

SPECIFICATIONS FOR ELECTRICAL WORKS

1.1 CONDUIT PIPES & CONDUIT ACCESSORIES

1.1.1 Conduit Pipe

The conduit for wiring of lights, socket outlets and other systems shall be made of PVC manufactured under the trade names conforming to BSS 3505/1968 Class-0.

The conduit shall have following wall thickness and standard weights: -

Pipe Size	Wt/100Rft.	Wall thickness
¾" dia	3.4 Kg.	.04" to .05"
1" dia	4.5 Kg.	.045" to .055"

Steel conduit shall conform to BSS 31/latest and shall be of brands. The conduit shall be enameled with good quality non-cracking and non-flaking black paint.

1.1.2. Flexible Pipe

Flexible conduit shall be furnished and installed where necessary for convenient dismantling and/or avoiding vibrations to be transmitted. Flexible conduit shall be spiral-interlocked type made of steel strip construction and coated with zinc.

1.1.3 Conduit Accessories

1.1.3.1. The use of factory made round PVC junction boxes 2-¼" dia and 2-¼" long, conforming to BSS 31/latest having nipples to receive PVC pipe with force fit shall be used for ceiling outlets. The wall type junction box shall also be of cast iron having minimum dimensions of 2-¼" dia and 1-¼" long. Each junction box shall be provided with one-piece cover, which shall be fitted on the box with chromium plated screws.

1.1.3.2 Conduit accessories such as switch boxes, socket outlet boxes, pull boxes and inspection boxes shall be made of 16 SWG sheet having dust tight covers. All boxes shall have required number of conduit entry holes and earth terminals for connecting E.C.C. All the rectangular or square shaped boxes shall have nipples to receive PVC conduit with force fit. All these boxes shall be painted inside and outside with black enamel, over a base coat of red oxide antirust paint. Shapes and sizes of these boxes shall be determined on each application.

1.1.3.3. The use of lopping in box shall be allowed in places where floor slab thickness permits 90-degree bends in conduit.

1.1.4. INSTALLATION INSTRUCTIONS

The contractors shall furnish all labour and material for the installation of conduit as required.

1.1.4.1. Conduit shall be installed concealed in RCC ceiling slabs, columns, walls and floors etc. recessed conduit shall be laid over the first tier of reinforcement and under the second tier of reinforcement before pouring of concrete. All conduit outlet boxes to be concealed shall be laid firmly flush with the soft of the slab or beam. The conduit should be tied to the reinforcement firmly so that the alignment is not disturbed by vibrators. All the outlet boxes installed shall be stuffed and their cover plates fixed so as to prevent concrete entering the outlet boxes. Do not make any chases in RCC structure for concealing conduit work.

1.1.4.2. The drawings do not show conduit routes and all the planning for the Contractor to the satisfaction of the Engineer shall carry out arranging conduit routes.

1.1.4.3. Adequate expansion joints shall be provided in all conduit runs passing across the expansion joints in the concrete slabs of the buildings.

1.1.4.4. Pull boxes shall be installed in conduit runs at intervals mentioned below to facilitate the pulling length of wires: -

i)	Straight runs	-	20 meters
ii)	Runs with one 90 Degree bends	-	15 meters
	Runs with two 90 Degree bends	-	10 meters

The minimum length of inspection/pull boxes should be four times the cable manufacturer's recommended bending radius of the cable.

1.1.4.5. The conduit shall be terminated at pull boxes distribution boards and switchboards in an approved manner to the satisfaction of the Engineer without any additional cost to the Owner.

1.1.4.6. All conduits of a system shall be run at least 6" away from the other systems one of the other systems and services where conduit one of system crosses the other it shall do so at right angle i.e. 90 degree.

1.1.4.7. No conduit less than 20mm dia shall be used for point wiring and 25mm dia for circuit wiring. The size of conduit shall however be determined from the number of wires required in the conduit run according to number of wires allowed as per IEE Regulations.

1.1.5 MEASUREMENT

1.1.5.1. All conduit Work including all accessories shall be measured on the basis of actual numbers of light points, fan points, call bell points and/or 5A or 15A socket outlet points installed as shown on the drawings. Conduit required for circuit wiring shall be deemed to have been included in the point wiring.

1.1.5.2. For other systems the conduit Work shall be on actual measurement basis on the running length installed in feet or meters as the case may be.

1.1.5.3. Make:

PVC Conduit & Accessories

Pakistan PVC (Sharyl)
GALCO

1.2 WIRES, CABLES AND CORDS**1.2.1 Wires & Cords**

The wires & cords for conduit wiring shall be single core, made of stranded copper conductors, PVC insulated, tested to BS 6004, 1975. The voltage grade shall be 300/500 volts or 450/750 V unless otherwise specified on drawings and Bill of Quantities. The size of the wire shall be as follows: -

For light or fan point wiring with 1.5 mm square (or 3/. 029) or as specified in the BOQ.

For light circuit wiring with 2.5 mm square (or 7/. 029) or as specified in the BOQ.

For power plug 15A wiring with 4 mm square (or 7/. 036) or as specified in the BOQ.

For Main to Sub Main wiring 7/. 004 (6 mm square), 7/. 064 (16 mm square), 19/. 044 (25 mm square) or as specified in the BOQ.

1.2.2 INSTALLATION INSTRUCTIONS

1.2.2.1 The wiring of the installation shall be strictly in accordance with the scheme, cable sizes and circuit details as shown on drawings.

1.2.2.2 All wiring shall be continuous between terminations and use of connector or joints is not allowed. Spur and Tee connections are strictly prohibited. Looping in system shall be followed throughout.

1.2.2.3 Not more than three circuits' wire shall be bunched in the same conduit. Wires of two different phases, however, shall not be run or terminated in the same outlet box for single phase wiring of lights, switches and sockets.

1.2.2.4 Porcelain or molded plastic connectors shall be provided for a joint between light point wiring and light fixture wiring and housed in the outlet box provided for this purpose. The connector after terminations are made shall be wrapped in PVC insulation tape.

1.2.2.5 The quantity and the size of the wire contained in any one conduit shall not be in excess of the numbers permitted by I.E.E. regulations.

1.2.2.6 All points and circuits wiring shall be solidly earthed by 14 SWG (2.5 mm square) insulated wire to serve as E.C.C., which shall be run inside the conduit.

1.2.2.7 All 5A & 15A sockets shall be wired separately and distinctly from light point wiring.

1.2.2.8 Make:

Pakistan Cable, Pioneer Cable, ASE Cables.

1.3 POINT WIRING, CIRCUIT WIRING AND SOCKET OUTLET WIRING:**1.3.1 General**

The Work included under this Section consists of furnishing all labour, material, services and skilled supervision necessary for the construction, erection, installation and connection of all circuits and equipment specified herein or shown on the drawings.

1.3.2 MEASUREMENT**1.3.2.1 Point Wiring**

For the purpose of measurement of light/fan point wiring the following Work shall be deemed to constitute the Work point wiring: -

Providing and fixing conduit from a switch to wall/ceiling outlet of fan/fixture including final Sub-circuit conduit from distribution board to the switch as described in Section 1.1.

Providing and pulling of wires from switch to fan/fixture outlet including providing and pulling of final Sub-circuit wiring in the conduit laid as in (a) above and as described in Section 1.2.

1.3.2.2 Socket Outlet Wiring

For 5A sockets on the light switchboard and also away from the board the basis of the measurement.

For 15A/20A sockets outlets the Work shall comprise as under: -

Providing and fixing conduit from distribution board to the socket outlet as described in Section 1.1.

Providing and pulling of wires in the conduit (a) above described in Section 1.2.

1.3.2.3 Call Bell Point Wiring

This shall be identical to Section 1.4.1. i.e. wiring for light points.

1.4 FANS

- 1.4.1 All fans shall be capacitor type Deluxe models and suitable for operation on 200/220 volts, 50 Hz. AC Supply. All ceiling fans shall be from the same manufacturer.

1.4.1.1 Fan Dimmer

The electronic fan dimmer shall be recessed type.

1.4.1.2 Fan Hook

The fan hook shall be made of 5/8" (15.85 mm) dia mild steel rod bent to shape of approved design. It should be in the form of a loop about 3-1/4" (87.5 mm) long and about 2" (50 mm) wide. The rod shall be bent to have at least 8" (200 mm) extension on both sides for tying it to the reinforcement steel of the slab.

1.4.2 INSTALLATION INSTRUCTIONS

- 1.4.2.1 All fans shall be installed at a height of 10 feet from the finished floor level.

1.4.2.2 The installation of fan shall include fixing of down rod, clamp, fan blades, fan regulator and extension of wiring through down rod from ceiling rose to the fan terminals, testing and commissioning.

1.4.3 EXHAUST FANS

The exhaust fans will have dynamically blade wheel at specified operating speed. The motor shall be split phase capacitor type with low starting torque and the bearing shall be permanently lubricated sleeve type. A strong and suitable finished fixing frame shall be provided with protecting guard on motor and discharge side with gravity operated heavy duty balanced shutters etc.

1.4.4 MEASUREMENT

For the purpose of measurement this item shall be as actual number of fans of various sizes installed.

1.5 LIGHT FIXTURE (INTERNAL)**1.5.1 General**

All light fixtures shall be furnished in standard color schemes as mentioned in the manufacturer's catalogue for respective fixtures, unless specifically stated in the specifications, drawings or bill of quantities or directed by the Engineer.

