



PART C: TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS

General Requirements

The installations shall generally be carried out in conformity with the requirements of Indian Electricity Act, 1910 as amended up to date and Indian Electricity Rules, 1956 framed there under, the relevant regulations of the Electric Supply Authority concerned and also with the specifications laid down in the Indian Standard SP 30 &. The work shall be executed as per National Electrical Code and if any item is not covered there under or there is any doubt, the specification approved by the Engineer-in-charge will be final and binding.

Ambient Conditions

All Electrical installations and equipments shall be suitable to work in following ambient conditions.

Maximum Temperature	:	50 degree Celsius
Relative Humidity	:	100%
In the vicinity of	:	Banharpali, Orissa.

System Conditions

The Electrical installations and equipments shall be suitable for operation in following system conditions.

Supply voltage :	415 Volts +/-10%
Supply frequency :	50Hz +/-5%
Number of Phases :	Three

3.1.1 Scope

The equipment and materials within the scope of supply shall include but not limited to:

- a) Lighting fixtures with lamps and accessories.
- b) Lighting panels/boards: Main lighting boards, lighting panels, street lighting panels etc.
- c) Not Used
- d) Mancooler, exhaust fans, receptacles, switches, switchboards etc.
- e) Cables, wires, splicing/termination/connection accessories.



- f) Conduit and accessories, junction and pull boxes, terminal blocks.
- g) Grounding materials and connections.
- h) All fittings, supports, brackets, anchors, clamps and connections.
- i) Steel for field fabrication of supports, brackets and cable rack

3.1.2 Materials:-

All materials, fittings, appliances used in electrical installations shall confirm to Indian Standard Specifications wherever these exist. A list of approved materials is attached. Materials not included in the list as well as any particular make should be approved by the Consultant or Engineer-in-charge before use. All required materials covered under this specification except mentioned otherwise clearly, shall be supplied and installed by the contractor complete in all respect. The materials and accessories required for completing the work will form part of the work although they have not been specified separately.

Selection of materials and installation work shall be such as to simplify operation, inspection, maintenance and testing. The work shall include all reasonable precautions and provisions for safety of operation and maintenance personnel.

3.1.3 Standard:-

(a) Unless otherwise specified, all materials covered under this specification shall be designed, manufactured, tested and installed in conformity with the latest Indian Standard Specifications. In case such Indian Standard Specifications are not published equivalent British Standard Specifications shall be followed. All equipments shall confirm to latest Indian Electricity Rules, CPWD and Local/State laws or byelaws as regards to safety, earthing and other essential provisions specified therein.

3.1.4 Inspection and Approval

The contractor shall put up samples of all major items for inspection and testing by the Consultant and/or Engineer-in-charge for which the contractor shall furnish minimum 10 days clear notice in advance to enable them to depute their Inspecting Officer. Similar procedure shall be adopted for the approval of Samples of minor materials/ accessories to be used for the work.

Material and equipment to be used in the work shall be inspected by the EIC. Such inspection will be of following categories.

- i. Inspection of material/equipment to be witnessed at the manufactures premises in accordance with relevant BIS /Agreement inspection procedure.
- ii. To receive materials at site with manufactures test certificates'



- iii. To inspect material at the authorized dealer Godowns to ensure delivery of genuine material at site.
- iv. To receive material after physical inspection at site.

3.2.0 GENERAL TECHNICAL SPECIFICATION OF MATERIALS

3.02.00 Ratings & Requirements

3.02.01 All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards.

3.02.02 Moulded case circuit breakers (MCCB), miniature circuit breakers (MCB), bus bar shall be fully rated for short circuit level at the point of application. The current corresponding to the maximum connected load in any circuit shall be limited to 80% or less of the MCB/MCCB rating.

3.02.03 All equipment and accessories shall have proper enclosure to suit the site conditions. Hazardous areas shall have flame-proof enclosure.

3.02.04 All wiring from lighting panels to fixtures and receptacles shall be carried out by PVC wires in G.I. Conduits.

3.02.05 Heavy duty AYWY FRLS cables shall be used only for connections:

- a) From main lighting board to area lighting panels
- b) From street/area lighting panel to street light poles/towers.
- c) From 415V MCCs to receptacles of 63A and above.

3.03.00 Method of Calculation

3.03.01 Standard Lumen method shall be adopted for interior & exterior lighting in order to determine the number of lighting fixtures for obtaining the desired average level of illumination.

3.03.02 The coefficient of utilization shall be considered to take care of Lumen loss due to -

- a) effect of room dimensions.



- b) absorption of light in luminaires.
- c) absorption of light at various room surfaces i.e ceiling wall etc.
- d) floor cavity, ceiling cavity.
- e) mounting height.

3.03.03 Moreover a maintenance factor shall also be considered to account for the fall of illumination due to aging, pollution like dust deposit etc. Maintenance factors to be considered for various areas shall be as follows:

Area	Maintenance factor
Control Room	0.8
Switchgear/MCC Room	0.60 - 0.65
General indoor area	0.55 - 0.60
Coal dust area	0.50 - 0.55

3.03.04 Lux level to be considered for various areas shall be 250 Lumen (or as per standard)

3.03.05 Voltage drop at the fixture from the MLDB bus shall not exceed 3%.

3.03.06 Circuit loading of each lighting Panel shall be done in such a way that almost balanced loading in all the phases i.e R, Y & B is achieved.

3.03.07 At least two sub circuits shall be used for illumination of a particular area.

3.03.08 Sub circuit loading of each lighting panel shall be restricted to 2000 Watts.

All switches, 5A plug socket , power plug sockets, TV sockets and Telephone sockets shall be flush mounting type with ISI mark of approved make. The switches and plug sockets shall confirm to IS:3854, IS:1293, IS:6538 & IS:4615/1968.



3.03.9 Fan Regulators & Dimmers:-

Electronic type fan regulators and light dimmers of approved make shall generally be used and shall be of flush mounting type.

3.03.10 Wires:-

The wires used for internal electrical wiring shall be of single core PVC insulated sheathed/ unsheathed 1100V grade stranded copper conductor wires (suitably colour coded to distinguish different phases and neutral) of approved make with ISI mark. The wires shall confirm to IS:694 (Part-I & Part-II)/1964. The minimum cross sectional area of conductors for the different uses shall be as specified below.

Lighting point wiring	2.5sqmm Copper
Power point wiring	2.5sqmm Copper
HPSV/HPMV Luminaries/LED	2.5sqmm Copper
Circuit wiring	2.5sqmm Copper
Sub-main wiring	10.0sqmm Aluminium.

