IS: 3961 (Part-2) -1967: Current rating for cable
- m) IS: 3961 (Part-5) -1968: Current rating for cable

- n) IS: 5082 / IEC-255 : Electrolytic copper and aluminum bus bars
- o) IS: 5216 (Part-1) -1982: Recommendations on safety procedures and practices in electrical work.
- p) IS: 6121 : Cable glands
- q) IS: 7098 (1 & 2) : XLPE insulated cables
- r) IS: 7752 : Improvement of power factor
- s) IS: 9537 : Conduits for electrical wiring
- t) IS: 10118 (Part-1) -1982: Selection, Installation and Maintenance of switchgear and Control gear
- aa) IS: 10810 : Test procedures for cables
- cc) IS: 13947 / IEC 947: ACB / MCCB

15. MATERIAL SAMPLES :-

It shall also be the responsibility of the Contractor to submit without any extra charge the samples / make of the materials/equipment as and when asked by the Consultant. If the Contractor wishes to use an alternative make due to non-availability of the approved one, he should take the prior approval of the Consultant/Owner. Under such situations the Contractor shall show such promptness as not to hamper the progress of the work.

16. ELECTRICAL DRAWINGS :-

- i) The electrical drawings issued from time to time to the contractor are diagrammatic but shall be following as closely as actual construction and work will permit. Any deviation from the drawings required to conform to the building construction shall be made by the Contractor at his own expenses. The architectural drawings shall take precedence over the electrical drawings as far as the civil and other trades works are concerned.
- ii) If there is any discrepancy due to in-complete description, ambiguity or omission in the drawings and other documents relating to this Contract found by the Contractor either before starting the work or during execution or after completion, the same shall be immediately brought to the attention of the Consultant / Owner and his decision would be final and binding on the Contractor.
- iii) **Shop Drawings**

The contractor shall prepare detailed coordinated electrical shop drawing and cable Schedule with other relevant services and submit to the Consultant for approval or the Engineer-in-Charge before commencing the work. The shop drawings shall indicate all setting out details, physical dimensions, layouts and positions of various services, such as:

- Distribution Boards / panels
- Earthing details with location of pits and conductor run
- HT Panel (RMU)
- LT Panel Boards
- Capacitor panels

- Schematic diagram for power distribution
- Cable layouts
- Cable trays

All drawings are to be approved before commencement of work. However, approval of these drawings do not relieve the contractor of his responsibility for providing maintenance-free and fool proof system in all respect. Contractor will submit 2 prints for preliminary approval and finally three prints of as built drawing.

17. INSPECTION, TESTING AND INSPECTION CERTIFICATE :-

- The Purchaser and the Consultant or duly authorized representative shall have at all reasonable times free access to the 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 Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.
- The Contractor shall give the Consultant/Owner a written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The Consultant/Owner unless witnessing of the tests is virtually waived will attend such tests within thirty 7 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.
- It is completely owner/Consultant choice whether to inspect or issue a waiver for the test. If the tests are not witnessed by the Consultant/Owner, Contractor shall perform the test with their own and issue the certificate immediately after testing to Consultant/Owner. Confirmation to proceed for next step will be issued by Consultant / Owner to Contractor after checking certificate. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment. Final acceptance will be only after the equipment is installed and commissioned at site. A MOM or with mutual agreement will be signed by both Owner/Consultant and Contractor before dispatch.

18. TESTS

Charging (Pre-commissioning tests)

- Pre-commissioning test shall be carried out as per relevant I.E.C. and/or as specified in the relevant clause. On completion of installation and completing connections between the equipment's 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.

Commissioning Tests

- The Contractor will check all connection properly. The commissioning test is to be conducted step by step. All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

- The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning and approval for Energization of the equipment. However necessary fee shall be reimbursed by Owner on production of requisite documents.

19. PACKAGING AND PROTECTION

All the equipment's 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 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 etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of any special packaging/transporting arrangement.

20. GUARANTEE / DEFECT LIABILITY PERIOD

The installation will be handed over to the Client after necessary testing and commissioning. The installation will be guaranteed against any defective design/workmanship. Similarly, the materials supplied by the contractor will be guaranteed against any manufacturing defect, inferior quality. The guarantee period will be for a period of 12 months from the date of actual completion or complete and satisfactory handing over to the client whichever is later. Installation/ equipment's or components thereof shall be rectified/ repaired to the satisfaction of the Engineer-in-charge free of charge.

21. HANDLING, STORING AND INSTALLATION

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

22. COMPLETION DRAWINGS / AS BUILT DRAWINGS

On completion of the work and before issue of certificate of virtual completion, the contractor shall submit to the consultant 3 sets along with soft copy of 'As Built' drawings of the work along with originals including write up (trouble shooting, operation and maintenance manual with instructions) incorporating all such changes and modifications during engineering and execution.

These drawings must provide:

- A complete layout of all Equipment's Installed including already available but connected to new installation.
- A complete wiring diagram as installed, GA Drawing and schematic drawings showing all connections in the complete electrical system including new and old.

- Location of all earthing stations, route and size of all earthing conductors etc.
- Layout and particulars of all cables.
- Location and details of PCC's, Capacitor control panels etc with description detailed control wiring diagram.
- Location of HT panel / accessories
- Layout of cable trays with support and their fixing details if installed.

SCHEDULE OF FISCAL ASPECTS

Commencement of work	The work shall commence within 7 days of issuance of LOI (Letter of Intent)
Period of Completion	2 months after Issue of LOI.
Earnest Money	Rs. 1% Of Tender Value
Initial Security Deposit	2% of Tender Value will be deposited after award of Tender. This Included 1% of the of Earnest Mony. This 2% amount will be returned One Month after completion of work.
Payment Terms	<p>10% (after reducing cable value) of contract value payable after completion of following work: - 1- Removal of OLD Equipment, 2-Making floor Area clear and making all base structure ready for Equipment Installation.</p> <p>60% (after reducing cable values) of Contract Value after All equipment received and installed at site.</p> <p>30% of contract value on testing, commissioning and train run and upon submitting as installed drawings and completion documents.</p>
Retention Money	5 % of the value of work done in each interim bill up to a maximum of 10 % of total contract value. This will be treated as performance guarantee. Will be returned after completion of warranty period of One Year.
Defects Liability Period	12 Months from the date of handing over. Where extended Guarantee periods are stipulated in the Contract Documents for particular parts of the Works, the Contractor shall furnish appropriate guarantees in approved formats for same before issuance of the Final Completion Certificate.
Interim Bills	Bills will be submitted as per the payment schedule. The bills in quadruplicate shall be submitted along with all supporting documents. The date of receipt of the bills shall be the date when all supporting documents of the bill are submitted.
Taxes and Duties	Contractor should include in his rates all taxes, duties,

Contribution to the Central, State Local Authority	The contractor shall alone be responsible for the payment of contribution etc. under any Central, State, Local Legislation applicable to the persons engaged as aforesaid i.e. Contribution towards ESI Provident Fund etc. If any time any liability or obligation (Financial or otherwise) is imposed upon client under the provision of any legislation or any enactment and /or schemes rules, regulation, bye-laws framed there under such amount shall be recovered from The contractors dues.
Working at all Heights	Rates of contractor shall be taken as inclusive of work at all heights above or below ground level.
Price Escalation	The rates quoted by the contractor shall hold good for the entire period of contract or the extended period, if any. No additional claim an account of increase in prices, fluctuation of market rates, increase in duties, taxes, levies, fees etc. shall be allowed.
Licenses and Permits	The contract at his own expenses shall procure all licenses and permits required in connection with the work.
Interest	No interest what so ever shall be payable on any money due to the contractor like earnest money, security, performance guarantee and interim / final bill etc.