The wiring between ceiling rose and fixture shall be with three core 0.75 Sq.mm and 1 Sq.mm. flexible cable, PVC insulated, PVC sheathed cable respectively for circuits protected by 10 Amps and 15/20 Amps. MCB's.

1.5.2 INCANDESCENT LIGHT FIXTURES

Surface mounted fixtures shall have white stove enameled sheet steel body. It may also be stain brass or aluminum anodized finish as required. The fixing holes shall match the outlet box. Wall bracket light fixtures shall have back plates with matching holes of the outlet box and decorative finish as required.

All light fixtures shall have bi-pin/screw lamp holders and Philips GLS/SL lamps; to BSS 161/latest clear or frosted and having a minimum useful life of 1000 hours.

1.5.3 FLUORESCENT LIGHT FIXTURES

All the light fixtures shall have lamps and efficient ballasts of the wattage specified. The fluorescent lamp shall be either 2 ft-18 watts or 4 ft-36 watts and the colour shall generally be daylight. The fluorescent lamps shall be Philips to BSS 1853 but having a minimum useful life of 5000 hours. The new generation of 26mm dia 18 watts and 36 watts energy efficient lamps shall be preferred.

All lights fixtures shall be provided with power factor improvement capacitors. The following capacitor combinations shall be used/wired on 'du' circuits. For 2x36 watts fixture 3.7 mfd capacitor 380 volts. Other combinations on single circuit shall be as under: -

For 1x36 watts fixture 4.5 mfd capacitor 250V.

For 2x36 watts fixture 4.5 mfd capacitor 250V.

For 1x18 watts fixture 3.7 mfd capacitor 250V.

The lamp holder shall be lock-in rotary type.

The starters shall have radio-interference suppressors.

Pendent type of fixtures shall have 2 Nos. ½" dia chromium plated pendent tubes for suspension or as per detail shown on drawings.

1.5.4 INSTALLATION INSTRUCTIONS

The light fitting shall be installed according to manufacturer recommendations or as approved by the Engineer.

The Contractor shall provide flexible connecting wires from outlet box to the fixture. Connector made of porcelain or thermoplastic material shall be provided and installed in the outlet boxes for connecting flexible wires to the point wires.

Outlet boxes or any openings in the ceilings are walls shall be covered with appropriately fabricated accessories to provide and architectural entity to conceal them.

Get approval of suspension / hanging rods prior to its manufacture for installation of light fixtures where shown on drawings.

1.5.5 MEASUREMENT

Actual numbers of units installed shall be taken as the basis for measurement.

1.5.6 Make:

Clifsal, Phillips, Global Lighting.

1.6 POWER CABLES**1.6.1 General**

Power cables conforming to these Specifications, described in the B.O.Q and as shown on drawings shall be supplied, tested and installed.

1.6.2 H.T. CABLES (11 kV POWER CABLES)

1.6.2.1 All XLPE cables shall be manufactured to I.E.C standard 502 or BSS-5467.

1.6.2.2 Galvanized Steel Wire Armouring is provided underneath an overall PVC sheath.

1.6.2.3 11 kV XLPE cables shall be manufactured by M/s. Pakistan Cables Limited or Pioneer Cables Ltd.

1.7 L.T. CABLES

- 1.7.1 The Low Tension (L.T.) cables shall be manufactured to the requirements of B.S. 2004, B.S. 6004, B.S. 3346, B.S. 6346 latest or VDE 0271 and Rated at 250/400 and 600/1000 volts as the case may be.
- 1.7.2 The conductors shall be annealed copper conductors, single or stranded, circular or shaped as the case may be, to B.S.S. 6360/69.
- 1.7.3 The conductors specified for use in the cables shall be of at least 98% IASC conductivity.
- 1.7.4 The reference temperature for the purpose of determining the standard resistance of the conductors shall be 20 degree centigrade.
- 1.7.5 The conductors shall be insulated with poly-vinyl-chloride insulation. The minimum thickness of the insulation shall be in conformity with the Specifications to which it is manufactured.
- 1.7.6 On all multi-core cables proper markings for core identification shall be provided to B.S. Specifications.
- 1.7.7 Power cables shall be multi-core cables, insulated and sheathed, armoured or unarmoured as required.
- 1.7.8 Various conductors forming the cables shall be laid together and voids shall be filled with soft plastic or fibrous materials so as to give a circular shape to the cable.
- 1.7.9 Although PVC shall be extruded over the cable so as to cover the insulated conductors and fillers.
- 1.7.10 Where armoring is required, a soft PVC jacket shall be provided over the laid up cable. Steel wire armoring shall be applied on a tough PVC sheathed extruded over the cable so as to cover the insulated conductors, fillers, jacket and armoring.
- 1.7.11 Complete identifications of the cable together with Owner's identifications markings if required shall be embossed on the final over sheath of the cable at every meter length.

1.7.12 CABLES TERMINATIONS

All PVC power cables shall be terminated with suitable tinned brass cable glands for securing the armour wires and incorporating a packing ring for exclusion of water and moisture. The cables shall be secured at required spacing by means of cleats fixed to walls or roofs or hangers and where multiple runs occur perforated metal tray made of heavy gauge galvanized steel shall be used.

1.7.13 CABLE MARKERS

For underground installation cable position markers shall be sited in the ground where cables change direction and at 30 meters intervals along straight runs of the cables. Markers shall also be provided to locate the position of joints. Cable markers shall be made of cast iron. Any one to the following words shall be embossed/engraved for the identification of cable routes.

11000 V	cable
440 V	cable
11000 V	cable joint
440 V	cable joint

The markers shall comprise of a cast iron circular disc of 115mm dia and 10 mm thick to which angle iron 25x3 mm bar 710 mm long shall be riveted at one end. The end of the bar shall be fork-opened upto a length of 75 mm. This end shall be embedded in a cement concrete block of ratio 1: 3:6 to a length, of 180 mm. The concrete block shall have a shape of truncated pyramid with base dimensions of 305x305 mm and top dimensions of 152x152 mm and a vertical height of 200 mm. the cable marker shall be buried in the ground such that its total height above ground level is 267 mm.

1.7.14 CABLES JOINTS

Generally cable joints are not allowed. The Contractor shall be in possession of a cable jointing kit and a bonafide and experienced cable jointer shall make all termination. All cable termination boxes kits and glands shall be of recognized makes and complete with claw clamps, ferrules, lugs, tapes, solders and jointing compounds.

1.7.15 INSTALLATION INSTRUCTIONS

The Contractor shall be under obligations to provide all labour, material and accessories for the installation of cables shown on drawings and listed in the BOQ conforming to the Specifications in this section.

- 1.7.16 For underground cable installation the depth of digging the trench shall be such that the top surface of the cable shall not be less than 900 mm and more than 1100 mm from the finished ground level.
- 1.7.17 Cable routes indicated on the drawings shall be followed unless otherwise specified or agreed to by the Engineer. Where change in direction of the cable is necessitated, the bending radius of the cable shall not be less than the diameter of the cable drum or 12 times the diameter of the cable which ever is greater.
- 1.7.18 At all road crossings the cables shall pass through 100/150 mm dia PVC pipes shrouded in cast concrete, the mouths of which shall be sealed with cable bitumen compound of approved quality after drawing the cable. The road cuts shall be first filled with mud and 50 mm size ballast upto 182 mm level below the road surface and after ramming it properly 150 mm thick layer of cement concrete 1:3:6 shall be laid over it.
- 1.7.19 The cushion of sand to be provided in the trench before laying the cable shall not be less than 75 mm and after laying the cable 150 mm. the total depth of cushion of sand shall be not less than 225 mm. over the final layer of sand, cable marking tiles/bricks or concrete masonry blocks of adequate strength 2" thick and 300mmx200mm in size. The rest of the trench shall be back filled with earth in 150 mm layers and rammed properly before dressing.
- 1.7.20 All trenches and holes dug for laying the cables shall not be left open and unprotected for any length of time without completing the job and back filling. Where trenches are left open due to some un-avoidable reasons the Contractor shall exhibit suitable danger signals such as banners, red flags and red lamps etc.
- 1.7.21 All cables shall always be lead out or lead into the ground through 2.5-meter long G.I. pipe of 75 mm length of the pipe in the ground shall be 600 mm. The pipe should be attached to the poles with approved clamps.
- 1.7.22 Markers of approved design and inscription shall be installed as specified.

1.7.23 MEASUREMENT

For the purpose of measurement this item shall be treated as actual lengths of cables installed in meters at site.

1.7.24 Make:

Pakistan Cable, Pioneer Cable, AGE,
Cable Accessories: 3M

1.8 MAIN L.T. SWITCHBOARD**1.8.1 General**

The L.T. switchboard shall be indoor type, free standing, free supporting, floor mounted, totally enclosed, sheet steel clad, dust and vermin proof, completely wired, factory assembled and suitable for operation on 3 phase 4 wire system, 415 V, 50 Hz, AC supply. The switchboard shall be designed to suit service conditions and ensure security and safety during operation, inspection, operation, cleaning and maintenance. The switchboard shall be designed and tested to IEC recommendations. Each panel shall withstand strain of 2000 volts insulation level for one minute power frequency test.

