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# Chapter 1. WIRING DEVICES

## PART 1 – GENERAL

### 1.1. WORK DESCRIPTION

- A. The drawings for the lighting and power points indicate approximate positions of all lighting fittings, switches, power outlet points, isolating switch points and the like. The actual positions of all fittings, switches, the wiring details and cable routes shall be co-ordinated with other trades on site and submitted for the approval of the Engineer. All time and cost required adjusting the layout or adjusting the completed installation to Engineer satisfaction and to suit site co-ordination is included in the Contract.
- B. During the exact positioning of lighting and power points, due consideration shall be given to the operational requirements of the installation, the selection of the most accessible routes for wiring and the convenience of switching.
- C. No additional cost will be entertained should the final positions be relocated within the same room or not more than five (5) metres away from the original locations due to any requirement.
- D. For the purpose of this Specification and related Drawings, each lighting and small power point circuits shall in general be coded with a prefix to indicate the corresponding distribution board number; details on the circuit way and phase shall be submitted for the approval of Engineer.
- E. Certain types of electrical equipment or systems involving sudden changes, or low frequency or of direct electric current such as fluorescent lamps, contactors, etc. shall be fitted with radio and television interference suppression components suitable to meet the levels specified in BS 800 “Limits of Radio Interference”.
- F. This section included the specification of the following :
  - 1. Distribution boards
  - 2. Miniature circuit breakers
  - 3. Earth leakage circuit breakers
  - 4. 6A Switch Socket Outlet
  - 5. 16A Switch Socket Outlets
  - 6. Shaver Outlets
  - 7. Isolating Switches
  - 8. Conduit Boxes
  - 9. Contactors
  - 10. Dimmers Switch
  - 11. Time Switch
  - 12. Cooler Control Units
  - 13. Water Heater Switches
  - 14. Bell Push Switches

## **1.2. STANDARDS**

- A. The complete wiring installation shall be engineered according to manufacturer data and constructed in accordance with the latest revision of the IS and the appropriate BS/IEC
- B. In the adoption of standards and requirements, the Contractor shall take the following precedence:
  - 1. Engineer's decision;
  - 2. Local codes of practice;
  - 3. Drawings;
  - 4. Specification;
  - 5. International standards and requirements.

## **1.3. SUBMISSION**

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
- B. As a minimum requirement, the submission shall include the following:
  - 1. Equipment catalogues submission with manufacturer's data;
  - 2. Sample submission include all wiring accessories;
  - 3. Shop Drawings of the lighting and power positions, circuit numbers, cable routings, switching arrangement, mounting height, etc. The positions and mounting heights shall be coordinated with other services. Fixing details of all wiring accessories shall also be included.
  - 4. Drawings showing the installation details.
  - 5. Labeling system
  - 6. Builder's works requirement.

## **PART 2 – PRODUCT**

### **2.1. LIGHTING POINT INSTALLATION**

- A. The various types of light fittings to be supplied and installed are described in the drawings and the Schedule of Lighting Fittings on Drawing
- B. Surface mounted light fitting shall terminate at a junction box having entries appropriate to the run of conduit and shall be complete with porcelain/ PVC connector suitable for the size and number of connections to be made at the point and the wiring required to connect the specified fitting. Wiring to the light fittings within the false ceiling spaces shall be by means of heat resistant (butyl or silicon rubber insulated to BS 6500) cables i.e. between the junction box and the lamp holder/terminal blocks, in flexible conduits.
- C. At every light fitting an approved type earthing terminal shall be provided for connection of the circuit protective conductor of the final circuit.
- D. Ferrous metalwork shall be of minimum thickness of 1mm. treated against corrosion by galvanizing after welding or be lead primer or other approved process. Metalwork shall be painted with one priming coat, one under-coat and two top coats finished stove-enamelled matt white, unless otherwise specified.

- E. Cables used for internal wiring of the lighting fittings shall be of appropriate type and size and number. Conductor shall be of size not less than 1.5 sq.mm. single core or the equivalent. The insulation of the cables shall be able to withstand throughout the life of the fitting the maximum temperature to which it will be subject in normal use without deterioration which could affect the safety of the fitting.
- F. Cables within the lighting fittings shall be neatly bundled by nylon self locking cable ties; wiring shall be properly routed and secured away from control gear etc. wherever possible.
- G. All cable terminations within the light fittings shall be suitably shrouded to the approval of the Engineer.
- H. All lighting fittings shall be self-supporting complete with the appropriate fixing accessories such as clips, supporting brackets, suspension sets, nuts, washers, screws etc. for the proper installation of the fittings on different types of ceiling panels. Suspension sets shall be of adjustable type suitable to carry the weight of the lighting fittings and unless otherwise stated or indicated on Drawings, the suspension sets shall be generally 900 mm in length; exact lengths required shall suit site situations.
- I. All lamps complete with control gear necessary in operational condition shall be provided together with the lighting fittings as specified.

## **2.2. SWITCHES**

- A. Lighting switches, unless otherwise specified, shall be single pole, quick make and slow-break, silent switch action type with solid silver alloy contacts and totally enclosed switch action for flush or surface mounting as required.
- B. Lighting switches shall be suitable for indoor or outdoor service according to location, housed in standardized purpose manufactured galvanized steel boxes completed with conduit knockouts made up into single or multi-gang units employing a grid switch system of fully interchangeable components at standardized fixing centres of matching switches of different types and ratings but of identical dimensions, push buttons, neon indicator lamps, blanking units, grids, steel boxes and plates all capable of integration into standard composite assemblies in any combination as required.
- C. Grids shall be adjustable for variation in depth of plaster and for squaring errors and of the same type for surface or flush mounting.
- D. Switches in mechanical plant rooms and electrical sub-stations and switch rooms shall be of the metal clad type approved by the Engineer, mounted in flush or surface conduit boxes as specified elsewhere.
- E. Switches located on brick or concrete walls shall be mounted in horizontal arrangement in plaster depth steel boxes or in galvanized steel boxes using box suspension straps and cover plates. Countersunk screws shall be provided for fixing to the conduit boxes.
- F. Switches for external use shall be of weatherproof construction with IP65 rating, unless otherwise specified.
- G. Samples of all switches, conduit boxes and plaster depth boxes shall be submitted to the Engineer for approval prior to installation.
- H. Samples shall be rated for 6 Amps (minimum light switch rating 6A), 16 Amps or 20 Amps as determined by circuit load which for inductive lighting circuit shall be assessed at twice the steady state connected load current, one way or two ways as indicated on the drawings and fixed generally at a height of 1200 mm from floor level and where located in rooms the switch shall, where possible be located on the inside of the room on the handle side of the door as close to the door as is practicable.

- I. An earthing terminal, connected to the earth continuity terminal shall be provided and connected to the circuit protective conductor at every lighting switch positions.
- J. Single pole switches shall be connected to break the phase wire of the supply; the neutral wire shall not be routed through switch boxes.
- K. Switches which are mounted in the same location shall be of multi-gang type, of the maximum number of gangs available.
- L. All switches used shall be of approved or prescribed items as required by local Authorities.
- M. Circuit from different phase and circuit from emergency power should have separate switch plate.

### **2.3. ISOLATION SWITCH**

- A. Isolating switches shall be of the current ratings and number of poles (generally double pole for single phase and 4-pole three phases) as indicated on the Drawings.
- B. Isolating switches shall be of the totally enclosed pattern, metal-clad or polycarbonate with positive quick-make and quick-break action.
- C. Switches shall be capable of passing and also interrupting their full rated current safely and without damage.
- D. Ferrous materials shall be galvanised, switch handles shall be interlocked to prevent opening the cover with the switch "ON".

### **2.4. 6 AMP SWITCH SOCKET OUTLETS**

- A. Switch socket outlets shall be as per BS1363 single pole 6 Amp 3 round pin shuttered outlets, one or two gang for indoor service except otherwise specified and either surface or flush mounting according to location.
- B. Switches shall be of the quick-make slow break type with silent, totally enclosed switch action and solid silver alloy contacts. Switched socket outlets for indoor use shall be housed in suitable galvanized steel boxes to BS 4662 with conduit knockouts. Types and finishes of socket plates shall match those for the lighting switches.
- C. Generally switch socket outlets shall be positioned 300 mm above floor level except in plant rooms, kitchen, etc. where they shall be positioned 1400 mm above floor level or 150 mm above counters or benches whichever is suitable.
- D. Switch socket outlet in all mechanical plant rooms, electrical switch rooms shall be of the metal clad type, with recessed or protected switch dolly, mounted in flush or surface conduit boxes as specified elsewhere.
- E. All switch socket outlets used shall be of an approved quality.

### **2.5. 16 AMP SWITCH SOCKET OUTLETS**

- A. 16 Amp switch socket outlets shall be 3 pin round type to BS 546 shuttered, of a finished similar to 6 Amp switch socket outlets and flush mounted in galvanised steel conduit boxes to BS 4662 requirements.

**2.6. WEATHERPROOF ISOLATOR**

- A. Weatherproof enclosure shall be of the high impact, water resistant to IP65. The isolator provided shall complete with lockable device. Isolators shall be double-pole, 4-pole as specified.

**2.7. LIGHTING DIMMERS SWITCH**

- A. Lighting dimmer switch shall be the solid state, variable load, Thyristor controlled type suitable for controlling fluorescent and or incandescent lighting circuits operating at  $230V \pm 6\%$  50Hz single phase AC supply.
- B. Dimmer switch shall be manufactured to eliminate TV and radio frequency interference in compliance with IS.
- C. The ratings of the dimmer units shall be suitable for lighting circuit specified on Drawing.

**2.8. TIME SWITCHES**

- A. Time switches shall be self-contained units suitable for mains operation. All units shall have a self-starting synchronous motor with a single-pole fuse in the motor circuit, a 3-way terminal block and a thirty-six (36) hours spring reserve complete with an automatic solar dial.
- B. When fitted, the solar dial shall be capable of switching ON at sunset and OFF at sunrise throughout the year by control of a secondary calendar dial with month and day settings, and the automatic switching time shall be adjustable.
- C. Time switches shall be encased in a dust-tight metal casing have a hinged front cover with a clear Perspex window. The casing shall be effectively earthed.
- D. A manual bypass switch shall be incorporated with the time switch to facilitate maintenance of the latter.

**2.9. MINIATURE CIRCUIT BREAKER**

- A. The MCB shall be suitable for manual closing and opening and automatic tripping under overload and short circuit. The MCB shall also be trip free type.
- B. Single pole/three pole versions shall be furnished as required.
- C. The MCB shall be rated for 10 KA fault level.
- D. The MCB shall be suitable for its housing in the lighting boards and shall be suitable for connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.
- E. The terminal of the MCBs and the open and close conditions shall be clearly and indelibly marked.
- F. The MCB shall generally conform to IS: 8828.

**2.10. EARTH LEAKAGE CIRCUIT BREAKER**

- A. ELCB shall be 4 pole 415 volts 50Hz, 30-300mA sensitivity. These shall be of approved make. The rating of the ELCB shall be as required. These shall be suitable for manual closing and opening and automatic tripping under earth fault circuit of 30-300mA as specified in item of work.

- B. The enclosure of the ELCB shall be moulded from high quality insulating material. The material shall be fire retardant, anti tracking, non-hygroscopic, impact resistant and shall withstand high temperature.
- C. All parts of switching mechanism shall be non-greasing, self lubricating material so as to provide consistent and trouble free operation.
- D. Operation of ELCB shall be independent of mounting position and shall be trip free type.

## **2.11. LIGHTING/SMALL POWER DISTRIBUTION BOARDS**

- A. Distribution boards shall be of standard make with MCBs as per approved make given. Distribution boards shall be constructed out of steel sheet all weld enclosure with double door IP42 protection and shall be powder coated.
- B. Ample clearance between the conductors of opposite pole, between conductors and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduits entry plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements.
- C. Also an additional/separate adopter box of suitable length and size shall be provided to accommodate wires and cables. No. of conduits etc. and nothing shall be payable on this account.
- D. The MCBs shall be mounted on high grade rigid insulating support and connected by electrolytic copper bus bars.
- E. Each incoming MCB isolator shall be provided with solder-less cable sockets for crimping.
- F. Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.
- G. Distribution boards shall be recessed in wall niche or if required mounted on the surface of the wall with necessary clamp bolts etc.
- H. The mounting height shall not exceed 1200mm from finished floor level. Distribution board shall be provided with proper circuit identification name plate and danger sticker/plate as per requirements.
- I. All the distribution boards shall be provided with engraved name plates with 'lighting', 'power' or 'UPS' with DB Nos., as the case may be.
- J. Each DB shall be provided with a circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number & phase.
- K. Each distribution board shall have a separate neutral connection bar and a separate earth connection bar mounted within the DB each having the same number of terminals as the total number of outgoing individual circuits from the distribution board. Conduit & cable armouring shall be bonded together & connected to the distribution board earth bar.
- L. Where oversized cables are specified due to voltage drop problems, it shall be contractors responsibility to ensure that satisfactory terminal arrangements are provided without an extra cost.

**2.12. TELEPHONE OUTLETS**

- A. Telephone outlets where called for shall be single or twin of the flush mounted type suitable to receive the plug-in telephone cable lead to the approval of the Telecom. The finishes of the telephone outlet plates at various areas shall be as specified for lighting switches.

**2.13. WATER COOLER DRINKING FOUNTAIN SWITCHES**

- A. Water cooler switches shall be flush-mounted having double pole AC switch rated at 20 amps and marked "water cooler".
- B. Associated connector units shall be provided next to the water cooler.
- C. The switches and the connector shall be IP65 waterproof rating.

**2.14. BELL PUSH SWITCHES**

- A. Bell push switches shall be flush-mounted having a single-pole AC switch rated at 6 amps and marked with bell symbol.

**2.15. SHAVER OUTLETS**

- A. Shaver outlets shall comprise a 20VA continuously rated double wound isolating transformer to provide an earth-free AC supply at mains frequency, complete with self resetting thermal overload device fitted in the primary circuit an insulated voltage selector switch to provide either 115 or 230 volt output, one ON-OFF switch and one universal socket outlet suitable for British, American, Continental and Australian razor plugs, all contained in a recessed sheet steel box with insulated moulded front plate suitable for flush, mounting and suitably inscribed to give a clear indication of the voltages available at the outlet and the service of the outlet.

**2.16. COOLER CONTROL UNITS**

- A. Cooler Control Units shall be flush mounted having a double pole AC switch rated at 30 amps complete with pilot indicating lamps and a self adhesive plastic identification label mounted on a removable chassis contained within steel box finished aluminium stoved enamel provided with conduit knockouts and earthing terminals. The cover plates shall be of the same finish as those specified for the lighting switches.
- B. Associated connector units shall be provided adjacent to the cooler units.
- C. Wirings between the cooler control units and associated connector units shall be provided in concealed conduits.

**2.17. WATER HEATER SWITCHES**

- A. Water heater switches shall be flush mounted having double pole AC switch rated at 20 amps fitted with pilot lamp and marked "water heater". The cover plates shall be of the same finish as those specified for the other switches. Associated connector units shall be provided next to the water heater units.

**2.18. POWER SUPPLY FOR LIGHTING AT WET CONDITION**

- A. Residual Current Circuit Breakers shall be provided individually for each circuits serving lighting subject to wet condition.



# WIRES AND CABLES

## PART 1 – GENERAL

### 1.1. WORK DESCRIPTION

- A. The design manufacture, testing and supply of single core PVC insulated 1.1 KV grade stranded twisted wires under this specifications shall comply with latest edition of following standards.
- IS-3961: Current rating for cables.
  - IS-5831: PVC insulation and sheath of electric cables.
  - IS-694: PVC insulated cables for working voltage up to and including 1100 volts.
  - IEC-54 (I): PVC insulated cable.
- B. Copper/Aluminium stranded twisted conductor PVC insulated wires shall be used in conduit as per item of work. Aluminium for power cables and copper for control cables shall be used.
- C. The wires shall be colour coded R Y B, for phases, Black for neutral and Green for earth.
- D. Progressive automatic in line indelible, legible and sequential marking of the length of cable in meters at every one-meter shall be provided on the outer sheath of cable.
- E. The design, manufacture, testing and supply of the cable under this specifications shall comply with latest edition of following standards:
- IS: 8130: Conductors for insulated electric cables and flexible cords.
  - IS: 5831: HRPVC/HR PVC insulation and LSZH sheath of electric cables.
  - IS: 3975: Mild steel wires, strips and tapes for armouring cables.
  - IS: 3961: Current rating of cables.
- F. The routing and the minimum rated current carrying capacity of the LV power cables shall be as indicated on the Drawings. The Contractor shall consider the manufacturer data and engineering the cable sizing to ensure it suit the conditions, viz grouping, ambient temperature etc., and for making any necessary adjustment to the Engineer's approval.
- G. All LV cables for normal power/control circuitries within buildings shall be copper conductor with XLPE insulated and PVC sheathed, denoted as XLPE/PVC cable or copper conductor with PVC insulated, denoted as PVC cable as specified.
- H. All LV cables for emergency power circuitries serving emergency lightings, Building Management System (BMS), Fire Protection System, Security Systems, emergency communication systems, and sump pump system and fire lifts etc. with back-up from standby generator sets or UPS systems or incoming and outgoing from the Emergency Main Switchboard shall be fire resistant cables as required.
- I. Cablings in service ducts, open trenches, direct-laid underground in soil shall be by means of armoured cables. Non-armoured cables shall be laid in conduits, trunkings or tray/ladder for mechanical protection.

## 1.2. STANDARDS

- A. Complete cabling shall be manufactured and constructed in accordance with the latest revision of the following standards :

1.	IS: 694:	HRPVC/XLPE insulated (heavy duty) electric cables for working voltage up to and including 1100 volts.
2.	IS:424-1475 (F-3):	Power cable-flammability test.
3.	IS:7098 (I):	Specification for cross-linked polyethylene insulated LSZHPVC sheathed cable for working voltage up to 1.1 KV.
4.	IS:1554:	Specification for PVC insulated (heavy duty) electric cables for working voltages up to and including 1100 volts.
5.	AS TMD:2863:	Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).
6.	ASTMD:2843:	Standard test method for measuring the density of smoke from the burning or decomposition.
7.	IEEE:383:	Standard for type of tests Class-IE, Electric cables, field splices and connections for power generation station.
8.	ASTME:662/IEC: 754(x):	Standard test method for specific optical density of smoke generated by solid materials
9.	IS:1041 8:	Cable drums.
10	IS-1081 0:	Testing method of cable.
11.	IS-6121:	Cable glands.
12.	IS-9537:	Rigid steel conduit.

- B. The manufacturing of the cable shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.
- C. In the adoption of standards and requirements, the Contractor shall take the following precedence:
1. Engineer's decision;
  2. Local codes of practice;
  3. Drawings;
  4. Specification;
  5. International standards and requirements.

### 1.3. SUBMISSION

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
- B. As a minimum requirement, the submission shall include the following:
  1. Equipment submission with manufacturer's data
  2. Sample submission
  3. Shop Drawings of the cable routings showing the co-ordinated routing of cables, arrangement on cable trays, methods of fixing of cable trays and cables, etc. All conduits including concealed conduit routing drawings shall also be included
  4. Cable test reports and IS Certification
  5. Builder's works requirement
  6. Cable schedule indicate the following data include:
    - a. Cable code and type and installation method
    - b. Cable feed from and serve to
    - c. Cable route length and voltage drop
    - d. Cable capacity and
    - e. Upstream protection breaker rating The cable schedule shall be prepare in according to the cable manufacturer's data..

## PART 2 – PRODUCT

### 2.1. LV CABLES

1. The cables shall be suitable for laying in racks, ducts, trenches conduits and under-ground buried installation with uncontrolled back fill and chances of flooding by water.
2. They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.
3. The aluminium/copper wires used for manufacturing the cables shall be true circular/sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.
4. The cable should withstand 2.5 KA for 1 Sec. with insulation armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of armour and screen (as applicable) shall not be less than the earth fault current values and duration.
5. The fillers and inner sheath shall be of non-hygroscopic fire retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.
6. Progressive automatic in line indelible, legible and sequential marking of the length of the cable in metres at every one metres shall be provided on the outer sheath of all cables and at every 5 metre 'LSZH marking in case of 'LSZH cables.
7. Strip/Wire armouring following method (b) mentioned in IS: 3975 shall only be acceptable. For single core cable aluminium wire armouring shall be used.
8. Allowable tolerance on the overall diameter of the cables shall be + 2mm.

9. The normal current rating of all HRPVC/XLPE insulated cables shall be as per IS: 3961.
10. A distinct inner sheath shall be provided by pressure extrusion process for all multicore armoured and unarmoured cables as per IS: 5831.
11. Outer sheath shall be provided by extrusion process as per IS: 5031.
12. The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface.
13. In plant repairs to the cables shall not be accepted.
14. All the cables shall be supplied in non-returnable drums as per IS: 10418.
15. In Case of LSZH Cables
  - The outer sheath of cables shall have an oxygen index of not less than 29 as per ASIMD : 2863.
  - The maximum acid gas generation by weight as per IEC:754 (i) shall not be more than 20% for outer sheath material of all cables. Bidder shall also guarantee the maximum theoretical acid gas generation with 20% by weight of outer sheath.
  - The cables outer sheath shall meet the requirement of light transmission of 40% (minimum and shall be tested as per ISTMD:2843). In case the test for light transmission is conducted as per ASTM E:662. The bidder shall furnish smoke density values as per this standard and shall co-relate the anticipated light transmission when tested as per ASTM D:2843.
  - The cable shall pass the fire resistance test as per SS:42, 41, 475 (I) and flammability test as per EEE:383.

A. Inspection:

All cables shall be inspected on receipt of the same at site and checked for any damage during transit.

B. Joints in Cables:

The contractor shall take care that the cables received at site are distributed to various locations in such a manner as to ensure maximum utilization and avoidance of cable jointing. Cable shall be rechecked before cutting in lengths, where the joints are unavoidable, and the location of such joints shall be got approved from the Owner/Consultant. The joints shall be done by qualified jointer strictly in accordance with manufacturer's instruction/drawings.

C. Joint Boxes for Cables:

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

D. Cable Joints:

1. All cable joints shall be made in suitable, approved cable joints boxes, on the jointing of cables in the joint box and the filling in of compound shall be done in accordance with manufacturer's instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.

2. End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1KV grade double compression type and made to tin plated heavy-duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.
3. All washers and hardware shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.
4. Cable lugs shall be tinned copper/aluminium solder less crimping type conforming to IS: 8309 suitable for aluminium or copper conductor.
5. Crimping of terminals shall be done by using Corrosion inhibitory compound, with crimping tool.
6. Fire resistant paint has to be applied 1 Meter on either side of cable joint.
7. The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison; no extra cost shall be incurred by the client.

## **2.2. H.T. CABLE (XLPE) (33 KV)**

- A. The cross linked polyethylene (XLPE) cable shall be aluminium conductor PVC outer sheath steel strip armoured over inner sheath construction. XLPE cable shall conform to testing in accordance with IS:7098 (Part-I) 1977 and (Part-II) 1973. The screening shall be done on individual cover. The armouring applied over the common covering shall be flat steel wires. Each and every length of cable shall be subjected to routine test.
- B. The termination and jointing techniques for XLPE cables shall be by using heat shrinkable or push on cable jointing kits.
- C. While laying underground cables in ducts care should be taken so that any underground structures such as water pipes, sewerage lines etc. are not damaged. Any telephone or other cable coming in the way shall be properly protected as per instructions of the Engineer-in-charge. The H.T. cable shall be laid at least 1200mm for cable upto 33 KV(E) below the ground level in a trench 450mm wide.
- D. After laying and jointing work is completed a high POT test shall be performed in presence of Engineer and test results submitted for approval in order to ensure that they have not been damaged during or after the laying operation. In case, the test results are unsatisfactory, the cost of all repairs and replacement and all extra work of removal and relaying will be made good by the contractor without any extra cost.  
Note: All other procedure will be followed as per L.T. cables.

## **PART 3 - EXECUTION**

### **3.1. ERECTION OF CABLES**

- A. Notwithstanding the cable routes indicated on the Drawings the Contractor shall be entirely responsible for the supply of correct lengths of the cables to be installed and for all allowances for connecting and terminating the cables to the switchgears and transformers respectively
- B. The Contractor shall submit proposed cable routes including details of supports for the cables for approval before installation. The cable shall not be run in places other than corridor, passageway, electrical riser or other designated areas subject to the Engineer's approval. The cost of support shall be deemed to have included in the Contract.

### 3.2. CABLE PULLING

- A. Winching of cables through ducts/pipes shall only be carried out with the approval of the Engineer in which event a pulley eye shall be attached to the conductors. Cable shall be run in neat and orderly manner to allow space for future cabling and maintenance and under no circumstances and cable shall be run diagonally across a room, cable basement, corridor, etc.
- B. A cable sheath stocking may be employed on cables where no undue stress in the sheath is likely to occur.
- C. Care shall be taken to ensure that the draw strain is applied to the armouring and protected during drawing against damage.

### 3.3. CABLE LAYING

- A. The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 8 times the diameter of cable.
- B. The cable of 1.1KV grade shall be laid not less than 750mm below ground level in a 375mm wide trench (throughout), where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the interaxial spacing between the cables except where otherwise specified shall at least be 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.
- C. In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 20 times the diameter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever is less. Minimum 3 meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.
- D. Greater care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall be conveyed on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.
- E. Cables laid in trenches in single tier formation, 10 cms. All around sand cushioning be provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30cm of sand cushion be provided over the initial tier. The cable shall be protected by 2nd class bricks of size not less than 230x115x75mm, stone tiles/RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the brick shall cover all cables and project at least 8 cms over the outer sides of the end cables.
- F. Filling of trenches shall be done after the sand cushioning and laying of tiles or bricks are carried out to the satisfaction of the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidate before laying the next layer.

- G. PVC pipe shall be provided for all road crossing. The size of the pipe shall be according to the cable and a minimum 100mm dia. pipe shall be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting with 1:5:10 shall be made as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Location of cables laid directly underground shall be indicated by cable marker at an interval of 30 meters & with change of direction. Aluminium strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.
- H. Where the cables are to be laid in ducts (pucca trenches) in side the building, they will have to be laid on MS rack/ on MS cable trays grouted in walls trenches. Cables sizing through floors shall be protected from mechanical damage by a steel channel to a height of one meter above the floor where cable pass through wall they shall be sleeved with PVC/steel conduit.
- I. Where the cables are laid in open (in building) along walls, ceiling or above false , cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray & riser shall be neatly dressed & clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multicore cables shall be fabricated of 25x3 GI flats. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fibre glass.
- J. Cable openings in wall/floor shall be sealed by the contractor suitably by hession tape & bitumen compound or by any other proven to prevent ingress of water.
- K. After the cables are laid, shall be tested as per IS and the results submitted to Architects/Engineer and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the contractor free of charge.

### **3.4. INTERNAL WIRING**

- A. All the wiring installation shall be as per IS:732 with latest amendment. PVC insulated copper conductor cables as specified in bills of quantity shall be used for sub-circuit runs from the distribution boards to the points and shall be pulled into conduits. They shall be twisted copper conductors with thermoplastic insulations of 1100 volts grade. Colour Code for wiring shall be followed.
- B. Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the consultant. No reduction of strands are permitted at terminations. No wire smaller than 1.5 sq.mm shall be used and shall be as per B.O.Q. Wherever wiring is run through trunkings or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals. Identification ferrules indicating the circuit and DB number shall be used for submains, subcircuit wiring. The ferrules shall be provided at both end of each submain and sub-circuit.
- C. Where single phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same phase of the supply. Circuits fed from distinct sources of supply or from different distribution boards or through switches or MCBs shall not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single phase switches connected to different phase shall be mounted within two meters of each other.

- D. All splicing shall be done by means of terminal blocks or connectors and no twisting connection between conductors shall be allowed.
- E. Industrial sockets shall be of polycarbonate and deeply recessed contact tubes. Visible scraping type earth terminal shall be provided. Socket shall have self adjustable spring loaded protective cap. Socket shall have MCB/ELCB/RCCB as specified in the schedule of work.

### 3.5. Fire Seal System

- A. All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.
- B. The fire proof sealing system shall fully comply with the requirements of relevant IS/BS:476 Part-B. The fire proof seal system shall have minimum one hour fire resistance rating.
- C. The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, antirodent and anti-termites.
- D. The material used in fire proof seal system shall be non-toxic and harmless to the working personnel.
- E. Type of fire proof seal system shall be foaming type or flammastic type compound or approved equivalent.
- F. After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.
- G. Cables for use on low and medium voltage system (1.1KV grade cables) should withstand for 15 minutes a pressure of 3000V DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities it is sufficient to test for one minute with a 1000V insulation tester In case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal & laying will be made good by the contractor.
- H. Cable shall be installed so that separations shown in the table below are observed.
 