TECHNICAL SPECIFICATIONS: -
SYSTEM DESCRIPTION

1.0 GENERAL INFORMATION

- 1.1** Ambient air temperature shall be taken as 50 deg. C for the purpose of designing of electrical equipment.
- 1.2** This specification shall be read and constructed in conjunction with the drawings and annexure to determine the scope of work.
- 1.3** All equipment shall be capable of continuous operation satisfactorily under the following conditions:
- | | | | |
|----|--|---|------------|
| a) | voltage variation | : | $\pm 10\%$ |
| b) | frequency variation | : | $\pm 5\%$ |
| c) | combined voltage & frequency variation | : | $\pm 10\%$ |
- 1.4** Nominal system supply available shall be as follows:
- | | | | |
|----|--------------|---|---|
| a) | Incoming | : | 11 kV, 3 Ph., 50 Hz, with fault level of 1500 MVA |
| b) | Distribution | : | 415V, 3 Ph., 4 wire, 50 Hz with fault level of 50 kA. |

2.0 CODES AND STANDARDS

- 2.1** All equipment and materials specified herein or not, shall be designed, manufactured and tested with the latest applicable standards & bureau of Indian standards.
- 2.2** All electrical equipment shall also conform to the latest electricity rules as regards safety and other essential provisions.
- 2.3** All electrical installation work shall comply with the requirements of the following Act / rules / codes as amended up to date:
- | | |
|----|---|
| a) | Indian electricity act. |
| b) | Indian electricity rules. |
| c) | National electric code published by BIS. |
| d) | All relevant Is codes of practice. |
| e) | Regulations published by tariff advisory committee. |

GENERAL & TECHNICAL
SWITCHGEAR AND CONTROLGEAR

1. GENERAL ASPECTS :-

- i. All items of switchgear and distribution boards (DB' s) shall be metal clad type.
- ii. The types, rating and/or categories of switch gear and protective gear shall be as specified in the tender schedule of work.
- iii. RCCB's and RCBO's where specified, shall conform to the requirements of current rating, fault rating, single phase or three phase configuration and sensitivity laid down in the tender documents. All lighting DB's are required to have RCCB or RCBO's as applicable.
- iv. While each outgoing way of distribution board (D.B.) shall be of miniature circuit breaker (MCB) as specified, and of suitable rating on the phase conductor, the corresponding earthed neutral conductor shall be connected to a common neutral terminal block and shall be capable of being disconnected individually for testing purpose.
- v. **Independent earth terminal block.**

Every distribution board (single phase as well as three phase) shall have an earth terminal block identical to, but independent from neutral terminal block, to enable termination of protective (loop earthing) conductors (incoming as well as out goings) individually by screwed connection and without twisting.
- vi. Earthing terminal (1 for single phase and 2 for three phase) shall be provided on the metal cladding of switches and D.B.' s for body earthing. These shall be suitably marked.
- vii. Knock out holes, with or without end plates as per standard design of manufacturers, shall be provided in the metal cladding of switches and D.B.' s for termination of conduits/cables.
- viii. Each distribution board shall be provided with a circuit list giving details of each circuit which it controls and the current rating of the circuit, and the size of the fuse element.

2. MCB TYPE DISTRIBUTION BOARDS (MCB DB) :-

- i. MCB DB' s may be of single phase, three phase (horizontal type) suitable for feeding single phase loads or 3 phase (vertical type) suitable for feeding single phase as well as three phase loads, each phase isolation type three phase DB in which each phase can be isolated by a separate circuit breaker or RCCB, as specified. These shall be complete with accessories, but without MCB' s, which shall be specified as a separate item in the tender documents.
- ii. The current ratings and the number of ways shall be as specified. Blanking plates shall be provided to close unused ways. These shall be indicated as a separate item in the Schedule of work.

- iii. MCB DB's shall be of surface/flush mounting pattern according to the requirement of their location, and shall be suitable to accommodate MCB's and MCB type isolators and RCCB (ELCB) at incoming in single pole or multi pole configuration, as required.
- iv. MCB DB's shall be double door type, dust and vermin proof conforming to IP 43 or as per BOQ, and shall be fabricated out of CRCA sheet steel, minimum 1.2 mm thick, with stove enameled paint finish.
- v. In case of Concealed / Recessed D.B.'s, the DB should have metallic collar for zero error installation, however, cutting of brick work, providing suitable lintel, making good the wall including plastering etc. with necessary civil work including all Civil material shall be included in contractor's scope for proper completion of work.
- vi. MCB DB's shall have removal type end plates with knock-outs at the bottom and top, and shall have hinged covers with locking arrangement.
- vii. Only the knobs of the MCB's shall protrude out of the front covers through openings neatly machine made for the purpose.
- viii. The bus bars used shall be solid electrolytic copper of appropriate sections.
- ix. Din bar(s) shall be provided for mounting the MCB's.
- x. The complete board shall be factory fabricated and shall be duly pre-wired in the works, ready for installation at site.
- xi. The board shall be fully pre wired with single core PVC insulated copper conductors/insulated solid copper links, and terminated on to extended type terminal connectors, suitable for connections to the sizes of the respective conductors.
- xii. All incoming and outgoing wiring to the pre wired MCBDB's shall be terminated only in the extended terminal connectors to be provided within the DB. The terminal connectors shall therefore be so provided as to facilitate easy cable connections and subsequent maintenance.

3. MCCB TYPE DISTRIBUTION BOARDS (MCCB DB) :-

- i. All MCCB DB's shall be of three phase suitable for feeding single phase loads or 3 phase loads through SP/TP MCB's, IP 43 enclosure, sheet steel, double door with tinned copper bus bar, neutral bar, earth bar, knock outs etc. The DB's shall be original factory fabricated of approved make.
- ii. The current ratings of Incomer MCCB shall be up to 250 amp and the number of ways shall be as specified. Blanking plates shall be provided to close unused ways.
- iii. MCCB DB shall be of surface/flush mounting pattern according to the requirement of their location, and shall be suitable to accommodate Four pole MCCB at incomer and SP/TP MCB's at outgoings, as required.
- v. MCCB DB's shall be dust and vermin proof conforming to IP 43, and shall be fabricated out of CRCA sheet steel, minimum 1.4 mm thick, with stove enameled paint finish.

- v. In case of Concealed / Recessed D.B.'s, the DB should have metallic collar for zero error installation, however, cutting of brick work, providing suitable lintel, making good the wall including plastering etc. with necessary civil work including all Civil material shall be included in contractor's scope for proper completion of work.
- vi. MCCB DB's shall have removal type end plates with knock-outs at the bottom and top, and shall have hinged covers with locking arrangement.
- viii. The bus bars used shall be solid electrolytic copper of appropriate sections.
- ix. Din bar(s) shall be provided for mounting the MCB's.

4. WORKMANSHIP :-

- i. Good workmanship is an essential requirement to be complied with. The entire work of manufacture/fabrication, assembly and installation shall conform to sound engineering practice.
- ii. The work shall be carried out under the direct supervision of a first class licensed foreman, or of a person holding a certificate of competency issued by the state Government for the type of work involved, employed by the contractor, who shall rectify then and there the defects pointed out by the Engineer-in-charge during the progress of work.

5. COMPLETION PLAN AND COMPLETION CERTIFICATE :-

- i. For all works completion certificate after completion of work shall be submitted to the Engineer-in-charge.
- ii. Completion plan drawn to a suitable scale in tracing cloth with ink indicating the following, along with three blue print copies of the same shall also be submitted.
 - a) General layout of the building.
 - b) Locations of main switch board and distribution boards, indicating the circuit numbers controlled by them.
 - c) Position of all points and their controls.
 - d) Types of fittings, viz. fluorescent, pendants, brackets, bulkhead, fans and exhaust fans etc.
 - e) Name of work, job number, accepted tender reference, actual date of completion, names of Division/Sub-Division and name of the firm who executed the work with their signature.

CIRCUIT BREAKERS**A. MINIATURE CIRCUIT BREAKERS (MCB): -**

Miniature Circuit Breakers (MCBs) are to be used in final power distribution and branch circuits, as well as control circuits for effective protection against overload and short-circuit protection. These shall conform to latest Indian and / or International Standards,

The breaking capacity shall not be less than 10kA at 415V AC. MCBs shall be C-curve type and DIN mounted. The offered MCBs should be 'ISI' marked. 'ISI' marking on the MCB should be clearly displayed (printed) on the MCB.

B. Earth Leakage Circuit Breaker / Residual Current Circuit Breaker - Current Operated Type (ELCB / RCCB / RCBO)

Residual Current Circuit Breakers shall conform to IEC 61008 & IS12640.

ISI marking is compulsory on RCCB.

The RCCBs shall have sensitivities of 30 mA, 100mA, 300 mA as per the requirement / as per BOQ. For People Protection the sensitivity must not be more than 30mA.

A 100/300mA RCCB is recommended for Protection against fire

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

The RCCBs shall have trip indication facility on the front face.

C. MOULDED CASE CIRCUIT BREAKER (MCCB's)

The rated normal current should be specified at 40°C

The present specification applies to moulded-case circuit breakers (MCCB) from 16A to 800 Amp for AC (50/60Hz) low voltage electrical installation from 220V to 415V.

MCCB shall be equipped with a trip Unit that offers the appropriate level of performance to fit to the application. MCCB shall have a rated operational voltage of 415 V and insulation voltage of 600 V (AC50/60 Hz).

The MCCBs shall have a rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) at defined operational voltage.

