

CORRIGENDUM

Minutes of online Pre-bid meeting held on 07/09/2023 at 11:00 AM

Name of Work: Design, Supply, Installation, Testing and Commissioning of Modern Rice Mill at Palakkad Dist. for Kerala Rice Limited

Tender No. : KINFRA/RTP-PLKD/TENDER/01/2023-24

The following points were discussed and decided as under,

Sl. No.	Bidder Query	Reply from Client/Consultant
1.	Bidder enquired what all comes under Defect Liability Period (DLP).	<p>As per tender; Defect Liability Period (DLP) is as follows;</p> <p>The Supplier shall guarantee that upon completion of the satisfactory commissioning and final taking over acceptance of the equipment by the Client, all portions thereof will perform in accordance with the requirement of the contract and will be perfect with respect to design, materials, workmanship, etc. for a minimum period of THREE year from the date of taking over of the equipment as per the conditions of the contract. The Supplier shall further guarantee that during the guarantee period he will repair and if unrepairable, replace all defective parts/equipment and materials furnished or installed under this contract, free of cost to the Purchaser. Supplier shall also arrange the annual inspection of boiler & air receiver of air compressor by liaisoning with F&B department; statutory fees shall be paid by purchaser.</p>
2.	Bidder enquired about the similar work for eligibility criteria.	<p>Tender clause 4. Eligibility Criteria of NIT is modified as,</p> <p>“Similar work shall mean Supply, Erection, Testing & Commissioning of rice mill machineries [either a single order or split orders] to a single Client within a period of one year”.</p>
3.	Bidder enquired what if the bidder does not have experience in Silos supply and erection.	<p>The bidder need not have experience in supplying all types of machineries/equipment in this tender. But the bidder shall satisfy eligibility criteria (experience in supplying rice mill machineries). But all the items in the tender shall be executed through experienced manufacturers/ agencies/ suppliers, as approved by Client/PMC.</p>
4.	Bidder enquired where will the tender be	<p>The tender can be purchased from KINFRA Head office at Sasthamangalam, Trivandrum, Kerala, by remitting tender fee of ₹ 11,800/- as DD in favour</p>

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	obtained? Is the tender fee payable online?	<p>of Managing Director, KINFRA, along with request letter and ID proof.</p> <p>Online payment option is also available as given below,</p> <p>Name: Kerala Industrial Infrastructure Development Corporation (KINFRA) A/c No. 31763060697 Bank: State Bank of India (SBI) Branch: Althara, Vellayambalam IFSC Code: SBIN0007203</p> <p>Bidder shall inform KINFRA about the details of online transaction with proof. Request letter and ID proof shall be sent to KINFRA by e mail - kinfraannexe@gmail.com and spl.officer@kinfraiii.org. On receipt of tender fee, the documents will be sent to the bidder by courier/speed post. Bidders shall submit original tender document duly filled and signed as per tender conditions. The bidder shall ensure timely submission of tender document. Tenders received late will be summarily rejected.</p>
5.	Bidder enquired about the capacity of Rice Mill	<p>The scope includes Design, Supply, Installation, Testing and Commissioning of Silo Storage system, 5 TPH Modern Rice Mill, air compressor & all associated pneumatic piping works, 5 TPH Husk fired boiler & all associated piping works (Steam piping both IBR & Non-IBR, water piping etc.) and other accessories as required, as per specifications.</p>
6.	Bidder enquired that the civil foundation is in their scope or not.	<p>The foundations for all the items/equipment/silos will be executed by another contractor assigned by the Purchaser based on design, foundation details and load details submitted by the successful bidder.</p> <p>The successful bidder shall thus provide design, load details, all the foundation details and drawings for each item/equipment/silos, indicating foundation size, location, bolt pocket sizes etc. within 21 days of the receipt of the order (Refer clause 10.1 of Technical Specifications, Part 1-Plant and machinery). The same will be approved by the Purchaser/Consultant.</p> <p>Providing all the foundation bolts of the entire system & grouting/fixing the same as required will be in the scope of successful bidder.</p>

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7.	Bidder enquired regarding the storage shed for safe storage of their supplied items.	The storage of equipment & material supplied by the contractor is the responsibility of the bidder. Weather proof storage has to be provided by bidder. Please refer tender clause 12.1 to 13.2 of SCC, Part-II-Plant and Machinery.
8.	Bidder requested for extension of Last date of submission of bid.	Tender submission date is extended up to 29/09/2023. Tender documents are available during office hours between 9.30 AM and 5.00 PM in all working days till 29/09/2023 (the sale will be up to 1.00 PM only on 29/09/2023). The tender should reach KINFRA Head Office (KINFRA House, TC31/2312, Sasthamangalam, Thiruvananthapuram-695010, Phone: +91471-2726585) on or before 29/09/2023 at 5.00 pm. Technical bid opening will be on 30/09/2023 at 11.00 AM at KINFRA Head Office.
9.	Bidder requested for change in the payment for erection by reducing to 10% since the supply cost of equipment is more and during taking over the percentage to be brought down to 5%.	<p>Payment conditions as per Cl 27 (page 11 of NIT) are modified as under,</p> <ol style="list-style-type: none"> a. <u>Advance Payment:</u> 20% of the contract price shall be paid on signing of the contract and upon submission of a bank guarantee for an equal amount valid till completion of work. b. <u>On approval of design:</u> 10% of the contract price shall be paid against approval of construction/fabrication designs as certified by Consultants/KRL. c. <u>On approval of final drawing:</u> 10% of the contract price shall be paid against approval of final drawings as certified by Consultants/KRL. d. <u>On progress of supply:</u> 35% of the contract price shall be paid on pro-rata basis, depending on the receipt of goods at site in good condition. Payment will be made based on bills certified by Consultants/KRL. e. <u>On progress of erection:</u> 15% of the contract price shall be paid on pro-rata basis, depending on the completion of erection of goods at site. Payment will be made based on bills certified by Consultants/KRL. f. <u>On taking over:</u> 10% of the contract price shall be paid on satisfactory commissioning and trial run of the entire system and on 'Taking over' of the system by KRL.

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		<p>g. On completion of Defects Liability Period: The 5% of contract value (Performance guarantee submitted by the Contractor) will be kept with KRL till completion of defects liability period (36 months) as per government order.</p>
10.	Bidder enquired about the capacity of the dryer.	<p>As per tender clause No.2.3.4, Unit A - Pre-cleaning, Parboiling & Drying, Sl. No.8 of TECHNICAL SPECIFICATION FOR 5 TPH MODERN RICE MILL; The capacity of the 1 No. dryer shall be 40 Tons Boiled per batch for the Unit A - Pre-cleaning, Parboiling & Drying.</p> <p>As per tender clause No.3.03. DRYER OF TECHNICAL SPECIFICATION FOR PADDY SILO STORAGE SYSTEM; The capacity of the dryer shall be 60T/Batch for the Paddy Silo Storage System.</p>
11.	Make of Boilers	<p>The following makes of Boilers are also included in “Approved Makes”</p> <ol style="list-style-type: none"> 1. MAXTHERM 2. BELFAB 3. CHEEMA Boilers
12.	Agreement for O&M	<p>The Contractor shall execute a separate agreement for the O&M. The final bill for the work will be released only after execution of agreement for O&M.</p>
13.	Quote for O & M for 5 years and BG details for O&M	<p>The bidders shall quote yearly increment of O&M charge in percentage (%) for 5 years. The same % increment quoted will be added up in succeeding years.</p> <p>The submission of BG for O&M (page 4 of NIT) is modified as “On successful commissioning of the Rice Mill the Contractor must submit Bank Guarantee (BG) equivalent to 120% of 1st year’s O&M charge agreed by the Contractor and to execute agreement for O&M. The BG should have validity till end of O&M period of 5 years plus 3 months.</p> <p>If the Contractor failed to complete the O&M for 5 years as per contract conditions, the O&M for the balance period will be executed by another agency appointed by the Client at the Risk and Cost of the original Contractor.</p>

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14.	Running of Plant in full capacity	The Contractor shall ensure minimum 5 TPH handling capacity of the plant during O&M contract period.
15.	Allowable non-operational days of the plant	Maximum permissible non-operational days of the plant for maintenance/service/repairs shall not exceed 25 days/year, excluding approved holidays. However, breakdown of plant due to natural calamities/power issues/reasons acceptable to the Client will not be the responsibility of the Contractor.
16.	Staffs for O&M	<p>The Contractor shall deploy necessary skilled and unskilled staffs for operation of Rice Mills in 2 shifts daily including necessary labours for shifting paddy to silos and shifting of finished goods to the storage space.</p> <p>Client will make all arrangements for unloading of paddy from the lorry and loading of finished goods to the lorry.</p> <p>The Contractor can engage any other suitable agencies for the O&M of the Rice Mill but all responsibility of O&M shall be with original Contractor.</p>
17.	Single quote for the work.	The work is a combination of rice mill, silo, compressor, boiler and allied piping works. So bidders shall quote a single amount for the whole work.
18.	How to find out lowest bidder?	The lowest bidder will be decided based on the total amount of O&M charges for 5 years and amount quoted for the work.
19.	Detailed Electrical Specification	PART II-Electrical technical specification in the tender stands deleted. The attached Electrical Specification shall be considered for the work.

Date: 14.09.2023

Sd/-
Managing Director

**ELECTRICAL
SPECIFICATION**

TECHNICAL SPECIFICATION
ELECTRICALS

1.0 TECHNICAL SPECIFICATIONS

1.1 General

- 1.1.1 The bidders should note that, it is the responsibility of the bidder to design, supply, install and commission the equipment and services required and statutory approval from authority for the satisfactory performance of the installation according to the relevant codes and standards of Kerala State Electricity Board and Electrical Inspectorate. The details given here are only indicative and are subject to changes and modifications to suit the requirements of the project and as directed by the Electrical Inspectorate during actual execution.
- 1.1.2 The intent of this specification is to define the requirements for the design, manufacture, shop testing, supply, installation, testing and commissioning of the electrical system like LT panel boards, Power & control cables, wiring and accessories including 3 ph and 1 ph industrial plug and sockets, Lighting of Silo area, earthing , Lightning protection etc for project for the construction of paddy Silos along with cleaning, drying and conveying etc for Rice Technology Park at KINFRA Mega Food Park, Palakkad Dist. The bidder shall furnish complete details of the equipment with all necessary drawings.

1.2 Scope of Work

Scope of work shall be includes but not limited to the following:

1. The Purchaser shall provide main LT power supply at 415 Volt, 3 phase & neutral, 50 Hz, from Purchaser's LT Power Control Centre (PCC). The Bidder shall avail power supply from the outlet earmarked by the Purchaser.
2. Bidder scope includes wherever required modification for existing LT panel to fulfill the proposed new system.
3. Bidder shall provide required LT Panel boards/Motor Control Centre, Capacitor panel, and sub switch boards. Separate panel should be provided for internal lighting and street light purpose.
4. Street Light Panel should be provided with timers, contactors, MCCB/MCB's
5. Supply, installation, testing, commissioning and handing over of all electrical equipment and accessories to be supplied along with the machinery in satisfactory operating condition.

6. Supply and laying of cables, termination at ends, testing and commissioning of LT Power and Control Cables from Panels/ PCCs / MCCs to equipment/motors. Adequate size cables shall be provided to meet the continuous current rating and voltage drop limits in the cable
7. Wherever buried cables are envisaged, scope of work includes digging of earth along the cable route, filling up of sand, protective covering as per specification, laying of cable, covering the cables with sand, laying of bricks, back filling of earth, etc., as per specification.
8. Installation of Hume pipes including excavation, erection, back filling etc. as required. Wherever drain/road crossings are required, hume pipe with manholes at both ends shall be provided. Hume pipe shall be suitably sized and at least 20 percent spare space shall be provided for future insertion of cables.
9. Supply and installation of Cable markers as required.
10. Supply and installation of 3 Ph and 1 Ph industrial plug and socket as required.
11. Supply and installation of motors with local controlling ON/OFF switch unit.
12. Supply & installation of Lighting System (including street lights) complete with light fittings, Lighting Sub-switchboard, DBs including wiring .
13. Supply, installation and testing of earthing system complete with required number of earth pits for system earthing, lightening protection, earth conductor of suitable rating including interconnection between earth pits, earth bus and equipment earthing etc. MCCs/PCCs/panel boards, DBs etc, and building and other structures shall be connected to the earth bus.
14. Supply and installation of Lightening protection for buildings under the scope of Bidder as per IS 2309 and IEC 62305 complete with air termination, down conductors, test joints and earth pits and inter connection.
15. Civil work includes Foundations of LT panel boards, fixing of cable trays, cable trenches, pipes with all necessary supports.
16. Supply and installation of structural steel components for panel supports, cable supports, push button mounting pedestal, etc.
17. In addition to the electrical erection the Contractor shall provide safety items like the electrical danger boards, shock treatment charts, rubber mats, etc. on all the panel boards and other places where it is required. Fire extinguishers, fire buckets etc. required for electrical rooms shall be provided.
18. The price quoted for installation shall include the charges for cleaning and painting the conduits & supports and as directed by Engineer-in- Charge.