1. HV Cable (33 KV)	- HV Cable (33 KV)	50 mm
2. ELV & LV 230 V/433 V	- ELV & LV cable 230 V/433 V	50 mm
3. HV cables (33 KV)	- ELV & LV cables 230 V/433 V	300 mm
4. LV cables 433 V	- Telephone/Instrument cable	350 mm
5. All cables	- All hot pipe work	200 mm

### 3.6. FACTORY TESTS

- A. Each type of cable specified shall be fully type tested according to IEC 502 and the appropriate British Standards. The types and sizes of cables required are shown on the Drawings.
- B. Should the Engineer require it, the Contractor shall submit reports issued by a national or international testing authority on type test that have been successfully performed on the cable for his approval.
- C. The type test shall include the following test:



1. Partial discharge test;
  2. Bending test, plus partial discharge test;
  3. Tan d measurement as a function of the voltage and capacitance measurement;
  4. Tan d measurement as a function of the temperature;
  5. Heating cycle test plus partial discharge test ;
  6. Impulse withstand test, followed by a power frequency voltage test;
  7. Medium-voltage alternating current test;
  8. Type test (non-electrical) as stipulated in IEC 502, Table VI.
- D. Cable routine test shall be conducted at factory in accordance with IEC 502 for the following tests: Measurement of the electrical resistance of conductors. Partial discharge test, 4-hour MV test.

### **3.7. SITE ACCEPTANCE TEST**

- A. The Contractor shall supply all necessary testing equipment for site testing. When required, these testing equipment shall be calibrated at the expense of the Contractor at a recognized national laboratory.
- B. The Contractor shall engage an Authorised Medium Voltage Testing Engineer who is recognised by SEB to perform all site tests.
- C. In addition to SEB's requirements and those recommended by the manufacturer, the following tests shall be carried out:
  1. Continuity test,
  2. Earth test,
  3. Polarity test,
  4. Insulation resistance test,
  5. DC high voltage test. The test voltage shall be in accordance with SEB's requirements and Engineer's approval.

## Chapter 2. BUS DUCT

### PART 1 – GENERAL

#### 1.1. DESCRIPTION

- A. This section specifies the supply, installation, testing, commissioning and setting to work of a totally enclosed, non-ventilated type of housing, low impedance insulated Aluminium bus duct system.
- B. Bus duct shall be of totally enclosed with independent copper earth bar, low impedance having minimum rating as indicated in the Drawings and Specification with all necessary fittings, tap-off units, supporting devices and manufacturer recommended accessories to complete the installation as a whole.
- C. Ratings and the indicative routings of bus duct shall be as indicated on the Drawings. It is solely the responsibility of the Contractor to carry out site survey, co-ordinated and check the location of these facilities and make any necessary adjustment modifications to the Engineer's approval.

#### 1.2. STANDARDS

- A. The bus duct shall be low impedance solid rectangular bus bars/ Trunking made of totally enclosed extruded aluminium housing with electro-tin plated hard drawn high conductivity copper to BS 1433 to BS 1432.
- B. The bus duct shall be type-tested assemblies (TTA) as defined in BS 5486: Part 1 (IEC439-1), manufactured and tested by a specialist bus duct manufacturer to BS 5486: Part 2 (IEC 439 – 2) or UL 857.
- C. Material and installation shall comply with BS7671, SEB regulations and any other recommended practices, Standards of ANSI, IEEE, NEMA and UL.
- D. BS: 381C/BS4800 - Specification for colours for identifications, coding & special Purpose
- E. BS: 1432 - Specification for copper for electrical purposes, High conductivity Copper rectangular conductors with drawn or rolled edges.
- F. BS: 2757 -Methods for determining the thermal classification of electrical insulation.
- G. IEC: 60529/EN60529 -Specification for degrees of Protection Provided by enclosure (IP code )
- H. IEC: 60439/EN60439 Part: 1 Section for low voltage switchgear & control gear assembled. Specification for type tested & partially type tested assemblies.
- I. IEC: 60947/EN 60947- 1-2, 3-4 Specification for low voltage switchgear & control gear etc. Technical & installation Requirements.
- J. The bus duct and associated equipment shall be certified for the category of duty specified hereafter, in particular, with regards to fault conditions and temperature rise limits.
- K. The manufacture of various components and accessories, including the plug-in units, shall be as recommended by the bus duct manufacturer to ensure compatibility of the components.
- L. The bus duct shall be of SEB approved type and the Contractor is required to submit project reference list for the Engineer's review.

### 1.3. SUBMISSION

- A. All technical submission shall be approved by the Engineer prior to the respective stages of construction.
- B. As a minimum requirement, the submission shall include the following:
  - 1. Equipment submission with manufacturer's data such as resistance per metre, reactance per metre, mV/A/m, contact resistance per joint, etc.;
  - 2. Test certificate for short circuit capacity and IP rating;
  - 3. Shop drawings for construction details of bus duct arrangements, spring hangers, wall flanges, floor flanges, plug-in boxes, etc.;
  - 4. Bus duct routing drawings showing the co-ordinated routing of the bus duct, setting out lines of the bus ducts relative to building grids, locations of bus duct joints, suspension and fixing units, etc.;
  - 5. Weight of equipment
  - 6. Builder's works requirement.

## PART 2 – PRODUCTS

### 2.1. GENERAL

- A. Bus duct shall be factory fabricated epoxy insulated totally enclosed, vermin and insect proof, non-ventilated type suitable for three phase four wire system with full sized Busbar for phases and neutral.
- B. Bus duct complete with plug-in units shall be type-tested to National Electrical Manufacturer's Association (NEMA) Standard (No. BU-1972) and U/L 857 and shall be able to withstand a short circuit condition equivalent to 50 kA 3 sec or not less than the type-tested short circuit capacity of the corresponding switchboards.
- C. Bus duct shall be insulated to Class B i.e. 85°C temperature rise above ambient temperature of 45°C but maximum operation temperature should not exceed 95°C.
- D. Eddy current heating shall be taken into account while designing the enclosure.
- E. A complete bus duct assembly shall comprise the following:
  - 1. Cable and box
  - 2. Hangers
  - 3. Plug-in/feeder Busbar
  - 4. Plug-in/tap-off box
  - 5. Elbow
  - 6. Off set
  - 7. Transposing unit
  - 8. End cap
  - 9. Fire barrier
  - 10. Expansion joints
  - 11. Integral earth
- F. Fire resistance bus duct shall be insulated with double layers of mica and silicone rubber on the bus bars. All jointing parts shall be protected with fire protective enclosure. Test certificate for fire resistant bus duct shall be submitted to the Engineer for approval. Fire resistance bus duct shall be provided for all circuit incoming and outgoing from the Emergency Main Switch Board.

- G. All bus duct and the associated fittings shall be minimum IP44 rating within Electrical room and Electrical riser. At car park, outdoor or plant room areas shall be weatherproof type to IP 65 in accordance to IEC 529. Weatherproof bus duct shall incorporate gaskets; drain holes, etc. suitable for outdoor use. All the plug-in, joint and accessories shall be special box-up to manufacturer detail to the same IP rating as the bus way.
- H. Minimum 2 nos. of hanger/support shall be provided for every 2m run of bus duct. Extra number of hangers will be required for joints. The bus duct shall be so supported that no visible stress shall be apparent from either unbalanced plug-in units. Vertical floor support shall be complete with spring hanger.
- I. All joints shall be the one-bolt removable/isolating type with through-bolts that can be checked for tightness without de-energizing the system. It shall be possible to make up a joint from one side in the event the bus duct is installed against the wall or ceiling. The joint shall be so manufactured so as to allow removal of any length without disturbing adjacent lengths. Belleville spring shall be provided to give positive pressure over complete contact area. Plug-in feeder shall use identical parts.
- J. The bus duct system shall be capable of being mounted in any position without de-rating. Plug in and feeder sections shall be interchangeable without the use of special adapter joint covers.
- K. The complete bus duct system shall be capable of withstanding the short circuit capacity of the electrical installation without damaging by the electrical, mechanical and thermal stress under fault condition of a service voltage of 440V 50Hz.
- L. Bus duct shall have rated insulation voltage and rated operating voltage of 650V respectively.

## 2.2. BUSDUCT

- A. The bus duct shall be of integrated one (single circuit) up to 2500 A and inter living type (Double circuit) above 2500 Amps.
- B. The bus duct conductor shall be Aluminium with 99.999 purity as per BS-1432. Adequately rated & supported by non-tracking moulded insulator spaced at suitable intervals. The complete assembly shall be capable of withstand the maximum mechanical stresses to which it may be subject to under fault conditions.
- C. The bus bar connections shall be constructed in accordance with the requirement of IEC-60439-1 or EN-60439-1 forgoing Part of switchboards & on current carrying capacity & limits of temperature rise.
- D. The current density of bus bars shall be considered as 0.8 Amps/ Sq.mm.
- E. The clearances between phase and neutral shall be as per BS 162; Bus bars shall be separated & supported with approximate clearances in air in addition to the requirements of providing full insulation. The material for phase identification shall be non-colour fading and adhesive label shall not be used.
- F. The bus duct shall be provided with three phase or three phases and neutral as indicated on drawing and BOQ.
- G. Non-deteriorating neoprene type gaskets shall be provided. The gaskets used for outdoor portion of the bus duct shall be non-deteriorating due to hostile climate conditions and direct exposure to sunlight.
- H. Bus bar supports shall be made of high quality insulating material such as FRP/DMC, SMC/Fibre glass araldite etc. The insulating material shall be treated against fungus. Surface of insulators shall be highly glazed and treated to minimize accumulation of dust.
- I. Flanged ends shall be provided to facilitate connection of bus ducts both at the transformer and switch gear end & switch gear to switchgear end. All hardware such as bolts, nuts, spring and plain washers shall be supplied along with bus duct to connect it at both ends.
- J. Reinforcement/stiffeners shall be provided for the covers from inside on which supporting lugs are provided.

- K. Flexible connectors shall be provided at the end terminations, both at transformer end and switch gear end and at intermediate places depending upon length and configuration of the bus duct. The connectors shall preferably be laminated to cater for linear expansion of bus bars. The material of flexible shall be same as bus bars. If different materials are used care shall be taken to prevent bimetallic corrosion.
- L. Earth bus of size made of Aluminium as mentioned in B.O.Q shall be fitted outside the bus duct throughout the length of the bus duct Two Nos. of terminals shall be brought out at ends of the earth bus to facilitate connection of earthing lead externally.
- M. A cross over chamber with sufficient number of links and supports shall be provided in accordance with system required. The cross over chamber shall effect change of phase sequences to match with respective phase sequences in the end equipment. The links, insulators and fasteners shall be located such that across the replacement/ tightening is available for all parts.
- N. Suitable fabricated adapter box with flexible links shall be provided wherever specified to interface with the termination arrangement on the end equipment connection. Bidder shall design the adapter box to suit exact requirements of the end equipment with adequate clearance and accessibility for end connections. All necessary links, supports, fasteners and washers shall be included in the scope of supply.
- O. The bus duct enclosure shall be fabricated for CRCA sheet steel of minimum size of 2mm.
- P. Bus bars and insulating supports shall withstand successfully thermal and dynamic stresses resulting from the circuit currents mentioned in the Data Sheets for the duration, so specified. Bus duct shall be able to with stand short circuit level of 50 KA for 1 sec.
- Q. The bus duct assembly enclosure shall be dust and vermin proof with IP-44 protection & IP-65 for outdoor installation. Adequate access shall be available for inspection/ replacement/ Tightening of bus bars and their support/fish plate etc.
- R. All steel fabrication work shall be powder coated of approved shade.

## **PART 3 – EXECUTION – TESTING & COMMISSIONING**

### **3.1. GENERAL**

- A. Store bus duct in clean dry area. Bus duct shall not be delivered or installed until building is enclosed and dry.
- B. Clean conducting surfaces and install bus in accordance with manufacturer's installation instructions. Torque all connections. Adjust spring hangers to equally distribute load.
- C. Provide 10 cm high concrete curb around bus duct floor penetrations.
- D. Provide a spring suspension hanger at each floor and not more than every 4 vertical meters.
- E. Provide expansion fittings in accordance with manufacturer's recommendations.
- F. Provide listed fire stop fittings at floor and wall penetrations.

### **3.2. DRAWINGS AND DOCUMENTS**

- A. Fully, dimensioned, scale drawing showing general arrangement, assembly, installation, configuration, clearance, creepage distances and interfacing details at both ends shall be submitted for approval.
- B. Calculations for bus bar capacity to carry rated current with specified maximum operating temperature.
- C. Short time thermal and dynamic withstand capacity under specified fault level, Heat loss calculations & Voltage drop calculations.

### **3.3. TEST**

- A. The bus duct shall be tested and inspected at fabrication shape in accordance with the relevant IS/ BS requirement for type and routine tests.
- B. After installation the following tests shall be performed before energising the bus duct.
  - High voltage withstands test for 1 min.
  - Megger test

### **3.4. INSPECTION**

- A. The Purchaser reserves the right to witness all routine tests at manufacturer's works prior to despatch to prove compliance with Specification. All expenses for conducting these tests shall be borne by the Bidder .Metering/testing equipment of approved range and accuracy class shall be arranged by the Vendor.

### **3.5. BASIS OF MEASUREMENT**

- A. The bus duct unit rate shall be based on per meter length basis measured along the longitudinal axis from flange to flange (centre line measurement} irrespective of horizontal/ vertical runs, bends, crossover chamber and adapter panel. The per meter rates shall be inclusive of bend, crossover box and adapter box flexible end coupler etc.

### **3.6. QUALITY ASSURANCE**

- A. Quality Assurance shall follow the requirements of Owner documents as applicable. QA involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirement.

### **3.7. DEVIATIONS**

- A. Deviation from specifications must be stated in writing at the quotation stage.
- B. In the absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

## **Chapter 3. PANEL BOARDS**

### **PART 1 – GENERAL**

#### **1.1. WORK DESCRIPTION**

- A. This specification covers the ‘General Requirements’ for the design, manufacture, supply performance, inspection, testing and commissioning including supply of indoor type low voltage switch boards up to 1000 V including necessary termination, cabling and bus work required for satisfactory operation .
- B. The Panel boards included, distribution boards and control panels shall be built in accordance with IEC 439 “Factory Built Assemblies for Low Voltage” or BS 5486 “Factory-built Assemblies of Switchgear and Control Gear for Voltage up to and including 1000 AC and 1200V DC.
- C. All factory built assemblies subject to rain or wet conditions or located outside electrical switch room shall be weatherproof constructed to IP 65, able to withstand high impact strength of 60 KN/m<sup>2</sup> (min.), temperature resistant, flame retardant and corrosion resistant.
- D. Specific requirements shall be in accordance with single line diagram/specification & BOQ.
- E. The technical parameters of switchgear equipments, transformers etc. shall be referred.

#### **1.2. STANDARDS**

- A. All equipment, material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where equipment is to be installed shall also be followed.
- B. The equipment offered complying with other standards, these standards shall be equal to or superior to those specified and full details of the differences shall be furnished along with the tender.
- C. The Panel boards shall be engineered and constructed in accordance with the latest revision of the following Indian and British standards:
  1. IS 13947 : A.C. Circuit Breakers
  2. IS 3427 : Metal enclosed Switchgear & Control Gear
  3. BS 162 : Safety Clearances
  4. IS 2705 : Current Transformers
  5. IS 3156 : Voltage Transformers
  6. IS 3202 : Code of Practice for climate proofing of electrical equipment
  7. IS 375 : Marking & Arrangement for Switchgear Bus Bars, main connections and auxiliary wiring.
  8. ARE 722 : A.C. Electric Meters
  9. IS 1248 : Direct acting Electrical Indicating Instruments

10. IS 3231 : Electrical Relays for Power System Protection
  11. IS 2544 : Epoxy Cast Resin Insulators
  12. IS 5082 : Electrolytic Copper/ Aluminium
  13. IS 5792 : High Voltage HRC fuses
  14. BS 88 : Cartridge fuses for voltages up to and including 1000V AC and 1500V DC.
  15. BS 89 : Direct acting electrical indicating analogue electrical measuring instruments and their accessories.
  16. BS 142 : Electrical protective relays
  17. BS 159 : Busbar and Busbar connection
  18. BS 1433 : Copper for electrical purposes. Rods and bars.
  19. BS EN 60898 : Circuit-breakers for over current protection for household and similar installations.
  20. BS 3938 : Current transformers
  21. BS EN 60947-2 : Low-voltage switchgear and control gear, Part 2 circuit-breakers.
  22. BS 4794 : Control switches (switching devices, Part 1 including contactor relays, for control and auxiliary circuits, for voltages up to and including 1000V AC and 1200V DC). General requirements.
  23. BS 5419 : Air-break switches, air-break disconnectors, and fuse combination units for voltages up to and including 1000V AC and 1200V DC.
  24. BS 5420 : Degrees of protection of enclosures of switch Part I great Part I and control gear for voltages up to and including 1000V AC and 1200V DC.
  25. BS 5424 : Control gear for voltages up to and including 1000V AC and 1200V DC – Part 1 Contactors.
  26. BS 5486 : Low-voltage switchgear and control gear Part 1 assemblies. Part I: Requirement for type tested and partially type tested assemblies.
  27. BS 5685 : Electricity meters – Part I: Class 0.5, 1 and 2 single phase and poly phase, single-rate and multi-rate watt-hour meters.
  28. BS 5992 : Electrical relays
  29. BS 6004 : PVC insulated cables, (nonarmoured), for electric power and lighting.
  30. BS 6231 : PVC insulated cables for switchgear and control gear wiring.
  31. IS 3043/ BS7430 : Earthing
- D. BS/IEC or IS not mentioned above but are applicable to this installation shall also apply.



### **1.3. SUBMISSION**

- A. Detailed co-ordination with other services, shop drawings for various electrical layouts such as equipment layout and earthing layouts, including equipment installation and cable termination details etc. prior to start of work.
- B. Such drawings shall show the proposed method of construction of the cubicles, method of supporting equipment and Busbar, full details of Busbar layout, method of support, electrical control wiring diagrams, equipment weight, colors, and surface treatment.
- C. The drawings shall also incorporate a full list of proposed materials. The construction shall not commence until the drawings are approved for construction.
- D. Factory and site testing procedures and report formats shall also be included.
- E. Preparation of bill of materials for Different Items as mentioned in Schedule of Quantities.
- F. Lighting/power panel schedule.
- G. Interconnection drawing.
- H. Protection co-ordination drawings/tables for complete power system.
- I. Shop inspection and testing procedures.
- J. Field testing and commissioning procedures.
- K. Preparation of as built drawings for the services the contractor is rendering. Any other work/activity which is not listed above; however is necessary for completeness of electrical system.

## **PART 2 – PRODUCTS**

### **2.1. PANEL BOARD**

- A. The switch boards shall be cubicle type, suitable for indoor installation, floor mounting and free standing. The design shall be totally enclosed, dust - tight, damp-proof and vermin proof offering degree of protection not less than IP-42.
- B. Separate segregated compartments shall be provided for circuit breakers, bus bars, cable box, voltage transformers, wire ways, relays, and instrument and control devices. Switchgear cubicles/ modules shall be provided with hinged doors in front with facility for padlocking door handles.
- C. Vent openings shall be covered with grills so arranged that hot gases cannot be discharged through them in a manner that can injure the operating personnel. These vent openings shall be vermin proof.
- D. All panels shall be of same height, width and depth. Panels shall be bolted together to form a continuous flush front switch board, suitable for front of board operation.
- E. The switchgear cubicles shall be rigid and robust in design and construction, fabricated out of CRCA sheet steel. Cubicles shall be made from rigid welded structural frames made of structural steel sections or of pressed/formed sheet steel of not less than 3mm thickness. The frames shall be enclosed by sheet steel of at least 2mm thickness, smoothly finished, leveled and free from flaws. Stiffeners shall be provided wherever necessary.

- F. All doors, panels, removable covers shall be provided with non deteriorating (neoprene) gaskets all around the perimeter.
- G. All doors shall be removable and supported by concealed type hinges. The hinges shall be strong and braced to ensure freedom from sagging, bending and general distortion of panel or hinged part.
- H. Floor mounted cubicles shall be provided with a 75mm high channel base frame. The total height of the cubicle shall not exceed 2400mm, keeping in view the operating height of top switch should not exceed 1750mm from FFL including base channel.

## **2.2. BUSBARS & BUSBAR CHAMBER**

- A. Three phase bus bars shall be of high conductivity electrolytic Aluminium as stated in B.O.Q.
- B. The bus bars shall be air insulated and housed in a separate compartment, segregated from all other compartments.
- C. Bus bars & bus bar connections shall be of uniform cross section shall be suitable for carrying rated current continuously and short circuit current for specified duration without overheating. The bus bars connections shall be adequately supported on insulators to withstand dynamic stresses due to short circuit current specified. Normal operating temperature for bus bars shall be 85 Deg C. Short circuit rating of the bus bars shall be 20 to 50 KA for 1 sec as per BOQ.
- D. All bus bar joints and bus tap joints shall be silver or tin plated. Joints shall be bolted type and shall be insulated. Spring/Lock washers shall be provided to ensure good contact on the joints.
- E. Direct access to accidental contact with bus bars and primary connections shall be avoided by providing shrouds. All apertures and slots shall be protected by barriers to prevent accidental shorting of bus bars. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle into another.
- F. All insulating materials used shall be non-hygroscopic and shall be treated for preventing fungus growth. Surface of insulators shall be highly glazed and treated with silicone compounds to minimize accumulation of dust, condensation and tracking.
- G. All bus bars shall be color coded as per IS:375.

## **2.3. CURRENT TRANSFORMERS (CTs)**

- A. Current transformers shall be of suitable ratio, burden & class/accuracy as specified in Single Line Diagram.
- B. Current transformers shall conform to latest edition to relevant standards. The Current transformers shall be epoxy resin cast with bar Primary or ring type.
- C. The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses due to the maximum short circuit current of the circuit.
- D. The current transformer shall preferably be capable of being left open circuited on the secondary side with primary carrying rated full load current, without overheating or damage. Short time current rating and rated withstand time shall be same as corresponding C.B.
- E. CT core laminations shall be of high grade silicon steel.

- F. Secondary terminals of CT shall be brought out to a terminal block which will be easily accessible for testing and external connections. Facility shall be provided for short circuiting and earthing of CT secondary leads through a removable and accessible link with provision for attaching test link.
- G. Rating plate details and terminal markings shall be according to the latest edition of relevant Indian Standard specification.
- H. Current transformers (core) shall be used for metering and protection.

#### **2.4. POTENTIAL TRANSFORMERS (PTs)**

- A. Potential Transformers shall conform to latest edition of relevant standards.
- B. Potential transformers shall be dry, cast epoxy resin type. The PTs shall be of single phase construction.
- C. The PTs shall be capable of operating continuously at 110% of the rated voltage without any damage. When star - star connection is required in non-effectively or ungrounded system, the PTs shall be suitable for continuous operation with a persistent phase to ground fault.
- D. Maximum temperature rise of the transformer at rated burden and with rated primary voltage and frequency shall not exceed 40 Dig's above an ambient of 45 Dig's.
- E. HRC Fuses shall be provided secondary side. It shall be possible to replace PT fuses easily without having to de-energise the main bus bars. Prospective interrupting current rating of the fuses shall be same as the system fault level.
- F. Voltage transformer ratio, output and class shall be as specified in the drawing & BOQ. Name plate as per relevant standards shall be provided on the PT.

#### **2.5. PROTECTIVE RELAYS**

- A. Relays type and numbers shall be in accordance with the protective scheme specified or as per drawings and B.O.Q.
- B. Relays shall be enclosed in rectangular shaped cases, suitable for flush mounting only, dust tight covers projecting from the front cover panel. The case shall be dust tight, damp proof and tropicalised.
- C. Relays shall be accessible for setting from the front. Access to setting devices shall be possible only after removal of front cover.
- D. Protective relays shall be draw out type. Where it is not possible to provide protective relays of the draw out pattern, fixed type relays with facilities for plugging in a portable test plug shall be provided. Necessary test plugs shall be furnished along with the relays.
- E. Relays shall be provided with positive action self reset type with indicator. The indicator/s shall be visible from the front.
- F. Relays conform to relevant standards in all respects.
- G. Relays shall be provided with minimum two pairs of self or hand reset type contacts as specified. Auxiliary relays shall have the number of NO and NC contacts as specified in data sheet.

## 2.6. SAFETY/ PROTECTION & INTERLOCKS/FEATURES

Following interlocks and features shall be incorporated for equipment protection and personnel safety under mal-operation. No deviations on these interlocks and safety features are allowed. These interlocks and safety features shall be fail-safe, positive and full-proof.

- A. It shall not be possible to plug-in or isolate a closed circuit breaker. An attempt to do so shall trip the breaker. (In case of breakers with vertical isolation, this will apply to raising and lowering). There shall be a positive locking facility to prevent closing of circuit unless it is in Service or Test position.
- B. Closing and opening operations shall be possible only in discrete, well defined Test and Service positions and not in any position midway. An extension adapter cable with plugs and sockets shall be preferably be provided so that the closing and opening operation of the circuit breaker can be done in fully withdrawn position outside the cable.
- C. Slow operation of circuit breakers shall be possible only in the circuit breaker in Test or Isolated position.
- D. Isolating switches if provided shall be interlocked with respective circuit breakers to prevent them making or breaking the current.
- E. 1 no. bus earthing truck shall be supplied with each panel to earth the out going cable of the VCB breaker.
- F. Automatic safety shutters for all openings which will lead to access to the live parts of the switchgear upon withdrawal or any operation the switchgear components/parts shall be provided, preferably with a padlocking facility.
- G. Spring of motor operated spring charged mechanism shall not discharge until they are fully charged and charging means are fully disconnected.
- H. Where key interlocking is employed, tripping of a closed circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.
- I. Any other interlocks which manufacturer may deem to be required for safety and specifically specified separately required for the system shall be included.
- J. All terminals, connections which may be live and exposed for accidental contact shall be adequately shrouded.
- K. Components within cubicles shall be properly labeled to facilitate testing.

## 2.7. EARTHING

- A. The switch board shall be provided at the bottom throughout its entire length with an earth bus of copper of adequate size to carry the fault current for the duration same as short time rating of the circuit breaker. Earth bus shall have two earthing connection facility at its both ends of earthing conductor.
- B. All non-current carrying metal parts, frames and equipment mounted in the switch board shall be bonded to earth bus.
- C. Earthing of moving carriage of draw out equipment shall be achieved by scraping earthing device. The earthing device shall maintain positive earth continuity in all Service Test and Isolated positions.
- D. It shall be possible to connect each circuit or set of three phase bus bars to earth either through earthing trucks or through the circuit breakers.
- E. One earthing trolley suitable for earthing of cables & bus bars for all circuit breakers of the same type/rating shall be provided.

## 2.8. INSTRUMENT & METERS

- A. Electrical indicating instruments shall be digital type with zero adjustment, probe from outside the cover.
- B. Multi function meter of CL 1.0 accuracy with RS 485 port shall be provided.
- C. Instruments/meters shall be suitable for flush mounting on the panel with flanges protecting outside the panel.
- D. All meters shall be industrial grade with accuracy of class 1.0 unless specifically indicated.

## 2.9. CONTROL WIRING

- A. All wiring for control, protection, alarm and indicating circuits on all equipment shall be carried out with at least 650V grade, PVC insulated, stranded, copper, 1.5 Sq.mm conductors.
- B. All wiring shall be run on the sides of the panels and shall be neatly bunched and cleared without affecting access to equipment mounted in the panel. Where wiring enters or passes through compartments containing HT apparatus then they shall be in earthed metallic conduits or ducts.
- C. All wiring shall be taken to terminal blocks without joints or tees in their run.
- D. All wiring shall be colour coded as follows:
  - Instrument Transformer AC circuit - Red, Yellow & Blue determined by the Phase with which the wire is associated.
  - AC Phase Wire - White
  - AC Neutral - Black
  - DC Circuits - Grey
  - Earth connections - Green
- E. Engraved core identification ferrules, marked to correspond with the wiring diagram shall be fitted to each wire. Ferrules shall fit tightly on the wires, without falling off when wire is removed. Ferrules shall be of white colour with black lettering. Each wire shall be identified by letter to denote its function followed by a number to denote its identity at both ends.
- F. All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block.
- G. All unused auxiliary contacts of the circuit breaker and relays shall be wired up to terminal block.

## 2.10. FITTINGS AND ACCESSORIES

### A. Indicating Lamps

1. LED type indicating lamps shall be provided everywhere except where low voltage filament type with series resistor called for.
2. Lamp covers shall be provided with interchangeable coloured lenses of Perspex or equivalent unbreakable material. The lenses shall not discolour in course of time due to heat of the lamp.
3. Bulbs and lenses shall be interchangeable and replaceable from the front.

