ENGINEERING PROJECTS (INDIA) LTD
(A Govt. of India Enterprise)

VOL - II

TECHNICAL SPECIFICATIONS

FOR

ELECTRICAL
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1. GENERAL REQUIREMENTS (SCOPE OF ELECTRICAL INSTALLATION WORKS).

The general character and the scope of work to be carried out under this contract is illustrated in Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Owner’s site representative. The Contractor shall furnish all labor, materials and equipment (except those to be supplied by the owner) as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete system as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The scope of work shall generally comprise, but not limited to the following:

a) HT/LT Power and Control Cables.
b) 415 V MCC/PCC’s, Automatic Capacitor Control Panels, Lighting Panels, Bus Ducts, etc.
c) Raising Mains, Cable trays, earthing station/materials, lightning protection System.
d) Battery, Battery Charger, Annunciator UPS, Inverter.
e) Any other items specified in Schedule of Quantities.

1.1 Comply in full with all requirements described in or implied by this specification and with the Conditions of Contract as well as Schedule and Drawings issued as part of the contract documents.

1.2 Request clarification and make all necessary enquiries prior to submitting the tender. Regarding any obscurities or contradictions on or omissions from the specification, related Documents and Drawings. No consideration will be given to cost claims for work arising from the failure to obtain such clarification.

1.3 Minor civil works like drilling and punching holes and openings in concrete floors, slabs, chasings of brick walls, fabrication of supporting structures, drainage of water from cable trenches, cleaning and clearing of all debris due to electrical installation.

1.4 Excavation, scaffolding and back filling for direct burial of cables and earthing conductors as applicable.

1.5 Preparation of execution drawings and as built-in- drawings.

1.6 Coordination with other contractors with regard to installation of items in Electrical Contractors scope.
1.7 The extent of work services under the contract include all items shown on the drawings, indicated in companion with specifications, not withstanding the fact that such items have been omitted from the price schedule. All equipments and services which are required to complete the intent of the contract shall also be deemed to be within the scope of the contract.

1.8 Training of Owner’s Staff.

2. COMPLIANCE WITH STANDARDS.

2.1 STANDARDS:

Comply with the requirements of all relevant Indian Standards (IS) or equivalent British Standards (BS) regarding equipment manufacture, design and installation whether or not these are specifically mentioned in the Specification.

2.2 ALTERNATIVE STANDARDS:

International Standards (ISO) or (IEC) which are equivalent to the appropriate Indian Standard (IS) may be used. Other standards may be offered as an alternative only if submitted for approval along with the equipment manufacturer’s written assurance that they are equal to BS, ISO or IEC Standards.

2.3 DISCREPANCIES:

In the event of a discrepancy between the Specification and any IS or BS or other approved standard request clarification in writing from the Engineer.

2.4 CODE, REGULATIONS AND STANDARDS

The installation shall conform in all respects to Indian Standard Code of Practice for Electrical Wiring Installation I.S.732-1982. It shall also be in conformity with the current Indian Electricity Rules Safety Codes and the Regulations and requirements of the Local Electrical Supply Authority. Wherever this specification calls for a higher standard of materials and/or workmanship then those required by any of the above regulations, this specification shall take precedence over the said regulations and standards. In general, the materials, equipments and workmanship not covered by the above shall conform to the following Indian Standards(latest),unless otherwise called for. Nothing in the enclosed specification shall be construed to relieve the contractor of this responsibility.

Classification of degrees of protection provided by enclosures of electrical equipment

Electrotechnical vocabulary : Part 9 Electrical
relays (Second revision of IS:1885)

Electrotechnical vocabulary : Part 10 Power system protection (first revision of IS 1885) 1885 (Part 10):1993 03

Electrotechnical vocabulary : Part 11 Electrical measurements 1885 (Part 11):1966 09

Electrotechnical vocabulary : Part 17 Switchgear and control gear (first revision) 1885 (Part 17):1979 08


Electrotechnical Vocabulary : Part 32 Electric cables (first revision of IS 1885) 1885 (Part 32): 1992 05

Electrotechnical vocabulary : Part 38 Transformers (first edition) 1885 (Part 38):1977 05


Electrotechnical vocabulary : Part 54 Insulators (First revision of IS 1885) 1885 (Part 54):1993 03


Electrotechnical vocabulary : Part 71 Generation, transmission and distribution of electricity Substation 1885 (Part 71):1993 06

Graphical symbols for diagrams in the field of electrotechnology : Part 3 Conductors and connecting devices 12032 (Part 3):1987 05

Graphical symbols for diagrams in the field of electrotechnology: Part 7 Switchgear, control gear and protective devices. 12032(Part 7):1987 12

Graphical symbols for diagrams in the field of electrotechnology: Part 8 Measuring instruments, lamps and signaling devices. 12032(Part 8):1987 07
Guide for colour coding of electrical mimic diagrams 11954:1987 02

Guide for limits of temperature rise of the windings of electrical equipment when tested by different methods. 9677:1980 02


Code of practice for earthing 3043:1987

Code of practice for the protection of buildings and allied structures against lighting (second revision) 2309:1989 15

Danger notice plates (first revision) 2551:1982 05

Guide for improvement of power factor in consumer installation Part I, Low and medium supply voltages 7752 (Part I):1982 06


Special publication - National Electrical Code 30:1984

Special publication Chart on treatment for electric shock 31:1986

Warning symbol for dangerous voltages 8923:1978 01

Boxes for enclosure of the electrical accessories:Part 1, Steel and cast iron box (with amendment No.2) 5133(Part 1):1969 03

Boxes for the enclosure of electrical accessories:Part 2, Boxes made of insulating material 5133(Part 2):1969 03

AC electricity meters:Part 2, Single-phase whole-current watt hour meters, Class II (first revision)(with amendment No.4) 722(Part 2):1977 02

AC electricity meters:Part 3, Three-phase whole current and transformer operated and single-phase transformer operated watt-hour meters, class 2(Second revision)(with amendment No.2) 722(Part 3):1977 03
AC electricity meters: Part 5, Volt-ampere hour meters for restricted power factor range, class 3.5 (first revision) (with amendment No.2) 722(Part 5):1980 05

Guide for testing, calibration and maintenance of AC electricity meters: Part 1, Single phase whole current watt hour meters, Class 2.0 (first revision) 9792(Part 1):1987 06

Maximum demand indicators (class 1) 8530:1977 04

Testing equipment for AC electrical energy meters 12346:1988 05

Application guide for the selection of High Voltage fuses for transformer circuit applications. 12534:1988 02

Carriers and bases used in rewirable type electric fuses for voltages upto 650 V (third revision) (Superseding IS:8724) 2086:1993 07

High voltage fuse-links for motor circuit applications) 10624:1983

High voltage fuses for the external protection of shunt power capacitors. 9402:1980 04

High voltage fuses: Part 1, Current limiting fuses. 9385(Part I):1979 10


LV Fuses for voltages not exceeding 1000 V AC or 1500 V DC: Part 2, fuses for use by authorized persons, Section 1, Supplementary requirements {Superseding IS 9224 (Part 2):1979} 13703(Part 2-Section 1):1993/IEC-269-2(1993)

LV Fuses for voltages not exceeding 1000 V AC or 1500 V DC: Part 2, fuses for use by authorized persons, Section 2, examples of standardized fuses. 13703(Part 2-Section 2):1993/IEC-269-2-1(1987)

LV Fuses for voltages not exceeding 1000 V AC or 1500 V 13703(Part 4) : 1993/
DC: Part 4, Supplementary requirements for fuse links for the protection of semiconductor devices (Superseding IS 9224 (Part 4):1980)

Application guide for measuring devices for high voltage testing

Methods of high voltage testing: Part 1, General definitions and test requirements, (first revision) (Superseding IS:2070-1972)

AC contactors of voltage above 1000 V upto and including 11000 V

Alternating current disconnectors (isolators) and earthing switches for voltage above 1000 V: Part 1, General and definitions.

Alternating current disconnectors (isolators) and earthing switches for voltage above 1000 V: Part 2 Rating.

Alternating current disconnectors (isolators) and earthing switches for voltages above 1000 V: Part 3, Design and construction

Alternating current disconnectors (isolators) and earthing switches for voltages above 1000 V: Part 4, Type tests and routine tests.

Dimensions of terminals of high voltage switchgear and control gear.

General requirements for circuit breakers for voltages above 1000 V.

General requirements for switchgear and control gear for voltages exceeding 1000 V

Guide for testing of circuit breakers with respect to out-of-phase switching.

Interconnecting bus bars for AC voltage above 1 kV upto and including 36 kV

Metal-enclosed switchgear and control gear for voltage above 1000 V but not exceeding 11000 volts (with
amendment No.1)

Methods of synthetic testing of high voltage alternating current circuit breakers. 13516:1993


Application guide for voltage transformers (first revision) 4146:1993


Current transformer:Part 4, Protective current transformers for special purpose applications (Second revision) 2705(Part 4):1992

Voltage transformers:Part 1, General requirements (second revision) 3156(Part 1):1992

Voltage transformers:Part 2, Measuring voltage transformers (second revision) 3156(Part 2):1992

Voltage transformers:Part 3, Protective voltage transformers (second revision) 3156 (Part 3):1992

Voltage transformers:Part 4, Capacitor voltage transformer (second revision) 3156(Part 4):1992

Circuit Breakers for over current protection for household and similar installations (first revision) 8828:1993


Code of practice for selection, installation and maintenance of switchgear and controlgear: Part 4, Maintenance.

Distribution pillars for voltages not exceeding 1000 Volts (first revision)

Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000 V (second revision)

Guide for marking of insulated conductors (first revision)

Identification of terminals of contactors and associated overload relays


LV switchgear and control gear, Part 2, Circuit breakers (superceding IS 2516(Part 1 & 2/Section 1):1985

LV switchgear and control gear Part 3, Switches, disconnectors, switch-disconnectors and fuse combination unit (Superceding IS 4064(Part 1 & 2)

LV switchgear and control gear Part 4, Contactors and motor starters Section 1, Electromechanical {Superceding IS 2959 and IS 8544 (all Parts)}

LV switchgear and control gear Part 5, Control circuit devices and switching elements, Section 1 Electromechanical control devices {Superceding IS 6875

Miniature circuit breaker boards for voltage upto and including 1000 volts AC.

Specification for low voltage switchgear and control gear assemblies: Part 1, Requirements for type-tested and partially type tested assemblies (first revision)

Specification for low voltage switchgear and control gear assemblies: Part 2, Particular requirements for bus bar trunking systems (busways) (first revision)

LV Switchgear and controlgear assemblies: Part 3, Particular requirements for equipment where unskilled persons have access for their use.
Code of practice for installation and maintenance of power cables upto and including 33 kV rating (second revision) 1255:1983

Compression type tubular in-line connectors for aluminum conductors of insulated cables (first revision) 8308:1993

Compression type tubular terminal ends for aluminum conductors of insulated (with amendment No.1) 8309:1993

Conductors for insulated electric cables and flexible cords (first revision) 8130:1984

Cross linked polyethylene insulated PVC sheathed cables:Part 1 for working voltage upto and including 1100 V (first revision) 7098(1):1988

Cross linked polyethylene insulated PVC sheathed cables:Part 2 for working voltage from 3.3 kV upto and including 33 kV (first revision) (with amendment No.2) 7098(2):1985

Drums for electric cables. 10418:1982

Methods of test for cables :Part 0, General 10810(Part 0):1984

PVC insulated cables for working voltages up to and including 1100 V (third revision) 694:1990

Application guide for electrical relays for AC systems: Part 1, Overcurrent relays for feeders and transformers 3842(Part 1):1967

Application guide for electrical relays for AC systems: Part 2, Overcurrent relays for generators and motors 3842(Part 2):1966

Application guide for electrical relays for AC systems: Part 3, Phase unbalance relays including negative phase sequence relays (with amendment No.1) 3842(Part 3):1966

Application guide for electrical relays for AC systems: Part 4, Thermal relays (with amendment No.1) 3842(Part 4):1966

Application guide for electrical relays for AC systems: Part 5, Distance protection relays 3842(Part 5):1968

Application guide for electrical relays for AC systems: Part
Application guide for electrical relays for AC systems: Part 7  
Frequency relays. 3842(Part 7):1972

Application guide for electrical relays for AC systems: Part 8, Voltage relays. 3842(Part 8):1976

Application guide for electrical relays for AC systems: Part 9, Relays for bus bar protection. 3842(Part 9):1977

Application guide for electrical relays for AC systems: Part 10, Relays for transverse differential protection 3842(Part 10):1976

Application guide for electrical relays for AC systems: Part 12, Differential relays for transformers. 3842(Part 12):1976

Specification for electrical relays for power system protection (with amendment No.4) 3231(Part 0):1986

Application guide for on-load tap changers 8478:1977

Application guide for power transformers 10561:1983

Cable sealing boxes for oil immersed transformers suitable for paper insulated lead sheathed cables for highest system voltages from 12 kV up to and including 36 kV. 9147:1979

5. ASSOCIATED SERVICES WORKS.

The Contractor shall co-ordinate his Working Drawings with required co-ordination of all other works simultaneously going on at site

8. COMPLIANCE WITH STATUTORY AND OTHER REGULATIONS.

8.1 STATUTORY REGULATIONS:
Comply with all relevant statutory instruments and regulations current at the date of tender and in particular the following:

The installation shall be in conformity with the Bye-laws, Regulations and Standards of the local authorities concerned, in so far as these become applicable to the
installation. But if these Specifications and Drawings call for a higher standard of materials and / or workmanship than those required by any of the above regulations and standards, then these Specifications and Drawings shall take precedence over the said regulations and standards. However, if the Drawings and specifications require something which violates the Bye-laws and Regulations, then the Bye-laws and Regulations shall govern the requirement of this installation.

8.2 OTHER REGULATIONS:


9 EXTENT OF WORKS.

9.1 LABOUR AND MATERIAL:

Provide all labour and, unless otherwise indicated, all materials and equipment to form a complete design and installation. All materials and equipment shall conform to the relevant Indian Standards and shall be of the approved make and design. Makes shall be strictly in conformity with list of approved manufacturers as per list enclosed. Any item which is of different brand/make/model from the approved list, if proposed by the Contractor, shall be supported by the credit to the Owner’s account (Savings). All such proposals shall be got approved in writing from the Architects, Consultants or Owner. The Contractor shall be responsible for safe storage and custody of all materials and shall have insured them, indemnifying the Architects, Consultants or Owner.

9.2 SUNDRY COMPONENTS:

Provide all incidental sundry components necessary for the complete execution of the works and for the proper operation of the installation, with their labour charges, whether or not these sundry components are mentioned in the Contract Documents.

9.3 TESTS:

1. Carry out all tests, adjustments and commissioning described in this Specification in order to give an effective working installation to the satisfaction of the Engineer. The work package contractor shall establish a database of all tests and test results and ensure that this is kept up to date. A record of the test results/progress shall be recorded at each site meeting.
2. Adequate notice shall be given to allow the engineer to study, assess and review any test procedures to be witnessed. The minimum notice required shall be forty eight (48) hours.

3. The contractor shall submit a full method statement indicating the tests, and testing procedures to be carried out/ witnessed etc. Details of all instrumentation used shall be recorded.

4. The original test sheet of all tests witnessed by the Engineer must be signed and witnessed by the engineer and a copy of the test sheet handed over to the engineer immediately following the test(s). Any unsigned test record shall be rejected by the engineer and the specific equipment/plant item retested. Any cost associated with this retesting shall be borne by the work package contractor.

9.4 WORKMANSHIP:
Carry out all installations in a neat and workmanlike manner to the satisfaction of the Engineer.

9.5 WORKING DRAWINGS:
Provide drawings as described in this Specification.

9.6 INSTRUCTION MANUALS:
Provide manuals as described in this Specification.

10. MANUFACTURES.

10.1 Provide materials and equipment for each service or function, as far as practicable, of one manufacture.

11. SUPERVISION.

11.1 Provide, throughout the whole period in which installation work is being carried out, a suitably qualified site supervision to oversee the complete installation work.

11.2 Supervision by the Engineer shall in no way relieve the Contractor from fully supervising the correct installation of the works.

12. SITE ENGINEER.

The Contractor shall employ a competent, licensed qualified full time electrical Engineer to direct the work of electrical installations in accordance with the drawings and specifications. The Engineer shall be available at all times on the site to receive
instructions from the Architect/Owner in the day to day activities throughout the duration of the contract. The Engineer shall correlate the progress of the work in conjunction with all the relevant requirements of the supply authority. The skilled workers employed for the work should have requisite qualifications and should possess competency certificate from the Electrical Inspectorate of Local Administration.

13. **QUALITY ASSURANCE.**

Continually monitor the quality of material and workmanship on site to ensure that only approved materials are employed and that they are installed in the proper manner for their purpose and entirely in accordance with the approved standards and installation methods.

14. **SUBSTITUTION OF NON-APPROVED MATERIALS.**

14.1 Should any material or equipment be used without approval, the Engineer reserves the right to request the substitution of the correct material or equipment. Should any substitution be necessary the Contractor will bear the cost of any associated builder's work or making good.

14.2 The acceptance of alternatives must be agreed and confirmed in writing by the Engineer. Adequate time shall be given in order to allow the Engineer to study, assess and review any alternatives offered.

15. **SAMPLES.**

15.1 Provide samples of any materials to be used on site as and when requested by the Engineer.

15.2 Note that the Engineer may require the samples to be subjected to tests to ensure compliance with British Standard and other relevant specifications. The cost of such tests shall be borne by the Contractor. Adequate time shall be given in order to allow the Engineer to study, assess and review any sample offered.

16. **TEMPORARY USE OF INSTALLATIONS.**

Do-not use any of the installations for any temporary purpose, except installation and commissioning tests, without approval from the Engineer.

17. **TEST AND INSPECTION OF CONTRACTOR’S WORK.**
17.1 The Engineer shall have access at all reasonable times to such parts of the Contractor's work as may be necessary for the purpose of inspecting and testing the materials, workmanship and performance of the plant.

17.2 The Contractor shall provide all labour, apparatus and instruments for carrying out routine tests in the presence of the Engineer.

18. WORKING DRAWINGS.

Prepare and submit to the Engineer for comments. Four paper prints of detailed drawings for the accurate and proper execution of the works. Ensure that before commencing all Architect's and Structural Engineer's drawings have been consulted and, where available, installation drawings from other trades and specialist equipment suppliers. Amend and resubmit any drawing as requested.

18.1 FORMAT:

All drawings shall be prepared in C.A.D. to the Client procedural notes, capable of being accessed by Autodesk ACAD LT2000. Drawings shall be A1 metric size to BS3429:1975 and in accordance with BS 308: Part 1: 1972 or equivalent Indian standards. Text shall be sized such that it can be easily read when the drawings are reduced to A3 size.

18.2 TITLE:

Incorporate an approved 'Title Block` on all drawings with the following information clearly indicated.