19. Approval shall be obtained from Purchaser/Consultant for scheme, general arrangement, size and component rating of panel boards, design of lighting system and type of light fittings, cable sizing, earthing design and layout etc. **All material shall be as per approved list.**
20. Obtaining Approvals/Certificates like initial approval, scheme approval, final approval, safety certificates, etc from Kerala State Electrical Inspectorate, as per requirements, shall be in the scope of the Bidder. Any changes/modifications as directed by the Electrical Inspectorate after their inspection shall be carried out free of cost to the Purchaser.
21. Any item not specifically listed above, but required for safe and smooth operation of plant and for meeting the relevant codes, standards and KSEB & Electrical inspectorate regulations, are required to be provided by the contractor.
22. Aviation lamp with wiring shall be provided to the top of the building, if required.
23. The Bidder should submit all electrical equipment details with individual power requirement and total power consumption in terms of connected load and maximum demand along with the submission of tender document for review.

DETAILED SPECIFICATIONS

1.3 LT Panel Boards

1.3.1 General

The switch boards are to be fabricated by a firm having CPRI test certificate for short circuit rating and IP classification etc for similar panels.

1.3.2 Switch Board Construction

The switch boards are to be manufactured/assembled as per the latest BIS specifications, IP42 classification, Indian electricity rules, including special requirements of state/ Central Electrical Inspectorate and the detailed specifications mentioned. This shall be floor mounted, free standing type, suitable for indoor installation in dust, vermin and weather proof construction.

1.3.3 Housing Details

The SB shall be fabricated out of 14 SWG sheet steel. It shall be provided with hinged doors on the front with necessary handles and earthed using flexible copper conductor. The doors shall be provided with neoprene gaskets. Suitable channel base frame should be provided for the panel board.

Detachable gland plates of 3mm thick shall be provided at the bottom and top of the cable chamber, suitable for the termination of cables with compression type glands.

Adequate space should be provided in the cable chamber for safe bending and termination of cables.

The enclosure shall be provided with lifting hooks, supporting legs and double earth terminals with double washers.

The switch board shall be in cubicle design (each feeder components are housed in individual cubicle) and fully compartmentalized having total segregation between each cubicle. Suitable cable and bus bar alleys as well as separate metering and relaying compartments shall be provided. All components of the switch board shall be approachable from front. The Bus bar chamber cover should be bolted type. The maximum operating handle/push button height of any feeder shall not be more than 1800 mm with reference to panel bottom. Supporting arrangement for dressing of power and control cables in cable alleys also shall be provided. The front openable/lockable door shall act as a cover for the switch boards. The bus bar should be extendable at both ends. No bus bar should be protruded in the cable alley.

1.3.4 Powder coating

All metal sheets shall undergo 7 tank metal treatment, thorough derusting- rinsing- degreasing-rinsing- phosphating-rinsing and then passivation. All metal surfaces shall be thoroughly cleaned and degreased to remove all scales, rust, grease and dirt. Fabricated structures shall be pickled and treated to remove any trace of acid. The undersurface shall be made free from all imperfections before undertaking powder coating.

Contractor shall obtain details of approved colour from the Engineer-in- charge before powder coating.

Panel finish shall be free from imperfections like pin holes, orange peels, run-off paint, etc.

All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust, corrosion, etc.

1.3.5 Insulation resistance to earth:

This is to be measured with all fuse links in place, all switches, all lamps and appliance in position by applying a voltage not less than twice the working voltage (subject to a limit of 500V). Insulation resistance of the whole or any part of the installation to earth must not be less than 50 Mega ohms divided by the number of outlets. In any case it should not be less than 1 Mega ohm for the whole installation.

1.3.6 Insulation resistance between conductors:

Test to be made between all the conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or neutral or the other

pole or phase conductors of the supply. For this test, all lamps shall be removed and all switches put on. The result of the test must be 50 Mega ohms divided by the number of outlets (point and switch positions) .In any case it should not be less than 1 Mega ohm for the whole installation.

1.3.7 Bus bar sizing connection and supports:

The bus bars shall be made from high conductivity electrolytic grade aluminium conductor conforming to IS 5082. The busbars and supports shall be capable of withstanding the rated and short circuit current as per the single line diagram/ feeder details. Minimum size of main power bus bars shall be of incomer switch rating and interconnecting busbar to feeders should be rated to switch rating. Maximum current density permissible for Aluminium bus bars shall be 0.8 Amps/Sq.mm without considering derating factors. An earthing busbar of minimum 150 sq.mm section copper shall be provided outside panel at bottom throughout the length of the panel. Bus bar shall be designed as per electrical inspectorate rules and regulations.

The bus bars shall be provided with heat shrinkable PVC insulating sleeve. Supports for bus bars shall be made of suitable size cast resin ribbed insulators and these should be adequate in number so as to avoid any sag in the busbars. (Hylam supports may not be used).

Minimum clearance between phase to phase shall be 32mm and that between phase to neutral/ earth shall be 26 mm.

1.3.8 Power Connection

- a) For power interconnections within the panel board

Rigid Aluminium conductor, with PVC insulation, of adequate cross section i.e., current carrying capacity not less than the outgoing switch rating shall be used. Cable lugs/ sockets of suitable size and type shall be used for all interconnections.

For incoming and outgoing feeders of the switch boards, Aluminium conductor cable will be used and hence the panel has to be designed for receiving these and wherever required cable boxes shall be provided in panel by removable gland plates and shall be provided on top/bottom of panel, for cable entries.

In case of panel boards having busduct as incomer, the panel board should be designed to accommodate proper connection/termination of the bus duct.

To prevent accidental contacts, all interconnecting cables/ busbars and all terminals also shall be shrouded.

Provision for clamping the cables inside the cable alley should be provided.

Standard colour code of red, yellow and blue for phases and black for Neutral to be followed for all busbars /conductors. b) Auxiliary wiring and Terminals Wiring for all

controls, protection, metering, signaling, etc. inside the switchboard shall be done with 1100 volts grey colour HFFR (Halogen free fire retardant) copper conductor cables. Minimum size of these conductors shall be 2.5 sq.mm. Control wiring to components fixed on doors shall be flexible type.

The complete panel would be sub-divided into different sections and each section shall have its own control circuit with fuse and indication.

All control wiring should be provided with necessary cable sockets/ lugs at both ends. Conductors shall be terminated using compression type lugs. Each termination shall be identified at both the ends by PVC ferrules.

The identification termination numbers should match with those on the drawings.

1.3.9 Component of switch boards

The panel shall be provided with ACB, MCCBs, SDFUs, fuses, meters, relays and instruments, etc. The switch gears should be positioned inside the panel board as per manufacturers standards.

1.3.9.1 Air Circuit Breakers

The incoming ACB shall be Micro processor based, quick make, quick break, trip free horizontal drawout type electrically operated, provided with Under voltage and shunt releases. The cradle used for movement of draw out type ACB shall be suitable for smooth withdrawal on steel balls or rollers. ACB should be suitable for remote communication capability and protection with microprocessors. The Breaker shall be suitable for rear horizontal & vertical mounting and line load reversibility, without any deration. The ACB shall conform to IS 13947-1&2 /IEC60947-1&2 for circuit breakers & shall be suitable for Isolation as per IEC. The breaker shall offer double insulation on the front face (Class II deg. of operating safety). Contact wear erosion indicator should be available in the ACB for maintenance schedule. The microprocessor control unit of ACB shall signal internal overheating by self monitoring alarm.

The micro processor based trip units should be of withstanding high ambient temperatures, switching surges, electromagnetic interferences, vibrations and switching arcs. The trip units should be of self powered by the built in CTs or capable of operation with auxiliary power supply (230 V AC, 24/30V DC). Indication system should be provided for the functionality of the trip unit system and microprocesor fault. The CT operated release should provide accurate and versatile protection, viz. Over load, short circuit and earth fault protection. The breaker shall comply with service, test, isolation and maintenance position setting with locking facility in any position. Test socket shall be provided to check through test kit the microprocessor trip unit operations/actual trip time on the protections. The release shall have push to reset button for anti-pumping function.

The microprocessor release shall have IDMTL curve for co-ordination of overload curve with HT switchgear.

Communication

The communication port shall be used to read and set the parameters for the protection function. It should be able to transmit the causes of tripping and alarms. It should be possible to access the trip history and maintenance indications.

Protection Overload

Protection

The release should provide inverse time characteristics against overload. Rated current I_r should be adjustable from 40% to 100% of the nominal current (I_n) with time setting from 15 sec to 480sec at 1.5 times rated current(I_r). O/C shall be indicated whenever current exceeds set current (I_r).

Thermal Memory

The microprocessor release shall optimize the protection of the equipment or the circuit conductors in the event of repeated overloads or faults by using thermal integration to memorize temperature rises.

Short circuit protection

The release should provide a wide range of protection under short circuit conditions.

Current should be adjustable in minimum 8 steps from 1.5 to 10 times the rated current (I_r).

Time delay should be adjustable with I2 t ON and OFF respectively from instantaneous to 0.4 sec.

Ground fault protection

The release should provides time delay protection under earth fault conditions.

Current should be adjustable in minimum 8 steps from 20% to 100% of I_n . Time delay should be adjustable from 100ms to 400 ms. It should also be possible to defeat ground fault protection, if not required.

The breaker shall have in-built battery backup for minimum 12 hours. Trip devices require a thermal memory function suitable for resistance welding loads on appropriate Sub-Stations.

Two spare “a” and “b” auxiliary contacts (2 NO+2 NC) for each circuit breaker wired to terminal block.

Shunt trip with 230 V AC, rated coil for remote tripping. Specifications of Air Circuit Breakers

Operating voltage	:	415V to 690V AC
Insulation voltage	:	1000V AC Dielectric
Strength	:	3.5 kV for 1 minute
Current ratings	:	as per approved calculation. Rated
Service short circuit	:	as per approved calculation.
Breaking capacity (Ics)	:	as per approved calculation
Rated short time withstand capacity (Icw)	:	as per approved calculation

Rated ultimate short breaking

capacity (Icu)	:	as per approved calculation.
Rated peak making	:	143kA-220kA Capacity (Icm)
Spring charging time	:	< 10 sec
Arcing time	:	< 10 msec
Spring charging motor	:	self powered
Protection	:	3 O/C and 1 E/F release.
Protection device	:	Microprocessor based release with wide selection of Current & time settings for highest degree of system discrimination & co- ordination with downstream MCCBs.

Features of protection device	:	Current setting can be changed to 40% of base - current by base - current select switch without switching OFF ACB and without changing CT tapings. Built in operation check function eliminates need for separate test instruments. Earth-Fault element incorporated in trip device with adjustable threshold: I ² t (ON & OFF) time setting eliminates need for separate earth fault relay. LED/FLAG indication to show discrimination between over load, short circuit and E/F tripping. Trip unit malfunction/ failure (self- diagnostics) shall be available on the breaker.
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Accessories for Draw out type ACBs	:	Safety shutter, position switch, short circuiting contact, Mal-insertion prevention device, rating interlock, padlocking, shunt trip coil, closing coil, close open cycle counter. It shall have door defeat interlock facility.
Shunt Trip	:	230V AC
Interlocking	:	OFF position Pad Lock / Door Interlock.
Standards & Tests	:	ASTA / IEC 60947-2 Category "B", IS 13947- 2 suitable for isolation as defined by relevant clauses in IEC 60947-2/ IS 13947- 2, Indian Register of Shipping Certified for shock resistant upto 70g vertical 30g horizontal for 6 msec, vibration resistant for 10-55 Hz 0.75 displacement.