4. Following colours shall be used for the function indicated:

Red	-	Circuit Breaker 'ON'
Green	-	Circuit Breaker 'OFF'
White	-	Continuous trip supply supervision
Amber	-	Auto trip
Blue	-	Spring charged
R.Y.B	-	Potential indication

**B. Push Buttons**

1. All push buttons shall be push to actuate the contact type.
2. Start & Stop push buttons shall be colored green and red respectively. Reset push buttons shall be yellow in color and test push buttons shall be blue in color. All other push buttons shall be black in color.
3. Emergency stop push buttons shall be lockable in the operated position, i.e. push to operate and key to release type. Push buttons for emergency stop shall be recessed/shrouded type to avoid accidental operation.

**C. Control & Selector Switches**

1. Control and Selector switches shall be of rotary type, having enclosed contacts accessible only after removal of cover.
2. All control and selector switches for circuit breakers and instruments shall be mounted on the front of the panel. Control switches for space heater/s and control supplies shall be mounted inside the panel.
3. Circuit Breaker control switches shall be provided with pistol grip handles. Selector switches shall be provided with round, knurled handles. All handles shall be black in color. Properly designated escutcheon plates clearly marked to show the operating positions shall be provided on all switches.
4. Circuit breaker control switches shall normally have three position close - Normal - Trip with spring return to normal position. Switch operating mechanism shall prevent the switch from being operated twice successively in the same direction. Circuit breaker control switch shall have one NONC contact along with other contacts as required.
5. All other instruments and selector switches shall have stay put contacts.
6. Contacts of all control and selector switches shall be rated for 10 Amps at 240V AC or 20 Amps at 220V dc (inductive break). Switch for space heater supply and control voltage supply shall normally be two pole rated for 25A A.C.

**D. Control Terminal Blocks**

1. Box - clamp type, 650V grade line up terminals of minimum 2.5 Sq.mm size shall be provided. Connection to terminals shall be from front.
2. Not more than one wire on each side shall be connected on any terminal. Where duplication of terminals block/s is necessary, suitable solid bonding links shall be incorporated.
3. Terminal blocks at different voltage shall be segregated into groups and distinctly labelled.
4. Current transformer secondary leads shall be brought to terminal blocks having facility for short circuiting and grounding the secondary.

5. Terminals shall be numbered for identification and grouped according to function. Engraved back on white PVC labels shall be provided on the terminal blocks describing the function of the circuit.
6. Separate terminal stems shall be provided for internal and external wiring.
7. Control terminal blocks shall be so located that control cables are fully segregated from power cables. Suitable insulated or earthed metal race ways shall be provided for control wiring. Separate unrolled removable gland plate shall be provided for the control cables at the bottom of each panel.
8. Minimum 10% of total number spare terminals shall be provided for future use.

#### **2.11. NAME PLATES AND LABELS**

- A. One Name plate giving designation of the MV switchboard shall be affixed prominently on top of the switch board. Details of designation will be specified.
- B. Labels giving following details shall be affixed on each feeder panel: i. Feeder No. ii. Equipment reference no. & Description iii. Rating (HP/KW/KVA/Amp.)
- C. All components whether mounted inside or on the door shall be permanently and clearly labelled with reference number/letter or their function. Rating of fuse shall be part of fuse designation. Paper labels, stickers or labels fixed with adhesives are not acceptable. All labels shall be properly fixed by screws with provision to prevent distortion due to expansion.
- D. All labels shall be non-corroding, preferably laminated plastic or rear engraved Perspex with white letters on black background.
- E. Labels for feeder panel designation fixed on front side shall be fitted with chrome plated, self tapping, and counter sunk head screws. These labels shall be of identical size to permit interchange.

#### **2.12. SPACE HEATERS**

- A. Adequately rated anti-condensation space heaters shall be provided in each cubicle.
- B. Space heater/s shall be trip type, rated with operation voltage of 240V, 50 Hz. AC supply.
- C. Each space heater shall be complete with a 2P MCB, 10KA and a control thermostat.
- D. The space heater shall be rated for maintaining the panel inside temperature 10 Deg.C above outside ambient temperature.

#### **2.13. CUBICLE LIGHTING**

- A. Each cubicle shall be provided with interior lighting by means of CFL light fixture. An ON/OFF switch/door switch shall be provided. The lighting fixture shall be suitable for operation from a 240V single phase, 50 Hz. A.C. supplies.

#### **2.14. AUXILIARY SUPPLY**

- A. Auxiliary supply for control, indication, space heater etc. shall be made available at one point on the switch board. Vendor shall provide suitable auxiliary supply in the switch board.

**2.15. FUSES**

- A. Fuses shall be HRC cartridge link type (Diazed Fuses are not acceptable) and shall be provided with operation indicator which shall be visible without removal of fuses from service.
- B. Fuses shall be pressure fitted type and shall preferably have ribs on the contact blades to ensure good line contact.
- C. It shall be possible to handle fuses during off load conditions with full voltage available on the terminals. Wherever required fuse pullers shall be provide. The fuse bases shall be so located in the modules to permit insertion of fuse pullers and removal of fuse links without any problems.
- D. Mounting of fuse fitting shall ensure adequate dissipation of heat generated and shall facilitate inspection and easy replacement of fuse.

**2.16. CONTACTORS**

- A. The contactors shall be air break type, equipped with three main contacts and minimum 2 NO + 2 NC auxiliary contacts. The main contacts of a particular contactor shall have AC 3 ratings for unidirectional motors & AC 4 for reversible motors.
- B. The auxiliary contacts shall be rated for minimum 5 Amps at 240V AC and 1.3 Amps at 110V DC (Inductive load).
- C. Unless specified otherwise, the coil of the contactor shall be suitable for operation on 240V, + 10% and – 15% 1 PH, AC supply. The contactor drop off voltage shall be between 15% to 65% of the rated coil voltage.

**2.17. SINGLE PHASING PREVENTOR (SPP)**

- A. Unless specified otherwise SPPs shall be provided in all motor starter modules with contactor rating of 200 Amps and above. The SPP shall be of the current operated type and shall operate on the principle of sensing negative sequence component of current.
- B. In case of single phasing, the SPP shall operate after a time delay of 2 to 3 secs. The relay shall be of the hand reset type and visual indication of the relay operation shall be available.
- C. The SPP shall be suitable for protection of the non-reversible and reversible motors. The relay operation shall be independent of the loading and RPM of the motor prior to the occurrence of single phasing.

**2.18. CABLE TERMINATION**

- A. The switch board panel shall be complete with suitable cable end termination for XLPE insulated cables. Cable and sealing box shall preferably be mounted inside the panel. For XLPE cables adequate space and clearances shall be made for heat shrinkable termination e.g. Raychem or cold flowing stress grading joints.
- B. Two earthing terminals shall be provided in each panel in cable box/cabling chamber for earthing armour/screen.
- C. Where more than one core is terminated on each phase, links suitably designed and properly supported shall be provided to avoid unnecessary bending of cable cores without decreasing the length of insulated cable tail. Electrical clearances which would normally be required when using one core per phase shall be maintained.
- D. Where core balance type current transformers are provided on switchgear feeder circuit cable/s for earth fault protection sufficient space, clearance and support, mounting arrangement shall be provided for the CT.



## **PART 3 – EXECUTION**

### **3.1. TESTING AND COMMISSIONING**

- A. All panel boards shall be inspected & tested in the presence of Owner/ Consultant's representative and certified by the installation Engineer that it is safe before supply is energized, and that all the equipment comply with the requirements of the Specification.
- B. Generally such tests in the factory and repeated at site are as follows:
  - 1. All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.
  - 2. Test for protective relay operation by secondary injection method.
  - 3. Operation of all meters.
  - 4. Secondary wiring continuity test
  - 5. Insulation test with 1000 Volts mugger, before and after voltage test.
  - 6. HV test on secondary wiring and components on which such test is permissible (2 KV for one minute)
  - 7. Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
  - 8. Measurement of power required for closing/trip coil of the breaker.
  - 9. Pick up and drop out voltages for shunt trip and closing coils.
  - 10. CT Polarity test.
  - 11. Power frequency voltage withstand test.
  - 12. Earth continuity tests;
  - 13. Check of clearance and creep age distances;
  - 14. Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications, etc.;
  - 15. Interfacing test with BMS control function
  - 16. All other tests required by the Engineer to verify compliance with the Specification.
- C. Triplicate sets of all principal test records and test certificates are to be supplied for all the tests carried out in accordance with the Specification to the Engineer for approval before dispatch from the factory.
- D. All costs, materials, equipment, labour, etc. necessary for the execution of the testing shall be included in this portion of work.

### **3.2. DRAWINGS AND INFORMATION**

- A. The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:
  - 1. General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cut-outs/trenches for external cables and elevations, transport sections and weights.
  - 2. Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.

3. Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.
  4. Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.
  5. Relay wiring diagrams. 6. Equipment List.
- B. Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.
- C. The information furnished shall include the following:
1. Technical literature giving complete information of the equipment.
  2. Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.
  3. A comprehensive spare parts catalogue.

### **3.3. TOOLS**

- A. One complete set of all special or non-standard tools required for installation, operation and maintenance of the switch board shall be provided. The manufacturer shall provide a list of such tools individually priced with his quotation.

### **3.4. SPARES**

- A. The manufacturer/tendered shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

### **3.5. TRANSPORTATION**

- A. Panel boards are not allowed to be delivered to site until the electrical room or switch room is in a clean and acceptable condition with lockable doors.
- B. Panel boards, transported to site shall be fully covered with weatherproof covers and transportation eye bolts shall be provided for handling at site.
- C. Panel boards, which are poorly packed and result in signs of corrosion, will be rejected.
- D. All necessary measures to cover and protect the panel boards at site shall be provided. Such measures shall include a complete PVC blanket over the whole panel boards.

### **3.6. REJECTION OF PANELBOARDS**

- A. Deviation from specification must be stated in writing at the quotation stage.
- B. In absence of such statement, it will be assumed that the requirements of the specifications are met without expectation.
- C. If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer. Delivery of panel boards on site without significant cable connection (Say 80%) shall not entitle progress payment certified for material delivery on site.

## Chapter 4. CIRCUIT BREAKER

### PART 1 – GENERAL

#### 1.1. SCOPE

- A. Circuit breaker including Air-circuit breaker (ACB), Moulded Case Circuit Breakers (MCCB), Miniature Circuit Breakers (MCB) and Residual Current Circuit Breakers (RCCB / RCD) shall be provided according to the specification.
- B. All breakers shall be capable of withstanding the electrical, mechanical and thermal stress of the prospective fault level experience. The prospective fault levels of the various breakers shall be verified according to result in short circuit/co-ordination study specified in specification Section 11002.
- C. The drawings, specification and BOQ complement each other and which is shown or called for one shall be interpreted as being called for on both. Material, if any, which may not have been specified but fairly required to make a complete assembly of switch gear as shown on the drawing, specifications shall be construed as being required and no extra charges shall be payable on this account.

#### 1.2. STANDARDS

- A. All equipment, material and components shall comply with the requirements of the latest editions of Indian Standards with updated amendments. Standards and Regulations applicable in the area where equipment is to be installed shall also be followed.
- B. The equipment offered complying with other standards, these standards shall be equal to or superior to those specified and full details of the differences shall be furnished along with the tender.
- C. The Panel boards shall be engineered and constructed in accordance with the latest revision of the following Indian and British standards:
  1. IS/IEC: 60947-2 : Air circuit breaker/molded case circuit breaker.
  2. IS: 3156 : Voltage transformers.
  3. IS: 2705 Part-I, II & III 1964 : Current transformers for metering and protection with classification burden and insulation.
  4. IS: 9224 : Low voltage fuse and protection.
  5. IS: 3231 : Specification for electrical relays for power system protection.
  6. IS:8623 : Specification for factory built assemblies of switchgear and control gear for voltage upto and including 1000-V AC/1200 V-DC.
  7. IS: 4237 : General requirements for switch gear and control gear for voltage not exceeding gear.
  8. IS: 2147 : Degree of protection provided by enclosures for low voltage switch gear and control gear.
  9. IS: 1018 : Switchgear and control gear selection/ installation and maintenance.

10. IS: 1248 : Direct acting electrical indicating instruments.
11. IS: 375 : Arrangement for switchgear, bus bars, main connections, auxiliary wiring and marking.
12. IS: 2959 : AC contactors for voltage not exceeding 1000V.
13. IS: 5578 : Guide for marking of insulated conductors.
14. IS: 11050 : Guide for forming system of marking and identification of conductors & apparatus terminal.
15. IS: 1248 : Direct acting indicating analogue electrical measuring instruments and testing accessories.
16. IS: 6005 : Code of practice for phosphating of iron & steel.
1. BS EN 60898 IEC 898 : Circuit breakers for over current protection for household and similar installations. 2.BS EN 60947-
  2. IEC 947-2 : Low-voltage switchgear and control gear, Part 2 circuit breakers.
  3. BS 54193. : Air-break switches, air-break disconnectors, and fuse combination units for voltage up to and including 1000V AC and 1200 VDC.
  4. BS 5486 : Low-voltage switchgear and control gear Part 1 assemblies. Part 1 requirement for type tested and partially type tested assemblies.
  5. BS 4293 : Residual Current Circuit Breaker
- D. D. BS/IEC or other National standards not mentioned above but are applicable to this installation shall also apply.

### 1.3. SUBMISSION

- A. A component list and catalogues.
- B. Preparation of bill of materials for Different Items as mentioned in Schedule of Quantities.
- C. Factory and site testing procedures and report formats shall also be included.
- D. Protection co-ordination drawings/tables for complete power system.
- E. Shop inspection and testing procedures.
- F. Field testing and commissioning procedures.
- G. General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cutouts/trenches for external cables and elevations, transport sections and weights.
- H. Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.
- I. Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.
- J. Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.
- K. Relay wiring diagrams.
- L. Equipment List.

- M. Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.
- N. The information furnished shall include the following:
1. Technical literature giving complete information of the equipment.
  2. Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.
  3. A comprehensive spare parts catalogue. Any other work/activity which is not listed above; however is necessary for completeness of electrical system.

## **PART 2 – PRODUCTS**

### **2.1. AIR CIRCUIT BREAKERS**

- A. Air circuit breakers shall be metal clad, flush mounted, horizontal draw out isolation, air break type complying to IS/IEC 60947-2. Air circuit breakers shall have a rupturing capacity of not less than short circuit current experienced at location of installation for 1 second certified by ASTA or other recognized testing authorities.
- B. The breaker shall be provided with variable microprocessor based releases for over load, short circuit and earth fault protection (and shall be compatible with PC) and shall be in conformance with this specifications.
- C. All air circuit breakers (ACBs) shall be of draw-out type encased in metal clad housings. The manufacturing of the breaker shall be such that there is no compulsory safety clearance imposed around the breakers, in order to optimise the switchboard space requirement.
- D. The ACBs shall be so manufactured that they comprise of main and arcing contacts of adequate ratings and housed in reinforced polyester casings, offering double insulation from the front face and ensuring no possibility of "Flashover" between phases. The main contacts shall have double-actions in each pole and all contacts shall be silver-plated and replaceable.
- E. Arc chutes with stainless steel filters shall be provided on each pole of the breaker as an efficient means of arc control. The filters must be effective to minimize the diffusion of ionized gas outside the breaker when the contacts open on short circuits. This manufacturing detail must be effective at all levels of current for which the breaker is manufacture to operate. Any arc created as a result of the opening of the breaker's contacts during fault conditions shall be completely contained in the chute without any possibility of a "Flashover" between poles or to adjacent earthed metallic parts.
- F. The draw out version of ACBs shall have three indicated positions as follows:
- a. The breaker is fully racked-in with all the main & auxiliaries engaged.
  - b. Connected: The breaker is fully racked-in with all the main & auxiliaries engaged.
  - c. Tested: The breaker is racked out and with the main disconnected, but all auxiliaries are still connected.
  - d. Disconnected: The breaker is fully withdrawn and all circuits disconnected.
- G. A clear means of Positive Contact Indication (PCI) shall be provided by a mechanical flag marked "ON" or "OFF" to indicate the circuit breakers contact positions. The stored energy mechanism shall also have clear indications marked "CHARGE" or "DISCHARGE" to reflect its status.
- H. Safety shutters shall be provided to all draw out breakers in order to inhibit inadvertent access (degree of protection IP20) to the "live" clusters when the breakers are in the "Test" or "Disconnected" positions. It must be possible to padlock the safety shutters in the SHUT position.

- I. Auxiliary switches shall be equipped for each breaker for indication, alarm and control purposes. Auxiliary switches shall be robust, with double break-action, easily accessible for maintenance and having adequate current ratings to carry the connected load. Each breaker shall have provision for extending the number of auxiliary switches to cover future alarm or signalling circuit requirements. All auxiliary circuitry wiring shall be connected on the front face of the breaker on a set of disconnecting terminals to facilitate the automatic disconnection of auxiliary circuits when the breaker is in the "Disconnected" position.
- J. Circuit breakers shall be manufactured for optimum performance with minimum maintenance. The mechanical endurance (C-O cycles) without maintenance shall be at least 12500 cycles for breakers up to 1600A, 10000 cycles for breakers from 2000A to 4000A and 5000 cycles for 5000A and 6300A breakers. The electrical endurance (C-O cycles) at 440V without maintenance shall be 10000 cycles for breakers up to 1600A, 8000 cycles for breakers of 2000A, 5000 cycles for breakers of 2500A to 4000A and 1500 cycles for 5000A and 6300A breakers.
- K. The circuit breakers shall be equipped with electrical motor operating mechanisms for automatic charging of the stored energy spring mechanism. However, this shall not prohibit the breakers to be operated manually, if required. Closing operations can be initiated either from the local push button on the front face of the circuit breaker or by remote control. The closing coils shall be rated at 230 v AC. After closing, the stored energy spring mechanism shall immediately be recharged automatically by the motor, so as to be ready for next closing operation when the breaker trips.
- L. Normal manual opening of the circuit breaker shall be accomplished either from the local push button on the front face of the circuit breaker or by means of a trip coil. The trip coil must be capable of carrying continuous rated current, i.e. being permanently energized, for electrical interlocking purposes. The tripping mechanism shall be robustly built and stable without possibility of being inadvertently operated by shock or jerk. The trip coil shall be manufactured such that the plunger operates immediately when activated, without having undue delay for the building up of the coil's magnetic field. Regardless of all circumstances, the speed of closing and opening shall be independent of the operator.
- M. The operating mechanism, carriage and hinged panel shall be so interlocked that it is not possible to withdraw the circuit breaker while it is in the closed position. Closing of circuit breaker in between service and disconnected position is also not possible and vice versa.
- N. Provision shall be made so that it is possible to operate the circuit breaker mechanism when it is in the disconnected position.
- O. The main circuit breakers for the incoming supply and the bus-tie (couple) breaker shall be mechanically and electrically interlocked such that only two of the three circuit breakers can be closed at any one time. The mechanical interlock shall be achieved by means of Ronis keys and electrical interlock by means of a permanently energized coil. The system shall be so arranged that the withdrawal of any one circuit breaker shall in no way effect the operation of the others.
- P. Pad locking facilities shall be provided for each breaker so that breaker operation can be locked in a particular position if so indicated.

- Q. The tests to verify the characteristics of circuit breaker shall include type tests, routine tests and special tests.
1. Type test shall include:
    - a. Verification of temperature rise unit
    - b. Verification of dielectric properties
    - c. Verification of rated short-circuit making and breaker current
    - d. Verification of mechanical operation and endurance
  2. Routine test shall include:
    - a. Mechanical operation tests
    - b. Calibration of releases
    - c. Dielectric tests
- R. Other tests, which are to be carried out on request of the relevant authorities, shall be done on the Vendor's account. Vendors must submit type test certificates issued by ASEFA, ASTA or other recognized testing authorities together with the Technical documents or upon request.

## **2.2. MOULDED CASE CIRCUIT BREAKERS (MCCB)**

- A. The MCCB shall comply with IS/IEC 60947-2. The MCCB shall be provided with over current protection by means of thermal and magnetic tripping element.
- B. All MCCB tripping mechanism shall be ambient temperature compensated. MCCB of frame sizes greater than 150 amps shall be equipped with continuously adjustable magnetic pick up setting. MCCBs used for incoming main feeders shall in addition be provided with continuously adjustable rated current settings in the range of 50 to 100% rated current.
- C. The MCCBs shall have quick make and quick break mechanism independent of the operating speed. The tripping mechanism shall be mechanically "trip free" from the handle so that the handle cannot be closed against fault conditions. All MCCBs should have isolation feature and line load reversibility.
- D. The MCCB shall be provided with door interlock handles. All handles shall be large and robust to carry out the switching operation with ease. The handle shall clearly indicate the "ON", "OFF" and "TRIP" positions. The handle shall be able to be locked in the "ON" or "OFF" positions. When locked in the "ON" position it shall still be possible for the handle to indicate "TRIP" when the MCCB has tripped. An interlock release mechanism shall be provided to enable the door to be opened when the MCCB is locked in the "ON" position.
- E. Multi-pole MCCB shall have a common-trip bar so that a fault condition on any one pole of the MCCB will cause all poles to trip simultaneously.
- F. The MCCB interrupting capacity shall be not less than that indicated on the drawings and back up discrimination/ cascading charts should be submitted of the OEM. G. MCCBs of ratings 200A and above shall be of Busbar termination type, adaptable for use with bolts and cable lugs.
- G. Automatic change over MCCBs shall be of the motorised type, fully withdrawable, with both mechanical and electrical interlock. The transfer operation shall be controllable by an adjustable time delay of between 0.1 to 30 sec. The actual transfer time of the MCCBs shall not exceed 2 sec. The motor mechanism shall utilise universal motor with electromagnetic clutch and shall be equipped with full handles to allow manual operation of the MCCB. All automatic change over MCCBs shall have a minimum mechanical life of 10,000 operations.
- H. MCCB when used for motor protection shall have characteristics suitable for the motor starting. Standard range MCCB shall not be substituted for motor protection circuits.

- I. All fully with
- J. drawable MCCB shall have interlocks to prevent withdrawal when the MCCB is ‘ON’.
- K. All main moulded case circuit breaker shall be provided with at least 2 pairs N/O and N/C auxiliary contact.
- L. Indicating lamps shall be of the panel mounting, LED type and shall have execution plates marked with its function wherever necessary. The colour of the lamp cover shall be red for ‘ON’ and green for ‘OFF’ indicating lamps shall be provided with series resistor.

### **2.3. MINIATURE CIRCUIT BREAKERS (MCB)**

- A. MCBs shall comply with IEC 898:1995. They shall be of the current limiting type having a sealed ambient temperature independent thermal magnetic tripping mechanism providing overload and short circuit protection. All MCBs shall be of 35mm D/N symmetrical rail mounted type.
- B. The breaking capacity of MCBs shall be at least equal to the prospective fault level at the point installation, unless back-up by a current limiting upstream breaker of the same make.
- C. The MCB operating mechanism shall be mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short circuit and overload conditions. It shall be of the automatic resetting type.
- D. The individual operating mechanism of each pole of a multi-pole MCB shall be directly linked within the MCB casing and not with the operating handles.
- E. The operating handle shall be of the toggle type with possibility for mounting of padlocking facility.
- F. Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short circuit protection.
- G. It shall be possible to fit on site auxiliaries like shunt-trip coil, under-voltage release, ON/OFF switch or alarm switch.

### **2.4. RESIDUAL CURRENT CIRCUIT BREAKERS (RCCB)**

- A. RCCB shall comply with BS 4293 and shall be of the current operated type.
- B. The RCCBs shall be manufactured to trip within 0.1 second for 30 mA.
- C. The RCCBs shall be of 2-pole construction for single phase and 4-pole construction for 3 phases.
- D. All RCCBs shall be complete with test buttons.
- E. All RCCBs shall be batch tested and bear the appropriate test label of approval to SEB requirement.
- F. All RCCBs shall be of high sensibility type as appropriate and as specified in the drawing. They shall be of surge proof manufacture to prevent nuisance tripping due to transient over voltage.



## **PART 3 – EXECUTION**

### **3.1. TESTING AND COMMISSIONING**

- A. All Switch gears shall be inspected & tested in the presence of Owner/ Consultant's representative and certified by the installation Engineer that it is safe before supply is energized, and that all the equipment comply with the requirements of the Specification.
- B. All routine tests specified in relevant Indian/British Standards shall be carried out on all circuit breakers.
  - 1. Test for protective relay operation by primary or secondary injection method.
  - 2. Operation of all meters.
  - 3. Secondary wiring continuity test
  - 4. Insulation test with 1000 Volts megger, before and after voltage test.
  - 5. HV test on secondary wiring and components on which such test is permissible (2 KV for one minute)
  - 6. Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
  - 7. Measurement of power required for closing/trip coil of the breaker.
  - 8. Pick up and drop out voltages for shunt trip and closing coils.
  - 9. CT Polarity test.
  - 10. Tests to prove correct operation of controls, interlocks, tripping and closing circuits, indications, etc.;
  - 11. Interfacing test with BMS control function.
  - 12. All other tests required by the Engineer to verify compliance with the Specification.
- C. Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests.
- D. Required copies of test certificates for all the tests carried out along with copies of type test certificates and certificates from Sub-Vendor for the components procured from them are to be submitted before dispatch of switch boards.

### **3.2. TOOLS**

- A. One complete set of all special or non-standard tools required for installation, operation and maintenance of the switch board shall be provided. The manufacturer shall provide a list of such tools with his quotation.

### **3.3. SPARES**

- A. The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

### **3.4. QUALITY ASSURANCE**

- A. Quality Assurance shall follow the requirements of Owner/ Consultant as applicable.

- B. Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

### **3.5. DEVIATIONS**

- A. Deviation from specification must be stated in writing at the quotation stage.
- B. In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.
- C. If any of the above tests fail to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site, the Engineer may reject the item or defective component thereof, whichever is considered necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit that item for further inspection and/or test. In the event of the defective item being of such nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item is to be replaced by the Contractor at his own expense, to the entire satisfaction of the Engineer.

# Chapter 5. CONDUIT SYSTEM, CABLE TRAY, CABLE LADDER AND TRUNKING INSTALLATION

## PART 1 – GENERAL

### 1.1. WORK DESCRIPTION

- A. This section describes the supply and installation of wiring facilities systems include conduits, cable trays, cable ladder and Trunking system, c/w associated fittings and accessories.
- B. All cables run above the suspended false ceiling, concealed in walls, columns, or on surface shall be supported by conduits, cable tray and Trunking or cable ladder system. No free slinging cable is allowed.
- C. The cable routes as shown in the drawings shall be used as a guide only. Prior to the installation, the cable routes shall be coordinated with other services. Uncoordinated and inaccessible routes after other services are installed, shall be relocated at the expense of the Contractor.
- D. All conduits, trunking, cable trays and cable ladders shall be earthed in accordance to IS: 4043.

### 1.2. STANDARDS

- A. The complete wiring facilities system shall be manufactured, supplied, installed and tested in accordance with the latest revision of the India-Delhi standards and the appropriate BS/IEC include:
  - 1. Steel Conduit and Fitting Accessories IS:9537 (Part-II)/ BS4568 & BS731
  - 2. PVC Conduit and Fitting Accessories IS-9537/1983 (Part-III)/BS6099 & BS4607
  - 3. Cable Tray BS729
  - 4. Cable Ladder BS729
  - 5. Cable Trunking BS4678
- B. The complete wiring facilities system shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.
- C. In the adoption of standards and requirements, the Contractor shall take the following precedence:
  - 1. Engineer's decision;
  - 2. Local codes of practice;
  - 3. Drawings;
  - 4. Specification;
  - 5. International standards and requirements

### 1.3. SUBMISSIONS

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction. Routing of installation Sample with proprietary factory-made accessories, elbows, risers, reducers, tees, crosses, etc.

## **PART 2 – PRODUCTS**

### **2.1. STEEL CONDUIT AND ACCESSORIES**

#### **A. Steel Conduit**

1. All conduits shall be of heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet up to 32mm dia and of 14 (2 mm) gauge for sizes higher than this.
2. Both inner and outer surfaces shall be smooth without burrs, dents and kinks.
3. Conduits shall be black stove enamelled inside and outside. The cross section of conduit shall be uniform throughout.
4. The welding shall be uniform such that welded joints do not yield when subjected to flattening test. Welded joint shall not break when threaded or bent at an angle.
5. Conduit shall conform to specifications of IS: 9537 (Part-II) and the capacity of conduits shall be in accordance with the standards and shall never be exceeded.
6. The minimum size of the conduit shall be 19/20mm dia.
7. Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit shall be used.