1. Name of project.

2. Scale of drawing.

3. Title of drawing, incorporating the name and location of the service or services shown.

4. Drawing number in accordance with an approved numbering system designed for use by all trades.

5. Name and address of the Main Contractor and the Sub-Contractor.

19.3 INSTALLATION DRAWINGS:

1. Show routes and sizes of all multi-core cables.

2. Show routes, fixing methods, separation details and sizes of all cable ladder, trays and trunking.
3. Show location of all distribution equipment, control panels, and terminal equipment.

19.4 WIRING DIAGRAMS:

1. Provide wiring diagrams for all systems detailing all circuitry within equipment together with inter-connecting wiring to associated equipment.

2. Indicate containing system for external circuit wiring.

3. Indicate the sizes and types of all cables together with the ratings of all such items as fuses, switches and control devices.

4. Show all terminal markings.

5. Arrange the circuit diagrams, where possible, so that the main sequence of events is from left to right and from top to bottom of the diagram and produce the diagrams generally in compliance with BS 3939.

6. Provide a schedule on each drawing to explain the abbreviations employed for the designation of components.

7. Securely fix and protect by non flammable transparent material a print of each of the circuit and layout diagrams to the inside of the hinged front door of the panels, as appropriate, or in such other positions as may be agreed with the Engineer. Reduce the prints to a suitable size in cases where inadequate space exists.

8. Individual circuit and layout drawings from component manufacturers will not be accepted in lieu of an overall drawing.

20. MANUFACTURER'S DRAWINGS:

1. Provide manufacturer's certified 'as made' drawings and illustrative literature.

2. Detail all internal circuitry and arrangement of equipment.

3. Detail external layout of equipment including terminals and indicate any restrictions of access to equipment, lifting information and fixing recommendations.

4. Indicate all component ratings, terminal references and wiring sizes.

21. BUILDERS WORK DRAWINGS:
1. Provide Builderswork drawings showing full dimensions of all foundations, bases, plinths, holes and the like as well as the overall size and mass of the plant concerned.

2. Holes, fixings and the like other than in plantrooms, switchrooms and roof areas may be marked out on site, with the agreement of the Engineer, instead of on drawings.

22. **CONTRACTOR'S RESPONSIBILITY:**

1. Comment by the Engineer on any drawings will not relieve the Contractor of his responsibility with respect to the accuracy of such drawings, nor to provide suitable equipment as specified, provide that any discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing by the Engineer.

2. Any delay resulting from the failure to provide accurate and sufficient drawings and other information in time to suit the construction programmed will be the Contractor’s Responsibility.

3. The Contractor's attention is drawn to the need to provide extremely comprehensive documentation with regard to the plant & materials associated with the convention meetings, in order to allow fault finding / remedial action to be carried out as quickly as possible.

23. **PROGRESS DRAWINGS:**

1. Maintain on site a set of drawings showing the progress of the works and any modifications carried out during the installation stage. The progress drawings shall be transferred/maintained/kept up to date via the C.A.D. drawings, which shall ultimately form the record drawings.

2. Progress drawings shall be available to the Engineer for his inspection during the contract period.

24. **RECORD DRAWINGS:**

24.1 Produce a comprehensive set of 'as installed' drawings, based on the Progress Drawings, for the purpose of providing a complete and clear record of the Works for the future users.

24.2 **FORMAT:**

Produce the final drawings, after corrections to take into account any comments by the Engineer, to a standard A1 metric size to BS 3429 : 1975 and in accordance with BS 308 : Part 1 : 1972 to ensure suitability for micro-filming.
24.3 **C.A.D. RECORD DRAWINGS:**
The Contractor shall together with the paper prints of the Record Drawing hand over two copies on separate CD-Readable media C.A.D. files in D.X.F. format of all Record drawings. Each disk shall also contain an A.S.C.I. "README.TXT" detailing the contents of the disk and any special information relating to the use of the disk.

24.4 **TITLE:**
Incorporate an approved 'Title Block' on all drawings with the following information clearly indicated.

1. Name of project
2. Scale of drawing
3. Title of drawing incorporating the name and location of the service or services shown.
4. Drawing number in accordance with an approved numbering system designed for use by all trades.
5. Name and address of the Main Contractor and the Sub-Contractor.
6. Contract number for the Main Contractor and the Sub-Contractor.
7. Date of completion of the installation.

24.5. **CONTENT:**
Ensure that the drawings contain the following information for each service installed.

1. The precise location of all multi-core cables.
2. The routes of all cable ladder, trays and trunking including number and sizes of the cables associated with them.
3. Location of distribution equipment, control panels and terminal equipment.
4. The name of the manufacturer, model and type number and all details of duty and rating of all items of equipment.
5. The precise locations, sizes, types and duty of all conduits concealed within the building structure including draw-in boxes.
6. The precise locations, depths, sizes and duty of all underground services, including cables, pipes, inspection chambers, cable markers, and precise entry points to buildings.

24.6 DRAWINGS.

1. Provide to the Engineer for comments at the time of the final inspection two paper prints of each of the preliminary Record Drawings.

2. Provide the Employer with two paper prints and one polyester negative of each final drawing within two weeks of practical completion.

24.7 CONTRACTOR’S RESPONSIBILITY:

Comments by the Engineer on any Record Drawing will not relieve the, Contractor of his responsibility with respect to the Accuracy of the drawing, nor will it imply the Engineer’s acceptance of responsibility for the accuracy of completeness of the drawing.

1. The Contractors attention is drawn to the need to provide extremely comprehensive documentation with regard to the plant & materials associated with the convention meetings, in order to allow fault finding / remedial action to be carried out as quickly as possible.

25. INSTRUCTION MANUALS.

25.1 GENERAL:
Compile a comprehensive set of Manuals for the purpose of providing the future users with a clear and complete understanding of the correct procedures for operating and maintaining all installations, plant and equipment installed under the electrical section of the work.

25.2 CONTENT:

Provide the following information:

1. Detailed description of all operation procedures.

2. Full details of the regular maintenance procedures recommended by the Manufacturer’s for each item of equipment.

3. List of spare parts to be kept in store for each item of equipment in accordance with the manufacturer's recommendations.
4. Manufacturer's printed manuals, regarding operating and maintenance procedures for all items of equipment.

5. Fully detailed manufacturer's drawings showing the construction of each item of equipment.

6. Fully detailed internal and external wiring diagrams.

7. Where two or more items of equipment are identical then one set of instructions will be accepted, but in the case of similar, but not identical items, then a set of instructions must be provided for each item.

**25.3 INDEXING:**

Clearly indicate on the cover or on the inside front page of the Manuals the following information:

1. Document Index and/or Content List. The index may include only the main headings of all sections of the document, but in that case the individual sections should be preceded by a content list giving full details of the documentation included within the section.

2. Name, address and telephone number of the Contractor.

3. Date of installation.

**26 ISSUE:**

1. Supply one copy of the preliminary manuals to the Project Manager for comments not less than eight weeks prior to the final inspection preceding the 'hand over' to the Employer.

2. Provide the Employer with two copies of the final and approved manuals at the date of 'hand over' of the completed Contract.

**27 FORMAT:**

Compile the final copies of the manuals after corrections to take into account any comments made by the Engineer, into adequately bound volumes with suitable covers to withstand continual usage.

**28 FAILURE OF INSTALLATION:**

Failure of any part of the installation subsequent to the 'hand over' that can be attributed to lack of maintenance or incorrect operation by the User caused by
omitting to supply adequately detailed Operating and Maintenance Procedures at the time of 'hand over', must be rectified at no expense to the Employer.

1. The Contractor's attention is drawn to the need to provide extremely comprehensive documentation with regard to the plant & materials associated with the convention meetings, in order to allow fault finding / remedial action to be carried out as quickly as possible.

29. **INSTRUCTION OF EMPLOYER'S STAFF:**

29.1 **COMMISSIONING PERIOD:**

Set all the installations to work during the commissioning period, and employ competent personnel (including manufacturer's representatives as necessary) to demonstrate and explain to the Employer's staff, with the aid of the Instruction Manuals, the correct procedures for operating and maintaining the complete installation.

29.2 **PERIOD OF INSTRUCTION:**

Ensure that adequate time is made available to properly instruct the end users staff in the operation and use of the plant equipment. The instruction shall be carried out by way of a series of workshops presented by the work package contractor and assisted by the specialist supplier’s staff, as required. Allow for the training to be carried out on site along with the workshops, which will be held in the DWTC meeting room. Major services workshops held in the DWTC premises will be presented via a power point presentation and drawings.

30. **SWITCH ROOM NOTICES.**

30.1 **SCHEMATIC DIAGRAM:**

Provide in each main switch room a durable non-fading print of the schematic diagram on a varnish timber base with a perspex front cover, or equal, and erect it on the switch room wall using screw fixings.

30.2 **TREATMENT FOR SHOCK CARD:**

1. Provide in each main switch room a card which indicates the action necessary in the treatment of persons injured by electric shock.

2. Mount the card on a varnished timber base with a perspex front cover or equal and erect it on the switch room wall using screw fixings.

30.3 **INSPECTION NOTICE:**

1. Provide a Periodic Inspection Notice in the form prescribed in the IEE Regulations, with the addition of the Installing Contractor's name.
2. Mount the notice on a varnished timber base with a perspex front cover, or equal and erect on the main switch room wall beside the schematic drawings using screw fixings.

31. **MATERIALS TO BE HANDED OVER.**

31.1 Hand over to the Employer, spare fuses, tools, loose equipment and the like (where specified) and obtain the Employer's signature of receipt for such material.

31.2 Submit a copy of each receipt with the final account for the Contract, together with an inventory of the materials handed over.

31.3 Spare parts and tools

32 **SPARE PARTS:**

Hand over to the Employer the spare parts specified.

33 **TOOLS:**

Provide specialist tools sufficient to carry out maintenance and major repair work on switchgear, electrical equipment and plant items included in the Contract.

34 **QUIET OPERATION AND VIBRATION ISOLATION.**

All equipment shall operate under all conditions of load without any sound or vibration, which is objectionable in the opinion of the Owner's site representative. In case of rotating machinery sound or vibration noticeable outside the room in which it is installed, or annoyingly noticeable inside its own room, shall be considered objectionable. Such conditions shall be corrected by the Contractor at his own expense. The Contractor shall guarantee that the equipment installed shall maintain the specified NC levels.

35. **ACCESSIBILITY**

The Contractor shall verify the sufficiency of the size of the shaft openings, clearances in cavity walls and suspended ceilings for proper installation of his ducting and piping. His failure to communicate insufficiency of any of the above, shall constitute his acceptance of sufficiency of the same. The Contractor shall locate all equipment, which must be serviced, operated or maintained in fully accessible positions. The exact location and size of all access panels, required for each concealed control damper, valve or other requiring attendance, should be finalized and communicated in sufficient time, to be provided in the normal course of work. Failing this, the Contractor shall make all the necessary repairs and changes at his
own expense. Accessibility (Access panel / Access) shall be standardized for each piece of
equipment / device / accessory and shall be clearly nomenclature / marked.

36. COMPLETION CERTIFICATE (By Contractor’s Licenced Personnel)

On completion of the installation, a certificate shall be furnished by the Contractor, counter
signed by the licensed supervisor, under whose direct supervision the installation was carried
out. This certificate shall be in the prescribed form as required by the local authority.

The Contractor shall be responsible for getting the entire installation for the system duly
approved

37.1 FACTORY INSPECTION AND TESTING.

The Owner may carry out inspection and testing at Manufacturer’s works for
equipment covered herein. All such testing and inspection expenses shall be to
Contractor’s account. Such tests shall generally prove that the equipment to be
 supplied complies the Specifications and relevant Standards. Tests shall also
demonstrate suitability in terms of site conditions, operational and control facilities,
circuitry of controls, protection etc.

If performance tests are not satisfactory, the Contractor shall, at his own expenses,
rectify the defects observed, and re-conduct the tests to Owner’s satisfaction. The
equipment shall be tested again after removal of defects, found if any, and shall be
delivered and installed only after approval by the Owner’s representative. Equipment
shall be delivered without the consent from Owner, in writing.

37.2 ON SITE TRAINING

Upon completion of all work and all tests, the Contractor shall furnish necessary
operators, labour and helpers for operating the entire installation for a period of
fifteen (15) working days of ten (10) hours each, to enable the Owner’s staff to get
acquainted with the operation of the system. During this period, the Contractor shall
train the Owner’s personnel in the operation, adjustment and maintenance of all
equipment installed. A certificate to the effect that adequate training has been
imparted shall be obtained by Contractor from the Owner’s designated official.

38. MAINTENANCE DURING DEFECTS LIABILITY PERIOD.

1. Complaints.
The Contractor shall receive calls for any and all problems experienced in the operation of the system under this contract, attend to these within 10 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

2. Repairs.

All equipment that requires repairing shall be immediately serviced and repaired. Since the period of Maintenance runs concurrently with the defects liability period, all replacement parts and labors shall be supplied promptly free-of-charge to the Owner.

39. **UP TIME GUARANTEE.**

- The Contractor shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the Defects Liability period shall get extended by a month for every month having shortfall. In case of shortfall beyond the defects liability period, the contract for Operation and Maintenance shall get extended by a month for every month having the shortfall and no reimbursement shall be made for the extended period.

- The Contractor shall provide log in the form of diskettes and bound printed comprehensive log book containing tables for daily record of all, power consumption, voltage, amperage, p.f. and all other parameters related to the installation, ambient temperature, temperature of the equipment, starting and stopping times for various equipment, daily services rendered for the system alarms, maintenance and record of unusual observations etc. Contractor shall also submit preventive maintenance schedule.

- Each tenderer shall submit along with the tender, a detailed operation assistance proposal for the Owner’s site representatives/Consultant’s review. This shall include the type of service planned to be offered during Defects Liability Period and beyond. The operation assistance proposal shall give the details of the proposed monthly reports to the Management.

- The tenderer shall include a list of other projects where such an Operation Assistance has been provided.

40. **INVENTORY:**

Provide an inventory in duplicate, which lists and identifies by manufacturer's references each spare part or tool handed over to the Employer at the Practical Completion of the Contract.

41. **GENERAL SCOPE.**

41.1 The Contractor shall furnish all tools, welding equipment testing equipment, test connections and kits, etc. required for complete installation, testing and commissioning of the items included in the contract work.
41.2 The rates quoted by Contractor shall include all necessary MS channels, angles, etc. required for erection of panels, distribution boards, etc. in floor walls/ cable trenches as required.

41.3 The contractor shall co-operate through the Architect/Owner/Engineer with other contractors at site, in all matters of common interest, so as not to obstruct operation of others and to ensure the safety of all personnel and works covered under this specification.

41.4 The work shall be carried out strictly as per the instructions and execution drawings. In case of any doubt/misunderstanding as to correct interpretation of the drawings or instructions, necessary clarifications shall be obtained from the Owner/Architect. This contractor shall be held responsible for any damage to the equipment consequent to not following the Manufacturer's instructions correctly. All necessary drawings, Manufacturer’s equipment manuals shall be furnished to the owners and a copy to Architects.

41.5 All thefts of equipments/component parts, after take over by the Contractor, till the installation is handed over to the Owner, shall be made good by the Contractor.

41.6 The Contractor shall have a separate cleaning gang to clean all equipment under erection and as well as the work area at regular intervals to the satisfaction of the Owner/Architects. In case the cleaning is not to the Owner's satisfaction he will have the right to carryout the cleaning operations and any expenditure incurred by the Owner in this regard will be to the Contractor’s account.

41.7 In order to avoid hazards to personnel moving around the equipment such as switchgear, etc. which is kept charged after installation before commissioning, such equipment shall be suitably cordoned off to prevent anyone accidentally going near it.

41.8 The Contractor shall carry out touch-up painting on any equipment indicated by the Owners/Architects, if the finish paint on the equipment is soiled or marred during installation handling.

41.9 Equipment shall be installed in a professional manner so that it is novel, plumb, and square and properly aligned and oriented. No equipment shall be permanently bolted down to foundation or structure until the alignment has been, checked and found acceptable by the Owner/Architects.

42 TOOLS, TACKLES AND OTHER MATERIALS.
42.1 The Contractor shall also furnish all necessary consumables like anchor bolts and nuts, rawl plugs, hacksaw blades, taps, dies, drills, files, wire brushes, necessary pipe scaffolding, ladders, wooden and consumable material like oxygen, acetylene, greases, cleaning fluids, fasteners, gaskets, temporary supports, cotton waste and all other miscellaneous supplies of every kind required for carrying out the work under the contract.

42.2 The Contractor shall not dispose off transport or withdraw any tools, tackles, equipment and material provided by him for the contract without taking prior written approval from Owner/Architect. Owner/Architect at all times shall have right to refuse permission for disposal, transport or withdrawal of tools, tackles, equipment and material if in his opinion, the same will adversely affect the efficient and expeditious completion of the project.

43 HANDING OVER AND TAKING OVER OF WORKS / EQUIPMENT / SYSTEMS.

The Contractor shall hand over and the Owner shall take over the works/equipments/systems covered under this contract only after they have been completely installed, tested and commissioned in all respects by the Contractor to the entire satisfaction of the Owner/Architect and after the said operation. And all relevant test forms/certificates operation and maintenance manual's, as built drawings, etc. Incomplete/partly commissioned works/equipments/system will not be taken over by the Owner. In this regard, the decision of the Owner/Architect will be final and binding on the Contractor.

44. ACTUAL QUANTITIES.

The Contractor shall verify the exact quantities of materials/equipments cables, etc., required after site measurements as per execution drawings by the engineer before procuring the same.

TECHNICAL SPECIFICATION FOR 415 VOLTS SWITCH BOARDS (INDOOR/OUTDOOR)

1. SCOPE.

This specification is intended to cover the design, manufacture, assembly, testing at manufacturer's works, properly packed for transportation, supply and delivery testing and commissioning complete in all respects with all components, fittings and accessories for efficient and trouble-free operation as specified hereinafter for the proposed project.

2. GENERAL_INFORMATION.

2.1 The equipment’s shall be designed, manufactured and equipped with accessories in accordance with this specification and the applicable codes.
standards indicated below. Materials and components not specifically stated in this specification but which are necessary for satisfactory and trouble free operation and maintenance of the equipment shall be supplied.

2.2 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance and service life as specified herein.

2.3 Switchboards shall be suitable for an ambient temperature of 45 Deg C.

3. CODES_AND_STANDARDS.

The equipment covered by this specification shall unless otherwise stated be designed, constructed and tested in accordance with the requirements of the Indian Electricity Act and Rules and latest revision of the following standards.

IS 375 : Arrangement of bus bars, main connection and auxiliary wiring.

IS 335 : Insulating coils.

IS 722 : AC electricity meters.

IS 1248 : Direct acting electrical indicating instruments.

IS 13947 : Motor starters AC, for voltage not exceeding 1000 V (Part-4,Sec 1) : Direct-on-line AC starters.

IS 2099 : Bushings.

