

5.03 SWITCH DISCONNECTOR FUSE UNITS

The Switch Disconnecter Fuse Units shall be double break type suitable for load break duty (AC 23) quick make and break action. Hinged doors shall be duly interlocked with operating mechanism so as to prevent opening of the door when the switch is in 'ON' position and also prevent closing of the switch when the door is not properly secured. All contacts incoming and outgoing terminals of switch shall be adequately sized to receive proper size of cables. High rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall be in accordance with IS 13703-1&2-1993 and having rupturing capacity of not less than 31 MVA at 415 volts. HRC fuse links shall be provided with visible indicators to so that they have operated. The switch disconnecter fuse units shall be manufactured in accordance with IS 13947-3-1993.

FUSE

Fuse shall be of the high rupturing capacity (HRC) fuses links and shall be in accordance with IS 13703-1&2-1993 and having rupturing capacity of not less than 31 MVA at 415 volts. The backup fuse rating for each motor/equipment shall be chosen as the fuse does not operate on starting of motors/equipments.

5.04 MEASURING INSTRUMENTS, METERING & PROTECTION

5.04.01 GENERAL

Direct reading electrical instruments shall be in conformity with IS 1248. The accuracy of direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between -10 degree Centigrade to + 50 degree Centigrade. All meters shall be of flush mounting type of 96mm square or circular pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instrument glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible without removal of the seal. The meters shall be provided with white dials and black scale markings.

The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside. The direction of deflection shall be from left to right.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three-phase supply.

The specifications herein after laid down shall also cover all the meters, instrument and protective devices required for the electrical work. The ratings type and quantity of meters, instruments and protective devices shall be as per the schedule of quantities.

5.04.02 Digital AMMETERS

Ammeters shall be standard digital type or specified in BOQ the ammeters shall be calibrated as per the latest edition of IS:1248. Ammeters shall be instrument transformer operated, and shall be suitable for 5A secondary of instrument transformer. The scales shall be calibrated to indicate primary current, unless otherwise specified. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

5.04.03 Digital VOLTMETERS

Voltmeters shall be standard digital type or specified in BOQ the ammeters shall be calibrated as per the latest edition of IS:1248. The range for 415 volts, 3 phase voltmeters shall be 0 to 500 volts. Suitable selector switch shall be provided for each voltmeter to read voltage between any two lines of the system. The voltmeter shall be provided with protection fuse of suitable capacity.

5.04.04 CURRENT TRANSFORMERS

Current transformers shall be in conformity with IS: 2705 (Part I, II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1kV. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated acceptable minimum class of various applications shall be as given below:

Measuring : Class 0.5 to 1

Protection : Class 5P10.

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 50KA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

All Current Transformer shall be Cast resin type.

5.05 MISCELLANEOUS

Control switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the filament type of low watt consumption, provided with series resistor where necessary, and with translucent lamp covers, bulbs & lenses shall be easily replaced from the front.

Push buttons shall be of the momentary contact, push to actuate type fitted with self-reset contacts & provided with integral escutcheon plates marked with its functions.

6.00 INTERNAL ELECTRIFICATION OF BUILDING

6.1 SCOPE

As specified in subhead 1.00

6.2 GENERAL

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice for Electrical Wiring Installation IS: 732-1989 and IS: 2274-1963. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these become applicable to the installation. Electrical work in general shall be carried out as per following CPWD Specifications with up to date amendment.

- Specifications for Electrical Works Part-I (Internal) by CPWD – 2005 or latest revision
- Specifications for Electrical Works Part-II (External) by CPWD – 1994 or latest revision

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.

6.3 DISTRIBUTION BOARDS.

As a general practice only pre-wired MCB type double door DB shall be used. Pre-wired DB shall have following features:

- i) Recess/ surface type with integral loose wire box.
- ii) Phase/neutral/ earth terminal blocks for termination of incoming & outgoing wires.
- iii) DIN channel for mounting MCBs.
- iv) Arrangement for mounting incomer MCB/RCCB/RCBO/MCCB as required.
- v) Copper bus bar.
- vi) Earthing terminals.
- vii) Wiring from MCBs to terminal block.
- viii) Interconnection between terminal block/ incoming switch/ bus bar/ neutral/ terminal block/ earth terminal connector with specified size of FRLS pre insulated copper conductor cable duly fitted with copper lugs/ thimbles.
- ix) Termination block should be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq. mm.
- x) Terminal block shall be made of flame retardant polyimide material.

- xi) Coloured terminal blocks and FRLS wires for easy identification of RYB phases, Neutral and Earth.
- xii) Pre-wired DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs. Terminal connectors from the DB without loosening the internal cable connections of phase and neutral circuits.
- xiii) The pre-wired DB shall have peel able poly layer on the cover for protection from cement, plaster, paints etc during the construction period.
- xiv) Detachable plate with knock out holes shall be provided at the top/ bottom of board. Complete board shall be factory fabricated and pre-wired in factory, ready for installation at site. The box and cover shall be fabricated from 1.6 mm sheet steel, properly pretreated, phosphotized with powder coated finish.
- xv) DB shall be of double door construction provided with hinged cover in the front.

Distribution Board shall be standard type. Distribution boards shall contain miniature circuit breakers of rating specified in BOQ/DB Schedule.

Miniature circuit breakers shall be quick make and quick break type with trip free mechanism. MCB shall have thermal and magnetic short circuit protection. All miniature circuit breakers shall be of 9 KA rated rupturing capacity unless otherwise specified.

Neutral busbars shall be provided with the same number of terminals, as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. All live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. A circuit identification card in clear plastic cover shall be provided for each distribution board.

MCB's shall be provided on the phase of each circuit. The individual banks of MCB's shall be detachable. There shall be ample space behind the banks of MCB's to accommodate all the wiring. All the distribution boards shall be completely factory wired, ready for connections. All the terminals shall have adequate current rating and size to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Earth Leakage Circuit Breaker shall be current operated type and of 30mA sensitivity unless otherwise specified. It shall also provide over-current and short circuit protection i.e. it shall be MCB-cum-RCCB (Residual Current Circuit Breaker). In case ELCB doesn't have inbuilt short circuit protection, same rating MCB have to be provided for short circuit protection along with ELCB. Cost of this MCB is deemed to be included in the cost of ELCB. ELCB shall be housed within the Distribution Board.

Distribution Boards shall be ready for connections and shall be inspected in the factory by HSCC Electrical Engineer before dispatch.

Before procurement of Distribution Boards, MCB's, ELCB's (incomer and outgoing) etc., the contractor has to take approval of the DB Schedule/Drawings of each DB from the HSCC Electrical Engineer. The whole unit i.e. Distribution Board, MCB's, ELCB's etc. shall come from the manufactures premises/workshop. After inspection and clearance from the HSCC Electrical Engineer the same may be dispatched to site for installation. However if a single component (such as ELCB or MCB or DB) is required for any reason such as replacement, increase in no. of circuits in the DB, change in the load of existing circuit, change in the total load on a particular DB etc., the same may be ordered separately but after the approval of HSCC Electrical Engineer.

6.4 METALLIC CONDUIT WIRING SYSTEM.

6.4.1 TYPE AND SIZE OF CONDUIT.

All conduit pipes shall be of approved gauge (not less than 16 SWG for conduits of sizes up to 32 mm diameter and not less than 14 SWG for conduit of size above 32mm diameter) solid drawn or reamed by welding finished with black stove enameled surface. All conduit accessories shall be of threaded type and under no circumstances pin grip type accessories shall be used. The maximum number of PVC insulated 650/1100 volts grade copper conductor cable that can be drawn in conduit of various sizes shall be as per IS Code. No steel conduit less than 20mm in diameter shall be used.

6.4.2 CONDUIT JOINTS.

Conduit pipes shall be joined by means of threaded couplers, and threaded accessories only. In long distance straight run of conduits, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and jam nuts shall be provided. In the later case the bare threaded portion shall be treated with anti-corrosive preservative. Threads on conduit pipes in all cases shall be between 13 mm to 19 mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories.

Cut ends of conduit pipe shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductor while pulling them through such pipes.

6.4.3 PROTECTION AGAINST CONDENSATION.

The layout of conduit should be such that any condensation or sweating inside the conduit is drained out. Suitable precaution should also be taken to prevent entry of insects inside the conduit.

6.4.4 PROTECTION OF CONDUIT AGAINST RUST.

The outer surface of conduit including all bends, unions, tees, junction boxes etc. forming part of conduit system shall be adequately protected against rust when such system is exposed to weather by being painted with two coats of oxide paint applied before they are fixed. In all cases, no bare threaded portion of conduit pipe shall be allowed. Unless such bare thread portion of conduit is treated with anticorrosive preservative or covered with approved plastic compound.

6.4.5 PAINTING OF CONDUIT AND ACCESSORIES.

After installation, all accessible surface (if any) of conduit pipes, fittings etc. shall be painted with two coats of approved enameled paint or aluminium paint as required to match the finish of surrounding wall, trusses etc.

6.4.6 RECESS CONDUIT.

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of building under construction, conduit shall be buried in the wall before plastering and shall be finished neatly after erection of conduit. In case of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work. Entire work of chasing the wall, fixing the conduit in chases, and burring the conduit in mortar before plastering shall form part of point wiring work.

The conduit pipe shall be fixed by means of staples or by means of saddles not more than 60cm apart or by any other approved means of fixing. Fixing of standard bends and elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with the long radius, which shall permit easy drawing in of conductors. All threaded joints of conduit pipe shall be treated with some approved preservative compound to secure protection against rust. Suitable inspection boxes to the barest minimum requirements shall be provided to permit periodical inspection and of facilitate replacement of wires, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers. Wherever the length of conduit run is more than 10 meters, then circular junction box shall be provided.

6.4.7 METAL OUTLET BOXES & COVERS.

The switch box shall be made of modular metal boxes with suitable size modular cover plates. Modular metal box shall be made of mild steel on all sides except on the front.

The metal box (other than modular type) shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanized mild steel. Metal boxes upto 20 x 30 cm

size M.S. box shall have wall thickness of 18 SWG and MS boxes above 20 x 30 cm size shall be of 16 SWG. The metallic boxes shall be painted with anticorrosive paint before erection. Clear depth of the box shall not be less than 60mm. All boxes shall be covered from top with Phenolic laminated sheet of approved shade. These shall be of 3 mm thick synthetic phenolic resin bonded laminated sheet as base material and conform to grade P-I of IS: 2036-1994.

6.4.8 ERECTION AND EARTHING OF CONDUITS.

The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested in presence of HSCC Electrical Engineer for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirement by means of special approved type of earthing clamp effectively fastened to conduit pipe in a workmen like manner for a perfect continuity between the earth and conduit.

6.4.9 SWITCHES.

All 5 and 15 Amp switches shall be modular type of 240 volts A.C. grade. All switches shall be fixed on modular metal boxes. All 5 Amp socket shall be 5 pin type and 15 Amp socket shall be 6 pin type (unless otherwise specified) suitable for 15/5 Amp. All modular switches, sockets, telephone outlets, TV outlet etc. shall be in off white finish unless otherwise specified. The switches controlling the lights or fans shall be connected to the phase wire of the circuit. Switch boards shall be located at 1200 mm above finished floor level unless otherwise indicated on drawings or directed by Engineer-In-Charge.

In case of computer power points, power points, telephone points etc. to be fixed on laminated partition board (furniture), same shall be fixed on laminated board (portion of laminated board meant for fixing power points) with base plate/cover plate as applicable, duly fixed with screws.

6.4.10 COVER PLATE.

All modular switches, sockets, telephone outlets etc. shall be fixed modular metal boxes with modular base plates and modular cover plates on top.

6.4.11 WALL SOCKET PLATE.

Each outlet shall have a switch located beside the socket preferably on the same cover plate/modular base. The earth terminal of the socket shall be connected to the earth wire.

6.5 WIRING.

All PVC insulated copper conductor wires shall conform to relevant IS Codes. All wires/cables shall be stranded type irrespective of its size. Cable conductor size and material shall be specified in BOQ.

All internal wiring shall be carried out with PVC insulated wires of 650/1100 volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/fan. A light/fan switchboard may have more than one circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring. Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switchboards. A separate earth wire shall be provided along with circuit wiring for each circuit. For point wiring red/yellow/blue colour wire shall be used for phase and black colour wire for neutral. Circuit wiring shall be carried out with red, yellow or blue colour PVC insulated wire for RYB phase wire respectively and black colour PVC insulated wire for the neutral wires. Bare copper wire shall be used as earth continuity conductor and shall be drawn along with other wires. No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire.

Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust and dirt. Drawing and jointing of copper conductor wires and cables shall be as per CPWD specifications.

Maximum number of PVC insulated 650/1100 V grade aluminium/copper conductor cable conforming to IS : 694 - 1990

Nominal Cross-Sectional area of conductor in Sq.mm.	25mm		32mm		38mm		51mm		64mm	
	S	B	S	B	S	B	S	B	S	B
1	4	5	6	7	8	9	10	11	12	13
1.5	10	8	18	12	-	-	-	-	-	-
2.5	8	6	12	10	-	-	-	-	-	-
4	6	5	10	8	-	-	-	-	-	-
6	5	4	8	7	-	-	-	-	-	-
10	4	3	6	5	8	6	-	-	-	-
16	2	2	3	3	6	5	10	7	12	8
25	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	4	3	5	4

NOTE :

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

6.5.1 JOINTS.

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits and junction boxes. Conductors shall be continuous from outlet to outlet.

6.5.2 LOAD BALANCING

Balancing of circuits in three-phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

6.5.3 COLOUR CODE FOR CIRCUIT WIRING.

Colour code for circuit and sub main wiring installation shall be Red, Yellow, and Blue for three phases. Black for neutral and yellow/green or green only for earth incase of insulated earth wire.

6.5.4 CLASSIFICATION OF POINTS.

6.5.4.1 General

Classification and measurement of Point wiring shall be as per CPWD specification for Electrical Works (Part-I-Internal) 1994.