1.8.2 AIR CIRCUIT BREAKERS

1.8.2.1 The Air Circuit breaker shall be triple pole of specified rating, fixed type, trip free, spring charged, quick make, quick break manually operated mechanism and visual ON/OFF position indicator. The circuit breaker shall be suitable for continuous duty for the rated current for indefinite period of time under service conditions. The circuit breaker shall have 50/65 KA (or as specified) breaking capacity and shall be capable of the following make/break operations:

Electrical	–	500 cycles
Mechanical	–	8000 cycles

The A.C.B. shall conform to BS 4752/1977. The contacts of the A.C.B shall be heavy duty, spring charged and silver-plated. Replaceable arcing contacts and chutes shall be provided. The operating handles if made of metal shall be either earthed or additionally insulated to withstand full insulation voltage. A certified copy of full type tests carried to by an independent agency on identical breakers shall be acceptable in lieu of the following type and routine tests: -

Making capacity, breaking capacity and short time current tests.

Mechanical and Electrical life endurance tests.

Temperature rise test.

Power frequency with stand test.

Milli volt drop test.

1.8.2.2 The relays shall have three elements, two for the over current and one for the earth fault: These shall be inverse over-current definite minimum time induction type with inverse characteristics. The relays shall be AC operated and provided with time and current setting adjustment of suitable range.

1.8.2.3 Three single pole resin filled current transformers, 15VA burden, suitable for metering and manufactured and tested to IEC publication 185 shall be provided. The standard accuracy class shall be 0.5%. The rated short time thermal current rating and the rated dynamic peak current rating shall be according to IEC recommendations.

C.T.'s conforming to B.S. 3938/1973 are also acceptable.

1.8.2.4 The following instruments shall be provided unless otherwise specified:-

KWH meter

Voltage 0-500 volts.

Voltmeter phase selector switch.

Ammeter commensurate with rating of ACB.

Ammeter phase selector switch.

All the instruments shall be flush mounted and back connected in a transparent dust proof cover with 144x 144mm (6"x6") dial which shall have prominent black graduations on white surface. The instruments shall be manufactured and tested in accordance with IEC Publications 51 or B.S. 89 Part 1/1970.

1.8.3 MOULDED CASE CIRCUIT BREAKERS

The Moulded Case Circuit Breakers shall be triple pole and of the rating specified in the schedule of quantities and/or shown on drawings. The M.C.C.B shall be of fixed type, having trip free, manually operated mechanism and ON/OFF/Trip position indicators. The MCCBS shall comprise of adjustable hydraulic magnetic releases for overload protection and instantaneous adjustable protection. The tripping devices shall have related time current characteristics so that positive discrimination and selective tripping is obtained assuring the tripping under fault ahead of the fault location. The MCCB shall have a rupturing capacity of 35 KA (or as specified) and shall be and manufactured tested to IEC publication 157-1 Part 1 or BS 4752/1977 or BSS 3871 parts I & II. The MCCBS manufactured by Terasaki and Merlin Gerin or approved equivalent.

1.8.4 LOAD BREAK SWITCHES

The load break switches shall be on load type having quick make and quick break mechanism with spring-loaded handles and ON/OFF visual indications. The load break switches shall be designed for continuous operation on rated current, rated voltage and rated frequency to BSS 861 (Part-2)/1972.

1.8.5 HRC FUSES

The HRC fuses shall be manufactured and tested to BSS 88/1967 (Part-1) for category of duty AC 33 (or as Specified). A supplement of 100% spare fuses of each size shall be supplied with the switchboard.

1.8.6 BUS BARS AND CONNECTIONS

A set of four bus bars, three for phases and one for neutral, made of copper having 98% IASC conductivity shall be provided. The bus bars in panels and chambers shall be tin plated, Air insulated having minimum clearance of 50mm between phase to phase and 25 mm between phase to earth. The neutral bar shall be of the same section. All the bus bars shall be mounted on insulators at suitable intervals and should be extensible on both ends. The marking and arrangement of bus bars, main connections and small wiring shall conform to BS 158/1961. Bus bars and bus bar connections shall conform to BS 159/1957.

1.8.7 ENCLOSURES

The enclosures shall be fabricated from 3mm thick high-grade sheet steel and shall be designed to house all the live parts that shall be accessible through front doors. The enclosure shall be tropical in design completely dust and vermin proof and liquid repellent, with special regard to danger of flashover both in service and in isolated position. Hinged lockable doors shall be provided on the front and bolted plates at the rear. Adequate air circulation by means of vent covered with suitable metal gauze shall be provided in the enclosures. All exterior and interior surfaces of the enclosure shall be thoroughly cleaned and freed of dust, rust and greasy matter. The enclosures shall be given three coats of paint. The primer shall be Zinc Chromate and/or iron oxide. The second and third coats shall be top quality battleship grey enamel. Enclosure for each panel shall be provided with designation labels.

1.8.8 EARTHING

The switchboard shall be effectively earthed by means of a Copper strip of 25 mm x 3mm (1"x1/8") cross-section bolted to connections near the bottom of the switchboard.

1.8.9 ACCESSORIES

Designation labels, lifting lugs, foundation bolts, interconnecting nuts bolts, and washers, thimbles, lugs, leveling shims cable glands and/or cable end boxes for all the sizes of incoming and outgoing cable shall be supplied with the switchboard.

1.8.10 TESTING

The following tests shall be conducted on each completed switchboard:-

Type Test

Temperature rise test.
Mechanical endurance test.
Making/Breaking Capacity test.

Routine Test

High Voltage test.

The switchboard shall be tested to British/Electricity Council Standard 41-5 and manufactured by M/s. Siemens (Pakistan), Libra or approved equivalent. Preference shall however, be given to switchboards fabricated from all components manufactured by only one manufacturer.

1.8.11 INSTALLATION INSTRUCTIONS

The Contractor shall provide all labour, equipment, tools and plant required to complete the installation. The switchboard shall be fixed firmly on the floor in perfect line, plumb and level position. All incoming and outgoing cable connections shall be made including Earth connections.

1.8.12 MEASUREMENT

For the purpose of measurement each L.T. switchboard shall be treated as a lumpsum job.

1.9 SUBMAIN BOARDS

The Sub-main boards shall be similar to the Main L.T. Board and the Components in its fabrication may differ and shall comprise of the components as shown on drawings and as described or listed in the schedule of quantities. The rupturing capacity of the each component for Sub Main Boards shall be as under: -

- | | | | |
|----|---|---|-------|
| 1) | Air circuit breakers
(or as specified) | - | 35KA |
| 2) | Moulded case circuit breaker | - | 25KA |
| 3) | Load break switches | - | 25KA |
| 4) | HRC fuses category | - | AC 33 |

All other details and Specifications as in Section 1.8 shall be applicable to this section.

1.9.1 MEASUREMENT

For the purpose of measurement each Sub-Main Board shall be treated as a lump sum job.

1.10 DISTRIBUTION BOARDS**1.10.1 General**

The distribution boards shall be free standing, cubicle type or wall mounting type suitable for surface and/or recessed mounting. Each distribution board (d.b.) shall be tropical in design, fully dust and vermin proof and liquid repellent. The cabinet housing the main components shall be fabricated from mild steel sheets 16 SWG thick and reinforced with structural steel members welded to it. Front access, mechanically locked and hinged doors, fully gasketed, having one or two leaves depending upon the size of the cabinet shall be provided on each Cabinet. A load distribution chart shall be provided in each DB showing areas fed by each circuit and a suitably sized pocket inside the front door shall be provided for the purpose. Each db shall be delivered complete with all instrument accessories, rating plates and designations.

Suitable cable entry glands shall be provided as required for floor mounted boards on the incoming cables but for outgoing cables and/or wall mounted boards exact number of conduit entry holes as are required shall be provided with male brass bushes. The bushes shall be tin plated and fully shrouded or housed in gasketed compartments.

1.10.2 COMPONENTS

The Main components e.g. Moulded case circuit breakers, load break switches, HRC fuses and instruments that are required for db's as shown on drawings and as described in schedule of quantities. However miniature circuit breakers (MCB's) used in db's are briefly described hereunder: -

1.10.3 MCB's

The incoming shall have triple pole mcb's suitable for use on 415V 50 Hz, AC and the outgoing mcb's shall be single pole or single phase for use on 220V, 50Hz, AC. The ratings are as shown in drawings and/or describe in the Schedule of Quantities.

The mcb's shall be manufactured and tested to BSS 3871/1966, and shall have a rupturing capacity of 7.5 KA. The final circuit mcb, on the outgoing, shall however be rated 5KA. The mcb's manufactured by Terasaki or approved equivalent are acceptable. The Distribution Boards shall be manufactured by intellectual manufacturer.

1.10.4 INSTALLATION INSTRUCTIONS

The Contractor shall provide all labour, equipment, tools, plant and accessories required to complete the installation shall be provided by the Contractor. The distribution board shall be fixed required in perfect line and plumb. All incoming and outgoing cables shall be terminated properly. All earth terminations shall be made on the neutral block.

1.10.5 TESTING

All db's shall be tested at manufacturer's Works and the Engineer without incurring any additional expense to the Owner shall witness tests.

1.10.6 MEASUREMENT

Each distribution board for the purpose of measurement shall be treated as a lumpsum job.

1.10.7 Make:

Terasaki, ABB, Siemens, Legrant.