IS 13947 : Degree of protection provided by enclosures for low voltage (Part - I) switchgear and control gear

IS 2419 : Dimensions of panel mounted electrical indicating and recording instruments.

IS 13947 : Circuit Breakers. (Part 2)

IS 2607 : Air-break isolators for voltage not exceeding 1000 Volts.

IS 2705 : Current Transformers.

IS 4201 : Application guide for CT's

IS 13947 : Contractors for voltages not exceeding (Part 4, sec 1) : 1000 V AC or 1200 V DC.

IS 3072 : Installation and maintenance of switchgear
IS 3231 : Electrical relays for power system protection.
IS 13947 : Air-break switches, air-break disconnectors and fuse combination units for voltages not exceeding 1000 V AC or 1200 V DC.
IS 3842 : Application guide for electrical relays: for AC System.
IS 4047 : Heavy duty air break switches and composite units of air break switches and fuses for voltages not exceeding 1000 V.
IS 4146 : Voltage Transformers.
IS 3156

IS 13947 : General requirements for switchgear and control gear for voltages not exceeding 1000 Volts.
IS 4483 : Preferred panel cut-out dimensions for electrical relays.
IS 5124 : Induction motor starters, AC (voltage: not exceeding 1000 V) installation and maintenance of code of practice.
IS 5987 : Selection of switches (voltage: not exceeding 1000 V)
IS 6875 : Control switches for voltages up to and including 1000V AC & 1200 DC.
IS 8588 : Code of practice for thermostatic bimetals Part-I general requirements and method of tests.
IS 8623 : Factory built assemblies of switchgear and control gear for voltages up to and including 1000 V AC and 1200 V DC.
IS 8828 : Miniature air-break circuit breakers for voltages not exceeding 1000 Volts.

4. SCOPE_OF_SUPPLY_UNDER_THIS_SPECIFICATION / CONTRACT.

As per Schedule of Quantities enclosed.

5. DESIGN_REQUIREMENT.

- The switchboards shall be designed for 415 V, 3 phase, 4 wire, 50 c/s supply.
• Switchboards shall be suitable for direct-on-line starting of all motors.

• Switchboards shall be rated for minimum fault level as mentioned in data sheets / Drawings.

• Control power supply of the switchboards shall be 240 V, 1 Phase, 50 Hz AC supply tapped from the respective module itself.

• The switchboards manufacturers shall apply all derating factors necessary to all components of the switchboards to comply with the conditions detailed in this specification.

• The ratings of motors, control-gears, fuse switches, etc. furnished in the drawings are for tender purposes only. Any changes in the above will be intimated at the time of placement of purchase order or before fabrication of panels.

• The MCC shall be modular, non-draw out type with DOL starters.

6. CONSTRUCTIONAL_FEATURES.

   The switchboard shall be:

   1. Of the totally metal enclosed, indoor, floor mounted, free standing cubicle type with draw out ACB and fixed type fuse switch units, with compartmentalized design.

   2. Made up of the requisite vertical sections, which when coupled together shall form continuous dead front switch boards.

   3. Provide dust and damp protection, the degree of protection being no less than IP 54 to IS 2147.

   4. Readily extensible on both sides by the addition of vertical sections after removal of the end covers.

   5. Provided with access to the feeders, bus bars, cable termination, cable alley etc. from front only.

   6. Each vertical section shall comprise:

   7. A front framed structure rolled/folded sheet steel channel section, of minimum 2 mm thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, fuse switch units, main horizontal bus bars, vertical risers and other front mounted accessories.

   8. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3 mm thickness and at least 75 mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.
9. Each compartment shall be provided with a hinged door interlocked with switch/breaker housed inside the compartment so that door can not be opened unless the switch/breaker is in 'OFF' position.

10. A cable chamber housing of minimum width 300 mm shall be provided for the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space of ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in and adjacent section.

11. A cover plate at the top of the vertical section, provided with a ventilation hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.

12. Front and rear doors shall be fitted with dust tight neoprene gaskets with easy operating type fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust. The doors shall have concealed hinges. Removable screwed covers shall be provided on the rear of the cubicles.

13. A set of horizontal main bus bars shall be provided at the top or bottom as required. The vertical bus bars shall be housed in separate fully enclosed chamber of min. width 350 mm and accessible from front and shall be tapped off from main horizontal bus bars.

14. All incoming/outgoing terminals of the individual feeders shall be provided with insulated shrouds to avoid accidental contact with live parts.

15. The height of the panel should not be more than 2200 mm. The working height shall be limited to a maximum height of 1800 mm. The total depth of the panel should be adequate to cater for proper cabling space. Panels arranged side by side or in same room shall have same height and depth.

16. Covers and partitions shall be of minimum 16 Gauge sheet steel, whereas doors shall be of min. 14 gauge sheet steel. All sheet steel work forming the exterior of switchboards shall be smoothly finished, leveled and free from flaws. The corners should be rounded.

17. All switches, push buttons etc. shall be operatable from the front and shall be flush/semi-flush mounted.

18. The apparatus and circuits shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary of degree of safety.

19. Apparatus forming part of the switchboards shall have the minimum clearances as per relevant IS. Clearances shall be maintained during normal service conditions. Creepage distances shall comply to those specified in relevant standards.
20. All insulating material shall be of DMC/FRP/SMC to withstand the effects of high humidity, high temperature, tropical ambient service conditions etc.

21. Each module of the draw out type switch boards shall have draw out type contacts for power termination both incoming and outgoing sides. The control leads shall also be wired through withdraw able contacts.

22. Foundation bolts and nuts for each panel shall be supplied along with the respective switchboard.

23. The lifting eyes for each shipping section and danger notice plates shall be provided for each switchboards.

24. Functional units such as circuit breakers and fuse switches

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

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

27. Cable termination’s of one functional unit, when working of those of adjacent unit/units.

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

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

7. METAL TREATMENT AND FINISH.

1. All steel work used in the construction of the switchboards should have undergone a rigorous metal treatment process.

2. All surface to be painted including interior and exterior of panels, and other metal parts shall be chemically treated to remove all rust, scale, grease and other adhering foreign matters. All parts shall be coated with two coats of highly corrosion resistant primer followed by two coats of synthetic enamel paint of approved colour of approved manufacturer. The finish shall be glossy or matt as required.

3. The complete treatment, painting, and drying with compressed air operations shall be done in dry and dust free atmosphere.

4. Should finished paint chip off or crinkle during transit/handling/installation, the contractor shall arrange for repainting the equipment at site at his own cost.
8. **BUSBARS.**

1. The bus bars shall be air insulated and made of high conductivity, high strength aluminum alloy complying with the requirements of grade E91E of IS 5082 and suitable for 415 Volts, 4 wire 50 Hz system.

2. The bus bars and connections shall be suitably supported/braced with non-hygroscopic DMC/FRP/SMC supports to provide a fault withstand capacity as specified.

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

4. The bus bars shall be liberally sized and shall have uniform cross section throughout, and shall be capable of carrying the rated current at 415 V continuously. The bus bars shall be designed to withstand a temperature rise of 45°C above the ambient. A current density of 0.8 Amps/Sqmm shall not be exceeded for Aluminum bus bars.

5. All bus connections, joints and taps shall be short and as straight as possible, and applied with contact grease in the mating surface.

6. The main horizontal bus bars shall be run through the entire length of the panel and shall be accessible for maintenance from the front as well as rear. Bus bar chamber shall have separately screwed covers. All bus bars, links etc. shall be provided with insulating cover to prevent accidental contacts. The natural bus bars shall have a continuous rating of at least 50% of the phase bus bars.

7. Bus bars shall be encased in colour coded heat shrunk PVC sleeves (snug fit type). An aluminum earth bus of size not less than 50 X 6 mm shall run through the length of switch boards at top or bottom as required.

9. **AIR CIRCUIT BREAKERS.**

1. Circuit breakers shall be TPN or 4P(neutral settable at 0.5 or 1 In), air break, horizontal drawout type. Microprocessor based protection release shall have self-diagnostics feature i.e Alarm/Indication for abnormal temperature rise in protection unit & mP release malfunction.

2. The breakers shall comply with the requirements of IS 13947 (Parts I & II & II/Sec. I) . The circuit breaker shall confirm to Isolation as per annexure 7.1.2 of IEC. It shall have :

3. A short circuit breaking capacity of not less than 50KA  RMS at 415 Volts 50 Hz AC.

4. A short circuit making capacity of 143 KA.

5. A short-time withstand circuit of 50 KA for 1 second.

6. Mechanical and electrical endurance (without maintenance) for 8000 operating cycles each
7. Electrical overload performance at 6 times the rated current, 110% of the rated voltage as recovery voltage and 0.5 power factor.

8. Dielectric test of 2.5 KV applied for one minute on main circuits.

9. Test evidence from a recognized independent Laboratory / Institution shall be furnished for compliance of the breakers with the above requirements.

10. The circuit breakers shall be fitted with detachable arc chutes on each pole designed to permit rapid dispersion, cooling and extinction of the arc. Interface barriers shall be provided to prevent flashover between phases.

11. Arcing contacts shall be of hard wearing material of copper tungsten or silver tungsten and shall be readily replaceable. Main contacts shall be of pure silver of high pressure butt type of generous cross section.

12. The operating mechanism shall be of robust design, with a minimum number of linkages to ensure maximum reliability. Manually operated circuit breakers shall be provided with spring operated closing mechanism which are independent of speed of manual operation. Electrically operated breakers shall have a motor wound spring charged closing mechanism. Breaker operation shall be independent of the motor which shall be used solely for charging the closing spring.

13. The operating mechanism shall be such that the breaker is at all times free to open immediately the trip coil is energized.

14. Mechanical operation indicators shall be provided to show open and closed position of the breaker. Electrically operated breakers shall be additionally provided with mechanical indications to show charged and discharged conditions of the charging spring.

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

16. The microprocessor base releases shall have following protections settable through navigation buttons/membrane pad-
   i. Overload protection with time delay.
   ii. Short-circuit protection with time delay.
   iii. Earth-fault protection with time delay (wherever specified in SLD/BOQ) Earth-fault alarm prior to earth-fault trip with LED lamp / Hooter is required to enable take preventive measure against E/F trip.

17. Microprocessor release shall have Segregated fault alarm/indications for O/L, S/C, E/F & mP failure. shunt trip & ZSI contact (to provide discrimination for S/C & E/F) under voltage release( wherever specified in SLD/BOQ).COM port(wherever specified in SLD/BOQ)
18. Circuit breakers shall be individually housed in sheet metal cassettes provided with hinged doors. The breaker along with its operating mechanism shall be mounted on a robust carriage moving on guide rollers within the cassette. Isolating contacts for both power and control circuits shall be of robust design and fully self-aligning. The assembly shall be designed to allow smooth and easy movement of the breaker within its cassette.

19. The breaker shall have three distinct positions within the cassette as follows:

a) 'Service' position : with main and auxiliary contacts connected.

b) 'Test' position : with power contacts fully disconnected and control circuit contacts connected.

c) 'Isolated' position : with both power and control circuit contacts fully disconnected.

20. It shall be possible to achieve any of the above positions with the cassette door closed. Mechanical position indicators shall be provided for the three positions of the breaker.

21. The moving portion of the circuit breaker shall be so interlocked that:

- It shall not be possible to isolate it from the connected position, or to plug it in from the isolated position with the breaker closed.

- The circuit breaker can be closed only when it is in one of the three positions or when it is fully out of the cassette.

- It shall not be possible to open the hinged door of the cassette unless the breaker is drawn to the isolated position.

- Inadvertent withdrawal of the circuit breaker too far beyond its supports is prevented by suitable stops.

22. Moving portions of breakers of the same ratings shall be interchangeable.

23. Provision shall be available for the padlocking of the circuit access flaps in any of the three positions.

24. Automatically operated safety shutters shall be provided to screen the fixed isolating contacts when the breaker is drawn out from the cassette.

25. The moving portion of the circuit breaker shall be provided with a heavy duty self-aligning earth contact, which shall make before and break after the main isolating contacts during insertion into and withdrawal from the service position of the breaker. Even in the isolated position positive earthing contact should exist.
26. Auxiliary switches directly operated by the breaker operating mechanism and having 4 NO and 4 NC contacts, shall be provided on each breaker. The auxiliary switch contacts shall have a minimum rated thermal current of 10 Amps.

10. MCCBs.

10.1 General.

i) The circuit breaker 3 or 4 pole shall fully comply with IEC60947(1&2) & IS13947(1&2). Certificate for all the sequences( sequence 1, 2 & 3) should be available. The circuit-breakers shall have no line-load restriction.

ii) All MCCBs shall have a rated operational voltage of 660V AC (50/60Hz).

10.2. Construction.

i) The breakers shall be operated by a toggle, which shall clearly indicate the three fundamental position ON, OFF & TRIPPED.

ii) If required all electrical accessories shall be fitted by manufacturer to avoid tampering at site.

10.3. Characteristics.

The protection release with thermal memory & EMC shall have –

i) Overload adjustable & Short circuit adjustable for ratings of 200A & above.

ii) For lower ratings overload protection shall be adjustable with fixed short-circuit protection.

iii) Earth fault protection(if specified) adjustable threshold with time delay.

iv) Upto 630A MCCBs shall be current-limiting type category A breakers. 800A & above the MCCBs shall be Category B with Icw rating.

v) the settings shall be adjustable, with a common adjustable knob for all 3-phases/neutral, without opening the cover;

vi) The breaking capacity of breakers shall not be less than 35kA

10.4. Operation.

i) The breaker will be equipped with extended rotary handle with facility for padlocking and door interlocking.
ii) The MCCB shall be equipped with a “push to trip” button to test operation and opening of the poles.

10.5. Options.

i) It shall be possible to combine the following functions if required as specified in SLD/BOQ:

ii) Earth leakage protection, Under-voltage protection or shunt trip release.

iii) Remote indication of circuit breaker trip condition & operational conditions (ON/OFF).

iv) Auxiliary contacts for electrical indication of MCCB position.

v) Alarm contacts should be available for remote indication of tripping on fault.

vi) Stored energy Motor mechanism.

10.6. Installation.

It should be possible to terminate Aluminum cable of required size for the current carrying capacity. The requisite size should be made available by means of extended terminals (as a standard offer) in case the direct terminals are not of adequate size. Adequate phase to phase clearance has to be ensured in case of extended terminations.

10.7. Contactors.

1. Contactors shall comply IS13947-4-1 for standards pertaining to contactors and motor starters.

   The contactor shall be capable of withstanding breaking & making capacities per following:
   
<table>
<thead>
<tr>
<th>Category</th>
<th>Making Current</th>
<th>Breaking Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC3</td>
<td>10 times Rated Current</td>
<td>8 times Rated current</td>
</tr>
<tr>
<td>AC4</td>
<td>12 times rated current</td>
<td>10 times rated current</td>
</tr>
</tbody>
</table>

   The impulse voltage withstand will be 8KV and insulation voltage 1000V.

2. The Contactors should operate without any deration at 55 deg. C for AC3 application.

3. The coil insulation class shall be preferably H class, to sustain frequent switching operations. The auxiliary contact block shall have a switching capacity of 240V at 2A.
4. Contactors shall have one auxiliary in-built and it shall be possible to have additional NO & NC contacts in steps of two.

5. Contactors used for capacitor application shall have built in damping resistors & block of early make poles.

10.8. Thermal Overload Relay.

- The TOR shall be capable of withstanding short circuit equal to seventeen times the rated thermal current (17 Ie).
- The TOR will be tripping class 10A as a standard or class 20 for certain applications where specified.
- The TOR should have built in single phasing protection and phase unbalance protection as per IEC947-4.
- The TOR shall have in built NO & NC contact.
- The setting shall be of the adjustable type and there should be a provision of sealing to make the same tamper proof.
- The TOR shall be suitable for Aluminum termination, with a maximum permissible temperature rise of 65K, at the terminals, with an ambient temperature of 40 deg. C.

11. MOTOR CIRCUIT BREAKER.

1. Motor protection circuit breaker for control and protection of motors.(MPCB)

2. The MPCB shall comply with the latest IEC 947 –1 (general rules), IEC 947 – 2 (for circuit breakers) and IEC 947 – 4 (motor starters).

3. The MPCB shall have a minimum electrical life of 100000 operations (at AC3 duty).

4. The MPCB shall be of current limiting type with a minimum breaking capacity of 15 kA at 415 V, 50Hz .

5. The MPCB should have built in phase loss and phase unbalance prevention.

6. The MPCB shall have continuously adjustable thermal overload setting from 60% - 100% of frame ampere and the magnetic pick-up (for short circuit protection) should get automatically adjusted to offer coordinated protection.

7. The MPCB should be capable of 100% Discrimination and Type 2 coordination, and the manufacturer shall furnish a selection chart for the same.
8. The MPCB shall have built in facility for padlocking in ‘OFF’ position. Change over contact block should be provided for O/L & S/C fault indication.

9. The MPCB shall have provision for mounting electrical auxiliaries like ON / OFF indication, TRIP indication, Remote switch-OFF through shunt or under voltage coil and panel building accessories like door interlock, common bus bar, etc. The addition of electrical control or rotary control must neither hide or lock the adjustments of the breaker.

12. MINIATURE CIRCUIT BREAKERS (MCB).

1. MCB for ratings up to 125 Amps shall be available in 1, 2, 3 or 4 pole versions.

   
i. It shall have trip free mechanism and toggle shall give positive contact indication.
   
   ii. Line supply may be connected to either top or bottom
   
   iii. The breaking capacity of the MCB shall be 10kA and energy limiting class 3.

3. The MCB shall be capable of being used as Incomer circuit breaker or as an isolator.

4. Electrical endurance of the MCB should preferably be 20,000 opns.

5. Power loss per pole shall be in accordance with IS8828 - 1996 and the same shall be furnished by the manufacturer’s ‘C’ curve type MCB should be used for lighting loads and ‘D’ curve type for SMPS/UPS circuits & control transformer protection.

13. RESIDUAL CURRENT CIRCUIT BREAKER (RCCB).

1. RCCB ratings from 25A to 125A shall comply with IS12640-1988/IEC1008.

2. The short circuit withstand capacity of the RCCB without the associated short circuit/overload protection shall be 6kA.

3. The Breaking Capacity shall be 1.5kA. Ratings and sensitivities shall be as specified in schedule of quantities.

4. There shall be clear identification of earth fault or overload/Short circuit fault on the RCCB.

5. The RCCB should be suitable for SMPS loads (i.e. unaffected by the d.c pulsed components, harmonics etc, lightning, line disturbances due to other equipments) and should not give nuisance tripping.
6. If RCBO is recommended for 2 Pole, it shall confirm to IEC1009 with B.C of 6kA.

