

TECHNICAL SPECIFICATIONS**I. Electrification Work (Building Works)****A- General Instructions:**

- 1- The electrification work shall be carried out by licensed workmen authorized to undertake such works under the provisions of the Electricity Act 1910 and the Pakistan Electricity Rules 1937.
- 2- The installation work shall be carried out in conformity with the Pakistan Electricity Rules 1937 and the latest edition of the Regulations for the Electrical Equipment of Buildings by the Institution of Electrical Engineering, London (I.E.E.). However, in case of conflict between these specifications and the I.E.E. Regulations, then these specifications shall be followed.
- 3- Contractor shall be responsible for submitting the test certificates and getting the installation passed by the Electrical Inspector of the Region.
- 4- The Contractor shall set out the work himself and if any discrepancy is found he shall report the matter to the Consultants and shall act as directed. If any defective or modified setting is carried out by the Contractor on his own he shall rectify or make it good at his own cost.

The Contractor shall provide all material, equipment, labour, installation materials, jigs, tools, & instruments etc., for complete supply, installation, testing and commissioning of the electrical works specified herein and on drawings and Bill of Quantities.
- 5- The Contractor shall keep the Architect informed about the program and the progress of the work so that there is no hindrance in the progress of work at site due to site conditions or delayed supply of material equipment and labor by the Contractor.
- 6- The Contractor shall take care not to damage the structure during execution of work. If so done he shall repair and make good all losses at his own cost.
- 7- The Contractor shall furnish all equipment and material at site, conforming fully to the specifications given herein and to the accepted standards and must comply with the standards listed in these specifications under the separate heading "Standards". All material and equipment supplied by the Contractor shall be new and in all respects conform to the high standard of engineering design and workmanship, perform and function as herein specified and fully meet the quality level and ruggedness requirements.

8- Standards:

The latest relevant Pakistan Standard Specifications shall be followed. The British Standard Specifications and codes, VDE, IEC Recommendations and Reports and I.E.E. recommendations shall be applicable and be followed for the equipment and installation specified herein provided these do not contradict the Pakistan Standard Specifications and Pakistan Electrical Rules and Act. In case of contradictions between these codes standards and recommendations the Engineer's ruling shall be final.

9- Climatic Conditions:

All equipment supplied shall withstand without developing any defect the climatic conditions in Karachi:

Maximum Ambient Temperature = 45 deg. Centigrade.

Maximum Relative Humidity = 80%

10- As-Built Drawings:

Upon completion of work the Contractor is required to prepare the As-Built Drawings showing the actually installed, fitted position and location of all equipment, material and fixture and submit to the Project In-charge for approval. Such drawings shall be in the form, size and scale equivalent to the construction drawings issued by the Consultants before and during the Contractor's work. After approval of As-Built drawings the Contractor shall submit 3 Nos. set of print and one reproducible set or CD of approved As-Built drawings to the Employer. The work of the Contractor will not be considered completed unless approved As-Built drawings shall be received by Owner, duly checked and certified by the Architect.

B- EQUIPMENT & MATERIAL SPECIFICATIONS:

1- Conduit, Pipes , Cable Tray, and Accessories:

1.1- Steel Conduit:

The steel conduit shall be used for surface wiring above false ceiling. The steel conduit shall be in standard length of heavy gauge 16 SWG (1.63mm wall thickness) steel conduit threaded at both ends, manufactured and tested in accordance with BSS 31. The steel conduit shall be protected by two coats of first quality black enamel paint. The paint coating shall be of heavy enamel applied over two coats of red lead oxide primer. The enamel paint shall not flake or crack from bending or rough usage. The black enamel coating shall also be given on the surface of conduit after fixing in position. The minimum size of conduit shall be ¾" (19mm) outer diameter. Conduit accessories such as inspection boxes, junction boxes and pulling boxes etc., shall be of cast iron or of heavy gauge 16 SWG sheet steel having blank sheet steel covers. These shall be painted inside and outside with black enamel paint over two base coats of anti-rust red lead oxide paint. Soft metal bushes shall be used at conduit termination ends in order to safe insulation from damage due to sharp conduit edges in cable pulling operation. The steel conduit shall be IIL make or approved equivalent.