1.11 EARTHING**1.11.1 General**

The Contractor shall be under obligation to supply all material and labour for the completion of the Earthing System as shown on drawings, listed in the Schedule/Bill of Quantities and conforming to Specifications laid down hereinafter. The completed installation shall, in general, conform to British Code of Practice CP 1013/1965 and regulations of Pakistan Electricity Act.

1.11.2 EARTH CONTINUITY CONDUCTOR

The earth continuity conductors and earthing leads shall be solid hard drawn, insulated electrolytic copper wires of sizes given on the drawings and Bill of Quantities. All fixing accessories such as saddles, copper bolts, nuts, and washers shall be provided. The size of conductor above 19/083 shall be of 1-1/8" flat copper strip or as specified.

1.11.3 EARTH POINT

The earth point shall comprise a 600x600x5mm (2'x2'x1/4") thick electrolytic copper plate, tinned for protection against corrosion. The edges of the copper plate shall be chamfered. The plate shall have two holes for connecting each earthing lead or tape to earth terminals. The terminals shall comprise of 5/8" dia copper bolts and nuts and double spring washers. 1/2" dia G.I. pipe with a tee at the top end shall be provided for watering purpose during dry seasons.

1.11.4 EARTH CONNECTING POINT

The earth connecting point in switch room or Sub-station shall comprise 300 mm x 50 mm x 5 mm (1'x2'x1/4") electrolytic copper bar having as many terminals of 3/8" dia copper bolts, nuts, and washers as are required. The earth bar shall be fixed on bus bar insulators of appropriate size. The fixing bolts shall be galvanized and provided for fixing the bar on the wall. The bar shall be tinned for protection against corrosion. Copper tapes from various equipment and earth point shall be terminated on this bar.

1.11.5 EARTH ELECTRODE

For the earthing of poles or any device or equipment rated less than 15 kW, earth assembly as shown on the drawing shall be installed.

1.11.6 MANHOLE

Cast concrete inspection manhole covers shall be provided on each earth point, as shown on drawings.

1.11.7 INSTALLATION INSTRUCTIONS

1.11.7.1 The earth continuity conductor (ECC) shall be run, inside, all along the installation. The ECC shall be insulated as specified elsewhere.

1.11.7.2 The E.C.C or copper strip shall be laid all along the length of perforated metal tray or walls of masonry ducts, fixed at 3' intervals. At terminations the ECC or tape shall be bolted firmly to the equipment as per standard practice. Copper tape at straight through joints shall be brazed or cad welded. Joints between stranded ECC shall be avoided or cad welded.

1.11.7.3 Earth plate shall be buried upright 1' below the natural Sub-soil water level but not less than 20 ft. below the ground level. A mixture of salt and charcoal shall be laid and packet upto 12" all around the plate. 1/2" dia G.I. pipe with a Tee at the top shall be provided for watering arrangement during dry seasons and/or where no Sub soil water is available.

1.11.7.4 The earth lead shall be laid 18"/24" below the natural ground level. Sleeves of 50 mm dia PVC pipe may be provided where ECC is laid across slabs, walls and/or foundations.

1.11.8 MEASUREMENT

1.11.8.1 Each earth point and earth manhole shall be treated as lumpsum job for the purpose of measurement.

1.11.8.2 ECC or tape, for the same purpose shall be measured as actual length installed.

1.11.8.3 For ECC in conduit wiring no separate measurement shall be taken and it shall be deemed to have been included in the rates of cable.

1.12 LIGHT FIXTURES (EXTERNAL)**1.12.1 General**

The lighting fixture types are given on the drawing, and each type is specified in detail in the Bill of Quantities. In all cases a definite manufacturer's type and catalogue number is specified to illustrate the type of fixture required.

- 1.12.2 Lighting fixtures for High-pressure mercury vapor lamps or given on the drawings or mentioned in BOQ shall be manufactured to conform to the requirements of BS 1788/latest and shall also comply with British Standard Code of Practice BS 5489 (formerly CP 1004).
- 1.12.3 The light fixtures body shall be shaped out of pressed or cast aluminum or aluminum alloy. The prismatic glass reflector shall be of vacuum-formed type for diffusing lights. The material used in the manufacture of bowl shall be either stabilized transparent polycarbonate, clear acrylic or heat resistant glass.
- 1.12.4 All fixings and clips shall be of stainless steel to provide a firm and corrosion free attachment.
- 1.12.5 The fitting shall be suitably wired at the factory with appropriate length of copper cables having heat resistant insulation capable of withstanding maximum temperature up to 350 degree centigrade. The internal wiring shall be terminated on a porcelain terminal block with tinned brass terminals and pressured type screwing arrangement. Screws which directly press into the cables shall not be acceptable.
- 1.12.6 The fitting complete with control gear shall be suitable for use with high-pressure mercury vapor, metal halide or high pressure sodium lamps of the sizes specified in the BOQ.
- 1.12.7 Lamp shall have a rating as specified in the BOQ. The rating of the control gear shall correspond with the rating of the lamp.
- 1.12.8 A compensating capacitor of suitable rating to improve the p.f. to 0.8 p.f. lagging shall be provided with the fixture.
- 1.12.9 The choke shall be noise and vibration free; polyester filled and compacts in design.
- 1.12.10 Get approval of suspension/hanging rods prior to its manufacture for installation of light fixture where shown on the drawings.

1.13 LAMPS

- 1.13.1 Mercury vapor/sodium/MDI/HAL/HIT/HIE lamps shall be high pressures self-igniting type rate to function at 220 volts 50 Hz single-phase alternating current in conjunction with suitable low power factor ballast. The interior of the lamps shall be coated with rare earth phosphor to give better lumen out put and good colour rendering.
- 1.13.2 The cap shall be suitable for fitting into E 40 or E-27 design lamp-holder.
- 1.13.3 The lamp shall rated at 125 watts or as specified.
- 1.13.4 The objective life shall not be less than 5000 burning hours.
- 1.13.5 The lamp shall be capable for burning in any direction.
- 1.13.6 Each lamp shall be complete with a ballast and p.f. Compensating capacitor.

1.14 GARDEN/FLOOD LIGHT POLES

1.14.1 Poles for mounting lighting fixtures shall be made of sheet steel. The steel used in the manufacture shall have the following properties: -

Tensile strength min:	39.7 Kg/mm square
Max:	56.3 Kg/mm square
Yield point min:	24.7 Kg/mm square

1.14.2 The poles shall be fabricated from welded carbon sheet steel.

1.14.3 The working stress at lower level of each section shall be as under: -

Safe working load	-	115 Kg
Breaking load	-	290 Kg

1.14.4 The minimum dimension of the bottom section of each pole shall be as under: -

-	Outer diameter of the section	:	200 mm
-	Thickness of section	:	10 mm

1.14.5 The overall height for garden lighting pole shall be as shown in Drawing.

1.14.6 For 18 meter high flood light mast shall be hot dipped in and out steel galvanized (conforming to BSS 729/71) Octagonal tapered pole with dished flange base plate, anchor bolts (steel galvanized bitumen dipped) pole/head frame painted with 3 coats of anti corrosive paint and three coats of head frame suitable to mount 20 fixtures type as given on the drawing. Pole base has weather proof inspection door 100% vandal proof suitable to hold control gear of the floodlights. Pole having climbing clips for access to head frame as mentioned in BOQ.

1.14.7 Tolerances in the manufacture of poles shall be as follows: -

A-	Overall length of the pole	+	2.5%
B-	Outside diameter	+	1%
C-	Tube thickness	+	1%
D-	Weight	+	3%

The poles shall be straight within 1/300 of the length.

1.14.8 The welds shall be grounded off to give smooth finish to the poles. The poles shall be relived of all drawing and welding stressed and thoroughly cleaned of all oxidation, scales, oil, grease and contaminants before finishing.

1.14.9 After through cleaning the exterior surface from top to the bottom of the poles shall be painted with two coats of red lead based primer. The surface to be buried below ground line and inner side throughout shall be painted with two coats of bitumen paint.

1.14.10 The poles shall be tested at manufacturer's end for transverse loading test and tensile test.

1.14.11 For transverse loading test poles shall be tested to failure and a load equal to twice the full test load applied at the points shown in the drawing. The test load shall be 115Kg.

1.14.12 Any permanent deflection after the application and removal of the full test load shall mean non-compliance with this specification. Failure at or before 2.5 times the test load shall also mean non-compliance with these Specifications.

- 1.14.13 The tensile test shall be carried out in accordance with ASTM A370-68. For the tensile test at least 3 test pieces from the pole shall be taken. In case more than one piece fails to the test it shall mean non-compliance of these Specifications.
- 1.14.14 The Contractor shall make arrangements to get the tests witnessed by the Engineer at his own expense.
- 1.14.15 The Owner may require special markings to be engraved on the poles supplied to him for proper identification and Contractor shall comply with such instructions.
- 1.14.16 Each pole shall be earthed as shown in the drawing.
- 1.14.17 A 16"x16"x $\frac{1}{2}$ " square shape base plate or as mentioned in BOQ shall be welded to the bottom of the pole. The top of the pole shall be provided with an approved cap.
- 1.14.18 The base plate shall be grouted in a standard concrete foundation cast in site.
- 1.14.19 The connection from the cable junction box to light fixture shall be by 2 core PVC/PVC cable size 2.5 sq. mm. The cable entry to the poles shall be through proper male brass bushes.
- 1.14.20 Make:
Bega, Clipsal, Phillips.