The moulded case circuit breaker shall have a breaking capacity as mentioned against each in Schedule of Quantity at 415 volts. Wherever required, higher breaking capacity breakers to meet the system short circuit fault shall be used. In absence of any capacity specifically mentioned in the bill of quantities and drawings, following breaking capacities shall be used –

100 / 125 Amp : 25 KA

160/200/250/300 Amp : 25 / 35 KA

400/630/800 Amp : 35 / 50 KA

General

Thermo-magnetic trip unit should have:

- Adjustable thermal protection from 75 – 100% times the current rating
- Protection setting shall apply to all circuit breakers pole thru single knob from the front of MCCB without opening the front cover of the MCCB.
- Fixed magnetic protection for current ratings up to 250 A.

Electronic trip units should have:

- Adjustable over load protection from 50 -100% times the current rating
- Variable short circuit protection from 2 to 10 Ir.
- Protection setting shall apply to all circuit breakers pole thru single knob from the front of MCCB without opening the front cover of the MCCB
- In case of 4 pole MCCB neutral should be adjustable as a Neutral unprotected or Neutral Protection.

Earth protection

Earth Fault protection, Where ever specified, MCCB should have Earth fault protection as provision. MCCB earth fault protection should have following settings.

- Selection of Ir MCCB rating.
- Earth fault sensitivity selection from 10 – 60% In
- Time delay selection in case of Earth Fault with instantaneous feature.

D. AIR CIRCUIT BREAKER**General:**

- Circuit breakers shall be of 3pole or 4pole, air break, moulded case, horizontal draw-out type fully interlocked shall be capable of carrying the full load current defined for 50° C without any derating.
- Air circuit breakers (ACB) shall comply with standards IS/IEC 60947-1 & 2. The breakers shall be tested & certified at CPRI/ERDA.

Interlocks:

- It shall not be possible to with-draw the breaker from the cubicle in "ON" condition. To achieve this, suitable mechanism shall be provided to trip the breaker before the Breaker is isolated.
- It shall not be possible to switch "ON" the breaker until it is either in the fully inserted position or for testing purposes it is in the fully isolated position.
- It shall not be possible for the Circuit Breaker to be plugged in unless it is in the OFF position.
- A safety catch shall be provided to ensure that the movement of the breaker, as it is withdrawn, is checked before it is completely out of the cubicle, thus preventing its accidental fall due to its weight.
- A door interlock shall be provided so that it shall not be possible to open the door until the air circuit breaker moving part is in the disconnected position.
- A mis-match interlocking shall be provided to prevent insertion of a draw-out type circuit breaker

having a rating higher than the current rating of the fixed part.

- The racking handle shall be stored on the air circuit breaker in such a manner as to be accessible without defeating the door interlocking.
- Provision should exist for fixing key lock to have secured interlocking with the other circuit breakers.
- The breaker shall be locked in disconnected position using key lock or padlock to avoid accidental charging of the breaker during maintenance phase.

Terminations:

- All 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 to ensure sufficient & safer clearances between phases.
- Provision shall exist to change the orientation of rear terminations from horizontal to vertical connection or vice-versa at installation to enable ease of bus bar/cable terminations.

Protections:

- The Circuit breaker protection shall be through micro processor based trip units.
- The micro processor release should be self powered type without any auxiliary power supply during normal operation of the breaker.

EARTHING**1. SCOPE :-**

This chapter covers the essential requirements of earthing system components and their installation. For details not covered in these specifications. IS code of Practice on Earthing (IS:3043-1987) shall be referred to.

2. INSTALLATION :-**1. ELECTRODES :-**

- i. Plate electrode shall be buried in ground with its faces vertical, and its top not less than 3 m below the ground level. The installation shall be carried out as per standard drawing.
- ii. When more than one electrode is to be installed, a separation of not less than 2 m shall be maintained between two adjacent electrodes.
- iii.
 - a) The strip or conductor electrode shall be buried in trench not less than 0.5 m deep.
 - b) If condition necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point.
- iv. Normally an earth electrode shall not be located closer than 1.5 m from

any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building, with the prior approval of the Engineer-in-Charge.

3. WATERING ARRANGEMENT :-

- i. In the case of plate earth electrodes, a watering pipe 20mm dia. medium class pipe shall be provided and attached to the electrodes. A funnel with mesh shall be provided on the top of this pipe for watering the earth.
- ii. The \watering funnel attachment shall be housed in a masonry enclosure of size not less than 30cm*30cm*30cm.
- iii. A cost iron/MS frame with MS cover, 6 mm thick, and having locking arrangement shall be suitably embedded in the masonry enclosure.

4. EARTHING CONDUCTOR (Main earthing lead) :-

- i. The earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.
- ii. A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanized "C" shaped strips, bolts, washers, nuts and check nuts of adequate size shall be used for the purpose.
- iii. The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class 15 mm dia GI pipe in the case of wire, and by 40 mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30 cm deep (to be increased 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.
- iv. The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switchboard by:
 - a) Soldered or preferably crimped lug, bolt, nut and washer in the case of wire, and,
 - b) Bolt, nut and washer in case of strip conductor.
 - c) Earthing Terminal / neutral point / earth bus in case of equipments / sub stations.

5. PROTECTIVE (Loop earthing/earth continuity) CONDUCTOR :-

- i. Earth terminal of every switchboard in the distribution system shall be bonded to the earth bar/terminal of the upstream switchboard by protective conductor(s).
- ii. Two protective conductors shall be provided for a switchboard carrying a 3 phase switch gear thereon.
- iii. All the mountings of industrial type switchboards shall be bonded to the earth stud/earth bar using a protective conductor looping from one to another. Loop earthing of individual units will not be however necessary in the case of cubical type switchboards.

- iv. The earth connector in every distribution board (DB) shall be securely connected to the earth stud/earth bar of the corresponding switchboard by a protective conductor.
- v. All metallic switch boxes and regulator boxes in a circuit shall be connected to the earth connector in the DB by protective conductor (also called circuit protective or loop earthing conductor), looping from one box to another up to the DB.
- vi. The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor. Where the switch boxes are non-metallic type, these shall be looped at the socket earth terminals, switch or at an independent screwed connector inside the switch box. Twisted earth connections shall not be accepted in any case.
- vii. Double earthing strips in rising mains, bus trunking etc. shall be securely connected to the earth bar/earth stud at the sending end switchboard. In the case of overhead bus bar systems, protective conductors shall be provided in addition to feeder cable armouring connection.

6. EARTH RESISTANCE :-

- i. The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be up to 8 ohms.
- ii. Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode(s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the Engineer-in-charge.

7. MARKING :-

- i. Earth bars/terminals at all switchboards shall be marked permanently either as "E".
- ii. Main earthing terminal shall be marked "SAFETY EARTH - DO NOT DISCONNECT".

4.0 Design Parameters**4.0.1 Ring Main Unit, Electrical data**

Rated Voltage	KV	11KV
Power Frequency Withstand Voltage	KV	28
- Across Disconnecter		38
Impulse Withstand Voltage	KV	75
- Across Disconnecter		95
Rated Frequency	Hz	50
Rated Current Busbars	A	630
Rated Current (Cable Switch)	A	630
Rated Current (Vacuum Circuit Breaker)	A	630
Breaking Capacities:		
Active Load	A	630
Closed Loop (Cable Switch)	A	630
Off Load Cable Charging (Cable switch)	A	20
Earth Fault (Cable Switch)	A	60
Earth Fault Cable Charging (Cable Switch)	A	35
Short Circuit Breaking Current (Vacuum Circuit Breaker) Class E1/S1 with 41% DC Component	KA	20
Rated Making Capacity	kA	50
Rated Short Time Current 3 Sec	kA	20

4.2.1 General data, enclosure and dimensions

Standard to which Switchgear complies	IEC
Type of Ring Main Unit	Metal Enclosed, SF6 Insulated, Compact Module.
Number of phases	3
Whether RMU is type tested	Yes
Whether facility is provided with pressure relief	Yes
Insulating gas	SF6
Expected operating lifetime	30 years
Whether facilities provided for gas monitoring	Yes, temperature compensated manometer
Material used in tank construction	Stainless steel sheet, 2 mm

No Operations, degree of protection and colours

Means of switch operation	separate handle
Degree Of protection for Encloser	IP54
Means circuit breaker operation	handle and push buttons
Rated operating sequence of Circuit Breaker	O – 3MIN – CO – 3MIN – CO
Total opening time of Circuit Breaker	approx. 40-80ms
Closing time of Circuit Breaker	approx. 40-70ms
Mechanical Endurance class of Switch & Circuit Breaker	M1

Electrical Endurance Class:	
Vacuum Circuit Breaker	E1
Load Break Switch	E3
Earth Switch	E2
Principle Switch Disconnecter	2 position puffer switch

Degree of protection:

High Voltage live parts,	SF6 tank IP 67
Front cover mechanism	IP 2X
Cable covers	IP 3X

Colours:

Front cover	RAL 7035 /7032
Side and cable cover	RAL 7035 / 7032

4.1 General Structural and Mechanical Construction

The offered RMU should be of the fully arc proof metal enclosed, free standing, floor mounting, flush fronted type, consisting of modules assembled into one or more units. Each unit is made of a robotically welded sealed-for life stainless steel tank of thickness not less than 2 mm filled with SF6, containing all high voltage components sealed off from the environment with Ingress protection IP54. The enclosure should meet the 'sealed pressure system' criterion in accordance with IEC 62271-200 standard.