1.2- PVC Conduit & Pipes:

The PVC conduit shall be used for concealed wiring installation only and never exposed on wall or over false ceiling. The PVC conduit shall have wall thickness 0.04 inches to 0.05 inches for ¾" dia and 0.045 to 0.55 inches for 1 inch diameter size and weight 4.27 Kg per 100 Ft for ¾" dia and 5.79 Kg per 100 ft fr 1" dia. Manufactured smooth bends shall be used and bending of conduit by heating shall not be allowed. The outlet boxes at wall or ceiling light point shall be 2-1/4" dia x 1-1/2" deep. Round junction boxes shall be provided with cover plate of PVC. The PVC pipe shall be D class, Dadex brand or approved equivalent.

2- Wiring Cables :

The single core wiring cables shall be made of soft annealed electrolytic copper stranded or solid as specified, PVC insulated only 250/440V or 300/500V grade made to BS2004 or 6004 1975.

The PVC insulation of single core cables for conduit wiring shall have color scheme Red, Yellow and Blue for phases, Black for neutral and white for return wires as specified.

All single core cables shall be of Pakistan Cables Limited, Pioneer Cables Ltd., and AGE Industries Ltd.

3- Wiring Accessories

3.1- Switches & Socket Units:

Switch and socket units shall be 3-pin rated for 15 A or 13 amps, 230 V, 50 c/s a.c., as specified in the Bill of Quantities. These shall be moulded plate type with white plastic face plate and suitable for mounting recessed in wall or column with 2mm thick sheet steel back box of appropriate size. Each socket shall have its control switch by the side of it on a common face plate and thus the complete unit specified in the Bill of Quantities shall comprise a switch & a 3-Pin socket of the rating specified. The unit shall be the best quality locally available or imported as to be approved by the Project In-charge /Engineer. The switch and socket units of 'Clipsal' or equivalent will be acceptable.

The 5Amps or 10Amps SP lights control switch shall be flush mounting type having moulded white plastic face plate. The switch shall have silver tipped moving and fixed contact and shall operate with snap action. The light control switches shall be gang type i.e one, two, three or four switches grouped on one moulded plastic face plate. The Gang switches should be "Clipsal" make or approved equivalent.

4- Sheet Steel Outlet Boxes:

The outlet boxes and looping boxes shall be made of 16 SWG (1.63mm) sheet steel of the required size suitable for the number of wires to pass through. The back boxes for switches and sockets shall be suitable for the dimensions of switches and switch and socket units. All sheet steel boxes shall be provided with earth terminal at the base of the box for terminating protective earth conductor. The terminal shall consist of brass bolt 1/4" dia. The sheet steel boxes are required to be painted inside and outside with black enamel paint over two base coats of anti-rust lead oxide paint. The sheet steel boxes of Husain & Co. or approved equivalent.

4-1 Cable Tray:

The cable tray is required to carry power cables, Data / /Voice cables as required in office area. The under floor cable trunking shall be fabricated from galvanized steel plates 2.5 mm thick having partition wall of same material and open able cover. The Trunking shall be fabricated in 8 ft. sections and these sections shall be joined by means of extension pieces so as to have a continuous tray for laying cables. At every third joint expansion provision shall be made. The sheet steel cable trunking shall be supplied complete with transition pieces/ sections, bends etc. The cable trunking shall be as per details shown on drawing. The cable tray shall be fabricated by approved manufacturer.

5- L.T. CABLES

The L.T. cables shall be of voltage grade 600/1100, conforming to BSS 5467 and International Electrotechnical Commission Standards' publication 502-94 with latest revision.

The multi-core L.T. cables shall be circular, with shaped conductors, PVC insulated and PVC sheathed. The conductors shall be made of stranded, high conductivity electrolytic soft annealed copper wires, complying to BS6360. The PVC insulation on each conductor and the over sheath shall comply with British Standard Specifications BS 6346 for thickness and BS6746 for properties. It shall be flame retardant and shall meet the requirements of BS EN50265.