6.5.4.2 Point Wiring (Modular)

Definition of point wiring

A point (other than socket outlet point) shall include all work necessary in complete wiring to the light points/fan/exhaust fan/call bell point from the controlling switch/MCB. The scope of wiring for a point shall, however, include the wiring work necessary in tapping from another point in the same distribution circuit i.e. from first

switch board (wiring from distribution board to first switch box is covered in the circuit wiring and is not in the scope of point wiring) to subsequent switch board(s) in the same distribution circuit. The point wiring includes all materials specified below including chasing the wall (in case of recessed wiring in wall), fixing the conduit and making the wall good as it originally was. It also includes supply, drawing, testing and commissioning of wires.

Scope of point wiring

Following shall be deemed to be included in point wiring.

- (a) Supply & fixing conduit & conduit accessories for the same and wiring cables (including supplying and drawing wires) between the switch box and the point outlet. [See also (i) below]
- (b) All fixing accessories such as clips, nails, screws, phil plug, rawl plug etc. as required.
- (c) Modular Metal boxes for control switches, regulators, sockets etc. recessed or surface type, modular base plates and modular cover plates over the same.
- (d) Outlet boxes, junction boxes, pull-through boxes etc. but excluding modular metal boxes if any, provided the switchboards for loose wires/conduit terminations.
- (e) In case of recessed wiring in wall the scope includes chasing of wall, fixing the conduit and making the wall good as it originally was.
- (f) Control modular switch (5/6A) as specified.
- (g) Ceiling rose or connector (in case of points for ceiling/exhaust fan point, prewired light fittings and call bells).
- (h) Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.
- (i) Interconnecting wiring between points on the same circuit, in the same switch box or from another. Interconnecting wiring from first switchboard to subsequent switch board(s).
- (j) Protective (loop earthing) conductor (as specified in the BOQ) from one metallic switch box to another in the distribution circuits, and from switchboard to each point (light/fan/exhaust fan/call bell etc).
- (k) Bushed conduit where wiring cables pass through wall etc.
- (l) Ceiling rose (in the case of pendants except stiff pendants).
- m) Lamp holder (in the case of goose neck type wall bracket, batten holder and fittings which are not pre-wired)..
- n) Back Plate (in the case of stiff pendants).
- (p) MS Fan Boxes with MS hook (as per CPWD specifications) for the erection of Ceiling Fans

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

Measurement of Point Wiring (other than socket outlet points)

- i) There shall be no linear measurement for point wiring for light points, fan points, exhaust fan points and call bell points. These shall be measured on unit basis by counting,
- ii) No separate measurement shall be made for interconnections between points in the same distribution circuit and for the circuit protective (loop earthing) conductors between metallic switch boxes.

6.5.5. Circuit and Submain Wiring

Circuit Wiring

Circuit wiring shall mean the wiring from the distribution board upto the tapping point for the nearest first point of that distribution circuit i.e. up to the nearest first switch box.

Submain Wiring

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

Measurement of circuit wiring and submain wiring

- (i) Circuit and submain wiring shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end to end of conduit, exclusive of interconnections inside the switchboard etc. The increase on account of diversion or slackness shall not be included in the measurement.
- (ii) The length of circuit wiring with two wires shall be measured from the distribution board to the first nearest switch box in the circuit irrespective of whether neutral conductor is taken to switch box or not.
- (iii) When wires of different circuits are grouped in a single conduit, the same shall be measured on linear basis depending on the actual number and size of wires run.
- (iv) When circuit wires and wires of point wiring are run in the same conduit, circuit wiring shall be measured on linear basis depending on the actual number and sizes of wires run in the existing conduit.
- (v) Protective (loop earthing) conductors, which are run along the circuit wiring and submain wiring, shall be measured on linear basis and paid separately. This is not applicable if protective conductor is clubbed with the BOQ item of circuit and submain wiring.

6.5.6 Power Plug Wiring

5A Plug Wiring

Wiring for all 5 A Socket Outlets shall be done with 2X1.5 sqmm PVC insulated copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire as specified in the BOQ/Drawings, from the switchboard or 15A power point as the case may be.

Measurement of 5A point wiring shall be done on number basis from switchboard/15A power point to 5A point. Conduit of point wiring/power point wiring can also be used for 5A point wiring, but both phase and neutral wires shall come directly from switchboard/power point. Looping of neutral shall not be done.

15A Power Plug Wiring

Wiring for all 15 A Socket Outlets/Gyser point shall be done with 2X4 sqmm PVC insulated copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire as specified in the BOQ/Drawings, directly from the MCB-Distribution Board or from one power point to another in case of computer power points. Looping shall not be done in general 15A power points (other than computer power points).

Measurement of power point wiring shall be done on number basis under following two subheads:

- i) Directly from MCB-Distribution Board to the Socket Outlets
- ii) From One power point/computer power point to another (looping)

Wiring for 20A Metal Clad Socket Outlets

Wiring for all 20A Metal Clad Socket Outlets shall be done with 2X6 sqmm PVC insulated copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire as specified in the BOQ/Drawings, directly from the MCB-Distribution Board. Measurement of wiring for 20A Metal Clad Socket outlet shall be done on number basis i.e. complete wiring directly from MCB-Distribution Board to the socket outlet.

No extra payment shall be made on account of minor changes in location of power points (15A or 20A or computer power points) due to change in the architectural layout or change due to any other reason. Height of the power socket outlets shall be 300mm from the finished floor level unless otherwise specified.

6.5.7 CONDUCTOR SIZE.

Wiring shall be carried out with following sizes of PVC insulated stranded single core copper conductor wire/cable.

- i. Light point. - 1.5Sq.mm

- ii. Ceiling /Cabin/Exhaust Fan Point - 1.5Sq.mm
- iii. Call Bell Point - 1.5Sq.mm
- iv. Plug Point (5 A Outlet) - 1.5Sq.mm
- v. Circuit Wiring - 1.5Sq.mm
- vi. General Power Point - 4Sq.mm
- vii 20A Industrial Socket Outlet – 6 Sqmm
- viii Special Power Point – 6 Sqmm
- ix A/C Box with 32A MCB- 6 Sqmm

6.5.8 LIGHTING FIXTURE AND FANS

6.5.8.1 GENERAL

- a. The Contractor shall supply and install lighting fixtures including but not limited to lamps, ballasts, accessories fixing hardware necessary for installations, as shown on the Drawings, as required, and as herein specified.
- b. All fixtures shall be delivered to the building complete with suspension accessories, canopies, hanging devices, sockets, holders, reflectors, ballasts, diffusing material, louvers, plaster frames, recessing boxes, etc. all wired and assembled as indicated.
- c. Full size shop detail drawings of special fixture or lighting equipment, where called for in the fixtures schedule, shall be submitted to the HSCC Electrical Engineer for approval.
- d. Fixtures, housing, frame or canopy, shall provide a suitable cover for fixture outlet box or fixture opening.
- e. Fixtures shall comply with all applicable requirements as herein outlined unless otherwise specified or shown on the Drawings.
- f. Manufacturer's name and catalogue number of light fixtures, fans, switchgears etc. shall be strictly adhered.
- g. Fixtures shall bear manufacturer's name and the factory inspection label.
- h. Fixtures shall be completely wired and constructed to comply with the IEE wiring regulations requirements for lighting fixtures, unless otherwise specified.

- i. Revamping the fixture shall be possible without having to remove the fixture from its place.
- j. Lamps of the proper type, wattage and voltage rating shall be furnished and installed in each fixture.

6.5.9 INSTALLATION

Fixtures shall be installed at mounting heights as detailed on the Drawings or as instructed on site by the Engineer-In-charge.

Pendent fixtures within the same room or area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation.

Flush mounted recessed fixtures, shall be installed so as to completely eliminate leakage of light within the fixture and between the fixture and adjacent finish.

Fixtures mounted outlet boxes shall be rigidly secured to a fixture stud in the outlet box. Hickeys or extension pieces shall be installed where required to facilitate proper installation.

Fixtures located on the exterior of the building shall be installed with non-ferrous metal screws finished to match the fixtures.

6.5.10 LAMPS-GENERAL

Lamp shall be supplied and installed in all lighting fixtures listed in the BOQ.

Lamp shall be the part of Fitting no extra Payment will be made

Lamps used for temporary lighting service shall not be used in the final fixture units.

Lamps shall be of wattage and type as shown in the BOQ.

Lamps for permanent installation shall not be placed in the fixtures, until so directed by the Engineer In-charge.

6.5.11 BALLASTS-FLUORESCENT

Ballasts shall be electronic type and having high power factor type.

Ballasts shall have manufacturer's lowest sound level and case temperature rise rating.

Ballasts shall be special cool operated type.

Ballasts for indoor fixtures shall be protected by an integral thermal automatic resetting protective unit, which shall disconnect the ballast in the event of overheating.

Ballasts shall be of the same manufacture as the lamps/fixture.

6.5.12 FIXTURE SAMPLES

Detailed catalogue for all fixtures or if so required by the HSCC Electrical Engineer sample fixtures shall be submitted for prior approval of the HSCC Electrical Engineer before orders for the fixtures are placed.

6.5.13 TESTING

After all lighting fixtures are installed and are connected their respective switches, test all fixtures to ensure operation on their correct switch in the presence of the engineer.

All non-operating fixtures or ones connected to the wrong or inconveniently located switch shall be correctly connected as directed by the Engineer In-charge.

6.5.14 CEILING FANS

All ceiling fans shall be provided with suspension arrangement in the concrete/slab/roof members. Contractor to ensure that provision are kept at appropriate stage at locations shown on the drawing. Fan box with MS hook shall be as per CPWD specification. Ceiling fan shall be double ball bearing type, copper wound motor complete with canopy, down rod, blades etc. and shall conform to relevant IS standards ceiling fan shall be white in colour. Ceiling fan shall be provided with electronic regulator. Electronic Regulator shall be suitable for 240 volts A.C supply 50 Hz and shall be of continuous duty type

6.5.15 EXHAUST FANS

Exhaust fans shall be heavy-duty type with double ball bearing and conforming to IS 2312 (latest revision). Exhaust fan shall be complete with copper wound motor, capacitor, Louver/shutter, frame and mounting bracket. Exhaust fan shall be suitable fan operation on 240 volts single phase A.C supply.

9.00 ADDRESSABLE FIRE DETECTION AND ALARM SYSTEM

9.01 GENERAL

The Contractor shall supply and install the Addressable Fire Detection & Alarm System as per schedule of quantities are as herein specified. The system shall include Addressable Main Fire Alarm Control Panel, battery charger, batteries, addressable heat detectors, addressable smoke detectors, manual fire alarm station, fire alarm bells/hooters, response indicators, conduiting, wiring and all necessary accessories required to complete fire alarm system installation as per IS: 2189-1988. Equipment like control panel, smoke detector, heat detectors etc shall be EN-54/ UL approved.

9.02 FEATURES

The system shall be general alarm electrically supervised type activation of manual fire alarm station or any of the automatic alarm initiating devices shall sound the general alarm bells on all floors and shall give indication on the control panel. The signal shall be continuous until the station from which it is originated is restored to normal and a reset button on the control unit is operated.

The system shall be electrically supervised against open and ground on both the stations and signal device wiring. Open and ground in the system shall cause a trouble bell to ring at the fire alarm control panel and a trouble lamp to light. It shall be possible to silence the bell but the lamp shall remain lit until the fault is rectified. In case of power failure the system shall automatically changeover to the battery standby.

9.03 CONDUITING & WIRING

Conduiting & Wiring for FDA system shall be carried out in M.S Conduit with copper conductor PVC insulated wires.

9.04 CONTROL PANEL

The fire control panel has to be addressable type.

The Main Fire Control Panel shall be constructed to sheet steel of red colour, and provided with windows for the alarm and trouble lights. All components shall be of the plug in type, for simple replacement and extension in the future. Control panel shall be wall mounting type conforming to IS 513-1986.

The number of loops is mentioned in B.O.Q. Each loop shall be able to support at least 125 any device addressable analog/digital (as the case may be) sensors and control module etc. The control panel shall have alphanumeric display. The Main Fire control panel shall be provided with all necessary relays, resistors, fuses, transformers, rectifiers and all other components to assure full and proper functioning of the system. All relays shall conform to the relevant IS Standards. Control panel shall include power on lamps, system trouble lamps, audible trouble signal, trouble silence switch with ring back, alarm silence push button with repeat

alarm capability, low battery indicator with reset, ground detection indicator, alarm reset, milli ammeter, supervised alarm lamps, zone "Open" test pushbutton, zone alarm test push button, end of line resistors etc.

Each zone shall be equipped with an auxiliary contact for control of a remote annunciation.

Main control panel shall include a power supply model to provide a filtered and regulated source of power to provide additional power wherever supplementary power is required within the system. It shall include an output fuse, key reset switch, provision for automatic transfer to standby power upon primary power failure.

Main control panel shall in addition have audible signal and lamp to indicate as failure of the charge of battery.

Two stages general Alarm shall be provided in which a continuous evacuation alarm is immediately given in zone of fire and its adjoining zones. In other zone intermittent alarm signal shall be provided as per IS 2189-1988.

Repeater Panel shall be of same specification as main control panel and shall have fire/fault indication with audio device.

9.05 CHARGER AND BATTERY

Unit shall comprise a ventilated cabinet supplied complete with charger, meters, high rate charge switch and lock and key in a sheet metal enclosure.

9.06 ELECTRONIC HOOTERS

Hooter shall be electronic solid-state speaker type having tone for fire, which shall be wailing. Hooter should be loop powered having an output of approximately 6 watt. The audible range shall be around 100m under normal condition. Cable for this in our system shall be 2 cores. The switching shall be provided on the control panel. The outer enclosure of the speaker shall be of MS sheet and shall be suitably oven baked and painted. The speaker shall be 4" heavy magnet type. All hooters shall be on one or more circuits.

9.07 MANUAL ALARM CALL POINT FOR SURROUNDINGS (ADDRESSABLE)

The manual call point shall be electrically compatible with the standard range of automatic detectors so that it can be connected directly into a supervised two-wire zone of the manufacturer's standard range of control units. The manual call point shall be of pleasant, streamlined and flat appearance permitting its use as flush and surface mounted unit. The manual call point shall consist of base plate, insert and cover. The push button shall have minimum one normally closed plus one normally open contacts. The push button shall not be shrouded and the same shall be projected out from the surface of the MS Box. The whole assembly of push button shall be enclosed in the 16 SWG MS Box except from the front side. The front side shall be sealed with breakable glass covering neoprene or equivalent gasket. The glass cover shall be fixed in such a way that the actuating push button is kept

depressed (with NC contact open) so long as the glass cover is in contact. In case of fire, when the glass cover is broken to give the fire warning the push button shall be released due the spring action hence giving remote fire alarm through the NC contact. The breaking of the glass must release an alarm. All inscriptions, texts and marks must be on the manual call point front plate, not on the glass, so that the glass can easily be replaced anywhere. The alarm contacts shall be of self-cleaning design to prevent failure after a prolonged period of inactivity in unclean environments.