RMU must have a pressure relief device at the bottom of the stainless steel housing to ensure that in the rare case of an internal arc, the high pressure caused by the arc will be released and the hot gases are allowed to be exhausted out at the bottom of the cubicle towards back side to ensure complete safety to the operator. A controlled direction of flow of the hot gas should be achieved.

4.2 DIELECTRIC MEDIUM

SF6 gas shall be used for the dielectric medium for 11KV RMU's in accordance with IEC376. It is preferable to fit an absorption material in the tank to absorb the moisture from the SF6 gas and to regenerate the SF6 gas following arc interruption. The SF6 insulating medium shall be constantly monitored via a temperature compensating gas pressure indicator offering a simple go, no-go indication. Maximum gas pressure shall be 1.4 bar absolute.

4.3 Load Break Switch (630 Amp cable feeder)

It should consist of an SF6 cubicle housing a switch disconnecter and an earthing switch. Bus bars and all electrical connections are located inside the tank. The switch positions are closed – open – earthed. The operating shafts for the switches should be have rotary seals where they enter the SF6 cubicle. The operating mechanisms should be located outside on the front of the SF6 tank. Cable bushings should be located on the front of the SF6 cubicle in a separate cable compartment. Front covers containing the mimic diagram and having a degree of protection IP2XCclose the fronts.

4.4 Circuit Breakers (630 Amp Transformer feeder)

The 630Amp T-off circuit breaker module should consist of an SF6 cubicle housing a fixed type vacuum circuit breaker and a series disconnecter & earthing switch. An integrated relay and related CTs is used for tripping of the circuit breaker. Bus bars and all electrical connections should be located inside the tank. The operating shafts for the switch disconnecter should have rotary seals where they enter the SF6 cubicle. The operating mechanisms are located outside on the front of the SF6 tank. Bolted type cable bushings should be located on the front of the SF6 cubicle in a separate cable compartment. Front covers containing the mimic diagram having a degree of protection IP2XC seal off the fronts.

Vacuum bottles should be used as interrupters of the currents. The make of vacuum bottles should be the same as that of RMU. The circuit breaker main circuit should be connected in series with a three-position disconnecter –earthing switch. The operation between circuit breaker and disconnecter earthing must be interlocked. VCB shall use a self-powered relay with low burden tripcoil. Relay shall draw the required energy from ring core CTs mounted on cables in the cable compartment.

4.5 Earthing of the Main Circuit

Each disconnecter/VCB shall be provided with an integral earth switch. Earthing switches should be rated equal to the switchgear rating. Earthing switches should be quick make type capable of making Rated Fault Current. Earthing switch should be operated from the front of the cubicle by means of a removable handle. The earthing switch can be closed only when the disconnecter is open. Mechanical interlocking systems shall prevent all operator errors such as closing the earth switch when switch is closed. The HT cables are terminated in the dedicated cable compartment. At the bottom of the cable compartment, an earthing bar system made of copper with a minimum cross section of 120 sq mm should be fitted.

4.6 Operating Mechanisms & Interlocking

All mechanisms should be situated in the mechanism compartment outside the SF6-tank and behind the front covers with degree of protection of IP2X. This gives the opportunity of easy access to all operating mechanisms if retrofit or service should be required. The speed of operation of these mechanisms is independent of how fast the handle is operated. All units shall be equipped with interlocked cable covers. This will prevent access to the cable compartment before earthing switch is in closed position. It will also be impossible to operate switch disconnecter to closed position before cable compartment cover is put back in place.

Each mechanism is equipped with a padlocking device. When adding a padlock to this device, the access to operate the mechanism will be prevented. This device has three holes with diameter 9 millimeter. All operating mechanisms are equipped with true position indicators for all switches. In order to safeguard true indication, indicators are directly connected to the operating shafts of the switches inside the SF6 tank. Operating handle shall have an anti-reflex system which prevents an immediate re-operation of the switch.

In rare case of mechanism failure, it shall be possible to replace the same at site without requiring SF6 gas refilling.

4.8.1 Load Break Switch Mechanism

The mechanism shall have two operating shafts; the upper one for the load break switch and the lower one for the earthing switch. Both shafts are single spring operated and are directly connected to the switches inside the SF6 enclosure.

Due to the mechanical interlock between the upper and the lower operating shaft, it is impossible to operate the load break switch when the earthing switch is in earthed position or to operate the earthing switch when the load break switch is in closed position.

4.8.2 Breaker Mechanism

This module has two mechanisms; the upper one is for circuit-breaker and the lower one with two operating shafts is for disconnecter and earthing switch.

The breaker mechanism can be charged by motor or manually by the integrated charging lever. The vacuum circuit-breaker has the possibility of rapid auto-reclosing duty. By means of mechanical push buttons it is possible to close and open the circuit breaker. The opening spring is always charged when the circuit-breaker is in closed position and will be ready to open.

immediately if the protection relay gives a trip signal. If the mechanism is recharged after closing, it is possible to perform open - close - open sequence.

The lower mechanism is identical to the load break switch module. There is a mechanical interlock between these two mechanisms which prevents operation of the disconnecter and the earthing switch when the circuit-breaker is in closed position. When the earthing switch is in closed position it is impossible to operate the disconnecter, but the circuit-breaker can be closed for testing purposes.

4.7 Busbars

Comprising the 3 single phases copper bus bars and the connections to the switch or circuit breaker. The bus bar should be integrated in the cubicle Bus bars should be rated to withstand all dynamic and thermal stresses for the full length of the switchgear.

4.8 Front Covers

Upper and lower front covers shall be manufactured with 2 millimeter Aluzinc and covered with a polycarbonate foil. These foils contain the mimic diagram of the main circuit with the position indicators for the switching devices. Background colour for these foils is grey RAL 7035, which makes the black single line diagram to stand out for easy optical reading of position indicators. Both the upper and lower front covers are removable. The voltage indicators are situated on the front panels.

4.9 Position Indicators

The position indicators shall be visible through the front cover and must be directly linked to the operating shaft of the switching devices. The operator shall be able to confirm the closing of earth switch. Same can be accomplished either by providing a viewing window for earth switch or by means of true position indication duly type tested as per IEC 62271-102 sub clause A.6.105 to verify proper functioning of position indicating device.

4.10 Voltage Indicators

The voltage indicators are situated on the front cover, one for each module, and indicate the voltage condition of each incoming cable. Identification of the phases is achieved with labels L1, L2 and L3 on the front of the voltage indicators. The voltage indicator satisfies the requirements of IEC61243.

4.11 Cable Compartment

It should be possible to terminate up to a 1x 3c x400 sqmm core HV cables in each cable compartment. The cable compartments should be in front and cable entry shall be from bottom. The access to the compartment will be possible by removing the cable cover only when earth switch is ON. Cable Compartments should be Arc Proof and interlocked with respective Earth Switches. Each module has a separate cable compartment that is segregated from each other by means of a partition wall. A partition wall should be fitted to divide the cable compartment from the rear side of the switchgear. In case of an arc inside the tank, followed by the opening of the pressure relief, the partition wall prevents the hot gases flowing out from the pressure relief to enter the cable compartments. All covers are removable. It should be possible to perform cable testing inside the cable boxes without disconnecting the cables.

4.12 Current Transformer

All current transformers should be complying with IEC 60185.

Current transformers should be of ring core, dry type, with ratings and ratios as required. Cable current transformers used in circuit breaker modules should be maximum 100mm wide and shall have sufficient VA burden for operation of self powered relays and low energy trip coil. Current transformers shall be placed in the cable covers so that it can be easily replaced at site without removing the bushings.

4.13 Auxiliaries

The switchgear should be prepared for options like motor operation, auxiliary contacts and short-circuit indicators. Necessary terminal blocks and wiring etc. should be placed behind the front cover or in LV box of each module.