All multi-core cables shall have phase identification coloured on each insulated core. The colour scheme shall be red, yellow, and blue for phases and black or grey for neutral. The manufacturer's name and the BS or IEC standard must be embossed on the outer PVC sheath of the cable. Cables manufactured by Pakistan Cables, Pioneer Cables and AGE will be acceptable.

6- Earthing

6.1.1 The earthing system shall comply with IEE regulations and Pakistan Electricity Rules. Separate earth electrodes and loops shall be provide for the following:

- a- Switchboards bodies and all non current carrying metal bodies. The existing earthing to be used for body.
- b- Dedicated earth for computers and related equipment

6.2 The protective earth conductor shall be solid or stranded, high conductivity electrolytic 99.6 % and higher purity copper, PVC insulated only or solid hard drawn as specified and of sizes shown on the drawing. The minimum size of protective earth conductor (PEC) shall be 2.5sq.mm and for motor body or switchboard body its size shall be 10 sq. mm. minimum or as shown on drawings.

6.1 Earth Electrode:

The vertical copper rod with drive end and clamp forming earth electrode shall be 20 mm dia round copper rod 2 meters in length, to be supplied in sections of one meter, having corrosion resistant couplings. The rod electrode shall be complete with driving head, pointed conical driven end and copper clamp for fixing conductor. The copper rod shall be hardened to drive directly in ground by hammering. The rod electrode shall be as per detail shown on drawing. The copper tape for joining the rod electrode and for looping at connecting points shall be of electrolytic copper 25mmx 2mm in cross section.

The plate type earth electrode where specified shall consist of electrolytic copper plate of 3mm thickness minimum and it shall be provided with two terminals of copper bolts nuts and washers diagonally placed in the plate. The copper plate shall be tinned for protection and shall have rounded edges.

7- Distribution Boards:

The MDB switchboard shall be sheet steel fabricated, cubicle type, free standing, factory assembled, ready wired for 3-phase, 4 wire, 415V 50 Hz. system. The switchboard's body shall be fabricated from 2.5 mm thick sheet steel, and painted with enamel paint over primer coat. A continuous copper bus bar shall be provided as given rating shown on line diagram and earthing bus bars.

The main switchboard shall be complete with incoming and outgoing circuit breakers, current transformers, meters, indicating lamps, bus bars etc. as specified in the following paragraphs.

7.1 Circuit Breakers:

The incoming and outgoing circuit breakers shall be moulded case triple 415 volts 50 Hz., having current ratings and short circuit capacity shall be at Ics as noted on drawing. The circuit breakers shall be non draw-out type and shall have over current and short circuit protections. The moulded case circuit breakers shall be Schneider Terasaki, Legerand, Merlin Gerin makes or approved equivalent.

Bus Bars:

The bus bars shall be high conductivity 99 % electrolytic copper bars fixed in full length of the switchboard and supported on insulators of infinity insulation resistance and with sufficient strength.

Meters:

Analogue volt meter and C.T. operated ammeters shall be provided with ammeter and volt meter ranges as shown on drawing or bill of quantity panel type 3-phase or single phase KWH meter for balance and unbalance loads shall be provided.

7.2 Distribution Boards for Lighting & Small Power:

The distribution boards for lighting and power shall be totally enclosed, sheet steel (2mm thick) fabricated wall mounting type. Designation of the distribution boards shall be conspicuously printed in the front. The circuits protecting mcb shall be accessible only on opening of front door. Two earth terminals shall be provided on the body in addition to an earth bar for outgoing earth connections. The colour shall be light grey or as to be approved by the consultant/ client.

Incoming load break switch of the DB shall be 3 pole 500V a.c. 50Hz., having current rating as shown on drawing. The load break switch shall have spring loaded handle and ON & OFF positions shall be printed on positions of the LBS. The switch shall be Technoelectric Italy, Siemens Germany or approved equivalent. As an alternative of load break switch moulded case circuit breaker without thermal protections may be provided in competitive price.