7. If EL + MCB is recommended for 2/4 Pole, it shall confirm to IEC1008 with B.C of 10kA.

14. **AUTOMATIC SOURCE CHANGE-OVER SYSTEM (CIRCUIT BREAKERS):**

14.1 **General.**

i) The Automatic Source Change-over System (ASCS) shall be both mechanically and electrically interlocked to exclude any possibility of coupling together the normal and emergency sources.

ii) To ensure continuity of service both circuit breakers shall have two stable position, CLOSED and OPEN. It shall be possible to manually operate each circuit breaker in the event of the absence of control voltage.

iii) For maintenance purpose, the ASCS shall have a neutral position with both circuit breakers in the OPEN position. It shall also be possible to lock each circuit breaker in the OPEN position.

iv) Each circuit breaker of the ASCS shall be equipped with auxiliary contacts and alarm contacts (TRIPPED status indication).

14.2. **Construction.**

i) Operations of the circuit breakers shall be by individually momentarily energized motor, mounted on each breaker.

ii) The ASCS shall include 2 circuit-breakers; 3 pole / 4 pole(drawout for ACBs type and fixed for MCCBs type).

iii) The ASCS shall have an Electrical interlock via microprocessor & mechanical interlock via base plate / flexible or rigid links for the 2 circuit-breakers to prevent both breakers to be in ON condition at same time.

14.3. **Circuit breakers:**

i) The circuit breakers shall confirm to IS 13947-1&2 /IEC60947-1&2, confirming to test sequence 1,2 & 3. It shall confirm to Isolation standard as per annexure 7.1.2 of IEC. The breakers shall have no line load restriction & shall be suitable for operation on 3 phase 415 Volts, 50Hz supply.

ii) Rating & Breaking Capacity:
The rating of the circuit breaker & breaking capacity shall be as per the drawings and schedule of quantities.
14.4. Protection:

The setting range shall cover the following:

Overload - adjustable.

Short-circuit – adjustable for ratings of 200A and above .

Instantaneous Earth fault(if specified)- adjustable threshold with time delay.

14.5. Automatic Controller:

The ASCS shall be provided by a micro-processor based controller.

The controller shall have 4 position selection –
1. Automatic operation.
2. Forced operation of ‘Mains’ source.
3. Forced operation of Standby’ source.
4. Stop (both ‘Mains’ and ‘Standby’ sources off).

The following settable time delays shall be possible:

1. Time delay between loss of voltage in Mains and switching OFF the Mains breaker.
2. Time delay between restoration of Mains voltage and switching OFF of Standby breaker.
3. Time delay between switching OFF of mains breaker and switching ON of Standby breaker during which load shedding can be done.
4. Time delay switching OFF of Standby breaker and switching ON of Mains breaker during which shed load can be reconnected.
5. Time delay for confirmation of presence of ‘Mains’ source voltage before stopping the Generator set.
6. The controller shall be provided with status indication: ON, OFF, Fault-trip, Automatic mode.
7. It should be possible to achieve the following functions:
   i) monitor loss of one phase in the Mains supply and effect changeover; Automatically.
   (ii) to transfer to ‘Standby’ source only if supplementary contact is closed (genset under-voltage, low frequency lock-out)
   (iii) Maximum startup time for the ‘Standby’ source to be settable.
15. **ACCESSORIES:**

CB shall be provided with following accessories, if specified, in schedule of quantities. Further these devices shall be field fittable from the front and common for all ratings.

- Under-voltage
- Shunt-trip
- Closing coil
- Auxiliary contacts:

16. **TEST CERTIFICATE:**

Original Test certificate of the CB as per IS13947-2/IEC60947-2 shall be provided on request.

17. **COMBINATION-FUSE SWITCH UNITS (FSU's)**

a. The fuse switch units shall be of the load break, fault make heavy duty, cubicle type.

b. The fuse switch units shall be double break and have quick make and quick break mechanisms, designed to ensure positive operation even in the event of failure of operating springs.

c. All fuse switch contacts shall be silver plated at current transfer surfaces.

d. The unit shall be provided with a front operating handle. The ON and OFF positions of the switch handle shall be clearly marked.

e. Interlocks shall be provided so as to prevent opening of the unit door when the switch is in the ON position, and also to prevent closing of the switch with the door not properly secured. It should, however, be possible to defeat the interlock mechanism to operate the switch with the door open intentionally.

f. The switches shall be capable of withstanding the thermal and electro-magnetic stresses caused by short circuit currents for the time of operation of the associated fuse links.

g. Fuse switch and air break switch operating handles shall be provided with padlocking facilities to lock them in OFF position.

h. The interior arrangement of the switch unit shall be such that all 'live' parts are shrouded.
18. **INDICATING LAMPS (LED TYPE).**

i) LED type indicating lamps confirming to IEC947-5-1, class 2, IP65; shall be provided wherever called for in the control schematic diagrams. The lamps assembly shall be complete with LED, holders and lenses.

19. **SPACE_HEATERS.**

   o Each vertical section of the switch boards shall be provided with thermostat controlled space heaters rated for 240 Volts + or - 10%, single phase, 50 Hz. The heaters shall have individual ON-OFF switch.

   o Wiring of space heaters in each switchboards shall be grouped and brought out to easily accessible terminals for connection to power supply, through switch-fuse unit.

   o Each switchboard shall be provided with plug-socket with switch fuse for connection of hand lamp rated 240 V, 50 Hz. single phase.

20. **FUSES.**

   • All control and power fuses shall be link type HRC fuses and they shall be provided with visible indication to show that they have operated.

21. **CURRENT_TRANSFORMERS.**

   • Current transformers shall comply with the requirements of IS 2705. They shall have ratios, outputs and accuracy’s as specified/required.

   • Current transformers wherever required and called for in the single line diagram and/or required shall be furnished.

   • The CTs shall be bar primary, in epoxy encapsulated type, rated for 415 V. The CTs shall be designed to withstand the thermal and mechanical stresses resulting from the maximum short circuit current.

   • The vendor shall ensure that the VA output of the CTs are adequate for the relays, meters and loads connecting them.

   • The CTs shall be provided with Class A/Class B insulation and proper polarity markings in a suitable manner.

22. **INDICATING/INTEGRATING_METERS.**

   • All indicating instruments shall be of flush mounting industrial pattern, conforming to the relevant standard.
• The instruments shall have non-reflecting bezels, clearly divided and indelibly marked scales and shall be provided with adjusting devices in the front.

• Integrating instruments shall be of flush mounting switchboard pattern, conforming to the relevant standards.

• Meters shall be provided with circular 90 scale with square casing of specified size.

23. TESTS.

ROUTINE TESTS

• During manufacture and on completion, all equipment shall be subjected to IS routine tests.

The tests shall include but not necessarily limited to the following:

i) Operation under simulated service condition to ensure accuracy of wiring, correctness of control schemes, protection/metering scheme and proper functioning of the equipment.

ii) All wiring and current carrying part shall be given appropriate High voltage tests.

iii) Primary current and voltage shall be applied to all instrument transformers.

iv) Routine tests shall be carried out on all equipment such as circuit breakers, instrument transformers, relays, meters. Meters etc. shall be calibrated in accordance with relevant IS standards.

• MT instruments shall have + or - 1% accuracy on full scale. Each meter shall be magnetically screened.

24. CABLE TERMINATIONS.

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

• Switch board shall be designed either for top or bottom or combined entries and outgoings which will be confirmed by architects at the time of drawing approval. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. Removable undrilled plates shall be furnished for fitting the cable glands.
• Sufficient space shall be provided to avoid sharp bending and for easy connection. A minimum space of 200 mm from the gland plate to the nearest terminal block shall be provided.

• Multiway terminal blocks complete with screws, nuts, washers and marking strips shall be furnished for terminating the internal wiring and outgoing cables.

• Power and control terminals shall be washer head screw type or stud type complete with crimping type connectors. Screw type terminals with screws directly impinging on conductor are not acceptable.

• Each control terminal shall be capable for connection of 2 Nos. 2.5 mm standard copper wire at each ends.

• Not more than two wires shall be connected to any terminal. If necessary a number of terminals shall be jumpered together to provide wiring points.

• Atleast 20% spare terminals shall be provided in each module.

• Terminal blocks for current transformer secondary lead wires shall be provided with shorting and earthing facility.

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

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

25. CONTROL_WIRING.

The wiring shall be complete in all respects so as to ensure proper functioning of control, protection and interlocking scheme.

All wiring shall be completed up to terminal blocks on the side of each unit-module.

All control wiring shall be carried out with 1100/660 V grade single core PVC cable having stranded copper conductors of minimum 2.5 Sq. mm.

Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wires shall not be spliced or tapped between terminal point.

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

All spare contacts of relays and switches shall be wired up to the terminal blocks.
Each of the DC circuit shall be provided with two fuses one in the positive and the other in the negative for 2 wire DC underground system of specified voltage.

26. **GROUND_BUS.**

i) An aluminum ground bus rated to carry maximum fault current shall be furnished along the entire length of each switchboard. Each stationary unit shall be connected directly to this ground bus by two separate and distinct connections in accordance with Indian Electricity Rules.

ii) Grounding terminals on the ground bus shall be provided. Connectors shall be provided at either end of switch board for connection to station ground mat.

27. **TERMINAL_BLOCKS.**

Terminal blocks shall be of 660 Volts grade of stud type. Insulating barriers shall be provided between adjacent terminals.

Suitable provision shall be made to terminate control/power connections in the respective module.

Terminal blocks shall have a minimum current rating of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions. The wire termination’s to the blocks shall be of screw type suitable for crimp type socket.

28. **NAME_PLATE.**

The panel as well as feeders compartments shall be provided with name plate of anodized aluminum, with white engraving on black background. They shall be properly secured with self tapping screws at the top of the cubicles. The panel/feeder descriptions shall be as indicated in the drawings/employers. The size of the name plates shall be proportionate to the respective equipment’s.

Also individual panel number and danger plate shall be furnished at back of panel.

29. **ACCESSORIES.**

The following accessories shall be furnished along with each switchboard.

1. One (1) no. fuse pulling handle for each switchboard.

2. One (1) no. winding handle for withdrawing breaker from the cubicle.

3. Other accessories as deemed necessary for trouble free and efficient operation of the equipment offered.
30. **DRAWINGS AND MANUALS.**

The following drawings shall be supplied for each switchboard.

- General arrangement drawing for each type of board showing constructional features and space required in the front for withdrawal of breaker, power and control cable entry points, location of various devices, terminal blocks, cross sectional details, bus bar supports.

- Number of buses, etc. shall be submitted within 15 days from the date of letter of intent for approval.

- Foundation plan and anchor hold details including dead load and impact load.

- Drawing and data sheet for each component.

- Electrical wiring diagram.

- Terminal block arrangement drawing for outgoing feeders.

- Complete relay technical particulars and recommended settings.

- Operation, maintenance and installation manuals, (one set to Consultants).

- Technical Catalogues/Leaflets of CTs, meters, lamps, etc. shall be submitted along with offer.

- The approval of the drawing does not absolve the vendor from his obligation of ensuring proper and correctness of functioning/operation of the system.

31 **TESTS.**

**Routine And Type Test.**

Type test certificates and results as per relevant Standards (Specification) for all the equipment offered under the scope of this specification shall be furnished.

All routine tests on all major components shall be made as per relevant specification.

**Inspection :**
Inspection of the Switchboards including inspection of wiring and electrical operational tests by the Owner/Architect before dispatch should be arranged by the tenderer. The cost of transport and incidental expenses to be borne by the tenderer. Two weeks clear notice to be given for carrying out the inspection.

**Dielectric Tests:**

- Insulation of the main circuit that is the insulation resistance of each pole to the earth and that between the poles shall be measured.
- Insulation resistance to earth of all control wiring should be tested with 1000 V megger.
- Insulation test shall be carried out both before and after high voltage test.
- Each switch board will be completely assembled, wired, adjusted and tested for operation under simulated conditions to ensure correctness of wiring and proper functioning of all equipment’s.

32. **HIGH VOLTAGE TEST.**

A high voltage test with 2.5 KV for one minute shall be applied between the pole and earth. Test shall be carried out on each pole in turn with the remaining poles earthed. All units racked in position and the breakers closed. Originals test certificate shall be submitted along with panel.

33. **PACKING AND TRANSPORT.**

The switchboards shall be sent to site by Road Transport packed in Wooden Crates. The packing should be of high quality to avoid any damage to the equipment’s during transit. They shall be wrapped with polythene sheets before being placed in crates to prevent damage to the finish.

34. **HANDLING:**

Switchgears and all its accessories shall be handled carefully in its upright position as indicated in the packing case. Lifting lugs and jacking pads shall be used for lifting of the switchgear. While using jacking pads utmost care shall be taken in proper application of jacks. Where switchgears is dragged or pulled on sleeper or rollers of the traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles.

35. **STORAGE:**

Equipments shall be stored under shelter in a well ventilated, dry place and covered by suitable polythene or tarpaulin covers for protection against moisture.

36. **ERECTION:**
Panels shall be installed over a trench. The panels shall be aligned properly and bolted to the flooring by at least four bolts. The cables shall be terminated into the panel through bottom plate. The panel shall be bonded to the earth by connecting earthing leads to the panel earth bus.

Should finished paint chip off or crinkle during transit / handling/ installation, the Contractor shall arrange for repainting the equipment at site at his own cost.

37. TESTS:

The following preliminary checks and precommissioning tests shall be carried out before commissioning the Switchgears in the presence of Buyer/Architect's representatives.

37.1 PRELIMINARY CHECKS:

1. Check name plate details according to specification.
2. Check for physical damage.
3. Check tightness of all bolts, clamps and connecting terminals.
4. Check oil level, air pressure and leakage (wherever applicable).
5. Check earth connection.
6. Check cleanliness of insulators and bushings, arc chambers.
7. Check all moving parts are properly cleaned and lubricated.
8. Check space heaters provided.

38 PRECOMMISSIONING CHECKS:

1. Check alignment of breaker trucks for free movement. Check correct operation of shutters.
2. Slow closing/opening operation.
3. Check control wiring for correctness of connections, continuity and IR values.
5. Owner closing/opening operation manually and electrically.
7. Trip free and antipumping operation.

8. I.R. values, resistance and minimum pick up voltage of coils.

9. Contact resistance.

10. Simultaneous closing of all three phases.

11. Pole discrepancy tests.

12. Single and three phase auto reclose operation.

13. Check electrical and mechanical interlocks provided.

14. Check on spring charging motor correct operation of limit switches and time of charging.

15. Check on C.Ts.

16. All functional checks with the relays, meters, alarm scheme, interlock as per scheme with primary injection kits.

17. High voltage tests on Control and Power Circuits (2.5 KV).

39 **SPECIFICATION FOR BUS DUCTS**

39.1 **AIR INSULATED TYPE**  Bus ducts

I. **Constructional Requirement**

The bus duct shall consist of three phases and neutral bus bar permanently positioned dust and vermin proof and the degree of enclosure protection shall be IP 42 for indoor installation and shall IP-55 for outdoor installation as per schedule of quantities.

Bus Duct / Rising mains shall be designed, constructed and tested in accordance with following codes :


IS 8623 (Part II) : Particular requirements for Bus-trunking.

Minimum thickness of CRCA sheet steel enclosures for various sizes of bus ducts are as per table below :

<table>
<thead>
<tr>
<th>Max. width of the enclosure</th>
<th>Thickness of sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>..........................................................</td>
<td>..................................................</td>
</tr>
<tr>
<td>Size Range</td>
<td>Thickness</td>
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<tr>
<td>-------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>150 mm or smaller</td>
<td>1.6 mm</td>
</tr>
<tr>
<td>Over 150 mm but not more than 750 mm</td>
<td>2.0 mm</td>
</tr>
<tr>
<td>Over 750 mm</td>
<td>2.6 mm</td>
</tr>
</tbody>
</table>

The bus bar shall be high conductivity electrolytic quality Aluminium conductor / copper conductor as mentioned in schedule of quantities conforming to relevant Indian Standards. Capacity of phase bus bars, neutral bus bars and earth bus bars shall be as asked for in the schedule of quantities. Each bus bar shall be insulated with heat shrink insulation sleeves. Maximum bus bar temperature shall not exceed 80° C under normal operating conditions. Joints in the bus bar shall be bolted. Construction joints of bus bar shall be provided with double fish plate covers with adequate contact area.

II. **Bus Bar Supports**

Bus bar shall be adequately supported and insulated.

III. **Ventilation**

The bus duct shall be natural cooled.

IV. **Inspection Covers**

Inspection covers shall be provided at suitable intervals as required.

V. **Expansion Joints**

The bus bar shall be supported in such a way that the expansion/contraction does not have undue strain on the bus and at the terminals. Such expansion joints shall be provided at regular intervals as approved.

VI. **Tap-Off Connection Points (Applicable for Rising Mains only)**

Tap of connection points shall be provided at every 1000 mm internals on front side, to make connections to the live bus bars safely. These points shall be provided with safety shutters to prevent inadvertent touching of bus bars when no tap-off box is fitted and to ensure that no foreign matter enters in bus bar chamber.

VII. **Tap-off Boxes (Applicable for Rising Mains only)**

These shall be designed to make connection to live bus bars safely. This shall consists of 14 gauge CRCA sheet steel box with a hinged door with provision for cable entry at the top / bottom.
MCCB of required rating shall be fitted inside and shall be solidly connected to the epoxy locked contacts mounted on top of the box.

Make before / break after earth contacts shall be provided to ensure earth continuity while plugging in and out operations. Necessary mechanical clamping arrangements shall be made to fix the box to the bus bar of rising mains after fixing. Each ‘Tap Off’ box shall have provision for tapping the three phases and neutral. A guide pin shall be provided to ensure correct polarity.

VIII. Rating

The trunking shall be designed for the continuous current rating and fault level withstand capacity as specified in Schedule of Quantities.

IX. Earthing

2 Nos. copper / GI earthing bus for entire length of the trunking shall be provided as specified in Schedule of Quantities.

X. Installation

Bus ducts running along the wall shall be supported at intervals not exceeding 1.5 m. In case of branching, there shall be support on all branches at a distance of 300 mm from the point of branching. Support shall not be less than 40 x 40 x 6 mm MS angle secured in an approved manner. Supports may also be provided in the form of brackets fixed to walls where the duct runs along the wall. In case of ceiling suspended bus ducts, supports made out of 40x40x6 mm MS angle iron shall be provided. The horizontal distance between two such supports shall not be more than 1200 mm. The ducts supports shall be suspended from suitable approved suspension devices provided in the ceiling. Fire barrier shall be provided at each floor/wall crossing as per relevant IS code.

XI. Test at Site

The following tests shall be carried out at site and test results to be recorded:

a. Insulation resistance shall be tested with 1000 V megger and shall be not less than 100 mega ohms. The testing shall be done as per IS : 8084-1976.

b. Earth continuity test.

40. SPECIFICATIONS FOR ERECTION, TESTING & COMMISSIONING OF 415 VOLTS SWITCHGEARS
1. **SCOPE**
Receiving Inspection, Unloading Storage, Installation, Testing and Commissioning of the Switchgears shall be in accordance with the specified code of practice and manufacturer's instructions. The panels shall be aligned properly and bolted, to the flooring by at least four bolts for each division of Transport. The cable shall be terminated into the panel through glands fixed to bottom/top plate. The panel shall be bonded to the earth by connecting leads to the panel earth bus.