Wire size shall be as follows :

For point wiring beyond lighting panel : 10 Sq.mm. Aluminium.
i.e from lighting Panel to junction box (main run) Stranded conductor

From Junction box to lighting fixture : 2.5 Sq.mm. Copper.
Stranded conductor.

Lighting Cable shall be heavy duty, 650/1100 Volt grade, multi-core stranded aluminium conductor, HR PVC or XLPE insulated, extruded PVC inner sheath, single round G.I. wire armoured and overall PVC sheathed to IS 1554.

Lighting wires shall be 1100 Volt grade, PVC insulated, stranded conductor, single core cable conforming to IS 694, colour coded as below :

RED	for	R-Phase	BLACK	for	Neutral
YELLOW	for	Y-Phase	WHITE	for	+ 'Ve D.C.
BLUE	for	B-Phase	GREY	for	- 'Ve D.C.

3.2.3.00 Conduits and Accessories



3.2.3.01 Conduits shall be rigid steel, hot-dip galvanised, furnished in standard length of 3 metres, threaded at both ends.

3.2.3.02 Thickness of conduits up to and including 25 mm dia shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 20 mm.

3.2.3.03 Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.

3.2.3.04 Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips and coated with PVC.

3.2.4.00 Junction Box

3.2.4.01 Junction boxes shall be of 16 SWG sheet steel hot-dip galvanised, dust and damp proof, conforming to IP-55.

3.2.4.02 Junction boxes shall be complete with gasketed inspection cover, conduit knock out/threaded hub and terminal blocks.

3.2.4.03 Junction boxes for outdoor use shall be weatherproof IP-55 and those for hazardous location shall be suitable for hazardous classification as per IEC 60079.

3.2.4.04 Junction boxes shall have following indelible markings:
Circuit nos. on top
Circuit nos. with ferrules (inside) as per drawing
DANGER sign in case of 415V circuit

6.16.00 Terminals

6.16.01 Multi way terminal blocks of approved type, complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires.

6.16.02 Each terminal shall be suitable for connection up to 2 nos. 10 Sq.mm stranded aluminum conductors without any damage to the conductor or looseness of connectors.

3.2.5 Switch & Switch Board

3.2.5.01 All switch boards/boxes shall be of bent steel construction, fabricated of 14 SWG M.S. sheet with 6 mm thick Bakelite cover with brass fixing screws.



3.2.5.02 Switch boards/boxes located in control room and office areas shall be flush mounted type on brick wall with only the switch knob projecting outside.

3.2.5.03 Switch boards/boxes shall have conduit knock outs on the sides. Adequate provision shall be made for ventilation of these boxes.

3.2.5.04 Flush type receptacles where provided shall be so located that only the plug projects outside.

3.2.5.05 Switches shall have quick-make and quick-break mechanism operated by a suitable external handle complete with position indicator

3.2.6 Angle/ Batten/ Pendant Holder & Ceiling Rose:-

Brass or Bakelite type 5A, 250V, Angle Holders, Batten Holders, Pendant Holders & three way ceiling rose confirming to IS:732/1982 & IS:371/1979 of approved make and design with ISI mark shall be used.

3.2.7 Distribution Boards:-

All the L.T. Distribution Boards shall be suitable for operation in 3 phase/ single phase, 415/240 Volts, 50Hz, neutral grounded at transformer system and a short circuit level of not less than 35MVA at 415 Volts. All Distribution Boards shall generally confirm to IS 2675 amended up to date.

Distribution boards shall be of wall/ floor mounting type and totally enclosed having hinged doors, dust, damp and vermin proof construction. These should be made out of CRCA sheet steel and the enclosure should be acid treated for rust proofing, thoroughly cleaned, painted with two coats of anticorrosive primer and two coats of white enamel paint for interior and industrial grey enamel paint for exterior. All doors and covers shall be fully gasketed with neoprene PVC strips and shall be lockable. All the hinged doors shall be effectively earthed with flexible copper wires. Cadmium plated fixing screws shall enter holes tapped into an adequate thickness of metal or provided with hank nuts. Self-threading screws shall not be used.

The distribution boards shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switch-gears. Knock out holes of appropriate sizes and number shall be provided on detachable plates in the board in conformity with the location of incoming and outgoing cables/ conduits. The switches shall be so arranged that fuses are not alive when the switch is in OFF position. No apparatus shall project beyond and edge of the panel. No switch body shall be mounted within 25mm of any edge of the panel and no holes, either than meant for fixing the panel shall be drilled within 13mm of the edge of the panel. The various live parts shall be effectively screened by barriers of non-hygroscopic, non-inflammable insulating materials or shall be so spaced that an arc can be maintained between such parts and earth. All



items of switch-gears shall be readily accessible and all connections, including those to instruments and apparatus, be easily traceable.

The bus bars and interconnections shall be of electrolytic annealed copper/ high conductivity electrolytic wrought aluminum of rectangular cross section suitable for carrying full load current for phases & neutral bus bars and shall be extensible on either side. The maximum current density shall be 1.00 Amp/sqmm for Aluminum and 1.25 Amp/sqmm for copper bus bars. The bus bars shall be supported on SMC/ DCM/ Glass fibre reinforced polyester, non-breakable non-hygroscopic insulators at regular intervals to withstand the forces arising from short circuit in the system. All busbars shall be provided in a separate chamber and properly ventilated. The minimum clearance between the phases shall be 25mm and between phase and earth shall be 20mm. The interconnection between busbars and switchgears of rating above 63A shall be through strips having 125% of the switch-gear current rating. All bus bars shall be suitably insulated by means of heat resistant PVC sleeves or PVC insulating tapes and colour coded in phase sequence of R-Y-B & N. The entire bus bar shall be covered on the front with a Bakelite sheet barrier. In longer sections of bus bars, provision shall be made for thermal expansion by providing flexible joints made out of multi-foil thin copper/ aluminium foils. All joints shall be of clamped type as far as possible else of bolted construction with double cover fish-plates.

All connections between pieces of apparatus or between apparatus and terminal on a board shall be neatly arranged in a definite sequence, following arrangements of the apparatus mounted there on, avoiding unnecessary crossings. Wire interconnections shall be colour coded and connected to terminals only by soldered lugs, crimped lugs without cutting away the strands. No interconnecting wires shall come in contact with the live bus bars other than the terminal points. The arrangement of bus bars shall confirm to IS:375

An enameled danger notice plate shall be provided on the boards connected to medium voltage supply & above.