#### **B. Fittings**

1. Samples of conduit fittings shall be submitted for approval prior to installation.
2. Fittings shall be those intended for use with screwed conduits and shall comply with IS 9537. However, bends, elbows and tees shall not be installed.
3. Boxes and cover plates that are installed outdoors shall have fixing lugs exterior to the box so that fixing screws do not enter the box interior.
4. Adaptors used with flexible conduits shall conform to IS: 9537.

#### **C. Circular Boxes**

1. Circular boxes shall be of malleable cast iron, galvanized and of standard pattern with spout(s). When used for connecting lengths of conduits, circular boxes shall be provided with cover plates of similar make that are complete with brass fixing screws.

#### **D. Rectangular Boxes**

1. Rectangular boxes (adaptable boxes) shall be of mild steel not less than 2.4 mm gauge and galvanized. When used as junction boxes, lids of the same gauge with brass fixing screws shall be used.

#### **E. Boxes for Accessories**

1. Boxes for accessories shall be suitable for surface mounting or recessed mounting according to the requirements. Surface mounted boxes and accessories shall be metal clad pattern. Recessed boxes and accessories shall be complete with insulated moulded type cover plates conforming to IS: 5133 Part I-1969.

#### **F. Covers**

1. All covers for boxes, etc shall be made of galvanized steel of 1.2 mm thickness.

## **2.2. PVC CONDUIT AND ACCESSORIES**

### **A. PVC Conduit**

1. All conduits shall be high impact rigid 2mm thickness PVC heavy duty type and shall comply with I.E.E. regulations for non-metallic conduit 2mm thick as per IS-9537/1983 (Part-III).
2. All sections of conduit and relevant boxes shall be properly cleaned and glued by using epoxy resin glue and the proper connecting pieces.
3. Inspection type conduit fittings such as inspection boxes, drawn boxes, fan boxes and outlet boxes shall be M.S. or otherwise mentioned.
4. Conduit shall be terminated with adapter/PVC glands as required.

### **B. PVC Conduit Accessories**

1. Accessories used for conduit wiring shall be of an approved type complying to IS: 3837- 1966.
2. All accessories used shall be of standard white or black colour, identical to conduit used.
3. Plain conduits should be jointed by slip type of couplers with manufacturer's standard sealing cement.
4. All conduit entries to outlet boxes, Trunking and switchgear are to be made with adaptors female thread and male bushes screwed.
5. PVC-switch and socket boxes with round knockouts are to be used. The colours of these boxes and the conduits shall be the same.
6. Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.
7. Samples of accessories shall be submitted for approval prior to installation.
8. All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

## **2.3. CONDUIT INSTALLATION**

### **A. Layout**

1. The conduit layout and conduit routes shall be submitted for approval. Allowance for adjustments due to site conditions shall be provided with no extra cost.
2. Conduit routes shall be chosen for easy, straight runs with a minimum of bends and crossings. Generally they shall follow the structure of building, running at right angles or in parallel to floors and ceilings. Conduits shall be kept within 300 mm of floors and ceilings when running parallel to them.
3. Outlet boxes for housing accessories shall be used as draw boxes. The total number of draw boxes shall be kept to a minimum and shall be provided so that conduit runs do not exceed 12 m or have more than two right angle bends.
4. All conduits shall be kept clear of gas and water pipes. In particular, conduits shall be at least 150 mm away from gas pipes. Where proximity to these pipes is unavoidable, they shall be effectually segregated e.g. using rubber or other insulating material to prevent appreciable voltage differences at possible points of contact. Segregation from extra low voltage circuits and telecommunication circuits shall also apply unless these are wired to the same voltage requirements as lighting and power circuits.

5. Conduits from different distribution boards shall not be connected to the same junction box. Each run of conduit shall be assembled complete with draw-in-wires.

#### B. Joints and Terminations

1. Electrical and mechanical continuity shall be maintained throughout all conduit joints and terminations. Conduit threads shall be thoroughly cleaned and the conduits tightly screwed. The conduit system shall be watertight after installation.
2. Conduits shall be connected using couples or via boxes. With a coupler, the ends of the conduit shall be butted close together and the running coupler is screwed tightly on and tightened by a locknut.
3. Conduits terminating into boxes provided with spouts shall be threaded so that there are no exposed threads. For boxes with no spouts, the termination shall be made using a brass bush and a coupler. The conduit is pushed through the knockout or drilled entry and the bush is screwed tightly onto its end. The coupler is screwed to butt firmly against the exterior wall of the box.
4. Where conduits are not jointed or terminated in boxes, they shall be terminated in a screwed brass bush.
5. In all joints and terminations, conduit threads shall not be exposed. Where this cannot be avoided as in a running coupler, the exposed threads shall be coated with red lead paint to seal against the ingress of water.

#### C. Bends

1. Conduits shall only be bent cold with an approved type of bending block or bending machine, without altering the dimensions of their sections.
2. All conduit bends shall be such as to permit compliance to the requirements for bends in cables to as stated in the BS 7671.
3. Bends shall be made with as large a radius as the position of the conduit within the building permits. Where the bend is more than 90 degree, circular or rectangular junction boxes are to be used for connecting conduits.

#### D. Cabling

1. The conduit system must be completely installed and free of obstructions and sharp corners before any cables are drawn in. Conduits shall be thoroughly swabbed to remove moisture and dirt immediately prior to the drawing in of cables.
2. Cables shall be drawn without crossing each other and shall not be pulled against the walls of the draw boxes. Slack cables shall be left in all draw boxes.
3. Cables shall be continuous throughout conduit lengths and no joints are permitted. There shall be no kink in cables, neither any cut, abrasion or chink in the cable insulation.
4. The same conduit shall carry the lead and return conductors bunched together. However, the same conduit shall not house cables from different distribution boards.
5. Cables for power and lighting circuits and extra low voltage systems shall not be drawn into the same conduit. Lighting and power final circuits shall be run in separate conduits except, where an adaptable box is employed as final distribution point, a number of final circuits may be grouped together in larger conduits between the distribution board and the adaptable box provided that all final circuits in one conduit are of the same phase. In the case of three phase circuits, all three phases including neutral, if any, shall be drawn into the same conduit.

6. Conduits shall not constitute the earth continuity path for the electrical circuit. A separate circuit protective conductor shall be installed within the conduit. The whole conduit system shall be effectively earthed.
7. Flexible conduits shall also have a separate earthing conductor installed within the tubing and connected at conduit ends. Flexible conduits in general shall not be used for more than 3m length.
8. Maximum number of PVC insulated 650/1100 V grade/copper conductor cable conforming to IS:694-1990

Nominal	20mm		25mm		32mm		38mm		51mm		64mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11	12	13
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	5	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

Note:

- i. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
- ii. The columns heads 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns heads 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
- iii. Conduit sizes are the nominal external diameters.

#### E. Access and Drainage

1. The conduit system shall be rewirable, that is, draw boxes must be accessible for the purpose. Where boxes are concealed, their covers shall be flushed with the finished surface.
2. The need for accessibility notwithstanding, the conduit system shall be protected against the ingress of water and impurities. When installed, conduits shall be kept dry and free of debris with approved pipe plugs or caps. Such plugging is

especially essential prior to pouring concrete for concealed installation. As for boxes, they shall be covered by steel plates prior to concreting.

3. When installed outdoor, and in situations liable to condensation of moisture, conduits shall be arranged to be self draining, so that water may drain to low points which are fitted with a drain plug. Conduits laid under concrete floors shall have watertight floor-traps of approved detail for access of these drainage points.
4. Conduits run on surfaces other than structural steel members shall be secured using galvanized space bar saddles and brass fixing screws. Spacing of saddles shall not exceed 1.2 m for conduit sizes up to and including 25 mm and 1.8 m for sizes 32 mm and above.
5. Conduits run on structural steel shall be secured using girder clips or an approved clamp. These conduits and those run in the vicinity of structural steel shall be bonded to the steelwork using an efficient and permanent metallic connection. The conduits shall not in any way be under mechanical stress.
6. All conduit boxes except loop-in patterns shall be fixed direct to the building structure in addition to the support provided by the conduits.
7. Conduits terminating into surface boxes shall be secured by a minimum of 3 saddles at not less than 32 mm, 150 mm and 300 mm respectively from the box.
8. Conduits shall be painted with an approved paint to blend with visual environment. A zinc rich undercoat shall be provided before painting the final coat.

#### **2.4. CABLE TRAY**

- A. Cable tray shall be of perforated type and constructed a minimum 2.0 mm hot dipped galvanized mild steel for outdoor damp condition, and epoxy coated electro-galvanized mild steel for indoor installation. All cable trays shall be installed in a straight run parallel to walls where possible.
- B. Cable trays shall be supported by electro-galvanized 'U' channel with galvanized threaded rod for indoor suspended tray and hot-dipped galvanized for area subject to weather.
- C. All hangers shall be installed at 1 metre intervals and shall be primed and painted to match with the surrounding building finish approved by the Engineer.
- D. For cable tray that are exposed to the weather, a hot-dip galvanized covers of 1.5mm gauge steel, flush fixing type with gasket, shall be installed on top of the tray.
- E. Depending on the size of cable trays spare space of 25% shall be maintained for future expansion.
- F. Copper earth link bar shall be fixed at every joint of the cable tray run.

#### **2.5. CABLE LADDER**

- A. All cable ladders and accessories installed indoors shall be heavy-duty epoxy coated electro-galvanized mild steel type. All cable ladders installed outdoors shall be heavy-duty hot dipped galvanized hot rolled mild steel. Thickness of the mild steel shall not be less than 2 mm.
- B. Cable ladder shall have a 150 mm high longitudinal side member for ladders width of 800 mm or above and 120 mm high longitudinal side member for ladder width less than 800 mm.



- C. The rungs shall be at least 50 mm wide, with slots of 25 mm x 10 mm at 25 mm intervals covering the length of the rungs. The rungs shall be spaced at 300 mm apart along straight lengths of the ladder.
- D. All nuts, bolts and washers for clips and brackets shall be zinc plated. Each cable ladder shall be in standard manufacturer's length and supplied complete with coupling sets consisting of fishplates, spined bolts, nuts and locking washers.
- E. The complete cable ladder installation shall be provided with all necessary proprietary factory-made elbows, risers, reducers, tees, crosses, drop-outs, etc. and any site fabricated items will not be permitted.
- F. Separate flexible earth continuity connectors of at least 16mm<sup>2</sup> copper jumpers shall be installed between the ladder sections.
- G. All cable ladders shall be supported from the ceiling concrete slab, steel structures or sidewalls using a frame system, with overhead hangers, support channels, hanger rods or angle brackets, beam clamps and ceiling brackets.
- H. Fixings and supports shall be installed at regular intervals not exceeding 1000 mm and 150 mm from all bends, tees, inter-sections and risers.
- I. When cable ladder is required to install across structure expansion joints, the ladder shall be in two sections between supports installed on either side of the expansion joint.
- J. The ladder sections shall then be jointed with expansion joint fishplates, bolts, nuts and washers installed in elongated holes permitting a lengthwise movement of 25 mm from the initial fastening position.
- K. For cable ladders that are exposed to the weather, a hot-dip galvanized cover of 1.5mm gauge steel, flush fixing type with gasket, shall be installed on top of the ladder.
- L. Copper earth link bar shall be fixed at every joint of the cable ladder run.

## **2.6. CABLES TRUNKING**

- A. Cable trunking shall be manufactured from 1.6 mm minimum electro-galvanized mild sheet steel to BS4678 finished in oven-baked electrostatically coated epoxy powder coating with color to the Engineer's choice.
- B. All trunking shall have removable lids extending over their entire lengths. Lids shall be fixed at interval not exceeding 1 metre by means of brass steel screws which are protected against corrosion by a finish of zinc coating or equivalent to zinc coating.
- C. Factory-made bends, joints, elbow, riser, tee, reducer and accessories with same material shall be provided throughout the installation for trunking.
- D. Trunking space factor shall be in compliance with latest IS standards.
- E. Copper earth link bar shall be fixed at every joint of the cable trunking run. Note: All items mentioned in this section shall be manufactured to comply with the specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA)

## Chapter 6. EARTHING SYSTEM

### PART 1 – GENERAL

#### 1.1. WORK DESCRIPTION

- A. This section specifies the engineering, supply, installation, testing, commissioning and setting to work of the complete earthing network for individual earthing systems, circuit protective conductors and bonding conductors. A complete earthing network comprising cables, copper tapes, electrodes and earth bonding of all relevant necessary non-current carrying metal parts of equipments/ apparatus shall have connected as required.
- B. The system shall have a common earthing system as described in the Specification and as shown on the Drawings. Individual earthing systems shall be provided as follows as per drawing. Earth main MV/LV/Generator Electrical Earthing shall have 2 connection to the earthing system:
  - 1. MV Electrical Earthing
  - 2. LV Electrical Earthing
  - 3. Generator Earthing
  - 4. ELV Earthing
  - 5. Data Communication Earthing
- C. Sufficient numbers of electrodes interconnected by Cooper/ GI (as per BOQ) to form earthing mat so that the overall earth resistance shall be less than 1 ohm for each individual earthing mat.
- D. The number of earth electrodes of the earthing mat are indicated on the drawings as minimum. The Contractor shall test the resistivity of soil at site. Exact number of earth electrodes shall be determined by the Contractor to achieve the earth resistance value subject to Engineer approval. The complete earthing installation include earth plate, earth mat detail to achieve the earth resistance value shall be included in the Contract.
- E. The Contractor shall inform the Engineer or his representative before driving Plate/ pipe earthing into the ground so that he may supervise the operation. Driving shall be carried out only in the presence of the Engineer or the representative and all earthing plates/ pipes shall be submitted for the examination before use.

#### 1.2. STANDARDS

- A. Complete earthing system shall be engineering and constructed in accordance with the latest revision of the following standards and the appropriate BS/IEC: 1.
  - 1. IS: 3043 : Earthing
  - 2. BS6651 : Lightning Protection System
  - 3. IEC 61024-1-2 : Lightning Protection System
- B. The detail of the Earthing System shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.

### **1.3. SUBMISSION**

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction.
- B. As minimum requirement, the submission shall include the following:
  - 1. Shop Drawings and Sample Submission;
  - 2. Builder's work requirements;
  - 3. Testing procedures and report format for testing of the earth electrodes and/or earth strips;
  - 4. Soil resisting test report with calculation report for the details of the earthing system detail including quantity and layout of earth electrodes and/or earth strips to achieve the required earth resistance. The report shall be endorsed by the Contractor's Installation Engineer who supervise and endorse the installation upon completion;
  - 5. Proposed details of earthing system including quantity and layout of the earth electrodes and/or earth strips according to the calculation result.

## **PART 2 – PRODUCT**

### **2.1. GENERAL**

- A. The resistance between earthing system and the general mass of earth shall not be greater than 1 ohm.
- B. The earth loop resistance to any point in the electrical system shall not be in excess of 0.5 ohms in order to ensure satisfactory operation of protective devices.
- C. The resistance to earth shall be measured at the following:-
  - 1. At each electrical system ground or system neutral ground.
  - 2. At one point on each grounding system used to ground electrical equipment enclosures.
  - 3. At one point on each grounding system used to ground wiring system enclosures such as metal conduits and cable sheaths or armoured.
- D. All earthing conductors shall be of high conductivity copper/ G.I. as per B.O.Q. and shall protected against mechanical damage. The cross-sectional area of earth conductors shall not be smaller than half that of the largest current carrying conductor. However, the contractor shall use the sizes specified in the bill of quantities of the Tender. Common earth mats of resistivity of less than one (1) ohm, shall be constructed below the lowest floor structure prior to any ground work construction. The earth mats shall comprise the complete earth electrodes, earth strips/grids, earth inspection chambers, earth leads, main earth terminals, earth test link boxes at ground level, etc. Each individual earthing system shall have earth leads connecting its main earth terminal directly to an earth electrode underground as specified.
- E. All earthing products/accessories shall be according to IS standards.
- F. The mating surface of all tapes at joints etc shall be cleaned before clamping and all joints shall be riveted, joint with proper connector or exothermic welded. All connections to electrical apparatus shall be made by a bolted connection in a visible and accessible position

## 2.2. PIPE EARTH ELECTRODE

- A. G.I. pipe shall be of medium class 100mm dia and 3m in length.
- B. G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other upto 2m of length from bottom.
- C. The electrode shall be buried in the ground vertically with its top not less than 20cm below ground level.
- D. Clamping of the earth leads to the earth rod shall be made by earth clamp. The clamps shall be capable of providing a high pressure contact between the earth rod and the earth leads to achieve a low contact resistance.
- E. When two or more electrodes are driven to form a group, the heads of the electrodes in the group shall be bonded to each other by means of a 25 mm x 3mm GI/ Copper strip, laid at a depth of at least 600 mm in soil.
- F. All earth electrode penetrations through basement water proofing membranes shall be provided with manufacturer's recommended water seal insert sleeve approved by Engineer. The installation of the water seal insert sleeve shall be under the supervision and endorsed by the manufacturer's representative to ensure the installation comply with the manufacturer installation detail.

## 2.3. PLATE EARTH ELECTRODE

- A. The plate earth electrode shall consist of copper plate or G.I. plate as per item of work. The plate electrode shall be buried in ground with its faces vertical and top not less than 4.5m below Ground level. The plate shall be filled with charcoal dust and common salt filling, extending 15cm around it's on all sides.
- B. A watering pipe of 50mm dia of medium class G.I pipe shall be provided.
- C. The top of the pipe shall be provided with a funnel and a G.I. mesh screen for watering the earth. In the case of pipe electrode a removable plug shall be provided.
- D. The earthing lead from electrode onwards shall be suitably protected from mechanical injury by a suitable dia medium class G.I. pipe in case of wire and size according to strip size.
- E. The overlapping of strips at joints shall done in approved manner
  - a. GI strips shall be riveted with rivets/ bolted and welded.
  - b. Copper strips shall be riveted with rivets/ bolted brass nuts, bolts and washers and brazed.
- F. The protection pipe within ground shall be buried at least 30 cm deep (to be increased to 60cm in case of road crossing and pavements).
- G. The portion within the building shall be recessed in walls and floors to adequate depth.
- H. In the case of plate earth electrode the earthing lead shall be securely bolted to the plate with two bolts, nuts, check nuts and washers.
- I. In case of pipe electrode, it shall be connected by means of a through bolt, nuts and washers and cable socket.
- J. Main earthing conductor is taken from the earth electrode with which the connection is to be made.
- K. No earth pit shall be fixed within 1.5 M of a wall of foundation. The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. Effort shall be made to locate them in grass lawns or near flower beds or water taps.

## **2.4. EARTH INSPECTION CHAMBER**

- A. Earth electrode shall be fitted with a heavy-duty pre-cast concrete inspection chamber/pit complete with heavy-duty cover as specified on drawings.
- B. For earth electrodes located outside or on the apron of the building, earth inspection chambers shall extend to a depth of not less than 300 mm below finished ground level and kept free of soil. For earth electrodes located inside building, earth electrodes shall be buried not less than 100 mm below the floor slab structure. Each earth electrode shall be clearly marked 'SAFETY ELECTRICAL EARTH CONNECTION – DO NOT REMOVE.
- C. The chamber and cover shall be heavy duty detail to consider the traffic load at the location of installation. The cover shall be recessed cover to receive the Architectural floor finish at the location of installation.

## **2.5. EARTH STRIP**

- A. Earth strips/grids shall be of bare GI/ Copper strips of 25 mm x 3 mm as specified.
- B. Earth strips shall be riveted or joint with proper connector to earth electrodes underground below the floor slab structure, and shall be buried not less than 300 mm below the floor slab structure.
- C. In order to minimise the mutual inductance between strips, earth strips shall be positioned at a distance not less than 6m apart unless otherwise specified.

## **PART 3 – EARTH BONDING**

### **3.1. CIRCUIT PROTECTIVE CONDUCTOR**

- A. Circuit protective conductor (CPC) is a system of conductors joining together all exposed conductive parts and connecting them to the main earth terminal.
- B. The purpose of circuit protective conductor is to provide a path for earth fault current so that the protective device will operate to remove dangerous potential differences during a fault condition.
- C. The circuit protective conductors shall take the form of separate cable with a sheath in green/yellow color or copper tape of minimum size 25mm x 3mm.
- D. All exposed non-current carrying metal parts of light fittings, switchgears, motors, enclosures, etc. shall be effectively earthed by circuit protective conductors for earth continuity protection.
- E. For equipment where an earth terminal is provided, the earth continuity wire shall be firmly clamped. Where no earth terminal is provided, the exposed metal part shall be cleaned of paint and surface rust before welding the earth continuity lead.
- F. The minimum size of the principal protective conductors shall be in accordance with to the current edition of IS: 3043/ BS7671 and BS7430.
- F. The external earth terminal on the outside of the end panel of any switchboard shall be connected to the main earth bar provided in two independent points.
- G. Circuit protective conductors shall be provided in electrical and mechanical rooms and along the routes for the bonding of all exposed conductive parts and extraneous conductive parts. A suitably sized earth terminal shall be provided at each zone of the building for this purpose.
- H. All exposed conductive parts shall be effectively connected in an approved manner to the principal protective conductors. The circuit protective conductors shall be single core copper cables or high conductivity annealed copper tapes specified. Unless otherwise specified, the minimum cross sectional area of the circuit protective conductors shall be selected in accordance with IS:3043/ BS7671:

## **Chapter 7. LIGHTNING PROTECTION SYSTEM**

### **PART 1 – GENERAL**

#### **1.1. WORK DESCRIPTION**

- A. The work to be done under this section comprises the engineering, supply and installation necessary for the complete installation of the Lightning Protection System.
- B. The Lightning Protection System shall be installed generally in accordance with BS6651 and IEC 61024-1-2 and additional requirements of this specification. The system shall be of the Faraday-cage type and shall consist of air terminations, down conductors, joints and bonds, testing joints, earth terminations and earth electrodes. The general arrangement shall be as indicated on the Drawings.
- C. The lightning protection system shall comprise:- 1. Air Terminations; 2. Down Conductors; 3. Joints and Bonds; 4. Test Links 5. Earth Terminations.
- D. Lightning protection system employing steel structural and reinforcement system as part of the down conductors shall be adopted as per Drawing specified. All requirements in the specification included cast-in re-bar down conductors shall be applied unless otherwise specified.

#### **1.2. STANDARDS**

- A. Complete installation shall be engineering and constructed in accordance with the latest revision of the following standards and the appropriate BS/IEC : IS 2309 - Lighting Protection System BS6651 - Protection of Structures against Lightning AS 1768 - Lightning Protection BS 7671 - Electrical Installation IEC 61024-1- 2 - Lightning Protection System
- B. The detail of the lightning protection system shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and acceptable to the Engineer.
- C. In the adoption of standards and requirements, the Contractor shall take the following precedence:
  - 1. Engineer's decision;
  - 2. Local codes of practice;
  - 3. Drawings;
  - 4. Specification;
  - 5. International standards and requirements.

#### **1.3. SUBMISSION**

- A. All technical submissions shall be approved by the Engineer prior to the respective stages of construction. B. As a minimum requirement, the submission shall include the following:
  - 1. Equipment submission with manufacturer's data;
  - 2. Sample submission;
  - 3. Shop Drawings showing the co-ordinate routing of air terminations, down conductors bonding to re-bar and foundation earth terminations, methods of fixing etc.
  - 4. Builder's works requirement.
  - 5. Proposal on testing procedures and report format for testing of the Lightning Protection System.
  - 6. Detail of the Contractor's installation Professional Engineer who supervise and endorse the installation for occupation permit application.

## **PART 2 - PRODUCT**

### **2.1. AIR TERMINATION**

- A. The Contractor shall supply and install an air termination system consisting of continuous horizontal conductors.
- B. The conductors shall comprise of 25mm x 3mm GI/ Copper tape unless otherwise specified, located as shown on the Drawings and securely fixed in place to the building structure. Wherever possible, the horizontal conductors shall be continuous lengths.
- C. Where saddled to masonry, the fixing screws shall be set in expansion type plugs contained in properly formed holes.
- D. All roof conductors are to be secured at intervals not exceeding 900mm.
- E. The Drawings showing the various roof levels of the building indicate the general arrangement and layout of the air termination system. The Contractor shall ensure that the whole of the air termination system is installed over its total route of the roof areas maintaining absolute electrical continuity.
- F. Provision shall be made with suitable fittings to allow for expansion and contraction of the horizontal conductors.
- G. 500mm height vertical GI/ Copper air terminal shall be provided for the Air Termination network fixing next to masonry material at the highest points and any connection to down conductor.
- H. Air termination on the vertical side of the building above 45mm as required by BS6651 shall be provided with maximum 30m spacing and minimum 2 points. The Contractor shall co-ordinate the installation detail to allow for bonding of the curtain wall to the embedded down-conductor re-bar to Engineer satisfaction and comply with BS6651 requirement. All additional materials and installation as required shall be included in the Contract.

### **2.2. DOWN CONDUCTOR**

- A. The down conductor routes shall be embedded in colour as indicate on drawing and shall be as direct as possible.
- B. The bonding conductor at roof conductor shall be of soft annealed GI/ Copper strip minimum size 25mm x 3mm. Where the conductors penetrate the roof, the holes shall be effectively sealed and waterproof with proprietary sealant to the approval of the specialist roofing contractor.
- C. All exposed metal running vertically external to the structure shall be bonded to the re-bar down conductor. This shall be included but not limited to curtain wall frame, pipes, ducts and other metal components running through the Buildings.
- D. The down conductors shall be run according to the route as shown in the Drawings or as required to BS6651 requirement.
- E. The Sub-Conductor shall ensure that the proper material and equipment are used in accordance with the manufacture's recommended installation.
- F. Lightning protection system shall employing steel structural or reinforcement as down conductor as per Drawing specified. Continuous re-bar down conductors shall be provided system to ensure continuity and run along steel reinforcement with bonding at maximum 1m interval or minimum two (2) points at each in-continuous steel structural member of reinforcement.

### **2.3. JOINTS AND BONDS**

- A. All joints and bonds shall be soundly secured and shall be of low resistance. The cross-sectional area of the material used e.g. GI/ Copper shall not be less than the main conductor (i.e. 25mm x 3mm) unless otherwise specified.
- B. Where possible, joints shall be kept as few as possible. All joints shall be carried out with manufacturer's recommended compress type clamp. Two (2) screws minimum shall be provided for each joint.
- C. Bonding Points shall be carried out with manufacturer's recommended sets. Customer's self-made items are not acceptable.
- D. Joining of dissimilar metals shall be protected from moisture by applying recommended compound on the material. Bi-metal joint shall be provided where dissimilar metals are used. E. All junction and bonding clamps shall be phosphor bronze material.

### **2.4. TEST LINK**

- A. A test link shall be provided for testing earthing pit at ground floor. The test link shall be of phosphor bronze and shall be located at 150mm above ground level in an easily accessible position for testing.
- B. The test link shall be protected from unauthorized interference. It shall be of an approved type and shall not constitute an electrical resistance within the system.
- C. Test clamps shall be provided at air termination network and Earth Termination for each down conductor and so arranged that all parts of the network can be tested independently.
- D. After installation and completion of testing, all test clamps shall be painted with bituminous paint to prevent corrosion.

### **2.5. EARTH TERMINATION**

- A. Down Conductor re-bar will be bonded to foundation steel network. GI/ Copper tape 25mm x 3mm shall be interconnect all re-bar down conductor at the lowest ground level along the perimeter of the building.
- B. The maximum permissible earth resistance of the Lightning Protection System shall be 10 ohms. Testing earth electrode shall be provided for earthing test.
- C. All earth electrode penetrations through basement waterproofing membranes shall be provided with manufacturer's recommended water seal insert sleeve approved by Engineer. The installation of the water seal insert sleeve shall be under the supervision and endorsed by the manufacturer's representative to ensure the installation complies with the manufacturer installation details.
- D. The top of each electrode shall be protected from damage by placing it in a heavy duty pre-cast concrete inspection chamber with heavy duty cover. The actual connection of the conductor to the electrode shall be accessible and visible when cover is removed.



## **PART 3 – LIGHTNING PROTECTION EQUIPOTENTIAL BONDING**

### **3.1. METALLIC CURTAIN WALL BONDING**

- A. All elements of the façade shall be directly earthed to the structure for the purpose of lightning protection. The Contractor shall make himself aware of the requirements under the latest revision of the standard. All necessary connections, conductors, earthing connectors etc shall be deemed to be included in this Contract.
- B. The Contractor shall co-ordinate with the Curtain Wall Supplier/Contractor for the exact interface and bonding requirements. The curtain wall is to be electrically continuous and the installation shall comply with BS6651. Tests shall be carried out by this Contractor to the satisfaction of the Engineer to ensure electrical continuity as stipulated in the code.
- C. Lightning protection bonding terminals along each re-bar down conductor shall be provided by the Contractor at the lowest levels and roof levels for bonding with curtain walls. Intermediate bonding terminals shall be provided at an interval of not exceeding 30m apart at each of the vertical intervals as required by the standard lightning protection bonding terminals shall be confirmed with the Curtain Wall Supplier/Contractor.
- D. As a general practice, bonding points shall be provided and located on the internal face of the claddings. A conductor shall be provided and installed by the Contractor for lightning protection bonding at the down conductors.
- E. The Curtain Wall Supplier/Contractor shall be required to confirm his details on the lightning protection bonding of curtain walls. It is the responsibility of this Contractor to ensure all details (both locations and quantity) agreed complied with BS6651.
- F. All metal cladding components including panels, glazing frames, mullions, transoms, fixings and support structures shall be fully bonded electrically to ensure electrical continuity of the building development.