2. **HANDLING / UNLOADING**
Switchgears and all its accessories shall be handled/unloaded carefully in its upright position as indicated in the packing case. Lifting lugs and jacking pads shall be used for lifting of the switchgear. While using jacking pads utmost care shall be taken in proper application of jacks. Where switchgears is dragged or pulled on sleeper or rollers of the traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles. Unloading from the lorry shall be carried out using a mobile crane or tripod with chain pulley block or rolling over to a platform.

3. **STORAGE**
Equipment’s shall be stored under shelter in a well ventilated, dry place and covered by suitable polythene or tarpaulin covers for protection against moisture.

4. **ERECTION**
Panels shall be installed over a trench. The panels shall be aligned properly and bolted to the flooring by at least four bolts. The cables shall be terminated into the panel through bottom plate. The panel shall be bonded to the earth by connecting earthing leads to the panel earth bus.

5. **TESTS**
The following preliminary checks and Precommissioning tests shall be carried out before commissioning the Switchgears in the presence of Buyer/Architect’s representatives.

   **5.1.0 PRELIMINARY CHECKS**

   5.1.1 Check name plate details according to specification.

   5.1.2 Check for physical damage.

   5.1.3 Check tightness of all bolts, clamps and connecting terminals.

   5.1.4 Check oil level air pressure and leakage (wherever applicable)

   5.1.5 Check earth connections.

   5.1.6 Check the cleanliness of insulators and bushings, arc chambers.

   5.1.7 Check that all moving parts are properly cleaned and lubricated.

   5.1.8 Check if space heaters provided.
5.2.0 PRECOMMISSIONING CHECKS

5.2.1 Check alignment of breaker trucks for free movement. Check correct operation of shutters.

5.2.2 Slow-closing/opening operation.

5.2.3 Check control wiring for correctness of connections, continuity and IR values.

5.2.4 Manual operation of breakers.

5.2.5 Power closing/opening operation manually and electrically.

5.2.6 Breaker closing and tripping time.

5.2.7 Trip free and anti pumping operation.

5.2.8 I.R. Values, resistance and minimum pick up voltage of coils.

5.2.9 Contact resistance.

5.2.10 Simultaneous closing of all three phases.

5.2.11 Pole discrepancy tests.

5.2.12 Single and three phase auto - reclose operation.

5.2.13 Check electrical and mechanical interlocks provided.

5.2.14 Check on spring charging motor correct operation of limit switches and time of charging.

5.2.15 Check on C.Ts

5.2.16 All functional checks with the relays, meters, Alarm Scheme, interlock as per scheme with primary injection kits.

5.2.17 High voltage tests on Control and Power circuits (2.5 KV)

41. SPECIFICATION FOR POWER AND LIGHTING DISTRIBUTION BOARDS

1. GENERAL.
This specification is applicable to 415 Volts, 3 phase 4 wire A.C supply and shall conform to the following Indian Standards (Latest Version).

IS-8623 - Factory built assemblies of switch gear and control gear for voltages up to and including 1000 V AC and 1200 V DC.

IS-8828 - Miniature circuit breakers for voltages not exceeding 1000 Volts.

IS-2675 - Specification for enclosed distribution fuse boards and cut outs for voltage not exceeding 1000 Volts.

IS-2208 - HRC cartridge fuse links 650 Volts.

IS-732 - Code of practice for electrical wiring installation.

2. **TYPE AND CONSTRUCTION.**

Distribution boards shall be made of Robust and rigid construction and of totally enclosed dead front safety type. The enclosures shall be made of MS sheet steel of not less than 16 gauge. The sheet steel shall be treated with a rigorous rust inhabitation process before fabrication, followed by two coats of red oxide primer and two coats of synthetic enamel paint of approved shade. The distribution boards shall comprise of switch fuse unit or miniature circuit breakers as incoming and required number of circuit breakers or HRC fuses as outgoing.

The main switch and outgoing shall have rating as specified in the drawings and schedule. The boards shall be designed to have adequate cabling space for either top or bottom entry of both incoming and outgoing cables. Earthing sockets should be fitted to the casing of D.B.

3. **BUS BARS.**

Suitable colour coded bus bars made of high conductivity aluminium strips and mounted on non-hygroscopic insulating supports shall be provided. Neutral bus bars shall be of half the size of phase bus bar. The earth bus shall be also provided of material and size as required.

4. **MINIATURE CIRCUIT BREAKERS.**

Miniature circuit breakers shall have a minimum breaking capacity of 9 KA. Circuit breakers shall be equipped with individual insulated, braced and protected connectors. The front face of all the breakers shall be flush with each other. The breakers shall have 'quick break trip free'
mechanism with current limiting and overload and short circuit tripping characteristics. The mechanism shall be such that the circuit can not be held closed when a fault occurs or persists. The contacts shall be silver tungsten or other suitable material to give long contact life. Multiple units shall have an intertripping mechanism thereby ensuring complete isolation in the circuit in the event of an overload or fault in anyone of the phases. The connectors shall be suitably shrouded.

5. **FUSES.**

Rating of the fuses and carriers shall be as per drawings and schedule of quantities. Fuse carriers and bases shall be best grade phenolic moldings. They shall be non-inflammable and non-hygroscopic, with hard gloss finish. HRC fuses shall have non-deteriorating type characteristics. It shall be link type with rupturing capacity of not less than 35 MVA at 440 V.

6. **SAFETY & INTERLOCKS.**

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

7. **CABINET DESIGN.**

The distribution board cabinet shall be totally enclosed type with dust and vermin proof construction. The interior surface shall be finished to a off-white shade. The interior components shall be mounted on a separate sheet which is mounted and locked on to the studs provided inside the cabinet. Over this, a cover made of hylam sheet or sheet steel shall be provided with slots equipped with a front door with hinges on one side. Cabinets shall have undrilled detachable glands plates at both top and bottom and sides. The door should be secured by robust fasteners enabling dust protection gasket to be compressed quickly and easily. Unless specified otherwise boards shall be flush mounted in walls.

8. **TERMINALS.**

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

9. **DIRECTORY.**
Distribution boards shall be provided with a directory indicating the description of loads served by such circuit breaker, the rating of breakers, size of conductors, etc. The directory shall be mounted in metal holder with a clear plastic sheet on inside surface of the front door. The DBs shall be provided with inscription plates. The size of letters shall be as approved and the wordings for inscription shall be given by Project Manager/Architects.

10. **INSTALLATION.**

Distribution boards shall be surface mounted or recessed mounted as required by the Consultants and at the locations shown on the drawings. The boards shall be fixed with suitable angle iron clamps and bolts. All the cables/conduits shall be properly terminated using glands/grips/check nuts, etc. Wiring shall be terminated properly using crimping/lugs sockets and PVC identification ferrules. The DBs shall be installed as specified in IS 732 and National Building Code.

11. **FASTENERS.**

All the screws, nuts, bolts, washers, etc. used for the current carrying parts shall be of brass or other approved non-ferrous material. Other fasteners shall be made of non-corroding materials. The screws used for fixing the top plate and the washers shall be of MS with nickel plated.

12. **TESTING.**

Distribution boards shall be tested at factory as per Indian Standard. The tests shall include insulation test, high voltage test, etc. Distribution boards shall be tested for insulation resistance after the erection.

13. **DRAWING APPROVAL :**

The contractor shall submit the drawings for approval before fabrication.

**42. SPECIFICATIONS FOR DISTRIBUTION SYSTEM, CONDUITS, WIRING & ACCESSORIES.**

1. **GENERAL.**

This Specification of Medium Voltage Distribution System shall be applicable for wiring 3 phase, 4 wire 415 Volts, 50 Hz AC and single phase, 2 wire 230 Volts, 50 Hz, AC supply.

2. **RIGID STEEL/PVC CONDUITS & ACCESSORIES.**

MS conduits shall be of welded and screwed sheet steel construction. Conduits shall be black stove enameled inside and outside. The conduits shall conform to the requirements of
relevant IS (latest edition) in all respects. The conduits shall have uniform wall thickness/cross section throughout. Conduits shall bear the name, trade mark of the manufacturer and size of conduit on each length. The conduits shall be delivered to the site in original bundles. Conduits of less than 19 mm dia. shall not be used. The minimum wall thickness of conduits shall be as follows:

- Rigid M.S Conduits:
  - a) 19, 25 & 32 mm - 16 gauge.
  - b) 38 mm & above - 14 gauge.

- Rigid PVC Conduits - 2 mm. (Heavy Duty)

Conduit Accessories: Conduit accessories such as bends, inspection bends, inspection tees, elbows, reducers, draw boxes, junction boxes, etc. shall be of approved makes. Boxes shall have internally tapped spouts, junction boxes/inspection boxes shall be internally tapped table covers. Necessary pull boxes of adequate sizes shall be provided wherever required at no extra cost.

All conduits shall be of ample size for easy 'draw in' and 'draw out' of all the wires in the conduits. In no case the total cross section of wires measured over all be more than forty percent of the area of the conduit.

All the conduits shall be adequately protected while stored on site prior to erection and no damaged conduit shall be used.

All conduit accessories shall be made out of 16 Gauge thick MS enclosures.

3. PREPARATION OF CONDUIT:

The inside surface and ends of conduits and threads and fittings used shall be clean, smooth, cut square and free from burrs and other defects. Powdered soap stone, talc or prepared compounds shall be used as lubricants to facilitate the smooth pulling in of conductors.

4. ERECTION OF CONDUIT.

The conduit shall be properly and tightly screwed between the various lengths and to the boxes to which it runs and terminates. No part of the conduit shall be under mechanical stress and the whole conduit system shall be electrically and mechanically continuous throughout.

Conduits shall be installed with provision for ventilation self drainage in the event of ingress of moisture due to condensation or any other reason and prevent sweating.

A suitable drainage hole shall be drilled in the bottom of the lowest conduit box in every 9 Mtrs. of horizontal length.

5. INSTALLATION OF CONDUIT:
5.1 Concealed Conduit System with PVC Conduit: FRLS

a) PVC conduit the size of the conduit shall be selected in conformity with I.S. code and as specified in the table given below. Factory made conduit bends and accessories shall be used. PVC Conduit shall be joined using coupler as supplied by the conduit supplier. The conduit in ceiling slab shall be straight as far as possible. Before the conduits are laid in the ceiling, the position of the outlet points, controls, junction boxes shall be set out clearly as per the dimensions and to minimise off-sets and bends. Before the reinforcement rods are kept in position electrical contractor should mark in paint the position of outlet points and conduit drop on the shuttering. When the outlet boxes are kept in position & before pouring the concrete, all outlet boxes shall be filled with paper to avoid entry of concrete inside the box. Conduits in ceiling shall be bonded to the reinforcement rods with Steel wire bonding wire at intervals not more than 1000mm, to secure them in position. PVC deep light outlet / pull boxes shall be provided as required. The conduit in ceiling slab shall be laid above the first layer of reinforcement rods to avoid cracks in the ceiling surface. In general the conduit shall not be laid directly on the shuttering surface to avoid cracks in the ceiling surface.

b) Conduits Concealed in the wall shall be secured rigidly by means of steel hooks / staples at min. 750 mm intervals. Before conduit is concealed in the walls, all chases, grooves shall be neatly made to proper required dimensions using electrically/manually operated groove cutting tools to accommodate number of conduits. The outlet boxes for control switches, inspection and draw boxes shall be fixed as and when conduits are being fixed. The recessing of conduits in walls shall be so arranged as to allow atleast 12mm plaster cover on the same. All grooves, chases etc. shall be refilled with 1:4 cement mortar and finished upto wall surface before plastering of walls is taken up by the general civil contractor. Horizontal chase in walls are not allowed. Where, unavoidable prior permission of PMG Engineer/Consultant shall be obtained before making any chasing. Where conduits pass through expansion joints in the building, adequate expansion fitting or other approved devices shall be used to take care of the relative movement. Whenever the conduits terminate into Control Boxes, distribution boards etc. conduits shall be rigidly connected to the boxes/boards with check nuts on either side of the entry. After conduits, junction boxes, outlet boxes etc. are fixed in position, their outlets shall be properly plugged with PVC stoppers or any other suitable material so that water, mortar, vermin or any other foreign materials do not enter into the conduit system. All conduit ends terminating into an outlet shall be provided with bushes of PVC or rubber after the conduit ends are properly filed to remove burrs and sharp edges. Necessary G.I./Steel wire pull wires shall be inserted into the conduit for drawing wires before concreting. Insulated earth wires shall be run in each conduit originating from the panel board upto the Light, Socket and Switch boxes. If the Electrical Contractor forgets to install any conduit/ boxes etc., before the plastering/ painting work is done by other agencies, he may be permitted to install the same with prior permission of PMG Engineer /Consultant and he shall be liable to make good the wall, floor, ceiling etc. at his own cost.
c) Conduits shall be so arranged as to facilitate easy drawing of wires through them. Entire conduit layout shall be done in such a way as to avoid additional junction boxes other than light points. The wiring shall be done in a looping manner. All the looping shall be done in either switch boxes or outlet box. Joints in junction or pull boxes are strictly not allowed.

d) All conduits shall be installed so as to avoid touching of steam and hot water pipes. Conduits shall be installed in such a way that the junction and pull boxes shall always be accessible for repairs and maintenance work. The location of junction/pull boxes shall be marked on the shop drawings and approved by the PMG Engineer/Consultant.

A separation of 200mm shall be maintained between electrical conduits and hot water lines in the building.

e) No run of conduit shall exceed ten meters between adjacent draw in points nor shall it contain more than two right angle bends, or other deviation from the straight line.

f) Caution shall be exercised in using the PVC conduits in location where ambient temperature is 50 degree Celsius or above. Use of PVC conduits in places where ambient temperature is more than 60 degree C is prohibited. The entire conduit system including boxes shall be thoroughly cleaned after completion of installations and before drawing of wires. Conduit system shall be erect and straight as far as possible. Traps where water may accumulate from condensation are to be avoided and if unavoidable, suitable provision for draining the water shall be made.

All jointing method shall be subject to the approval of the PMG Engineer/Consultant.

g) Conduit Joints

Conduits shall be joined by means of plain couplers. Where there are long runs of straight conduit, pull/inspection boxes shall be provided at intervals, as approved by the PMG Engineer/Consultant the conduits shall be thoroughly cleaned before making the joints. In case of plain coupler joints, proper jointing material like vinyl solvent cement (gray in color) or any material as recommended by the manufacturer shall be used.

h) Bends in Conduit

Wherever necessary, long bends or diversions may be achieved by bending the conduits or by employing normal bends. No bends shall have radius less than 2.5 times outside diameter of the conduit. Heat may be used to soften the PVC conduit for bending, but while applying heat to the conduit, the conduit shall be filled with sand to avoid any damage to the conduit. Kinks in the conduit bends shall not be acceptable.

i) Bunching of Cables:
Cables of AC supply of different phase shall be bunched in separate conduits. The number of insulated wires/cables that may be drawn into the conduits shall be as per the following table. In this table, the space factor does not exceed 40%. However, in any case conduits having lesser than 20 mm diameter shall not be used.

MAXIMUM PERMISSIBLE NUMBER OF 1100 VOLT GRADE SINGLE CORE CABLES

THAT MAY BE DRAWN IN TO RIGID PVC CONDUITS.

<table>
<thead>
<tr>
<th>CABLE SIZE IN SQ.MM</th>
<th>SIZE IN</th>
<th>SIZE OF CONDUITS (MM)</th>
<th>MAX. NO. OF CABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>1.5</td>
<td>4</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>2.5</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>4.0</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>6.0</td>
<td>1</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>10.0</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>16.0</td>
<td>-</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

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

6. INSTALLATION OF SURFACE CONDUIT SYSTEM.

Conduits shall run in square and symmetrical lines. Before the conduits are installed, Conduits shall be fixed by heavy gauge GI base plates, saddles, secured to suitable rawl plugs, at an interval of not more than 1 Mtr. Conduits shall be joined by means of screwed couplers and screwed accessories only. In long distance straight runs of conduit, inspection type couplers or running type couplers or pull boxes shall be provided.

Bends in conduit runs shall be done by bending conduits by pipe bending machine. Bends, which cannot be negotiated by pipe bends, shall be accompanied by introducing inspection boxes or inspection bends. Not more than three equivalent 90° bends shall be used in a conduit run from outlet to outlet.

All the conduit openings shall be properly plugged with PVC stoppers/bushes. The conduits shall be adequately protected against rust by applying two coats of approved synthetic enamel paint after the installation is completed.

Wherever conduits terminate conduits shall be rigidly connected to the box/board with brass hexagonal checkouts with compression washers on either side of the entry to ensure proper electrical and mechanical continuity.

The crossing of surface conduits shall not be generally permitted and to avoid such crossings, adopter boxes shall be used at junctions/crossings.
All unused conduit entries shall be blanked off in an approved and where conduits terminates in adopter boxes. All removable box covers shall be firmly secured to provide complete enclosure.

7. **CONDUITS ABOVE FALSE CEILING.**

In the false ceiling area, the conduits shall be run above the false ceiling frame work supported by means of M.S straps secured and fixed to both conduits and structural ceiling, keeping the outlet box as near as possible to the fittings/fans for connections. The conduit boxes for fittings/fans are independently supported by means of separate fixing arrangements to the box and structural ceiling so that the box is held rigidly.

8. **ENCLOSURE FOR ELECTRICAL ACCESSORIES.**

- Enclosure for electrical accessories shall conform to IS: 5133-Part I. The wall thickness of MS enclosures shall be not less than 1.6 mm. The enclosure boxes shall be provided with a minimum of four fixing lugs located at the corners for fixing the covers. All fixing lugs shall have tapped holes to take machined brass screws.

- Sufficient number of knockouts shall be provided for conduit entries. The enclosures shall be adequately protected against rust of corrosion both inside and outside. The enclosures shall be provided with 5 mm thick overlapped white PVC or perspex sheet cover with rounded corners and beveled edges for mounting switches, sockets etc. Wherever different phase conductors are brought into the same enclosure, phase barriers shall be provided.

- Minimum size of the box shall be 75 x 75 x 75 mm.

- Draw boxes of ample dimension shall be provided at convenient points on walls/ceilings to facilitate pulling of long runs of wire. These boxes will be as few as possible and located where found necessary and approved by Architects at no extra cost.

- Where flush conduits are required to terminate at surface mounted equipment, the conduit shall terminate at a flush box and the back of the equipment should fully cover the flush box and brass screws shall be used between the equipment and the box in addition to any other means of fixing and earthing arrangement.

- The alternative arrangement to the above shall be by means of fixing a terminal extension box to the flush conduit box in which case a break joint ring shall be fitted between boxes.