Adequate space shall be provided for accommodating various instruments. These shall be accessible for testing and maintenance without any accidental contact with live parts of circuit breakers, switch-gears, bus bars and interconnections. The indicating lamps shall be provided with individual switch and fuses. The voltmeters shall be provided with fuses for each phase. The control wires shall be of 2.5sqmm copper for CT circuits and 1.5sqmm copper for the rest. The control wires shall be neatly bunched together inside PVC trunking securely fasten to the compartment properly marked with ferrules at the end. A separate tamper proof compartment with locking arrangements as per the requirements of the supply authority shall be provided for housing of the energy meters.

(a) Branch Distribution Boards (BDB):-

The branch distribution boards shall be surface mounted or concealed type and made out of 1.6mm (16 swg) CRCA sheet steel. At least one number hexagonal earthing stud for single phase BDBs and two numbers earthing studs for three phase BDBs shall be provided. The components of the BDBs

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shall be mounted on a detachable 2mm thick CRCA sheet steel frame works for easy maintenance. The minimum size of wires to be used as interconnecting wires shall be 2.5 sqmm copper or 4.0 sqmm aluminium. Each outgoing circuit of the BDB shall be provided with a fuse/ MCB on the phase or live conductor. The earthed neutral conductor shall be connected to a common link and be capable of being disconnected individually for testing purpose. Door interlocking with MCBs shall be provided such that doors shall open only with MCBs in OFF position. All the live parts inside the BDB shall be covered with a Bakelite sheet with at least 3mm thick.

(b) Main Distribution Boards and Sub Distribution Boards:-

The Main Distribution Boards (MDB) and Sub Distribution Boards (SDB) shall be wall mounted or floor mounted type and made out of 2.0mm (14swg) CRCA sheet steel. In case of wall mounted boards the entire sheet steel enclosure shall be mounted on a m.s. angle frame work with adequate fixing arrangement for grouting. In case of floor mounted boards the enclosure shall be fixed to a m.s. angle framework with m.s. base channels. All the incoming and outgoing switch-gears and breaker other than MCBs shall be fixed in separate compartments.

All switch-gears above 63A rating and breakers shall be provided with door interlocks so as to open only in OFF position. All MCCBs shall be provided with external operating handle. The ON, OFF, TRIP (where available), Rating marking and nomenclature plates shall be provided near operating handle. A continuous earth bus made out of Galvanised Iron or Aluminium strips of adequate size shall provided at the bottom of panel for the entire length. Arrangement shall be made at both the ends of earth bus for easy entry and termination of earthing lead from external earth installations.

Cable compartments of adequate size shall be provided for easy termination of all incoming and outgoing cables entering from bottom or top. Proper cable supports shall be provided in cable compartments. All incoming and outgoing terminals shall be brought out to terminal blocks or to a extended rigid strip directly from the switch-gear/ breaker. Separate cable compartments shall be provided for incoming and outgoing cables. Ventilation arrangement in the form of finely divided wire mesh shall be provided at both sides towards the top.

3.2.8 Miniature Circuit Breaker (MCB):-

The miniature circuit breakers of approved make shall be ISI marked and capable of withstanding minimum 25000 switching operations and fully automatic with provision of thermal and magnetic tripping arrangements. All MCBs shall be of minimum 9KA short circuit rating IS: 8828& BS: 3871.

3.2.9 Changeover Switches:-

The changeover switches shall be load break types having three distinct position of operation. The ON and OFF positions of the switch shall be clearly indicated. The door interlock with defeat mechanism shall be provided for switch units confirming IS:8623. The changeover switches shall confirm to IEC:408 and bear ISI mark.



3.2.10 Re-wireable Fuses

The re-wire able fuses (Kit-kat) shall be semi-enclosed type consisting of a re-wireable fuse carrier and fuse base and shall be made out of either porcelain or Bakelite. The breaking capacity of these fuses shall be 4000 Amp on 400 Volt. These shall bear ISI mark.

3.2.11 Energy Meters (KWH Meter)

The Energy Meters (KWH meter) shall be either whole current or CT operated type. These shall be duly tested and calibrated by the supply authority prior to fixing and necessary test certificate shall be furnished.

3.2.12 LT Power Cables

The LT power cables shall be of PVC insulated and PVC sheathed, 1100 Volt grade, single core or multi core, un-armoured or GI wire / strip armoured, stranded aluminium conductor cables of approved make and should bear ISI mark. The armoured cables shall confirm to IS:1554(Part-I) and un-armoured cables to IS:694/1977.

3.2.13 LED Fittings

The LED fittings shall be of the following type.

Box type fitting

All LED-fittings shall be of approved make and in general confirm to IS:1913/1969. These shall be complete with all standard accessories as per specification such as lamp holder etc duly factory wired. Provision shall be extended to earth all the metallic part of the fixtures and all the detachable metal parts such as stove enameled reflector of industrial fitting, metallic louver of mirror optic fitting etc shall be provided with loop earthing by flexible wire. The choke shall be copper wound and polyester filled. Power factor improvement capacitor shall be provided confirming to IS: 7752(Part-I)/1975 and of such rating to improve the power factor to 0.9.+3. 250 Lux to be maintained in the floor space .

3.2.14 Incandescent Fittings

The Incandescent fittings shall be of the following type.

(a) Ceiling flush type

(b) Bulk head type

These shall be complete with all standard accessories as per specification and provision for earthing the metallic parts of the fitting.

3.2.15 Street Light Luminaries

The street light luminaries shall be of the following types.

(a) LED street light fitting



These shall be of approved make complete with all standard accessories as per specification such as ballast, capacitor, igniter, starter, lamp holder etc and shall have provision for earthing of all the metallic parts of the fitting. The luminaries shall in general conform to IS:10322 (Part-1 to Part-5).