The incoming and outgoing MCCB on sub-main DB or lighting and small power DB shall have the same specifications as given above for Main MDB

The miniature circuit breakers for switching and controlling of lights and power plugs circuits shall be single phase 250 V single phase moulded case having short circuit and over current protections. The short circuit capacity shall not be less than 10 KA at 240 V. These shall be Terasaki Japan and MG make.

The magnetic contactors shall be air-break 3-pole 415V having single phase or two phase coil. ON/OFF push switches and indicator lamps as also auxiliary contacts for remote operation shall be provided. The contactors shall be National Japan or approved equivalent

Meters shall be provided as shown on drawing. The incoming side shall be provided with voltmeter 0-500 V with selector switch and C.T. operated ammeter with range as indicated on drawing and with 7 position selector switch. The energy meter of single phase or three phase as indicated on drawing shall be 4-wire and for balanced and un-balanced loads.

8. Lighting Fixtures:

8.1.1 Down Lighters: The fixture shall be ceiling mounted or recessed in false ceiling. These shall be cylindrical type made of aluminum and polished reflector complete with LED, lamp holder etc. The fixture shall be Philips, Pierlite or Save Power. The type of fixture noted in the BOQ.

8.1.2 Fluorescent Light Fixtures:

The basic batten fluorescent light fixture shall have sheet steel body , 1x36W or 2x36W TLD fluorescent lamp complete with lamp holders, ballast, power factor improvement capacitor where required .The fixture shall be Philips type TMS 015/236 including all components, with cover shall be GMS complete with all respects.

8.1.3 Louvred fluorescent: The fixture shall be surface recessed type as specified having sheet steel body, luminance control lamella, and with 4 x 18 W fluorescent TLD lamps complete with ballasts, lamp holders starters, and capacitors. The fixture shall be Philips type or Pierlite type. The type of fixture noted in BOQ item.

8.1.4 Mirror Light Fixture: The fixture shall have sheet steel of pressure die-cast carbonate body, gasketed water proof acrylic diffuser cover , 1x18W TLD fluorescent lamp, choke, starter ,lamp holders etc. complete in all respects.

8.2.5 Sign Lights: The sign lights shall include EXIT, ENTRY, IN, OUT , RESERVED etc. Fixtures shall be self powered, steel back box, injection moulding high impact acrylic panel with back ground colours RD, GREEN as to be approved for given sign. The fixture shall be self powered with nickel cadmium battery and charger.

9. Data / Voice Systems:

9.1 General:

For a Data/Voice system in this project structure cables and conduits and outlets are to be laid serving different work station and offices as shown on the drawing. The Server equipments 42U racks, Patch panels, Patch cords, UTP etc. shall be provided.

9.2 Conduit:

For wiring of Data and Voice system shall be laid surface through cable trunking and partially surface in steel conduit and under floor where required as shown on drawings. All conduits for structural cabling shall be of the same specifications as given above in the case of electrical system.

9.4 Data/ Voice Outlets:

The Data / Voice outlet shall be RJ 45 pin type. The sheet steel outlet box shall be 3"x3"x2" deep where required. The Data/ Voice outlet shall be duplex having 2 Nos. RJ45 connectors on common plastic face plate British style shuttered type.

10- Fire Alarm System Equipment:

10.1 General:

The fire alarm system shall be addressable, electrically supervised fore warning system utilizing manual alarm initiating devices (Call Point), alarm bells (Sounders) and Fire Alarm Control Panel (FACP), optical smoke detectors, isolator modules, monitor modules etc. as specified etc. The F.A. system's equipment offered by Honeywell or Simplex or Gents or equivalent having good after sales service arrangement in Pakistan shall be acceptable. The system shall operate on 230V single phase or 400V three phase 50Hz a.c. power supply and built-in DC supply provided in the in the FACP offered by the manufacturer.

All equipment shall conform to British Standard Specifications BS 5839 and/or NFPA standards. The system shall be modern and extendable. The system shall consist of but not limited to the following:

1. A 2-loop Fire Alarm Control Panel (FACP) as shown on the line diagram.
2. Manual break glass type switches or call points loop connected.
3. Sounders, indoor and outdoor weather proof loop powered
4. Optical Smoke and heat combined detectors.