### **3.2. EQUIPMENT / STRUCTURE BONDING ON ROOF & OTHER EXTERNAL AREA**

- A. The Contractor shall be responsible for bonding of all metal equipment/structure on roof and other exposed external area on flat roof and ground level, complete cabling by means of 25 x 3mm GI/ Copper tape up to the termination point provided by respective Contractor. Bonding within the equipment for maintaining electrical continuity of all metal components will be provided by the respective work in the Contract.
- B. All metallic projections, chimneys, vent pipes, cooling towers, railings, antenna masts, fuel tanks, etc. on or above the main surface of the roof and other external areas shall be bonded to and form the part of the air termination network.
- C. For equipment with plan area above 100sq.m, bonding shall be provided at distance not more than 30m apart equally spaced along the perimeter of the equipment.
- D. All bonding shall be to the nearest down conductor by most direct route available.

**PART 4 – TESTING & COMMISSIONING**

- A. The Contractor shall arrange with the Engineer for inspection and testing of lightning conductor system. Before the joint testing, the Contractor shall have conducted his own inspection and testing to ensure that all requirements are met as specified. Test report certified by Contractor's installation Professional Engineer shall be submitted to the Engineer. All equipment, transportation, manpower and other necessary costs for the joint inspection and testing shall be borne by the Contractor.
- B. The system shall also be tested at not greater than twelve (12) months intervals for earth resistivity, resistance to earth of the electrodes and electrical continuity of the system during the course of building construction and DLP. The results of these tests shall be by the Contractor's installation Professional Engineer compiled in report prepared by the Contractor.
- C. The Contractor shall supply facilities for the recording of the test results referred to above, arranged in such a manner that comparisons can be readily made with earlier readings.
- D. The Contractor shall submit a detailed layout drawing showing the positions of testing carry out on site.
- E. The record sheet and layout drawing shall be kept on site at all times during the course of construction.
- F. The Contractor shall carry out monthly inspection on the lightning protection system including the earthing pits to ensure that the system is in good working order.

## **Chapter 8. LUMINAIRES (LIGHT FITTINGS) AND LAMPS**

### **1.1. Scope:**

The scope of this section comprises of Supply, erection, testing and commissioning of lighting fixtures for internal lighting, wherever required, of the specified models.

Without restricting to the generality of the foregoing, this section shall include luminaires, lamps and accessories necessary and required for the installation.

Whether specifically mentioned or not, the luminaires and lamps shall be provided with all fixing devices, terminal blocks, holders etc. as required.

### **1.2. General Requirements:**

All the luminaires and lamps shall be of best quality and as per approved makes. Wherever alternative makes are specified the choice of selection shall remain with the Engineer-in-Charge.

The luminaires and lamps shall be fixed in a neat work man like manner, true to level and in accordance with manufacturer's instructions.

The luminaires and lamps shall be provided with such accessories as are required to complete the item in working condition whether specifically mentioned in the specifications, drawings or not.

### **1.3. Luminaires:**

1. Luminaires shall comply with relevant IS.
2. Unless otherwise indicated, enclosure of luminaires shall provide a minimum degree of protection of IP20 when located within buildings and IP 44 when located outside buildings, but luminaires mounted externally; and less than 2 M above finished ground or paved level shall be IP 54 unless specified in BOQ.
3. Unless otherwise indicated, luminaires, both with and without built-in ballast or transformers shall be suitable for direct mounting on normally flammable surface.
4. Where specific requirements related to flame propagation and flammability of translucent covers are indicated, certificates of tests shall be submitted to the Engineer-in-Charge. The tests shall comply with relevant IS.
5. Terminal blocks for connection of the supply cables shall be of adequate size for the size of conductors forming the loop in wiring unless separate tails are required. Wherever indicated, the terminal block shall incorporate a fuse of suitable type and rating.
6. Ballasts for tubular fluorescent lamps shall have a maximum value of harmonics complying with the colour headed "without H Marking" in Table VII of BS 288. Power factor correction shall be provided and this shall not be less than 0.85 lagging unless otherwise indicated.
7. Translucent covers and reflective surfaces shall be clean at the completion of the works.

### **1.4. Applicable BIS standards:**

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc. shall comply with the latest applicable standards, more specifically the following:

**1.5. General and safety requirements for luminaries:**

Tubular fluorescent lamps	IS-1913 (Part-1)
Industrial lighting fittings with metal reflectors	IS – 1977
Decorative lighting outfits	IS – 5077
Bayonet lamp holders	IS – 1258
BI-pin lamp holders for tubular fluorescent Lamps	IS – 3323
Electronic Ballasts for fluorescent lamps –General & safety requirement	IS – 13021 (Part-1)
Electronic ballasts for fluorescent lamps – Performance requirement	IS – 13021 (part – 2)
Ballast for HP MV lamps	IS – 6616
Tubular fluorescent lamps	IS – 2418 (part-1 to 4)
Luminaries – general requirement	IS – 10322 (part – 1)
Luminaries – constructional requirement	IS – 10322 (part – 2)
Luminaries – screw and screw-less Termination	IS – 10322 (part – 3)
Luminaries – methods of tests	IS – 10322 (part – 4)
Particular requirement – general purpose Luminaries	IS – 10322 (part-5 sec-1)
Particular requirement– recessed Luminaries	IS – 10322 (part- 5/sec-2)
Particular requirement – luminaries for Road and street lighting	IS – 10322 (part-5/sec-3)
Particular requirement – portable general Purpose luminaries	IS– 10322 (part-5/sec-4)
Particular requirement – Food lighting	IS– 10322 (part-5/sec-5)
High pressure Mercury Vapour lamps	IS – 9900 (part-1)
Tungsten filament general electric Lamps	IS – 418

**1.6. Lamps:**

1. Lamps shall be of the type and ratings as indicated.
2. All lamps shall be supplied and installed by the contractor unless otherwise directed.
3. Lamp caps shall be suitable for the lamp holders listed socket by means of a locking ring.

**1.7. Support and Fixings:**

1. Where fluorescent luminaries 1200 mm or more in length are supported directly by the conduit system, they shall be fixed to two circular conduit boxes both of which shall form an integral part of the conduit system.
2. Where the weight of a luminaire is supported by a conduit box or cable Trunking, the fixing of the conduit box or Trunking shall be adequate for the purpose and approved by Engineer-in-Charge.
3. Luminaries fitted with tungsten filament lamps and having metal back plates shall not be fixed directly to conduit box in which thermoplastic material is the principal load bearing member.
4. Support of luminaries from cable Trunking shall be by means of proprietary clamps or brackets.

5. Where luminaries are supported from the structure other than by the conduit system, the supports shall be adequate for the purpose and approved by Engineer-in-Charge.
6. Luminaries mounted on or recessed into suspended ceilings shall not support luminaries unless specifically shown and approved.
7. For wall mounted luminaries, the mounting height shall be 1900 mm above finished floor level, measured to the centre of the conduit box, unless otherwise indicated.

#### **1.8. Wiring Connections:**

1. Where luminaries, are fixed at places other than circular conduit boxes or are supported by pedants or chains, the final circuit wiring shall terminate at a terminal block in the conduit box.
2. Where luminaries having fluorescent tubes are fixed direct to circular conduit boxes, the final circuit wiring may be terminated within the luminaries unless otherwise indicated. The wiring shall enter each luminaire at the conduit entry nearest to the terminal block and where a loop in wiring system is used, leave by the same entry; wiring shall not pass through a luminaries unless the approval of the Engineer-in-Charge.
3. Where luminaries are mounted on or recessed into a suspended ceiling, connection shall be by flexible cord from a plug-in ceiling rose unless otherwise indicated. The plug-in ceiling rose shall be located not more than 500 mm from the access in the ceiling and shall be firmly supported, unless otherwise approved by the Engineer-in-Charge.
4. Cables and flexible cords for final connections to luminaries shall be suitable for the operating temperature of the luminaire.
5. The size of final connection cables or flexible cords shall be as indicated.
6. Cables and cords passing close to ballast within a luminaire shall be suitable for the operating temperature of the ballast.
7. A protective conductor shall connect the earthing terminal or earthing contact of each luminaire to an earthing terminal incorporated in the adjacent conduit box. Where the final connection is by flexible cord, the protective conductor shall form part of the cord.

#### **1.9. High Pressure Sodium Vapour and Metal Halide Luminaries**

The high-pressure sodium vapour lamp fittings and components shall conform the general requirements and to the requirements of IEC 662. They shall be of the integral type complete with accessories such as chokes, capacitor, reflectors, igniters, suspension hooks or eyes, suspension arrangements, the inserts or hooks, lamp, connectors, holders etc. complete. The fittings shall be with vapour proofing arrangement.

The control gear box, and suspension brackets shall be epoxy powder coated.

The reflector shall be Electrochemically brightened, polished and Glaskote finish high purity spun aluminium. The unit shall have the facility to receive vapour proofing arrangements.

The lamp holder shall be skirted type and of integral design. The material of the lamp holder shall be glazed porcelain.

The holder shall be provided with a locking ring. The ring shall be of threaded type and made of high-grade copper alloy duly electroplated. The centre contact pillar of the holder shall be made out of stainless steel. The holder shall be provided with back up springs made of stainless steel. The holder mounting arrangement shall be

provided using an adjustable bracket to achieve narrow or wide beam light distribution.

Vapour proofing arrangements shall be obtained by using gaskets and 5 mm thick heat resistant toughened glass of high transmission quality mounted on a steel ring with hinged joint to facilitate fastening to reflector. The gaskets shall be moulded from neoprene compound.

The suspension hook/ ring shall be made of cold drawn mild steel, rod forged to shape. The arrangement for assembling the unit to the canopy shall include a collar and threaded end to facilitate assembly-using nuts and check nuts. The hook /ring opening shall not be less than 30 mm clear to provide for the swing of luminary around suspension.

The lamp shall be of specified wattage at a nominal voltage of 220 V volts. The outer shell of the lamp shall be made of hard glass. The discharge tube shall be made out of translucent poly crystalline Aluminium Oxide positioned so as to have a floating construction near the lamp end to avoid stress development.

The ignition arrangement shall consist of electronic type of igniter for ensuring instant striking of discharge and shall be of external type. Bimetallic types built in igniters are not acceptable.

For HPSV lamps, the colour-rendering group of the lamp shall be 3 and the colour-rendering index shall not be less than 21.

For Metal Halide lamps, the colour-rendering group of the lamp shall be 3 and the colour-rendering index shall not be less than 65.

## Chapter 9. 11 KV DISTRIBUTION TRANSFORMER

### 1.1. SCOPE

Design , manufacture, factory testing , supplying and commissioning of 11000 / 415 volts step down, oil filled, core type, copper wound distribution transformer as per specifications

### 1.2. STANDARD

The design, manufacture and performance of transformer shall confirm to the Indian Standard IS 2026 and its latest edition

### 1.3. RATING

Suitable for continuous rating

### 1.4. CONNECTIONS & VECTOR GROUP

Delta on high voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the vector group dyn11.

### 1.5. SYSTEM OF SUPPLY

3 phase, 50 Hz., 11 KV effectively earthed system

### 1.6. TAPPINGS

Off circuit tap changing on HV side. The tapings to be provided for variation on HV side +/- 7½% in steps of 2.1/2% each. The tap changing switch shall be provided with locking device and an indication plate

### 1.7. TEMPERATURE RISE

Continuously for full load, temperature rise not exceeding 45°C by thermometer in oil / 55°C by resistance in winding over an ambient of 50°C.

### 1.8. TYPE: Outdoor / indoor.

### 1.9. TERMINALS

Single gland trifurcating cable box with brass cone wiping gland shall be suitable for 3 core XLPE insulated armoured aluminium conductor cable on HV side.

The cable box with glands on 433 side shall be suitable for single core/three core PVC insulated, armoured aluminium conductor cables.

Cable compound wherever required is included in the cost of terminations.

### 1.10. COOLING

Natural cooling by means of pressed/round tubes around transformer tank. The radiators shall be detachable with top and bottom shutoff valve and air release plug on each radiator top.

### 1.11. INSULATION - OIL

### 1.12. EARTHING

Two separate earthing terminals to be provided at the bottom of the tank on both sides.

### 1.13. FITTINGS & ACCESSORIES

The following accessories and fittings shall be provided Lifting lugs. The arrangement for lifting the active part out of the transformer tank along with the cover by means of all lifting lugs with out disturbing the connections.

#### A. *SWIVEL TYPE ROLLERS*

The transformer to be provided with the 4 nos. Bidirectional rollers fitted on cross channels to facilitate the movement of transformer in both directions.

#### B. *OIL CONSERVATOR*

The transformer to be provided with an oil conservator with welded end plates. It is to be bolted to the cover and can be dismantled for purpose of transport. It has to be provided with oil level gauge with marking for minimum 'level' and an oil filling hole with the cap which can be used for filtering oil. For draining purpose a plug is to be provided. A connection pipe between the conservator and the main tank is to provided which projects inside the conservator.

#### C. Thermometer pocket

#### D. Rating and diagram plate

#### E. *AIR RELEASE VALVE*

An air release valve is to be provided on the top of the tank cover to facilitate the release of the entrapped air and filling of oil.

#### F. *BREATHER*

The transformer to be provided with an indicating dehydrating silicagel breather of sufficient capacity.

#### G. *DRAIN – CUM - OIL FILTER VALVES :*

The transformer to be provided with a drain-cum-oil filter valve at the bottom of the tank.

#### H. *OFF-CIRCUIT TAP CHANGER :*

An externally, hand operated off-circuit tap changer with handle, having a position indicating plate and locking device etc. filter valve at top.

#### I. Explosion vent.

#### J. Double float Buchholz Relay with alarm and trip contacts

#### K. 6” winding temperature indicator with alarm and trip contacts

#### L. 6” oil temperature indicator with alarm and trip contacts

#### M. Marshalling box/ junction box

#### N. First filling of oil.

### 1.14. WINDING

The transformer shall be copper wound

### 1.15. CORE

The magnetic core shall be made up of cold rolled grain oriented low loss steel stampings.



**1.16. DRAWINGS AND INSTRUCTION MANUALS**

3 copies of manual of complete instruction for the installation, operation, maintenance and repairs, circuit diagram, foundation and trenching details shall be provided with the transformers

**1.17. DRAWINGS AND INSTRUCTION MANUALS**

3 copies of manual of complete instruction for the installation, operation, maintenance and repairs, circuit diagram, foundation and trenching details shall be provided with the transformers

**1.18. TESTING**

The transformer shall be subject to the following tests at the factory before despatching the same and the test certificates shall be furnished :

- A. Measurement of winding resistance
- B. Ratio polarity and phase relationships
- C. Load losses
- D. Impedance voltage
- E. No load losses and no load current
- F. Insulation resistance
- G. Induced over voltage withstand
- H. Separate source voltage withstand

The cost of performing above tests shall be included in the equipment cost

**1.19. Copy of heat run test and impulse test carried out on a similar transformer during the last three years shall be submitted**

## **Chapter 10. MAINS FAILURE STANDBY GENERATING SYSTEM (D.G. SETS)**

### **PART 1 – GENERAL**

#### **1.1. WORK DESCRIPTION**

This specification is intended to cover supply, installation, testing and commissioning of D.G. Sets and associated equipment/ materials, panels, cables etc.

#### **1.2. SCOPE OF WORK:**

The scope of work shall include under this specification design, manufacture, supply, loading, unloading, storage, installation, testing and commissioning of D.G. Sets with alternators and associated equipment/ materials, panels, cables etc. including labor, tools, tackles and plants, hardware and consumables, steel fabrication and items as described below:

- Silent Diesel engine & alternator set complete with base frame, acoustic container and accessories.
- Engine mounted/ separately mounted engine control integrated panel duly wired up to terminal box for engine safeties, EFC Governor with solid state potentiometers, sensors and protection for inter facing with PLC.
- Fuel oil system including day service oil tank, piping, valves, filters etc. from engine to service day oil tank. Return fuel line with fuel cooler and piping with accessories up to day service tank or collecting point as called for.
- Lube oil system with piping etc. (Pre-lube oil pump with controllers as required).
- Cooling system with engine mounted radiators.
- Exhaust emission shall meet pollution norms (CPCB & SPCB) with or without catalytic converter and residential silencer, exhaust piping with mineral wool insulation and aluminium cladding as called for.
- Steel fabricated structure/support/hanger including fixing, grouting and bolting etc. Painting of steel work.
- L.T. / Control cabling.
- Auxiliary control panel.

The bidder shall also indicate in his offer the time schedule for routine maintenance/ overhauling operations necessary for continuous satisfactory operation of D.G. Set.

The item rate shall remain valid for variation to any extent of the estimated quantities given in the Schedule of Quantities.

#### **1.3. FEE, PERMITS & TESTS:**

The contractor shall obtain all sanctions and permits required for the running of DG sets from all the relevant authorities. All actual fees payable in this regard will be reimbursed against receipt/documentary proof (evidence). On completion of the work, the supplier shall obtain N.O.C from concerned authorities including SEB, Chief Electrical Inspectorate, of State. The original of the same shall be delivered to the employer through Consultants.

The Owner shall have full power regarding the equipments/ materials get tested by authorized/ recognized independent agency at the contractor's expense in order to prove their soundness and adequacy. The contractor will rectify the defects/ suggestions pointed out by independent agency through Owner at contractor's expense.

The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations (for F.F. etc.) as amended up to date, there under and special requirements, if any, of the State Electricity Boards etc. The contractor shall be liable to furnish the list of authorized licensed persons/ employed/ deputed to carry out the works/ perform the assigned duties to fulfill the requirement of Rule No.3 of IER 1956 as amended up to date.

#### **1.4. CODES & STANDARDS:**

The design, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (BS), International Electro Technical Commission (IEC) publication, NEMA & VDE Standards amended up to date.

The design engineering, manufacturing and the installation shall be in accordance with established codes, sound engineering, practices and specifications. Further, the same shall conform to the statutory regulations applicable in the country. Contractor shall obtain all approvals from statutory authorities, e.g. Electrical inspector, pollution control boards, SEB or any other agency as applicable before commissioning of electrical system.

Some of the relevant Indian and British Standards are listed below.

Indian Electricity Act.

Indian Electricity Rules.

Factory Act.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

In case of any deviation/conflict of this specification with the codes & standards, the following order of precedence shall govern

1. Engineer's decision.
2. Local codes of practice
3. Drawings.
4. Specifications
5. International standards & requirements.

#### **1.5. DESIGN:**

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the contractor shall be complete in all respects. Any materials or accessories, which may not have been specifically mentioned, but which are usual and necessary for the completion of the system and satisfactory & trouble free operation and

maintenance of the equipment shall be provided without any extra cost to the Owner. This shall also include spares for commissioning of the equipment.

This specification defines the basic guidelines to develop a suitable electrical system as necessary for the Complex. All data required in this regard shall be taken in to consideration to develop a detailed engineering for the system. Site conditions as applicable are mentioned elsewhere.

Compliance with these specifications and/or approval of any of the Contractor's documents shall in no case relieve the Contractor of his contractual obligations.

All work to be performed and supplies to be made be as a part of contract shall require specific approval/review of Owner or his authorized representative

The engineering activities shall comprise the submission for approval of the following from Consultants/Owner

#### **1.6. BIDDER SHALL BE RESPONSIBLE FOR:**

- Detailed co-ordination with other services, shop drawings for various electrical layouts such as equipment layout, cabling layouts, earthing layouts, including equipment installation and cable termination details etc. prior to start of work.
- Preparation of bill of materials for cabling, earthing and miscellaneous items etc.
- Cable schedules.
- Interconnection drawing.
- Protection co-ordination drawings/ tables for complete power system.
- Shop inspection and testing procedures.
- Field-testing and commissioning procedures.
- Preparation of as built drawings.

Bidder shall also be responsible for:

Any other work/activity which is not listed above, however is necessary for completeness of electrical system

Bidder shall clearly understand and quote accordingly:

To ensure that all clauses given in this part of the specifications shall also apply to all other electrical works of other segments. The bidder shall bring to the notice of the Owner the differences, if any, and get the same clarified failing which the Owner may impose the more stringent of the specification/ clauses at the sole risk and costs of the contractor.

#### **1.7. DATE OF COMMENCEMENT AND COMPLETION PERIOD:**

- A. The contractor shall be allowed admittance to the site on the date of commencement as described in the General Conditions and he shall thereupon and forthwith begin the works and shall regularly proceed with and complete the same on or before the date of completion subject, nevertheless to the provisions for the extension of time. The time being the essence of the contract, the Contractor will adhere to the time, progress chart and project schedule and will give proportional output/progress in proportional time

**1.8. SCHEDULE AND MANNER OF OPERATIONS:**

- A. Time being the essence of this Contract, the Contractor will be expected to furnish all labour and materials in sufficient quantities and at appropriate times, expedite and schedule the work as required and so manage the operation that the work will be completed within the time stated in the Contract.

**1.9. PROJECT SCHEDULE:**

- A. The contractor will have to submit a detailed project schedule.
  - 1. For various items of works to be carried out by him.
  - 2. For various associated works to be carried out by other agencies. so that the work gets completed with in the contractual completion time. This schedule shall be submitted by the contractor in Microsoft project software format. The contractor shall follow this schedule meticulously and shall also coordinate/ follow up with other agencies to expedite the works associated with his own work. Liquidity damages clause will become applicable for any delay in completion of the work.
- B. The contractor will submit within 7 days of the award of work, a detailed schedule of program of work. C. No additional payment will be made to the contractor for any multiple shift work or other incentive methods contemplated by him in his work schedules even though the time schedule is approved by the Consultant/Engineer-in-Charge.

**1.10. DESIGN CONDITIONS:**

Design ambient: 45 Deg. C maximum dry bulb temperature & 2 Deg. C minimum dry bulb temperature Altitude: 300 m above sea level Relative Humidity: 98% maximum Site Environment: Normal.

**1.11. COORDINATION OF WORK**

- A. Contract documents establish scope, materials and quality but are not detailed installation instruction.
- B. Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.
- C. The drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other divisions will permit. Provide off-sets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings of other divisions to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.
- D. The locations of thermostats, switches, panels and other equipment indicated on the drawings are approximately correct. Exercise particular caution with reference to the location of panels, thermostats, switches, etc., and have the precise and definite locations accepted by the Engineer before proceeding with the installation.
- E. The drawings show only the general run of services and approximate location of equipment, outlets, panels, etc. Any significant changes in location of equipment, outlets, panels, etc., necessary in order to meet field conditions shall be brought to the

determine attention of the Engineer for review before such alterations are made. Modifications shall be made at no additional cost to the Contract.

- F. Carefully check space requirements with other division works to ensure that equipment can be installed in the space allotted.
- G. Wherever work interconnects with work amongst different installation, coordinate with other trades to insure that they have the information necessary so that the Contractor may properly install the necessary connections and equipment. Identify items requiring access in order that the Ceiling Trade will know where to install access doors and panels.
- H. Consult amongst installation so that, wherever possible, motor controls and distribution equipment are of the same manufacturer.
- I. Furnish and set sleeves for passage of risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each riser passing through building surfaces.
- J. Provide fire stopping around all pipes, conduits, ducts, sleeves, etc, which pass through fire compartments.
- K. Provide required supports and hangers for equipment suitably so as not to exceed allowable loading of structures.
- L. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion include a set of these drawings with each set of record drawings.
- M. Coordinate with the local utility companies/authorities for their requirements for service connections and provide all necessary provisions, grounding, materials, equipment, labour, testing, and appurtenances.
- N. Before commencing works, examine adjoining works on which this work is in any way affected and report conditions which prevent performance of the works. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered. W. The Contractor is responsible to any modifications required due to service not properly coordinated.

#### **1.12. EXAMINATION OF SITE**

- A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.
- B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work, based on examination of the site or other information. Failure to examine the drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

**1.13. EXCAVATION AND BACKFILL**

- A. Where ever required provide trenches details, duly approved by the consultant with all relevant section etc. as per IS codes to the Civil contractor, minimum before 1 month of laying the pipes, etc. Co ordinate with the civil contractor during the excavation, and ensure that the excavation and backfilling is being properly done as per requirement.
- B. Where ever it is asked by the Owner/ consultant for providing trenches in contractor's scope. It is deemed that the cost of the pipe is inclusive of trench digging and backfilling. The following points needs to be taken care of while making the trenches.
- C. The trench shall be of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum over depth of four inches below the trench depths indicated on the drawings or required. Backfill over depths in the rock excavation and unauthorized over depths with loose, granular, moist earth, thoroughly machine tamped to a compaction level of at least 95% to standard proctor density or 75% relative density or as specified by the Engineer. Wherever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.
- D. Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade as required by local authorities.
- E. Trenches should not be placed within 3 meters of foundation or soil surfaces which must be resist horizontal forces.
- F. Do not backfill until all required tests have been performed and installation observed by the Engineer. Comply with the requirements of other sections of the specifications. Backfill shall consist of non-expansive soil with limited porosity. Deposit in 15 cm layers and thoroughly and carefully tamp until the work has a cover of not less than 30 cm. Backfill and tamp remainder of trench at 30 cm intervals until complete. Uniformly grade the finished surface.

**1.14. CUTTING AND PATCHING**

- A. All kinds of cutting and repairing of brick Walls or Partitions, etc. for the proper routing of pipe, shall be in the scope of the contractor. However, cutting and repairing of RCC wall, or ceiling shall be in the scope of civil contractor.
- B. Where cutting, channelling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc., using skilled trade people of the trades required at no additional cost to the Contract.
- C. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Contract.

### **1.15. SEALING OF PENETRATIONS**

- A. Air Tight Seals
  - 1. All penetrations through the building fabric subject to suction or pressurization shall be sealed airtight.
- B. Holes in Roof
  - 1. Roof penetrations for passage of conduits or circular PVC and PVC Cables shall be sealed watertight using a flexible polypropylene conical sleeve manufacturer to seal the cable to the roof structure, regardless of the roof profile.
  - 2. All sharp metal edges, which may come in contact with the cable, shall be suitably bushed.
- C. Fire Rated Penetrations Where services penetrate any fire rated barrier, the Contractor shall seal the penetration with the use of an appropriate material to ensure the integrity of the fire barrier. The Contractor shall seal the cable enclosures through fire rated barriers to ensure the integrity and rating of the fire barrier.
- D. Acoustic Penetrations Where services penetrate acoustic barriers, sealant shall be supplied and installed to maintain the acoustic separation at least equal to the barrier penetration.

### **1.16. MOUNTING HEIGHTS**

- A. Verify exact locations and mounting heights with the Engineer before installation.

### **1.17. SUPPORTS**

- A. Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.
- B. Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and equipment room.
- C. Provide supporting frames or racks for equipment which is installed in a free standing position.
- D. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.
- E. Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on ducts, pipe, electric conduits, raceways, or cables for support.
- F. Equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splinters, runners, bars and the like in the plane of the ceiling). Provide independent support of equipment. Do not attach to supports provided for ductwork, piping or work of other trades.
- G. Provide required supports and hangers for equipment so that loading will not exceed allowable loading of structure. Equipment and supports shall not come in contact with work of other trades.



**1.18. FASTENINGS**

- A. Fasten equipment to building in accordance with the best industry practice.
- B. Where weight applied to the attachment points is 45 kg or less, conform to the following as a minimum:
  - 1. Wood : Wood screws
  - 2. Concrete and solid masonry : Dash Fastener of appropriate ratings - HILTI/FISHER
  - 3. Solid metal : Machine screws in tapped holes or with welded studs
- C. Where weight applied to the building attachment points exceeds 45 kg, but is 135 kg or less, conform to the following as a minimum:
  - 1. At concrete slabs provide 60 cm x 60 cm x 13 cm steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top slabs screed line, where no fill is to be applied.
  - 2. At steel decking or sub-floor for all fastenings, provide through bolts and threaded rods. The tops of bolts and rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.
- D. Where weight applied to building attachment points exceeds 135 kg, coordinate with and obtain the approval of Engineer and conform to the following as a minimum:
  - 1. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall suitably weld or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
- E. For items which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
- F. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars.