1.15 SERVICE TERMINAL BOXES

- 1.15.1 Power cables in the system shall be terminated by tinned brass cable glands to be saddled neatly in rust proof and water tight terminal boxes designed to take two cables of size upto 2.5 mm square garden light cable & 1 cable size 2x4 mm square PVC/PVC cable.
- 1.15.2 The terminal boxes shall be metal clad and deep enough to take the cable leads comfortably without undue twisting and pressure.
- 1.15.3 The size of the terminal plate shall be 12"x5" or according to pole manufacturer's standards.
- 1.15.4 The terminal plate shall be fixed in the pole.
- 1.15.5 Neoprene glands and screws bushes shall be provided for sealing the entries.
- 1.15.6 The service box shall be provided with lockable hinged front cover.
- 1.15.7 The terminal block shall consist of brass terminals adequately insulated with either a molded phenolic compound or a neutral block housed in glazed porcelain housing shall be provided for connecting up the incoming and outgoing cables.
- 1.15.8 Compression type lugs shall be used for terminating the cables.
- 1.15.9 The terminal block shall be tested for temperature rise and also subjected to heat cycle test besides dielectric strength test.
- 1.15.10 The temperature rise of the terminals shall not exceed 30 degree centigrade, at a frequency of 50 Hz, 400 Volts, unit power factor and rated maximum current.
- 1.15.11 The insulation between all terminals and all metal parts including the frame shall withstand the applications of an alternating test voltage of 2000 volts (r.m.s.).
- 1.15.12 A porcelain fuse base and fuse carrier rated at 30 Amps with a cartridge fuse link rated at 1.5 amps for lamps shall also be housed in the service box. The cartridge fuse links shall be to BS 1362. Alternatively a suitably rated mcb as specified shall also be installed.
- 1.15.13 All the exposed terminals excluding the fuse and barkers nob's shall be covered by 3 mm thick Bakelite sheet.
- 1.15.14 The Contractor shall submit a sample of a complete terminal plate and obtain prior approval of the Engineer before proceeding with the fabrication of total requirements.
- 1.15.15 The lid shall be fully gasketed and provided with triangular head screws of captive type. One key for every ten terminal boxes or part there of shall be provided.
- 1.15.16 The terminal box door shall have finish similar to pole.

1.16 SUBSTATION EQUIPMENT**1.16.1 High Tension Switchgear**

1.16.1.1 The Switchgear shall be 11000 volt metal clad type of 350 MVA braking capacity for indoor application. It shall be triple pole and all the three poles shall be coupled so as to operate simultaneously.

1.16.1.2 The switchgear shall comprise of vacuum circuit breaker / load break switches.

1.16.1.3 The switchgear shall be supplied and tested in accordance with the following International Electro Technical Commission Publications:

IEC Publications	56-1	
IEC Publications	56-1A	
IEC Publications	56-1B	
IEC Publications	56-2	
IEC Publications	56-3	
IEC Publications	56-4	
IEC Publications	185	Specifications for current Transformers.
IEC Publications	51	Specifications for Instruments.

1.16.1.4 The switchgear shall be supplied in the form of single panels for quick assembly at site in the form of a switchboard.

1.16.1.5 Each panel shall comprise of a draw-out type circuit breaker and all its associated equipment and accessories shall be self-contained and self-supporting. Each panel shall be capable of being supporting. Each panel shall be capable of being connected to a switchboard on either side.

1.16.1.6 In each panel the circuit breaker shall be equipped with a mechanism for moving it physically between the connected and disconnected positions and also equipped with self-aligning and self-coupling primary and secondary disconnecting devices.

1.16.1.7 All secondary circuit wiring, instruments, meters and relays etc, shall as far as possible be isolated by grounded metal barriers from all primary circuit elements with the exception of short lengths of wires such as instrument transformer terminals.

1.16.1.8 All removable components of the same type and rating in a switchboard shall be physically and electrically interchangeable.

1.16.1.9 The breaker shall have mechanical "ON", "OFF" and "EARTHED" position indicator.

1.16.1.10 Mild steel rails shall be provided at the base to guide smooth entry of the breaker carriage into the panel.

1.16.1.11 The terminals and interconnections between parts shall be designed to ensure permanently low resistance contacts. The power carrying circuits shall be capable to carry its rated current at rated voltage and rated current continuously shall not be seriously impaired. The Contractor shall furnish the manufacturer's literature and technical data to prove this point.

1.16.1.12 The mechanical strength and physical characteristics of the insulation structure shall be in accordance with the classification of IEC Publication No. 85.

1.16.1.13 Circuit breakers shall be so constructed that the interval between the contacts of the individual pole touch or separate shall not exceed 10 ms during closing or opening operation.

1.16.1.14 The rods or tubes used for raising or lowering the moving contacts of the securely pinned at each end to prevent rotation or displacement of the contacts.

1.16.1.15 Ventilation outlets from circuit breaker shall be so arranged that any discharge of oil and/or gases or both will not cause Electrical breakdown and shall be directed away from a likely place where an operator may have to be in the course of his ordinary duties. The construction shall be such that gas cannot collect at any point where fire can be caused during or after operation, by sparks arising from normal worming of the circuit breaker or its ancillary equipment.

1.16.1.16 A set of 6 male and 6 female silver-plated self-aligning isolating contacts shall be provided for separating the breaker from the Sub-bars. These shall be interlocked and protected by automatic shutters with locking facility. The shutters shall be marked "BUS-BARS" and "CABLES" and distinctly colored. No operation shall cause exposure of the high voltage bus or equipment. The shutters shall operate with certainty upon the withdrawal and replacement of a removable portion but shall be so arranged as to permit the cover over a set or sets of live contacts to be locked by hand in the closed position while the cover over the dead contacts may be opened.

1.16.1.17 Silver plated plug contacts shall be provided between separate units to complete the secondary circuits. They shall be pressure loaded self-aligning types.

The temperature rise of the main circuit of a circuit breaker shall not exceed the values given in Table I of ICE Publication 56-2. The maximum temperature of auxiliary circuits and devices when the circuit breaker is carrying the rated current and voltages and when tested in accordance with Clause II of IEC Publication N. 56-2 shall not exceed the values given in Table I. The reference ambient temperature shall be taken as 50 degree centigrade.

These circuit breakers shall have the following characteristics:

S.No.	Characteristics
1-	Current Rating
2-	Voltage Rating
3-	Frequency
4-	Breaking Capacity
5-	Breaking Current Sym
	Breaking Current Asym
6-	Making Capacity
7-	Power Frequency withstand Voltage
	Type Test
	Routine Test
8-	Impulse withstand voltage
9-	Operating duty
10-	Total maximum break time

1.16.1.18 The circuit breakers shall be capable of breaking any power upto their rated breaking capacity. For all recovery voltages between the two rated voltages the breaking capacity ratings in amperes shall be inversely proportional to the voltage. For recovery voltages below rated voltages the braking capacity expressed in amperes shall have a constant value corresponding to the lower rated voltage.

1.16.1.19 The operating mechanism shall be charged spring power mechanism with manual push button for closing and opening the breaker. The closing spring shall be hand charged.

1.16.1.20 The mechanism shall be trip free.

1.16.1.21 The closing mechanism shall not prevent or delay the opening of the circuit breaker beyond the standard interrupting time.

1.16.1.22 Latches shall be so designed as to not require delicate or frequent adjustments.

1.16.1.23 The mechanism shall be such as to give a minimum of 1000 operations without wear, breaking or adjustments. Each operation shall consist of complete opening and closing of the circuit breaker.

1.16.1.24 The mechanism shall be of robust construction and of rust proof materials, it shall be capable of withstanding shocks and prevent in advertent operations causes.

1.16.1.25 The mechanism shall be provided with means to prevent operation during maintenance.

1.16.1.26 The following routine tests shall be made on all circuit breakers and manufacturer's certificate shall accompany each breaker.

Temperature rise test (IEC Publication 56-2 Clause 15).

Test for operating Conditions (IEC Publication 56-3 Clause 37).

Power frequency dry voltage (IEC Publication 56-4 clause – 17).

Tests on auxiliary circuits (IEC Publication 56-4 Clause-19).

Oil Tank leakage tests by any one of the following methods:-

- A. Compressed Air Test.
- B. Oil or Water Pressure Test.
- C. Penetrating liquid without Pressure.

1.16.1.27 The Contractor shall make suitable arrangements for the Engineer to witness such tests at the manufacturer premises or any recognized test laboratory without any expense to the Owner.

1.16.1.28 A set of three bus bars made of 98% I.A.S.C. Electrical conductivity copper of current rating of 1000 Amps shall be provided.

1.16.1.29 The bus bars shall be fully covered with insulation capable of withstanding the full line voltage. These shall be supported on porcelain insulators and air insulated. The bus bars shall be tinned at all joints and a drawing showing details and method of jointing shall accompany the breakers.

1.16.1.30 Bracing of sufficient mechanical strength shall be provided to withstand forces of short circuit current to the extent of 23 kA.

1.16.1.31 The bus bars shall be capable of extension on either side and have adequate provision for expansion and contraction due to temperature variations over a range of 80 degree centigrade.