The contractor shall submit all details together with shop drawing of addressable fire alarm system with complete details of equipment and installation for approval before starting the work.

11. UPS Equipment:

1. The UPS should be a solid state single phase UPS system designed to provide regulated and conditioned sinusoidal power to both linear and non-linear type loads. The UPS shall provide uninterruptible power during all modes of operation. There should be no interruption of power to the critical load when the UPS transfers to and from battery operation.

2. The UPS and batteries should be fit into enclosure intended fit outdoor installation. It should be of modular construction for ease of servicing in the field.
3. The primary input power source to the UPS shall be utility power.

Components:

- i. The UPS and Batteries should be designed to fit into enclosure intended for outdoor installation.
- ii. The cabinet is made of steel and painted white with a customized coating system ensuring suitability for outdoor environments.
- iii. **Battery System:** Sealed maintenance free Batteries should be provided. The batteries should be fully wired and contained within either the UPS cabinet or a separate battery cabinet. Battery run time on 100% full load should be provided.
- iv. **Inverter:** The inverter shall convert power supply from the utility, when within specified limits or from the batteries, when with the battery manufactures specified limits to AC power. It should be a pulse width modulated type without need of a transformer.
- v. **Static Bypass Switch:** The unit shall contain a Static Bypass Switch as a standard feature. The normal operating mode of the SB switch is to connect the inverter to the critical load with the utility in a standby mode, in case of any converter/rectifier or inverter failure the SBS will transfer to the utility without interruption to the critical load.
- vi. **Charger:** The battery charger should maintain the batteries at full charge. The standard battery charger shall recharge the battery in 10 time the discharge time maximum.
- vii. **Power Connection:** The UPS should be hard wired input and output.

Monitoring system

- viii. The system status panel on UPS should have a 160 character liquid crystal back lit display. The LCD display shall display UPS operating information such as input voltage, input current, output voltage, output KW, etc. The LCD display should be located inside the cabinet.
- ix. The following parameters should be provided.
 - Lower Battery
 - On Bypass
 - Summary Alarm
 - Input Fail
 - UPS On

- x. Operating parameters, including input and output data and UPS status should be provided.

C- INSTALLATION INSTRUCTIONS:

01- Installation of conduits and pipes:

The steel conduit for electrical wiring above false ceiling shall be installed on the surface of wall column, CC ceiling etc. and should not be placed or fixed on false ceiling or its supports. The wiring from outlet box to the fixture shall be in flexible galvanized flexible steel conduit. No exposed wires shall be installed on false ceiling.

On surface installation the steel conduit shall be fixed on the surface of wall, column, beam, RCC ceiling etc. by means of steel clamps and steel or C.I. saddles. The thickness of sheet steel saddle shall not be less than 1/4" (6mm) and clamps shall be made of 16 SWG sheet steel. The saddles shall have two screwed holes for fixing the clamps by means of galvanized screws. The saddles shall also be fixed by means of nylon plugs and galvanized screws. Clamps and saddles shall be fixed at a maximum of 24" interval along the length of conduit and at each bend and near termination of conduit.

Male brass bushes shall be used at steel conduit terminations at sheet steel outlet boxes etc. At the termination of steel conduit whether in outlet box or as a stub-up for under floor connections to equipment proper threading must be done. The threads shall be 3/8" to 3/4" long as required and as directed at site.

The termination of conduits at or near the equipment, machine etc., is shown diagrammatically on drawings. The exact final location of the termination shall be coordinated with the equipment installed at site.

02- Installation of Cables & Wires :

Installation of cables and wires of all description and sizes the Contractor shall provide and install all installation material whether specified here or otherwise required. The BOQ item rates shall include all works such as transporting the cable to site, laying, installing, providing and fixing cable markers, cable identification tags, cable ties, mounting brackets, saddles, clamps, nuts bolts etc.