**1.19. IDENTIFICATION**

- A. Identify equipment with permanently attached black phenolic nameplates with 13 mm high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates shall be attached with cadmium plated screws; peel and stick tape or glue on type nameplates is unacceptable.
- B. Services runs shall be properly identified as per the requirements in the Contract.
- C. See individual section for additional identification requirements.

**1.20. PROHIBITED LABELS AND IDENTIFICATIONS**

- A. In all public areas, tenant areas, and similar locations within the project, the inclusion or installation of any equipment or assembly which bears on any surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited.
- B. Required test lab certification labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

**1.21. EQUIPMENT PADS AND ANCHOR BOLTS**

- A. Provide all details with proper sections for the equipment pads and anchor. The equipment pads casting and making provision for anchor fastening shall be as per the final UNALTERED drawing duly approved by the consultant, shall be in the scope of Civil contractor. However, the Contractor shall ensure the proper coordination with the civil contractor.
- B. All equipment pads for all vibrating equipments shall have cork vibration pads sandwiched between the finish surface and the bottom surface of required thickness suggested by the civil consultant, to ensure that the minimum vibration can travel below.
- C. Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.
- D. Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an attached to 15 cm square, galvanized metal back plates which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not acceptable.

**1.22. MISCELLANEOUS:**

- A. A site order book will be maintained at site, which will be in the custody of the Owner, or his representative and all instructions given to the contractor will be recorded in the site order book and the same has to be signed by the contractor to comply with the instructions given therein.
- B. After completion of the work the whole installation shall be tested by the contractor in the presence of the Consultant/Engineer-in-Charge. The tests shall comply the following I.E.E. Regulations and shall be submitted along with the final bill:
  - 1. The result of the insulation test shall comply with the I.E.E. Regulations 1101 to 1108A and 1008B as may be applicable.
  - 2. Test shall be carried out to ascertain that all the non-linked SP switches have been connected to the phase conductor.
  - 3. The continuity test of the earthing system shall comply with I.E.E. Regulations 1108 to 1109 to the latest addition.
- C. If the result of the above tests does not comply with the I.E.E. Regulations, the contractor shall be bound to rectify the faults so that the required results are obtained.
- D. The contractor shall be responsible to provide all the necessary testing instruments, such as megger insulation tester, earth tester multi-meter, AVO meter etc for carrying out the above tests.
- E. The work will not be considered as complete and taken over by the employer till all the components of the work after being completed at site in all respects have been inspected/ tested by the Consultant/Owner to his entire satisfaction and a completion certificate issued by the Owner/Consultant to this effect.

- F. Shop drawing for electrical work e.g. equipment, cable earthing and conduit layout for all systems shall be prepared by the contractor and got approved before starting of the work.
- G. At the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit 6 sets of drawing and two tracing of each drawing to Owner of each layout drawings drawn at approved.
- H. Contractor's Superintendence:
1. The contractor shall provide all necessary superintendence during the execution of the works and as long thereafter as the engineer may consider necessary. The contractor or his competent and authorized agent or representative approved of in writing by the owner/ Engineer (which approval may at any time be withdrawn) is to be constantly on the works and shall give his whole time to the superintendence of the same. Such authorized agent or representative shall receive on behalf of the contractor, directions and instructions from the Engineer-in-charge or his representative.
  2. The contractor shall provide detailed organization of the execution team deployed for the works with names and CV's, of all key staff before the commencement of work and get it approved of in writing by the Owner/ Consultant. Contact telephone or pager numbers for emergency and/or twenty-four (24) hour call shall also be included.
  3. If in any case of withdrawal of any worker/ technician/Engineer from the execution team, the replacement of the same shall be done with equivalent qualification, and shall be approved in writing by the Owner/ Consultant.

## **PART 2 – PRODUCT, TESTING & COMMISIONING**

### **2.1. DESIGN CRITERIA**

Electrical Details for Incoming Supply:

- Supply Voltage: as approved by SEB
- Fault Level (Sym.) at supply point (Designated): MVA (to be confirmed from State Electricity Board by Bidder).
- Neutral: Grounded
- Voltage Regulations: + 10%
- Frequency Regulations: + 3%
- Combined Regulations: + 10%
- LT Power Distribution System:
- Voltage: 415 V
- Frequency: 50 Hz
- Neutral: Grounded
- Short Circuit Fault withstand capacity: 35 to 50 KA for 1 sec., as per BOQ and specifications

Control supply for Electrical System:

- The various supply voltage to be used in the control panels for the main equipment shall be as under:
- Spring charge motor: 230 V AC or 240 V DC (Universal Motor)
- Closing/ Trip Coil: 24 C DC
- Alarm/ Indication/ Relays: 24 V DC
- Heaters: 230 V AC

Painting of Panels:

- Powder coating of approved shade as per Specification. (Refer clause of painting)
- Painting of Cable Trays and Structural steel:
- Powder coating of approved shade as per Specification. (Refer clause of painting)

Cable Details:

- LT Control Cables: Copper conductor armoured PVC insulated 1.1 KV grade.
- LT Power Cables: Aluminium conductor armoured XLPE insulated.
- Grounding Conductors: Copper/ G.I. as specifications and BOQ

Accuracy Class of Meters:

- Revenue Meters: Class-I or as approved by SEB
- Ammeters, Voltmeters & Other Instruments: Digital Type

## **2.2. DRAWINGS:**

The list of drawings is enclosed along with this specification. These drawings are meant to give general idea to bidder regarding the nature of work covered by these specifications.

Any information/data shown/not shown in these drawings shall not relieve the contractor of his responsibility to carry out the work as per the specifications. Additional information required by the bidder for successfully completing the work shall be obtained by him.

## **2.3. SHOP DRAWINGS:**

The contractor shall prepare detailed coordinated electrical shop drawing indicating D.G. set layout, D.G. Control Panel and Cable Schedule with other relevant services and submit to the Consultant for approval or the Engineer-in-Charge before commencing the work. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. Control and Relay Panel D.G.'s, cable schedule and routes, manhole trap and fixing details for the above mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings do not relieve the contractor of his responsibility for providing maintenance free and full proof system including any missing component/accessories to meet with the intent of the specifications. Contractor will submit 2 (two) prints for preliminary approval and finally 6 (six) prints for distribution.

## **2.4. MANUFACTURER'S INSTRUCTIONS:**

Where manufacturers have furnished specific instructions, relating to the material/equipments to be used on this job, covering points not specifically mentioned in this document, manufacturer's instructions should be followed.

## **2.5. COMPLETION DOCUMENTS AND DRAWINGS:**

1. Three copies of operation manuals/catalogues of all standard equipment are to be furnished by the contractor immediately after commissioning of plant.
2. Three copies of write up on preventive maintenance, trouble shooting and operating instructions of the system along with as-built drawings are to be supplied by the Contractor at the time of commissioning.

3. On completion of the work in all respects, the Contractor shall supply five portfolios (300x450 mm), each containing complete set of drawings on approved scale, clearly indicating complete layouts, location; wiring and sequencing of automatic controls, location of all concealed wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The Contractor shall frame under glass, in the Panel rooms, one set of these consolidated control diagrams.

## 2.6. MATERIALS AND EQUIPMENT:

All the materials and equipments shall be of the approved make and design. Unless otherwise called for any approval by Owner's Engineer-in-Charge, only the best quality materials and equipment shall be used.

### ***Space Heaters:***

Suitable number of adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

### ***Fungi static Varnish:***

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

### ***Ventilation Opening:***

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

### ***Degree of Protection:***

The enclosures of the control cabinet, junction boxes and marshalling boxes, panels, etc to be installed shall provide degree of protection as detailed here under.

Installed indoor :	IP-55
Installed indoor in air-conditioned area :	IP-31
Installed in covered area : I	P-42
Installed indoor in non air-conditioned area where possibility of entry of water is limited :	IP-41
For LT Switchgear (AC and DC distribution boards) :	IP-42

The degree of protection shall be in accordance with IS: 13947 (Part –I) IEC-947 (Part –I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

### ***Rating plates, Name plates and Labels:***

D.G. Sets, D.G. Control panel and auxiliary items installed in the building is to permanently attached to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name,

type or serial number together with details of loading conditions of equipment in question has been designed to operate and such diagram plates as may require by the owner. The rating plate of each equipment shall be in accordance to IEC requirement.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates on with Hindi and another with English inscriptions may be provided.

***First fill of consumables, Oil & Lubricants:***

All the first fill of consumables such as oils, lubricants, filing compounds, touch up paints, welding/ soldering/ brazing material for all Copper/ G.I earthing and essential chemicals etc. which will be required to put the equipment/ scheme covered under scope of the specifications, into successful operation, shall be furnished by the contractor unless specifically excluded under the exclusions in these specifications/ documents.

***Design Improvements:***

The bidder shall note that the equipment offered to him in the bid only shall be accepted for supply. If for any reason, contractor wished to deviate from specification, prior permission from owner/ consultant shall be sought.

If any change is agreed upon and that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/ or schedule of completion before the contractor proceeds with the change. Following such arrangements, the provision thereof, shall be deemed to have been amended accordingly in the specification.

***Quality Assurance Programme:***

To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Owner's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Owner after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

1. His organization structure for the management and implementation of the proposed quality assurance programme.
2. Documentation control system.
3. Qualification data for bidder's key personnel.
4. The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
5. System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
6. Control of non-conforming items and system for corrective actions.
7. Inspection and test procedure both for manufacture and field activities.
8. Control of calibration and testing of measuring instruments and field activities.
9. System for indication and appraisal of inspection status.
10. System for authorizing release of manufactured product to the Owner.

11. System for maintenance of records.
12. System for handling storage and delivery and.
13. The Owner or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor / his Vendor's quality management and control activities.

#### ***Quality Assurance Documents***

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.

All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.

Welder and welding operator qualification certificates.

Welder's identification list, listing welder's and welding operator's qualification procedure and welding identification symbols.

Raw material test reports on components as specified by the specification and / or agreed to in the quality plan.

Stress relief time temperature charts/oil impregnation time temperature charts.

Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.

The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactory.

#### **2.7. INSPECTION, TESTING AND INSPECTION CERTIFICATES:**

The Owner and the Consultant or duly authorized representative shall have at all reasonable times free access to the Contractor's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Owner and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the Owner/Consultant the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test were pending payment would be made on successful completion of type/routine test(s) actually carried out as per Consultant/Owner instructions.

The Contractor shall give the Consultant/Owner thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The Consultant/Owner unless witnessing of the tests is virtually waived will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of Owner/Consultant and he shall forthwith forward to the Consultant duly certified copies of tests in triplicate.

The Consultant/Owner shall within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.

When the factory tests have been completed at the Contractor's or Sub-contractor's works, the Consultant/Owner shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Consultant/Owner, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Consultant/Owner. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the Owner to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of MICC by the Owner.

For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by Owner/Consultant or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

The inspection by Owner/Consultant and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

The Consultant/Owner will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.

The Owner/Consultant reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Contractor.

## **2.8. TESTS:**

### ***Charging (Pre-commissioning tests):***

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/Consultant and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial precommissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. / vendor/ bidder submittal and as included in the Contractor's quality assurance programme.

### ***Commissioning Tests:***

The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions which do not correspond to the specified conditions.



All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.

The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimburse by Owner on production of requisite documents.

## **2.9. PACKAGING:**

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of any special packaging/transporting arrangement.

## **2.10. PROTECTION:**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

## **2.11. FINISHING OF METAL SURFACES:**

### ***General:***

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanize. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

### ***Painting:***

All sheet steel work shall be degreased, pickled, and phosphated in accordance with the IS-6005 "Code of practice for Phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swab shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After Phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

Powder coating/electrostatic painting of approved shade shall be applied. The exterior color of the paint shall be as per IS-5 or as approved by Consultant. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.

In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for Owner's review and approval.

## **2.12. HANDLING, STORAGE AND INSTALLATION:**

In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Owner or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

Contractor shall follow the unloading and transporting procedure at site, as well as storing, testing and commissioning of the various equipment being procured by him separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's Engineer(s) and shall extend full co-operation to them.

In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Owner/Consultant. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer's drawings/instructions correctly.

Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

The Contractor shall submit to the Owner every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Owner in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Owner, as well as protection of the same against theft, element of nature, corrosion, damages etc.

The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.

The words 'erection' and 'installation' used in the specification are synonymous.

Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

**2.13. PROTECTIVE GUARDS**

- A. Suitable guards shall be provided for protection of personnel on all exposed rotating and / or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.
- B. The Contractor shall also conform to the general regulations governing personnel on the site and must keep to the working space allocated for their use.
- C. The contractor shall be responsible for any kind of mishap, etc. happened with personnel. The Owner shall not take the responsibility for any of such kind.

**2.14. TOOLS AND TACKLES:**

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dismantling and maintenance of the equipments.

**2.15. PERFORMANCE REQUIREMENTS:**

The equipment shall be capable of delivering power continuously at the generator terminals, a net output not less than the specified value at 0.8-p.f. excluding auxiliary power (shall be included over and above), when operating under the site ambient conditions described in this specification. Gen. Set should have minimum 50% single step loading capacity and it should be able to take full load in less than 25 sec. from start. (The set shall be suitable for prime duty). The bidder shall furnish the detailed derating calculation due to temperature and other parameters with supporting document.

The design parameters of the generator and excitation system shall be so chosen that the set is stable while running at any load between no-load and full load and also during starting of motors as specified in Annexure-I. It should also have iso-synchronous speed control with load sensing governing system suitable for parallel running of D.G. sets.

Engine should be heavy-duty four strokes, turbo charged after cooler 'V' construction, electric start. Engine should have minimum lube oil change period 300 hrs.

The set shall have vibration limit less than 250 microns (as per BS: 4999 Part-142) and noise level shall be (105-110 db (A)) at 1 Mtr) under all conditions of load. The set shall be dynamically balanced. The set shall be mounted directly on the inertia foundation or with foundation bolts etc. The efficient residential silencer shall be provided.

The total harmonics contents should be less than 3% as per IS 4722/1969. The graph & calculation for harmonic distortion shall be submitted.

Contractor to specify and guarantee maintenance contract cost and to give an Undertaking to take a comprehensive maintenance contract after expiry of warranty period for which price may be quoted.

The successful bidder will submit shop drawing of the equipments/accessories selected for this work for the approval of Consultant/ Employer.

## **2.16. DIESEL ENGINE – CONSTRUCTION**

Material of construction of major parts shall be as under or as per manufacturer design.

M.S. base frame with anti-vibration mountings.

Crankcase – Aluminium alloys.

Crank shaft, connecting rods – Forged Alloy Steel.

Piston – Al. alloy casting

Piston rings – Alloy steel

Engine block – Cast iron.

Cylinder liner – Cast

All other materials of construction shall be as per relevant standard/code and the copies of same shall be supplied free of cost to Consultant/Owner.

The Diesel Engine shall be multi-cylinder, 4-stroke, water cooled with engine mounted radiator with shaft driven fan (not motor driven), totally enclosed, continuous duty, direct fuel injection, turbo charged, compression ignition, inter cooled oil engine or with individual cylinder head with provision to measure exhaust temperature.

One common base frame shall be provided for mounting the engine and alternator complete with electric suspension between DG set and foundation bolts, leveling lines etc. as required.

All externally mounted hardware shall be high tensile steel only.

The engine shall be fitted with an exhaust gas driven turbo charger of air/water cooled type complete with its own self contained lubricating system. The turbocharger shall be positioned at the free end of the engine preferably. The turbocharger will be provided with a provision to check its lube oil level.

The engine shall be fitted with a charge air inter cooled of the air/water type. Air from the turbo-charger compressor passes through the inter cooler and then to the engine manifold. The inter cooler shall be of tubular construction or as per manufacturer design with aluminium bronze tubes, mild sheet steel and cast iron water headers.

Diesel engine shall be capable of starting and operating for a few minutes without supply of raw water for cooling. Contractor shall indicate the maximum time for which the Diesel Engine can be operate.

## **2.17. GOVERNING SYSTEM**

The Governor shall be electronic fuel control type for coupled Genset along with speed control switch (solid state potentiometer) at the end of start on over speed.

## **2.18. ENGINE STARTING SYSTEM**

Starting of the Diesel Engine shall be done by electric starting system.

The electric starting system shall comprise starter motor, starter batteries and battery charger including with all required instruments and accessories. The engine mounted alternator shall charge the batteries while engine is running and floor panel mounted solid state battery charger while engine is at stationery. The battery charger shall be of 2 rate (boost/trickle) with all metering and control instruments and protections for A/C and D/C circuit. The total system shall be suitable for auto and manual operation including their wiring etc. Calculation for the battery and battery charger capacity as well as complete descriptive circuit diagram shall be submitted for review of Consultant based on 6 consecutive start commands.

## 2.19. CATALYTIC CONVERTER

- A. Catalytic Converter should be suitable for high speed diesel oil available in the country with sulphur contents to control Hydrocarbon (HC), Carbon Monoxides (CO), Total Particulate Matter (TPM) and NOX.
- B. The catalytic converter should be suitably designed to avoid sulphation of catalyst up to 550 Deg.
- C. The converter should be air washable type or can be washed with DG set exhaust gasses in case compressed air is not available. The casing of the catalytic converter should be in stainless steel construction and should have a metal catalyst applied to a wash coat ceramic substrate which will durable at 500 Deg. C temperature. The life of the catalytic converter should be more than 10,000 hrs. C. The conversion efficiency of the catalytic converter to control exhaust gas pollutants should be as following at the outlet of converter.

CO (Carbon Monoxides) : 80 – 90%

THO (Total Hydrocarbon) : 80 – 90%

TPM (Total Particulate Matter) : 40 – 50%

NOX : 15 – 20%

Catalytic converter shall be able to reduce the noise level by 10db (A)

## 2.20. FUEL OIL SYSTEM:

The manufacturer shall furnish a mild steel day tank of required capacity for individual engine. The day tank shall be suitably located to avoid gravity feed to the engine, shaft driven fuel oil pumps and shall be complete with gauges, glasses, filling, draining and vent connection with valves and level switch for auto filling of tank and for alarm in case oil level goes beyond limit.

The fuel system shall be provided with full flow duplex oil cartridge filter preferably changeable during running of the set.

The fuel oil system shall be equipped with a crankshaft driven fuel oil transfer pump which will draw the fuel oil from the day tank via filters and shall be as per the engine manufacturer design.

Multi point (electronically controlled) fuel injection system or direct injection/through ISO synchronous fuel Governing system shall be designed taking into account the type of fuel used, engine speed etc. so as to achieve safe knock free performance with low emission smoke.

## 2.21. LUBRICATING OIL SYSTEM:

All lubricating parts of the engine shall be connected to a pressurized lubricating oil distribution piping system being continuously charged by gear type lube oil pump mounted at the free end of the engine and driven from the engine crank shaft. The pumps shall take suction from a sump tank integral with the engine through a foot valve, suction filter through oil cooler and deliver oil to a main supply header. High-pressure oil shall be supplied to the main and big end bearings, crankshaft bearings, governor, auxiliary drive gear etc. Suitable lubricating arrangement for engine cylinder valve gear, cams and pistons at the required level shall be arranged. A pressure relief valve shall be mounted on the main supply header for safety against too high-pressure while starting with cold oil. A timer based, auto running (auto

priming pump) shall be provided to keep engine primed all the time complete with control system (if required).

The lube oil system shall be provided with full flow duplex lube oil cartridge filters. The minimum lube oil change shall be 300 hrs.

Arrangement shall be provided to bypass the lube oil pressure switches and safety at the starting till the pressure is built up.

The lube oil sump shall have provision to sense the low level of lube oil in the sump and fill it up manually or automatically from the main lube oil tank/sump and stop the transfer pump, once the lube oil is filled in the sump without stopping the engine. Pressure switches to give alarm under extreme low pressure of lube oil and subsequently to trip the unit when the minimum safe pressure has been reached, shall be provided.

All necessary accessories such as pressure gauges, temperature indicators, pressure relief valves, bypass valves, pressure switches shall be provided and the safeties shall be wired up to junction box

## **2.22. EXHAUST SYSTEM:**

Engine emission exhaust system shall be residential type silencer ducting, bends, hood/canopy, thermally insulated aluminium clad exhaust piping etc. shall be provided along with structural support with stays for each engine. Heat resistant paint shall be provided on exhaust pipe for the portion, which is of outside the building including canopy. Exhaust system pollution level shall be indicated and shall be got approved by authorities. (Exhaust smoke quality & quantity should be within the norms of central & state pollution control board).

## **2.23. ENGINE ALTERNATOR CONTROL PANEL:**

- A. Engine alternator (D.G.) control panel shall be provided with speedometer, lubricating oil pressure gauge, lube oil temp, jacket water temp, battery charging, water pressure, fuel pressure for local indication panel mounted on the engine itself.
- B. Engine shall be supplied with engine control module (ECM) for diesel generating set monitoring control system, which should be equipped with (digital) electronic Governor along with solid-state AVR to facilitate discreet control of speed and voltage or as per manufacture design. The system shall be equipped with starting control including integrated fuel ramping to limit the black smoke frequency overshoot with optimized cold weather starting. The engine instrument panel shall be equipped with digital alarm and status to monitor and display the following parameters. The scanner, inter face modules, converter, probe and their wiring up to terminal block in panel with 485 ports etc. making compatibility with PLC. The necessary CT/PT shall be included and wired accordingly to meet the requirements.
- C. Engine Indicators:
  - Digital tachometer with running hour meter
  - Lubricating oil pressure low
  - Lube oil temp. high
  - Coolant water temp. high.
  - Over speed

- Bearing temperature.
- Engine fail to start
- Lack of fuel due to low level.
- Volts RY-YB-BR.
- Amps R-Y-B.

## 2.24. AMF CONTROL PANELS:

Control Philosophy:

*Automatic Starting and Stopping of Engines:*

The system should come in operation after sensing of GRID FAILURE and / or the voltage drops below preset value. For this purpose the NB-2 or equivalent “ENGINE CONTROL & AUTOMATIC MAINS FAILURE STAND BY SYSTEM” shall be provided to perform the following functions.

- Sensing the healthiness of supply from Supply Company, the engine shall be at rest.
- On sensing the supply healthiness (the supply fails or drop below the preset value) the command shall be issued to start the D.G. Set.
- In case the D.G. Set does not start in the 1st command, the two more commands shall be given to start the D.G. Set at an equal interval of time (5 Sec). Even then if the engine does not start, the indication shall appear on window / screen “Set fail to start” and alarm shall be generated.
- On starting of D.G. Set & monitoring the healthiness of supply, the load shall automatically be transferred on D.G.
- On restoration of the supply & monitoring the healthiness of the system, the load shall be transferred to Mains automatically & vice versa.

*Manual Mode:*

Select manual mode on the relay unit.

The Set shall only be started by pushing the “start button” on the relay.

On attaining the requisite voltage & frequency, the D.G. breaker / Contactor will be closed or tripped manually without shutting down the engine.

The Engine shall be shut down manually by pressing the push button.

*Test Mode:*

The test mode operation is independent of the conditions of the mains supply & thereby enables routine testing or exercising of the D.G. Set without closing the D.G. breaker / contactor. (Select the switch on selector mode & is similar to the auto mode except closing of the breaker).

The relay shall have following features such as:

- Mode selector switch (Auto/Manual/Test/Off)
- Engine Control switch (On/Off push button)
- Reset/Acknowledge push button.
- Breaker close/open push button.
- Test push button.
- Set of visual indication shall be

- Load on Mains.
- Load on D.G. Set.
- Set fails to start.
- Low-pressure alarm & Trip.
- High temperature alarm & Trip.
- Engine over speed.
- Alternator overload & short circuit.
- Voltages, phase to phase & phase to neutral.
- Ammeter Line / Phase current.
- Power factor meter.
- Kilowatt-hour meter.
- Frequency meter.
- Tachometer.

#### **2.25. ALTERNATOR (415V – 3 PHASE, 4 WIRE SYSTEM):**

- The Alternator shall be industrial type screen protected drip proof. IP-23. Class – H insulation with temperature rise limited to Class-’H’, self ventilated, air cooled, rotating field, salient pole, brush less, machine with self excited, self regulated exciter and shall be rated for continuous duty.
- The Alternator shall have a continuous rating of not less than the value specified under specific requirement shall be at 0.8. The alternator shall be suitable to run for P.F.0.99 (lag) with capacitor controlled by APFC relay.
- The short circuit ratio (SCR) of the generator at rated KVA and rated voltage shall not be less than 0.48.
- The Alternator shall withstand without mechanical damage, an over speed of 20% for a period of 3 minutes.
- The generator/alternator shall withstand over load of 10% for 1 hour every 12 hourly. The terminal voltage shall be adjustable and the range of adjustment shall be + 5% of nominal voltage.
- The Alternator shall be capable of withstanding without damage/injury for 3 secs., 3-phase short circuit at its terminals, when operated at rated KVA and power factor at 5% over voltage with fixed excitation (3 times the line current for 10 Sec.).
- The Alternator shall be capable of withstanding for thirty (10) secs. a current of fifty (50) percent in excess of its rated current, the voltage being maintained, as near the rated value as possible, consistent with max. capacity of the prime mover.
- Six Nos. embedded Resistant temperature detector (RTDs) of platinum. 100-ohm resistance at 0 Degree to measure the winding temperature and 2 Nos., BTDS bearing temperature shall be provided.
- The leads of embedded RTDs shall be wired up to the terminal block in a separate auxiliary terminal box. Manufacturer shall indicate the setting values for each RTD/BTD for alarm and trip.
- All external nuts and bolts shall be of high tensile steel only.
- Alternator shall be provided with anti-condensation space heater of adequate rating suitable for 240V, 50 Hz., 1ph A.C. supply and shall be wired up to a separate terminal box. Thermostatically controlled shall work when the machine is in idle condition only (wiring and equipment shall be provided by D.G. supplier).



- Two independent earth terminals on the frame, complete with nuts, spring washer and plain washer shall be provided.
- Alternator shall be provided with suitable terminal box for terminating TP&N bus-duct/cables droop and protection. CTS within the terminal box duly wired up to the panel should be provided.
- The alternator shall be capable to sustain the unbalanced current between the phases minimum 40% of rated current provide that the KVA rating and maximum current does not exceed 11% of rated current in any phase as per BS-4999 Part-101.
- The alternator shall be fitted with radio interference suppressors in accordance with BS-613-1977 and shall be within the limit of CISPR standard also.
- The alternator shall be dynamically balanced complete with rotor and shaft.
- Alternator should have bearings at both shaft ends.
- Damper winding shall be provided in the pole to damp the oscillations and ensure satisfactory performance during parallel operation.
- Winding of 3 phase alternator shall be of star connected and neutral point shall be brought out to the terminal box through protection and earthed with independent earth or through contactor as per scheme.
- Protection CT's/PT's shall be mounted above the terminal box with enclosure. Bus duct/cable shall be terminated on terminals through this.
- Diesel generating set shall be able to start motor of 30% capacity of D.G. set with a 20% base load.

## **2.26. AUTOMATIC VOLTAGE REGULATOR:**

An automatic high speed, dead band channel voltage regulator shall be provided with all accessories. The regulation system shall be with equipment accessories for automatic as well as for manual switchover control.

The voltage regulator shall be dual be dual control type i.e. the voltage regulation shall be through compound transformer or magnetic amplifier and the electronic regulation through solid state devices automatically both shall be secured from all three phases. The combined voltage regulation shall be  $\pm 1\%$  from full load to no-load from hot to cold at unity power factor and 0.8 to 0.99 power factor with 4% speed regulation of the engine.

Voltage regulation and steady state modulation shall be within  $\pm 1\%$  of the line voltage and with manual voltage adjustment capability within  $\pm 5\%$ . The maximum permissible wave from distortion should not exceed 5% at any load.

Necessary equipment for field suppression and surge protection shall be provided.

The response time of the exciter and the generator shall be matched to avoid hunting.

AVR system shall be provided with equipment for auto-manual operation from remote (PLC – joystick or push buttons)

In the event of AVR failure, the generator excitation control is transferred automatically without any change in the excitation current.

Necessary equipment shall be furnished for the following:

To prevent rise of field voltage in case of failure of potential supply.

To initiate from automatic to manual control of excitation on fuse failure in the generator potential signal.

To facilitate reactive load sharing of parallel operating generator shall be in proportion to their ratings. The quadrature droop current transfer compensation feature should be provided on exciter regulation and droop voltage shall be within 1% variation.

D.G. Set Vendor shall inspect the existing system and include all necessary hardware, input/ output modules and junction box with terminal block and its wiring complete as required to make the system operational in PLC/ Manual mode and to be included in price bid.

## **2.27. COMMISSIONING CHECKS:**

In addition to the checks and test recommended by the manufacturer, the Contractor shall supervise the following commissioning checks to be carried out at site.