1.16.1.32 Single pole, epoxy resin insulated, dry type self-contained indoors current transformers suitable for mounting in switchgear shall be supplied.

1.16.1.33 The current transformers shall be manufactured and tested in accordance with IEC Publication 185 (1966) and particulars listed therein.

1.16.1.34 The transformation ratio shall be as stated in the Bill of Quantities.

1.16.1.35 The current transformers shall have two core construction and each core shall be designed for protection and metering. Both cores shall be identical.

1.16.1.36 Three phase, self-contained, indoor drawout type voltage transformers shall be supplied as required and detailed in the Bill of Quantities. The transformers shall be epoxy resin insulated.

1.16.1.37 The rated frequency shall be 50 Hz and voltage ratio shall be 11000/415 volts. The accuracy and tests shall have the above noted frequency and voltage ratio as reference.

1.16.1.38 The characteristics shall be as follows: -

I- Rated Burden VA 100 per Phase

II- Accuracy Limit 0.6%

1.16.1.39 The voltage transformer shall withstand for one second the mechanic and thermal stresses resulting from a short circuit on the secondary terminals with full voltage maintained on the primary terminals.

1.16.1.40 The following tests shall be carried out on the voltage transformer: -

Dielectric test of low frequency.

Impulse test on high voltage windings only.

Ratio and phase angle tests at one standard burden.

Temperature rise tests.

Impedance Test.

The dielectric test voltage shall be as under: -

		Impulse Test Voltage		
Rated Primary	Low Frequency Test Voltage (rms.)	Chopped Wave Crest Voltage	Min. time Flash over	Full wave Crest Voltage
11 kV	34 kV	110 kV	1.8 Microseconds	95 kV

1.16.1.41 The voltage transformers shall be equipped with fuse and fuse links in accordance with BS 88/1967.

1.16.1.42 Back connected dust proof, semi-flush, switchboard type protective relays with transparent removable and sealable covers shall be provided. These shall be preferably plug-in with drawable type and all operations for removal and replacement shall be carried out from the front side of the panel.

1.16.1.43 The relays shall be suitable for climatic conditions described in these Specifications and capable of 5000 electrical operations when tested at rated quantities and at a rate which will not result in overheating. The relays shall withstand a test-voltage of 2000 volts (rms.).

1.16.1.44 All relays shall be A.C. operated and provided with time and current setting adjustments with suitable range.

1.16.1.45 The rated error of all the protective relays shall be not more than 7.5% at all settings. The relay minus 7.5% with changes in ambient temperature of plus or minus 10 degree centigrade from the reference temperature of 25 degree centigrade and with changes in frequency of plus 2% and minus 6% from the rated frequency.

1.16.1.46 The following type of tests shall be carried out: -

Limits of error.

Temperature rise test.

Overload test.

Contact rating test.

Mechanical Durability.

Variation characteristics with ambient conditions and frequency.

The manufacturer shall supply certified test result by an independent agency on the type of relays.

1.16.1.47 All live parts of the panel including bus bars, connections, circuit breaker, isolators, voltage transformer, current transformers shall be suitably enclosed. Access for normal maintenance shall be through doors with locking facilities. The enclosure shall have hinged door in front and bolted plates in rear. However, the incoming panels will be provided with hinged doors with locks in the rear as well.

1.16.1.48 The enclosure and the breaker shall be completely derusted and degreased. It shall be given a priming coat of zinc chromate and iron oxide or any other equivalent.

1.16.1.49 The following instruments shall be installed on the incoming panels: -

One voltmeter 0-12 kV range, moving iron spring controlled in a pressed steel case.

One ammeter of suitable range conforming to the CT ratio, moving iron, spring controlled in pressed steel case.

One voltmeter phase selector switch.

One ammeter phase selector switch.

One kWh meter with MDI

One KVARH meter.

1.16.1.50 The indicating instruments shall be flush mounted back connected, dust proof with a transparent dust proof cover. The dials shall be white with permanent, black graduations.

1.16.1.51 The instruments shall be manufactured and tested in accordance with IEC Publication 51.

1.16.1.52 CT operated kWh and KVARH meters shall also be installed where required. The meters shall be manufactured and tested in accordance with I.E.C. Publication 43.

1.16.1.53 The panel or the switch board as described in the Bill of Quantities shall be delivered complete at site ready wired complete with name plate, designation labels, circuit labeling. The small wiring shall be tested at 2000 Volts D.C.

1.16.1.54 The following data shall appear on the nameplate of each circuit break:

Manufacturers Name and Address.

Manufacturer, type, designation and serial number.

Year of Manufacture.

Owner's Identification Mark.

Standard to which Manufactured.

Rated Normal Current.

Rate Frequency.

Rated Normal Current.

Rate Impulse Withstand Voltage.

Symmetrical Breaking Capacity.

Asymmetrical Breaking Capacity.

Rated Short Time Current.

Making Capacity.

Rated operating Duty.

Total Break Time at rated Breaking Current.

Control and Tripping Voltage.

1.16.1.55 The switch-gears as detailed in the Bill of Quantities shall be delivered tested and commissioned at Site under this Contract and shall be complete in every aspect, and manufactured by M/s. Siemens (Pakistan), M/s. ALSTOM (Pakistan).

1.16.1.56 Installation of the switchgear

The Electrical Contractor shall provide all labor, equipment and tools necessary for complete installation as well as all shimming of the supporting steel frame that may be required to set the switch-gear in level position. The equipment shall be fixed firmly on the floor according to the manufacturer's recommendations. All outgoing and incoming cable connections shall be made and special care should be taken in fixing cable terminations and cable connections so that no danger of damage during operation is possible. All terminal block connection shall be checked for any looseness.

1.16.1.57 Measurement

This job shall be treated as lump sum job for measurement purposes.

1.16.1.58 Make:

Siemens, ABB, Legrant, Terasaki.

1.16.2 POWER FACTOR IMPROVEMENT PLANT

1.16.2.1 General

The Power Factor Improvement Plant shall be indoor type, free standing, floor mounting, sheet steel clad, totally enclosed, completely dust proof, fabricated from 3mm thick mild steel sheet suitably ventilated with vermin proof louvers, supplied fully assembled, readily wired, as one integral unit and capable of alignment to Main L.T. Switchboard. The use of mechanical forced ventilation is allowed. The plant shall be designed to house all delicate components e.g. p.f. meter, sensing relay, Main and auxiliary indicator lights, control fuses with bases etc. in dust proof enclosures.

The fabricated plant housing shall be completely cleaned, degreased and derusted, before applying one coat of antirust primer and two coats of battleship grey enamel.

The plant shall be designed to meet the service conditions at site and provide reasonable assurance of performance in mechanical and electrical adjustments. The plant shall be suitable for use on 415V, 50 Hz, 3-Phase 4 wire, A.C. supply.

1.16.2.2 Components

1.16.2.2.1 Each capacitor shall have rating of not more than 25/50 KVAR and shall conform to BS 1650/1971. Full capacitance of the plant as specified shall be capable of being switched in 10 equal steps. The capacitors shall be rated 525 V. The capacitor bank shall consist of single phase capacitors arranged in star formation with solidly grounded neutral.

1.16.2.2.2 A 12 stage-sensing relay with time delay characteristics shall be provided for carrying out all switching operations automatically.

1.16.2.2.3 A manual control switch shall be provided to carry out manual switching if and when required.

1.16.2.2.4 Magnetic contactors suitable for 380/420 volts operation shall be provided in sufficient numbers to carry out automatic switching operations. Then Contractor shall conform to BS 775/latest.

1.16.2.2.5 Suitable discharge resistors and hoods shall be provided.

1.16.2.2.6 A 6"x6" dia flush mounted power factor meter shall be supplied.

1.16.2.2.7 The PFI plant shall be manufactured by M/s. Siemens (Pakistan), M/s. ALSTOM (Pakistan) or J&P.

1.16.2.3 Testing

1.16.2.3.1 The capacitors shall be charged by application of full voltage for a period of one minute and then discharged through resistors. This will constitute one cycle and the tests shall be carried out for 5 such cycles.

1.16.2.3.2 The sensing relay shall be tested in accordance with tests specified in BS 142.

1.16.2.3.3 All small wiring shall be subjected to a high voltage test at 2000 volts for one minute.

1.16.2.3.4 The plant as a whole shall be tested by the application of inductive load.

1.16.2.4 Measurement

This job shall be treated as a lumpsum job for the purpose of measurement.

1.16.3 POWER TRANSFORMERS

1.16.3.1 Three phase Power Transformers for indoor use having transformation ratio of 11000/415 volts at frequency of 50 Hz and KVA ratings as given in the Bill of Quantities shall be supplied and erected by the Contractor.

1.16.3.2 The Transformers shall be manufactured, supplied and tested in accordance with the following standards: -

British Standard 171/1959 – Power Transformers.

British Standard 358/1959 – Measurement of Voltage with sphere gaps.

British Standard 923/1940 – Impulse voltage testing.

British Standard 2757/1964 – Classification of insulating materials for electrical machinery and apparatus on the basis of thermal stability in service.

American Standards Association C. 57.12.1956 – Requirements terminology and test code for distribution power and regulating transformers and distribution power and regulating transformers and reactors other than current limiting reactors.

I.E.C. Publication 76 – Recommendations for Power Transformers.