Specifications:

- No glare, no flash
- Eco friendly
- Choice of colors COOL WHITE, WARM WHITE & NORMAL WHITE
- Life - 50,000 hours
- voltage 230 VAC to 300 VAC
- Beam angle 120 degree
- Efficacy (Lm/W) - 100
- THD <15, CRI >80 , Power factor >0.95
- Constant current drive, low current fluctuation
- Efficient light distribution
- Perfect luminance and brightness levels for roadways

3.2.16 Industrial heavy duties Fans/ Mancooler (confirming to IS 374)

The **Industrial heavy duties** fans shall be of approved make & brand and suitable for operation on 230V/ 415V 50Hz single/ three-phase supply. The fans shall consist of all standard accessories such as fan blades, capacitors speed regulator. The fan motor shall be of permanent capacitor run totally enclosed with double ball bearing and the winding shall be made of super enameled copper wire high performance Mancooler having Robust Construction, Aerofoil dynamically balanced Cast Aluminum Impellers & heavy duty TEFC 'F' Class continuously Rated Motor facilitates the shop floor in the Industries

3.2.17 Exhaust Fans

The exhaust fans shall be of approved make & brand and suitable for operation on single/ three phase 230/ 415V 50Hz supply. The fans shall consist of all standard accessories such as impeller blade, fixing frames, capacitors, anti vibration pads etc. The exhaust fan motor shall be of permanent capacitor run, continuous rated, totally enclosed with double ball bearing and the winding shall be made of super enameled copper wire with class-F insulation. Sound level of the exhaust fans shall not exceed 60db for domestic application and 65db for industrial application. Gravity louver shutters made out of aluminium sheets with a steel frame/ wire guard shall be provided with these fans. These shall have IP:44 degree of protection.



3.3.0 INSTALLATION

3.3.00 Wiring

3.3.01 Wiring shall be generally carried out by PVC wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawing is permissible.

3.3.02 Wire shall not be pulled through more than two equivalent 90° bends in a single conduit run.

3.3.03 Wiring runs which exceed standard cable length shall be connected at junction boxes with approved terminal strips. Maximum two wires can be connected to each way of the terminal block. .

3.02.04 For lighting fixtures, connection shall be teed off through suitable round conduit or junction box, so that the connection can be attended without taking down the fixture.

3.02.05 For vertical run of wires in conduit, wires shall be suitably supported by means of closed mesh cable grips at each pull/ junction box whose spacing shall not exceed 30 metres.

3.02.06 A.C. and D.C. circuits shall not be run in the same conduit and junction boxes. Circuits fed from different transformers shall be run through different conduits and Junction boxes.

3.02.07 Receptacle circuits shall be kept separate and distinct from lighting and fan circuits.

3.02.08 Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in form of switch or fuse.

Portions of Wiring

Point wiring shall consist of a switch on the board and wiring up to termination point via the control switch and neutral.

These termination points can be :

A ceiling rose or connector in case of fan or exhaust fan point wiring. The wiring from ceiling rose or connector to fan or exhaust fan point shall be considered with the installation of fans.

A ceiling rose in case of directly fixed type LED fixtures, suspended pendants.

A back plate in case of suspended type LED fixtures, suspended or stiff pendants, wall brackets, bulk heads, spot light similar fittings.



A lamp holder in case of angle or batten holders.

A convenient wall plugs in case of plug on board or separate board points.

Wiring for light points and fan points shall be carried out with minimum 2.5 sqmm copper stranded conductor wire. For the purpose of measurement the points are classified as below wherever specified.

- (a) **Short points** : **Up to 3.0m long**
- (b) **Medium points** : **3.0m to 6.0m long**
- (c) **Long points** : **6.0m to 10.0m long**
- (d) **Special long points** : **Above 10.0m long (As specified)**

Where classification of points are not specified, the point wiring shall mean wiring to the all types points as described above irrespective of the length of the point.

The wiring whether concealed or surface shall be easily accessible for inspection. Power and Heating sub-circuits shall be kept separate and distinct from lighting and fan sub-circuits. The balancing of circuits in three phase installations shall be arranged before hand. Circuits of different phases of a.c. system shall be kept minimum 2.0m apart or enclosed in earthed metal casing. Medium voltage wiring and associated apparatus shall comply, in all respect, with the requirements of rules 50, 51 and 61 of Indian Electricity Rules, 1956.

The position of runs of wiring and the exact position of all points, switch boards, distribution boards shall be marked in the building for approval of Engineer-in-charge prior to execution. The wiring shall be carried out in looping back system in which the phase conductor shall be looped at the switch box and that of neutral at the junction box and point terminals. In no case, joint shall be made bare or by twisting the conductors.

Lights and fans may be wired on a common circuit. Such circuit shall not have more than a total of either 10 points or a load of 800 watts.

For the purpose of determining load per circuit, the following rating for points shall be assumed.

- (a) **High bay UFO Light** : **500 watts**
- Linear LED Light Fixture – Industrial LED light** : **200 watts**



	Street light	:	30 watts
(b)	Industrial heavy duties fan points	:	1800 watts
(c)	Exhaust fan points	:	500 watts
(d)	5Amp plug points	:	100 watts
(e)	15Amp plug points	:	1000 watts

Unless and otherwise specified, the following minimum mounting height of the bottom most part of the fittings and fixtures from finished floor level shall be maintained.

(a)	Distribution Boards	2.130 metre
(b)	Switch board	1.300 metre
(c)	5A & 15A plugs on separate board	0.300 metre
(d)	Industrial heavy duties fan	2.750 metre
(e)	Light fittings	2.600 metre

3.3.1b Circuit Wiring

Circuit wiring shall mean wiring from BDB/ SDB up-to the junction boxes for switch boards containing 5A/15A switches and plugs. For the purpose of measurement, in case of multiple switch boards under one circuit, the circuit wiring shall mean the sum of the length of wiring from BDB/ SDB up-to junction box of first switch board and junction box of first switch board to the junction box of next switch board and so on. The minimum size of conductor for circuit wiring shall be 2.5 sq mm copper. A circuit shall not contain more than 2 number power plugs. If not specified in point wiring to power plugs, the wiring to the same shall be treated as circuit wiring.

3.3.1c Sub-main Wiring

Sub-main wiring shall mean wiring from Main switch/ Meter board up-to BDB/ SDB. The minimum size of wire shall be 4.0sqmm copper or 6.0sqmm COPPER. There shall be no jointing of wires as far as practicable. PVC ferrules shall be provided at both the ends of the wire for easy identification.



3.3.2 Types of Wiring

Conduit System

- 3.3.2.01 In case of unarmored cable, all conduits shall originate from the respective lighting panel and terminate in lighting fixtures, receptacles etc.
- 3.3.2.02 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls as far as practicable. Unnecessary bends and crossings shall be avoided to present a neat appearance.
- 3.3.2.03 Conduit supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.
- 3.3.2.04 Conduits shall be clamped on to approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be fixed to the building steel by welding and to concrete or brickwork by grouting as shown on drawings.
- Wooden plug inserted in the masonry or concrete for conduit support is not acceptable.
- 3.3.2.05 Embedded conduits shall be securely fixed in position to preclude any movement.
- 3.3.2.06 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less than 40 mm.
- 3.3.2.07 Where conduits are run on cable trays they shall be clamped to supporting steel at an interval of 600 mm.
- 3.3.2.08 For directly embedding in soil, the conduits shall be coated with an asphalt - base compound. Concrete pier or anchor shall be provided where necessary to support the conduit rigidly and to hold it in place.
- 3.3.2.09 Not Used
- 3.3.2.10 Not Used
- 3.3.2.11 Conduits shall be kept, wherever possible, at least 300 mm away from hot pipes, heating device etc. when it is evident that such proximity may impair the service life of cables.