Rated short time withstand current (I_{cw}) for 1 sec should be equal to the rated service breaking capacity (I_{cs}) and equal to the ultimate breaking capacity (I_{cu}).

1.3.9.2 Moulded Case Circuit Breakers

General

Moulded case circuit breakers (MCCBs) shall be incorporated wherever required and shall be of current limiting type and preferably double break. MCCBs shall conform to IS 13947-1/IEC 60947-1 for general rules and IS 13947-2/IEC 60947-2 for circuit breakers in all respects. MCCB shall be suitable for isolation as per standard, single phase 240V or three phase 415 V, 50Hz, AC and shall have a rated insulation voltage of 750 V AC. The MCCBs shall have thermal memory and shall have no Line-Load restriction. All the breakers shall have tropicalisation as a standard feature.

Construction

The MCCB case & cover shall be made of high strength heat resistant and flame retardant thermosetting insulating material.

The operating handle shall be quick make, quick break trip free type. The operating handle shall have suitable 'ON', 'OFF', 'TRIPPED' indicators.

In order to ensure suitability for isolation complying with IS13947-2/IEC60947-2, the operating mechanism shall be designed such that the toggle or handle can only be in 'OFF' position.

Three phase MCCBs shall have a common operating handle for simultaneous operation and tripping of all the three phases.

Rating & Breaking Capacity:

The rating of the circuit breaker shall be as per the drawings and schedule of quantities.

The MCCB shall have Service Breaking Capacity (Ics) equal to Ultimate Breaking capacity (Icu).

The Breaking Capacity (Icu) in kA for different ratings at 415V AC, 50Hz, 0.2 p.f shall preferably be as follows:

25kA for ratings upto 100A

35KA for ratings above 100A and upto 250A

50KA for ratings above 250A and upto 630A. Protection

All breakers of 250A and above shall have micro-processor based trip unit with adjustable overload protection from 40% to 100% of the nominal current(I_n) and extra current limiting type. The short circuit protection should be adjustable from 2 to 10 times the rated current(I_r) with tripping time fixed. The Instantaneous Short Circuit protection to be fixed, without any time delay at 11 times the nominal current(I_n). MCCBs upto 250A shall be thermal magnetic with adjustable overload protection

The microprocessor control unit shall have - true RMS sensing , Electromagnetic compatibility(EMC), thermal memory. The mP release shall be immune to harmonics.

630A MCCBs shall have fault indication of (O/C, S/C and E/F).

The MCCBs shall be possible to fully co-ordinate the over-load & short- circuit tripping of the circuit breakers with the upstream and downstream circuit breakers to provide Total Discrimination.

MCCB should have the flexibility of connecting the load either on the top or on the bottom side without deration.

Accessories

MCCBs shall be provided with the following accessories and all these devices shall be fittable at site. The accessories shall be separated from Power circuit. Preferably the Shunt trip release and under voltage release shall be snap-in type and fitted with terminal blocks.

Shunt trip Auxiliary switch Extended rotary Handle.

Interlocking

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

Handle interlock to prevent unnecessary manipulations of the breaker.

Door interlock to prevent door being opened when breaker is in ON position. Door-interlock defeat to open the door even if the breaker is in ON position. Front operated rotary handle should have OFF-position pad-locking facility.

1.3.9.3 Switch Disconnecter Fuse Units (SDFUs)

Heavy duty switch disconnecter fuse unit to be incorporated in the cubicle switch boards shall comply fully with the requirements of IS: 13947 (part 3) and IEC 947-3, and all switch fuse units shall comply with the requirement of IS: 4064. The fuse switch units shall be of the double break type, suitable for load break (AC 23 A) duty with quick make and quick break action shall be capable of making and breaking 300% of the rated current. The unit shall be suitable for accommodating HRC cartridge fuse links and should have phase barriers and terminal shrouds. Each SDFU should have an auxiliary switch having 1NO+1 NC contacts, which shall be site fittable without SDFU being removed from the panel board. All switch contacts shall be silver plated. The door of the unit shall be interlocked with the operating mechanism so as to prevent opening of the door when the switch is in 'ON' position and also to prevent closing of the switch with the door not properly secured. However by releasing interlock, switch shall be able to operate in any door position. The length of handle operating shaft shall be adjustable at site. The interior arrangement of the switch shall be such that all live metal is shrouded. The moving contacts shall be mounted on their own operating shaft so that they can be removed as a complete sub-assembly to facilitate inspection and maintenance. The terminal connections of the unit shall be capable of taking the appropriate sizes of cables with Aluminum conductors. For heavy duty fuse switch units, the connections to the units from the busbars and cables shall be terminated in pressure bolted joints inside the switch contacts, enabling readily removal of individual switch fuse unit from the front of the Board, if required. All normal duty switch fuse units shall have an external earthing terminal to enable the enclosure to be earthed.

a) HRC cartridge fuse links

The high rupturing capacity cartridge fuse links to be used in the switch disconnecter fuse units shall comply fully with the requirement of IS 2205. The fuse links shall have a certified rupturing capacity of not less than 35 kA. Fuses should have failure indication so that during fuse failure the operator can easily identify fuse failure.

HRC fuse shall be DIN/Blade type.

1.3.9.4 Motor Starters/Contactors

All motors are to be provided with suitably rated starters with over-load protection. Motor power cables shall be rated to withstand starting current of the motors. Selection of starters for motors shall be as per K.S.E.B/electrical inspectorate standards. Bimetal overload relays are to be totally enclosed and sealed so that the sensitive mechanism within is not tampered with during maintenance. Relays should be ambient temperature compensated and should be kept independent of the push buttons. All motor starters shall meet the required category of duty Contactors should conform to IS : 2959. Contactor coils shall be suitable for 110/240/415 volts, 50 Hz. All contactors shall be supplied with minimum 2 NO + 2 NC auxiliary contacts. Additional contacts if required, for interlocking etc. shall also be provided. Suitable protection relays shall be provided as per Indian Electricity Rules, including Kerala State Electrical Inspectorate specifications. DOL connecting motor shall be rated for DOL operation and connecting cable should be rated for the starting current. All remote & fairly loaded equipments such as blower fans, cyclone fans, etc shall be provided with single phasing relays.

All starters shall be capable to be monitored and controlled by PLC control and monitor system.

1.3.9.5 Indicating Lamps

Type	: Panel mounting wide band LED type with in built surge suppressor to protect LED against switching surges and built-in low voltage glow protection of 25V. IEC 947-5-1
Diameter	: 22mm
Operating voltage	: 240V AC
Illumination Level	: Minimum 100 lux on the front face of the lens. as per standards
Colour of lamps:	Phase-Red/Yellow/Blue, Open/stop/emergency- Red, Close/Start - Green

1.3.9.6 Measuring instruments

These shall be of square pattern having dimensions of 96x96 mm flush mounting type. Instruments like ammeter, Voltmeter, frequency meter etc. and instrumental transformers/transducers, etc. are also included in the scope of supply.

All AC meters shall be of class 1 accuracy.

Voltmeter shall be suitable for direct line connection. Voltmeters shall be connected through MCBs only.

All voltmeters shall be provided with selector switches. Ammeters shall be CT operated.

1.3.9.7 Current Transformers (CTs)

CTs shall be cast resin insulated type. Primary and secondary terminals shall be marked indelibly. CTs shall preferably be mounted on stationery parts. CT rating and ratios shall be as per feeder ratings. These shall be capable of withstanding momentary short circuit and symmetrical short circuit current for 1 second. Neutral side of CTs shall be earthed. Protection CTs shall have low reactance, accuracy class "5P" and an accuracy limit factor greater than "10". Instrument CTs shall be of accuracy class "1.0" and accuracy limit factor less than "5.0".

1.3.9.8 Connection

Connections to the busbars shall be made by drilling holes. However, no holes shall be left in the busbars except at the both ends of the main busbar for panel extension. The bolts & nuts used for connections to busbars shall be of Aluminum alloy of tinned forged brass. For tapping of connections from busbars suitable size PVC sleeved copper conductor (minimum size 4.0 Sq.mm) shall be used with suitable size and type of crimped lugs/cable sockets. For connection of feeder above 63 Amps only busbar links with heat shrinkable PVC shall be used. Suitable size cable boxes shall be provided for incoming/outgoing cables. For all outgoing cables, cable alleys of suitable sizes in sides and tops, as required for proper cable connections/laying inside the panel, shall be provided. Switch board shall be suitable for Aluminium conductor PVC insulated incoming and outgoing cables. Removable gland plates shall be provided for cable entries.

1.3.9.9 Earthing

Two independent earthing points shall be provided outside the panel near bottom and these shall be inter-connected with Cu earthing busbars of size 25 x 6 mm. All earthing points inside the distribution board shall be interconnected to these earthing points with suitable size copper conductor.

1.3.9.10 Name plates

Switch board/distribution board shall be provided with danger plate and name plates for all incoming and outgoing feeders. These name plates shall be of PVC (black colour base & white letters engraved) screwed to panel. PVC identification ferrule numbers shall be used for all internal wiring. The name plate shall contain the following information.

Panel Board Identification name & number

Feeder name.

Switch/ fuse rating.

Cable size.

Feeder Cable from/ to.....

1.3.9.11 Supports

Busbars shall be rigidly fixed to the supports, of SMC/DMC solid block type base. Busbars shall be firmly held within the slots in sheet type supports, which in turn shall be rigidly fixed to the chamber.

1.3.9.12 Clearances

The minimum clearances to be maintained for enclosed indoor air insulated busbars for medium voltage applications shall be as follows:

<u>Between</u>	<u>Min. clearances</u>
Phase to earth	26 mm
Phase to phase	32 mm

1.3.9.13 Arrangement of busbars and main connections

Busbars and main connections, which are substantially in one plane, shall be arranged in the order given below:

- i) AC System
 - a) The order of phase connections shall be red, yellow and blue.
 - b) When the run of the conductors is horizontal, the red shall be on the top or farthest away as viewed from the front.
 - c) When the run of the conductors is vertical, the red shall be on the left, or farthest away as viewed from the front.
 - d) When the system has a neutral connection in the same plane as the phase connections, the neutral shall occupy the bottom position if horizontal and extreme right if vertical, or nearest position when viewed from the front.
 - e) Unless the neutral connections can be readily distinguished from the phase connections, the order shall be red, yellow, blue and black.

1.3.9.14 Capacitors

Capacitor should be of heavy duty gas filled type.

All capacitors shall be of loss less than 0.2 W / kVAr, suitable to withstand + 10% voltage variation and rated for operating temperature up to 700 C.

Capacitor units shall be provided with externally mounted discharge resistors to reduce the residual voltage to less than 50 volts in one minute of switching off. Timer

shall be provided in the circuit so that supply is not restored before discharge of the capacitor Bank.

Each capacitor unit shall be capable of operating continuously at 10% over voltage over and above the rated RMS voltage.

1.3.9.15 Push Buttons

1	Type	:	Manually operated spring return type.
2	Standard applicable	:	IEC947-5-1
3	Electric Shock protection	:	Class 2 (IEC 536)
4	degree of protection	:	IP54 (IEC529)
5	Diameter	:	22mm
6	Type of mounting	:	snap type
7	Color of actuator	:	Start PB - Green Stop PB - Red Test/Reset PB - Black
8	Contact configuration	:	2NO+2NC

1.3.9.16 Approvals

The drawing showing general arrangements and detailed wiring diagram for the Panels shall be submitted to the Engineer-in-charge for approval, prior to manufacture and the same shall be got inspected, prior to despatch to project site. The complete switch board and its component shall conform to Indian Electricity Rules & Relevant IS.

1.4 IPFC BASED CAPACITOR BANK SYSTEM

Bidders scope shall include design, supply, installation, testing and commissioning of IPFC based power factor improvement capacitor bank systems to improve the power factor to 0.99 under actual loading condition. The design and selection of suitable rating of capacitors and capacitor banks based on actual load study is included in Contractor's scope. There shall be 7 % series reactors in the capacitor banks to limit the inrush currents and to limit harmonics. The power factor shall be improved to 0.99 under varies loading condition.