It shall be possible to test the call point without destroying the seal or removing the cover. The manual call point shall be equipped with a self-holding device to maintain the alarm condition until reset by an authorized person. The complete unit and the push button shall be painted signal Red. The internal surface of the MS enclosure of the box shall painted white colour. The external painting shall be of synthetic enameled paint. Aluminium hammer shall be suspended on a hook fixed to the external MS enclosure by means of a non-corrodible easy breaking of the glass cover.

Manual alarm call point located on the outer walls of the building and/or exposed to weather conditions shall be weather proof type and satisfying the requirement of APB.

The manual call point shall be capable of being remotely tested from control panel.

9.08 IONIZATION TYPE SMOKE DETECTORS (ADDRESSABLE TYPE)

Ionization smoke detectors shall respond to invisible and visible combustion gases. Ionization smoke detectors shall have an inherently stable sensor with built-in automatic compensation for changes in ambient conditions. All electronic circuits must be solid-state devices and virtually hermetically sealed to prevent their operation from being impaired by dust, dirt or humidity. All circuitry must be protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The detector shall have no moving parts or components subject to wear. All radioactive parts of the detector shall be safeguarded against tampering. The radioactive source shall be fully gold plated. The response sensitivity of each detector shall be factory set. A built-in barrier shall prevent entry of insects into the sensor. A built-in optional integration circuit shall allow the suppression of bried deceptive phenomena. The detector shall be designed for fast and simple laboratory cleaning.

The detector shall be inserted into or removed from the base by a simple push-twist mechanism to facilitate exchange for cleaning and maintenance. The manufacturer shall produce and provide test equipment allowing to test and exchange ionization type smoke detectors upto 7m (23ft) above floor level. The detector shall connect to the control unit via a fully supervised two-wire circuit.

The detector shall be capable of being remotely tested from control panel.

9.09 HEAT DETECTOR (ADDRESSABLE TYPE)

Heat detector shall be combined rate of rise and fixed temperature type. Heat detectors shall consist of two independent thermistors, designed to automatically

compensate virtually hermetically sealed to prevent their operation from being impaired by dust, dirt or humidity. All circuitry must be protected against usual electrical transients and protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The detector shall have no moving parts or components subject to wear. It shall be possible to test the detector in the field. The response (activation) of a detector shall be clearly visible from the outside by a flashing light of sufficient brightness. The detector shall be installed into the base by a simple push-twist mechanism to facilitate exchange for cleaning and maintenance. The detector shall connect to the control unit via a fully supervised two-wire circuit.

The manufacturer shall produce and provide test equipment allowing to test and exchange rate-of-rise/temperature heat detectors up to 7m (23ft) above floor level.

The detector shall be capable of being remotely tested from control panel.

9. 10 PLUG-IN BASES

The smoke & heat detectors shall fit into a common type of standard base. Once a base has been installed, it shall be possible to insert, remove and exchange different types of detectors by a simple push-twist movement. The standard base shall be equipped with screw wiring terminals capable of securing wire sizes up to 14 AWG and weakening of contact pressure. The standard base shall be supplied with a sealing plate, preventing dirt, dust, condensation or water from the conduit reaching the wire terminals or the detector contact points. All standard bases shall be supplied with a removable dust cover to protect the contact area during installation and construction phase of the building. It must allow the check out and certification of the zone wiring before insertion of any detectors. The standard base shall feature a built-in mechanism, which allows mechanical locking of an installed detector head, thus preventing unauthorized removal or tampering while maintaining.

The detector contact points shall be designed to retain the detector safely and to ensure uninterrupted contact also when exposed to continuous severe vibration. All electronic components of base and modules must be solid state and virtually hermetically sealed to prevent their operation from being impaired by dust, dirt or humidity. All circuitry must be protected against usual electrical transients and electromagnetic interference. Reversed polarity or faulty zone wiring shall not damage the detector. The standard base shall allow snap-on insertion of an (optional) electronic module, it shall be possible to turn a standard base part into an individually addressable detector base with its own unique identification address at the control unit. The standard base shall have a built in alarm indicator which is repeatable by connecting a simple 2 core wire to the base. No changes in the zone wiring shall be required to operate the additional alarm indicator. Removal and insertion of dust covers or detectors shall be feasible by a simple push twist movement, even if the locking device has been activated. Special base assemblies

shall be available for use in air ducts and aspiration air-sampling system wherever required.

Contractor is required to submit samples and get approved from HSCC Electrical Engineer of all above mentioned items including Response Indicators, Hooters, manual call points.

10.00 LIFT INSTALLATION

10.01 The scope of work shall cover design, supply delivery, installation, testing and commissioning of passenger lifts/bed lifts. The scope of work shall also include the following item of civil works.

- a) Necessary scaffolding temporary barricade in the hoistway required during the erection of the elevators.
- b) Minor building work comprising of cutting holes and making good the car and counterweight rail brackets, hall buttons and indicators including laying of sills in position.
- c) Steel items such as machine beams, bearing plates buffer support channels, sill angles and fascia plates etc.
- d) Suitable trap doors with steel chequered plate covers.
- e) Providing and install a suitable vertical iron ladder for access to the pit.
- f) Any other item required for successful completion and commissioning of lifts. (including the hoisting beam in the machine room)

10.02 The work shall be done in accordance with regulations of any local code and following ISI codes which govern the requirements of installations.

IS: 1860-1980 code of practice for installation, operation and maintenance of Electric Passenger and Goods Lifts.

IS: 3534-1976 Outline dimensions of Electric Lifts.

IS: 4666-1980 Specifications for Electric passenger and Goods Elevators.

Indian Electricity Act 1910.

Indian Electricity Rules, 1956.

Delhi Lifts Rules, 1942.

10.03 SHOP DRAWINGS AND APPROVAL OF ELECTRICAL INSTALLATIONS :

The selected tenderer shall prepare a furnish shop drawings for approval by The Client, such shop drawings shall be based on the Architectural drawings and requirements laid down in specifications, local laws and regulations etc.

The detailed drawings shall be submitted within one month of placement of order. The successful tenderer shall obtain the approval of electrical Inspector and other local authorities as per requirements before submitting the drawings to Client/ Engineer. The contractor shall not proceed with in installation work till the drawings are approved by the Engineer-in-Charge. Expenses incurred such as license fee etc.

towards obtaining the approval of Electrical Inspector, local authority shall be reimbursed to the contractor as per actual on production of documentary proof.

Approval of contractor's drawings shall not absolve the contractor of any of his obligations to meet the requirements of specification under this contract

Five sets of completion drawings operation manual, maintenance manual, spare parts details shall be submitted to the Client/ Engineer after completion of work.

10.04 GUARANTEE

The tenderer shall guarantee the equipment against all defects of materials and workmanship for a period of one year from the date of commissioning of the equipment as certified by the owner. Any defects arising during the guarantee period shall be rectified and replaced by the tenderer, at his own expense, to the satisfaction of the owner.

10.05 PERMITS, INSPECTION & LICENSE FEE

The contractor shall arrange all necessary local, provincial or national government permit and shall make arrangements for inspection and tests required thereby. Expenses to be borne by purchaser.

10.06 MAINTENANCE

After the completion of the installation and before handing over of each elevator by the elevator contractor, maintenance service for the equipment furnished shall be provided for a period of twelve (12) months. This service shall include regular examination of the installation by trained employees, and shall include all necessary adjustments, greasing oiling, cleaning supplies and genuine standard parts to keep the equipment in proper operation, except any parts made necessary by misuse, accident or neglect caused by other. Contractor shall provide 24 hours Emergency local call back service facility and shall furnish full details of such facilities available.

10.07 POWER SUPPLY

The apparatus shall be designed to operate on 415 + 5% Volts, 3 Phase, 4 wires, 50 Hz A.C.. Supply for illumination signal equipment shall be 240 Volts + 5% single phase 50Hz A.C..

10.08 ELECTRICAL WIRING

The necessary A.C. supply of 3 Phase, 415 Volts 50 HZ shall be made available in the main control switch unit to be provided by the contractor in the machine room. All the electrical works beyond the main supply switch shall be carried out by the contractor i.e. supply and installations of panels for drive motors, switches and control complete with wiring as per system requirement and approval of the Engineer.

The wiring shall be carried out strictly in accordance with Indian Electricity Rules and Indian code of Practice for Electrical Wiring Installation IS-732-1963 System Voltage not exceeding 650 V). For works not covered under any of the above wiring rules,

the 13th edition of Electrical Engineers (Condense) shall apply. The cable and conduits to be used shall be of suitable size and grade conforming to relevant IS specification. Wiring for LT switchboard to the motor terminal shall be with heavy duty 1.1 KV grade PVC insulated PVC sheathed, FRLS aluminium cable. All the trailing cables used for control and safety device shall conform to IS: 4289-1967, Specifications for lifts cables. The trailing cable circuits for controls, safety devices, lighting and signaling shall be separate and distinct.

Power wiring between controller and main board to various landings shall be drawn in suitable size heavy gauge conduit stove enameled/painted conforming to I.S specifications.

The Voltage and frequency of the supply shall be subjected to variations permissible under Indian Electricity Acts and Rules.

10.09 PARTICULAR SPECIFICATIONS

10.09.1	TYPE	:	Bed Lifts/Passenger Lifts.
10.09.2	NO. OF ELEVATORS	:	As Per Bill of Quantities.
10.09.3	CAPACITY	:	As Per Bill of Quantities.
10.09.4	SPEED	:	As Per Bill of Quantities.
10.09.5	FLOORS SERVED/RISE	:	As Per Bill of Quantities.
10.09.6	STOP	:	As Per Bill of Quantities.
10.09.7	OPENINGS	:	(All Openings on same side). As Per Bill of Quantities.
10.09.8	OPERATION	:	Duplex/Simplex Collective as per BOQ.

10.09.9 CAR FRAME:

The car frame, which supports the car platform and enclosures, shall be made of structural steel and equipped with suitable guides and a car safety device mounted underneath the car platform. The hoist ropes shall include adjustable self/ aligning hinges. Walls of lift enclosure shall have a fire rating of two hours.

The car shall be so mounted on the frame that vibration and noise transmitted to the passenger is minimized.

10.09.10 CAR SAFETY AND GOVERNER :

Suitable car safety to stop the car whenever excessive descending speed is attained shall be operated by a centrifugal speed governor connected to the governor through a continuous steel rope.

The governor shall be provided with self tensioning device to keep governor rope in proper tension even after rope stretch. Suitable means shall be supplied to cut off power from the motor and apply the brake on application of the safety.

10.09.11 COUNTER BALANCE :

A Suitable guided structural steel frame with appropriate filler weights of cast iron shall be furnished to promote smooth and economic operation.

10.09.12 TERMINAL AND FINAL LIMITS :

Terminal limit switches shall be provided to slow down and stop the car automatically at the terminal landings within permissible over travel and final limit switches shall be provided to automatically cut off the power and apply the brake, should the car travel beyond the permissible over travel. They shall act independently of the operating devices and buffers.

10.09.13 TERMINAL BUFFERS :

Heavy duty spring buffers shall be installed as a means of stopping the car and counterweight at the extreme limits of travel. Buffers in the pit shall be mounted on steel channels which shall extend between both the car and counterweight rails.

10.09.14 CONTROLLER :

A Controller shall be provided to control starting stopping and speed of the elevator motor and also be automatically able to apply the brake if any of the safety devices operate or if power fails from any cause. In case of power failure and again restore of power the lift shall land to next floor and shall not go to basement/lowest level. Suitable software/hardware or rescue device shall be provided.

10.09.15 REVERSE PHASE RELAY :

A reverse phase relay shall be provided on the controller which is designed to protect the lift equipment against phase reversal and phase failure.

10.09.16 GUIDES :

Machined steel tee guides shall be furnished for the car and counterweight. The guide rails should be of steel solid and shall have tongued and grooved joints. Sliding clips shall be used for fastening the guides to allow building settlement without distorting the guide rails. To keep down the noise level and to reduce wear and tear of the sections, only Nylon Ribs shall be used in the guide shoes, after smoothing of the rails. The flanges shall be machined for the fish plate mounting such that rail alignment at joints almost remain constant.

10.09.17 FOUNDATIONS :

The machine shall be placed directly above the hoistway upon the machine room slab provided by the Owner.

10.09.18 ROPES :

The elevator shall be provided with traction steel ropes. Steel wire rope having a tensile strength of not less than 12.5 Ton/cm² of good flexibility shall be used for lift. The lift rope shall conform to IS: 2365-1963.

10.09.19 MACHINE :

The machine shall be of the single wrap traction type and shall include a motor, electromechanical brake, steel worm, bronze gear, steel sheave shaft and Farrow-Molybdenum sheave all compactly mounted on a single base or bed plate. The worm shaft shall be provided with ball bearings to take the end thrust and roller bearings shall be furnished for the sheave shaft to ensure alignment and long bearing life. The driving sheave shall be grooved to ensure sufficient traction and minimize rope wear. Shall be provided for all bearings and the worm gear.

10.09.20 BRAKE :

The direct current brake shall be spring applied and electrically released and designed to provide smooth stop under variable loads. The brake should be capable of operation automatically by various safety devices, current failure, and by normal stopping of car. It should be possible to release the brake manually, such releases brake manually, such releases requiring the permanent application of manual force so as to move the lift car in short sties. For this purpose one set of brake release equipment shall be supplied.

10.09.21 MOTOR :

The motor shall be suited to the service proposed and arranged for adequate lubrication. The motor shall be class F insulation and one (1) hour rated squirrel cage induction type having high starting torque. It shall also be provided with Thermistors embedded in the stator windings for the highest degree of thermal motor protection.

10.09.22 CONTROL

The control shall be variable voltage variable frequency A.C. variable voltage, closed loop control system using solid state devices and electronic speed pattern generator to command the motor from a velocity transducer and load compensation circuits for a comfortable ride.