- 3.3.2.12 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change shall cause no distortion due to expansion or contraction of conduit run.
- 3.3.2.13 For long runs or runs with numerous bends, junction/pull boxes shall be provided at suitable intervals to facilitate wiring.
- 3.3.2.14 Conduits shall be securely fastened to junction box or cabinets, each with a locknut and insulated bushing inside the box and locknut outside.
- 3.3.2.15 Conduit lengths shall be joined by screwed couplers. Couplers shall be clearly cut.
- 3.3.2.16 Conduit joints and connections shall be made thoroughly water-tight and rust-proof by application of a thread compound, which shall not insulate the joints.
- White lead is suitable for application on embedded conduit and red lead for exposed conduit.
- 3.3.2.17 The Battery Room installation shall be made with acid fume proof conduits.
- 3.3.2.18 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations or flattened surfaces. Heat shall not be applied in making any conduit bend.
- 3.3.2.19 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded.
- 3.3.2.20 Lighting fixture shall not be suspended directly from junction box in the main conduit run.
- 3.3.2.21 Conduits and fittings shall be properly protected during construction period against mechanical injury. Conduits ends shall be plugged or capped to prevent entry of foreign material.
- 3.3.2.22 After installation the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.
- 3.3.2.23 In control rooms and office areas provided with false ceiling conductor run shall be concealed type, embedded in the walls and ceiling.

3.3.3 Cable Laying & Installation

3.3.3.00 Cabling



3.3.3.01 In outdoor areas, main runs from lighting panels shall be by means of AYWY cables, directly buried in ground or laid in trenches for the underground portion and through conduit for the over ground portion.

3.3.3.02 Direct buried cables shall be laid and covered with sand/ riddled earth, and protected from damage by bricks at sides and pre cast concrete slab at top. Buried cables shall have cable markers at 50M interval and projecting 150 mm above ground. At cable bends and joints markers shall be provided.

3.3.3.03 When buried cables crossroad / railway track, additional protection to be provided in form of hume / G.I. pipe

The cables shall be of approved make and tested at factory in presence of Engineer-in-charge or his authorised representative. The cables shall be dispatched to the work site packed on wooden drums with both ends properly sealed. Jointing of the cables in between the terminal points shall be avoided as far as possible. For longer length of cable exceeding the normal length of manufacture, cables may be joined by means of jointing kits only. The cables shall be tested for insulation resistance by 500-volt insulation Megger for cables up-to 1100 volt grade and by 2500 volt insulation Megger for cables beyond 1100V grade prior to laying of the same. Cable loops for future requirement shall be kept at both ends as per direction of the Engineer-in-charge.

One number 6 swg G.I. wire in case of single phase 230V a.c. system and either 2 numbers 6 swg G.I. wire or 2 numbers suitable size G.I. flat in case of multi phase 400V or more a.c. system shall run all along the trench or tray with the cables as earth continuity conductor. The supply and laying of earth continuity conductor such as G.I. wire or flat has been considered separately in the schedule of quantity.

Minimum bending radius for PVC insulated armoured cables shall be 1200mm. At joints and terminals, the individual cores of multi-core cable should never be bent so that radius of bending is less than 12 times the overall diameter of the cable.

Wherever more than one cable shall exist, suitable marker tags inscribed with cable identification details shall be permanently attached to all cables in the man hole, pulpits, joints, open ducts, underground cables etc at suitable intervals.

The laying and installation of cable shall be carried out as per IS:255/1983. The methods of cable laying shall be of following types depending upon the requirements.

- (a) Laying directly under ground
- (b) Laying inside ducts
- (c) Laying on racks or trays in air



(d) Laying along building structural elements

3.3.3a Laying Directly Under Ground

Cable trenches shall be excavated cutting all types of soil and rock up-to a minimum depth of 750mm for L.T. cables & 1200mm for H.T. cables and of appropriate width (not less than 350mm) to accommodate the cables and cable protecting materials within the tendered rate.

The sides and bottom of the trench shall be dressed and filled with 75mm thick layer of fine sand. The cables shall then be laid with bricks on both side of each cable continuously along the length. Space between the bricks shall be filled with fine sand up-to 75mm above the top of the cable. The top layer bricks shall be placed side by side continuously as protective cover. The horizontal distance between the adjacent cables shall be minimum 200mm. The clearance between the outer cable to the sides of the trench shall be at least 150mm.

In case of multiple tiers, same procedure shall be applied keeping a vertical clearance of 300mm among the tiers and the top most layer shall be kept at a depth of 750mm for LT cables and 1200mm for H.T. cables from finished ground level.

The trench shall then be filled up with the excavated materials free from stone or sharp edged debris and duly compacted. A crown of earth neither less than 50mm nor more than 100mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

Cable route markers shall be installed at salient and strategically located points parallel to and 500mm or so away from the edge of the trench for easy identification of cable routes at a maximum interval of 10 metre for straight run.

In locations such as road crossing, pipe line crossing, entry to buildings or poles in paved area etc, the cables shall be laid in pipes or closed ducts. Pipes provided for entry to building shall slope upward to prevent entry of water to the building. Stone ware, cast iron, NP-2 class RCC pipes or medium class M.S./G.I. pipe of appropriate diameter shall be laid during the construction to avoid damage later on.

In case of stone ware pipes, a 100mm thick 1:3:6 cement concrete covering shall be provided. In case of cast iron or RCC pipes no concrete covering is required. The collars in case of RCC pipes shall be embedded by 1:2:4 cement concrete. Top surface of pipe shall be at a minimum depth of 1.0 metre. The minimum size of hume pipes shall not be less than 100mm in diameter for a single cable and not less than 150mm for multiple cables.

The diameter of the cable protecting pipes shall be at least 1.5 times the outer diameter of the cable. In one pipe, single core cables shall not be laid individually but instead, all the three/four cables of the same system shall be laid.