9. **WIRING CONDUCTORS.**

All wiring conductors shall be PVC insulated, copper conductors of 1100 V grade, and shall conform to IS:694 Part II (Latest Edition).
Wiring conductors shall be supplied in Red, Blue, Yellow, Black and Green colours for easy identification of wires. The wires shall be supplied in sealed coils of 100 Mtrs. length and shall bear manufacturer's trade mark, name, Voltage grade etc.

10. **INSTALLATION OF WIRING CONDUCTORS/CABLES.**

1. The wiring conductors shall not be drawn into the conduits until all the works of any nature that may cause damage to the wires are completed. The installation and termination of wires shall be carried out with due regard to the followings:

2. While drawing the wiring conductors, care shall be taken to avoid scratches and kinks which cause breakage of conductors. There shall be no sharp bends in the conduit system.

3. Strands of the wires shall not be cut for connecting to the terminals or lugs. The terminals shall have adequate cross section to take all the strands.

4. Oxide inhibition grease shall be applied at all terminals and connections.

5. Brass flat washers of large area shall be used for bolted terminals.

6. Bimetallic connectors should be used wherever aluminum conductors are tapped from copper mains or vise-versa.

7. Wiring for power and lighting circuits shall be carried out in separate and distinct wiring systems.

8. The wiring system envisaged is generally shown on the layout drawings and line diagrams. However, a brief account of the general wiring system is given below:

9. Submains wiring - Wiring from Meter boards/switch boards to the individual distribution boards, and shall consist of wires, conduits, all conduit and fixing accessories as required and specified. The sizes of conduits and number of wires shall be as specified in Schedule of Quantities. Wires shall be drawn in conduits as required without being damaged, with necessary draw boxes if required. The wire lengths must be adequate for terminating at either end and identifying ferrules shall be provided at termination. The wiring shall be colour coded. The rate shall include all materials, connections, labour etc. as specified above.

10. Circuit wiring - Wiring from DBs to the first point control boxes for lighting, fans, 5A sockets, call bells, etc. The scope of work shall be same as in submain wiring.

11. Power wiring: The wiring from DBs to heating supplies, 15 A 3 pin socket outlets, etc. The scope of work shall be same as in sub-main wiring.

12. Each sub-main/circuit main/power wiring circuit shall also have its own earth continuity wire as specified.
13. All the wiring shall be carried out in loop-in-loop system only and phase or line conductors shall be looped at switch box and neutral conductor can be looped from light, fan or sockets.

14. The maximum number of various size conductors that could be drawn into various sizes of conduits shall be as per table II of IS:732 (Latest Edition). The wiring shall be colour coded for easy identification of phases and neutral. The following colour codes shall be adopted.

1. Phases - Red, Yellow and Blue.
2. Neutral - Black.
3. Earth - Green or Bare wire as specified.

15. All submains and circuit wiring shall be provided with printed PVC identification ferrules at either end bearing the circuit number and designation.

11. **SWITCHES, SOCKETS AND ACCESSORIES.**

11.1 **General Requirements :**

- General control switches shall be of a 5 A rating and shall be of approved make/type suitable for flush mounting. Switches shall have either integral mounting plates or white PVC/perspex of min. 4.5 mm thick.

- All sockets, 5A and 15A ratings shall be of flush mounting type with combined control switches of the same rating as that of the sockets. All sockets outlet shall be of 3/5 pin type.

- The switch, plug socket or regulator boxes shall be made of GI/sheet steel of minimum 16 SWG on all sides except in the front. Depth of boxes shall not be less than 75 mm and suitably increased where fan regulators are mounted in flush pattern. The boxes shall be provided with suitable earthing studs. Wherever required switches/fittings shall be fixed on metal strip, which in turn are welded to the box.

- Fan regulators shall be flush type and earthed with earth continuity conductor. The fan regulator shall be of electronic type.

12. **LAMPHOLDERS, CEILING ROSES, ETC.**

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

- Screwed holder shall be used in brackets and pendants, light fittings shall have brass holders on T.W. round blocks.
• Ceiling roses for recessed system of wiring shall be porcelain make and flush type. For surface type of wiring this shall be bakelite.

13. INSTALLATION OF SWITCHES, SOCKETS AND ACCESSORIES.

All the switches shall be wired on phases. Connections shall be made only after testing the wires for continuity, cross, phase etc. with the help of megger. Regulators shall be fixed on adjustable MS flat straps inside the enclosure. The arrangement of switches and sockets shall be neat and systematic. Covers for enclosures accommodating switches, sockets etc. (point control boxes) shall be of 4.5 mm thick, fine finished PVC/perspex material or laminated hylam sheet and fixed to the enclosure in plumb with counter sunk head, chromium plated MS screws and washers. Outlets shall be terminated into a flush type fan box for fan points. For wall plug sockets, the conductors may be terminated directly into the switches and sockets. The outlets point control boxes etc. shall be set out as shown on the drawings. Before fixing these, the contractors shall obtain clearance from the Owner/Architect with regard to their proper locations. The enclosures of sockets/and 3rd pin of the sockets shall be connected to the ground through an earth continuity wires, as specified.

14. CAPACITY OF CIRCUITS.

Light points, 5A socket points, fans, and call bell points may be wired on a common circuit. Such of those circuits shall not have more than 10 nos. of Light/fan/socket points or a load of 800 W whichever is less. Not more than two numbers of 15A socket outlets shall be wired on the same circuit.

15. POINT WIRING.

• Point wiring shall commence from the first point control box/local control box for the points connected to the same circuit. Point wiring for lights, ceiling and exhaust fans, 5A sockets, call bells etc. shall be carried out with 1100 V Grade PVC insulated wires. The point wiring shall be inclusive of conduits of not less than 19 mm size, switches, wiring alongwith conduit accessories such as bends, inspections bends, reducers, pull boxes, junction boxes, switch boxes, fan boxes, covers etc. together with wiring accessories such as ceiling roses, brass lamp holders, T.W Blocks, loose wires upto 1 Mtr. long at outlet end connectors point control boxes (enclosure for electrical accessories) switches, etc. Point wiring shall be provided with earth continuity wire as specified for earthing 3rd pin of sockets, luminaries and fan fixtures. Light control shall be either single, twin or multiple points controlled by a switch, as specified.

• The point wiring for Light/Fans/5A sockets etc. shall include the supply and installation of all materials specified above. Any item not specifically included but required for satisfactory completion of the point wiring shall also be included. No separate extra price will be allowed for any item under point wiring.

• A dependent socket point shall mean the combination 5A switch socket outlet/point mounted on the same switchboard as any other point/points and shall include the 5A switch and socket.
• The fan point shall be complete with fan hook box flush mounted in slab, control switch mounted in switch box and electronic regulator, complete with cover. The measurement will be numbers of each kind of point and as specified in Schedule of Quantities.

16. **FIXTURES /FANS:**

16.1 **LIGHT FITTINGS:**

• Unless otherwise specified, light fittings shall be generally fixed as directed by Owner/Architects.

• Fittings such as wall brackets shall be fixed at 2200 mm from FFL.

• Bulk head fittings shall be flush with ceiling/wall as required and shall be at a height as specified or directed.

• Pendant fittings shall be suspended to a height of 2400 mm from FFL.

• The fluorescent fittings shall be fixed in such a manner that the wiring conductors shall not terminate in a ceiling rose but in a junction box 300 mm away from the center of the fitting along the length of the fitting so that no exposed wiring is seen from outside.

16.2 **FANS.**

**CEILING FANS**

• Ceiling fans shall be suspended from the special fan hook boxes. The fan wiring shall be terminated in porcelain/PVC multiway connector.

• Each fan shall have a separate switch and speed regulator. The canopy at the top of the suspension rod shall effectively hide the suspension hook.

• The control switch and the electronic regulator for the fan shall be included in the point wiring.

17. **TESTING OF ELECTRICAL INSTALLATION.**

**TESTING OF INSTALLATION SHALL BE AS PER IS 732-1982**

• The insulation resistance shall be measured by applying between earth and whole system of conductors of 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, where a direct current pressure of not less than twice the 
working pressure provided that it need not exceed

- 500 Volts for medium voltage circuits. Where the supply is derived from the three wire (A.C 
or D.C) or a poly phase system, the neutral pole of which is connected to earth either direct 
or through added resistance, the working pressure shall be deemed to be that which is 
maintained between the outer or phase conductor and neutral.

- The insulation resistance measured as above shall not be less than 50 megohms divided by 
the number or points on the circuits provided that the whole installation shall be required to 
have an insulation resistance greater than one megohm.

- Control rehostats, heating and power appliances and electric signs may, if required be 
disconnected from the circuit during the test but in the event of the insulation resistance 
between the case or frame work and all live parts of each rheostat appliances and all live 
parts of each rheostat and sign shall be less than that specified in the relevant Indian Standard 
Specification or where there is no such specification shall not be less than half a megohm.

The insulation resistance shall also be measured between all conductors connected to one 
pole or phase conductor of the supply and all the conductors connected to the middle wire or 
the neutral or to the other pole or phase conductors of the supply and its value shall not be 
less than specified in sub-clause 17.1.2.

18. TESTING OF EARTH CONTINUITY PATH.

The earth continuity conductor including metal conduits and metallic envelopes in all cases 
shall be tested for electrical continuity and 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 electrodes to any point in the earth continuity conductor in 
the completed installation shall not exceed one ohm. For checking the efficiency of earthing, 
the earth resistance of each earth electrode shall also be measured. This test shall preferably be 
done during summer months.

19. TESTING OF POLARITY OF NON-LINKED SINGLE POLE SWITCHES.

- In a two wire installation, a test shall be made to verify that all non-linked, single pole 
switches have been fitted in the same conductor throughout and that such conductor has been 
connected to an outer or phase conductor or to the non-earthed conductor of the supply.

- The contractor shall be responsible for providing the necessary instruments and subsidiary 
earth for carrying out the tests. The earth coordinating tests shall comply with the IS 
specifications as may be applicable. Should the above tests not complete with the limits laid 
down, the contractors shall do the necessary rectification of the fault till the required results 
are obtained.
43. SPECIFICATION FOR LOW TENSION CABLES

1. SCOPE

- This specification covers the technical requirements of supply, laying, testing and commissioning of Heavy duty medium voltage cables upto 1100 Volts for power, control and lighting application for efficient and trouble free operation.
- The cable shall be properly packed for transportation, supply and delivery at site.

2. CODE AND STANDARDS

The materials covered by this specification shall unless otherwise stated as designed, constructed, manufactured and tested in accordance with latest revisions of the relevant Indian Standards.

- IS 1554 (Part I)- 1988 : PVC insulated cables for Working voltages Up to and including 1000 V.
- IS 5831 - 1984 : PVC insulation & sheath of. electric cables
- IS 8130 - 1984 : Conductors for insulated electric cables
- IS 3961 (Part II) - 1977 : Recommended current ratings for PVC insulated and PVC sheathed heavy duty cables.

RATING

The cable shall be rated for a voltage rating of 650/1100 Volts.

3. SELECTION OF CABLES:

Cables should be selected considering the conditions of maximum connected load, ambient temperature, grouping factor and allowance for voltage drops. However it is the responsibility of the contractor to recheck the sizes before cables are procured. He should submit the cable de rating, voltage drop and length calculation to Architects for approval before procuring cables.
4. **INSULATION:**

The conductor is insulated with suitably compounded PVC applied to the conductor by the extrusion.

The PVC compound used for insulation shall have reduced flame propagation property. This shall also have reduced emission of hydrogen-chloride gas fumes etc. when severely overheated during fires.

5. **CORE IDENTIFICATION:**

The cores of the cables shall be provided with the colour scheme of PVC insulation as per IS for any easy identification.

6. **ARMOURING:**

The armoring of multi core cable consists of either GI round steel wires or GI flat strips and in case of single core cable armoring shall be of non-magnetic material such as hard drawn aluminium or aluminium alloy wires or strips.

7. **OUTER SHEATH:**

The PVC compound used for outer sheath shall be resistant to termites, fungus and rodent attacks and shall also have reduced flame propagation property as specified above.

8. **IDENTIFICATION:**

The manufacturer's name, voltage grade of cable, year of manufacture, nominal cross-sectional area of conductor shall be embossed on the outer sheath of the cables throughout the length of the cable at regular intervals.

9. **PACKING, MARKING AND TRANSPORT:**

The cables shall be supplied in strong, non-returnable wooden drums of heavy construction.

Each cable drum is marked with particulars of cable size, voltage class, length, direction of rolling, position of outer gross weight, ISI certification marking etc.

10. **STORING, LAYING, JOINTING AND TERMINATIONS:**

**STORING:**
All the cables shall be supplied in drums, on receipt of cables at site, the cables shall be inspected and stored in drums with flanges of the cable drum in vertical position.

Employer/Architects will inspect the cables before storing. Contractor shall take out samples from the drums as per their instructions and send them to the manufacturers to conduct the approval tests. After the receipt of the test analysis, the cable will be accepted by the Employer.

11. LAYING:

Cables shall be laid as per the specification given below:

Cables in Outdoor Trenches:

Cables shall be laid in outdoor trenches wherever called for. The depth of the trenches shall not be less than 75 cms. from the Formed Ground Level (FGL) which has to be ascertained from the Architects. The width of the trenches shall not be less than 45 cms. A spacing of not less than the cable diameter shall be allowed between the cables. The trenches shall be cut square with vertical side walls and with uniform depth. Suitable shoring and propping may be done to avoid caving in of trench walls. The floor of the trench shall be rammed level. Cable unreeling from drums shall be done only with the help of cable drum rolling supports. The cables shall be laid in trenches over the rollers placed inside the trench. The cable drum shall be rolled in the direction of the arrow for rolling. Wherever cables are bent, the minimum bending radius shall not be less than 12 times the diameter of the cable. 15 cms thick layer of sand cushioning to be provided full of stones and pebbles. Cable shall be taken lifted and placed over this and cushion. The cable shall then be covered with a 15 cms thick sand cushion, where cable is laid in rocky situation. Extra thick cushioning of sand as may be required/decided by the Project Manager/Architects shall be done without extra charge. Over this, a course of cable protection tiles or brick shall be provided to cover the cables by 5 cms on either side. Unless otherwise specified, the cable shall be protected by concrete tiles/stone slabs of minimum 25 mm thick placed on top of the trench breadth wise for the full length of the cable. Trench shall be back filled with earth and consolidated. Cables shall be laid in Hume pipes at all road crossings and in GI pipes / PVC pipes at the wall entries. Approved cable markers made of concrete blocks indicating the voltage grade and the direction of run of the cables shall be installed at regular intervals of 25 Mtrs. The depth of concrete blocks shall be at least 300 mm below ground and 50 mm above ground.

Cables in Indoor Trenches:

Cables shall be laid in indoor trenches wherever specified. Suitable painted MS base plate clamps, saddles, GI nuts/bolts or alternatively UV resistant tie wraps shall be used for securing the cables in position at an interval not more than 450 mm. Spacing between the cables shall not be less than 15 mm center to center. Wherever specified,
trenches shall be filled with fine sand and covered with steel chequered trench covers or RCC slabs.

All chases and passage if necessary for the laying of service cables at the entry or of premises shall have to be cut and made good to the satisfaction of the Project Manager/Consultants.

All cables entries into the buildings/cable trenches/ducts, etc. shall be suitably sealed as required by the Project Manager/Consultants without extra cost.

12. JOINTING AND END TERMINATIONS:

Cable jointing shall be done as per the recommendations of the cable manufacturer. Jointing shall be done by qualified cable jointer under strict supervision. Sample crimping of different size cables shall be subjected to contact resistance and heating tests in the presence of the Architects.

Each termination shall be carried out using Electroplated Brass double compression glands and copper cable sockets and approved jointing materials are to be used. Hydraulic crimping tool shall be used for making the end termination’s. Cable gland shall be bonded to the earth by using suitable copper wire with earth tag’s. The cable armoring is to be earthed properly so that the earth continuity is maintained. All outdoor terminations shall be provided with PVC shroud’s to make them water vermin proof.

13. TESTING:

- Cables shall be tested at factory as per the regulations of IS:1554 Part I. The tests shall incorporate routine tests, type tests and acceptance tests.

Copy of such test certificates shall be furnished to the Owner.

- Cables shall be tested at site after installation and results shall be submitted to Consultants/Engineers.
- Insulation resistance between conductors and neutral and conductors and earth.

44. SPECIFICATION FOR CABLE TRAYS

1.0 SCOPE:

This specification covers the design, supply, fabrication fixing, aligning, and painting of cable trays and other steel frame works at site as required.

i. The cable trays shall be designed and fabricated / factory made out of various sections such as GI / M.S angles, flats, channels etc. and got approved by Consultants.
ii. Before fabrication the GI/ MS sections shall be properly straightened, aligned, cleaned properly to remove rust if any.

iii. All materials used for fabrication of cable trays shall conform to IS 226 and fabrication shall be as per IS : 800.

iv. After fabrication the cable trays, and accessories shall be free from sharp edges, corners, burrs and unevenness, and a coat of cold phosphating chemical shall be applied followed by a coat of red oxide primer.

v. The cable trays shall be welded to the mounting supports which in turn are either welded to plate inserts or grouted to structural members.

vi. Plate inserts for cable tray mounting supports shall be provided by Civil Contractor.

vii. Cable trays shall either run in cable trenches or run overhead and supported from available structure.

viii. Minimum clearance between the top most tray tier and structural member shall be 300 mm.

ix. The type and size of tray to be used shall be as required.

x. Each continuous length of cable tray shall be earthed at minimum two places.

xi. All hardware such as passivated bolts, nuts, washers, and other consumable required for the fabrication and erection shall be included in the rate quoted by contractor. However, if any grip/Anchor bolts or fasteners are required, the same shall be paid extra.

xii. The cable trays, accessories, covers etc. shall be painted with two coats of red oxide primer followed by two finishing synthetic enamel paint of approved shade. Where any cuts or holes are made or welding is done on finished steel work, the same shall be sealed against oxidation by red oxide primer followed by finished paint.

45. TECHNICAL SPECIFICATION FOR LIGHT FITTINGS AND ACCESSORIES

1.0 SCOPE:

This Specification also covers the design, material specification, manufacture, testing at works, inspection and delivery at site of light fittings and their associated accessories.
2.0 **STANDARDS:**

The light fittings and their associated accessories such as lamps/tubes, reflector, housings, ballasts etc. shall comply with the latest applicable standards. All luminaries, lamps and accessories shall be of same make.

3.0 **GENERAL REQUIREMENTS:**

Fittings shall be designed for continuous trouble-free operation under hot humid atmospheric conditions, at an ambient of 45°C without reduction in lamp lift or without deterioration of materials and internal wiring. Outdoor fittings shall be weatherproof and waterproof type.

The fittings shall be designed so as to facilitate easy maintenance, including cleaning, replacement of lamps/starters etc.

Connectors between different components shall be made in such a way that they will not work loose by small vibration.

For each type of light fitting, the Manufacturer/Vendor shall supply the utilisation factor to indicate the proportion of the light emitted by the bare lamp which falls on the working plane.