A) Capacitors

Capacitor should be of heavy duty type. All capacitors shall be of loss less than 0.2 W / kVAr, suitable to withstand + 10% voltage variation and rated for operating temperature up to 700 C.

Capacitor units shall be provided with externally mounted discharge resistors to reduce the residual voltage to less than 50 volts in one minute of switching off. Timer shall be provided in the circuit so that supply is not restored before discharge of the capacitor Bank.

Each capacitor unit shall be capable of operating continuously at 10% over voltage over and above the rated RMS voltage.

1.5 Motors

All motors are to be totally enclosed fan cooled (TEFC), IP55 type unless otherwise specified. The motor along with the fan is to be dynamically balanced to a high degree of accuracy. The rotor surface and the inside surface of the stator are to be suitably protected against corrosion. All motors should comply with IS:325, IEC:34. The motors should generally be rated for 415 V, three phase, 50 Hz operations. All motors are to be provided with Class F insulation and shall be preferably energy efficient. Push button control station shall be provided for all motors. All motor shall be sufficient rated as per permitted temperature rise, running time according to the Indian Electricity Rules, including special requirements of Kerala State Electrical Inspectorate and detailed specifications

1.5.1 Motor push button control station

These shall be provided in Aluminium cast/powder coated sheet steel housing, completely dust, vermin and weather proof, suitable for 415 volts, 50 Hz, complete with cable glands for incoming and outgoing cables. ON/OFF push button shall be provided for local isolation and testing purpose. Push button starting shall be based on PLC controlled Locking without mechanical key system.

1.5.2 Motor Junction Box

Motor Junction box may be provided as per requirement. These shall be in Aluminium cast/sheet steel housing, completely dust, vermin and weather proof(IP 55), suitable for 415 volts, 50 Hz, with heavy duty bakelite connector, complete with cable/conduit gland. Sample is to be got approved before use. Motor Junction Box shall be capable to terminate motor cables.

1.6 Cables & Cabling

1.6.1 Scope

The scope under this section covers the following:

- a) Power cables
- b) Control cables

1.6.2 Armouring and Serving

All multicore cables liable for mechanical damage shall be armoured. Cables, when armoured, shall have galvanised steel wire (flat or round) for armouring.

Steel wire armouring is preferred where the cables are liable to tensile stresses in applications such as vertical runs, suspended on brackets or laid in soil that is likely to subside.

1.6.3 Storage and handling

1. Storage:

- (i) The cable drums shall be stored on a well-drained, hard surface, so that the drums do not sink in the ground causing rot and damage to the cable drums. Paved surface is preferred, particularly for long term storage.
- (ii) The drums shall always be stored on their flanges, and not on their flat sides.
- (iii) Both ends of the cables should be properly sealed to prevent ingress/absorption of moisture by the insulation during storage.
- (iv) Protection from rain and sun is preferable for long-term storage for all types of cables. There should be enough ventilation between cable drums.
- (v) Damaged battens of drums etc. should be replaced, as may be necessary.

2. Handling:

- (i) When the cable drums have to be moved over short distances, they should be rolled in the direction of the arrow marked on the drum.
- (ii) For manual transportation over long distances, the drum should be mounted on cable drum wheels, strong enough to carry the weight of the drum, and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.
- (iii) For loading into and unloading from vehicles, a crane or a suitable lifting tackle should be used. Small sized cable drums can also be rolled down carefully on a suitable ramp or rails, for unloading, provided no damage is likely to be caused to the cable or to the drum.

1.6.4 Standards

The following standards & its latest amendments shall be applicable:

- 1. IS : 1753 : Specification for Aluminium conductors for insulated cables
- 2. IS : 2982 : Specification for copper conductors in insulated cables.
- 3. IS : 5831 : Specification for XLPE insulated and PVC sheath of electric cables.
- 4. IS : 6474 : Polythene insulation and sheath of electric cables.
- 5. IS:3975 : Specification for mild steel wires, strips and tapes for armouring of cables.
- 6. IS : 694 : PVC insulated cables.
- 7. IS : 7098 : Specification for XLPE insulated PVC sheathed cables.
- 8. IS : 3961 : Recommended current ratings of cables.
- 9. IS : 5819 : Recommended short circuit ratings for high voltage PVC cables.

1.6.5 Power cables (HV) 11 kV grade XLPE insulated cable

The conductors shall be screened by extruded compound and XLPE insulated. The cores shall be screened by extruded compound in combination with non-metallic tape. The inner sheath over laid up cores and outer sheath over the armour shall be extruded black PVC compound type ST-2. Core identification shall be by printed numerals. The inner and outer sheath should be separated by steel armouring. The construction, performance and testing of the cable shall comply with IS:7098-part-2. Dry cure (Radiant curing process) technology should be used for the manufacturing of cross-linked polyethylene cable. Bi-metallic plate washers should be provided wherever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible.

1.6.5.1 General details

Cross sectional area of conductor	: as per requirement.
No. of cores	: 3
Conductor	: Aluminium

1.6.5.2 Insulation

The thickness of insulation shall be on the basis of insulation material, voltage and conductor size conforming to the relevant standard specification. The cores shall be colour coded to IS specifications. The XLPE insulation & sheathing shall be of high quality.

1.6.5.3 Sheathing

The sheathing shall be PVC and shall be before and after the armouring, the thickness of the sheathing shall be based on the conductor size and overall diameter below the sheathing.

1.6.5.4 Armouring

Single core cables shall be armoured with earthed at one end and if insisted it shall be of non-magnetic material. Multi core cables shall be with armouring. The armouring for cables above 16 mm sq. shall be galvanised steel strips and below with wire strips.

1.6.5.5 Power Cable termination

Cable termination shall be heat shrinkable type and the bushings shall be covered with adequate insulation with a provision for using the cable test rods for cable testing. 11 kV cable compartments for each circuit shall be separately enclosed. Cable termination shall be suitable for copper or aluminium conductor. Suitable cable termination kits and other accessories shall be included in the scope of supply. Bi-metallic plate washers should be provided where ever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible. The cable should be properly terminated to avoid stress on end termination.

End termination must be done by an authorised cable jointer approved by the manufacturer.

The cable compartment shall be complete with bottom plate for 3 core 150 sq.mm XLPE cable.

1.6.6 Power cables (LV) 1.1kV grade XLPE insulated cable

Power cables for use on 415 V system shall be of 1100 volt grade, Aluminium conductor, XLPE insulated, PVC sheathed, armoured and overall PVC sheathed cable, strictly as per relevant IS specification. Unarmoured cable to be used only if specifically mentioned in schedule of requirements. Bi-metallic plate washers should be provided wherever cables, lugs, and switch terminals are of different materials. Cables and cable lugs should be of same material where ever possible.

No Aluminium conductor cable of size less than 4 sq.mm shall be used.

1.6.7 Control Cables

Control cables for use on 415 V system shall be HFFR (halogen free Fire retardent) type 1100 volts grade, copper conductor, PVC insulated, PVC sheathed, armoured/ steel braided and overall PVC sheathed, strictly as per IS : 1554 (Part I) - 1978. Unarmoured cables to be used only if specifically mentioned in schedule of requirements. Control cable carrying current should be black colour and voltage circuit shall be of grey colour and shall be segregated.

No cable of size less than 2.5 sq.mm. shall be used.

1.6.8 Cable Glands

Cable glands shall be of heavy duty compression type of brass, chrome plated. These shall have a screwed nipple with conduit electrical thread and checknut. These shall be suitable for armoured/unarmoured cables, which is being used.

1.6.9 Cable Connectors

Cable connectors, lugs/sockets, shall be of copper/aluminium alloy, suitably tinned, solderless, crimping type. These shall be suitable for the cable being connected and type of function (such as power, control or connection to instruments, etc.)

1.6.10 Cable Indicators

These shall be self-sticking type and of 2 mm thick lead strap for overall cable. PVC identification numbers, ferrule shall be used for each wire.

1.6.11 Cable Route Markers

These shall be galvanised Cast Iron plate with marking (LT/HT) diameter 150 mm with

600 mm long 25x25 mm MS. angle riveted/bolted with this plate.

1.6.12 G.I. Pipes for Cables

For laying of cables under floor, ground etc. G.I. class 'B' pipes shall be used. MS. conduits is not acceptable for this purpose. All accessories of pipes shall be threaded types. Size of pipe shall depend upon the overall outer diameter of cable to be drawn through pipe. No G.I pipe less than 40 mm dia. shall be used for this purpose. To determine the size of pipe, assume that 40% area of pipe shall be free after drawing of cable.

1.7 Wiring Systems

1.7.1 Materials

A. Wires

Wires shall comply the following features:

PVC insulated with a rating of 105 deg.C bright annealed electrolytic grade (99.9% pure) copper stranded for uniformity of resistance, dimension and flexibility.

Fire Resistant Low smoke (FRLS), suitable upto 660V grade wires for single phase circuits and 1100 V grade for 3 phase circuits as per IS 694/1990 amended upto date.

Colour coded as below:

Phase - R	-	Red
Phase - Y	-	yellow
Phase - B	-	Blue
Neutral	-	Black
Earth	-	Green

B. Conduits

Two types of Conduit Wiring System shall be followed.

Rigid Steel Conduit Wiring System

Rigid PVC (heavy gauge) Conduit Wiring System i. General requirements:

- a) All rigid conduit pipes shall be IS I marked. The wall thickness shall be not less than 1.6 mm for conduit upto 32 mm dia and not less than 2 mm for conduits above 32 mm dia.
- b) The maximum number of PVC insulated cables conforming to IS:694-1990 that can be drawn in one conduit is given size wise in Table I, and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.
- c) No conduit less than 20 mm in diameter shall be used.

Flexible conduits will only be permitted for interconnections between switchgear, DB's and conduit terminations in wall.

All flexible conduits used in the system should be Halogen free, flame retardant and self-extinguishing polyamide conduits.

ii. Conduit Accessories

- a) The conduit wiring system shall be complete in all respects, including their accessories.
- b) All conduit accessories shall be of solvent cement plastering type, and under no circumstances pin grip type of clamp grip type accessories shall be used.
- c) Bends, couplers, etc. shall be solid type in recessed type of works and may be solid or inspection type as required.
- d) 1) Saddles for surface conduit work on wall shall not be less than 0.55 mm (24 gauge) for conduits up to 25 mm dia. and not less than 0.9 mm (20 gauge) for larger diameter.
2) The minimum width and the thickness of girder clips used for fixing conduits to steel joists, and clamps shall be as per Table II.

iii. Outlets

- a) The switch box or regulator box shall be made of metal on all sides, except on the front. In the case of cast boxes, the wall thickness shall be at least 2 mm and in case of welded mild steel sheet boxes, the wall thickness shall not less than 1.2 mm (18 gauge) for boxes upto a size of 20 cm x 30 cm, and above this size 1.6 mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection.
- b) An earth terminal with stud and 2 metal washers shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.
- c) Clear depth of the box shall not be less than 60 mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.
- d) The fan regulators can also be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Engineer-in-charge.
- e) Except where otherwise stated, 3 mm thick phenolic laminated sheets as per clause shall be fixed on the front with brass screws, or cadmium plated iron screws as approved by the Engineer-in-charge.

TABLE I

MAXIMUM NUMBER OF PVC INSULATED 650/1100 V GRADE ALUMINIUM/ COPPER
CONDUCTOR CABLE CONFORMING TO IS: 694-1990 IN
RIGID PVS/STEEL CONDUITS

cross sectional area of conductor in sq.mm	2 mm		2 mm		32 mm		38 mm		51 mm		64 mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1.5	5	4	8		18	12	-	-	-	-	-	-
2.5	5	3	6		12	10	-	-	-	-	-	-
4	3	2	5		10	8	-	-	-	-	-	-
8	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

Note:

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

TABLE II
GIRDER CLIPS CLAMPS

Size of conduit	Width	Thickness
20 mm	19 mm	0.9 mm (20 SWG)
25 mm	19 mm	0.9 mm (20 SWG)
2 mm & above	25 mm	1.2 mm (18 SWG)

1.7.2 WIRING

A. POINT WIRING

i) Definition

A point (other than socket outlet point) shall include all works necessary in complete wiring to the following outlets from the controlling switch or MCB. The scope of wiring for a point shall, however, include the wiring work necessary in tapping from another point in the same distribution circuit: -

- (a) Ceiling rose or connector (in the case of points for ceiling /exhaust fan points, pre-wired light fittings and call bells).
- (b) Ceiling rose (in the case of pendants except stiff pendants).
- (c) Back plate (in the case of stiff pendants).
- (d) Lamp holder (in the case of gooseneck type wall brackets, batten holders and fittings which are not pre-wired).