3.3.3b Laying along Building Structural Elements

Cables can be routed inside the buildings along the structural elements such as walls, columns etc or inside trenches or hume pipes or G.I. pipes under floor. The cables shall be laid or fixed along the wall or column with the help of M.S./G.I. flat clamps or saddles with an interval not



exceeding 0.5 metre. The cables inside brick masonry trenches shall be laid on racks or directly above the floor of the trench and the trench shall be covered with m.s. chequered plates. In case of laying inside hume pipes or G.I. pipes, man hole chamber with RCC cover shall be provided at suitable location for easy maintenance. The cables shall not intersect each other along its route.

3.3.4 Jointing of Cables

The quality of joints shall be such that it does not add any resistance to the circuit. The materials and techniques employed for jointing should give adequate mechanical and electrical protection to the joints under all service conditions. The joints shall be resistant to all corrosion and chemical reactions. The following three basic types of cable joints shall be used.

- (a) Straight through joints
- (b) Tee or branch joints
- (c) Termination or sealing joints

3.3.5 Installation of Distribution Boards

All main switch-gears shall be installed in dry situation as near as possible to the point of supply. The neutral wires shall be continuous except at the linked switch-gear. Main distribution boards shall be installed in well-ventilated rooms or cupboards accessible to only authorised persons or recessed having locking arrangement. The distribution boards shall not be installed in damp situations, in the vicinity of storage batteries, places exposed to chemical fumes or where inflammable or explosive dust, vapour or gas is likely to be present. These boards shall not be erected above gas stoves, sinks, in bath rooms, lavatories, toilets, kitchens, places exposed to weather or within 2.5 metre of a washing unit in the washing rooms and wash basins.

Fixing of distribution boards in places likely to be exposed to weather, drip or abnormal moist atmosphere shall be avoided. Where it is unavoidable, out door distribution boards with outer casing on the switch boards shall be installed making it weather proof and shall be provided with gland or bushings or adapted to receive screwed conduit according to the manner in which cables are run.

The indoor distribution boards shall be mounted concealed or semi-concealed or surface to the wall or on foundations above the floor. The panels shall be so mounted that it is accessible for fuse replacement and operation of switch-gears & breakers.

The top most height of the panel shall not be more than 2 metre from the floor level. In case of Branch Distribution Boards shall generally be installed at a height of 2.13 metre from finished floor level. A minimum clearance of 1 metre shall be provided from the surface of door opening of the boards for maintenance.

All distribution boards shall be marked lighting or power, voltage, number of phases of supply, circuit list, current rating of the circuit and rating of fuse element. All wiring and terminations shall be provided with cable lugs and neatly arranged.



Adequate space shall be provided on bottom or top or back as required for easy cable and conduit entry. The cables shall be terminated at the distribution board with corresponding size of brass cable gland. The glands shall be fixed tightly to the panel without allowing any gap or opening on the hole. The armours of the cable shall be suitably earthed. For conduit entry, PVC couplings for non-metallic flexible conduit and brass coupling for G.I. flexible conduit shall be used. No holes shall be kept open on any side of distribution board.

Distribution boards shall be earthed at two points from two separate & distinct earth electrodes in case of three phase boards and one point in case of single phase boards effectively by means of G.I. wire or flat as specified.

3.3.6 Installation of LED Fixtures

3.3.6.00 Lighting Fixtures

3.3.6.01 Continuous rows of high bay LED shall be mounted on a continuous M.S. angle for each row of lights.

3.3.6.02 In workshop hall, fixtures shall be mounted to maintain sufficient clearance from the overhead travelling crane trolley.

3.3.6.03 In both the side area, mounting height of fixtures shall be about 2500 mm from ground.

Bracket for fixture mounting shall be fabricated at site from 40 mm conduits with a reducing socket to suit the fixtures.

If a roof over platform is available, the fixture can be pendant mounted.

3.3.6.04 Floodlights shall be mounted on steel base facing the tentative direction shown on drawings. Fixing holes shall be provided with slot to turn the fixture about 5 Deg on both sides. Bolts shall be finally tightened with spring washer.

The Seller shall supply the steel base for fixing the flood light on the flood light towers.

Terminal connection to the floodlight shall be made through PVC coated flexible metallic conduits.

3.3.6.05 Fixtures shall be mounted on Plant structures with suitable clamps. No cutting or drilling of Plant structures is permitted.

3.3.6.06 The fixtures after erection shall be marked up indelibly with corresponding circuit number for easy identification of lamp circuit.



The LED fixtures shall be either directly fixed on walls or ceiling or suspended from ceiling of buildings. The contractor shall make proper marking for alignment and level of fitting as per the drawing prior to installation and get it approved from Engineer-in-charge. The contractor shall assemble and install the fittings as per the manufacturer's instructions. Connection from ceiling rose or connector shall be done with 3 core 2.5sqmm flexible copper cord. Each fitting shall be effectively earthed.

For fixing the fitting directly on walls and ceiling, the same shall be fixed on two numbers seasoned wooden round blocks. The round blocks shall be duly painted and fixed to wall or ceiling by means of PVC fill plugs and screws.

In case of fitting being suspended from ceiling, the same shall be fixed by means of two numbers 16 swg stove enameled m.s. conduit down rods along with cast aluminium ball sockets, conduit check nuts, circular Bakelite cover etc. The down rods shall be painted with 2 coats of enamel paint of approved shade. The fixing arrangement to the ceiling shall be capable of sustaining the entire load of fitting and down rod. The minimum mounting height of the fitting shall not be less than 2.5 metre from the finished floor level.

3.3.7 Installation of Incandescent Fittings

The incandescent fittings shall be rigidly fixed to wall or ceiling using Bakelite sheet. The metal parts of the fitting shall be effectively earthed by the earth continuity conductor. The flexible pendants, chandeliers etc shall be suspended from a hook provided in the slab during casting. The bulkhead fittings shall be recessed/ surface mounted on wall or ceiling.

3.3.8 Installation of Street Light Fittings

The street light fittings shall be fixed by means of either suitable G.I. bracket or on arms of tubular pole. The G.I. bracket shall be fixed by means of minimum two pairs of m.s. flat clamps duly painted. Loop-in-loop-out junction boxes shall be embedded inside the bottom foundation of the support wherever required. The wiring to the fitting shall be carried out by minimum 2 core 2.5 sqmm PVC insulated stranded copper wire along with 16 swg hard drawn bare copper earth continuity conductor. The fitting shall be assembled and mounted as per the manufacturer's instructions.