The fittings shall be supplied complete with lamps.

The fittings and accessories shall be designed to have low temperature rise. The temperature rise above the ambient temperature shall be as indicated in the relevant Standards.

All Sodium vapour, Mercury vapour and Metal Halide fittings shall be completed with accessories like lamps, ballasts, power factor improvement capacitors, starters/igniters wherever applicable etc. These shall be mounted as far as possible in the fitting assembly only. If these cannot be accommodated inside, then a separate metal enclosed box shall be included to accommodate the accessories and in addition with a fuse and a terminal block suitable for loop-in, loop-out connections by 1100V Grade PVC insulated wires up to 4 Sq mm.

Outdoor type fittings shall be provided with outdoor type Control gear box. The fittings shall be power factor corrected to 0.95 (maximum)

Each fitting shall have a terminal block suitable for loop-in, loop-out T-off connection. The internal wiring shall be completed by the manufacturer by means of stranded Copper wire and terminated on the terminal block.

All hardware used in the luminaries, shall be Cadmium plated.
4.0 **EARTHING:**

Each light fitting shall be provided with an earthing terminal suitable for connection to the earthing conductor.

All metal or metal-enclosed parts of the housing, shall be bonded to the earthing terminal so as to ensure satisfactory earth continuity throughout the fixture.

5.0 **PAINTING/FINISH:**

All surfaces of the fittings shall be thoroughly cleaned and de-greased. The fittings shall be free from scale, sharp edges and burns.

The housing shall be stove-enameled/epoxy stove-enameled/vitreous enameled powder-coated of anodised as indicated as indicated under various types of fitting.

The finish of the fitting shall be such that no bright spots are produced either by direct light source or by reflection.

6.0 **ACCESSORIES FOR LIGHT FITTINGS:**

6.1 **Reflectors:**

The reflectors shall be made of CRCA sheet steel. Aluminum/Silvered glass as indicated, for the above mentioned fittings.

The thickness of Steel/Aluminum, shall comply with relevant Standards. Reflectors made of Steel, shall have stove-enameled /Vitreous-enameled / Epoxy-coating finish.

Aluminum used for reflectors, shall be anodized / Epoxy Stove-enameled / Mirror polished.

Reflectors shall be free from scratches or blisters and shall have a smooth and glossy surface having an optimum light reflecting co-efficient such as to ensure the overall light output specified by the manufacturer.

Reflectors shall be readily removable from the housing for cleaning and maintenance without disturbing the lamps and without the use of tools, they shall be securely fixed to the housing by means of positive fastening device of captive type.

6.2 **LAMP/STARTER HOLDERS:**

Lamp Holders shall comply with relevant Standards. They shall have low contact resistance, shall be resistant to wear and shall be suitable for operation at the specified temperature without deterioration in insulation value. They shall hold the
lamps in position under normal condition of shock and vibration met within normal installation and use.

Lamp Holder for the fluorescent lamps shall be of the spring loaded bi-pin rotor type. Live parts of the lamp holder shall not be exposed during insertion or removal of the lamp or after lamp has been taken out. The lamp holder contacts shall provide adequate pressure on the lamp cap pings when in working position.

Lamp Holder for incandescent, Mercury Vapour and Metal Halide lamps shall be of bayonet type up to 100W and Edison Screw (E.S) type for Higher Wattages.

Starter holders for fluorescent lamps shall conform to the relevant Standards. All material used in the construction of the holder shall be suitable for tropical use.

The Starter Holder shall be so designed that they are mechanically robust and free from any operational difficulties. They shall be capable of withstanding the shocks met within normal transit, installation and use.

6.2 **BALLASTS:**

The ballasts shall be designed, manufactured and supplied in accordance with the relevant Standards. The ballasts shall be designed to have a long service life and low power loss.

Ballasts shall be mounted using sell locking, anti vibration fixings and shall be easy to remove without de-mounting the fittings. They shall be in dust-tight, non-combustible enclosures.

The ballasts shall be of the inductive, heavy-duty type, filled with thermosetting insulating, moisture-repellant, Polyester compound filled under vacuum. Ballasts shall be provided with tapping to set the voltage within the range specified. End connections and taps shall be brought out in a suitable terminal block, rigidly fixed to the ballast enclosure. The ballast wiring shall be of Copper wire that shall be free from hum. Ballasts which produce humming sound shall be replaced free of cost by the Vendor.

Low loss Silicon steel lamination, shall be wounded with super enameled Copper wire with Class "F" insulation on glass filled Nylon bobbin.

High temperature-resistant interlayer Polyester film shall be used for inter layer insulator glass-filled Polyester connector should withstand high voltage up to 5 KV.

Separate ballast for each lamp shall be provided in case of multi lamp fittings.

The ballast for each lamp shall be provided in case of multi lamp fittings.

The ballasts for Metal Halide lamps shall not be constant wattage type.
6.3 **STARTERS:**

Starters shall have bi-metal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool. Starters shall have brass contacts and radio interference capacitor.

The starters shall generally conform to the relevant Standards.

6.5 **CAPACITORS:**

The Capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits.

The capacitors shall be suitable for operation at supply voltage as specified and shall have a value of capacitance so as to correct the power factor of its corresponding lamp circuit to the extent of 0.95 lag.

The capacitors shall be hermetically sealed preferably in a metal enclosure to prevent seepage of impregnate and ingress of moisture.

6.6 **LAMPS:**

Incandescent (GLS) lamps shall be of "Clear" type unless otherwise specified. The fluorescent lamps shall be "Cool Day Light" type unless otherwise specified and shall be provided with features to avoid blackening of lamp ends. The fluorescent lamps shall have a high lumen output of 3250 lumens. The lamp shall have triple coil electrode with an anode ring and a tri band Phosphor coating.

Mercury Vapour lamps shall be of high pressure, colour corrected type, with a luminous efficiency of 50 lumen/watt. The discharge tube shall be made of high grade quartz.

Sodium Vapour Lamp are of high pressure type.

Metal Halide lamps shall be provided with internal diffuse coating and the average lumen output shall be 19000 lumen for 250W and 32000 lumen and the lamp voltage shall not exceed 100V for 250W and 128 V for 400W. The colour rendering index of the lamp shall be 93. The lamp shall be suitable for universal burning position and for use in open type luminarie. The lamps shall be suitable for operating on a Sodium Vapour Control gear.

The lamps shall be capable of withstanding small vibrations and the connections at lead in wires and filaments/electrodes, shall not break under such circumstances.

Lamps/Tubes shall conform to relevant Standards and shall be suitable for supply voltage and frequency specified.
46. SPECIFICATIONS FOR STREET LIGHT POLES AND POSTS

1. The street light poles/pathway light poles shall be of swaged type construction conforming to IS 1239. The dimensional and other details shall be as specified in the enclosed Standard Drawings.

2. The street light poles shall have M.S pipes of progressively reduced dimensions and post top lanterns poles shall be of uniform cross section. The poles shall be treated with a rigorous rust inhibition process and the outside surface of the pole shall be painted with two coats of paint conforming to IS 2339.

3. Where portion of the pole is required to be embedded in concrete and below ground, the inner circle shall be treated with two coats of bituminous paint.

4. The poles shall be complete with base plate of minimum size 300 x 300 mm and 10 mm thick, and as indicated in the standard drawing.

5. The pole below the ground level shall be grouted in 1:2:4 concrete as per standard drawing. The bottom portion of foundation shall be 800 x 800 mm.

6. Two nos. 50 dia. G.I pipes in arc with 600 mm radius shall be embedded in concrete pedestal upto marshaling box for running of incoming and outgoing cables.

7. Earthing studs shall be provided on pole.

8. Each pole shall be provided with a junction box made of 2 mm thick sheet steel mounted on supporting clamps welded to pole at +450 mm from ground level. The box shall be of weatherproof and dust tight construction with neoprene gaskets and provided with hinged front cover/door with key operated locking device. The box shall have overall dimension of 200 x 150 x 100 mm and shall be complete with the following: Alternatively, arrangement shall be for an integral type junction box as shown in drawing.

   i) 8 ways 30 Amp. strip type terminals each terminal being suitable for termination of loop in and loop out of Aluminium conductor cables upto 25 Sqmm.
   
   ii) 10 Amps SPN (double pole) MCB.
   
   iii) Internal wiring from box to lamp holder of light fitting at top by means of 2 runs of 100 V grade PVC copper conductor wire of size 4 Sqmm and one run of 2.5 Sqmm green earth wire.
9. The gate lights installation shall be with 600 mm long MS pipe out of which 300 mm is embedded in compound/gate wall. The junction box shall be flush mounted in wall at +450 mm from ground level and with 19 mm dia. MS conduit interconnecting pole and junction box for running wires. The light poles shall be numbered with neat letters in paint.

10. The rate shall include all items/works described as above and including civil works, reducers suitable size foundation bolts as per standard drawing and any other items not specified but necessary for completion of installation.

**LIGHT FITTINGS**

The light fittings shall be of specified type and complete with Polyester filled copper choke, HPF condenser holder, ignition, control gear, lamp/bulb of appropriate wattage and type, connectors, fuses etc. whether specified or not in the Bill of Quantities.

**NOTE**

1. The Contractor shall submit the drawings of the poles based on above specification and schedule for approval before fabrication.

2. The civil foundation works of security and pathway lights have to be executed by the contractor including supply of all materials. The price for erection in schedule of quantities contain the cost of civil foundation.

**SPECIFICATION FOR UPS & INVERTER SYSTEM**

1. **RATING OF UPS** : AS PER BOQ

   **TYPE** : ON LINE

   **INPUT:**
   
   **VOLTAGE** : 415V ± 10% to –25% (Three Phase or Single Phase)
<table>
<thead>
<tr>
<th><strong>FREQUENCY</strong></th>
<th>50Hz + / -5%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OUTPUT: VOLTAGE</strong></td>
<td>240V + / -2% (True sine wave) (Three Phase or Single Phase)</td>
</tr>
<tr>
<td><strong>TRANSIENT</strong></td>
<td>+ / -5%</td>
</tr>
</tbody>
</table>
| **OVER LOAD CAPACITY** | 110% for 30 Minutes  
125% for 05 Minutes  
150% for 01 Minutes |
| **FREQUENCY**     | 50Hz + / - 1%                    |
| **DC CHARACTERSTICS** | DC ripple with battery connected = 1%  
DC ripple with battery connected = 2% |
| **OPERATING TEMPERATURE** | 40 Degree centigrade maximum.  
90% Humidity. |
| **CABLE ENTRY**   | Cable entry provision to be given for Both top and bottom entry. |
| **BYPASS**        | Manual bypass to be provided.    |
| **OUTGOING MCB**  | AS PER BOQ / SCHEMATIC.          |
| **PROTECTIONS & INDICATIONS** | Standard protections and indications to be provided as required.  
Harmonic Filters to be provided. |
| **HARMONIC DISTORTION** (Allowed Total Voltage & Current HD) | Harmonic distortion shall be less than 8% as per IEC. |
| **BATTERIES**     | Batteries to be sealed maintenance free complete with all the required mounting accessories. |
| **BACKUP TIME**   | 30 Minutes / 15 Minutes as per BOQ. |
| **COOLING**       | Forced Air.                      |
| **BATTERY CHARGING CURRENT** | Shall be calculated for Unity Power Factor. |
| **BATTERY CAPACITY** | To be indicated, Calculations to be furnished. |
| **DIMENSIONS OF UPS & BATTERY OVERALL SPACE FOR MOUNTING ALONG WITH ROOM SIZE.** | Shall be furnished. |
| **EARTHING**      | Dedicated earthing for Input & Output side  
Secondary Neutrals. |
**BATTERY AND BATTERY CHARGER.**

**GENERAL**

i) The battery shall be lead acid type with Planate or Tubular positive plates.

ii) The plates shall be designed for maximum durability during all service including high rate of discharge and rapid fluctuation of load.

**CONSTRUCTION**

i) Each cell shall be assembled in the heat resistant, shock absorbing, robust, clear glass or hard rubber container with float type level indicator.

ii) Electrolyte level shall be marked on the clear glass container or level indicators as applicable. The markings shall be for upper and lower limits.

iii) The cells shall be supported on porcelain insulator fixed on the rack with adequate clearance between adjacent cells.

iv) The cell terminals posts shall be provided with connector bolts and nuts, effectively coated with lead to prevent corrosion.

v) Separator between plates shall permit free flow of electrolyte. Separator shall be wood or other acid resisting materials. Proper arrangement to keep the end plates in position shall be furnished.

vi) Sufficient sediment space shall be provided so that the cells will not have to clean out during normal life.

vii) Lead or lead coated copper connectors shall be furnished to connect up cells of battery set.

viii) Positive and negative terminal posts shall be clearly and indelibly marked for easy identification.

ix) Lead coated bent copper plate, tubular copper lugs, teakwood clamp, bolts, nuts, washers, etc. shall be furnished for connection of outgoing aluminium conductors cables.

x) The battery shall be shipped uncharged with the electrolyte furnished in a separate non-returnable container. 10% extra electrolyte shall be furnished to cover spillage during transit or erection.
RACKS

i) The racks for supporting battery cells shall be constructed of best quality teakwood tinted with at least three (3) coats of anti acid paint of approved shade.

ii) Racks shall be free standing type, mounted on the porcelain insulators.

iii) Numbering tags for each cell shall be attached on the racks.

FITTINGS AND ACCESSORIES

Each battery shall be furnished complete with the following:-

i) First charge of electrolyte plus 10% extra.

ii) Teakwood racks with 3 coats of anti acid paints.

iii) Stand insulators 5% extra.

iv) Cell insulators plus 5% extra.

v) Cell interconnectors and end take-off.

vi) Lead-coated connection hardware plus extra.

vii) Cell numbering tag with fixing arrangements.

viii) Teakwood cable clamps with hardware.

ix) Two (2) extra cell.

x) One (1) interconnector bolt wrench.

xi) One (1) hydrometer Syringe.

xii) One thermometer with specific gravity correction scale.

xiii) One (1) Cell testing Voltmeter with leads.

BATTERY CHARGER

GENERAL
i) The charger shall be natural air cooled, solid-state type with full wave, fully controlled, bridge configurations.

ii) The charger shall be provided with automatic voltage regulation, current limiting circuitry, smoothing filter circuits and soft start feature.

iii) Voltage shall be stepless, smooth and continuous.

iv) The charger shall be self-protecting against all A-C and D-C transients and steady state abnormal currents and voltages.

v) Voltage setters shall be provided for setting the output of the float boost charge. Setting shall be independent of each other so that setting of one voltage shall not require resetting the other.

vi) There shall be separate transformers for float and boost charger.

vii) Charger A-C input and D-C output shall be electrically isolated from each other and also form panel ground.

CONSTRUCTION

i) The charger shall be free-standing. Floor mounted with sheet steel enclosure with all access from the front.

ii) The panel shall conform to the degree of protection IP 42. Minimum thickness of the sheet metal used shall be 2 mm.

iii) Access doors shall be with concealed hinges and neoprene gaskets. Ventilating louvres shall be covered with fine wire mesh.

iv) All equipment within the panels shall be arranged in the modular units and laid out with sufficient space for easy maintenance.

v) Switches, meters, relays etc. shall be flush mounted on the front of the panels. Nameplates of the approved size and type shall be provided for all circuits and devices.

CHARGER EQUIPMENT

i) All power diodes and control rectifiers shall be silicon type. Rectifier transformer shall be dry type, double wound, with copper conductor and class B insulation.

ii) Blocking diodes shall be fully rated and redundant so that failure of a single diode shall not incapacitate the system in any way.
iii) Isolating switches shall be heavy-duty, load break type, operated by external handle with provision for padlocking in ON or OFF position.

iv) Change over switch shall be 3 position, 4 pole, and load break type with 2 No+2 NC auxiliary contacts.

v) Contactor shall be air-break type with thermal overload relays being in built single-phase prevent or.

vi) Fuses shall be HRC type and arranged for easy replacement. Semi conducting device fuses shall be fast acting.

vii) Indicating lights shall be low-watt filament type with series resistor. Both lamps and lens shall be replaceable from the front.

viii) Meters shall be 96 x 96 mm switchboard type, 250 deg.scale, antiglare glass, ±2% accuracy with zero adjuster on the front.

**ALARMS**

i) One (1) ten-point alarm facia shall be provided on charger panel, complete with proper actuating devices, circuitry and legends.

ii) The arrangement shall be such that, on occurrence of a fault the corresponding window will light up and stays lighted until the fault is cleared and reset button is pressed.

iii) Each time a window lights up, a master relay will get energized to provide group alarm signals for remote panel.

iv) Following minimum annunciation shall be provided:

   # A.C. supply failure *
   # D.C. voltage low
   # D.C. voltage high*
   # D.C. system ground*
   # Charger overload*
   # SCR fuse blown
   # Filter fuse blown
   # D.C. output fuse blown
   # Alarm points marked with an asterisk(*) shall have electrically separate set of contacts wired up to the terminal block.
   # Alarm contacts shall be rated 1A at 110V D.C. and 5A at 240V A.C.

**OUTGOING FEEDERS**
i) Each outgoing feeders shall be provided with double pole switch and with HRC fuses.

ii) Outgoing feeders shall be located in separate module forming part of charger panel with separate cable alley for terminating outgoing cables.

**LAMP/SPACE HEATERS/RECEPTACLES.**

i) The charger panels shall be provided with:

- Internal illumination lamp with door switch
- Space heater with thermostat control

ii) Lamp, heater circuits shall have individual switch fuse units.

Requirements:

**BATTERY**

i) Type : Lead acid

ii) Nos. of cells per Battery : 55

iii) Battery nominal voltage : 110 Volts.

iv) Ten hour rating to 1.85 Volt/cell at 27 deg.c: 100Ah.

v) Proposed method of working:
   a) Float charging (normal) : 2.15 Volts per cell.
   b) Boost charging (After complete discharge) : 2.75 Volts per cell (Maximum)

vi) Intermediate tapping : 42\(^{nd}\) cell.

vii) Mounting : Wooden racks.

**BATTERY CHARGER**

i) Charger : Float & Boost

ii) Float charging current : 25A.

iii) Type : Solid state
iv) A.C. Input supply : 415V, 3 phase, 50HZ, 4wire.

v) Ripple content in charger dc output : ± 1 %

vi) Outgoing feeder 10 Nos pole switchfuse of 32A : Each consisting of double

47. SPECIFICATION FOR EARTHING SYSTEM

1.0 SCOPE.

This specification covers the requirements of supply, installation, testing and commissioning of earthing systems. The work shall be carried out in accordance with relevant layout drawings, typical drawings and installation notes etc. All metal conduits, cable sheathes, switchgear, distribution boards, light fixtures, fan and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes.

2.0 CODES AND STANDARDS.

2.1 The earthing systems shall comply with all currently applicable standards, regulations and safety codes of the locality where the installation is to be carried out. Nothing in this specification shall be construed to relieve the Contractor of this responsibility.