The power Cables on tray, over the false ceiling or on wall shall be installed on angle iron brackets. The brackets shall be installed by anchor bolts of 2-1/2" length and 1/4" dia. The brackets shall be installed at an interval of 2 to 3 feet and not more. The cable shall be installed on tray and fixed by cable ties, allowing acceptable sag of cable between two brackets. Each cable shall be provided with identification tag with circuit number printed or embossed. The PVC/PVC cables shall not be bent to a radius less than 10 times the over-all diameter of cable.

The cable shall be terminated at floor mounting or wall mounting switchboards by using appropriate size cable gland. Direct entry of cable in the switchboard shall not be allowed. The cable cores inside the switchboard shall be neatly fanned out and clamped. Appropriate type of cable lug must be used for connecting the cable core to the circuit breaker or switch terminal.

The wiring installation in conduits shall be carried out only after the conduit system is completely installed and all outlet boxes, junction boxes, looping boxes, switchboards and distribution boards are installed in place. All installations material such as lugs, solder, identification tags, pins, clips, straps, lubrication etc., shall be provided without any additional cost to the Owner.

The wires shall be pulled in conduit with care and to facilitate pulling, the cable manufacturer's recommended lubrication only shall be used for decreasing friction. Use of any kind of oil or soap will not be permitted. Where several wires are to occupy the same conduit, they shall be pulled together. The wires shall not be bent to a radius less than ten times the overall diameter of the wire.

The wiring shall be continuous between the terminations. The looping-in system shall be followed throughout. Any joint in wires will not be allowed. The use of connectors will be allowed only at locations where looping-in is rendered difficult. The consent of the Project in-charge/Engineer in writing will be required before installing any connector. The connector shall be of porcelain body or PVC moulded having sunk-in screw terminals and terminal strip. The connector shall be wrapped with PVC insulation tape after its installation.

The wires inside switchboard and distribution boards shall be fanned out in a neat arrangement and clamped separately using cable ties. The wires shall not be laced to conducting material unless 1/5th inch thick plate of insulating material is provided between wires and conducting material.

All wires shall be provided with ferrules with circuit numbers and the number of distribution board printed on it.

03- Installation of Lighting Fixtures:

All types of light fixtures as specified in the BOQ shall be supplied and installed by the Contractor at site. The fixtures shall be completely assembled and internally wired.

Fluorescent lights shall be fixed by steel rawl bolts at two points. All incandescent or down lighters shall be installed with back plate fixed at two point with nylon plugs of Fischer or approved equivalent.

The fixtures shall be connected by using PVC/PVC flexible wires not less than 1.5 sq.mm. size having 3 cores or 2-core with separate earth conductor. The metallic body of all types of fixtures shall be connected to earth protective conductor

04 Data/ Voice System Installation:

The Data/ Voice conduit installation shall be as per instructions given on the above for electrical conduit in these specifications. Data/ Voice conduit and cable trunking shall be laid not less than 6" away from the electrical conduit or power cable tray, and where ever electrical conduit and Data/ Voice conduit cross each other they shall do so at right angles only.

The Data / Voice outlets shall be installed in outlet box of steel of required size. The Server equipments 42U racks, Patch panels, Patch cords, UTP etc. shall be provided and installed by NSN.

05- CCTV System Installation:

All CCTV equipment shall be installed in accordance with manufacturer's instruction for installation. The locations of various units are shown on drawings which may be adjusted according to the site conditions and as to be finally approved by the consultants.

The contractor is required to prepare and submit to the Project In-charge for approval, detailed shop drawings for the entire system showing installation methods, wiring routes, all equipment locations etc. The installation work shall be started only after the approval of shop drawings obtained from the Project In-charge. Also to be supplied before commencement of installation are all catalogues and manuals of each and every equipment received from the manufacturer as printed catalogues or CD.

On completion of all works the contractor shall prepare and submit As-Built drawings and get these verified by the consultants after checking at site and finally submit three prints of approved As-Built drawings and one original tracing or CD.

06- F.A. System Installation:

The conduit installation for fire alarm system shall be carried out in accordance with the instruction given in these specifications for lighting and power wiring conduit. Steel conduit shall be used for all fire alarm wiring.

All wiring for the fire alarm system shall be with twisted pair shielded cables so that when addressable system is desired in future wiring need not be changed.