3.3.9 Installation of Industrial heavy duties Fans

Unless otherwise specified, the bottom most part of the ceiling fans shall normally be kept at a height of 2.75 metre above finished floor level. In no case, it shall be lower than 2.4 metre above the finished floor level. The mounting height of all **Industrial heavy duties** fans installed inside a hall or room shall be same. The metal parts of the ceiling fans shall be effectively earthed. The fans shall be assembled and mounted as per the manufacturer's instructions.

The wiring to the ceiling fan from the nearest point shall be carried out with 3 core 1.5 sqmm PVC insulated stranded copper conductor cords. The down rod & clamp shall be painted with



enamel paint of approved shade without involving any extra cost. Round bakelite sheet shall be provided on the fan hook boxes.

3.3.10 Installation of Exhaust Fans

Exhaust fans shall be fitted by means of rag bolts embedded in the wall. The required holes in the wall shall be made and finished neatly with cement plaster and brought to the original finish of the wall within the tendered rates. Gravity louvre shutters of suitable size shall be fixed on the outside wall covering the hole for the exhaust fan in order to restrict the inrush of rainwater etc. A wire mesh shall be provided in place of gravity louvre shutters to restrict the entry of birds where there is no chance of inrush of rainwater. All the metal parts of the exhaust fans shall be effectively earthed. The fans shall be assembled and mounted as per the manufacturer's instructions. The wiring to the exhaust fan from the nearest point shall be carried out with 3 core 1.5 sqmm PVC insulated stranded copper conductor cords.

3.3.11 Installation of Earthing

The earthing installations shall generally conform to IS:3043/1966 and requirements of Indian Electricity Rules, 1956.

All three-phase medium voltage equipments shall be earthed by two separate and distinct connections with earth through earth electrodes. Single phase equipments shall be earthed at least at one point. In case of high & extra high voltages, the neutral point shall be earthed by not less than two separate and distinct connection with earth each having its own electrode.

An earthing electrode shall not be situated within a distance of 1.5 metre from the building whose installation system is being earthed. The cross sectional area of earth continuity conductor in electrical installation shall nowhere be less than 16swg copper or 14swg GI wire. The earth resistance for various installations shall be restricted within the following maximum permissible limits.

Non industrial Buildings : 5 ohms

Earth continuity inside an installation : 1 ohm(From electrode to any point in installation)

The following types of earthing installations shall in general be provided.

(a) Pipe earthing

3.3.12 Pipe Earthing

Pipe earth electrodes shall be of perforated G.I. pipe of specified length and diameter. Galvanising of pipes shall conform to relevant IS 4736. The G.I. pipe electrode shall be cut tapered at the bottom and provided with holes of 12mm dia drilled not less than 75mm from each other in zigzag manner up-to 500mm from the top of the electrode. A pair of 50mm x 5mm G.I. flat clamp



with 2 nos 18mm dia drilled holes on either side shall be welded to the electrode at about 150mm below the top of the pipe.

The electrode shall be buried in the ground vertically with its top not less than 200mm below the ground level. The pipe earth electrode shall be surrounded by, either salt & charcoal in alternate layers or a homogeneous mixture of the both, for a radius of about 150mm and up-to a height of about 250mm below the top of the electrode. The balance portion of the excavated pit shall be filled with good quality soil and properly compacted.

A brick masonry chamber with hinged cast iron/ removable RCC inspection cover of size 300mm x 300mm shall be constructed within the tendered rate. Watering arrangement shall be made with funnel and wire mesh fixed by means of a reducer socket on the top of the electrode.

3.3.13 Installation of Earthing Leads

The earthing lead connecting the earth electrode to the apparatus or installation directly shall be of the same material as earth electrode. The earthing leads shall be either wires or strips of adequate size as specified and of either G.I. or tinned copper. The G.I. leads shall be connected to the electrode by means of 16mm dia G.I. nut bolts with flat & spring washer and the tinned copper leads shall be connected to the electrode by means of 16mm dia brass nut bolts with flat & spring washer.

All earth connections shall be visible for inspection. The earthing lead from electrode onwards shall be suitably protected from mechanical injury by means of 20mm dia G.I. pipe for G.I. wires. The portion of this protection pipe within ground shall be buried at least 300 mm deep from ground level. (Subject to increase up-to a depth of 600mm in road crossings and pavements.) The portion within the building shall be recessed or clamped at not more than 500mm interval in the walls/ columns/ beams etc and recessed in the floors. Joints in the earthing lead from earth electrode to apparatus shall be avoided as far as practicable. However if joints are inevitable, same shall be done by welding or proper bolting in case of G.I. strips and brazing or proper bolting in case of tinned copper strips. The welded joints in G.I. strips shall be applied with bituminous paint and wrapped with bituminous tape.

3.4.0 TESTING

Before a completed installation or an addition to an existing installation is put into service, the following tests shall be carried out by the electrical contractor in presence of Engineer-in-charge.

- (i) Polarity test
- (ii) Insulation resistance test
- (iii) Earth continuity test
- (iv) Earth electrode resistance test

3.4.1 Polarity Test

It shall be ensured by this test that the single pole switches have been fitted on the live side of the circuit they control. In a two-wire installation, test shall be made to verify that all switches in



every circuit have been fitted to phase conductor or non-earthed conductor of the circuit. In three or four-wire installation, test shall be performed to verify that every non-linked single pole of switch is connected to one of the phase conductor of supply.

3.4.2 Insulation Resistance Test

The insulation resistance shall be measured by applying between earth and whole system of conductors or any section thereof with all fuses in place and all switches closed and except in earth concentric wiring, all lamps in position or both poles of installation otherwise electrically connected together, a d.c. voltage of not less than twice the working voltage, provided that it does not exceed 500 volts for medium voltage circuit. Where the supply is derived from 3 wire a.c. or d.c. or polyphase a.c. system the neutral pole of which is connected to earth direct or through added resistance, the working voltage shall be deemed to be that which is maintained between the outer or phase conductor and neutral.

The insulation resistance of an installation measured as above shall not be less than 50 Mega-Ohms divided by the number of points of the circuit provided that the whole installation shall be required to have insulation resistance greater than one Mega-ohm.

Control rheostats, heating and power appliances and electric signs may, if desired, be disconnected from the circuit during the test, but in this case the insulation resistance between the case of frame and all live parts of each rheostat, appliances and signs shall not be less than half a Mega-ohm.

The insulation resistance shall also be measured between all conductors connected to one pole or phase conductor of the supply and all conductors connected to the neutral or the other pole or phase conductor of supply. Such test shall be made after removing all metallic connections between two poles of the installation. The insulation resistance between the conductors of installation shall not be less than that specified above.