2.2 The installation work shall conform to the latest applicable Electricity Rules, Relevant Indian Standards and Codes of Practices as follows:

2.2.1 IS 3043 - Code of Practice for Earthing.

2.2.2 IS 732 - Electrical Wiring Installation.

2.2.3 IS 3975 - Galvanized round steel wire.

2.2.4 Indian Electricity Rules 32, 61, 67 and 68 of IER 1956.

3.0 EARTHING ELECTRODES.

3.1 Earthing electrodes shall be designed as per the requirements of IS 3043. The resistance of earth electrodes shall be as low as possible, the maximum allowable value being one Ohm.

Earth electrodes shall be as far as possible embedded below permanent moisture level. Earth pits shall be further treated with salt and charcoal to improve the soil resistant. In rocky areas where the required earth resistance cannot be attained using the standard earth electrode. Configuration then application of deep well earth pits should be examined.
3.2 **PLATE ELECTRODE**

Plate electrodes shall be made of copper plate of 3.15 mm thick and 600 x 600 mm size. The plate shall be buried vertically in ground at a depth of not less than 2.5 Mtrs. to the top of the plate, the plate being encased in powdered charcoal to a thickness of 15 Cms. around. Salt and river sand shall not be used. Earth leads to the electrode shall be laid in a medium grade GI pipe and connected to the plate electrode with brass bolts, nuts and washers. The GI pipe of 19 mm dia. shall be placed vertically over the plate and terminated in a funnel of 5 Cms above the ground. The funnel shall be enclosed in masonry precast chamber. The chamber shall be provided with CI frame and CI cover. The earth station shall also be provided with a suitable permanent identification label/tag.

3.3 **PIPE ELECTRODE**

Pipe electrode shall comprise of 50 mm dia. GI pipe with wall thickness 3.65 mm and not less than 3.0 mtrs long buried vertically in a pit of 350x350 mm size and filled with alternate layers of charcoal, salt and river sand and connected at the top to a medium grade GI pipe of 19 mm dia, 1 mtr long with a funnel at the other end, clamped to the pipe electrode with brass bolts, nuts and washers. GI pipe electrodes shall be cut tapered at the bottom and provided with holes of 12 mm dia. drilled not less than 75mm from each other upto 2 Mtrs., length from bottom. The top end of the pipe shall be threaded and provided with G.I cap. A hole shall be provided at 100 mm from the top end to receive a 13 mm bolt with double nuts and washers. The funnel and the earth lead connections shall be enclosed in a masonry precast chamber/inspection pit. The chamber shall be provided with C.I frame and C.I cover. A proper permanent identification tag/label/earth cable marker shall be provided for each electrode.

4.0 **EARTHING SYSTEM.**

4.1 **GENERAL**

- Each installation shall have one common earth grid connected to atleast two groups of earth electrodes.

- The earth grid shall extend throughout the installation in the form of a ring circuit with branch connections to the equipment and structures to be earthed.

4.2 **EARTHING CABLES AND CONNECTIONS :**

- Earth systems shall be of solid copper/galvanized flats type, of cross-section specified on the relevant design earth layout drawing.
• Connections between earth electrodes and main ring earth conductors shall be executed in accordance with Electrical Drawings and in such a way as to facilitate the inspection and testing the earth resistance of each individual earth electrode group without disconnection of the earth system main ring.

• All uninsulated parts of earth conductors shall be suitably protected against direct contact with the soil to prevent electrolytic corrosion. This may be achieved by lap wrapping bared sections with green PVC adhesive tape.

• All earthing termination’s shall be made with compression type cable lugs. Interconnections shall be directly clamped with compression type branch connectors as detailed in Electrical Drawings.

• Execution of earth cable branch connection by means of exothermic welding shall require the approval of The Company Site Representative, who will take into account the suitability of the welding equipment and the previous experience of the Contractor’s personnel.

• The resistance between each earth electrode configuration and the general mass of earth shall not exceed 5 ohms when isolated from the main earth grid.

• Location of earth electrodes, earth conductors connections and earth cable routes shown on the installation earth layout drawing shall be considered as diagramatic only, and site inspection shall be necessary to determine earth connection onto equipment’s locations and conductor routes prior to installation.

• Within buildings, strips of high conductivity copper/GI, sized in accordance with the layout earthing design drawing, should be utilized.

• Where copper tape or cable is fixed to building structure it shall be by means of purpose made saddles.

• Fixings shall be made using purpose made lugs and clamps.

• Fixings requiring drilling of holes through stripes shall be used, considering the effective cross-section of the particular run is within relevant regulations.

• Where tape or cable is run in the ground or fixed externally, and is liable to corrosion, it shall be wrapped with corrosion-resistant material. Alternatively, PVC wrapped tape or cable may be used.

• Joints in copper tape shall be tinned before assembly, riveted with a minimum of two rivets, and sweated solid.

• Where holes are drilled in the earth tape for connection to items of equipment, effective cross-sectional area of connections shall be not less than required to comply with the relevant Regulations.
• Bolts, nuts and washers for any fixings of earth tape shall be of high-tensile grade.

4.3 ELECTRICAL EQUIPMENT

• Metallic enclosures of all electrical equipment shall be earthed at two ends by connection to the common earth grid.

• Cross-sectional area of the equipment earth connections shall be in accordance with the earth layout design drawing.

4.4 NON-ELECTRICAL EQUIPMENT

• All metallic equipment used for storage, processing, transportation or pumping flammable liquids, vapours or gases, and their associated supporting structure or skid, shall be electrically bonded to the installation main earth ring.

• Electrical bonding of associated metal work, in handrails, walkways, etc., is not necessary if it is demonstrated by testing that they are electrically continuous with the structure. However, the same shall be bonded to earth at one point.

• Piping which is not in electrical contact with its associated tank or vessel, such as an open discharge line into a tank, shall be bonded to the tank.

• In installations that do not contain electrical equipment, the resistance between each earth electrode configuration and the general mass of earth shall not exceed 5 ohms when isolated from the main earth grid.

4.5 BONDING

• Metal sheaths and armour of all cables operating at low voltage, metal conduits, ducting, trunking, and protective conductors associated with such cables, which might otherwise come into contact with adjacent fixed metalwork, shall be effectively either segregated from, or bonded to, adjacent metal work.

• Metallic sheaths and / or non-magnetic armour of all single-core cables in the same circuit normally shall be bonded together at one and end only of their run (solid bonding) unless specified otherwise.

• All interior metal, water and gas piping shall be bonded together and made electrically continuous.

• Non-conductive coatings (such as paint, lacquer and enamel) on equipment to be earthed shall be removed from threads and other contact surfaces to ensure good electrical continuity.

48. SPECIFICATION FOR POWER FACTOR IMPROVEMENT SYSTEM.
1. **GENERAL.**

The Power Factor improvement system shall comprise of capacitors and associated switchgear and control gear as per the requirements.

2. **CAPACITORS.**

- Power factor correction capacitors shall conform in all respects to IS: 2834-1981 (amended upto date) or BSS: 1650-1971 or VDE 0560 Part 4 or IEC:70:1967. The CPRI test certificates of the capacitors shall be submitted. The capacitors shall be suitable for 3 phase 415V, at 50HZ frequency and shall be available in three phase units. The capacitors shall be suitable for indoor use upto ambient temperature of 50 Deg. C. The permissible overloads shall be given below.

- Voltage overload shall be 10% for continuous operation and 15% for 6 hours for 24 hour cycle.

- Current overload shall be 15% for continuous operation and 50% for 6 hours in 24 hours cycle.

- Overload of 30% continuously and 45% for 6 hours in a 24 hours cycle.

- Capacitors (Gas Filled) shall be hermetically sealed in sturdy corrosion proof, CRCA sheet steel containers. The capacitors shall be provided with suitable discharge devices to reduce the residual voltage from crest value of the rated voltage to 50V or less with in One Minute after capacitor is disconnected from the source of supply. The loss in the capacitor shall be very low.

- Each capacitor shall be interconnected by tinned copper bus bars with final connections to capacitor terminals by means of copper flexible to relieve insulator from mechanical stresses.

- The terminals shall be brought out through Epoxy resin bushings. The terminals shall be provided with detachable covers on all terminals and live parts. The capacitor unit shall have earthing studs.

- Capacitors shall withstand power frequency test voltage of 2500V A.C. for one minute. The insulation resistance between capacitors, terminals and containers when a test voltage of 500V D.C is applied shall not be less than 50 mega ohms.

- The copies of the following type tests shall be submitted along with routine test certificates.
  - Test for Dielectric loss angle.
  - Test for Capacitors losses.
• Thermal stability test.
• Test Certificates from relevant authorities / Electricity Boards.

3. **CAPACITOR CONTROL PANEL**

3.1 The capacitor control panel shall generally comprise of following:

i. Main incoming switch fuse unit or MCCB.

ii. Power factor correction relay.

iii. Step controller with reversing mechanism.

iv. Time delay and no-volt relays.

v. Protection fuses.

vi. Contactors and switch fuses for individual capacitor banks.

vii. Change over switch for either manual or automatic operation.

viii. Current transformers.

ix. Power factor meter with protection fuses.

x. Indicator lamp and push buttons for each bank.

3.2 The capacitor control panel shall be of cubicle type and shall be fabricated out of 16 G sheet steel suitably rust inhibited and stove enameled. The panel shall have adequate space for mounting the capacitors. The panel shall be of dust and vermin proof construction. Panels shall be of dead front pattern and floor mounting type.

3.3 The technical specification and construction features of capacitor control panel shall be same as that of medium voltage power / motor control centers, except the back covers of the panel housing the capacitor banks. The capacitor banks shall be mounted at the rear side of the cubicle panel in different tiers arrangement. The interconnection between the switches / contactors and capacitor banks shall be by means of suitably rated aluminum bus bars and / or PVC armoured cables.

49. **SPECIFICATION FOR LIGHTNING PROTECTION SYSTEM.**
PREVECTRON, the ESE lightning Conductor, complete with a CENTRAL PICK-UP ROD, made of either electrolytic Copper or stainless steel, with an UPPER SERIES of electrodes to generate sparks, a WATERPROOF HOUSING connected to the earth and, an ELECTRICAL TRIGGERING DEVICE, sealed within the protective housing and, a LOWER SERIES of ELECTRODES to collect the ambient electrical energy.

The ESE unit should have the following features:

- Large Protection Radii.
- Optimal Protection against the direct effects of lightning.
- Improved maximum effectiveness and longevity.
- Total autonomy.
- Activates itself only when there is a risk of lightning
- Permanent single drop from the tip of the Air-terminal down to the earth.
- Full compliance with international standards - example the French Standard NF C17-102
- Reliability and Sturdiness to be tested by both International test laboratories and in Real-live lightning conditions, tested and witnessed by reputable authorities (for example, Atomic Energy Commission)
- Proven, Robust Design able to withstand Multiple Lightning Strikes.
- 5 Model Range offering customized solutions for each Project.
- Multilevel Protection.
- The manufacturer should have at least 20 years experience specifically in manufacture of ESE lightning protection.

1. **SCOPE.**

This specification covers the requirements of supply, installation, testing and commissioning of lightning protection system in conformity with the requirements of IS:2309, consisting of vertical air termination the horizontal air termination’s, down conductors and earth stations.

2. **AIR TERMINATION’S.**

The air termination’s shall be provided at the points shown on the drawings. The vertical air termination’s shall consist of copper spikes fixed onto 25 mm dia. copper tubes of atleast 1.5 Mtrs. long grouted to the surface of the roof with base plate as approved by Consultants. The horizontal air termination’s shall consist of a rigid network of tapes fixed to the surface of the roof. All exposed metal work and roof structures forming part of the structure to be protected shall be bonded to the net work by the conductors of the appropriate cross section.

3. **DOWN CONDUCTORS.**

Air termination’s shall be connected to the earth termination’s by tapes fixed onto walls of the structures with spacers. The tapes shall be securely fixed to walls by means of brass saddles and metallic fasteners. Where the down conductors are laid underground, they shall be laid at a depth of 750 mm below the ground level, buried in trench, covered with a 100 mm thick layer of sand.
and protected by cable protection tiles. All metallic parts of the building above the main roof level including ducts, towers, pipes gutters and other mechanical equipment’s shall be bonded to the down conductors.

4. **GENERAL.**

- The materials shall be free from rust, scale and other electrical and mechanical defects. The size, materials and quantity shall be as specified.

- Steel earthing conductors above ground shall be hot dip galvanized. If painted it shall be given two coats of approved bit mastic paint/anti-corrosive paint.

- Test links in suitable enclosures shall be installed by the contractor at no extra cost for connection between each lightning conductor down conductor and earth electrode.

- The scope of installation of lightning conductors on the roof of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods where necessary, laying, fastening/cleating/welding of the down-comers on the walls/columns of the building and connection to the test links above ground level, and upto earth station.

- Lightning protection conductors shall not be connected to other general earthing conductors.

- The lightning protection air termination rods and/or horizontal air termination conductors shall be fixed in such a way that they remain in their installed position even during adverse weather conditions.

- The down conductors shall follow a direct path to earth. There shall not be any sharp, turns and kinks in the down conductors.

- All joints in the down conductors shall be of welded/brazed type. All metallic structures within 2 m vicinity of down conductors shall be bonded to the lightning protection system.

- Every down conductor shall be provided with a test link at about 1000 mm above ground level. The test link shall be directly connected to the earthing system/electrode.

- The lightning protection system shall not be in direct contact with the underground metallic service ducts, cables, cable conduits and metal enclosures of electrical equipment’s.

- Lightning conductors shall not pass through or run inside G.I conduits.
• Wherever required, if indicated in drawings, for fuel oil and other inflammable liquid storage tanks lightning and protection shall be provided with horizontal conductors strung between tall poles covering the entire areas.

5. **JOINTS BONDING.**

The system shall have preferably no joints and they shall be made mechanically and electrically strong and effective. Bolted joints should only be used on test points or on bonds to as existing metal. Generally jointing/connections/installations shall be as in Earthing system.

6. **EARTH TERMINATION’S.**

• Suitable number of earth termination’s shall be provided. The earth termination shall consist of pipe/plate earth electrode as specified elsewhere in the Earthing Specification, and generally conforming to IS : 3043. The earth termination’s shall be complete in all respects with chamber and cover, etc. as per the detailed specifications.

• Before installing the lightning protection system, the contractor shall obtain approval from the Engineer with respect to the locations of air termination’s and the routes for the down conductors.

7. **TEST CLAMPS/LINKS.**

• Test clamps/links shall be manufactured from phosphor bronze or approved equivalent with four fixing holes. Tape conductors shall be fixed to flat roof surfaces by means of suitable fixing arrangement as approved.

• All fixing screws shall be brass.

8. **TESTING.**

Suitable testing links be provided at required points as per the code of practice CP 326/IS 2309. The contractor shall carry out tests on completion of the installation and submit the readings for approval.

50.1 **MS RACEWAYS:**

The concealed floor raceways shall be fabricated using MS powder coated with 2mm thick base/slides, with removable covers. The colour shall be off white or approved shade as per IS 733. The necessary bends, suitable size junction boxes, tees and other accessories required shall be included. The powder coating shall be with 10/15micron thick including finishes. The following standard sizes are used: 150x40mm and 100x 40mm.
50.2 **PVC Raceways:**

The surface mounted raceways shall be with DLP U-PVC trunking. The colour shall be of white. The necessary supporting accessories such as base, flexible cover, three compartment with two partition separation, clipon partition, clips, base joints, joints for cover, wall crossing accessories, cable tie bases, end caps, flat angles, internal angles, external angles and flat junctions, tees and other accessories required shall be included.

The following standard sizes are used:

a. 150 x 50mm for power wiring,

51. **PREAMBLE TO SCHEDULE OF QUANTITIES**

All items of work mentioned in the Schedule of Quantities shall be read and executed strictly in accordance with the description of the item in the Schedule of Quantities, equipment schedule/Data sheet, drawing and standard specifications read in conjunction with the appropriate IS and conditions of contract.

The rate for each item of work included in the bill of quantities shall unless expressly stated otherwise include cost of:

a) Wastage on materials and labour.

b) All taxes, duties, octroi, including works contract tax, sales tax, transit insurance, packing and forwarding charges, loading, transportation, unloading handling, hoisting, to all levels, setting and fixing in position, disposal of debris and all other labour necessary in accordance with contracts documents, good practice and recognized principles.

c) Liabilities, obligations and risks arising out of conditions of contract.

d) Liaison service charges.

All requirements of system whether such of them are mentioned in the item or not the specifications and drawings are to be read as complimentary to and part of the schedule or quantities and any work called for in one shall be taken as required for all. In the event of conflict between the bill of quantities and other documents, the most stringent shall apply and interpretations of the Architect shall be final and binding.

5. The installation of price of switchboards, metering panels, DB’s or any other items shall include supply and fixing of supporting steel structures /MS channels grouting of the same civil works etc. as required.

6. No change in unit rate shall be allowed for any change in quantity or for any other reason whatsoever.
7. Supply of materials shall mean supply of materials at site. The rate for supply shall include all 
taxes, octroi, insurance, packing and forwarding charges, transportation, unloading at site.

8. The successful contractors shall submit the Schematic diagrams, fabrication drawings with 
details of equipment wiring diagrams etc. to Architects for approval prior to supply/commencement 
of such works. The approval of these drawings will be general and will not absolve to contractor of the responsibility of the correctness of these drawings. At least four 
copies of the approved drawings supplied to Architects for their distribution to various agencies 
at site at no cost to owner.

9. The tenderers must see the site conditions such as type of soil, locations etc. and take all factors 
into consideration while quoting the rates as no extra cost will be allowed on any ground arising 
out or relating to the site conditions.

10. Any error in description in quantity or omission of items from the contact shall not vitiate this 
contract but shall be corrected and deemed to be a variation required by the Architect/Owners.

11. The Liaison service charges shall include the following:

   i) Follow up expenses with the Electricity Board from the drawing approval up to servicing 
   the installation and getting the safety certificate.

   ii) Preparation of detailed drawings required by the Electrical Inspector.

   iii) Obtaining Approval of drawings and Installation.

   iv) Renewal of any temporary power supply connection during construction.

      a) All incidental charges/expenses associated with the above work.

      b) Provision of labour in assisting electricity Board for installing DP Structure and 
      accessories.

   Official deposits paid to the above agencies will be reimbursed separately at actuals 
   by the owners.

12. All testing and calibration charges for the meters shall be included in the installation price of the 
Meter Board.

13. The tender shall take into account The expenses of pre-commissioning tests to be conducted as 
per specification of the complete installation by licensed agencies.
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<td><strong>DELTON</strong></td>
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Signature of the Bidder with Seal
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1. Samples along with test certificate must be produced and approval by the competent authority obtained before using on the works.

2. Non-availability of materials (approved) will not be entertained to change the brand and required quantity of materials should be procured well in advance. In unavoidable circumstances certificate from the manufacturers / authorized dealers for non-availability should be produced for getting alternate brands approved by the competent authority.