In Normal operation, the electromagnetic brake shall only be applied when the lift has come to a complete standstill. The brake shall only be meant for holding the lift in position at every landing, providing stopping without any jerking effect.

Each controller cabinet containing memory equipment shall be properly shielded from the pollution.

MICROPROCESSOR

The control shall employ a microprocessor working on a program such that precision leveling and highly efficient handling of passengers for least possible waiting and reduced travel time is ensured. The microprocessor system should be designed to accept programming with minimum downtime. It should be able to monitor the state of input calls (such as car calls from COP and hall calls from hall fixtures) and output commands such as starting, decelerating and stopping the elevator. It should be able to generate floor location data, thereby, providing a reference position to establish the safety zones for door opening and closing, and also to initiate leveling slowdown.

10.09.23 DUPLEX COLLECTIVE OPERATION

The operation shall be duplex collective with/without attendant for each elevator and shall consist of the following:-

IN THE CAR

There shall be furnished a flush type attractively finished stainless steel panel which contains a series of luminous buttons numbered to correspond to the landings served, an emergency stop switch and an emergency call button connected to a bell which serves as an emergency signal.

AT HOISTWAY LANDINGS

There shall be provided an UP luminous push button and a DOWN luminous push button at each intermediate landing and a single button at the terminal landings.

The car shall not start unless the door is in the closed position and all hoistway doors are closed in the locked position.

If the car is idle and one or more car or landing buttons above the landing at which the car is standing are pressed, the car shall start in the UP direction and proceed to the highest landing for which any button is pressed and stops at intermediate landing for which a car button or up landing button is pressed sufficiently in advance of the car's arrival at such landings to permit these stops to be made. After each stop, the car shall proceed in the UP direction until it reaches the highest landing for which a call is registered. The car shall not stop on the UP trip at any landing in response to a DOWN call.

Similarly, if the car is idle and one or more car or landing buttons below the landing at which the car is standing are pressed, the car shall start in the DOWN direction, proceed to the lowest landing for which any button is pressed and stop at each intermediate landing for which a car button is pressed.

When the car is idle and a button for a landing above the car and a landing below the car are pressed, the car shall start towards the landing corresponding to the button pressed first. The call registered for the landing in the opposite direction from the car

shall be answered after the car has responded to the farthest call in the direction established by the button pressed first.

A time relay shall hold the car for an adjustable interval of few seconds at the landings at which stops are made to enable passengers to enter or leave the car.

OPERATION WITH AN ATTENDANT

The regular car operating panel shall include buttons, switches, etc. for the collective-automatic control and shall also include.

A two-position key-operated switch marked to indicate ATT (attendant operation)

A buzzer: UP and DOWN direction light jewels and A non-stop button.

A car operating panel shall also include an UP and DOWN button.

When the key-switch is in the position of WITH ATTENDANT, the direction light and buzzer shall become operative and the UP and DOWN direction button in the regular car operating panel shall be made effective for the attendant operation.

When an attendant operation, the car and hoistway doors shall open automatically at each stop but the closing of the doors shall be subject to the UP or DOWN direction buttons. As a visual signal to the attendant, the UP and DOWN direction jewel shall illuminate upon registration of either car or landing calls to indicate the direction of the travel of the car. The attendant shall operate the elevator normally in the direction indicated by the direction jewel but, if desired, opposite direction travel may be realized by pressure of a car button for a landing in that direction from the car.

The pressure of a direction button shall cause the doors to close and the car to start in the direction desired, provided a call is registered for that direction. If pressure of the direction button is released before the car starts, the doors will re-open and car shall not travel. It shall so arrange the pressure on direction button can be released, once the car has started.

Continuous pressure of the nonstop button shall cause the car to by-pass all landing calls and respond only to registered car calls.

10. 09. 24 CAR ENCLOSURES :

The car enclosures shall be of sheet steel and shall be of an elegant design comprising of the following :

- a) Suspended ceiling with light diffuser Perspex ceiling and fluorescent light.
- b) Concealed pressure fan with grille in suspended ceiling. The lift shall have sensor so that the fan is operation only when if there is at least one person inside the lift.

- c) Ceiling steel painted white.
- d) Complete stainless steel car enclosure in plain finish for passenger and Bed Lifts
 - a) PVC flooring (with 3mm thick tiles of approved shade) for Bed Lifts
 - b) Mirror on one face (front face when we enter the car)

10.09.25 CAR DOOR

The car entrance shall be provided with stainless steel sliding doors in plain finish giving a clear opening of 1200mm wide by 2000mm high for bed lift. The lift car door shall have a fire resistance rating of one hour.

10. 09. 26 HOISTWAY DOORS :

At each landing, a center/ telescopic opening , stainless steel sliding door in plain finish giving a clear opening as per CPWD general specifications for electrical works –Part-III – Lifts & Escalators, shall be provided. The hoist way doors shall have a fire resistance rating of one hour.

10. 09. 27 SIGNAL AND OPERATIVE FIXTURES :

The following signal and operative fixtures shall be provided for each lift in stainless steel face plates except in fireman's switch which shall have a glass face plate.

a) CAR OPERATING PANEL

There shall be one (1) No. panel in car, with hinged stainless steel face plate and shall comprise illuminated floor buttons, door open and emergency stop controls emergency call buttons, door open and emergency stop controls emergency call button, two position key operated switch, a Buzzer, UP and DOWN direction light panels, a non stop button, and an integral interphone. The jewels and accentuator shall be of modular construction, face plate mounted, rewired using snap on lugs.

b) HALL BUTTONS AND HALL POSITION INDICATOR

There shall be provided combined signal fixture (one riser) of compact design and of attractive hairline stainless steel face plate at the elevator entrance on each floor which for terminal landings shall have a single luminous push button and for intermediate landings shall have an UP luminous push button and a DOWN luminous push button. The jewels shall be of modular construction mounted on a stainless steel face plate. Whenever a button is pressed, the jewel shall light up to indicate registration of the call and shall remain enlightened till the car arrives.

c) CAR POSITION INDICATOR IN CAR

This shall be of compact design and of attractive hairline finish stainless steel face plate with easy to read digital display of the floors, indicating through which floor the elevator is passing or on which floor the elevator is stopped. This shall also incorporate illuminated arrows showing the direction of travel.

d) BATTERY OPERATED ALARM BELL AND EMERGENCY LIGHT

A solid state siren type alarm unit operated by 2 Nos. 9 volt rechargeable Nickel Cadmium batteries shall be provided which shall give a waxing and waning siren when alarm bell in the car is pressed momentarily.

An emergency light unit using a 9 volt dry battery power pack and incandescent lamp with stainless steel face plate shall be provided inside the car which shall operate automatically in the case of power failure.

e) OVERLOAD WARNING

Overload warning radars with audio-visual indication (visual indication shall show OVERLOADED) with stainless steel face plate shall be installed in the elevator car, so that when there is overload in the car the sign shall light up a flash indicating OVERLOADED and a buzzer shall operate during this period and the doors shall remain open until the overload is removed.

f) FIREMAN'S SWITCH

A toggle switch covered by a glass cover shall be provided on the ground floor for each elevator which shall permit a fireman to call the elevator to the ground floor by canceling all car and landing calls. The elevator shall then stop at the ground floor with the door open to permit the fireman to have exclusive use of the elevator without any interference from the landing calls.

g) INTERPHONE

Interphone shall have one master unit in each machine room, one master unit on the ground floor for each 1 (outside hoistway) and one slave unit in each elevator car.

10. 09. 28 ELECTRIC DOOR OPERATOR FOR CAR DOOR AND HOISTWAY DOOR :

An electric door operator for opening and closing the car door shall be provided. The opening of a car and hoistway doors shall be such that the doors shall start opening meant for so that by the time the elevator stops completely, the elevator and hoistway doors shall be fully open.

The equipment shall consist of a machine on the elevator car operating the car door when the car is stopping at a landing.

The car door and hoistway door shall be mechanically connected and shall move simultaneously in opening and closing.

The car and hoistway doors shall be power opened and closed and shall be checked in opening and closing with an oil cushioning mechanism built into the gear unit.

Each hoistway door shall be provided with an interlock which will prevent movement of the car away from the landing unit.

The doors are closed in the closed position as defined in the ISI codes.

An electric contact for the car door shall be provided which shall prevent car movement from the landing unless the door is in the closed position as defined in the ISI codes. The locking arrangement shall be so designed that the electrical circuit cannot be completed unless the doors are in the closed position and mechanical latching is effected.

Necessary switches shall be provided in the elevator machine room to control the operation of the doors.

The car and hoistway, doors shall open automatically as the car is stopping at a landing. The closing of the car and hoistway door must occur before the car can be started. Doors can be stopped and reversed during their closing motion.

10. 09.29 DOOR HANGER AND TRACKS :

For the car and each landing door, sheave type two point suspension hangers complete with tracks shall be provided. Means shall be provided to prevent the door from jumping off the track and for vertical and literal adjustment of doors.

Sheaves and rollers shall be of steel and shall include shielded ball bearing to retain grease lubrication. Adjustable ball bearings rollers shall be provided to take the upward thrust of the doors. Tracks shall be of suitable steel section with smooth surface. The locking of the two leaf parting type doors should be positive.

10. 09.30 SAFETY SHOE :

A safety shoe (one on each door panel) shall extent to the full height of and project beyond the front edge of the car door.

Should this shoe touch a person or an object while the car door is closing, the car and hoistway doors shall return to the open position. The doors shall remain open until the expiration of a pre-determined interval and then close automatically.

10.09.31 LANDING ENTRANCE MATERIAL'S :

These shall consist of headers, extruded aluminium sills and strut angles.

10.09.32 WIRING :

Complete wiring in the equipment.

10.09.33 AUTOMATIC RESCUE DEVICE :

Automatic Rescue Device to be provided for all the lifts with battery backup so that it can land to the nearest level in case of power failure. Automatic Rescue Device shall

have suitable battery backup so that it can operate minimum 20 times in 8 hours duration.

10.00 LT CABLES

10.1 GENERAL

L.T. Cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings, specifications, relevant Indian Standards specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drums. The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed.

10.2 MATERIAL

The L.T. power cable shall be PVC insulated PVC sheathed type aluminium conductor armoured cable and L.T. control cable shall be PVC insulated PVC sheathed type copper conductor unarmoured cable conforming to IS: 1554: 1988 (Part-I) with up to date amendments.

10.3 INSTALLATION OF CABLES

Cables shall be laid directly in ground, pipes, masonry ducts, on cable tray, surface of wall/ceiling etc. as indicated on drawings and/or as per the direction of HSCC Electrical Engineer. Cable laying shall be carried out as per CPWD specifications.

10.4 INSPECTION

All cables shall be inspected at site and checked for any damage during transit.

10.5 JOINTS IN CABLES

The Contractor shall take care to see that the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilisation and avoiding of cable joints. This apportioning shall be got approved from Engineer-in-Charge before the cables are cut to lengths.

10.6 LAYING CABLES IN GROUND

Cables shall be laid by skilled experienced workmen, using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. With great care it shall be unrolled on over wooden rollers placed in trenches at intervals not exceeding 2 metre. Cables shall be laid at depth of 0.75 metres below ground level for LT Cables and 1 metre below ground level for HT cable. A cushion of sand total of 250mm shall be provided both above and below the cable, joint boxes and other accessories. Cable shall not be laid in the same trench or along side a water main.

The cable shall be laid in excavated trench over 80mm layer of sand cushion. The relative position of the cables, laid in the same trench shall preserved. At all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a

radius of bent not less than 12 times the diameter of cables. Minimum 3 metre long loop shall be provided at both end of cable.

Distinguishing marks may be made on the cable ends for identifications of phases. Insulation, tapes of appropriate voltage and in red, yellow and blue colours shall be wrapped just below the sockets for phase identifications.

Cable route marker shall be provided as per CPWD specifications. Cost of cable route markers is deemed to be included in the cost of cables/cable laying.

PROTECTION OF CABLES

The cables shall be protected by bricks laid on the top layer of the sand for the full length of underground cable. Where more than one cable is laid in the same trench, the bricks shall cover all the cables and shall project a minimum of approximately 80mm on either side of the cables. Cable under road crossings and any other places subject to heavy traffic shall be protected by running them through Hume Pipes of suitable size. Pipes for cable crossing the road shall be laid at a depth of 1000 mm.

EXCAVATION & BACK FILL

All excavation and back fill required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceeding 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The Contractor shall restore all surfaces, road ways, side walks, curbs, wall or the works cut by excavation to their original condition to the satisfaction of the Engineer-in -Charge.

LAYING OF CABLES ON CABLE TRAY/SURFACE OF WALL/ CEILING

Cable shall be laid on perforated M.S. Cable tray/ladders. Cables shall be properly dressed before cable ties/clamps are fixed. Wherever cable tray is not proposed, cables shall be fixed on surface of wall or ceiling slab by suitable MS clamps/saddles. Care shall be taken to avoid crossing of cable.

CABLES ON HANGERS OR RACKS

The Contractor shall provide and install all iron hangers racks or racks with die cast cleats with all fixings, rag bolts or girder clamps or other specialist fixing as required.

Where hangers or racks are to be fixed to wall sides, ceiling and other concrete structures, the Contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good.

The hangers or racks shall be designed to leave at least 25mm clearance between the cables and the face to which it is fixed. Multiple hangers shall have two or more fixing holes. All cables shall be saddled at not more than 150mm centres. These shall be designed to keep provision of some spare capacity for future development.

CABLES TAGS

Cable tags shall be made out of 2mm thick aluminium sheets, each tag 1-1/2 inch in dia with one hole of 2.5mm dia, 6mm below the periphery. Cable designations are to be punched with letter/number punches and the tags are to be tied inside the panels beyond the glanding as well as below the glands at cable entries. Tray tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 metres.

10.7 TESTING OF CABLES

Prior to installation burying of cables, following tests shall be carried out. Insulation test between phases, phase & neutral, phase & earth for each length of cable.

- a. Before laying.
- b. After laying.
- c. After jointing.

Along with the test as prescribed in IS Code, cross sectional area shall also be checked.

On completion of cable laying work, the following tests shall be conducted in the presence of the Engineer in Charge.