In the case of call bell points, the words “from the controlling switch or MCB” shall be read as “from the ceiling rose meant for connection to bell push”.

ii) Scope

(A) Following shall be deemed to be included in point wiring.

- 1) Conduit, accessories for the conduit and wiring cables between the switch box and the point outlet.
- 2) Ceiling rose or Connectors shall be provided near the fitting as required.
- 3) For points coming in false ceiling, as far as possible, wiring shall be terminated in a junction box/connector very close to the points.
- 4) For points coming in false ceiling, all conduits shall be adequately supported.

- 5) Loop wiring in rigid/flexible conduit
- 6) All fixing accessories such as clips, nails, screws, Phil plug, raw plug etc. as required.
- 7) Metal switch boxes for control switches, regulators, sockets etc. recessed or surface type, and phenolic laminated sheet covers in case of piano type switches and outer & inner cover plates in case of modular type switches.
- 8) Outlet boxes, junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with switchboards for loose wires/conduit terminations.
- 9) All the civil works such as chipping, plastering, Making good all damages connected with the fixing of switch boxes, conduit laying etc are included in the scope.
- 10) Control switch
- 11) Connections to ceiling rose, connector, lamp holder, switch etc.
- 12) Interconnecting wiring between points on the same circuit, in the same switch box or from another.
- 13) Loop earthing in rigid/flexible conduit
- 14) Protective (loop earthing) conductor from one metallic switch box to another in the distribution circuits, and for socket outlets.

B. Following shall be deemed to be included in group control point wiring.

- 1) Conduit, accessories for the conduit and wiring cables between the Control location (DP/SP MCB/Isolator/ DP switch) to the first point and wiring cable between points forming the particular number of group
- 2) Ceiling rose or Connectors shall be provided near the fitting as required.
- 3) For points coming in false ceiling, as far as possible, wiring shall be terminated in a junction box/connector very close to the points.
- 4) For points coming in false ceiling, all conduits shall be adequately supported. When large number of points comes in false ceiling, conduits shall be run in adequate steel supports/tray. The size and cross section of the above mentioned supports shall be planned as per the site condition and got approved by the engineer in charge before commencing the work.
- 5) Loop wiring in rigid/flexible conduit
- 6) All fixing accessories such as clips, nails, screws, Phil plug, rawl plug etc. as required.
- 7) Junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with MCBDB for loose wires/conduit terminations.
- 8) Connections to ceiling rose, connector, MCB etc.
- 9) Loop earthing in rigid/flexible conduit

C. CIRCUITS AND SUBMAIN WIRING

i) Circuit wiring

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

ii) Sub main wiring

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

D. WIRING IN CONDUIT

The wiring in conduit shall comply the following:

Wire sizes	Copper conductor
Light point / Sub main wiring	1.5 sq.mm
Light Circuit Point	2.5 sq.mm
Power points	4.0 sq.mm
Machinery	As per Schedule of requirements

Jointing of wires is not permissible, however looping may be done from point (same circuit) or using a terminal strip in junction box where site condition warrants, prior permission from Engineer-in-Charge shall be obtained.

Metallic/non-metallic trunking may be used if number of conduits are many. The metallic trunking shall be earthed securely at DB end and throughout the length. Single trunking with metallic partition may be used for wiring different services.

E. WIRING ACCESSORIES

i) Control switches for points

(a) Control switch shall be placed only in the live conductor of the circuit. No single pole switch or fuse shall be inserted in the protective (earth) conductor, or earthed neutral conductor of the circuit.

(b) Combined switch cum socket shall not be permitted.

ii) Socket outlets

The 5A/6A socket outlet shall be 5 pin socket outlet with 5A/6A switch,

The power point outlet shall be 15A/5A or 16A/6A 6 pin socket outlet with 15A/16A switch,

iii) Switch box covers

Phenolic laminated sheet of 3 mm thick of approved shade shall be used for switch box covers in case of piano type switches. For Modular type switches/ sockets suitable outer and inner cover plates shall be provided over the standard box as recommended by the manufacturers of modular type switch/ sockets and no separate sheet cover is required to be provided.

iv) Ceiling rose

- (a) Ceiling rose shall be of 3-plate type.
- (b) A ceiling rose shall not be used on circuit the voltage of which normally exceeds 250V.
- (c) Only one flexible cord shall be connected to a ceiling rose.
Specially designed ceiling roses shall be used for multiple pendants.
- (d) A ceiling rose shall not embody fuse terminal as an integral part of it.
- (e) Where ever ceiling roses are not used the wires are to be terminated in good quality connectors of 6A capacity inside PVC junction boxes.
- (f) All the junction boxes are to be covered with good quality round cover plate of approved colour.

v) Lamp holders

- (a) The standard constructional feature of manufacturers (ISI approved) of lamp holders is acceptable.
- (b) Where the lamp holders are part of light fixtures the holders shall be suitable for the type of lamps used.

F. MS Items

i) Scope

Supply, fabrication, painting and fixing of M.S items such as Flat / Tees / Angles / Channels etc. required for the cable bay/conduit tray and necessary civil works such as grouting, finishing etc.

Scope covers supply of all anchor fasteners, anchor bolts and all connected civil works such as cutting holes on wall, making good the same.

ii) Material

The steel sections used should be of good quality, manufactured by reputed companies. Steel sections of reputed manufacturers (like SAIL, Vaizah steel etc) shall be used. If smaller sections of these makes are not available, re-rolled steels of reputed make shall be used. In any case the make of steel should be got approved from engineer in charge before its supply

1.8 Light fixtures

1.8.1

- i) Area wise LUX level required as per IS 3646
- ii) Client/ Consultant reserves the right to give approval for make of light fixtures for special application other than approved make list
- vii) All light fixture used for External / Street light should be with IP65 protection
- ix) Though a particular model number of a fitting is mentioned in the tender, Client reserve the right to reject the make if the quality of these fitting is found to be not up to the standard.
- x) The contractors shall supply all the accessories of the light fittings.
- xi) Ceiling fans including their suspension shall conform to relevant Indian Standards.
- xii) Wall Fans, Air Circulators, Exhaust fans etc shall conform to relevant Indian Standards

1.8.2 Street lighting

1.8.2.1 Description of Streetlight Poles

The street light poles shall be of swaged steel hot dip galvanised tubular type with suitable arrangement at the top of the pole for fixing the lighting fixture. Poles shall be made from steel of ultimate strength 42 Kgf/ MM² IS:2713(Part II) 1980 Outside diameter and thickness of various sections of the Tubular poles as per IS

For reducing the section of street light poles for stepped design, swaging process only shall be used conforming to IS:2713 part II/1980 pole provided with a canopy arrangement to suit single arm, luminaire on top, pole ultimately finished two coats of synthetic enamel paint(app.make & color) over two coats of anti-corrosive yellow zinc chromate primer (approved make) above ground & one coat bituminous paint for below ground.. Each poles would have one polycarbonate box covered with water tight polycarbonate cover complete with MCB, 15A bakelite 6 way connector(heavy duty) or Al busbar for loop-in/loop out arrangement, 3way neutral link (brass), earthing terminal, cable glands etc. as shown in the diagram.

1.8.2.2 Installation

- i) Where the work involves provision of looping boxes for cables in street lighting works, these should be installed at 90cm from ground level or above high flood level whichever is more. The cables shall be routed from ground through GI pipes of suitable size to the looping box. These pipes shall be suitably bent outwards and embedded when the foundation work is done, thus avoiding any cutting later.
- ii) Looping boxes for compound lighting poles may be installed within the concrete pedestal for the poles (before casting of the pedestal) at such a height that rainwater may not enter these boxes. Necessary cable entry pipe(s) shall be fixed to the box, properly bent outwards, when fixing the box to the pole. Necessary chamfering should be done on the pedestal to enable lifting the front cover of looping box and having proper access inside for maintenance.

- iii) Brackets for luminaries shall be fixed to the poles firmly so as not to be disturbed by wind or by manual pressures during maintenance. Clamps, locking studs or any other reliable means shall be adopted for this purpose. The luminaries shall be fixed to the brackets firmly such that they are not disturbed by wind, vibration due to traffic, etc. Arrangement, if any recommended by the manufacturer, should be followed.
- iv) Wiring of poles from looping box to the fittings should be done as per specification, including size of copper conductor PVC insulated cables, earthing etc. The wire should run inside the pole from the looping box through a hole. The holes shall be sealed with rubber bushing.
- v) Where compression type glands are used with the boxes, the cables shall be terminated on to them. Where the cable entry pipes are terminated directly on to the boxes, without the provision of cable gland(s), suitable metallic clamp shall be provided with each cable end for earthing the cable armour through the earth terminal in the boxes.
- vi) All poles shall be numbered with figure height of 30mm.

1.8.2.4 Special notes

- 1.8.2.4.1 Location of street light poles shall be shown on the working drawings and the same shall be submitted to Client/Consultant for approval. However, if due to site conditions the location cannot be adhered to, the same shall be brought out to the notice of the Engineer-in-charge for advice.
- 1.8.2.4.2 Maintenance and custody of light fixture after installation / commissioning would be with contractor till that building / area is completed and handed over to Purchaser/ Engineer-in-charge in satisfactory working order.

1.9 M C B Distribution Boards (MCB DBs) and accessories.

A) M C B Distribution Boards (MCB DBs)

All SPN & TPN DBs are to be weather proof, thermo plastic or MS powder coated suitable for flush mounting with double door and to be provided with inbuilt additional compartment for looping of loose wires/adaptor boxes for entry of armoured cables with IP 42 category of protection and conform to IS: 8623.

i) Material

The DBs are to be fabricated out of CRCA sheets suitable for all weather operation. The current carrying parts are to be made of electrolytic grade copper and are to be rated for the duty intended. The DBs should have knock out holes at the bottom, and detachable plate with knock out holes at the top.

ii) Painting

The DBs are to be subjected to seven tank phosphatising processes (Degreasing, pickling, surface activation, phosphatising and passivation) and to be powder coated ensuring rust prevention and scratch resistant.

iii) Accessories

Following accessories are to be provided: -

- (a) Copper bus bars of rated current capacity per phase.
- (b) Special brass terminals to ensure perfect connections of incoming cable with the bus bars.
- (c) Brass neutral bars three numbers, one for each phase, isolated and insulated from the enclosures with suitable cross sectional area.
- (d) Earth bars for firm earthing and for facilitating individual earthings for each outgoing terminal.
- (e) Sufficient number of blanking plates.
- (f) Provision for accommodating four pole MCB and RCCB as incomer.

B) Miniature Circuit Breakers (MCBs)

All MCBs should conform to IS:8828(1996), BS: 3871, IEC:898(1995) and rated for 10kA category of short circuit duty and tested for breaking capacity upto 10 kA. B curve type MCBs should be used for resistive loads, C curve type for inductive loads and D curve type for UPS loads. MCBs shall be suitable for use in frequency range 40 Hz to 60 Hz and shall accommodate AC/DC supply according to requirements. It should have inverse time overload and short circuit tripping mechanism with trip free operation and toggle shall give positive contact indication. Arc chutes should be provided for effective quenching of arc during operations and fault conditions. Terminals should be provided with proper shrouding arrangement. Silver cadmium Oxide tipped contacts should be provided in MCBs. Pressure clamp terminals for users upto 4 sq.mm and bolted lugs for higher rating should be provided. Multi pole MCBs should be provided with common operating handle and integral tripping. The MCBs shall be of IP 20 degree of protection. The power loss per pole shall be in accordance with IS:8828(1996) and shall be furnished by the manufacturer.