The Addressable Fire Alarm Equipment, fire alarm bells and detectors shall be supplied and installed and commissioned by the Contractor in accordance with these specifications and as to be advised by the F.A. equipment manufacturer.

07- Earthing Installation:

- 7.1 A complete earthing system as shown on drawing shall be installed by the Contractor. The system shall give earth resistance equal to or less than one ohm. The contractor shall supply all installation material, sockets, thimbles, saddles clamps, solder, nuts, washers, copper brazing, copper welding etc., without any additional cost. At all connections of PEC to body of switchboard, or any other metallic body, proper size copper or brass sockets, thimbles or lugs shall be used to which the copper wire shall be welded by copper brazing. Tin soldering of copper wire at joints or termination shall not be allowed. At main earth loop copper wires, all tee-off connections shall be by copper brazing. After brazing, the jointed surface shall be protected by oxide inhibiting compound of low electrical resistance. For connections to metallic body, the surface shall be thoroughly cleaned to the bright metal surface before bolting the lug or socket.
- 7.2 Each switchboard body, motor body and all such conducting but non-current carrying metal bodies shall be connected at least at two points by two independent earth wires tapped from the earth loop or from the earth bar.
- 7.3 Separate earthing system shall be provided for Computer sever with separate set of earth electrodes and loops as shown on drawing.

The protective earth conductor shall be installed along the length of cables as shown on drawing. These shall have separate clamps or cable ties. The clamps or cable ties should not be common for the cable and for earth conductor.

- 7.4 Plate Type Earth Electrode Installation: The earth electrode of plate type shall be installed as earth point. A pit of appropriate dimensions and down to the depth of 15'-0" feet shall be first excavated in the bare ground at location to be approved at site. The earth plate after bolting the earth leads at the terminals and pulled through a G.I. pipe of given diameter shall be lowered in the excavated pit up right and shall be surrounded with the mixture of charcoal and salt in the ratio of 3:1, one foot all around the plate and at the top. The remaining pit shall then be filled with earth in layers of one foot, tamping and consolidating layer by layer right up to the general ground level. At the ground level an inspection chamber of cement concrete shall be constructed as shown n drawing. The earth leads shall be taken to the connecting point in G.I. pipe without break from the earth plate to connecting point.
- 7.5 The rod type earth electrode shall be hammered down directly in the bare earth ground. The copper tape shall be installed at one meter depth measured from the general ground level and shall be fixed firmly at driving end's clamp from rod to rod and up to the connecting point.
- 7.6 Earth Connecting Point: The earth connecting point shall be installed at various places as per details shown on drawing. It shall consist of 2"x1/4" cross section copper flat 1'-0" long installed on wall by grouting with galvanized steel bolts. The terminals on the copper flat shall be of copper bolts, nuts and washers. The protective earth conductors shall be connected on earth connecting point by using copper lugs.

8- Installation of Main Switchboards:

The main switchboard and distribution boards shall be supplied and installed at site showing location of placement. All installation material such as bolts brackets, support, cable glands, copper lugs, insulation material etc., shall be supplied and installed by Contractor within item rates. All test results of the tests carried out shall be recorded and submitted to the Engineer for his review and approval before energizing. All tests shall be carried out in the presence of Engineer.

All Lighting & Power distribution boards shall be installed on the surface of wall or column at location shown on drawing. The mounting height shall be 4'-6" above finished floor level. The distribution boards shall be mounted directly on surface of wall or column using galvanized steel anchor bolts.

All incoming and outgoing cables shall be connected as directed at site. Appropriate sized cable glands of approved type shall be installed on each incoming and outgoing cables. No cables shall be brought-in directly to the circuit breaker of switchboard. Appropriate size cable lugs of copper and of required current rating shall be installed on each core of the cable. The lugs shall be bolted on the circuit breaker /switch terminals by copper bolts.

Distribution boards shall be installed on walls recessed or on surface as specified on drawing. The D.B. shall be installed recessed in wall for which a back-box shall be fixed in place and all conduit terminations fixed before plastering of wall. The D.B. shall be assembled and installed on the back-box and all cable and wiring terminations made. The earth connections shall be at the provided earth bar in the D.B and also on the box as mentioned above. The mounting height shall be 4'-6" above finished floor level.