### **A. Load Test (site and factory):**

The engine shall be given test run for a period of at least 6 hours. The set shall be subjected to the maximum achievable load as directed by Owner without exceeding the specified D.G. Set rating: During the load test, half hourly records of the following shall be taken:

- Ambient temperature
- Cooling water temperature at a convenient point adjacent to the water output from the engine jacket.
- Lubricating oil temperature where oil cooler fitted.
- Lubricating oil pressure.
- Color of exhaust gas.
- Speed.
- Voltage, wattage and current output.
- Oil tank level.

The necessary load to carry out the test shall be provided by the Owner.

### **B. Insulation Resistance Test for Alternator:**

Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 1000V megger shall not be less than

$$IR = 2 \times (\text{rated voltage in KV}) + 1$$

### **C. Fuel consumption Check:**

A check of the fuel consumption shall be made during the load run test. This test shall be conducted for the purpose of proper tuning of the engine.

### **D. Insulation Resistance of Wiring:**

Insulation resistance of control panel wiring shall be checked by 500V megger. The IR shall not be less than one mega ohm.

### **E. Functional Tests:**

Functional tests on control panel. Functional test on starting provision on the engine. Functional tests on all Field devices. Functional tests on AVR and speed governor.

### **F. Vibration Measurement:**

The vibration shall be measured at Load as close to maximum achievable load and shall not exceed 130 microns.

**2.28. TEST CERTIFICATES AND REPORTS:**

Test Certificate shall be submitted in eight (8) copies.

The test certificates shall be furnished to the owner for prior approval before dispatch of any equipment from works and the approval in writing from owner shall be essential to effect dispatch of the equipment.

The test reports shall furnish complete identification of the data including serial number of each equipment.

**2.29. NOISE CONTROL IN DIESEL GENERATOR ROOMS:****A. Construction Features/ Requirements:**

1. The container shall be designed for easy access to serviceable parts of the D.G Set.
2. The acoustic container shall be made of Modular construction for easy assembling and dismantling.
3. The container shall be fabricated out of CRCA sheet of 14 Gauge. Base frame should be made out of ISMC of suitable sections or made out of sheet steel minimum of thickness 5 mm.
4. All the hard ware used shall be of high tensile grade.
5. Fuel tank shall be kept outside of enclosure and shall have 990-liter capacities. The fuel piping shall be carried out to connect the D.G set kept inside.
6. Battery shall be accommodated in the container itself.
7. The container doors should be gasketed to avoid leakage of sound.
8. All the door handles shall be lockable type.
9. The D.G set shall be integrated part of the container .The complete assembly shall be one unit

**B. Painting:**

The sheet metal components should be hot dip and seven tanks pretreated.

To have long life of container it shall be painted with P.P. based powder coated (inside as well outside)

**C. Acoustic Insulation:**

Sound proofing of enclosure should be done with quality rock wool/mineral wool

The Residential silencer should be provided within the DG to control exhaust noise as per noise emission laws

Interconnection between silencer and engine should be through stainless steel flexible hose/ pipe.

The insulation should be designed to have 75 dB (A) at a distance of one meter to meet the noise limitations of pollution department

- D. D. Ventilation and Air Circulation:**
1. The system should be designed to provide air inlet/exhaust acoustic louvers for efficient air circulation
  2. The ventilation should be designed to restrict the temperature rise above ambient as five to seven degree centigrade.
  3. The manufacturer of acoustic container shall have approval from engine manufacturer for the design parameter as specified above and laid down by them from time to time for engine performance and warrantee.

**E. Electrical:**

1. Provision for Neutral/Body Earthing: Points shall be available at side of the enclosure with the help of flexible copper wires from alternator neutral, and electrical panel body respectively. The earthing point shall be isolated through DMC insulator mounted on enclosure.
2. Control Panel shall be mounted outside the container.
3. Safeties:
  - Low lube oil pressure
  - High water temperature
  - High enclosure temp.

There should be provision for emergency shut down from outside the container.

F. Exhaust Pipe Insulation:

Exhaust pipe insulation shall be carried out with mineral wool (rigid pipe sections) of 150 kgs/m<sup>3</sup> for temp above 250 °C. The material for pipe insulation shall be factory faced with aluminium foil reinforced with Kraft paper. The aluminium foil shall extend by min. 50 mm on one side of pipe side along the length to seal all longitudinal joints etc.

**TESTING AND COMMISSIONING:**

- A. Testing and commissioning shall be done as per the programme/instructions to be given by Owner/Consultant's authorized representative. All testing equipments necessary to carry out the tests shall be arranged by the electrical Contractor.
- B. Before the electrical system is made live, the electrical Contractor shall carry out suitable tests to the satisfaction of Owner/Consultant that all equipment wiring and connections have been correctly done and are in good working condition and will operate as intended.

# **Chapter 11. POWER FACTOR CORRECTION EQUIPMENT**

## **PART 1 – GENERAL**

### **1.1. DESCRIPTION**

Provide power factor correction equipment in accordance with the Contract Documents.

### **1.2. STANDARDS**

The installation shall comply with IS-2834 – Capacitors, BS 1650 and IEC 70 and SEB regulation.

### **1.3. SUBMITTALS**

- A. Manufacturer's product data sheets for Capacitor Banks, over current protection devices, automatic power factor regulators, harmonic filters, etc.
- B. Dimensioned layout and elevation drawings showing the capacitor banks, housekeeping pads, and support locations and types.
- C. One line diagram showing capacitor ratings, over current protection device ratings, cable lugs, metering displays, identification nameplate, and fuse clip sizes.
- D. Wiring diagrams.
- E. Installation instructions.
- F. Certified test reports.

### **1.4. FIELD TESTING**

- A. Field inspection and testing shall occur after installation is complete, feeders are terminated, and the room is secure. Testing shall be conducted not more than 4 weeks before equipment is energized.
- B. Testing Scope:
  - 1. Visual and physical inspection of equipment.
  - 2. Check control wiring and metering.
  - 3. Meter calibration.
  - 4. System Grounding
- C. Certified Test Reports:
  - 1. Field testing shall be performed by an independent third party testing agency.
  - 2. Verify that the installation is in accordance with the manufacturer's instructions.
  - 3. Verify that the equipment has been fully type tested and is operational.
  - 4. Perform testing and compile detailed test reports for each capacitor banks and over current protection device.

## **PART 2 – PRODUCTS**

### **2.1. POWER FACTOR CORRECTION / HARMONIC FILTERING EQUIPMENT**

- A. Voltage: 400volts  $\pm$  10% three phase, 50HZ
- B. Operating Temperature Limits: manufacture detail to operate at 100 percent rated voltage in ambient air temperature up to 500C.
- C. Indicators: Include LED indicating light for each step of capacity.
- D. Basic Impulse Level: 30kV
- E. Integrated Equipment Short-Circuit Rating: 65,000 rms amperes symmetrical.
- F. Power Factor Sensing and Control: Utilize reactive current sensing and solid state electronic controller to automatically connect appropriate correction capacitors and detuned reactors to line through contactors. Include time delay to accommodate capacitor resistor discharge and prevent hunting.
- G. Contactors: electrically held, three-pole, 600-volt, general-purpose magnetic contactors sized in accordance with IEC Standard. Contacts shall be silver plated. Allow 50 kVAR steps.
- H. Power Bus: tin-plated copper sized to handle rated current without abnormal temperature rise.
- I. Under voltage Relay: Controller shall incorporate an under voltage relay to interrupt control relays for power failures longer than 15 milliseconds.
- J. Fuses each individual capacitor branch circuit on the line side of the contactor. Fuses shall be current limiting type with 100,000-ampere symmetrical interrupting capacity.
- K. Blown Fuse Indicator: Each capacitor and harmonic filter fuse circuit shall be provided with a blown fuse indicator consisting of a fused neon lamp which illuminates without requiring removal of covers.
- L. Transient Suppressors: Each capacitor and harmonic filter branch circuit shall include a current-limiting air core inductor. The inductor shall be sized to limit the capacitor in-rush current to a value equal to or less than the capacitor switching rating of the contactor.
- M. Blocking Reactor; a harmonic current suppression (Blocking Reactor – 7%) shall be provided for each step.
- N. Power Factor Meter: switchboard-type power factor meter with display range of 0.5 lagging accuracy, plus or minus 1 percent to 0.5 leading. Meter shall be located in the door of the controller enclosure.
- O. Current Transformer: Provide a current transformer with turns ratio as required. Extend control conductors to controller.
- P. Dielectric Impregnate: non-PCB, non combustible liquid.
- Q. Enclosure: Complete with enclosure and located in switch room outside switchboard
- R. Construction: internally fused, replaceable capacitor cells factory assembled and bussed and together in protective enclosure; include internal discharge resistor.
- S. Cooling: naturally ventilated.
- T. Access: enclosure access through a removable capacitor door located on top of enclosure; access door shall be interlocked to de-energised contactor(s) when the door is opened.
- U. Finish: manufacturer's standard grey enamel

## **PART 3 – EXECUTION**

### **3.1. EXAMINATION**

- A. Install in accordance with manufacturer's instructions.
- B. Locate capacitors and harmonic filters to allow adequate ventilation around enclosure.
- C. Provide disconnecting switch to remove capacitors and detuned reactors.

### **3.2. DEMONSTRATION**

- A. Provide a factory trained field representative to instruct the Employer's personnel for a period of no less than 2 days in maintenance and operation of the equipment.

### **3.3. FIELD QUALITY CONTROL**

- A. Test the Capacitor Banks in accordance with the requirements of Start-up Testing and Commissions of Electrical Equipment.

## **Chapter 12. ELECTRICAL GENERAL PROVISIONS**

### **PART 1 – GENERAL**

#### **1.1. WORK DESCRIPTION**

- A. The scope of works for all electrical works and systems comprises engineering, supply, delivery, installation, testing and commissioning, handover, training, maintenance and warranty all as described or reasonably implied in the Contract. The Contractor is obliged to provide fully functioning works and systems in conformance with the requirements of the Contract. In the event certain items are not fully described or indicated in the Contract, but deemed essential by the Engineer for the performance of the works and systems then the provision of such items shall form part of the Contractors scope of works at no additional cost to the Owner.
- B. The Contractor shall be responsible to co-ordinate the equipment and services and shall produce properly co-ordinated shop drawings to demonstrate the installation comply with the performance requirement with shop drawing, calculations and details. A. Shop drawings shall take into account actual measurement and setting out dimensions/levels obtained and determined by the Contractor on site, actual equipment/material used, actual routing of services, co-ordination with all installation, and site conditions/constraints. This specification is intended to cover installation, testing and commissioning of LV Panels and associated equipment/ materials, panels, etc.

#### **1.2. SCOPE OF WORK:**

- A. The Electrical and ELV installation shall generally include the following:
  - 1. Common Services:
    - a. Liaison with the local supply Authority to obtain and coordinate provision of incoming electricity supply.
    - b. Installation, testing & commissioning of MV system including incoming electricity supply, consumer main MV switchboard, cabling to component MV switchboards, cabling to power transformer, power transformers and associated accessories to SEB requirement and arrange SEB acceptance upon completed.
    - c. Supply, installation, testing & commissioning of telephone system including incoming telephone lines, component telephone distribution panel at each level, interconnecting cabling and associated accessories.
    - d. To provide telephone cabling as specified on the drawings.
    - e. Complete central earthing systems for connection with component electrical systems.
  - 2. Internal Services
    - a. Complete LV distribution system including main LV switchboard, automatic power factor correction devices, sub-boards and distribution boards, UPS and associated distribution main and sub-main cabling and associated accessories.



- b. Complete lighting and power installation including all final circuiting work and associated accessories.
  - c. Normal and emergency lighting supply and installation and associated accessories.
  - d. Complete earthing system.
  - e. Complete lightning protection system and associated accessories.
  - f. Complete telephone cabling system and associated accessories.
  - g. Complete wiring work to external/landscape and public area architectural/special lighting and dimming systems and associated accessories.
  - h. Complete cable support system for future structure cabling system and associate works.
  - i. Miscellaneous works like providing and fixing of rubber mats, fire buckets, first aid box, fire extinguishers, etc.
  - j. All associated interfacing power supply work to other mechanical installations.
  - k. All interfacing works with the Building Management System for remote control and monitoring.
  - l. All associated interfacing works with other M&E installations.
  - m. Other works as shown on the Drawings and described elsewhere in the Contract documents.
- B. The item rate shall remain valid for variation to any extent of the estimated quantities given in the Schedule of Quantities.
- C. All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration.
- D. Minor civil work is included in the contractor's scope of work. Further, the responsibility of coordination with the civil and other contracting agencies ensuring completion of turnkey contract rests with the contractor.
- E. Contractor shall co-ordinate with all other agencies working at site for interconnection and safety aspects.
- F. Also the Contractor shall furnish back up combined guarantee minimum for 1 year from the date of successful commissioning from the manufacturer. In case there is any defect, the free replacement of any part or in whole will be made immediately at no extra cost to Owner.

### **1.3. FEE, PERMITS & TESTS:**

- A. The contractor shall obtain all sanctions and permits required for the above said works from all the relevant authorities. All actual fees payable in this regard will be reimbursed against receipt/documentary proof (evidence). On completion of the work, the Contractor shall obtain N.O.C from concerned authorities including SEB, Chief Electrical Inspectorate, of State. The original of the same shall be delivered to the Owner through Consultants.
- B. The Owner shall have full power regarding the equipments/ materials get tested by authorized/ recognized independent agency at the contractor's expense in order to prove their soundness and adequacy. The contractor will rectify the defects/

suggestions pointed out by independent agency through Owner at contractor's expense.

- C. The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations (for F.F. etc.) as amended up to date, there under and special requirements, if any, of the State Electricity Boards etc. The contractor shall be liable to furnish the list of authorized licensed persons/ employed/ deputed to carry out the works/ perform the assigned duties to fulfill the requirement of Rule No.3 of IER 1956 as amended up to date.

#### **1.4. CODES & STANDARDS:**

- A. The design, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (BS), International Electro Technical Commission (IEC) publication, NEMA & VDE Standards amended up to date.
- B. The design engineering, manufacturing and the installation shall be in accordance with established codes, sound engineering, practices and specifications. Further, the same shall conform to the statutory regulations applicable in the country. Contractor shall obtain all approvals from statutory authorities, e.g. Electrical inspector, SEB or any other agency as applicable before commissioning of electrical system if required.
- C. Some of the relevant Indian and British Standards are listed below.
1. Indian Electricity Act.
  2. Indian Electricity Rules.
  3. Factory Act.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

In case of any deviation/conflict of this specification with the codes & standards, the following order of precedence shall govern

1. Engineer's decision.
2. Local codes of practice
3. Drawings.
4. Specifications
5. International standards & requirements.

#### **1.5. DESIGN:**

- A. The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the contractor shall be complete in all respects. Any materials or accessories, which may not have been specifically mentioned, but which are usual and necessary for the completion of the system and satisfactory & trouble free operation and maintenance of the equipment shall be provided without any extra cost to the Owner. This shall also include spares for commissioning of the equipment.

- B. This specification defines the basic guidelines to develop a suitable electrical system as necessary for the Complex. All data required in this regard shall be taken in to consideration to develop a detailed engineering for the system. Site conditions as applicable are mentioned elsewhere.
- C. Compliance with these specifications and/or approval of any of the Contractor's documents shall in no case relieve the Contractor of his contractual obligations.
- D. All work to be performed and supplies to be made as a part of contract shall require specific approval/review of Owner or his authorized representative
- E. The engineering activities shall comprise the submission for approval of the following from Consultants/Owner

**1.6. BIDDER SHALL BE RESPONSIBLE FOR:**

- 1. Detailed co-ordination with other services, shop drawings for various electrical layouts such as equipment layout, cabling layouts, earthing layouts, including equipment installation and cable termination details etc. prior to start of work.
- 2. Preparation of bill of materials for electrical works.
- 3. Protection co-ordination drawings/ tables for complete power system.
- 4. Shop inspection and testing procedures.
- 5. Field-testing and commissioning procedures.
- 6. Preparation of as built drawings.

Bidder shall also be responsible for:

Any other work/activity which is not listed above, however is necessary for completeness of electrical system

Bidder shall clearly understand and quote accordingly:

To ensure that all clauses given in this part of the specifications shall also apply to all other electrical works of other segments. The bidder shall bring to the notice of the Owner the differences, if any, and get the same clarified failing which the Owner may impose the more stringent of the specification/ clauses at the sole risk and costs of the contractor.

**1.7. DATE OF COMMENCEMENT AND COMPLETION PERIOD:**

- A. The contractor shall be allowed admittance to the site on the date of commencement as described in the General Conditions and he shall thereupon and forthwith begin the works and shall regularly proceed with and complete the same on or before the date of completion subject, nevertheless to the provisions for the extension of time. The time being the essence of the contract, the Contractor will adhere to the time, progress chart and project schedule and will give proportional output/progress in proportional time

**1.8. SCHEDULE AND MANNER OF OPERATIONS:**

- A. Time being the essence of this Contract, the Contractor will be expected to furnish all labour and materials in sufficient quantities and at appropriate times, expedite and

schedule the work as required and so manage the operation that the work will be completed within the time stated in the Contract.

### **1.9. PROJECT SCHEDULE:**

- A. The contractor will have to submit a detailed project schedule.
  - 1. For various items of works to be carried out by him.
  - 2. For various associated works to be carried out by other agencies. so that the work gets completed with in the contractual completion time. This schedule shall be submitted by the contractor in Microsoft project software format. The contractor shall follow this schedule meticulously and shall also coordinate/ follow up with other agencies to expedite the works associated with his own work. Liquidity damages clause will become applicable for any delay in completion of the work.
- B. The contractor will submit within 7 days of the award of work, a detailed schedule of program of work.
- C. No additional payment will be made to the contractor for any multiple shift work or other incentive methods contemplated by him in his work schedules even though the time schedule is approved by the Consultant/Engineer-in-Charge.

### **1.10. DESIGN CONDITIONS:**

- A. Design ambient: 45 Deg. C maximum dry bulb temperature & 2 Deg. C minimum dry bulb temperature
- B. Altitude: 300 m above sea level
- C. Relative Humidity: 98% maximum D. Site Environment: Normal.

### **1.11. COORDINATION OF WORK**

- A. Contract documents establish scope, materials and quality but are not detailed installation instruction.
- B. Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.
- C. The drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other divisions will permit. Provide offsets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings of other divisions to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.
- D. The locations of thermostats, switches, panels and other equipment indicated on the drawings are approximately correct. Exercise particular caution with reference to the location of panels, thermostats, switches, etc., and have the precise and definite locations accepted by the Engineer before proceeding with the installation.
- E. The drawings show only the general run of services and approximate location of equipment, outlets, panels, etc. Any significant changes in location of equipment, outlets, panels, etc., necessary in order to meet field conditions shall be brought to the determine attention of the Engineer for review before such alterations are made. Modifications shall be made at no additional cost to the Contract.

- F. Carefully check space requirements with other division works to ensure that equipment can be installed in the space allotted.
- G. Wherever work interconnects with work amongst different installation, coordinate with other trades to insure that they have the information necessary so that the Contractor may properly install the necessary connections and equipment. Identify items requiring access in order that the Ceiling Trade will know where to install access doors and panels.
- H. Consult amongst installation so that, wherever possible, motor controls and distribution equipment are of the same manufacturer.
- I. Furnish and set sleeves for passage of risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each riser passing through building surfaces.
- J. Provide fire stopping around all pipes, conduits, ducts, sleeves, etc, which pass through fire compartments.
- K. Provide required supports and hangers for equipment suitably so as not to exceed allowable loading of structures.
- L. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion include a set of these drawings with each set of record drawings.
- M. Coordinate with the local utility companies/authorities for their requirements for service connections and provide all necessary provisions, grounding, materials, equipment, labor, testing, and appurtenances.
- N. Before commencing works, examine adjoining works on which this work is in any way affected and report conditions which prevent performance of the works. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.
- O. The Contractor is responsible to any modifications required due to service not properly coordinated.

#### **1.12. ELECTRICAL POWER SUPPLY INTERFACES**

- A. The Contractor shall provide power supply points/isolators at certain designated locations within the development for all mechanical and electrical installations as indicated on the drawings. It is the responsibility of the Contractor to coordinate and make connections to these power supply points/isolators and to provide all the necessary 'down-stream' power supply distribution board/network to the mechanical system's control panels, equipment, sensors, field devices, etc.

#### **1.13. BUILDING MANAGEMENT SYSTEM AND INTERFACES**

- A. The Contractor shall co-ordinate the mechanical system and equipment to interface with the Building Management System in accordance with the point schedules specified on the Drawings. All necessary interfacing works shall be included in the Contract.

#### **1.14. CENTRAL CONTROL ROOM INTERFACES**

- A. The Contractor shall include the supply and installation of a custom-built control console of proprietary make in the Fire Command Centre and each building component's Security Room to integrate all control panels, mimic panels, and central equipment of the following systems:
1. Building Management system
  2. Security systems, including CCTV, access control, door monitoring, watchman tour, panic alarm system, etc.
  3. Fire Alarm and Detection system
  4. Ventilation Control Panel for all emergency operation fans/systems
  5. Lift system
  6. Escalator system
  7. Fireman Intercom system
  8. Fire Protection Pumps Control Panel
  9. Fireman's Override Control Panel
  10. Public Address and Emergency Evacuation Announcement systems
  11. MATV System
  12. all other systems to be housed inside the Fire Command Centre/Security Room

#### **1.15. INTERFACING WITH ALL SERVICES AND SYSTEMS**

- A. General
1. The Contractor shall provide all necessary provisions for interfacing amongst installation, services, and equipment. All necessary sensors, current/voltage transformers, voltage-free contacts, relays, auxiliary contacts, terminals, transducers, etc. for interfacing works shall be provided by the Contractor.
  2. All control/monitoring wiring from sensors, equipment, and components for the interfacing shall be terminated at a separate interfacing compartment located at the respective equipment/system's switchboard or control panel. The interfacing compartment shall be completed with all necessary connectors, terminals, and with proper identifications to allow interfacing works to be easily carried out. The compartment shall clearly indicate "Extra Low Voltage Cable Only. No Power Cable Connection". Where there is no equipment/system switchboard or control panel involved, the Contractor shall provide separate interfacing panels with provisions same as the interfacing compartment as described above. The locations of the switchboard/control panels and the interfacing panels shall be properly coordinated.
  3. For every control panel and each module of the switchboard, at least five (5) spare terminals shall be provided for future interfacing works.
  4. Wiring and cables for interfacing with the fire alarm system and other fire protection and life safety systems shall be fire rated to comply with Civil Defense's requirements.
  5. Unless otherwise specified or shown on the Drawings, interfacing wiring from Fire Alarm and Building Management systems shall be provided and terminated at the terminals of the interfacing compartments or panels by the Fire Alarm System and Building Management System installation respectively. The Contractor shall co-ordinate the current and voltage requirements for the interfacing works/provisions. The type of provisions for interfacing signals shall be as follows, unless otherwise specified:

6. Digital inputs and outputs : voltage-free dry contact
7. Analog inputs and outputs : 4 – 20 mA or 0 – 10 mV
8. All the interface provisions shall be DC operated and rated not more than 50 mA.
9. For interfacing works between Fire Alarm System and Building Management System, the Contractor shall provide the Fire alarm installation with interface wiring and terminate them at the Building Management System's interfacing compartments or panels.
10. The Contractor shall provide and make all power cable connections from mechanical equipment, local control panels, and distribution boards to the electrical isolators or power points (including cable termination) provided under Division 16 works. Location of power supply isolators and power points shall be properly coordinated.
11. In addition to the interfacing requirements shown on the Drawings, interfacing provisions as described below shall also be provided and included in the Contract.

#### B. Electrical Installation

1. The Electrical Installation shall provide the following:
  - a. Isolators and power points (fused spur units) for all mechanical equipment and systems. Where shown on the Drawings, the Electrical installation shall include direct power cable connections to the mechanical system's main motor control centres.
  - b. Earthing terminal in the Fire Command Centre and all other plant rooms for supplementary equipotential bonding of mechanical equipment and systems.
  - c. Power failure signal to the Lift System (including wiring terminations into the Lift interfacing panel in the Lift Motor Room), Fire Alarm System and the Building Management System.
  - d. Electrical bonding of all roof equipment and external metal cladding including provisions and connection of bonding cables.
  - e. Fuel main storage tank and day tank High/Low level alarm signals to the Building Management System.
  - f. Emergency power supplies to Building Management System (including all field panels), Fire Alarm System, car parking system, and all security systems.
  - g. Emergency power supplies to all fire shutters, smoke shutters/curtains, and automatic doors.
  - h. Power point in each toilet for the plumbing installation (for connection to automatic sanitary sensors and flush valve under the Plumbing and Sanitary installation).
2. Power supply to variable air volume (VAV) boxes and the ACMV system's control components/sensors shall however be provided under the ACMV installation from the corresponding equipment motor control panel.

#### **1.16. EXAMINATION OF SITE**

- A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.
- B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work, based on examination of the site or other information. Failure to examine the drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

### **1.17. EXCAVATION AND BACKFILL**

- A. Where ever required provide trenches details, duly approved by the consultant with all relevant section etc. as per IS codes to the Civil contractor, minimum before 1 month of laying the pipes, etc. Co ordinate with the civil contractor during the excavation, and ensure that the excavation and backfilling is being properly done as per requirement.
- B. Where ever it is asked by the Owner/ consultant for providing trenches in contractor's scope. It is deemed that the cost of the pipe is inclusive of trench digging and backfilling. The following points needs to be taken care of while making the trenches.
- C. The trench shall be of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum over depth of four inches below the trench depths indicated on the drawings or required. Backfill over depths in the rock excavation and unauthorized over depths with loose, granular, moist earth, thoroughly machine tamped to a compaction level of at least 95% to standard proctor density or 75% relative density or as specified by the Engineer. Wherever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.
- D. Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade as required by local authorities.
- E. Trenches should not be placed within 3 meters of foundation or soil surfaces which must be resist horizontal forces.
- F. Do not backfill until all required tests have been performed and installation observed by the Engineer. Comply with the requirements of other sections of the specifications. Backfill shall consist of non-expansive soil with limited porosity. Deposit in 15 cm layers and thoroughly and carefully tamp until the work has a cover of not less than 30 cm. Backfill and tamp remainder of trench at 30 cm intervals until complete. Uniformly grade the finished surface.

### **1.18. CUTTING AND PATCHING**

- A. A. All kinds of cutting and repairing of brick Walls or Partitions, etc. for the proper routing of pipe, shall be in the scope of the contractor. However, cutting and repairing of RCC wall, or ceiling shall be in the scope of civil contractor.
- B. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc., using skilled trade people of the trades required at no additional cost to the Contract.
- C. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Contract.



**1.19. SEALING OF PENETRATIONS**

- A. Air Tight Seals 1. All penetrations through the building fabric subject to suction or pressurization shall be sealed airtight.
- B. Holes in Roof
  - 1. Roof penetrations for passage of conduits or circular PVC and PVC Cables shall be sealed watertight using a flexible polypropylene conical sleeve manufacturer to seal the cable to the roof structure, regardless of the roof profile.
  - 2. All sharp metal edges, which may come in contact with the cable, shall be suitably bushed.
- C. Fire Rated Penetrations
  - 1. Where services penetrate any fire rated barrier, the Contractor shall seal the penetration with the use of an appropriate material to ensure the integrity of the fire barrier.
  - 2. The Contractor shall seal the cable enclosures through fire rated barriers to ensure the integrity and rating of the fire barrier.
- D. Acoustic Penetrations
  - 1. Where services penetrate acoustic barriers, sealant shall be supplied and installed to maintain the acoustic separation at least equal to the barrier penetration.

**1.20. MOUNTING HEIGHTS**

- A. Verify exact locations and mounting heights with the Engineer before installation.

**1.21. SUPPORTS**

- A. Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.
- B. Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and equipment room.
- C. Provide supporting frames or racks for equipment which is installed in a free standing position.
- D. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.
- E. Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on ducts, pipe, electric conduits, raceways, or cables for support.
- F. Equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splinters, runners, bars and the like in the plane of the ceiling). Provide independent support of equipment. Do not attach to supports provided for ductwork, piping or work of other trades.

- G. Provide required supports and hangers for equipment so that loading will not exceed allowable loading of structure. Equipment and supports shall not come in contact with work of other trades.

### **1.22. FASTENINGS**

- A. Fasten equipment to building in accordance with the best industry practice.
- B. Where weight applied to the attachment points is 45 kg or less, conform to the following as a minimum:
1. Wood : Wood screws
  2. Concrete and solid masonry : Dash Fastener of appropriate ratings - HILTI/FISHER
  3. Solid metal : Machine screws in tapped holes or with welded studs
- C. Where weight applied to the building attachment points exceeds 45 kg, but is 135 kg or less, conform to the following as a minimum:
1. At concrete slabs provide 60 cm x 60 cm x 13 cm steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top slabs screed line, where no fill is to be applied.
  2. At steel decking or sub-floor for all fastenings, provide through bolts and threaded rods. The tops of bolts and rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or subfloor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.
- D. Where weight applied to building attachment points exceeds 135 kg, coordinate with and obtain the approval of Engineer and conform to the following as a minimum:
1. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall suitably weld or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
- E. For items which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
- F. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars.