MCB casing shall be made of self-extinguishing tropicalized material. It shall be suitable for mounting on 35 mm DIN rail/surface mounting. Line supply may be connected to either top or bottom terminals i.e there shall be no line load restriction. Degree of protection, when the MCB is flush mounted, shall be IP 40. MCB shall be supplied with clamping terminals fully open. Contact closing shall be independent of the speed of the operator. The MCB shall be capable of being used as incomer circuit breaker and shall be suitable for use as an isolator. In case of multiple MCBs in a single location (DB), it shall be possible to remove MCB without having to disturb other MCBs in the vicinity. All MCB's shall be capable of carrying 35sq.mm. cable termination. Both the upper and lower terminals of MCB's shall be bi-connect type, ie.,

capable of connecting busbar and cable at both the end.

C) Residual Current Circuit Breaker (RCCB)

Residual Current Circuit Breakers based on residual current operation should provide complete protection against Earth leakage faults. The breakers should conform to IS: 12640-1988, IEC 601008- 1 and IS: 8828-1996 should be rated for 6 kA or more. The RCCB shall have threshold sensitivities (non-user adjustable) of 30mA, 100 mA & 300 mA with inbuilt time delay of 200 ms for discrimination with downstream RCCB. The short circuit withstand capacity of the RCCB shall not be less than 6 kA. It shall be operationally independent of line voltage. The breaker should be maintenance free. The breaker should be capable of detecting earth leakage currents and disconnecting the faulty lines. **The RCCBs should be capable of preventing the risk of unwanted tripping due to transient voltages (lightning, line disturbances on other equipment) and transient currents (from high capacitive circuits). The RCCB should be unaffected by the DC pulsated components, present if any in the circuit, and should not give nuisance tripping.** A test device should be incorporated to check the integrity of the system and tripping mechanism. Terminals should ensure easy termination of cables and should provide covers to shield incoming and outgoing terminals with IP 20 degree of protection. The breaker should be suitable for DIN rail mounting. All RCCB's shall be capable of carrying 35sq.mm. cable termination. Both the upper and lower terminals of RCCB's shall be bi-connect type, ie., capable of connecting busbar and cable at both the end.

1.10 Earthing

1.10.1 Types

The type of earth electrode shall be any of the following, as specified.

1. Pipe earth electrode; as per IS:3043
2. Plate earth electrode; as per IS:3043

General

All cladding or steel work should be bonded to the earthing system, as should all structural steel work. A main earth bar should be provided, so disposed as to allow of the shortest subsidiary connections to all major equipment, such as DG set, Substations and electrical panel boards. When piles are used they should be bonded by welding and connected to earth bonding bars. All earth connections shall be visible for inspection.

- i) Electrode materials and dimensions
 - a) The materials and minimum sizes of earth electrodes shall be as per fault level calculation.

- b) GI pipe electrodes shall be cut tapered at the bottom, and provided with holes of 12 mm dia, drilled not less than 7.5 cm from each other upto 2 m of length from the bottom.
- c) Pipe electrode shall be buried in the ground vertically with its top not less than 20cm below the ground level. The installation shall be carried out as per IS:3043 and as directed by the engineer in charge.
- d) Plate electrode shall be buried in ground with its face vertical, and its top not less than 2m below the ground level. The installation shall be carried out as per IS:3043 and as directed by the engineer in charge.
- e) When more than one electrode is to be installed the distance between the pipe electrode shall be 5m and that between plates shall be 8m.
- f) The strip or conductor electrode shall be buried in trench not less than 0.5m deep.
- g) If the conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point or as directed by the Engineer-in-charge.
- h) All joints in copper conductor should be tinned properly.

1.10.2 Earthing Conductor

- a) The earthing conductor (protective conductor from earth electrode upto the main earthing terminal/earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified.
- b) Protective (Earth continuity/Loop earthing) Conductor)
- c) The material and size of protective conductors shall be as specified by the Engineer-in-charge.

1.10.3 Location for Earth Electrodes

- i) Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building, with the prior approval of the Engineer-in- Charge.

1.10.4 Protective (Loop earthing/earth continuity) Conductor:

- i) Earth terminal of every switchboard in the distribution system shall be bonded to the main earth bus.

- ii) Two protective conductors shall be provided for a switchboard.
- iii) A protective conductor shall securely connect the earth connector in every distribution board (DB) to the earth bus.
- iv) All metallic switch boxes and regulator boxes in a circuit shall be connected to the earth connector in the DB by protective conductor.
- v) Provision should be given for the testing of earth electrodes by connecting a group of rod driven electrodes to the main earth grid through a bolted link adjacent to the electrodes in a sunken concrete box. Simpler disconnecting arrangements are not acceptable.

1.10.5 Marking

- i) Earth bars/terminals at all switch boards shall be marked permanently as E
- ii) Main earth terminal shall be marked Safety Earth – Do Not Disconnect.

1.10.6 Lightning Protection

A) Scope

This chapter covers the detailed requirements of installation of lightning conductor system for protection of buildings against lightning. For details not covered in these specifications, reference may be made to IS:2309 - 1989.

B) Principal Components:

The principal components of a lightning protective system are:

- a) Air terminations b) Down conductors c) Joints and bonds d) Testing joints
- e) Earth terminations f) Earthelectrodes.

C) Materials:

The materials of air terminations, down conductors, earth termination, etc. of the protective system shall be reliably resistant to corrosion, or be adequately protected against corrosion. The material shall be of the following, as specified.

All air terminations and down conductors shall be of copper.

The recommended shape and minimum sizes of conductors for use above and ground shall be conforming to relevant I.S. specifications.

D) Layout

The system design and layout shall be done in accordance with IS:2309 - 1989. The

work shall be carried out accordingly satisfying at the same time, the requirements given below.

E) Air terminations:

- i) Air termination networks may consist of vertical or horizontal conductors, or combinations of both. For the purpose of lightning protection, the vertical and horizontal conductors are considered equivalent and the use of pointed air terminations, or vertical final is, therefore, not regarded as essential.
- ii) A vertical air termination, where provided, need not have more than one point, and shall project at least 30 cm, above the object, salient point or network on which it is fixed.
- iii) For a flat roof, horizontal air termination along the outer perimeter of the roof shall be used. For a roof of larger area a network of parallel horizontal conductors shall be installed. No part of the roof should be more than 9 m from the nearest horizontal protective conductor.
- iv) Horizontal air terminations should be carried along the contours such as ridges, parapets and edges of flat roofs, and where necessary, over flat surfaces, in such a way as to join each air termination to the rest, and should themselves form a closed network.
- v) All metallic projections including reinforcement, on or above the main surface of the roof which are connected to the general mass of the earth, should be bonded and form a part of the termination network.
- vi) If portions of a structure vary considerably in height, any necessary air terminations or air termination network for the lower portions should be bonded to the down conductors of the taller portions, in addition to their own conductors.

F) Down Conductors

- i) The number and spacing of down conductors shall be as specified, or as directed by the Engineer-in-charge.
- ii) Routing
 - a) A down conductor should follow the most direct path possible between the air terminal network and the earth termination network. Where more than one down conductor is used, the conductors should be arranged as evenly as practicable around the outside walls of the structures.
 - b) The walls of light wells may be used for fixing down conductors, but lift shafts should not be used for this purpose.
 - c) Metal pipes leading rainwater from the roof to the ground may be connected to the

Down conductors, but cannot replace them, such connections should have disconnecting joints.

- d) In deciding on the routing of the down conductor, its accessibility for inspection, testing and maintenance should be taken into consideration.
 - e) Proper porcelain/ DMC supports should be used to support the lightning conductor at regular intervals.
- iii) Provision when external route is not available:
- a) Where the provision of external routes for down conductors is impracticable, for example, in buildings of cantilever construction from the first floor upwards, down conductors should not follow the outside contours of the building. To do so would create a hazard to persons standing under the overhang. In such cases, the down conductors may be housed in an air space provided by a non-metallic and non-combustible internal duct and taken straight down to the ground.
 - b) Any suitable covered recess, not smaller than 76 mm x 13mm, or any suitable vertical services duct running the full height of the building may be used for this purpose, provided it does not contain an unarmoured or a non-metal sheathed cable.
 - c) In case where an unrestricted duct is used. seals at each floor level may be required for fire protection. As far as possible, access to the interior of the duct should be available.
- G) The lightning protective system should be so installed that it does not spoil the architectural or aesthetic beauty of the building.

1.11 INSTALLATION

1.11.1 Scope

The intent of this specification is to define the requirements for the installation, testing and commissioning of the electrical items mentioned in the schedule of requirements. The work shall, however at all times carried out strictly as per the instructions of the Engineer-in-Charge.

The Contractor shall furnish all tools, welding equipment, rigging materials, testing equipment, test connections and kits etc. Required for complete installation, testing and commissioning of the items included in the Contract.

The Contractor shall carry out touch-up painting on any equipment indicated by the Engineer-in-Charge, if the finish paint on the equipment is soiled or marred during installation handling.

The interconnecting control cables between LT panel boards , 230V auxiliary power supply etc. should be done by the contractor as required.

The installation shall conform in all respects with Indian Standard Code of Practice.

1.11.5 LT Panel Boards

Switchgears shall be installed in accordance with specified code of practice and the Consultants instructions. The panels shall be delivered in convenient shipping section by the contractors. The Contractor shall be responsible for final assembly and inter-connection of busbars/wiring. Foundation channel shall be grouted in the flooring by the Contractor. Switchgear panels shall be aligned and levelled on their base channels and bolted or tack welded to them as per the instructions of the Engineer-in-charge. The earth bus shall be made continuous throughout the length. Loosely supplied relays and instruments shall be mounted and connected on the switchgear. Wherever the instruments and relays are supplied separately, they shall be mounted only after the associated control panel have been erected and aligned.

After erection the switchboard shall be inspected for dust and vermin proofness. Any hole, which might allow dust or vermin etc. to enter the panel, shall be plugged suitably at no extra cost.

If the instrument transformers are supplied separately they shall be erected as per the direction of the Engineer-in-charge. The Contractor shall fix the cable glands after drilling the bottom top plates of all switch boards with suitable holes at no extra cost.

Range of overload relays/timers etc. shall be checked with requirement of purchaser actually to be connected at site and if the same is under- sized/over-sized, it shall be brought to the notice of Engineer-in-charge and shall arrange procurement of correct rated components. However, the Contractor shall not charge anything extra for cost/labour for such replacements.

1.11.5.1 Testing

The Contractor shall perform operating tests on all switchgear and panels to verify operation of switchgear/panels and correctness of the interconnections between various items of the equipment. This shall be done by applying normal ac or dc voltage to the circuits and operating the equipment for functional checking of all control circuits, eg. closing, tripping, control interlock, supervision and alarm circuits.

All connections in the switchgear shall be tested from point to point for possible grounds or short circuit.

All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

The Contractor shall arrange testing and calibrations of relays. The testing equipment including primary and secondary injection sets (if required) etc. shall also have to be

arranged by the Contractor. Payment for above work shall be deemed to have been included in the erection of switch boards/control panels.

Insulation resistance tests shall be carried out by following rating meggers:

- a) Control circuits upto 220 V : by 500 V megger
- b) Power circuits, busbars, connections
Upto 11kV : by 1000V meggar

Before electrical panel is energised, the insulation resistance of each bus shall be measured from phase to ground. Measurement shall be repeated with circuit breakers in operating positions and contact open. Before switchgear is energised, the insulation resistance of all DC control circuits shall be measured from line to ground.

The following tests shall be performed on all circuit breakers during erection:

- i) Contact alignment and wipe shall be checked and adjusted where necessary in accordance with the breakers manufacture's instructions.
- ii) Each circuit breaker shall be closed manually and its insulation resistance measured from phase to phase and phase to ground before erection.
- iii) All adjustable direct acting trip devices shall be set using values given by the Engineer-in-charge/manufacturer.
- iv) The dielectric strength of insulating oil wherever applicable shall be checked

Before switchgear is energised the following tests shall be performed on each circuit breaker in its test position.