I.E.C. Document 14 (Secretariat) 53.

I.E.C. Document 14 (Secretariat) 54.

I.E.C. Document 14 (Secretariat) 55.

I.E.C. Publication 60 – High Voltage test techniques.

1.16.3.3 The transformers shall be oil-immersed types with core and winding immersed in natural mineral oil. The core shall be of a laminated construction made of high-grade Electric steel sheet rigidly packed and free of vibrations due to frequency and stresses.

1.16.3.4 The windings shall be uniformly insulated. The thermal class of insulating material shall be Class-A. Test voltages shall be based on highest of the system voltage i.e. 12 kV. Power frequency voltage shall be 28 kV and impulse voltage to be 95 kV. The wave being 1/50 microseconds.

1.16.3.5 The insulation to earth of the winding shall be uniform.

1.16.3.6 The limits of temperature rise above ambient of the windings, cores and oil shall be as under: -

Winding	–	50 Degree Centigrade
Core	–	50 Degree Centigrade
Oil	–	40 Degree Centigrade

1.16.3.7 The transformer shall be designed and constructed to withstand, without damage, the effects of short circuit of magnitude equal to 25 times the symmetrical r.m.s. value of valid current for 2 seconds.

1.16.3.8 The transformer shall be capable of withstanding, without damage on any tapings, under service conditions, the electromagnetic forces arising under short circuit conditions as determined from the symmetrical peak value of the current in the winding which shall be taken as not greater than 2.55 times the over current derived.

1.16.3.9 The transformer shall be provided with regulating taps. The adjusting tapping shall be $+2\frac{1}{2}\%$, normal, $-2\frac{1}{2}\%$, -5% and $-7\frac{1}{2}\%$. The tapings being located on the higher voltage winding.

1.16.3.10 Tap changing shall be affected by means of an externally operated off circuit switch capable of being locked in position. It shall be accessible with safety.

1.16.3.11 When tapings are used to compensate for variation of voltage the transformer shall be capable of operation at its rated KVA capacity on any tapping without injury. The tap changing gear shall be capable of carrying the same currents, due to external short circuits.

1.16.3.12 The method of cooling shall be natural air; the method of circulation of oil shall be by natural thermal head and would be indicated by symbol ON.

1.16.3.13 The primary windings shall be "delta" connected and the secondary winding shall be "Star" connected internally. The star point shall be brought out as neutral. The internal connections shall be clearly indicated on the nameplate together with tap changing connections. The vector group DY-11 of the transformer shall also be indicated on the nameplate.

1.16.3.14 The tank shall be tested for any leaks by any of the following methods:-

Compressed Air Test.

Oil water Pressure Test.

Penetrating liquid without Pressure.

1.16.3.15 An oil conservator tank fitted with a dehydrating breather and oil level indicator shall be internally fitted to the transformer tank.

1.16.3.16 The complete assembled tank shall be tested to withstand without deformation or leakage a pressure of 15 lbs./sq. in (1.05 Kg/sq.cm).

1.16.3.17 The tank finish shall be battleship grey colour. The paint shall be highly resistant to the effects of high temperatures and shall have a long life under the normal working conditions. As a minimum it shall consist of a priming coat and two finish coats applied after complete derusting and degreasing of the tank. The thickness of the paint shall not be less than 0/12 mm.

1.16.3.18 The oil level indicator shall be visual glass type with minimum oil level marking at 30 degree centigrade and with two additional marks "Empty" and "Full" to be provided. These corresponding to the upper and lower temperatures for which the transformer is required to operate on site.

1.16.3.19 Compound filled cable end boxes for Bus tie duct XLPE cable on H.T. side and on L.T. side shall be provided for connecting the transformer to relevant switchgear. Arrangement for solidly grounding the neutral shall be made.

1.16.3.20 The following routine tests shall be carried out on the transformers:

Temperature Rise Test.

Impedance Test.

Ratio and Phase angle test at one Standard Load.

Dielectric Test of Low Frequency.

1.16.3.21 A certified copy of a complete type tests carried out by and identical transformer shall accompany each transformer failing which the Contractor shall make arrangements to carry out these tests in the presence of Engineer without any extra expense to the Owner.

1.16.3.22 The following fittings shall be provided with each transformer.

Rating Plate.

Terminal Marking Plate.

Lifting Lugs.

Earthing Terminals for Tank.

Oil filling holes and plug.

Oil level indicator.

Drain valve with built-in sampling device.

Conservator.

Air Vent.

Dehydrating Breather.

Dial type thermometer with maximum temperature indicator.

Single Float Buchholz Relay complete with auxiliary relay on the panel.

Steel Rollers with rolling direction parallel to the longer side.

1.16.3.23 The rating plate shall carry the following information: -

Manufacturers Name.

Manufacturers Serial Number.

Year of Manufacture.

Owner's Identification Mark.

Rated KVA

No. of Phases.

Frequency.

Rated Voltage at no load (Higher Voltage/Lower Voltage).

Percent Impedance Voltage.

Rated current (Higher Voltage/Lower Voltage).

Winding connections and phase displacement symbols of vector diagram.

Type of Cooling.

Total weight of the transformer.

Total quantity and weight of the oil.

Weight of core and winding assembly.

1.16.3.24 The terminal marking plate shall carry the following information: -

Vector Group Symbol.

Winding connections of high voltage and low voltage sides.

Tapings with subscripts.

Voltage ratios at various tapping the lower voltage being kept constant.

Rated Current (Higher Voltage/Lower Voltage).

Letters ABC shall be used for the high voltage side and a b c shall be used for low voltage side.

1.16.3.25 The transformers shall be manufactured by M/s. Siemens (Pakistan), PEL, Climax or J&P.

The transformer of the ratings as given in the Bill of Quantities shall be supplied tested erected and commissioned under this Contract and shall be complete in every respect with first filling of dehydrated mineral oil specified herein after.

1.16.3.26 Measurement

This job shall be treated as lump sum job for measurement purposes.

1.16.3.27 Payment

Payment shall be made for each transformer unit as specified in the Bill of Quantities.

1.16.4 OIL FOR TRANSFORMERS

1.16.4.1 Oil for transformers shall conform to British Standard 149.

1.16.4.2 Insulating oil shall be straight run mineral oil obtained from fractional distillation of crude petroleum, refined specially for use as an insulating and cooling medium in oil immersed transformers.

1.16.4.3 For satisfactory service of the equipment the oil dielectric strength above 40 kV will not be required when tested according to BS 148.

1.16.4.4 Measurement

No measurement is involved for this item, as each equipment using this oil is reckoned complete with oil.

1.16.4.5 Payment

Payment of oil is included with the equipment using the oil.

1.16.4.6 Make:

Siemens, PEL.

1.17 TESTING**1.17.1 General**

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

The Contractor shall furnish, install and maintain all tools, instruments, test equipment, material, connections, etc. and furnish all personnel including supervision and "Standby" and adjustment of all electrical facilities and their component parts, including putting the same into operation.

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

1.17.2 Insulation Test

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

Circuit fewer than 230 volts – 500 volts test.

Circuit fewer than 500 volts – 1000 volts test.

The minimum acceptable insulation resistance value will be 5 Mega-ohms.

The Contractor will furnish the test equipment for insulation testing.

Before making connections at the ends of each cable run, the insulation resistance test of each cable shall be made. Each conductor of a multicore cable shall be tested individually to each other conductor of the group and also to 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 tested.

All equipment shall be given an insulation resistance measurement test to ground after installation but before any wiring is energized. 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 that specified above, the cause of the low reading shall be determined and removed. Corrective measures shall include dry-out procedure by means of heaters if equipment is found to contain moisture. Where corrective measures have been necessary and the insulation resistance reading taken after the correction has been made it should satisfy the requirements specified herein. Repeated insulation resistance maintenance test shall be made twice and at least 12 hours apart. The maximum range for each reading on the 3 successive tests shall not exceed 20% of the average value. After all tests have been made successfully, the equipment shall be reconnected.

1.17.3 Earth Resistance Tests

The Contractor shall make each resistance tests on the Earthing system, separating and re-connecting each earth connection as may be required by the Engineer.

1.18 TELEPHONE AND INTERCOM SYSTEM**1.18.1 General**

The work included under this section consists of furnishing all labour, materials, services and skilled supervision necessary for the construction erection, installation and connection of all facilities specified herein or shown on the drawings and or normally required for the complete telephone and Intercom system and its delivery to the Employer upon completion in all respects and ready for use except telephone/intercom sets.

1.18.2 Telephone Services

The telephone services entrance locations shall be coordinated with the Pakistan Telegraph and Telephone Department. This installation shall include.

a) Main Telephone Cable Entry into Building:

This shall consist of G.I Pipe for loading the cable into telephone junction box located inside the building. The Contractor shall coordinate the actual specific details with the Pakistan Telegraph Department.

b) Pull wire shall be furnished and installed in the duct line as recommended by Pakistan Telegraph and Telephone Department.