3.4.3 Earth Continuity Test

The earth continuity conductor including metal conduits and metallic envelope of cables in all cases shall be tested for electric continuity and electrical resistance of the same along with the earthing lead but excluding any added resistance of earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed 1 ohm.

3.4.4 Earth Electrode Resistance Test

The resistance of each earth electrode shall be tested with an earth tester and the combined earth resistance of the earth grid of an installation shall be maintained as mentioned below.

Distribution Substations	:	2 ohms
Industrial Buildings	:	4 ohms



Non industrial Buildings : 5 ohms

Earth continuity inside an installation : 1 ohm(From electrode to any point in installation)

The completed installation shall be taken over only if the results obtained from the above tests are within the limits mentioned above and in accordance with I.E. Rules. On completion of testing of installation, a certificate shall be furnished by the contractor countersigned by the certified supervisor having a valid electrical supervisory license issued by Electrical Licensing Board of the State Government under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form obtainable from local supply authority.

3.5.0 SPECIAL CONDITIONS for Electrical Installation

3.5.1 Authorities

The contractor while executing the work shall obey to the provisions of the Government Acts relating to the work and the regulations and by-laws of statutory bodies or local authorities and supply authorities. The contractor shall undertake to provide all test certificates and make necessary arrangements to obtain electric supply.

3.5.2 Drawings

The installations work shall be carried out as per the approved execution drawings. Prior to laying of conduits or cables, the contractor shall submit drawings for same indicating the route, conduit size and numbers, location of inspection boxes etc. for approval.

The contractor on completion of the installation shall submit the following drawings in tracing paper.

As built electrical layout drawings of each floor showing the position of points & outlets, type of fittings & fixtures, location of switch boards & distribution boards, circuit & phase indication, position of earth electrodes, cable & conduit routes, position of lightning terminals & conductors etc neatly drawn.

As built schematic single line diagram of the entire installation showing

- all distribution boards having description of capacity, system & source of supply, type & their numbers;
- location, size, type, length of main and sub-main cables/ wires;
- Load details of each circuit or ways of distribution board or switch gear.

The drawings shall furnish the identification details such as name of work, job no., accepted tender no., date of completion, site location, name & address of owner, name & address of consultant, signature & name of contractor, his address, scale of drawing.



3.5.3 Commercial

All types of labourers referred in the schedule such as masons, electricians, wiremen, cable jointers, helpers, labourers etc are required to carry out electrical installation work to a building with all necessary tools and plants with them.

After completion of the installation, the contractor shall test the same in the presence of Engineer-in-charge for safety and durability as per IS specification and I.E. Rules. He shall get the electrical installation inspected by the Electrical Inspecting Authority and obtain necessary inspection report and statutory clearance to energise the installation at his own cost. However all fees for inspection prescribed by the statutory authority paid by the contractor shall be reimbursed by the owner on production of documentary evidence. The contractor shall submit necessary test certificates as and when required.

After completion of testing, necessary statutory inspection by competent authority and contract/ agreement with local supply authority, the contractor at his own cost shall arrange for final commissioning and energisation of installations before final handing over to the owner.

Rate quoted shall include all cost of labours with tools and plants, sundries and accessories, transportation of materials from local store, insurance, storage and handling, providing watch and ward to the installation carried out by him and materials in his custody, and expenses for maintaining the installation in proper order till final taking over. The contractor shall make good the damages caused during the course of work at his own cost.

Only materials of approved make shall be used. All other materials not included in the list of approved materials shall be got approved from Engineer-in-charge. If required, the materials may be sent for testing to any standard testing laboratory for conforming the quality and specification as per ISS. The cost towards testing shall be borne by the contractor. No surplus material procured by the contractor shall be accepted by the owner.

The work shall be carried out in accordance with the specification of the schedule complete with cost of all materials (except otherwise mentioned), all types of labour involved, all types of tools & plants required, sundries and accessories and as per the drawing, design and direction of Engineer-in-charge.

The electrical installation work shall be carried out by a registered and licensed electrical contractor duly authorised by the local Electrical Licensing Authority. The work shall be directly supervised by a Licensed Electrical Supervisor. Copy of valid license and details of previously executed works of the contractor and his supervisor shall be furnished along with the tender.

3.5.4 Payment linked to Testing & Commissioning

Payment, up-to maximum 80% of the quoted rate on each item completed but awaiting testing and commissioning, shall be made. Another 10% payment shall be made after successful testing in presence of Engineer-in-charge & inspection by statutory authority. The balance 10% payment shall be made after completion of work with final commissioning, energisation, handing over to owner & submission of performance bank guarantee.

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3.5.5 Performance Guarantee

The entire electrical installations carried out by the contractor shall be guaranteed for a trouble free operation against any bad workmanship; bad quality of material used for a minimum period of 12 months from the date of taking over by the owner or 18 months from the date of commissioning, whichever is earlier. Any defects found during this period shall be rectified and all faulty materials shall be replaced by the contractor free of cost.

The performance guarantee shall be executed in shape of a bank guarantee, in the prescribed format of the owner, amounting to 5% of the total value of electrical works executed, through any Nationalised Bank valid till completion of the guarantee period.

LIST OF MAKES				
C	ELECTRICAL			
14	LV BOARDS, MCCBs	ABB	L&T	SCHNEIDER
18	CAPACITORS	NEPTUNE	SIEMENS	
22	SELECTOR SWITCHES & ROTARY SWITCHES	SALZER	KAYCEE	HAGER
31	MCB & BCCB DISTRIBUTION BOARDS	LEGRAND	HAGER	ABB
34	LIGHT LED(INDUSTRIAL)	HAVELLS	WIPRO	CG
37	HT & LT CABLES (POWER & CONTROL)	HAVELLS	RR	FINOLEX
38	PVC INSULATED COPPER WIRES(FRLS)	HAVELLS	RR	FINOLEX
41	PVC RIGID CONDUITS	AKG	BEC	STEEL CRAFT
46	INDUSTRIAL SOCKETS IN SHEETSTEEL ENCLOSURE WITH MCB	BCH	LEGRAND	
47	CEILING ROSE	ANCHOR	LISHA	
48	LIGHTING & POWER CONTROL SWITCHES, RECEPTACLES	ABB CHEIRON	SCHNDIER OPAL	LEGRAND MYRIUS
		MANTRA UDYOG		



50	Industrial heavy duties FANS & EXHAUST FANS	HAVELLS	CG	USHA
51	TERMINALS	ELMEX	WAGO	CONNECTWELL