- i) Close and trip the circuit breaker from its local & remote control switch, push button or operating handle. Switchgear control bus may be energized to permit test operation of circuit breaker with AC closing with prior permission of the Engineer-in-charge.
- ii) Test operation of circuit breaker latch, check carriage limit switch if provided.
- iii) Test proper operation of lockout device in the closing circuit, wherever provided by simulating conditions, which would cause a lockout to occur.
- iv) Trip breaker either manually or by applying current or voltage to each of its associated protective relays.

Before switchgear is energised, the test covered above shall be repeated with each breaker in its normal operating position.

All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

The Contractor shall arrange testing and calibrations of relays. The testing equipment including primary and secondary injection sets (if required) etc. shall also have to be arranged by the contractor. Payment for the above work shall be deemed to have been included in the erection of switch boards/control panels.

Performa for Panels

- a) Circuit (breaker or Bidder module designation/bus no.)
- b) Insulation resistance tests (contacts open, breaker racked in position).
 - i) Between each phase of bus : Mega ohm
 - ii) Between each phase and earth : Mega ohm
 - iii) DC and AC control & auxiliary circuits : Mega ohm
 - iv) Between each phase of CT/PT and CT & PT circuit if any : Mega ohm
- c) CT checks:
 - i) CT ratio
 - ii) CT secondary resistance
 - iii) CT polarity check
- d) Check for contact alignment and wipe.
- e) Check/test all releases/relays.
- f) Check mechanical interlocks.
- g) Check switchgear/control panel wiring.
- h) Check electrical interlocks.
- i) Checking of breaker/control circuits for
 - i) Closing-local and remote (wherever applicable)
 - ii) Tripping-local and remote (wherever applicable)
- j) Opening time of breaker/contactors.
- k) Closing time of breaker/contactors.

(This Performa shall be jointly signed by the Engineer-in-charge and the Contractor.)

1.11.5.2 Completion tests

After supply and installation of complete project or a particular building / area, the contractor shall carry out following tests before switching on the power to installation and the results shall be recorded and submitted to the engineer-in-charge. If results are not satisfactory / as per the standard, the contractor shall identify the defects/short coming and shall rectify the same. Nothing extra shall be paid for carrying out these tests and contractor has to arrange all necessary instruments.

1.11.5.3 Insulation resistance to earth

This to be measured with all fuse links in place all switches on all lamps and appliance in position by applying a voltage not less than twice the working voltage (subject to a limit of 500V). Insulation resistance of the whole or any part of the installation to earth must not be less than 50 Megaohms divided by the number of outlets (points and switch positions) except that it need not exceed 1 Megaohm for the whole installation.

1.11.5.4 Insulation resistance between conductors

Test to be made between all the conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or neutral or the other pole or phase conductors of the supply. For this test, all lamps shall be removed and all switches put on. The result of the test must be 50 Megaohms divided by the number of outlets (point and switch positions) but need not exceed one Megaohm for the whole installation.

1.11.5.5 Polarity of single pole switches

Test shall be made to verify that all non-linked single pole switches are on phase conductor (Live) and not on the neutral or earthed conductor.

1.11.5.6 Resistance of metal conduits/sheaths (Earth continuity test)

In case of cables encased in metal conduit or metallic sheathing, the total resistance of the conduit or sheathing from the earthing point to any other position in the completed installation shall not exceed 2 ohms.

1.11.5.6 Bus bar chamber

Busbar chambers shall be installed on fixed type switch boards with GI bolts and nuts.

1.11.5.7 Connections

- i) Connections to busbars shall be made either by clamping arrangement, or by bolts and nuts as required. Tapped holes with studs may be permitted only for copper busbars for tapping conductor size upto 16 sq.mm.
- ii) All connections shall be made such that there is a clear metal to metal area contact at the tappings so that the current density of the busbars at the point of connection does not exceed permissible limits, avoiding local heating.
- iii) For tap-off connections from busbars, PVC insulated wiring cables may be used for current capacity upto 100A. and for higher current capacities, solid conductors/strips suitably insulated with PVC sleeve/tape shall be used.

- iv) The bolts and nuts used for connections to busbars shall be of aluminium alloy, tinned forged brass or galvanised iron. Suitable precaution shall be taken against heating due to bi-metallic contact, spring washers and plate washers, shall be used with the studs/nuts to ensure proper contact pressure.

1.11.6 Cabling

Cable network shall include power, control and lighting cables, which shall be laid in underground trenches, Hume pipes, open trenches, cable trays, GI pipes, or on building structure surfaces as detailed in the relevant drawings. Cable schedules or as per the Engineer-in-charge's instructions. Supply and installation of cable trays, GI pipes/conduits, cable glades sockets at both ends, isolators, junction boxes, remote push buttons stations, etc. shall be under the scope of the Contractor.

1.11.6.1 General requirements for handling of cables.

- a) Before laying cables, these shall be tested for physical damage, continuity absence of cross phasing, insulation resistance to earth and between conductors. Insulation resistance tests shall be carried out with 500/1000 volt Megger.
- b) The cables shall be supplied at site, wound on wooden drum as far as possible. For smaller length and sizes, cables in properly coiled form can be accepted. The cables shall be laid by mounting the drum of the cable on drum carriage. Where the carriage is not available, the drum shall be mounted on a properly supported axle, and the cable laid out from the top of the drum. In no case the cable will be rolled on, as it produces kinks which may damage the conductor.
- c) Sharp bending and kinking of cables shall be avoided. The bending radius for PVC insulated and sheath armoured cable shall not be less than 10 D Where 'D' is overall diameter of the cable.
- d) While drawing cables through GI pipes, conduits, RCC pipe, ensure that size of pipe is such that, after drawing cables, 40 % area is free. After drawing cable, the end of pipe shall be sealed with cotton/bituminous compound.
- e) High voltage (11 kV and above), medium voltage (230 V and above) and other control cables shall be separated from each other by adequate spacing or running through independent pipes/trays.
- f) Armoured cables shall never be concealed in walls/floors / roads without GI pipes, conduits RCC pipes.
- g) Joints in the cable throughout its length of laying shall be avoided as far as possible and if unavoidable, prior approval of site engineer shall be taken. If allowed, proper straight through epoxy resin type joint shall be made, without any additional cost.

- h) A minimum loop of 3 M shall be provided on both ends of the cable, or after every 50 M of unjointed length of cable and on both ends of straight through cable joint. This additional length shall be used for fresh termination in future. Cable for this loop shall be paid for supply and laying.
- i) Cable shall be neatly arranged in the trenches/trays in such a manner so that criss- crossing is avoided and final take off to the motor/switchgear is facilitated. Arrangement of cables within the trenches/trays shall be the responsibility of the Contractor.
- j) All cable routes shall be carefully measured and cable cut to the required lengths and undue wastage of cables to be avoided. The routes indicated in the drawings is indicative only and the same may be rechecked with the Engineer-in-charge before cutting of cables. While selecting cable routes, interference with structures, foundations, pipe line, future expansion of buildings, etc. should be avoided.
- k) All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be taped with an approved PVC or rubber insulating tape. Use of friction type or other fabric type tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.
- l) Wherever cable rises from underground/concrete trenches to motors/ switchgears/ push buttons, these shall be taken in GI pipes of suitable size, for mechanical protection upto 300 mm distance of concerned cable gland or as instructed by the Engineer-in- charge.
- m) Where cables pass through foundation/walls of other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures the electrical Contractor shall determine their location and obtain approval of the Engineer- in- charge before cutting is done.

1.11.6.2 Installation of Cables

Wherever cables are taken through masonry works and road crossings etc., they shall be protected by running through GI pipes and Hume pipes respectively. Depth shall be 1200 mm from top of finished road surface and it shall extend for about 1070 mm on both sides of the roads.

Utmost care shall be taken to avoid scratches, kinks and cuts on the conductor while transporting the cables to site or during installation. Suitable inhibiting grease shall be liberally applied to bare conductors, wherever they exist.

The junction boxes, cable end boxes etc. wherever required to be provided shall have sufficient wiring spaces with regard to the sizes of cables indicated in the drawings. Wherever required, the items to be supplied for electrification shall be complete with requisite type of cable glands, cable boxes, termination etc. and other

accessories which are necessary for the satisfactory installation/operation of the installations as per relevant statutory rules and regulations.

Installation of all cables should be as per E.I. Standards. Fuses should be graded properly and should be selected based on the rating of cables. The cables shall be laid in trenches/overhead racks wherever available. The cables from cable trenches to the switcher shall be buried (as per standard practices and or taken through GI pipes to 1.2 m above ground/racks floor level. The cables taken over racks/ walls/ columns/ trusses shall be properly clamped using aluminium clamps of 16 SWG 1/4 hard or 3/4 hard sheet, the width varying from 12.5 to 25 mm at intervals of 750 mm. 225 mm minimum horizontal interaxial spacing shall be maintained when more than one cable is laid in same trench. Suitable and permanent type of cable markers is to be provided indicating the route and position of joints of cable. Loops should be provided at either ends of the cable. Identification tags should be provided for each cable in the trench at a distance of 3 metres.

Supply and installation of danger notice boards, where required, and other provisions under the statutory rules and regulations shall be included in the scope of this work.

The Contractor has to provide materials and carry out the wiring work including earthing according to IS 3043 unless otherwise specified and get it approved before using for work, by the authorised engineer of the Purchaser.

The complete installation work shall be conforming to NEC-1985 and complying with the Indian Electricity Rules and to meet the approval of the State Electrical Inspector etc. Installation of all switch boards and distribution boards should be in conformity with Rule 51(1)(c) of I.E.R. 1958. MV installation should conform to I.S. 7732.

The cable terminations and earth terminations, wherever required, shall only be using compression type cable glands and suitable lugs.

All the materials to be supplied for this work shall be got approved by the concerned engineer at site.

The work will be considered complete only if the following tests are conducted, by the contractor at his own cost, satisfactorily in the presence of the site Engineer and are:

- a) Insulation test
- b) Earth resistance test and
- c) Continuity test

1.11.6.3 Laying of cables (underground system)

- a) Cables shall be so laid in ground that these will not interfere with other underground structures. All water pipes, sewage lines or other structures, which become exposed by excavation, shall be properly supported and protection

from injury until the filling has been rammed solidly in places under and around them. Any telephone or other cables coming in the way are to be properly shielded diverted as directed by the Purchaser.

- b) Cables shall be laid at minimum depth of 750 mm in case of LT & 1200 mm in case of HT, from ground level. Excavation will be generally in ordinary alluvial soil. The width of the trench shall be sufficient for laying of required number of cables.
- c) Sand bedding 75 mm thick shall be made below and above the cables.

A layer of bricks (full size) shall be laid on the edge, above sand bedding on the sides of cables and a flat brick to cover cable completely. More than one cable can be laid in the same trench by providing a brick on edge between two cables. However the relating location of cables in trench shall be maintained till termination. The surface of the ground after back filling the earth shall be made good so as to conform in all respects to the surrounded ground and to the entire satisfaction to the Engineer-in-charge.

- d) For all underground cables, route markers should be used.
 - i) Separate cable route markers should be used for LT, HT and telephone cables.
 - ii) Route markers should be grounded in ground with with 1:2:4 cement concrete pedestal size 230 x 230 x 300 mm.
 - iii) Cable markers should be installed at an interval not exceeding 50 M along the straight routes of cables at a distance of 0.5 M away from centre of cable with the arrow marked on the cable markers plate indicating the location of cable. Cable markers should also be used to identify change in direction of cable route and for location of every joint in underground cable.
- e) RCC hume pipes for crossing road in cable laying shall be provided by Contractor. RCC hume pipe at the ends shall be sealed by bituminous compound after laying and testing of cable by electrical Contractor without any extra charge.

1.11.6.4 Laying of cables under Floors

- a) GI class A pipe shall be used for laying of outgoing cables from distribution boards to various equipment. Preferably one cable shall be drawn through one pipe. Size of pipe shall be such that after drawing of cable 40 % area is free. If length of pipe is more than 30 M, free area may be increased to 50 %.
- b) Use of elbows is not allowed at all and number of bends shall be kept minimum. Instead of using bends with sockets, pipe bending machine shall be used for making long smooth bends at site.