- a. Insulation Resistance Test (Sectional and overall).
- b. Continuity Resistance Test.
- c. Earth Test.

All tests shall be carried out in accordance with relevant Indian Standard code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipments and labour for conducting the above tests & shall bear all expenses of conducting such tests.

11.00 CABLE TRAY

11.01 Ladder Type Cable Tray

Ladder type cable tray shall be fabricated out of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a centre to centre spacing of 250 mm. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanised or painted to the desired lengths.

11.2 Perforated Type Cable Tray

The cable tray shall be fabricated out of slotted/perforated M.S. Sheet as channel section single or double bended. The channel section shall be supplied in convenient length and assembled at site to the desired lengths. These shall be galvanised or painted as specified. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mm x 50mm x 6mm as two longitudinal members, with cross-bracings between them by 50mm x 5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

11.3 Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II -External, 1994.

11.4 The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

11.5 The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

11.6 The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

11.7 Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in figure 3 of CPWD General Specification of Electrical Work Part II -1994). The radius of bend,

junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

- 11.8** The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mm x 5mm flats at specified spacing as per CPWD General Specification of Electrical Work Part II -1994. Flat type suspenders may be used for channels upto 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the PMC/Consultant to take the weight of the cable tray with the cables.
- 11.9** The entire tray (except in the case of galvanised type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.
- 11.10** The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.
- 11.11** The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross-joints, etc, and paid for accordingly.

12.00 EARTHING

12.01 GENERAL

All the non-current metal parts of electrical installation shall be earthed properly. All metal conduits trunking, switchgear, distribution boards, switch boxes, outlet boxes, and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. Earthing work shall conform to CPWD General Specifications for Earthing work shall conform to Internal) -1994 and Indian Electricity Rules 1956 amended up to date and in the regulations of the local Electricity Supply Authority.

12.02 EARTHING CONDUCTOR

Earth continuity conductor along with submain wiring from Main/Sub Distribution boards to various distribution boards shall be of copper. Earth continuity conductor from distribution board onward up to outlet point shall also be of bare copper. Earth continuity conductor connecting Main & Sub Distribution boards to earth electrode shall be with galvanised MS strip.

12.03 SIZING OF EARTHING CONDUCTOR

Single phase distribution board shall have one earth continuity conductor while three phase distribution board shall be provided with two earth continuity conductors. Earthing of main switch board and sub switch boards shall be earthed with two independent earth electrodes or as indicated elsewhere. Earth conductor laid in ground shall be protected for mechanical injury & corrosion by providing GI pipe.

12.04 GI pipe shall be of medium class 40mm dia and 4.5 metre in length. Galvanising of the pipe shall conform to relevant Indian Standards. GI pipe electrode shall be cut tapered at the bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other upto 2 metre of length from bottom. The electrode shall be buried in the ground vertical with its top not less than 20cm below ground level as per detail enclosed. Earth electrode shall not be situated less than 2metres from the building. The location of the earth electrode will be such that the soil has reasonable chance of remaining moist as far as possible. Masonry chamber of size 300 x 300 x 300mm shall be provided with water funnel arrangement a cast iron or MS frame & cover having locking arrangement at the top.

12.05 PLATE EARTH ELECTRODE

Earthing shall be provided with either GI plate electrode or copper plate electrode of following minimum dimensions.

- i. GI Plate Electrode : 600mm x 600mm x 6mm thick

- ii. Copper Plate Electrode : 600mm x 600mm x 3mm thick

The electrode shall be buried in ground with its faces vertical and not less than 3 metres below ground level. 20mm dia medium class GI pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on the top of this pipe for watering and earth electrode. Earth electrode the watering funnel attachment shall be housed in masonry enclosure of not less than 300 x 300 x 300mm deep. A cast iron or MS frame with cover having locking arrangement shall be provided at top of metres from the building. Care shall be taken that the excavation for earth electrode may not affect the column footing or foundation of the building. In such cases electrode may be further away from the building.

12.06 ARTIFICIAL TREATMENT OF SOIL

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, then the soil resistivity immediately surrounding the earth electrodes shall be reduced by addition of sodium chloride calcium chloride, sodium carbonates copper sulphate, salt and soft coke or charcoal in suitable proportions.

12.07 RESISTANCE TO EARTH

The resistance of earthing system shall not exceed 5 ohm.

13.00 SAFETY EQUIPMENTS

13.01 DANGER NOTICES

Danger notices shall be affixed permanently in a conspicuous position in Hindi or English and the local language of the district with sign of skull and bones at every overhead lines, transformer, electrical equipments motors, etc.

13.02 FIRST AID BOX

Standard first aid box with all standard contents shall be supplied.

13.03 FIRE BUCKETS

The fire bucket unit shall consist of our galvanised iron baskets, which shall be with round bottom, and of 13 liters capacity. They shall be filled with dry sand. Arrangement shall be made to hang them on GI pipe stand comprising of at least 2 vertical and one horizontal members of 50 mm GI pipe. The stands shall have hooks and locking chain arrangement. The buckets and stand shall be painted with epoxy red paint.

13.04 FIRE EXTINGUISHER

Foam type Fire extinguishers of 9 Kg. capacity and Dry Chemical type Fire Extinguishers of 10 Kg capacity shall be of approved make. It shall be filled with carbon tetrachloride. It shall have horns. Extinguishers shall be fixed on walls/columns with necessary clamps made out of 50 mm x 6mm MS flat and coated bolts and nuts grouted in wall/column.

13.05 RUBBER MAT

Corrugated rubber insulating matting shall be provided in front of all power & motor control centers, push button station and distribution board in the electrical rooms. The width of matting shall be one meter. It shall be as ISI mark.

13.06 INSTRUCTION CHART

Printed instruction chart both in English and Hindi and duly framed with front glass, prescribing treatment to be given to persons having Electric shock, shall be supplied.

14.0 DIESEL GENERATOR SETS

14.1 INTENT OF SPECIFICATION

14.1.1 This specification covers the design, manufacture, assembly, packing, dispatch, transportation supply, erection, testing, commissioning, performance and guarantee testing of **Diesel Gen-Sets with Acoustic Enclosure**, complete in all respects with all equipment, fitting and accessories for efficient and trouble free operation as specified here under.

14.2 SCOPE OF WORK:

14.2.1 Scope of Supply & Services:

General Scope of work shall include, supply, erection, testing and commissioning of the following:

- a) Diesel engine complete with all accessories, an Alternator directly coupled to the engine through flexible/rigid coupling complete with all accessories for starting, regulation and control, including base frame etc. interconnecting piping and accessories, power and control cable glands and lugs.
- b) Diesel Local/Remote control panel including cables between bidders local equipment and special cables if any.
- c) Equipment necessary for engine cooling system, radiators, pumps, valves, inter connecting pipes etc.
- d) Equipment necessary for fuel storing and distribution, day oil tank (990 Lt.), pipings, pumps, valves, level indicators etc.
- e) Flexible connections and residential type silencer of exhaust system, including thermal lagging.
- f) Batteries with iron battery stand and battery charging equipment, including their connections as necessary along with tools & accessories for battery maintenance.
- g) Anti Vibration Mountings etc.
- h) Preparing all related shop drawings for approval from client/consultant and statutory bodies.
- i) Obtaining approval of the installation of Diesel Generators by the Electrical Inspectorate and Pollution Control bodies and any other statutory bodies.

- j) Minor civil works like chasing, grouting etc. for execution of jobs.
- k) Carrying out performance and guarantee test at site available load but not more than the capacity of D.G. Set.
- l) Acoustic enclosure as per CPCB norms and type approved.

14.2.2 Specific Exclusions:

Following items of works are excluded from the scope of works under this specification:

- a) All civil works relating to DG foundation etc.
- b) All cables between contractors and owners equipment other than special cables external to the equipment.

14.3.2 The installation work shall conform to Indian Electricity act and Indian Electricity Rules as amended up to the date of installation.

The fuel oil installation shall meet all statutory requirements of Govt. of India as amended up to the date of installation. Any approval required from statutory authorities shall be obtained by the Contractor. Nothing in this specification shall be construed to relieve the contractor of these responsibilities.

14.3.3 Equipment conforming to any other National/International Standard which ensures equal or better quality may be accepted. In such case the bidder shall furnish copies of the standards in English along with his bid and shall clearly bring out the salient features of comparison with corresponding listed standards.

14.3.4 The equipment furnished under this specification has to operate in a tropical climate and shall be given tropical and fungicidal treatment as per relevant specification

14.3.5 Period of Operation/Duty Cycle:

The sets are intended to supply power only during an emergency for essential services and may be idle for long periods except for periodic routine tests once in a week. When there is a total failure of main power supply, the sets shall be required to operate continuously at full load for a period which at times may exceed even 24 hours.

14.4 ENGINE:

14.4.1 Type:

The diesel engine shall be of stationary type four stroke/two stroke with vertical in line or (V) type cylinder arrangement, Turbo-charged, cooled with radiators.

14.4.2 Rating:

- a) Prime power BHP rating of the engine shall be such that the DG set deliver the specified net electrical output while supplying power/driving all electrical and mechanical auxiliaries connected to alternator terminals and engine shaft at specified site conditions and ambient temperature of 50°C. The bidder shall submit the deration calculations if the engine is not designed for 50deg C. ambient temperature.
- b) It shall also be capable of satisfactorily driving the alternator at 10% over load at the rated speed for one hour in any period of 12 hours of continuous running.

The bidder shall have to furnish copy of deration chart from the original manual of the engine manufacturer and supporting calculations to arrive at diesel engine rating.

14.4.3 Speed and Vibration Levels:

- a) Speed shall be 1500 revolutions per minute. Speed governor/over speed protection shall be provided.

At due running conditions, speed shall be stabilized at plus or minus 2% nominal speed, regardless of load. At transient condition, engine speed shall vary not more than 10% plus or minus. Governor class shall be A1 (4% drop) for normal application unless otherwise specified.

- b) The engine vibration level shall not exceed 100 microns.

14.4.4 Lubrications:

- a) The engine shall have a closed cycle forced & splash lubricating system with positive oil pressure and a crank chamber for collection/storage of the lubricating oil during circulation.
- b) A lubricating oil filter shall be provided for operation under normal conditions for a period of 300 hours without the necessity of its replacement or cleaning.
- c) In case lubricating oil coolers are required it shall be supplied as an integral part of the Diesel Generator Set.
- d) Necessary temperature and pressure gauges and other instruments shall be supplied and fitted on the lubrication system.

- e) A lubricating oil level dipstick suitably graduated shall be provided and located in the accessible position.

14.4.5 Fuel System:

- a) The engine shall be capable of running on all types of diesel fuel oil normally available in India.
- b) The fuel consumption of the engine at full, three quarters and half of its rated power output shall be indicated by the Contractor in the bid.
- c) A fuel service tank of 990 litres capacity with each D.G. Set shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in litres, filling inlet with removable screen, an outlet, a drain plug, an air vent and necessary piping. The fuel tank shall be painted with oil resistant paint. All pipe joints should be brazed/welded.

14.4.6 Air Intake System:

The diesel engine shall be provided with special dry type air filters having low resistance to air passage, high dust retaining efficiency and provision for easy cleaning. Filters shall be suitable for achieving satisfactory engine operation and ensuring the engine life under tropical humid conditions, with sulphur dioxide fumes, abrasive dust and coal particles of 5 to 100 microns present in the atmosphere. The minimum efficiency of filters shall be 90% down to 5 micron size.

14.4.7 Cooling:

The diesel engine should be water cooled with radiator heat exchanger system. The cooling system should include temperature gauge with high temp., alarm/trip corrosion resistor etc.

14.4.8 Engine Governor:

The governor shall be Electronic ISO-Chronous type to maintain zero speed rate or regulation and shall be AI type as per BS:5514 in order to take care of heavy motor starting. It shall have necessary characteristics to maintain the speed substantially constant even with sudden variation in load. However, a tripping shall be provided if speed exceeds maximum permissible limit. The governor shall be suitable for operation without external power supply.

14.4.9 Turbo Charger:

It shall be of a robust construction, suitable of being driven by engine exhaust having a common shaft for the turbine and blower. It shall draw air from filter of adequate capacity to suit the requirements of the engine.

14.4.10 Quietness of Operation:

- a) The engine shall be designed to achieve maximum quietness of operation.
- b) Efficient residential silencer shall be provided as per engine manufacturer's approved make only for the exhaust.
- c) Noise level of the set shall not exceed 115-120dbA at one meter distance of the engine.

14.4.11 Engine Starting:

- a) Engine starting shall be by electric starting motor complete with manual/automatic starting arrangement. The starter motor shall conform to IS:4722 and shall be of adequate power for its duty and be of inertia or pre-engaged type. The pinion shall positively disengage when the engine starts up or when the motor is de-energized. The engine cranking shall be only from the panel both for AMF & DG sets (Manual) and any engine starting devices etc. that are given as original fitment on the engine by engine manufacturers shall be either removed or padlocking arrangement given for this so that all normal start/stop operations could be done only from panel whether the set is AMF or manual.

The engine wiring shall be appropriately modified, ferruled to totally match with schematic drawings of the panel.

- b) Time for Run-up to Speed:
From the initial operation of the starting device, the engine shall start, run up to normal speed and be capable of accepting 60% of full load within a maximum time of 20 seconds, and full load within a further 20 second.

14.4.12 Starter Battery:

- a) The battery shall conform to the requirement of IS:1651. Starting battery each of 12 V, heavy duty high performance approved make/quality shall be provided to enable crank & start the engine even in cold/winter morning conditions. Type/voltage/AH capacity of same on 20 hour rated discharge period shall be indicated in the offer. The battery set shall be capable of performing at least (5) five normal starts without recharging.
- b) The battery shall be provided with good quality teakwood stand painted with acid proof black paint with min 3mm thick rubber mat below the batter.

- c) Batteries shall be of load container type only and not with PVC moulded sealed container so that each individual cells are available for individual monitoring during its life span. Each cell shall be provided with electrolyte filling cap with level floats for easy monitoring of electrolytic level.
- d) The battery shall be provided with 2 Nos. cables, minimum 1.5m long heavy duty rubber/PVC insulated cabling with brazed tinned lug at one end and with brazed tinned brass terminal lug at battery end - for connecting batteries to cranking system - with 0.25 m long inter battery connecting cable.
- e) The lugs shall be clearly stamped (+) or (-) and positive cable also red sleeved for easy identification.
- f) The batteries Set shall be supplied fully filled and first charged ready to use.