4.14 Fault Passage Indicators

Bidders shall quote fault passage indicator as a separate optional item. These shall facilitate quick detection of faulty section of line. The fault indication may be on the basis of monitoring fault current flow through the device. The unit should be self-contained requiring no auxiliary power supply. The FPI shall be integral part of RMU to avoid thefts. The FPI shall have clear display, automatic reset facility and shall be SCADA compatible.

4.15 Retrofit

Units shall be fully SCADA compatible. Retrofitting/motorization at site shall be possible at a later date for cable switches as well as T- OFF circuit Breaker to enable remote operation and monitoring.

5.0 Manufacturing Facility

The manufacturer shall ensure workmanship of high quality. There shall be adequate machinery tools and tackles such that the product shall meet the internationally accepted standards. Facility should be certified for ISO 9001, 14001 and OHSAS 18001. The manufacturing facility shall be equipped with the following:

- Robotic welding station for stainless steel main tank, ensuring a leak rate of less than 0.1% per year.
- Work benches with pneumatic adjustable work benches and torques wrenches, giving flexibility to workmen for proper tightness of internal components of sealed tank.
- State of the art fully automatic gas filling and leakage testing machine for ensuring the quality of sealing and have precision to measure leak rate less than 0.1% per year.
- High voltage testing station to have high voltage power frequency test and partial discharge measurement.
- Computerized system to measure time travel characteristic of breaker before sealing the tank.

6 TESTING AND CERTIFICATION.**6.1 Type Tests.**

Units should be type tested in accordance with IEC standards 60056, 62271-102, 60265, 62271-200, 62271-105, 60529 and 60694. The following type tests have been performed and available if required

- Short time and peak withstand current test
- Temperature rise tests
- Dielectric tests
- Test of apparatus i.e. circuit breaker and earthing switch
- Arc fault test
- Measurement of resistance of main circuit.
- Mechanical endurance test.
- Duty cycle test.
- Internal arc test for HT chamber.
- Tests to verify true position indication devices as per IEC 62271-102.

6.2 Routine tests

Routine tests should be carried out in accordance with IEC 62271-200 standards. These tests should ensure the reliability of the unit.

Below listed test should be performed as routine tests before the delivery of units:

- Withstand voltage at power frequency
- Measurement of the resistance of the main circuit
- Withstand voltage on the auxiliary circuits
- Operation of functional locks, interlocks, signaling devices and auxiliary devices

- Suitability and correct operation of protections, control instruments and electrical
- connections of the circuit breaker operating mechanism
- Verification of wiring
- Visual inspection
- Time travel characteristics measurement facility for Breaker should be available with the manufacturer to assess the quality of RMU.

7.0 DOCUMENTATION

An instruction manual should be provided with necessary information for receiving, handling, storage, installation, operation and maintenance.

Routine test certificate should be follow each unit, and standard schematic drawings should be delivered for Ring Main Units. Compact Switchgear should be have drawings that consist of system single line drawings, general arrangement and schematic drawings for order specific units. All drawings shall confirm to International Standards Organization (ISO) "A" series of drawing sheets/Indian Standards Specification IS : 11065. All dimensions and data shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. Units.

7.1 List of drawings and Documents

The bidder shall furnish four sets of relevant descriptive and illustrative published literature, pamphlets and the drawings for preliminary study along with offer.

- General outline drawings showing dimensions and shipping weights, quantity of Insulating media.
- Sectional views showing the general constructional features of the circuit breaker
- Including operating mechanism, arcing chambers, and contacts with lifting dimensions for maintenance.
- Drawings showing control cabinets and circuit diagrams for operating mechanism.
- Schematic diagrams of breaker offered for control and supervision
- Structural drawings for support structures.
- Foundation plan and loading data and foundation design.

8.0 TRAINING

Installation of the switchgear should be required no special tools. Optional product training should be available at the manufacturer's facility.

L. T. PANEL**1. CONSTRUCTION FEATURES**

- a) Panels shall be indoor, metal clad, modular construction, fix or folding type (except circuitbreaker cubicles) air insulated and floor mounted type.
- b) Unless otherwise mentioned, panels shall be of single front construction and shall be of dead front type.
- c) All panels shall be extensible on both sides.
- d) All panels shall be dust proof and vermin proof.
- e) The panels shall have horizontal Bus bar Chamber at top of the panel even for top cable entry.
- f) All panels shall have provision for cable entry from top or from bottom as per site requirement. The same shall be confirmed to the Vendor during detailed engineering approval of shop drawing of panel manufacturer.
- g) All panels including capacitor panels shall be fully compartmentalized with metal insulating partitions between individual compartments.
- h) The Horizontal bus bar chamber shall be separate & totally enclosed.
- i) Minimum thickness of CRCA MS sheet member shall be 1.6 mm for non load bearing members and 2.0 mm for load bearing members.
- j) All panels shall comprise a continuous line up of dead front, free standing vertical sections. The installation of circuit breakers shall be limited to the bottom two tiers only. In two tiers formation two nos. of up to 1000 Amp. breakers can be provided.
- k) The back doors of the panels shall be double door leaf type where the panels have more than 400 mm width.
- l) All doors shall be supported by strong concealed type hinges.
- m) All relays, meters, and switches etc. shall be flush mounted type.
- n) All incoming terminals shall be provided with shrouds. Supports / shrouds shall be transparent and shall be made of SMC / DMC material. However Bakelite Hylam material is not acceptable and shall not be used anywhere in panels.
- o) The complete structure shall be rigid, self supporting free from vibration, twists and bends etc.
- p) The panels housing circuit breaker feeders shall be in single front draw out execution. The incoming & bus coupler circuit breaker feeders shall be in single tier formation while the outgoing circuit breaker feeders may be in double tier formation, unless otherwise specified.
- q) A suitable barrier shall be provided between the circuit breaker and the associated control.
- r) The number of modules shall be so decided that the cable alleys are not over crowded. However the number of module in any panel shall not exceed six. The

minimum size of module shall be 300mm and 225mm for starter and switch fuse / MCCBs feeders respectively. The minimum clear width of cable alley shall be 300mm.

- s) In cable alley, outgoing terminals shall be identified with feeder number.
- t) The panel shall be provided with three phase buses and neutral bus bars of aluminium sections throughout the length of the panel and shall be adequately supported and braced to withstand the stresses due to the short circuit Rating of bus bar shall be 50 KA for main L.T. panel & 35 KA for other PDBS for 1 sec. Maximum temperature rise of bus bars and bus bar connection while carrying rated current shall not exceed 40 C over an ambient temperature of 50 C. Bus bar sizing calculation shall be submitted for approval before start of fabrication..
- u) The maximum height of the Panel should not exceed 2100 mm unless specifically approved for suitable site conditions.

2 BUS AND BUS TAPS

- a) The main buses and connection shall be of high grade of aluminium bus bars conductivity aluminium 1 aluminium alloy (Grade EC-91 E), sized for specified current ratings with max, temp. limited to 85 deg. C (35 deg. above 50 deg. ambient temp.).
- b) Vertical bus bars shall be designed depending upon the actual feeder requirement. Bimetallic connector shall be provided for connection between dissimilar metals.
- c) Bus bars and connections shall be fully insulated for working voltage with adequate phase to ground clearances. Insulating sleeves for Bus bars and shrouds for joint shall be provided. Minimum clearance of 32 mm is required between phases and 26 mm between phase & earth.
- d) Shrouds for bus bars joints / tapping points shall be of fiber glass only. Bus insulators shall be flame retardant, track resistant type with high creepage surface and of non-hygroscopic material such as epoxy / SMC / DMC.
- e) Bus bars shall be supported and braced to withstand the stresses due to max. short circuit current and also to take care of any thermal expansion. .
- f) The bus bar size shall be of similar size as of bus duct.

3 CHANGE OVER SWITCHES

- a) Changeover switches shall be 4 pole, heavy duty, group operated load break fault make type with AC 23A duty.
- b) The switches shall be capable of successfully withstanding the thermal stress for one sec. caused by the short circuit corresponding to the fault level specified.
- c) The switches shall be able to withstand mechanical stresses caused by the peak short circuit currents corresponding fault level specified.
- d) The switches shall be provided with operating handle compartment door and shall be so interlocked that on the hinged compartment door and shall be so interlocked that :
 - i) The door can be opened only when the switch is in OFF position.

- ii) It shall not be possible to close the switch when the door is open.
- e) The switch shall be provided with pad-locking arrangement for 250A and above rating.
- f) The switch shall be provided with defeat interlock facilities.