- c) Ends of pipe shall be sealed temporarily while laying with cotton / jute / rubber stopper etc. to avoid entry of building material.
- d) Exact locations of equipment shall be ascertain prior to laying of pipe.

1.11.6.5 Laying of cable in Masonry Trenches

- a) Masonry/concrete trenches of laying of cable shall be provided by Contractor. However steel members such as MS angles/flats etc. shall be provided & grouted by electrical Contractor to support the cables. Cables shall be clamped to these supports with aluminium saddles/ dampers. More than one tier of cables can be provided in the same trench if the number of cables is more.
- b) Entry of cables in trenches shall be sealed with bituminous MASTIC compound to stop entry of water in trenches.

1.11.6.6 Laying of cables in cable racks

Cable Racks to be used for cables laid indoors except for single cables. The cable racks shall be of ladder type fabricated out of structural steel, MS, GI or aluminium perforated as indicated. The cable racks shall be of adequate strength to carry the weight of cables without sagging. Structural bracket grounded in the buildup trenches to support the cable such supports shall be at intervals of not less than 750 mm centers. All the structural steel work shall be finished with two coats of paint over primer.

- a) Cables shall be fixed in cable trays in single tier formation and shall be clamped with aluminium flat clamps and galvanised bolts/unit.
- b) Earthing flat/wire can also be laid in cable tray along with cables. c) After laying of cables minimum 20 % area shall be spare.

1.11.6.7 Laying of cables on building surface / structure

- a) Such type of cable laying shall be avoided as far as possible and will be allowed only for individual cables or small group of cables which run along structure.
- b) Cables shall be rigidly supported on structural steel/masonry using individual cast/malleable iron galvanised saddles and these supports shall be approximately 400 to 500 mm for cables upto 25 mm overall diameter and maximum 1000 mm for cables larger than 25 mm. Unsightly sagging of cables shall be prevented. Only aluminium/GI clamps with GI bolts/nuts shall be used.
- c) If drilling of steel structure must be resorted to, approval must be secured from the Engineer-in-charge and steel must be drilled where the minimum weakening of the structure will result.

1.11.6.8 Termination and Jointing of cables

a) Use of GI Glands

All PVC cable upto 1.1 kV grade, armoured or unarmoured shall be terminated at the equipment/junction box/ isolators/push buttons/control accessories, etc. by means of suitable size compression type cable glands armour of cable shall be connected to earth point. The Contractor shall drill holes for fixing glands wherever necessary. Wherever threaded cable gland is to be screwed into threaded opening of different size, suitable galvanised threaded reducing bushing shall be used for approved type.

In case of termination of cables at the bottom of the panel over a cable trench having no access from the bottom, a close fit holes should be drilled in the bottom plate for all the cables in one line, then bottom plate should be split in two parts along the centre line of holes. After installation of bottom plate and cables with glands, it shall be sealed with cold sealing compound.

b) Use of Lugs/Socket

All cable leads shall be terminated at the equipment terminals, by means of crimped type solder less connectors unless the terminals at the equipment ends are suitable for direct jointing without lugs/sockets.

The following is the recommended procedure for crimped joints and the same shall be followed:

- i) Strip off the insulation of the cable end with every precaution, not to sever or damage any strand. All insulation to be removed from the stripped portion of the conductor and ends of the insulation should be clean and square.
 - ii) The cable should be kept clean as far as possible before assembling it with the terminal/socket. For preventing the ingress of moisture and possibility of re-oxidation after crimping of the aluminium conductors, the socket should be fitted with corrosion inhibiting compound. This compound should also be applied over the stripped portion of the conductor and the palm surface of socket.
 - iii) Correct size and type of socket/ferrule/lug should be selected depending on size of conductor and type of connection to be made.
 - iv) Make the crimped joint by suitable crimping tool.
 - v) If after crimping the conductor in socket/lug, same portion of the conductor remains without insulation the same should be covered sufficiently with PVC tape.
- c) Dressing of Cables inside the Equipment

After fixing of cable glands, the individual cores of cable shall be dressed and taken

along the cableways (if provided) or shall be fixed to the panels with polyethylene straps. Cable shall be dressed in such a manner that small loop of each core is available inside the panel.

For motors of 20 HP and above, terminal box if found not suitable for proper dressing of an aluminium cables, the Contractor shall modify the same without any additional cost. Cables inside the equipment shall be measured and paid for.

d) Identification of Cables/Wires/Cores

Power cables shall be identified with red, yellow & blue PVC tapes for trip circuits identification, additional red ferrules shall be used only in the particular cores of control cable at the termination points in the switchgear/control panels and control switches.

In case of control cables all cores shall be identified at both ends by their wire numbers by means of PVC ferrules or self sticking cable markers, wire numbers shall be as per schematic/connection drawing. For power circuit also wire numbers shall be provided if required as per the drawings of switchgear manufacturer.

1.11.6.9 Testing of Cables

- a) Before energising, the insulation resistance of every circuit shall be measured from phase to phase and from phase to ground. This requires 3 measurements if one side is grounded and 6 measurements for 3 phase circuits.
- b) Where splices or terminations are required in circuits rated above 650 volts, measure insulation resistance of each length of cable before splicing and/or terminating. Report measurements after splices and/or terminations are complete.
- c) DC High Voltage test shall be made after installation on the following:
 - i) All 1100 Volts grade cables in which straight through joints have been made.
 - ii) All cables above 1100 V grade.

For record purposes test data shall include the measured values of leakage current versus time.

The DC High Voltage test shall be performed as detailed below:

Cables shall be installed in final position with the entire straight through joints complete. Terminations shall be kept unfinished so that motors, switchgear, transformer etc. are not subjected to test voltage.

The test voltage and duration shall be as per relevant codes and practices of Indian Standards Institution.

1.11.6.10 Proforma for Testing Cables_

Proforma - A

Date of Test

- a) Drum No. from which cable taken b) Cable from to
 c) Length of run of this cable metre
 d) Insulation resistance test :
 Voltage of Megger Volts
- i) between core-1 to earth.Megaohm
 ii) between core-2 to earth.Megaohm
 iii) between core-3 to earth. Megaohm
 iv) between core-1 to core-2. Megaohm
 v) between core-2 to core-3.Megaohm
 vi) between core-3 to core-1. Megaohm

- e) High voltage test Voltage Duration
 i) between cores and earth
 ii) between individual cores

Signature of
 Engineer-in-Charge

Signature of
 Contractor

Proforma - B

Cable Laying

(To be shown for each cable separately, voltage wise)

Date(s) of Test:.....
 Voltage of Megger used:.....

Continuity of cores laying	IR value (mega ohm)		Before
	Before back filling	Between value	
_____	_____	_____	_____
	Between	Value	

1) From.....To.....PVC/XLPE.....x sq.mm
 LV/MV/HV cable.....m in length.

R-N R-N Y-N Y-N B-N B-N

R-Y	R-Y B-R	B-R Y-B	Y-B
R-E	R-E Y-E	Y-E B-E	B-E

Signature of
Engineer-in-Charge

Signature of
Contractor

Proforma - C

Cable Jointing

(To be shown for each cable separately, voltage wise)

Date(s) of Test:.....

Voltage of Megger used:.....

Number of Joint

Location

Type of cable(s)

Type of joint (Indoor/Outdoor, straight through/termination, LV/MV/HV)

1.11.7.2 Installation of Ceiling Fans

Scope of work under this item shall start from the ceiling rose of the fan point with 3 core 1.5 Sq.mm PVC insulated copper wires to the connector in the fan, connections, fixing of fan (complete with all accessories) to the fan hook of fan point, testing the fan with regulator and commissioning.

Extension/replacement of hanging rod of fans shall be carried out only if advised by the Engineer-in-charge on drawing/site instruction book. Only GI pipe ('B' class) shall be used for ceiling fan hanging. Screwed joint within the length of fan hanging rod is not allowed and shall never be adopted. Fan hanging rod should be preferably of one piece and if not possible, welded joint can be allowed.

1.11.7.3 Installation of Exhaust fan

Scope of work under this item shall start from the ceiling rose of exhaust fan point, with 3 core 2.5 Sq.mm PVC insulated copper wire from ceiling rose to connector of exhaust fan, connections, including fixing of exhaust fan complete with accessories and louvers on walls with hold-fasts, testing the exhaust fans and commissioning.

1.11.7.4 Special notes

- a) Location of lighting fixtures/fans shall be shown on the working drawings and the same shall be followed. However, if due to site conditions the location cannot be adhered to, the same shall be brought out to the notice of the Engineer-in-charge for advice.

1.11.8.0 Earthing

1.11.8.1 Scope

The scope of this section shall cover the following:

- a) Earthing station
- b) Earthing conductors
- c) Earthing of equipment and installation

1.11.8.2 Standards

The following standards shall be applicable: IS : 3043 COP for earthing IS : 5216 Safety procedures & practice in electrical work

1.11.8.3 Earth Station

The earth station shall be made by excavating the ground to a depth as required and the excess earth after back filling shall be removed from site. Ground with rocky strata, the depth of excavation shall be less. However additional earthing stations or earth matting to be provided to achieve the system earthing less than one ohm.

1.11.8.4 Electrodes

Sufficient number of earth pits shall be provided and inter-connected so as to have the resistance of the earthing installations not more than 1 ohm. In case the soil resistivity is found to be very high, a high sensitive relay may be used to co-relate the relay setting with high earth resistance.

- a) Various types of electrodes
 - i) Pipe electrode shall be buried in the ground vertically with its top at not less than 20 cm below the ground level. The installation shall be carried out as shown in the figure and as directed by the Engineer-in-charge.
 - ii) Plate electrode shall be buried in ground with its face vertical, and its top not less than 2 m below the ground level. The installation shall be carried out as directed by the Engineer-in-charge.
 - iii) a) The strip or conductor electrode shall be buried in trench not less than 0.5 m deep.
 - b) If conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point or as directed by the Engineer-in-charge.

1.11.8.5 Earthing Conductor (Main earthing lead)

The earth conductors shall be fixed to the wall/columns etc at every 500 mm centres

with 10 mm spacers. The total earthing system shall be mechanically and electrically connected to provide independent path to earth.

- i) In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.
- ii) A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanised "C" shaped strips, bolts, washers, nuts and checknuts of adequate size shall be used for the purpose.
- iii) The earthing conductor from the electrode upto the building shall be protected from mechanical injury by a medium class, minimum 15 mm dia. GI pipe in the case of wire, and by 40 mm dia. medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30 cm deep to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due co-ordination with the building work.
- iv) The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by bolt, nut and washer.

1.11.8.6 Earth bus and main earthing terminal

- i) The Main Earth bus shall be laid as directed by the Engineer-in-charge.
- ii) Following conductors shall be terminated into the main earthing terminal/earth bus.
 - a) Earth connection from the Sub station.
 - b) Earthing conductor from electrode.
 - c) Protective conductors;
 - d) Equi-potential bonding conductors.

1.11.8.7 Protective (Loop earthing/earth continuity) Conductor

- i) Earth terminal of every switch board in the distribution system shall be bonded to the main earth bus.
- ii) Two protective conductors shall be provided for a switchboard.
- iii) A protective conductor shall securely connect the earth connector in every distribution board (DB) to the earth bus.

- iv) All metallic switch boxes and regulator boxes in a circuit shall be connected to the earth connector in the DB by protective conductor.
- v) The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor.

1.11.8.8 Marking

- i) Earth bars/terminals at all switch boards shall be marked permanently, either as E or as
- ii) Main earth terminal shall be marked “Safety Earth – Do Not Disconnect”.

Proforma for testing Earth Electrodes

- i) Total number of earth electrodes..... ii) Earth resistance of each earth electrode:

Sl.No.	Location	Value

Signature of
Engineer-in-Charge

Signature of
Contractor

1.12 Approved Makes of Equipment and Materials

1.12.1 Scope

The scope of this section covers the recommended makes of equipment, material components. The final choice of makes shall be indicated at the time of finalization of order.

The makes of material offered by the contractor shall be indicated at the space provided for proper evaluation of the offer and shall be one of the recommend makes. In the absence of such indication, the decision rests with the Purchaser/consultant.

1.12.2 Makes recommended

The makes of material recommended are exhibited in respective section. The offers shall be strictly on the basis of the makes recommended.