14.4.13 Battery Charging System:

- a) Float rate charging and quick rate charging system shall be provided at the generator panel with appropriate bridge charger system, LC network, rate selector switch and generously rated charging transformer and silicon one rectifier bridge, so that the cranking battery system can be kept fully charged at all times from E.B. supply network with quick charging rate limited to 0.8 times rated discharge current with provision in control transformer and Si rectifier present to enable boost charging the battery at 2 times rated discharge current in case of emergencies. To this and in the mode selector switch boost charge position shall be present which however shall be kept disconnected at mode selector switch normally.
- b) DC ammeters to clearly indicate float charging current and quick/boost charging current shall be provided.
- c) Dropper resistor network on the load side of battery charger system shall be provided so that higher charger voltages in quick or boost conditions does not get impressed on the I/L and Contactor coils, which voltage shall remain well within +10% of rated voltage.
- d) Battery charging subsystem shall be designed for continuous operation at cubicle ambient of 50°C corresponding to 45°C ambient outside and should be designed to operate at 1.5 times rated maximum current corresponding to boost charge current which can reach in practice as high as 2.5 times or 3 times rated discharge current.
- e) Any charger dynamo and dynamo charging current network present on the set shall be made in operative so that both for AMF and manual application the cranking battery system is kept charged from the charger at the panels at all times during or shut down periods of the set.

- f) To the above and in case of manual DG sets, the input to charger subsystem viz., 240 V AC is foreseen to be provided from customer network from the portion that is normally supplied by manual DG Set during DG operation or being fed by E.B. System.

14.4.14 Engine Fitments:

The engine shall be provided with but not limited to following essential basic fitments:

Crank case breather	-	Dry type element.
Air Cleaner	-	Dry type mounted.
Corrosion resistor	-	to control acidity and impurities from coolant.
Lubricating Oil Cooler	-	
Filters	-	Lub oil & fuel oil, paper element type.
Coolant Pump	-	Gear Driven.
Fuel Pumps	-	Priming & Transfer
Governor	-	Electronic Class A1.
Turbo Charger	-	Exhaust gas driven in case of turbo charged engines.
Flywheel with flywheel housing	-	SAE Type
Vibration dampers	-	One Set
Exhaust/Intake manifolds	-	
Oil Sump (crank case) with dip stick		
Engine Supports		
Residential type silencer in exhaust system		
Electrical starter 12 V or 24 V		
Safety controls & instruments		

14.4.15 Engine Instrumentation:

The following instruments mounted on instrument panel shall be essentially present as minimum:

- Engine speed tachometer with service hour counter
- Lub oil pressure gauge
- Coolant water temperature gauge

The instrument panel shall be mounted on engine using rubber dampers for vibration isolation.

The gauges shall have clear red marking to identify the limiting dangerous levels, 'Zone Markings' on the scale to indicate the normal healthy & abnormal operating zones for the parameters concerned.

The metering could be either normal electro-mechanical analogue type or electronic digital type, latter being preferred as manufacturers fitment only.

The engine control panel must be supplied by the engine manufacturer only.

14.5 ALTERNATOR:

14.5.1 The alternator shall have brushless type with rotating field and static excitation circuit controlled by field control unit suitably compounded for voltage and load current for a self excited self regulated system.

14.5.2 The alternator shall be in SP-DP enclosure, foot mounted with ball and roller bearings on end shields.

14.5.3 The alternator shall conform to IS:4722/BS:2613 and shall be suitable for tropical conditions.

14.5.4 The alternator shall comply with the following specifications:

Rating	-	As per BOQ. (Shall be capable of 10 % over loading at the rated speed for one hour of 12 hours continuous running).
Voltage	-	415 V
Speed	-	1500 RPM
Frequency	-	50 Hz.
P.F.	-	0.8 lag
Enclosure	-	IP:23
Insulation	-	H
Execution	-	-Self excited, self regulated with brushless system and static voltage control unit suitably compounded for voltage and current to maintain terminal voltage constant at $\pm 5\%$ at all load for p.f. not less than 0.8. lag.
Terminal Box	-	As per BOQ.
Earthing Studs	-	2 Nos. in each DG

14.5.5 Neutral Point:

The winding of the alternator shall be star-connected.

14.5.6 Terminal Box and Connection:

The alternator output terminals shall be enclosed in a terminal box mounted in an accessible position on the alternator frame. As far as possible, connections between the exciter and alternator shall be contained within the machine frame and connections carrying A.C. and D.C. shall be segregated from each other. The terminal box shall be of sufficient size to conveniently terminate the size and number of the Owner's cables, which shall be intimated during detailed engineering. Suitable tinned copper pads shall be provided for power cable termination along with all necessary hardware and cable lugs. Glands and lugs shall be provided for control cables also. For single phase cables, gland plate shall be of non-magnetic material. Gland plate shall be removable type.

14.5.7 The generating set shall be so designed that it is capable of reaching its full voltage and frequency and shall be ready to take full load within 30 seconds of a remote starting impulse being received.

14.5.8 Acoustic Enclosure:

Thickness of Sheet – 14-G:

High Class sheet metal fabricated enclosure for reducing the noise level of DG Set and also acts as weather proof housing. Genset will be an integral part of acoustic enclosure and whole construction will be on multi-fold sheet channels and ISMC sections. Enclosure construction is fully bolted keeping in view the major service requirements all doors are provided with specially designed hinges and lockable handles, battery, fuel tank is housed inside the enclosure.

Acoustic Materials:

Rock wool in the form of slabs of 75 – 100 mm thickness and 48 KG/Metric cube density (Specification of Rock wool conforms to IS:8183).

Further to increase the life of Acoustic material resin coated fiber glass cloth is provided on exposed surface of Rock wool slabs and the panels are supported by perforated sheets.

Ventilation:

Acoustic enclosure is designed in such a way that there are no hot pockets around engine and it is provided with suitable designed engine radiator/or additional axial flow fan and does not allow the temperature to rise more than 7°C.

To achieve optimal output and minimum sound level from the DG Set, suitable openings with acoustic hoods are provide for increasing the inflow of air required for combustion and forced ventilation. Air intake system as per the recommendations and engine requirement are provided.

- Acoustic hoods with noise splitters provided to block and reduce the sound leakage.
- The sound control system designed to suppress the sound level to 75 db maximum at 1 meters distance in open environment.

Silencer:

Specially designed low noise silencer is provided. Silencer & engine exhaust outlet, connected with flexible SS below.

Vibration Isolation:

To avoid transfer of vibration from Genet to enclosure & surrounding specially designed vibration isolators are used.

14.6 AMF PANEL:

14.6.1 General:

- a) The control panel shall be sheet steel enclosed and shall be dust and vermin proof providing a degree of protection of IP-42. Sheet steel used shall be cold rolled and at least 2.0mm thick and properly braced and stiffened.
- b) Control panel shall be provided with hidden hinged door(s) with pad locking arrangement and suitable brackets/channels shall be provided for floor mounting.
- c) All doors, removable covers and plates shall be caskeyed all around with neoprene gaskets. All accessible live connections shall be shrouded and it shall be possible to change individual switches, fuses, MCCBS without danger of contact with live metal.
- d) All live parts shall be provided with at least phase to phase and phase to earth clearances in air of 25mm and 20mm respectively.
- e) Adequate interior cabling space and suitable removable cable gland plate shall be provided. Necessary number of cable glands shall be supplied and fitted on to this gland plate. Cable glands shall be screwed on type and made of brass.
- f) Two number of earthing terminals shall be provided.
- g) All sheet steel work shall be degreased, pickled, phosphate and then applied with two coats of zinc chromate primer and powder coat finishing both inside and outside of shade 631 (gray).

14.6.2 AMF Control of Diesel Generating Sets:

- a) All DG Sets shall be controlled independently.
- b) Diesel Generator shall be capable of being stopped manually from remote as well as local. However, interlock shall be provided in the DG local control panel to prevent shutting down operations as long as circuit breaker is closed.

c) Auto Operation:

When mains power is available, the healthiness of this power will be monitored through a mains voltage monitor. If voltages on the 3 phases are within limits, the monitor will send a closing signal to the mains breaker and mains power will be connected to the load.

If the voltage drops on any phase or on all phases, the monitor will sense this drop through a timer, and if this drop persists for more than a pre-adjusted period of time (say 1 to 20 seconds) a signal is sent to the engine starting circuit while at the same time opening the mains supply breaker and disconnecting load from mains as voltage is below acceptable limits.

The engine starting control monitor will send a signal to the D.C. battery supply for starting the engine through the starting solenoid. When the engine is healthy, it starts up in a few seconds and the generator develops voltage. The generator voltage monitor, monitors the voltage and when the voltage is developed, this give a signal to the generator breaker which closes and connects the diesel generator to the load. Simultaneously, it sends a signal to de-energize the engine starting circuit and the starter motor is disengaged. The engine protection circuits for high water temperature and low lubricating oil pressure are also energized.

d) Resumption of Supply:

If voltage from mains is resumed, the main voltage monitor will sense this voltage for healthiness, i.e. for maintained correct voltage for a period of time (adjustable up to three minutes) and then send a signal to stop the engine and to change over the breakers from generator to mains and normal supply is resumed to the load. The solenoid operation and closing and tripping of breakers should be done through control voltage 24 V.D.C.

e) Failure to Start:

A three attempt starting facility using two impulse timers and a summation timer for engine shall be provided and if voltage fails to develop within 30 seconds from receiving the first start impulse, the set shall lockout automatically and a visual and audible alarm shall be given in the control panel. The remote panel shall receive "DG Trouble Alarm".

14.6.3 The control panel shall have the following provisions for the control of each DG Set:

1. MCCB's & ACB's as per BOQ.
2. Master engine control which for OFF/AUTO/MANUAL/TEST with a facility for starting and stopping of the set.
3. Voltmeter 144 Sqmm with selector switches for alternator/Mains/Phases complete with protection.
4. Local/Remote selector switch to facilitate remote starting/stopping of the DG Set.
5. Frequency meter 144 Sqmm reed type.

6. Current transformers required for metering.
7. Ammeter 144 Sqmm with C.T. & selector switch, KWH Meter, KW 144 Sqmm.
8. Mains Supply, voltage monitor.
9. Engine control monitor.
10. Alternator voltage monitor.
11. D.C. Control relays, timers.
12. Engine protection system for low oil lubricating pressure and high water temperature.
13. Window type annunciator with static relays, alarm/hooter and accept, test, reset push buttons for all functions.
14. Engine hours run counter.
15. Control fuses.
16. Lifting Hooks.
17. Gland Plates.
18. Power/Control Contactors.
19. Earthing Studs.
20. Antivibration pads.
21. IDMT relays [CDG – 31]
22. Under Voltage Relays
23. Over Voltage Relays

14.6.4 Indication/Annunciation:

Pilot indicating lamps/shall be provided for the following:

1. Charger - ON/OFF
2. Earth Fault
3. Set shutdown due to 'Engine high water temp.'
4. Set shutdown due to 'Low oil pressure'

5. Set shut down due to 'Lock of fuel'
6. Over speed trip

Indicating lamp shall be of the panel mounting filament type with series resistors.

14.6.5 The DG Sets would normally be controlled from remote for which following provisions are being made on the remote control panel. The necessary control devices/contacts for these external connections shall be wired out to the DG control panel terminal blocks.

1. Starting and stopping of the DG Set
2. DG running indication
3. Watt hour meter, Wattmeter, Voltmeter, Ammeter and Frequency meter.

14.7 ENGINE SAFEGUARDS:

Safeguards shall be provided and arranged when necessary to stop the engine automatically by the following:

- a) Energising a solenoid coupled to the stop lever on the fuel injection pump rack.
- b) De-energising the "fuel on" solenoid
- c) Energising the "fuel - cut off" solenoid.

The operation of the safeguard shall at the same time give individual warning of the failure by illuminating an appropriate local visual indicator and remote alarm at generator panel.

The contactors, relays and other devices necessary for signal and control, for above purposes shall be provided at Generator panel.

At the set at a easily accessible place an "EMERGENCY STOP" mushroom head stay put type P.B shall provided to stop the set in emergency mode.

The safe guard to "STOP THE SET" shall stop the set irrespective of mode selection of the set viz Auto, Manual or test for following cases, with simultaneous isolation of alternator ckt.

- a) Emergency stop P.B's operation
- b) Over speed.
- c) Low lube oil pressure.
- d) Earth fault

4.1 SYNCHRONISING PANEL

4.1.1 The technical specification and details of the microprocessor based PLC controller for the DG set synchronizing and load sharing shall be as follows:

4.1.2 The microprocessor based PLC panel shall be suitable for use with AVR and electronic speed governor to protect and monitor DG sets.