1.18.3 Telephone And Intercom Conduit Systems

a) The telephone and intercom conduit system including telephone feeder conduit and outlet boxes shall be furnished and installed as shown on the drawings.

b) Underfloor trunking

Telephone floor trunking shall be installed in PVC ducting in the floor slab.

c) Junction boxes

Junction boxes of dimension approx. 150 x 150 mm or Standard sizes available shall be made of 16 SWG (1.63mm) mild steel according to the relevant standard.

d) Distribution box

Distribution point boxes incl. sub-distribution boxes shall be constructed from galvanized mild steel sheets of thickness 1.50 mm and with 12 mm thick plywood backing for terminal tag mounting / heavy duty plastic suitable also for wall mounting. Distribution boxes shall have the same number of ways indicated in the drawings and shall be comply with the necessary number of jumper rings.

e) Type of cables

The cables shall be suitable for operation on a 50V DC service for use in the telephone installation system

The cables shall comprise the necessary numbers of wires, each PVC insulated, laid up in pairs and served with and extruded PVC sheath

The conductor shall comprise tinned annealed copper wires, smooth drawn, pliable, uniform in quality and free from all defects, having a min. diameter of 0.5 mm or 0.63 mm.

Insulation of conductors, colour coded as per standards and codes.

f) Wiring points

All telephone points shown in the drawings shall be provided with cables. The number of cables cores required can be calculated acc. to the required number of points incl. 20% spare for each main-section.

Every final point shall be terminated to an approved plug-in unit from its junction box.

g) Earthing

The earthing system consist of earthing termination points, inspection chambers and covers and interconnected 1,5mm x 20mm (0.0625" x 0.75") copper tape between termination points.

The earthing termination points shall consist of 16mm x 5,5m (0.625" dia x 18ft. length) copper rods driven into the ground. The total earthing resistance of the complete system shall not exceed 5 Ohms.

1.18.4 Make:

Telephone Cables :

Siemens Germany
Pakistan Cables
Clipsal

Telephone Junction Boxes:

Hussain & Co.
Sunbeam Engineer
Clipsal
Babar – Brothters.

1.19 FIRE DETECTION AND ALARM SYSTEM**1.19.1 Description:**

- A. This section of the specifications includes the furnishing, installation, and connection of the microprocessor-controlled fire alarm equipment required to form a complete coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panel, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein.
- B. The fire alarm system shall comply with requirements of NFPA Standard No. 72 except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
- C. Basic System Functional Operation
 - 1. Alarm Detection: When an alarm condition is detected by one of the system initiating devices, the following functions shall immediately occur:
 - a. The System Alarm LED on the panel shall flash.
 - b. A local sounding device in the panel shall be activated.
 - c. The corresponding LED on the initiating zone(s) in alarm shall flash.
 - d. All automatic programs assigned to the alarm point shall be executed and the associated indicating devices and relays activated. As each indicating circuit or control relay is activated, its green LED shall be illuminated.
 - e. If used, the Remote Signaling (NFPA 72C) or Municipal Tie (NFPA 72 B) connection shall be activated.
 - 2. System Trouble Detection: When a trouble condition is detected by one of the system initiating or indicating circuits, the following functions shall immediately occur:
 - a. The System Trouble LED shall flash.
 - b. A local sounding device in the panel shall be activated. This sound shall be distinct from the alarm sound from this device.
 - c. The trouble LED for the corresponding initiating or indicating circuit shall flash on its respective module. If the trouble condition is caused by a CPU or Power Supply Trouble, the corresponding LED on the CPU shall flash.

1.19.2 Guaranty:

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance.

1.19.3 Contract Maintenance:

- A. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.
- B. As part of the submittal work, include a quote for a maintenance contract to provide all maintenance test and repair as required after the warranty period. Include also a quote of hourly rates, response time and technician travel costs. Submittals which do not include a complete statement of maintenance costs will not be accepted.

1.19.4 Applicable Publications:

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

A. National Fire Protection Association (NFPA) - USA:

- No. 70-90 National Electrical Code (NEC)
- No. 71-89 Central Station Signaling Systems
- No. 72-90 Protective Signaling Systems
- No. 72E-90 Automatic Fire Detectors
- No. 72G-89 Notification Appliances for Protective Signaling Systems
- No. 72H-88 Testing Procedures for Signaling Systems.
- No. 101-91 Life Safety Code

B. Underwriters Laboratories Inc. (UL) - USA:

- No. 50 Cabinets and Boxes, May 16, 1987
- No. 268 Smoke Detectors for Fire Protective Signaling Systems, July 20, 1987
- No. 864 Control Units for Fire Protective Signaling Systems, May 26, 1987
- No. 268A Smoke Detectors for Duct Applications.
- No. 521 Heat Detectors for Fire Protective Signaling Systems.
- No. 228 Door Closers-Holders for Fire Protective Signaling Systems.
- No. 464 Audible Signaling Appliances.
- No. 38 Manually Actuated Signaling Boxes.
- No. 346 Waterflow Indicators for Fire Protective Signaling Systems.
- No. 1481 Power supplies for Fire Protective Signaling Systems.
- No. 1971 Visual Indicating Appliances.

C. Local and State Building Codes

D. All requirements of the Authority Having Jurisdiction (AHJ).

1.19.5 Approvals:

A. Each system must have proper listing and/or approval from the nationally recognized agency responsible for the particular area.

- UL Underwriters Laboratories, Inc.
- FM Factory Mutual
- ULC Underwriters Laboratories Canada

- B. The Fire Alarm Control, Panel shall meet the modular listing requirements of Underwriters Laboratories Inc. Each subassembly of the FACP, including all printed circuit boards, shall include the appropriate UL modular label.

1.19.6 Make:

Gent (UK), Simplex (USA), Deota (Italian).

1.20 PRODUCTS**1.20.1 Equipment And Material, General:**

- A. All equipment and components shall be new, and the manufacturer's current model.
- B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations.
- C. All Equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

1.20.2 Conduit And Wire:**A. Conduit:**

- 1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
- 2. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
- 3. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.
- 4. Conduit shall be 3/4 inch (19.1mm) minimum.
- 5. Conduit shall not enter the Fire Alarm Control Panel, or any other remotely mounted Control Panel equipment or backboxes, except where specified by the factory.

B. Power Supply:

- 1. The Main Power Supply for the Fire Alarm Control Panel shall provide all control panel and peripheral device power needs, as well as 3 amperes of 24 VDC power for Audio-Visual alarm indicating devices.
- 2. Provisions will be made to allow the Audio-Visual power to be increased as required by adding modular expansion Audio-Visual power supplies. All Power Supplies shall meet UL and NFPA requirements for power-limited operation on all indicating and initiating circuits.
- 3. Positive-temperature-coefficient thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries up to 25 AH, or may be used with external battery and charger systems. Battery arrangement may be configured in the field.
- 4. The Main Power Supply shall continuously monitor all field wires for Earth Ground conditions, and shall have the following LED indications:

Negative Ground Fault LED

Positive Ground Fault LED

Battery Fail LED

AC Power Fail LED

- 5. The power supply shall include provisions to add battery voltmeter and ammeter.

C. Duct Smoke Detectors:

Duct Smoke Detectors shall be 24 VDC type with visual alarm and power indicators, and a reset switch. Each detector shall be installed upon the composite supply/return air ducts(s), with properly sized air sampling tubes.

D. Automatic Heat Detectors:

1. Automatic Heat Detectors shall be combination rate of rise and fixed temperature rated at 135 degrees Fahrenheit for areas where ambient temperatures do not exceed 100 degrees, and 200 degrees for areas where the temperature does not exceed 150 degrees.
2. Automatic Heat Detectors shall be low profile, ceiling mount type with positive indication of activation.
3. The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture-proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 15 degrees F. per minute.
4. The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
5. Automatic Heat Detectors shall have a smooth ceiling rating of 2500 square feet.

E. Water flow Switches:

1. Shall be integral, mechanical, non-coded, non-accumulative retard type.
2. Shall have an alarm transmission delay time which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.
3. All water flow switches shall be of a single manufacturer and series.
4. Water flow switches shall be provided and connected under this section and installed by the mechanical contractor.
5. Where possible locate flow switches a minimum of one (1) foot from a fitting which changes the direction of the flow and a minimum of three (3) feet from a valve.

F. Sprinkler and Standpipe Valve Supervisory Switches:

1. Each sprinkler system water supply control valve riser or zone control valve, and each standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valve shall be equipped with a supervisory switch.
3. Mount switch so as not to interfere with the operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.

4. The mechanism shall be contained in a weatherproof aluminum housing, which shall provide a 3/4 inch conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. Switch housing to be finished in red baked enamel.
6. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.
7. Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.

1.21 EXECUTION**1.21.1 Installation:**

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

1.21.2. Test:

Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

- 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- 2. Close each sprinkler system control valve and verify proper supervisory alarm at the FACP.
- 3. Verify activation of all flow switches.
- 4. Open initiating device circuits and verify that the trouble signal actuates.
- 5. Open and short indicating appliance circuits and verify that the trouble signal actuates.
- 6. Ground initiating device circuits and verify response of trouble signals.
- 7. Check all alarm notification devices.
- 8. Check installation, supervision, and operation of smoke detectors.
- 9. Verify that each initiating device alarm signal is properly received and processed by the fire alarm control panel (Walk Test).
- 10. Conduct tests to verify trouble indications for common mode failures, such as alternating current power failure. Consult the manufacturer's manual for other common mode failures and conduct the described testing procedures.

1.21.3 Final Inspection:

At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

1.21.4 Instruction:

Provide instruction as required to the building personnel and fire and safety personnel. "Hands-on" demonstrations of the operation of the system shall be provided.