D- TESTING

1- General:

Upon completion of the installation the Contractor shall perform field tests on all equipment, materials and systems. All tests shall be conducted in the presence of the Engineer for the purpose of demonstrating equipment or systems in compliance with specifications.

The Contractor shall furnish, install and maintain all tools, instruments, test equipment, materials, connections, etc., and furnish all personnel including supervision and “standby” labour required for the testing, setting and adjustment of all electrical facilities and their component parts, including putting the same into operation.

All testing shall be made with proper regard for the protection of the equipment, and the Contractor shall be responsible for adequate protection to all personnel during such tests.

The Contractor shall record all test values of tests made by him on all equipment, giving both “as found” and “as left” conditions. Three copies of all tests data shall be given to the Engineer for record purposes.

2- Insulation Tests

Insulation resistance tests shall be made on all electrical equipment, using a self-contained instrument such as the direct indicating ohm-meter of the generator type. Direct current potentials shall be used in three tests and shall be as follows:

Circuits under 220 volts	-	500 volt test
Circuits 220 V to 440 V	-	1000 volt test

The minimum acceptable insulation resistance value will be 5 megohm. The Contractor will furnish the test equipment for insulation testing.

Before making connections at the ends of each cable, run the insulation resistance measurement test of each cable shall be made. Each conductor of a multi-core cable shall be tested individually with each other conductor of the group and also with earth. If insulation resistance test readings are found to be less than the specified minimum in any conductor, the entire cable shall be replaced and the new cable shall be tested.

All switchgears shall be given an insulation resistance measurement test to ground after installation but before any wiring is connected. Insulation tests shall be made between open contacts of circuit breakers, switches and between each phase and earth.

If the insulation resistance of the circuit under test is less than specified above, the cause of low reading shall be determined and removed. Corrective measures shall include dry out procedure by means of heater if equipment is found to contain moisture. Where corrective measures have been necessary and the insulation resistance readings taken after the correction has been made, satisfy the requirements specify herein, repeat insulation resistance measurements shall be made twice and at least 12 hours apart. The maximum range for each reading on the average value. After all tests have been made, the equipment shall be reconnected.

3- Earth Resistance Test

Earth resistance tests shall be made by the Contractor on the earthing system, separating and reconnecting each earth connection as may be required by the Engineer. If it is indicated that soil treatment or other corrective measures are required to lower the ground resistance values, the Engineer will determine the extent of such corrective measures.

The electrical resistance of the ECC, together with the resistance of the earthing lead measured from the connection with earth electrode to any other position in the completed installation, shall not exceed one ohm.

Earth resistance test shall be performed as per Electrical Inspector's requirements. Where more earthing sets than one are installed, the earth resistance test between two sets shall be measured by means of Resistance Bridge Instrument. The earth resistance between two sets shall not exceed one ohm.

4- Switchgear

In addition to the insulation resistance test on the switchgear, polarity or phase rotation test shall also be made.

Each air circuit breaker shall be operated mechanically, ascertaining that handle mechanisms are operating. All interlock control circuits shall be checked out for proper connections in accordance with the wiring diagrams given by the manufacturers.

The Contractor shall identify the phases of all switchgears and power cables by stencilling the switchgear and tagging the cables so that the phases can be identified for connections to give phase sequence.

5- Operating Tests

Current load measurement shall be made on equipment and all feeders. The current reading shall be taken in each phases wire while the circuit or equipment is operating under actual load conditions. Clip-on ammeters may be used to take current readings.

Completed Test

After any equipment has been tested, checked for operation etc., and is accepted by the Engineer, the Contractor shall be responsible for the proper protection of such equipment for assurance that subsequent testing of other equipment or systems does not disturb the completed work.

Systems Testing:

All systems specified in these documents such as telephone system. Fire alarm system, CCTV system shall be tested as per manufacturer's recommendations. The contractor shall submit tests pro-forma to the Architect before commencing field tests for approval and for timing to be fixed for each test.

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