4.1.3 Double Frequency Meter and Double Voltmeter shall be provided in synchronizing panel.

4.1.4 Synchro check relay also shall be provided.

4.1.5 The PLC shall be provided with following features and audible alarm:

- Engine pre glow control
- Fuel solenoid control
- Engine starter control
- KVA controlled cool-down timer
- Speed monitoring
- Over speed protection
- Oil pressure monitoring, alarm and shutdown of the engine.
- Water temperature monitoring, alarm and shutdown of the engine
- Battery voltage monitoring
- Over speed monitoring and alarm.
- 3 attempt start failure alarm
- Under/Over Frequency
- Reserve Power (Inverse time delay)
- Loss of excitation
- Over current (inverse time delay)
- Loss of utility power detection
- Load surge
- Current unbalance
- Voltage unbalance
- Mains Protection (vector shift, df/dt ROCOI)
- True RMS power calculations accurate control
- Configurable loading/unloading ramp rates
- Isochronous load sharing of up to 4 units using percentage based load sharing
- Base load control for optimum fuel efficiency
- Import export control using a watt transducer
- Soft utility transfer function
- Digital signal processing to eliminate harmonic issues
- Adjustable phase window, Voltage and dwell time
- Safe dead bus closing logic internal to the control
- Synchronization across generator and mains breakers

- Multiple short re-closing with adjustable time delay
 - Manual voltage and speed adjusts for manual synchronizing
 - VAR sharing on isolated busses using percentage based reactive load sharing
 - Power factor or VAR control when base loaded
 - Externally adjustable VAR or PF set point levels.
 - The DG set shall start and stop automatically based on plant bus demand.
- 4.1.6 The PLC system shall be provided with built in relays for protection of the following:
- Reverse Power
 - Reverse KVAR
 - Over current
 - Under and over voltage
 - Under and over frequency
 - Synchronization check and earth fault relay.
- 4.1.7 The PLC system shall be suitable for load sharing by sensing active and reactive power.
- 4.1.8 The PLC system shall comprises of the following:
- Main processor unit
 - Power module for power supply to the processor and the system
 - Power monitor to monitor voltage, KVA, KVAR, KW, KWH, KVAH, KVARH.
 - 16/32 channel Digital input module
 - 16/32 channel Digital output module
 - EEPROM for main processor unit
 - Computer to PLC communication card with necessary cables.
 - Window based operator interface Software Package
 - Mounting chassis for the equipment
- 4.1.9 The microprocessor based main processor of the system shall be suitable for 128 digital I/P and 128 O/P and comprises of the following:
- 4.1.10 The main processor unit shall be suitable for operation on 24 Volts DC with integrated memory. The integrated Ram memory shall be 20 K Words for program, data and constants plus data memory and flash EP ROM of 16 K works for backup application program, communication card and real time clock.
- 4.1.11 4 Nos. discrete combination module (Input/output Module) shall be provided and the same shall be suitable for operation on 24 volts DC system. Combination module shall be with 16/32 inputs and 16/32 output channels as per the actual requirement.
- 1 No. 2 slot extension rack
 - 1 No. Ram back up battery unit
 - 8/4 Nos. digital input module

- 8/4 Nos. digital output module

4.1.12 The CPU display unit shall be suitable for 4 lines of 40 characters. The display shall be with back lit LCD. Clarity shall be not less than 5 x 7 pixels. The height of the characters shall be not less than 5 mm. The data entry shall be with the help of 24 function keys. In addition to this there shall be 10 service keys and 12 alphanumeric keys.

4.1.13 The system shall be provided with RS 232 communication port.

4.2 OPERATION AND COMMUNICATION

4.2.1 The PLC shall monitor the bus bar load continuously. In event of mains failure the PLC shall give signal to select and start the generator, which is closer to the load sensed during the last 60 seconds. In case the load at the time of main failure is more than the highest rating DG set, the PLC shall give command to start 2 Nos. DG sets to suit the load, synchronize the sets and give command to close the breaker on the main LV panel.

4.2.2 If load starts reducing the PLC shall give command to turn off the DG sets through cool down timer. On restoration of main power supply, the PLC shall check the voltage and frequency and if they are stabilized and within the permissible tolerances, the PLC shall give command to shut down the DG sets through cool down timer.

4.2.3 The control and monitoring of the cooling tower and fan and feed pump shall be done through PLC control system. Necessary control wiring between cooling tower, pumps and PLC panel shall be carried out within the scope of work.

4.3 SYNCHRONIZING MODULE

4.3.1 The synchronizing module shall be a microprocessor based intelligent unit, which shall monitor the electrical parameters and shall be able to communicate with the PLC control unit in the process of synchronizing and load management. The system shall be suitable for dynamic synchronization. The synchronizing module shall be suitable for programming and set the preferred difference between DG set and bus bar.

4.3.2 The synchronization module shall monitor and fulfill the following conditions before the system synchronizes the DG set to mains.

4.3.3 Feed back signal from the DG breaker on main LV panel that the breaker is in open condition.

- Bus bar voltage is present
- Generator voltage is present

4.3.4 The frequency regulator in the system shall start when the generator voltage and the bus bar voltage is over 50% of normal voltage. The voltage regulator in the system shall start when the frequency is within 90% of the normal system frequency.

- 4.3.5 The system shall close the breaker on the power panel with out carrying out synchronization when all the below mentioned conditions are fulfilled.
- 4.3.6 Feed back signal from the DG breaker on main LV panel that the breaker is in closed condition.
- Bus bar voltage is present
 - Generator voltage is present
- 4.3.7 The synchronizing module shall transmit all monitored electrical parameters to the PLC unit and the PLC unit shall start controlling the synchronization of the DG sets and its load management. The data logging, monitoring and controlling shall be through a PC based SCADA station.

14.8 TESTS:

- 14.8.1 The alternator of each type and rating shall be type tested for the following tests as per IS:4722, IEEE 115 & BS:5000. Test certificates to be provided for routine and type tests from the manufacturers.

14.9 ERECTION, TESTING, COMMISSIONING AND PERFORMANCE & GUARAANTEE TESTS/PROCEDURE AT SITE:

The entire work of erection, testing and commissioning of equipment supplied under this package shall be carried out by contractor and performance and guarantee tests to be conducted at site are also included under the scope of this specification. For this purpose the contractor shall depute suitable qualified technical supervisor to site on advance intimation to the Owner along with all special testing equipment required for testing and performance and guarantee tests. The supervisor(s) shall be responsible for the installation, testing, commissioning checks and performance & guarantee tests mentioned in relevant clauses of this volume and the checks recommend by the contractor.

The contractor shall ensure that the equipment supplied by him is installed in a neat workman like manner such that they are leveled, properly aligned and well oriented. The tolerances shall be established in Contractors drawings and/or as stipulated by the Owner.

All special tools and tackles and spares required for erection, testing and commissioning of equipment shall be supplied by the contractor.

Erection, testing and commissioning manuals and procedures shall be supplied, prior to dispatch of the equipment.

The contractor shall ensure that the drawings, instruction and recommendations are correctly followed while handling, setting, testing and commissioning the equipment.

14.9.1 Commissioning Check Tests/Performance and Guarantee Test:

In addition to the checks and test recommended by the manufacturer, the contractor shall supervise the following acceptance tests to be carried out on each test at site.

i. Load Test:

The DG Set shall be given load test at site for a period of at least 6 hours depending upon the actual power factor of the load and set shall be subjected to the maximum achievable load without exceeding the engine or alternator capacity.

This full load test is to be followed immediately by a 10% overload run for one hour. The performance of the engine, alternator shall be satisfactory at the end of this overload run.

During the load test half hourly records of the following shall be taken:

- a) Ambient temperature
- b) Cooling water temp.
- c) Lubricating oil pressure.
- d) Speed
- e) Voltage, wattage and current output.
- f) Oil tank level

ii. Speed and Governing:

The speed of the engine shall be verified to ensure that it conforms to the requirement of BS:5514.

iii. Check of Fuel Consumption:

A check of the fuel consumption shall be made through out the test run of full load and overload.

iv. Noise Level:

The equivalent 'A' weighted sound level measured at a distance of 1 meter horizontally from the base of any equipment furnished and installed under these specifications expressed in decibels to a reference of 0.0002 microbar, shall not exceed the limit given as per CPCB norms. 75 dbA average at 1 mtr. distance from acoustic enclosure.

15.00 PROCUREMENT, INSPECTION OF EQUIPMENT & APPROVALS

Approved list of makes and vendors are given in the end of technical specifications. The makes of equipment/materials supplied shall be strictly as mentioned therein. For items not specially mentioned, prior approval shall be taken before procurement of the same. All equipments/material supplied shall be brand new and shall be procured directly from the manufacturers, dealers or authorised agents.

HSCC Electrical Engineer shall have access to the manufacturer's premises for stage inspection/final inspection of any item during its design, manufacturing, and assembly and testing. After carrying out the necessary factory tests and routine tests as per IS Standards, a copy of the routine test certificate shall be forwarded along with the call for carrying out the inspection at the manufacturer's works.

Based on the inspection certificate, HSCC Electrical Engineer reserves the right to carry out the inspection at a mutually agreed date and/or give inspection waiver. A minimum of two weeks will be needed after receipt of complete shop inspection report and other details to depute our inspector for inspection.

It is the responsibility of the contractor to ensure that all electrical works are carried out as per the IE Rules & regulations, National Building Code and IS Codes & Standards. All necessary drawings and details as required by Electricity Board, Electrical Inspector, Fire Department and other Local Statutory agencies, shall be prepared by the contractor. **The contractor is responsible to submit the drawings and other details as required to the Local Authorities (refer above) and obtain necessary approvals including sanction of load/enhancement of electrical load from SEB before energizing and commissioning.** All official fee required for getting the approval will be reimbursed on account of Client on submission of original documents.

16.00 BUS TRUNKING

16.01 SCOPE

This section covers manufacture, supply, installation, resting and commissioning of sandwich insulated bus trunking. And rising mains, indoor/ out door type.

16.02 Supply voltage

415/ 440 Volt, 3 pahse, 4 wire, 50 Hz AC supply.

16.03 Standards for compliance:

IS:8623/ 1993 I & II and IEC 60439/ I & II.

16.04 Construction:

The enclosure will be made from 16 SWG GI/ CRCA sheet steel powder coated of approved shade. Bus bars would be of high conductivity aluminium in “Sandwich” construction and the conductors will be individually insulated with halogen free, fure retardant class– H – epoxy insulation. No drilling of Bus bar is permitted. Length of the section will be limited to maximum three metre. Bus bar of one section will be connected to bus bar of adjacent section by uni-block joint system removable as separate sub-assembly, so that it can be inserted or removed with out disturbing the adjacent sections.

16.04.1 Technical Parameters:

Bus trunking shall be designed to withstand short circuit current of 50 KA for one second.

Bus bar system should be designed for high temperatures withstand capability of 55 degree Celsius over 50 degree Celsius as normal operating temperature.

Insulation voltage 1.1 KV

Bus trunking will be suitably chosen to give permissible voltage drop.

Rated impulse withstand voltage 12 KV at 1000 volt.

Single bolt bridge system to be incorporated.

Plug in boxes

Plug in boxes will be of draw out type. Contacts will be of silver plated copper and spring loaded. Earth connection will be the first to make and last to break during insertion and withdrawl. Pluf in boxes will be made from 1.6 mm CRCA sheet steel

powder coated. Inside the plug in Boxes MCCB or SFU with the fuses will be located as per requirements. The operating handle will be interlocked with plug in box cover so that MCCB can be operated only with the suitable cover in closed position. The plug in box will be interlocked with bus bar trunking so that it can not be inserted or removed with the plug in box lid open. MCCB/ SFU will be of 4 pole type unless otherwise specified in BOQ. Short circuit breaking capacity of MCCB in PIB should be same as that of bus trunking i.e. 50 KA.

16.05 List of test to be carried out:

16.05.1 Routine tests:

- i. Verification of insulation resistance.
- ii. Inspection of assembly, interlocks, locks etc.
- iii. Dielectric test.

Copies of the following certificate should be submitted:

- i. Verification of temperature rise limits
- ii. Verification of di-electric properties.
- iii. Verification of short circuit strength.
- iv. Verification of degree of protection.
- v. Insulation resistance test with 500 volt megger. The insulation resistance shall be not less than 100 mega ohm.

17.00 CAPACITOR PANEL

17.01 SCOPE

Supply, installation, testing and commissioning of medium voltage capacitors and Automatic Power Factor Correction Panel (APFC) for improvement in power factor of electrical system. It will be connected to main LT panel. It shall improve power factor up to 0.98 lagging from initial power factor. Capacitor panel shall be provided with day/ night mode selector switch and double ratio C.Ts, for day/ night mode. Day/ night mode shall be selected based on estimated day / night load requirement.

17.02 RATING

Capacitor units as specified in the BOQ shall be used to form a bank of capacitors.

17.03 ENCLOSURE

The panel shall be indoor, floor mounted and free standing type with IP-42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure and shall be finished with powder coating in the approved colour shade. Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided. The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors (7%). The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

17.04 APFC Relay

Microprocessor based APFC relay, (intelligent VAR controller) of suitable steps as mentioned in the BOQ, shall sense the PF in the system and automatically switch ON/OFF the capacitor unit or bank to achieve the preset target PF. The controller shall have digital settings of parameters like PF, switching time delay, step limit etc, indication of PF, preset parameter, minimum threshold setting of 1% of CT current.

17.05 CAPACITORS

The capacitor shall generally conform to IS:13341-1992 and 13340-1993 and IEC 60831-1 &2.

General specification: three phase, delta connected, 50 Hz.

- i. **Voltage:** Must be designed to withstand system over voltage, increased voltage due to series reactor and harmonics.
- ii. **Capacitor type:** The capacitor unit shall be super heavy duty mix dielectric type. The dielectric should be made of metalised tissue paper. These elements shall be

- combination of capacitor tissue paper and BOPP film impregnated with non PCB bio-degradable impregnant or film foil capacitor manufactured using Poly Propylene film placed between 2 layers of metal foil and winding. Capacitor should be fitted with safety device like pressure sensitive disconnecter. The capacitor should be low loss type (total losses should not exceed 0.45 W/ KVAR).
- iii. **Temperature category:** -25 degree C to 70 degree C.
 - iv. **Over voltage** +10% (12h in 24 hours), +15% (30 minutes in 24 hours), +20% (5 minutes) and 30% for I minute as per clause 6.1 of IS 13340-1993.
 - v. **Over current:** 2.5x In
 - vi. **Peak inrush current withstand:** 350 x In
 - vii. Capacitor shall be provided with permanently connected discharge resistors so that residual voltage of capacitors is reduced to 50 volts or less within one minute after the capacitors are disconnected from the source of supply.
 - viii. Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for AYPY cable as specified.
 - ix. Two separate earthing terminals shall be provided for earth connection of each bank.

17.06 SWITCHGEAR & PROTECTION:

Incomer switchgear will be as specified in BOQ. Suitable contactor for each step shall be used and must be capable of capacitor switching duty. Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cable used shall have superior mechanical, electrical and thermal properties. Internal wiring between main bus bars, contactor, capacitor etc shall be made with 1100 volt grade PVC insulated FRLS copper conductor of appropriate size by using suitable copper crimping terminal ends etc suitable bus links for input supply cable termination shall be provided.

Control circuit shall be duly protected by using suitable rating MCB. An emergency stop push button shall be provided to trip thr entire system (22.5 mm dia, mushroom type, press to stop and turn to reset). 440 Volt caution board shall be provided on the panel.

17.07 TESTS AT AMNUFACTURER’S WORKS:

All routine and type tests as per IS:2834 relevant to capacitor bank s as amended upto date shall be carried out at manufacturer’s works and test certificates to be submitted to HSCC.