### **1.23. IDENTIFICATION**

- A. Identify equipment with permanently attached black phenolic nameplates with 13 mm high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates shall be attached with cadmium plated screws; peel and stick tape or glue on type nameplates is unacceptable.
- B. Services runs shall be properly identified as per the requirements in the Contract.
- C. See individual section for additional identification requirements.

### **1.24. PROHIBITED LABELS AND IDENTIFICATIONS**

- A. In all public areas, tenant areas, and similar locations within the project, the inclusion or installation of any equipment or assembly which bears on any surface any name,

trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited.

- B. Required test lab certification labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

### **1.25. EQUIPMENT PADS AND ANCHOR BOLTS**

- A. Provide all details with proper sections for the equipment pads and anchor. The equipment pads casting and making provision for anchor fastening shall be as per the final UNALTERED drawing duly approved by the consultant, shall be in the scope of Civil contractor. However, the Contractor shall ensure the proper coordination with the civil contractor.
- B. All equipment pads for all vibrating equipments shall have cork vibration pads sandwiched between the finish surface and the bottom surface of required thickness suggested by the civil consultant, to ensure that the minimum vibration can travel below.
- C. Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.
- D. Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an attached to 15 cm square, galvanized metal back plates which are attached to the gypsum board with an approved nonflammable adhesive. Toggle bolts installed in gypsum board partitions are not acceptable.

### **1.26. MISCELLANEOUS:**

- A. A site order book will be maintained at site, which will be in the custody of the Owner, or his representative and all instructions given to the contractor will be recorded in the site order book and the same has to be signed by the contractor to comply with the instructions given therein.
- B. After completion of the work the whole installation shall be tested by the contractor in the presence of the Consultant/Engineer-in-Charge. The tests shall comply the following I.E.E. Regulations and shall be submitted along with the final bill:
  - 1. The result of the insulation test shall comply with the I.E.E. Regulations 1101 to 1108A and 1008B as may be applicable.
  - 2. Test shall be carried out to ascertain that all the non-linked SP switches have been connected to the phase conductor.
  - 3. The continuity test of the earthing system shall comply with I.E.E. Regulations 1108 to 1109 to the latest addition.
- C. If the result of the above tests does not comply with the I.E.E. Regulations, the contractor shall be bound to rectify the faults so that the required results are obtained.
- D. The contractor shall be responsible to provide all the necessary testing instruments, such as megger insulation tester, earth tester multi-meter, AVO meter etc for carrying out the above tests.

- E. The work will not be considered as complete and taken over by the Owner till all the components of the work after being completed at site in all respects have been inspected/ tested by the Consultant/Owner to his entire satisfaction and a completion certificate issued by the Owner/Consultant to this effect.
- F. Shop drawing for electrical work e.g. equipment, cable earthing and conduit layout for all systems shall be prepared by the contractor and got approved before starting of the work.
- G. At the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit 6 sets of drawing and two tracing of each drawing to Owner of each layout drawings drawn at approved.
- H. Contractor's Superintendence:
  - 1. The contractor shall provide all necessary superintendence during the execution of the works and as long thereafter as the engineer may consider necessary. The contractor or his competent and authorized agent or representative approved of in writing by the owner/ Engineer (which approval may at any time be withdrawn) is to be constantly on the works and shall give his whole time to the superintendence of the same. Such authorized agent or representative shall receive on behalf of the contractor, directions and instructions from the Engineer-in-charge or his representative.
  - 2. The contractor shall provide detailed organization of the execution team deployed for the works with names and CV's, of all key staff before the commencement of work and get it approved of in writing by the Owner/ Consultant. Contact telephone or pager numbers for emergency and/or twenty-four (24) hour call shall also be included.
  - 3. If in any case of withdrawal of any worker/ technician/Engineer from the execution team, the replacement of the same shall be done with equivalent qualification, and shall be approved in writing by the Owner/ Consultant.

## **PART 2 – PROUCT, TESTING & COMMISIONING**

### **1.1. DESIGN CRITERIA**

- A. Electrical Details for Incoming Supply:
  - 1. Supply Voltage: as approved by SEB
  - 2. Fault Level (Sym.) at supply point (Designated): MVA (to be confirmed from State Electricity Board by Bidder).
  - 3. Neutral: Grounded
  - 4. Voltage Regulations: + 10%
  - 5. Frequency Regulations: + 3%
  - 6. Combined Regulations: + 10%
- B. LT Power Distribution System:
  - 1. Voltage: 415 V
  - 2. Frequency: 50 Hz
  - 3. Neutral: Grounded
  - 4. Short Circuit Fault withstand capacity: 20 to 50 KA for 1 sec., as per BOQ and specifications

- C. Control supply for Electrical System: The various supply voltage to be used in the control panels for the main equipment shall be as under: 1. Spring charge motor: 230 V AC or 24 V DC (Universal Motor) 2. Closing/ Trip Coil: 24 V DC 3. Alarm/ Indication/ Relays: 24 V DC 4. Heaters: 230 V AC
- D. Painting of Panels: Powder coating of approved shade as per Specification. (Refer clause of painting)
- E. Painting of Cable Trays and Structural steel: Powder coating of approved shade as per Specification. (Refer clause of painting)
- F. Cable Details:
  - 1. LT Control Cables: Copper conductor armoured PVC insulated 1.1 KV grade.
  - 2. LT Power Cables: Aluminium conductor armoured XLPE insulated.
  - 3. Grounding Conductors: Copper/ G.I. as specifications and BOQ
- G. Accuracy Class of Meters:
  - 1. Revenue Meters: Class-I or as approved by SEB
  - 2. Ammeters, Voltmeters & Other Instruments: Digital Type

## **1.2. DRAWINGS:**

- A. The list of drawings is enclosed along with this specification. These drawings are meant to give general idea to bidder regarding the nature of work covered by these specifications.
- B. Any information/data shown/not shown in these drawings shall not relieve the contractor of his responsibility to carry out the work as per the specifications. Additional information required by the bidder for successfully completing the work shall be obtained by him.

## **1.3. SHOP DRAWINGS:**

- A. The contractor shall prepare detailed coordinated electrical shop drawing indicating Panel layout, with other relevant services and submit to the Consultant for approval or the Engineer-in- Charge before commencing the work. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. Control and Relay Panel and fixing details for the above mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings do not relieve the contractor of his responsibility for providing maintenance free and full proof system including any missing component/accessories to meet with the intent of the specifications. Contractor will submit 2 (two) prints for preliminary approval and finally 6 (six) prints for distribution.

## **1.4. MANUFACTURER'S INSTRUCTIONS:**

- A. Where manufacturers have furnished specific instructions, relating to the material/equipments to be used on this job, covering points not specifically mentioned in this document, manufacturer's instructions should be followed.

## **1.5. COMPLETION DOCUMENTS AND DRAWINGS:**

- A. Three copies of operation manuals/catalogues of all standard equipment are to be furnished by the contractor immediately after commissioning of plant.
- B. Three copies of write up on preventive maintenance, trouble shooting and operating instructions of the system along with as-built drawings are to be supplied by the Contractor at the time of commissioning.
- C. On completion of the work in all respects, the Contractor shall supply five portfolios (300x450 mm), each containing complete set of drawings on approved scale, clearly indicating complete layouts, location; wiring and sequencing of automatic controls, location of all concealed wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The Contractor shall frame under glass, in the Panel rooms, one set of these consolidated control diagrams.

#### **1.6. MATERIALS AND EQUIPMENT:**

All the materials and equipments shall be of the approved make and design. Unless otherwise called for any approval by Owner's Engineer-in-Charge, only the best quality materials and equipment shall be used.

- A. Space Heaters: Suitable number of adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.
- B. Fungi static Varnish: Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.
- C. Ventilation Opening: In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.
- D. Degree of Protection: The enclosures of the control cabinet, junction boxes and marshalling boxes, panels. etc to be installed shall provide degree of protection as detailed her under.
  - 1. Installed indoor : IP-55
  - 2. Installed indoor in air-conditioned area : IP-31
  - 3. Installed in covered area : IP-42
  - 4. Installed indoor in non air-conditioned area where possibility of entry of water is limited :IP-41
  - 5. For LT Switchgear (AC and DC distribution boards) :IP-42 The degree of protection shall be in accordance with IS: 13947 (Part –I) IEC-947 (Part –I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.
- E. Rating plates, Name plates and Labels: LV panel and auxiliary items installed in the building is to permanently attach to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture,

equipment name, type or serial number together with details of loading conditions of equipment in question has been designed to operate and such diagram plates as may require by the owner. The rating plate of each equipment shall be in accordance to IEC requirement. All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and another with English inscriptions may be provided.

- F. Design Improvements: The bidder shall note that the equipment offered to him in the bid only shall be accepted for supply. If for any reason, contractor wished to deviate from specification, prior permission from owner/ consultant shall be sought. If any change is agreed upon and that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/ or schedule of completion before the contractor proceeds with the change. Following such arrangements, the provision thereof, shall be deemed to have been amended accordingly in the specification.
- G. Quality Assurance Programme: To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Owner's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Owner after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:
1. His organization structure for the management and implementation of the proposed quality assurance programme.
  2. Documentation control system.
  3. Qualification data for bidder's key personnel.
  4. The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
  5. System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
  6. Control of non-conforming items and system for corrective actions.
  7. Inspection and test procedure both for manufacture and field activities.
  8. Control of calibration and testing of measuring instruments and field activities.
  9. System for indication and appraisal of its inspection status.
  10. System for authorizing release of manufactured product to the Owner.
  11. System for maintenance of records.
  12. System for handling storage and delivery and. The Owner or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor / his Vendor's quality management and control activities.
- H. Quality Assurance Documents The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.
1. All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.

2. Welder and welding operator qualification certificates.
3. Welder's identification list, listing welder's and welding operator's qualification procedure and welding identification symbols.
4. Raw material test reports on components as specified by the specification and / or agreed to in the quality plan.
5. Stress relief time temperature charts/oil impregnation time temperature charts.
6. Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.
7. The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactory.

#### **1.7. INSPECTION, TESTING AND INSPECTION CERTIFICATES:**

- A. The Owner and the Consultant or duly authorized representative shall have at all reasonable times free access to the Contractor's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Owner and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.
- B. All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the Owner/Consultant the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test were pending payment would be made on successful completion of type/routine test(s) actually carried out as per Consultant/Owner instructions.
- C. The Contractor shall give the Consultant/Owner thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The Consultant/Owner unless witnessing of the tests is virtually waived will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of Owner/Consultant and he shall forthwith forward to the Consultant duly certified copies of tests in triplicate.
- D. The Consultant/Owner shall within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.
- E. When the factory tests have been completed at the Contractor's or Sub-contractor's works, the Consultant/Owner shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Consultant/Owner, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Consultant/Owner. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the Owner to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of MICC by the Owner.
- F. For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labor, materials, electricity, fuel, water, stores, apparatus and instruments as may be required



by Owner/Consultant or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

- G. The inspection by Owner/Consultant and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.
- H. The Consultant/Owner will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.
- I. The Owner/Consultant reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Contractor.

### **1.8. TESTS:**

- A. Charging (Pre-commissioning tests): On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/Consultant and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial precommissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. / vendor/ bidder submittal and as included in the Contractor's quality assurance programme.
- B. Commissioning Tests:
  - 1. The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions which do not correspond to the specified conditions.
  - 2. All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
  - 3. Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.
  - 4. The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimburse by Owner on production of requisite documents.

### **1.9. PACKAGING:**

- A. All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the

Contractor. Owner takes no responsibility of the availability of any special packaging/transporting arrangement.

#### **1.10. PROTECTION:**

- A. All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a nonmetallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

#### **1.11. FINISHING OF METAL SURFACES:**

- A. General: All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hotdip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanize. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.
- B. Painting:
  - 1. All sheet steel work shall be degreased, pickled, and phosphated in accordance with the IS- 6005 “Code of practice for Phosphating iron and sheet”. All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swab shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
  - 2. After Phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved.
  - 3. Powder coating/electrostatic painting of approved shade shall be applied.
  - 4. The exterior color of the paint shall be as per IS-5 or as approved by Consultant. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.
  - 5. In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for Owner’s review and approval.

#### **1.12. HANDLING, STORAGE AND INSTALLATION:**

- A. In accordance with the specific installation instructions as shown on manufacturer’s drawings or as directed by the Owner or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment

included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

- B. Contractor shall follow the unloading and transporting procedure at site, as well as storing, testing and commissioning of the various equipment being procured by him separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's Engineer(s) and shall extend full co-operation to them.
- C. In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Owner/Consultant. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer's drawings/instructions correctly.
- D. Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- E. The Contractor shall submit to the Owner every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- F. The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Owner in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Owner, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- G. The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.
- H. The words 'erection' and 'installation' used in the specification are synonymous.
- I. Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- J. The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

### **1.13. PROTECTIVE GUARDS**

- A. Suitable guards shall be provided for protection of personnel on all exposed rotating and / or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.
- B. The Contractor shall also conform to the general regulations governing personnel on the site and must keep to the working space allocated for their use.
- C. The contractor shall be responsible for any kind of mishap, etc. happened with personnel. The Owner shall not take the responsibility for any of such kind.

### **1.14. TOOLS AND TACKLES:**

- A. The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dismantling and maintenance of the equipments.

## **Chapter 13. PREAMBLE TO BILL/ SCHEDULE OF QUANTITIES**

- 1.1. Tender shall be on the basis of item rates which shall include the cost of materials, labour, all taxes, duties and all other services required for the complete installation, testing and commissioning in accordance with the relevant NEC/IER and code in practice including the fees for inspection together with the liabilities and obligations as detailed in the general conditions of contract. It will also be the responsibility of the bidder to obtain all types of sanctions etc like power/light connections and the drawings etc if any, required by the concerned local authorities.
- 1.2. Prices shall remain firm and free from variation due to rise and fall in the cost of materials and labour or any other price variation whatsoever whether during extended period of completion, if any.
- 1.3. Item rates shall remain valid for any variation in the estimated quantities given in schedule of quantities.
- 1.4. In order to facilitate the technical scrutiny of the various quotations, the bidder must supply with their quotations detailed technical particulars make catalogues and erection drawings for various items under different parts specified in the schedule of quantities.
- 1.5. The drawing and specifications lay down minimum standard of equipment and workmanship and the deviations. In the absence of any deviations, it will be deemed that the bidder is fully satisfied with the intents of the specifications and drawings and their compliance with the statutory and fire insurance provisions including local codes, where the drawings and specifications conflict, the stringiest shall apply.
- 1.6. All equipments and the installations shall be tested as specified and a test certificate in the prescribed form as required by the local supply authorities shall be furnished.
- 1.7. The entire installation shall be guaranteed against defective materials or workmanship for a period of 12 months from the date of the installation certified by the Consultant and taken over by the Client. During the guarantee period all the defects shall be rectified by the contract free of cost.
- 1.8. The successful bidder shall submit the shop drawings to the Consultant for approval prior to start the work. The approval of these drawings will be general and will not absolve the contractor of the responsibility of the correctness of these drawings. At least 6 copies of the approved drawings shall be supplied to the Consultant for their distribution to the various agencies at site at no cost to the Client.
- 1.9. The position of distribution boards and switchboards may require some minor adjustments due to either site requirements or change in structural layout. All such changes from the position, shown in the drawings, shall be required to be incorporated without any extra payment or deduction for change in length of wiring etc.
- 1.10. The bidders must see the site conditions and take all the aforesaid and foregoing factors while quoting the rates, as no extra payment will be allowed on any ground arising out of or relating to the aforesaid and foregoing.
- 1.11. In single phase (230 V) A.C. supply system circuit wires of same phase shall be drawn in same conduit. For 3 phase, 4 wire wiring system wires of different colour shall be used and for insulated neutral only black colour wire shall be used.
- 1.12. The bidder shall include in his rates for painting with three coats of synthetic enamel paint to match the surroundings or as directed by the Consultant for all steel structure used for works at no extra cost.

- 1.13. The successful bidder shall supply completion drawings of the entire installation on tracing cloth as well as three prints of each drawing showing the complete wiring diagram as executed at site drawn to scale approved by the Consultant after the completion of work but before completion certificate is given by the Consultant.
- 1.14. After laying and jointing the cables shall be subject to necessary tests as stipulated in IS: 5959 (Part-I): 1970.
- 1.15. As more than one make is mentioned, prior approval of particular make for use shall be obtained from the Consultant. All samples of all electric fittings and other accessories shall be approved by the Consultant prior to their installation.
- 1.16. No alteration whatsoever is to be made to the text of quantities of this schedule of quantities, unless such alteration is authorized in writing by the Consultant. Any such alteration or addition shall, unless authorized in writing, be disregarded when tender documents are considered.
- 1.17. Any error in description or in quantity or omission of items from the contract shall not vitiate this contract but shall be corrected and demand to be a variation required by the Consultants.
- 1.18. All measurements shall be taken in accordance with the Indian Standard Electrical Installation in buildings method of measurements of IS: 5908:1970, unless otherwise specified.
- 1.19. The contractor shall provide, within one month after completion of the work or along with the final bill, three sets of manuals properly bound which shall contain the following information:
  - A. Description of installation items using main items of equipments.
  - B. Description of all equipments and system operation with trouble shooting manuals.
  - C. Line diagram of each system including main feature of equipments and showing method of setting controls.
  - D. Method of fault finding, routine, adjustment and wiring diagram.
  - E. Description of routine maintenance, oil and greasing points and recommended lubricants.
  - F. Manufacturer service manuals for all equipments.
  - G. Spares reference manuals.
- 1.20. The contractor shall provide the following at no extra cost to the Client.
  - A. Danger Notice Boards
  - B. Treatment for electric shock giving details of FIRST AID TREATMENT with chart diagrams (mounted in suitable frame).
  - C. Line wiring diagrams of the electrical system mounted in suitable frame.
- 1.21. The contractor will remove all the debris and surplus earth from work site (belonging to his work) free of cost.

## Chapter 14. ACCEPTABLE MAKES OF MATERIALS – ELECTRICAL

S.NO	Details of Materials / Equipment	Manufacturer
1.	MAIN LT PANEL AND MOTOR CONTROL CENTRE	L&T, SIEMENS, C&S, SCHNEIDER (OR FIRMS WITH VALID CPRI TEST CERTIFICATES)
2.	MCCB, MCB, RCCB, ELCB	SCHNEIDER ELECTRIC (MERLIN GERIN), LARSEN & TOUBRO, LEGRAND, HAGER
3.	DISTRIBUTION BOARD	SCHNEIDER ELECTRIC (MERLIN GERIN), LARSEN & TOUBRO, LEGRAND, HAGER
4.	POLY CARBONATE MCB DB	HENSEL, LEGRAND, HAGER OR EQUIVALENT
5.	CHANGE OVER SWITCH	LARSEN& TOUBRO, HPL-SOCOMEK, GE, SIEMENS
6.	METAL CLAD SHEET STEEL ENCLOSURE SOCKET/PLUG BOX	L&T, LEGRAND, HAGER, SIEMENS, SCHNEIDER, HENSEL
7.	SWITCH FUSE UNIT, HRC FUSE	L&T, ABB,GE, SIEMENS
8.	HRC HBC FUSES & BASES	L&T, SIEMENS, LEGRAND, SCHNEIDER
9.	AUTOMATIC TRANSFER SWITCHES	L&T, SIEMENS, LEGRAND, SCHNEIDER
10.	LOAD BREAK SWITCHES	L&T, SIEMENS, GE, SCHNEIDER
11.	PROTECTION RELAY (NUMERIC TYPE)	ALSTOM, ABB, SIEMENS, L&T, SCHNEIDER
12.	MODULAR PLATE SWITCHES AND SOCKETS	LEGRAND, CLIPSAL, CRABTREE, MK
13.	OVERLOAD RELAYS WITH BUILT IN SINGLE PHASE PREVENTER	LARSEN & TOUBRO (ESBEE), SIEMENS, SCHNEIDER ELECTRIC (TELEMECANIQUE-LDR SERIES)
14.	ELECTRONIC DIGITAL METERS (A/V/PF/HZ/KW/KWH) WITH LED DISPLAY	CG SCHLUMBERGER, SECURE, L&T- CONZERV
15.	BUSTRUNKING RISING MAINS	LEGRAND, C&S, OBO
16.	AUTOMATIC POWER FACTOR CORRECTION RELAY(NUMERIC TYPE)	BLEUK (GERMANY), LARSEN & TOUBRO, ABB, EPCOS, ALSTOM
17.	XLPE ALUMINIUM/COPPER CONDUCTOR ARMoured MV CABLES UPTO 1100 V GRADE	FINOLEX, RR KABEL, POLYCAB, HAVELLS, CCI

S.NO	Details of Materials / Equipment	Manufacturer
18.	1100 VOLTS GRADE FRLS PVC CONTROL CABLES	FINOLEX, RR KABEL, POLYCAB, HAVELLS, L&T
19.	11/33 KV HT CABLE	FINOLEX, HAVELLS, L&T, RR KABEL, POLYCAB
20.	LT JOINTING KIT / TERMINATION	RAYCHEM, SAFE KIT, M-SEAL
21.	CABLE GLANDS DOUBLE COMPRESSION WITH EARTHING LINKS	COMET, PEECO, GRIPWELL, DOWELLS
22.	BIMETTALIC CABLE LUG	DOWELL'S , LAPP KABEL, COMET
23.	PVC INSULATED COPPER CONDUCTOR STRANDED FLEXIBLE WIRES (FRLS)	FINOLEX, RR KABEL, HAVELLS, POLYCAB, NICCO,
24.	MS CONDUIT (ISI APPROVED)	BEC, AKG, PRECISION
25.	ACCESSORIES FOR MS CONDUIT (ISI APPROVED)	SHARMA SALES CORPORATION, PRAKASH ENGINEERING WORKS, SUPER SALES CORPORATION
26.	PVC CONDUIT & ACCESSORIES (ISI APPROVED)	POLYCAB, HARSH, BERLIA, AKG
27.	CEILING FAN	CROMPTON GREAVES, POLAR, BAJAJ, HAVELLS,
28.	VCB/HT SWITCHGEAR (11/33KV)	SIEMENS, CROMPTON, SCHNEIDER, ABB, L&T
29.	LIGHT FIXTURES	PHILIPS/ WIPRO/ HAVELLS-SYLVANIA/ AS PER BOQ
30.	EXTERNAL LIGHTING FIXTURE, POLES	PHILIPS/ WIPRO/ CROMPTON/ BAJAJ/ AS PER BOQ
31.	LAMPS	PHILIPS, OSRAM, HAVELLS
32.	SELECTOR SWITCH, TOGGLE SWITCH	SALZER (LARSEN & TOUBRO), KAYCEE, SIEMENS
33.	TIMER IN DISTRIBUTION BOARDS	SCHNEIDER ELECTRIC (TELEMECANIQUE), MDSLEXIC, LARSEN & TOUBRO (HAGER), ABB, SIEMENS, GE(C&I)
34.	BATTERIES LEAD ACID	EXIDE, STANDARD FURKAWA, AMRON, AMCO
35.	SEALED MAINTENANCE FREE BATTERIES	EXIDE, AMRON, STANDARD FURUKAWA, HBL
36.	BATTERY CHARGER	VOLSTAT, CROMPTON GREAVES, CALDYNE, CHHABI ELECTRICALS
37.	LT SERVO AUTOMATIC VOLTAGE STABILIZER	ICON, RECON, SELVON, AUTOMATIC ELECTRIC



S.NO	Details of Materials / Equipment	Manufacturer
38	CABLE TRAYS (FACTORY FABRICATED) /RACEWAYS	VENUS/PILCO/SLOTTCO/INDIANA/STEELWAYS/ PROF AB/SKABER/ DYNAMIC
39	FIRE SEALANT	BIRLA 3M, HILTI, PROMAT
40	220/24V TRANSFORMERS	VOLSTAT ELECTRONICS, AUTOMATIC ELECTRIC
41	LIGHTING HIGH MAST SYSTEM	PHILIPS, BAJAJ, KESELEC, CROMPTON
42	SOFT STARTER	ALLEN BRADLEY, SIEMENS, ABB, L&T, SCHNEIDER.
43	VARIABLE SPEED DRIVES	ALLEN BRADLEY, SIEMENS, ABB, L&T, SCHNEIDER, DANFOSS.
44	TELEPHONE OUTLETS	LEGRAND, MK, CLIPSAL
45	MULTI-METERS & MEGGARS	ESCROP/MOTWANI OR EQUIVALENT
46	LIGHTING PROTECTION	INDELEC, PIORTEH, POUYET
47	PUMPS	KIRLOSKAR, CROMPTON, GRUNDFOSS, KSB, MATHER & PLATT
48	FLEXIBLE CONDUIT	LAPP, HENSEL, JAINSONS
49	BAKELITE SHEET	HYLAM/FORMICA/GREENLAM
50	TELECOMMUNICATION CABLE	BATRA HENLAY, FINOLEX, DELTON, HAVELLS
51	TV COAXIAL CABLE	BATRA HENLAY, FINOLEX, DELTON, HAVELLS
52	COMPUTER/DATA CABLE	LEGRAND, DIGILINK, D-LINK, AVAYA, AMP, CLIPSAL
53	TAG BLOCK	KRONE, ERICSSON
54	MOTORS	SIEMENS, KIRLOSKAR, CROMPTON, ABB
55	TRANSFORMERS (OIL IMMERSSED & DRY TYPE)	ABB, KIRLOSKAR, CROMPTON, SCHNEIDER, SEIMENS
56	RING MAIN UNIT	SCHNEIDER, SIEMENS, ABB, L&T
57	AIR-BREAK SWITCH	ABB, CROMPTON, SCHNEIDER, LEGRAND
58	CURRENT TRANSFORMERS/ POTENTIAL TRANSFORMERS	MDC, AE, KAPPA, POWERONICS, RESISE, C&S, INDOTEC, FORME MARSHALL, GILBERT & MAXWELL
59	DG SET	CATERPILLAR, LERROYSOMER, CUMMINS, STAMFORD, VOLVO-PENTA, KIRLOSKAR
60	DG AMF PANEL, DG AUXILIARY PANEL AND MOTOR CONTROL CENTRE	SAME AS LT PANEL/ DG PACKAGER.
61	VIBRATION ISOLATORS	RESISTOFLEX, FLENONICS (USA), GERB

S.NO	Details of Materials / Equipment	Manufacturer
62	NOISE CONTROL SILENCER / MUFFLER	INTERTEC, SOUND CONTROL INDIA
63	D.G. PACKAGER	SUDHIR GENSETS, TIL, STERLING WILSON, JAKSON, GMMCO, RAIPOWER.
64	HSD FUEL TRANSFER PUMPS	ROTODEL
65	FUEL TANK	AVENUE ENGINEERS, INDO ASIATIC ENGINEERS PVT LTD
66	CCTV	SONY, HONEYWELL, SANYO
67	UPS	EMERSON, SOCOMEC, AROS, PCI, MITSUBISHI
68	SMOKE DETECTORS	MORLEY-IAS, EDWARDS, NOTIFIER, COOPER, SCHRACK
69	HEAT DETECTORS	MORLEY-IAS, EDWARDS, NOTIFIER, COOPER, SCHRACK
70	CONTROL MODULES / MONITOR MODULES / FAULT ISOLATORS	MORLEY-IAS, EDWARDS, NOTIFIER, COOPER, SCHRACK
71	MAIN CONTROL PANEL	MORLEY-IAS, EDWARDS, NOTIFIER, COOPER, SCHRACK
72	MANUAL CALL STATIONS / HOOTERS	MORLEY-IAS, EDWARDS, NOTIFIER, COOPER, SCHRACK
73	STROBE LIGHTS	MORLEY-IAS, EDWARDS, NOTIFIER, COOPER, SCHRACK
74	SPEAKERS/ AMPLIFIERS	BOSE, BOSCH, EDWARDS, NOTIFIER, COOPER,
75	RESPONSE INDICATOR	MORLEY-IAS, EDWARDS, NOTIFIER, COOPER, SCHRACK
76	MIMIC PANEL	MORLEY-IAS, EDWARDS, NOTIFIER, COOPER, SCHRACK
77	MICC CABLES	TYCO (UK), WREXHAM (UK), MICC(UK), KME (ITALY)
78	VOICE EVACUATION SYSTEM	EDWARDS, NOTIFIER, HONEYWELL
79	FIRE FIGHTING TELEPHONE	EDWARDS, NOTIFIER, HONEYWELL