4 FUSES

- a) All fuses shall be HRC cartridge link type.
- b) The fuses shall be provided with visible indication when they have operated.
- c) Rating of the fuses shall be so chosen so as to have co-ordination with switch. Fuses shall preferably mounted directly on plug in type fuse bases & sufficient number of insulated fuse pullers shall be supplied.
- d) Fuses and links functionally associated with the same circuit shall be mounted side by side.

Earthing and neutral links in main supply circuits shall be of silver plated copper & of bolted pattern.

5 CONTACTORS

- a) Contactors shall be of double break, single throw and electromagnetic and non-gravity type.
- b) Contactors shall be suitable for interrupted duty and shall be rated for class AC-3 duty.
- c) Main contacts of contactors shall be silver faced.
- d) Operating coils of contactors shall be suitable for operation on 220/240V AC, 1 phase, 50 Hz supply.
- e) Contactors shall be provided with at least two pairs of 'NO' and 'NC' auxiliary contacts.
- f) Contactors shall not drop out at voltages down to 70% of coil rated voltages and min. pick up voltage shall be 85%.

6 OVERLOAD RELAYS

- a) Overload protection for each motor feeder (wherever required) shall be provided by thermal overload relay on each of the three phases.
- b) The relay shall be duly compensated against fluctuations on ambient temp. and frequency and shall have single phasing preventer feature.
- c) Relay shall be hand reset type from the front of the cubicle door.

Overload relay for fan applications shall be of heavy duty type with provision of bypassing the same during starting of the fan.

7 CAPACITORS

- a) The capacitor shall be of mixed dielectric type rated for 440Volts. Capacitors shall be provided with discharge resistors. The value of discharge resistors should be such that the residual voltage be less than 50V in one minute.
- b) Capacitors shall be suitable for prolonged operation at an rms. voltage between terminals not exceeding 1.10 times the rated voltage, excluding transients.
- c) Capacitors shall be suitable for continuous operation at an rms. line current not exceeding 1.30 times the current which occurs at rated sinusoidal voltage and rated frequency excluding transients.
- d) The maximum continuous reactive output of a capacitor (including any due to flow of harmonic currents) shall not exceed 30% over rated reactive output of a capacitor.
- e) Loss in the capacitors shall be kept as low as possible. (Max. 0.5W/KV AR).
- f) Wherever capacitor consists of several elements inside the units, each element shall be provided with individual fuses, so that the unit need not be discharged or disconnected (although with moderate reduction in output), if one of short circuit to any of the elements.

8 AUTOMATIC POWER FACTOR CONTROL RELAY

- a) Automatic Power factor control relay (APFCR) shall operate its auxiliary relay by sensing the power factor of the plant thru' current and voltage signals.
- b) APFCR shall have no. of steps specified in drawings.
- c) APFCR shall be provided with Built in PF meter (0.5 lag to 0.5 lead), calibrated setting dial.
- d) APFCR shall be suitable for 5A secondary current.
- e) APFCR shall be suitable for flush mounting in capacitor panel/MCCs.
- f) Current rating of its auxiliary relay shall be compatible with switching and continuous energization of main contactor of capacitors. Otherwise, additional relay shall be provided.

9 COOLING

- a) All the Capacitor Panels shall be properly ventilated. If required a small exhaust fan of suitable rating shall be provided on the rear door of the panel, with the opening properly covered with fine wire mesh. The fan shall start/stop automatically along with normal start/stop provision.
- b) Louvers shall be provided on the door on rear side with a fine wire mesh.

10 CURRENT TRANSFORMERS

- a) Current Transformers shall be cast - resin type .All secondary connections shall be brought out to terminal blocks where connection will be made.
- b) Accuracy class of the current transformers shall be :
 - (i) Class 5P20 for protection.
 - (ii) Class 1.0 for metering.

(iii) Class PS for differential Protection & REF.

- c) Current transformer shall be provided with test links and shorting on both secondary leads for testing purpose.
- d) All current transformers shall be earthed by a separate earth link on terminal blocks.
- e) Additional name plate of CTs / PTs shall be provided (if required) at such a place that it shall be possible to find out details of CTs / PTs after mounting in the panel.

11 VOLTAGE TRANSFORMERS

- a) Voltage transformers shall be cast-resin, fixed type and shall have an accuracy class of 1.0.
- b) Low voltage fuses, sized to prevent overload, shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while the board is energized.

12 RELAYS

Relays wherever provided shall be of draw-out design with built-in testing facilities. Small auxiliary relays may be in non-draw out execution-.

13 CONTROL AND SELECTOR SWITCHES

- a) Control and selector switches shall be of rotary type having enclosed contacts, which are accessible by the removal of cover.
- b) Control and selector switches shall be of flush mounted type and on front of panels.
- c) Selector switches shall be of stay-put maintained contact type.
- d) Control switches shall be provided with escutcheon plate clearly marked to show the position.

14 INDICATING METERS AND INSTRUMENTS

Indicating instrument (96 x 96 mm) shall be digital meter, switch board type and accuracy class of.1 (1 % full scale \pm 1 count).

15 INDICATING LAMPS

- a) Indicating lamps shall be of LED type, low watt consumption and provided with appropriate value of resistors. The LEDs shall also have an in-built surge suppressor.
- b) Bulbs and lenses shall be interchangeable and easily replaceable from the front of the panel.

16 PUSH BUTTONS

- a) All push buttons shall be of the push to actuate the contact type.
- b) All push buttons shall be oil tight and shall be provided with adequate no. of contacts.

17 POWER AND CONTROL CABLE TERMINATION

- a) Suitable supporting arrangement shall be provided for all power and control cables entering the panel.
- b) Removable undrilled gland plate of 3 mm thick of MS for multicore cables and 4mm thick of Aluminium for single core cables sufficient in size to accommodate all compression type, heavy duty brass glands shall be provided.
- c) Adequate termination arrangement shall be provided for all power cables which shall be aluminium / copper conductor, PVC insulated, sheathed, armoured PVC sleeved overall, heavy duty cables, 1.1 KV grade. Power cables termination shall be by means of crimping type lugs on conductor cables.
- d) The terminal blocks shall be bolted lug type for cables. These shall be protected type and rated for 1100 Volts service. The minimum current rating of terminal block shall be 16 Amp. The construction shall be such that after the connection of cable by means of lugs, necessary clearance and creepage distance are available.
- e) Wherever there is more than one equipment connected on the same feeder, separate terminals shall be provided.

18 INTERNAL WIRING

- a) All internal wiring shall be carried out with stranded copper conductors, PVC insulated, 1100/650 V grade.
- b) Min. size of conductor 2.5 sq. mm for AC control wiring and 4.0 sq. mm. for DC control wiring. Current transformer secondary wiring shall be with 2.5 sq. mm conductor.
- c) All wiring shall be run on the sides of the panels and shall be neatly bunched and shall not affect access to equipment mounted in the panels.
- d) Wiring shall be terminated on terminal blocks using crimping type lugs and without joints or tees on their runs.
- e) Power wiring shall be done either by phase identifying colored wires or suitably colored PVC sleeves shall be provided at each end of wire.

The following wiring codes shall be used.

Instrument Transformer	:	Red, yellow or blue depending upon phase with which wire is associated.
A-C phase wire	:	White
A-C Neutral wire	:	Black
Earth connection	:	Green

- f) PVC identification ferrules, yellow colour with black engraved letter shall be provided at each end of all control wires marked to correspond with equipment designation & termination numbers.
- g) Ferrules provided shall be oil tight and numbered from left to right.

19 TERMINAL BLOCKS

- a) Terminal blocks for control wiring shall be 650V grade 10 sq. mm size.
- b) Terminal blocks shall be grouped depending on circuit voltage. Different voltage groups of terminals blocks shall be segregated.
- c) Terminals blocks shall be numbered for identification and provision shall be provided for terminal labels.
- d) Terminal blocks requiring duplication shall be provided with solid bonding links.
- e) Terminal blocks for current transformer secondary lead wires shall be provided with shorting, disconnecting / earthing facilities.
- f) Terminal blocks and control wiring shall be so arranged that only one conductor of external wiring required to be terminated in at each terminal.

20 GROUND BUS

- a) A ground bus, rated to carry maximum fault current, shall extend to full length of the panel.
- b) The ground bus shall be provided with two-bolt drilling with GJ. bolts and nuts at each end to receive up to 75X 10 mm G.I. flat. .
- c) Each stationary unit shall be connected directly to the ground bus. The frame of each circuit breaker and shall be grounded through heavy multiple contacts at all times.
- d) Wherever the schematic diagrams indicate a definite ground at the switchgear, a single wire for each circuit thus grounded shall be run independent to the ground bus and connected thereto.
- e) C.T. shall be earthed through removable links so that earth of one circuit may be removed without disturbing other.
- f) Frames and non current carrying metal parts of all equipment mounted shall be effectively to earth bus.
- g) All hinged doors shall be connected to earth bus by flexible tinned bare copper wire.
- h) Instrument and relay cabinets shall be connected to earth by 2.5 sq. mm stranded copper insulated wire 1100 V grade.

21 SPACE HEATERS

Each cubicle shall be provided with thermostat controlled space heaters.

22 AC/DC POWER SUPPLY

- a) The panels shall be suitable to receive following power supplies.
AC Supply : Single Feeder
DC Supply : Double Feeder
- b) Isolating switch fuse units shall be provided at each switchgear for the incoming supplies, 4-pole, single throw for AC.
- c) Bus-wires of adequate capacity shall be provided to distribute the incoming supplies

to different cubicles. Isolating switch-fuse units shall be provided at each cubicle for AC supplies.

- d) AC load shall be so distributed as to present a balance loading on three phase supply system.

23 NAME PLATES

- a) Name plates of anodized aluminium shall be furnished at cubicle and at each instrument, device mounted on and inside the cubicle.
- b) Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.
- c) Name plates for feeders shall be provided on front and back of the panel.

24 TROPICAL PROTECTION

- a) All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion.
- b) Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

25 PAINTING AND TREATMENT

The panel shall have eight tank pretreatment process comprising of degreasing, rinsing, derusting, rinsing, activation, phosphating, rinsing, and passivation followed by powder coat painting having a paint thickness of 60 micron or as specified of approved shade of SIEMENS grey (Shade RAL 7035 / 7032). The powder paint will be subjected to oven heated process.

26 TESTS & INSPECTION

After completion of all work at the manufacturer's works the switchboards shall be inspected and tested in presence of Purchaser's representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship. The following tests shall be carried out:

- i) All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.
- ii) Test for protective relay operation by primary or secondary injection method.
- iii) Operation of all meters.
- iv) Secondary wiring continuity test
- v) Insulation test with 1000 Volts megger, before and after voltage test.
- vi) HV test on secondary wiring and components on which such test is permissible (2 KV for one minute)
- vii) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
- viii) Measurement of power required for closing/trip coil of the breaker.

- ix) Pick up and drop out voltages for shunt trip and closing coils.
- x) CT Polarity test.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out along with copies of type test certificates and certificates from Sub-Vendor for the components procured from them are to be submitted before dispatch of switch boards.

27. DRAWINGS AND INFORMATION

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

- i) General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cutouts/trenches for external cables and elevations, transport sections and weights.
- ii) Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.
- iii) Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc. Vendor drawings to be based on Purchaser's Control Wiring Diagram, if furnished.
- iv) Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.
- v) Relay wiring diagrams.
- vi) 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:

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

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.

SPARES

The manufacturer shall provide with his quotation separate priced list of recommended commissioning and operation spares. Commissioning spares (list of which shall be approved) shall be purchased with the main HV Switchgear.

QUALITY ASSURANCE

Quality Assurance shall follow the requirements of Owner/ Consultant as applicable.

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

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.

CAPACITORS

Power factor correction capacitors shall conform in all respects to IS 2834-1964, IS : 13340, 13341 & IEC 831 – 1&2. The shunt capacitors shall be suitable for 3 phase 440V at 50Hz. frequency and shall be available in units as per B.O.Q. to form a bank of capacitors of desired capacity. All these units shall be connected in parallel by means of high conductivity aluminium busbars of adequate current carrying capacity having S.C rating of 50 KA for 1 sec. Each capacitorbank terminal shall be suitable for connecting aluminium conductor cable/solid bus connections. Two separate earthing terminals shall be provided for each bank for earth connection.

The capacitor bank shall be subject to routine & type tests as specified in relevant Indian Standard and the bidder will submit testing procedure for capacities at factory & site. The capacitor shall be suitable for indoor/outdoor use upto 45 Deg.C over and above ambient temperature of 50 degree

A. The permissible overloads shall be as given below:

- a) Voltage overload shall be 10% for continuous operation and 20% for every 6 hours in a 24 hours cycle.
- b) Current overload 15% for continuous operation and 50% for every 6 hours in a 24 hours cycle.

The capacitor banks shall be floor bracket mounting type indoor housing using minimum floor space.

Capacitors shall be of aluminium foil and craft paper (heavy duty self healing type). Hermetically sealed in sturdy corrosion-proof sheet steel 2mm thick containers and impregnated with non-inflammable synthetic liquid and of low power loss version. Every element of each capacitor unit shall be provided with its own built in in-rush current inductor with discharge resistor and silvered fuse against short circuit % / over load protection. The capacitor shall have suitable discharge device to reduce the residual voltage from crest value of the rated voltage to 50 V or less within one minute after capacitor is disconnected from the source of supply. The loss factor of capacitor shall not exceed 0.005 for capacitors with synthetic impregnants. The capacitors shall withstand voltage of 2500V AC supply for 1 minute.

The insulation resistance between capacitor terminals and containers when test voltage of 500V A.C. is applied shall not be less than 50 megohms.

- Capacitors shall be rated for 650 V AC 50 Hz.
- Capacitor bank and switching equipments shall be housed in separate cubicle compartment having degree of protection IP-42 and constructed with sheet steel of minimum 2mm thickness.
- Each capacitor shall be provided with built-in/externally provided inductor coil to limit inrush current within safe limit.

Filter:-

- Testing shall be done as per applicable standards for shunt capacitors.
- Insulation test etc.
- For harmonic suppression inductive reactor with tapping shall be provided along with capacitor. These shall be switch on or off incase of 3rd Harmonic distortion is increasing more than 3%.

CAPACITOR CONTROL PANEL

The capacitor control panel shall general comprise of the following:

- a) Automatic power factor correction relay microprocessor based for 4 quadrant operation with built-in step controller (for forward & backward) and shall perform the function as well display on screen:

Target Cos phi	:	Cos phi, KVAR missing.
Transformer ratio	:	Electric supply parameter.
Switching settings	:	Temperature.
Harmonic cut off	:	Harmonics
Start power	:	Stages
		Other information.

Programming (inter – select and menu).

- b) Relay should have inbuilt facility to check phase sequence when every time switched on and adjust the phase sequence automatically to get the proper PF.
- c) The relay shall decide the no. of capacitor banks to switched on or off according to the set power factor requirements.
- d) Protection MCCB with static O/C and S/C.
- e) Capacitor duty contactor for individual capacitors with MCCB control.
- f) Change over switch for either automatic operation or manual operation with push button control.
- g) C.T.s with ammeter and selector switch.
- h) Voltmeter with selector switch.
- i) Indicating lights RYB.
- j) In the manual mode also timer to be incorporated to allow discharge time of capacitors.

All the capacitors and contactors shall be interconnected with PVC insulated copper conductor wires of adequate size in a neat and acceptable manner. Three phases and neutral bus bar (copper) shall be provided in panel as required.

The above control gear, P.F. meter, Digital Microprocessor based P.F. correction relay, push button station etc. shall be housed in a sheet steel metal enclosure cubical type, free standing frontoperated with lockable doors. The panel shall be fabricated from MS sheet steel 2mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet steel shall be seam-welded. The panel shall be totally enclosed design completely dust tight and vermin proof. Gaskets between all adjacent units and beneath all covers shall be used to render the joints effectively.

Ventilation fan with a thermostat any toggle switch shall be provided inside panel to maintain internal temperature mentioned else where.

SAFETY PROCEDURE

1. While the Indian Electricity Rules 1956, as amended upto date, are to be followed in their entirety, particular attention is drawn to the various clauses indicated in Appendix 'C'. Any installation or portion of installation, which does not comply with these rules, should be got rectified immediately.
2. The detailed instructions on safety procedures given in B.I.S. Code No. 5216-1982 "Code of Safety Procedures and Practices in Electrical Works" shall be strictly followed.
3.
 - a) Schematic diagram
It shall be responsibility of the JE (E)/AE (E) to ensure that for each building, a comprehensive schematic diagram is prepared starting from the main board upto the final DBs. All such boards are to be duly marked and numbered.

Similarly, for each campus consisting of substation/substations and a number of buildings, a comprehensive power distribution schematic diagram for the entire campus shall be prepared.

Based on additions/alterations such diagrams should be updated from time to time.
 - b) Keep premises clean

Premises like substations, switch rooms, pump house, generating rooms etc. shall be kept clean. Such premises should not be used to store broken furniture, dismantled materials, waste material, parking boxes etc.
 - c) Keep all electrical shafts clean and locked

Such shafts should not be used for dumping floor malwa etc.
 - d) Protected premises

All premises like substation, pump house etc. to be maintained as protected area, admission allowed to authorized persons only.
 - e) Also, the frontage of such areas shall be kept free and parking etc. in front shall not be allowed.
4. No inflammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Indian Explosives Act.
5. Rubber or insulating mats should be provided in front of the main switchboards or any other control equipments of medium voltage and above.
6. Protective and safety equipments such as rubber gauntlets or gloves, earthing rods, linemen's belt, portable artificial respiration apparatus etc. should be provided in each sub-station, service center/enquiry office and important installations. Where electric welding or such other nature of work is undertaken, goggles shall also be provided.
7. Necessary number of caution boards such as "Man on Line, Don't switch on" should be readily available in each sub-station, enquiry office and important installations.
8. Standard first aid boxes containing materials as prescribed by the St. John Ambulance Brigade or Indian Red Cross should be provided in each sub-station, enquiry office and important installations and should be readily available.

9. Periodical examination of the first aid facilities and protective and safety equipments provided at the various installations shall be undertaken for their adequacy and effectiveness and a proper record shall be maintained.
10. Charts (One in English and another one in the regional language) displaying methods of giving artificial respiration to a recipient of electrical shock should be prominently displayed at appropriate places.
11. A Chart containing the names, addresses and telephone numbers of nearest authorized medical practitioners, hospitals, fire brigade and also of the officers in executive charge shall be displayed prominently along with the First Aid Box.
12. Executive Engineers should take immediate steps to train supervisory and authorized persons of the Engineering staff viz. A.Es., J.Es, Head Electricians, Foremen, Electricians and Wiremen in the First Aid Practices, including various methods of artificial respiration with the help of local authorities such as Fire Brigade, St. John Ambulance Brigade, Indian Red Cross or other recognized institutions equipped to impart such training, as prompt rendering of artificial respiration can save life at times of electric shock.
13. All new recruits should be given such First Aid Training immediately after appointment.
14. All Supervisory and authorized persons of the Engineering staff should be deputed for refresher course in First Aid Training after every two years.
15. Details of preventive maintenance to be undertaken shall be in accordance with the chapter 14 of these specifications. All preventive maintenance works shall be preplanned as far as possible and names of persons who are assigned to this work should be entered in a logbook.
16. Electrical wiring and control switches should be periodically inspected and any defective wiring, broken parts of switches which will expose live parts, should be replaced immediately to make the installations safe for the user.
17. Reports indicating details of preventive maintenance works done should be kept in a register by each Junior Engineer (E) and should bear signatures of Assistant Engineer and Executive Engineer by way of checks.
18. No work shall be undertaken on live installations, or on installations, which could be energized unless another person is present to immediately isolate the electric supply in case of any accident and to render first aid, if necessary.
19. No work of live L.T. switch board in the sub-stations should be handled by a person below the rank of a Wireman and such a work should preferably be done in the presence of the Junior Engineer (E) in charge of the work.
20. When working on or near live installations, suitably insulated tools should be used, and special care should be taken to see that those tools accidentally do not drop on live terminals causing shock or dead short.
21. The electrical switchgears and distribution boards should be clearly marked to indicate the areas being controlled by them.
22. Before starting any work on the existing installation, it should be ensured that the electric supply to that portion in which the work is undertaken is preferably cut off. Precautions like displaying "Men at Work" caution boards on the controlling switches, removing fuse carrier from these switches, and these fuse carriers being kept with the person working on the installation, etc. should be taken against accidental energisation. "Permit to Work" should be obtained from the Junior Engineer-in-Charge. No work on H.T. main should be undertaken unless it is made dead and discharged to earth with an earthing lead of

appropriate size. The discharge operation shall be repeated several times and the installation connected to earth positively before any work is started.

23. Before energizing on an installation after the work is completed, it should be ensured that all tools have been removed and accounted, no person is present inside any enclosure of the switch board etc. any earthing connection made for doing the work has been removed, "Permit to Work" is received back duly signed by the person to whom it was issued in token of having completed the work and the installation being ready for re-energising and "Men at Work" caution boards removed.
24. In case of electrical accidents and shock, the electrical installation on which the accident occurred should be switched off immediately and the affected person should be immediately removed from the live installation by pulling him with the help of his coat, shirt, wooden rod, broom handle or with any other dry cloth or paper. He should be removed from the place of accident to a nearby safe place and artificial respiration continuously given as contained in B.I.S. Code and Standard prescribed by St. John Ambulance Brigade or Fire Brigade.
25. While artificial respiration on the affected person is started immediately, help of Fire Brigade and Medical Practitioner should be called for and artificial respiration should be continued uninterrupted until such help arrives.
26. These instructions should be explained in Hindi/local language to those staff that does not understand English.
27. Executive Engineers should take particular care to ensure that these instructions are imparted to the existing staff and as well as to the new entrants.

TESTING OF INSTALLATION

SCOPE

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

1.0 GENERAL

1.1 TESTS

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

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

1.2 Witnessing of tests

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

1.3 Test instruments

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

2.0 INSULATION RESISTANCE

- 2.1** The insulation resistance shall be measured by applying between earth and the whole system of conductors, or any section thereof with all fuses in place, and all switches closed, and except in earthed concentric wiring, all lamps in position, or both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure, provided it need not exceed 500 volts for medium voltage circuits. Where the supply is derived from a three wire D.C., or a polyphase A.C. system, the neutral pole of which is connected to earth either directly or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.
- 2.2** The insulation resistance shall also be measured between all the conductors connected to one pole, or phase conductor of the supply, and all the conductors connected to the neutral, or to the other pole, or phase conductors of the supply with all the lamps in position and switches in "off position, and its value shall be not less than that specified in sub-clause 16.2.3.
- 2.3** The insulation resistance in mega ohms measured as above shall not be less than 12.5 mega ohms for the wiring with PVC insulated cables, subject to a minimum of 1 mega ohm.
- 2.4** Where a whole installation is being tested, a lower value than that given by the formula, subject to a minimum of 1 mega ohm, is acceptable.
- 2.5** A preliminary and similar test may be made before the lamps etc. are installed, and in this event the insulation resistance to earth should not be less than 25 mega ohms for the wiring with PVC insulated cables, subject to a minimum of 2 mega ohms.

- 2.6 The term "outlet" includes every point along with every switch, except that a switch combined with a socket outlet, appliance or lighting fitting is regarded as one outlet.
- 2.7 Control rheostats, heating and power appliances and electric signs may, if required, be disconnected from the circuit during the test, but in that event the insulation resistance between the case or frame work, and all live parts of each rheostat, appliance and sign, shall be not less than that specified in the relevant Indian Standard Specifications, or where there is no such Specification, shall be not less than one mega ohm.

3.0 POLARITY TEST OF SWITCH

- 3.1 In a two wire installation, a test shall be made to verify that all the switches in every circuit have been fitted in the same conductor throughout, and such conductor shall be labeled or marked for connection to the phase conductor, or to the non-earthed conductors of the supply.
- 3.2 In a three wire or a four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted in a conductor which is labeled, or marked for connection to one of the phase conductors of the supply.
- 3.3 The installation shall be connected to the supply for testing. The terminals of all switches shall be tested by a test lamp, one lead of which is connected to the earth. Glowing of test lamp to its full brilliance, when the switch is in "on" position irrespective of appliance in position or not, shall indicate that the switch is connected to the right polarity.

4.0 TESTING OF EARTH CONTINUITY PATH

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

5.0 MEASUREMENT OF EARTH ELECTRODE RESISTANCE

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

$$R = \frac{V}{I}$$

Where,

- R - Resistance of the test electrode in ohms,
 V - Reading of the voltmeter in volts.
 I - Reading of the ammeter in amps.

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

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

- 5.3** At the time of test, the test electrode shall be separated from the earthing system.
- 5.4** The auxiliary electrodes shall be of 13 mm diameter mild steel rod driven upto 1 m into the ground.
- 5.5** All the three electrodes shall be so placed that they are independent of the resistance area of each other. If the test electrode is in the form of a rod, pipe or plate, the auxiliary current electrode 'C' shall be placed at least 30 m away from it, and the auxiliary potential electrode 'B' shall be placed mid-way between them.
- 5.6** Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by increasing the distance between electrodes A and C upto 50m, and each time placing the electrode B midway between them.
- 5.7** On these principles, "Megger Earth Tester", containing a direct reading ohm meter, a hand driven generator and auxiliary electrodes are manufactured for direct reading of earth resistance of electrodes.

6.0 TEST CERTIFICATE

On completion of an electrical installation (or an extension to an installation), a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as given in Appendix 'E' in addition to the test certificate required by the local Electric Supply Authorities.