17.08 TEST AT SITE:

Insulation resistance with 500 V DC Megger shall be carried out and test results should be recorded.

Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute. Each discharge resistor shall be tested for its working.

Drawings and Instruction manual:

17.09 INSTALLATION:

Capacitor bank shall be installed at least 30 CM away from the walls on suitable frame work of welded construction. The earth terminals provided on the body of capacitor bank shall be bonded to main capacitor panel earth bus with 2 nos 8 SWG copper or 6 SWG GI earth wire.

Contractor shall submit four copies of the following certified drawings:

- i. General arrangement of capacitor bank and control panel indicating main dimensions, type of mounting, location of various devices etc., including foundation details.
- ii. Schematic diagram for automatic sequential switching with terminals and ferrules numbers.
- iii. Wiring diagram of control panel indicating terminal blocks and various apparatus.
- iv. Final list of components of control panel.

Contractor shall also submit four sets of installation and maintenance manual.

18.00 11 KV TRANSFORMERS (OLTC TYPE)

GENERAL

The transformer shall be double wound core type, oil naturally cooled suitable for indoor installation. The transformer shall be designed and manufactured as per IS specification and having no load voltage ratio as 11000/433v.

SPECIFICATION STANDARD

Unless otherwise stated below, transformer & transformer oil shall conform to IS 2026 & 335 respectively.

SYSTEM OF SUPPLY

KV 3 phase, 50 Hz system

NO LOAD RATIO

11000/433 volts

KVA RATING

Transformer shall be suitable for continuous rating as stated in BOQ and on drawing.

TYPE

Out door

WINDING

The transformer shall be copper wound.

CORE

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

COOLING

Natural oil cooling by means of pressed/round tubes around transformer tank (ONAN)

FREQUENCY

50Hz plus minus 3%

RATED VOLTAGE

Transformer shall operate at its rated KVA at any voltage plus minus 10% of rated voltage of that particular tap.

VECTOR GROUP

Corresponding to the vector symbol Dyn-11

CONNECTIONS

H.V side of transformer shall be provided with suitable size cable box for 3 core XLPE cable. Indoor heat shrinkable termination kit shall be used for termination of HV Cable.MV side of transformer shall be suitable for bus duct connection arrangement.

TAPPING

ON load tap changing arrangement on 11kv side. The range for circuit taps, which shall be provided on H.V. side, shall be plus 5% & minus 15% in steps of 1.25%

TEMPERATURE RISE

The transformer shall conform to the requirements of temperature rise specified in IS: 2026(PartII) 1977.Continuously rated for full load, temp. rise not to exceed 50 degree C by thermometer in oil (55degree C by resistance)

INSULATION LEVELS

The insulation levels shall be in accordance with IS 2076(Part III) 1977.
TERMINAL MARKINGS, TAPPING & CONNECTIONS

The terminal marking, tapings & connections shall be in accordance with IS 2026(PartIV) 1977.

REQUIREMENTS WITH REGARDS TO ABILITY TO WITHSTAND SHORT CIRCUIT.

As per IS 2026 (part I) 1977

IMPEDANCE VOLTAGE

As per table 3 of IS 2026 (part I) 1977

ON LOAD TAP CHANGING SWITCH

On load tap changer with RTCC panel and AVR

PARALLEL OPERATION

Transformer shall be suitable for parallel operation with similar unit of same rates.

GENERAL REQUIREMENTS OF TRANSFORMERS

Transformer shall be suitable for operating at rated capacity continuously at any of the taps under ambient conditions and with the voltage and frequency variations indicated without exceeding permissible temperature rise and without any detrimental effect to any part.

Transformer shall be designed to be loaded as per IS:6600.

On Load tap changer shall be provided in the transformer with RTCC panel. The range of OLTC will be -15% to +5% in the steps of 1.25% as per BOQ.

All windings shall have uniform insulation resistance to earth.

Disconnecting chamber shall be air filled. Suitable cable end box shall be provided for termination of cables. Gland plate for single core cables shall be non-magnetic.

Transformer shall be able to withstand electrodynamic and thermal stresses due to terminal short circuit of the secondary, assuming the primary side is being fed from an infinite bus. All leads and windings in cores shall be properly supported. Short circuits withstand and duration shall be 2 secs. As per IS: 2026.

Short circuit test results for similar transformers shall be furnished.

There shall be a marshalling box for gathering all alarm signals. All alarm shall be wired up to terminal strip provided in marshalling box. 20% spare terminals shall be provided. Armoured cable of 2.5 sqmm cu shall be provided along with suitable size glands for terminating these contacts in marshalling box.

Guides shall be provided to facilitate tanking and untanking of the core with the coil assembly. The details of anchoring of core and coils assembly of tank shall be furnished.

Radiators shall be provided on the tank to facilitate cooling. These shall be detachable type and shall be provided with isolating valves at ends, drain plugs and air release plug. Radiators of 1.2 mm thickness seamless steel tubing or pressed sheet steel.

Means for lifting and jacking of transformer shall be provided.

Class-A insulating material specified in IS:1271 shall be used. Paper insulation shall be new and free from punctures. Wood insulation, wherever used, shall be well seasoned and treated.

The mineral oil shall comply with IS: 335. 10% extra oil in seal tins/ drums shall be supplied.

All valves shall be of globe type. Valve body of carbon steel and trim of 135 cr. Steel.

Oil temp. Indicator for measuring top oil temp. Shall comprise 150mm dial type thermometer pocket and capillary tube jacketed with PVC sleeve. Thermo-meter shall have 2 sets of contacts, one for alarm and the other for trip, and set points can be set by hand. Contacts shall be wired up to marshalling box.

Buchholz relay shall be provided as per IS: 3637. It shall be double float type with two sets of contacts for alarm and trip with facility for testing by injection of air by hand pump and with cock for draining and venting of air. Relay shall be provided with shut off valves on conservator side as well as on tank side.

Alarm and trip contacts shall be suitable for 1A 230 AC.

A marshalling box shall be provided to accommodate all auxiliary devices except those which are to be located directly on transformer. It shall be of dust, weather and vermin proof type of sheet steel 2mm thick and shall have sufficient space for ease of cabling. 20%extra terminals shall be provided.

All steel surfaces exposed shall be treated with suitable anti –rust, anti –corrosive paints

Bushing insulator shall be rated for max. System voltage and shall be as per IS. Bushing shall be enclosed in terminal box and shall be detachable from outside the tank. Separate neutral bushing shall be provided for earthing the neutral. When LT cable box is provided, a neutral bushing shall be brought out for solid earthing.

Transformer efficiency shall not be less than 98% at full load at 08 pf (lag).

Transformers shall have same percentage impedance & other characteristics with foundation plan parallel operation as per IS: 10028

FITTINGS

The following accessories and fittings shall be provided with the transformer

- i. **LIFTING LUGS:** The arrangement of lifting the active part of the transformer along with the cover of the tank by means of lifting lugs without disturbing the connections. Also complete transformer lifting lugs shall be provided.
- ii. **ROLLERS:** The transformer to be provided with 4 Nos. rollers fitted on cross channels to facilitate the movement of transformer.
- iii. **OIL CONSERVATOR:** The transformer to be provided with a conservator with welded end plates. It is to be bolted to the cover and can be dismantled for purposes of transport. It has to be provided with oil gauge with marking for minimum level and an oil filling hole with a cap which can be used for filtering of oil. For draining purposes a plug is to provide. A connection pipe between the conservator and tank is to be provided, which projects inside the conservator.
- iv. **AIR RELEASE VALVE:** An air release valve shall be provided on top of the tank cover to facilitate of the entrapped air while filling of oil.
- v. **BREATHER:** The transformer shall be provided with an indicating dehydrating silica gel breather of sufficient capacity.
- vi. **DRAIN VALVE WITH PLUG:** The transformer to be provided with drain valve with plug at the bottom of the tank.
- vii. **DIAGRM WITH RATING PLATE:** One diagram and rating plate indicating the details of transformer connection diagram vector group tap changing diagram etc.
- viii. **THERMOMETER:** Dial type thermometer (150mm dia) with maximum set pointer 75 degree C electrical contacts for electrical contacts for electrical alarm at high temp.

- ix. EXPLOSION VENT: Explosion vent or pressure relief device shall be provided of sufficient size of rapid release of any pressure that may be generated within the tank and which might result in damage in the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank.
- x. FILTER VALVE: Filter valve on the top of the tank.
- xi. BUCHOLTZ: Oil actuated relay equipment shall conform to IS 3637-1966(amended up to date) and shall be double float type having contacts which close following oil surge or under incipient fault condition. Bucholtz relay shall have contacts for alarm / trip.
- xii. WINDING TEMPERATURE INDICATOR :
- xiii. Winding temperature indicator with electrical contact for alarm/ trip
- xiv. OIL TEMPERATURE INDICATOR: Oil temp. Indicator with alarm & trip contacts.
- xv. MARSHALLING BOX: the transformer shall be provided with suitable size marshalling box to terminate the control cables of thermometer and bucholtz relay.
- xvi. CONTROL CABLING: all control cables required from Marshalling box to H.T panel board for Trip/alarm of winding temp. Indicator, oil temp indicator, Buckholz relay etc. shall be provided and deemed to be included in the rate of transformer equipments.
- xvii. TRANSFORMER OIL: First filling of oil.
- xviii. EARTHING: Two separate earthing terminals are to be provided at the sides of the tank on both the sides for earthing.
- xix. ON LOAD TAP CHANGER; High speed resistor type OLTC shall be provided along with RTCC and AVR.

SOAK PIT

Soak pit for oil filled transformer shall be made as per IS 10028 (Part II) 1981 with up to dated amendments. Sump shall be formed in the transformer room and shall be connected to soak pit outside the transformer room with a pipe. All the civil works required for the soak pit shall be done by the contractor and the cost shall be deemed to be included in quoted rates of the transformer item.

INSTRUMENTATION MANUAL

The successful bidder shall submit three copies of manual of complete instructions for the installations, operations, maintenance and repair, circuit diagrams, foundations and trenching details shall be provided with the transformer.

SHOP DRAWINGS

The selected supplier shall prepare and furnish shop drawings for the approval by the consultant/client before commencing fabrications/ manufacture of the equipment. Shop drawing shall be based on the requirement laid down in the specifications. The manufacture of the equipment shall be commencing only after the shop drawings have been approved in writing by the consultant. Transformer shall be manufactured conforming to specification of Local supply authority.

INSPECTION

- i) The transformer shall be inspected on arrival as per the inspection manual of the supplier

- ii) Shall be examined of any sign of damage and special attention shall be given to the following parts.

- Oil tank and cooling tubes
- Bushes crakes or broken
- Oil sight glass

INSTALLATION

- i) The transformer shall be installed as per transformer manual of the transformer supplier and conforming to Indian standards.
- ii) The transformer is to be erected on suitable size M.S channels embedded in the cement concrete flooring including providing & fixing the channel. The transformer supplied shall be lifted by all lifting lugs for the purpose of avoiding imbalance in transit.
- iii) The transformer wheels shall be locked by suitable locking arrangement to avoid accidental movement of the transformer.
- iv) The transformer cable end boxes shall be sealed to prevent absorption of moisture.
- v) The transformer natural earthing and body earthing shall confirm to Indian Standard.

FACTORY TEST

The transformer shall be subjected to test as laid down in IS 2026 (Part I) 1977 at factory/manufacturing unit prior to dispatch of the transformer to the site.
All original test certificates shall be furnished.

TESTING AT SITE

Prior to commissioning of the transformer the following tests shall be performed

- i) Insulation resistance of the winding between phases and earth of H.V and M.V side.
- ii) Winding resistance of all the winding on all tap positions shall be taken.
- iii) The supplier gives sufficient advance information about the test schedule to enable the owner to appoint his representative.

HIGH SPEED RESISTOR ON LOAD TAP CHANGER

GENERAL

High speed resistor on load tap changer shall be provided with the transformer wherever specified. The high speed resistor OLTC shall be for rated voltage up to 11KV rating current of 100 Amp, 3phase, 17step conforming to Indian standard with AVR & RTCC panel.

TYPE AND CONSTRUCTION

OLTC shall be a compact unit for use with three phase distribution transformer. It shall be completely self contained and designed to bolt directly to a part flange on the transformer.

The assembly comprise of

1. Tank
2. Selector Switch
3. Driving Mechanism
4. Barrier Board

5. Local control Gear
6. Control cable Terminations
7. AVR & RTCC panel

TANK

The complete tap changer shall be housed in a single tank of welded sheet steel construction. The tank shall be divided into two separate compartments to house the selector switch, driving mechanism and Local control gear. Access to the compartments shall be made easy by means of removable covers and a weather proof door. Anti- condensation heater shall be provided in the compartment which houses driving mechanism and control gear.

OPERATION MECHANISM

An impulse is received either from a remote control panel or from a local manual operation switch, which energizes the appropriate raise/lower contactor to initiate a tap changer in the required direction. The contactor when energized seals itself via its own contact and the driving motor commences to run. At a predetermined point a directional sequence switch closes, taking over the handling duties of the contactor whose original hold circuit shall be isolated. At the completion of the tap changer the directional sequence switch opens and de-energizes the driving motor. The arrangement ensures that a short period initiating pulse shall be accepted by the control gear.

CONTROL CABLE TERMINATION

A detachable undrilled gland plate and the terminal station for all the external connections shall be provided in the driving mechanism compartment of the tap changer.

AUTOMATIC VOLTAGE REGULATOR

Solid state automatic voltage regulator shall be provided for the regulation of the secondary voltage of the power transformer with on load tap changer (OLTC). The band width control shall allow the dead band to be set in the terms of upper (LOWER VOLTS) and lower (RAISE VOLTS) voltage limit around a particular nominal value with a specified sensitivity. AVR shall be provided with time delay control to allow the regulator to respond only to voltage fluctuations lasting for period greater than a selected time delay. Where the voltage correction requires more than one tap change, the time delay shall be reinitiated before further tap changes. Regulations shall reset automatically after voltage correction. Solid state lamps (LED) shall be provided to indicate voltage outside the preset limit & control relay operation.

RTCC PANEL

RTCC panel shall be provided to operate OLTC from control room located in substation. RTCC shall be provided with main switch, a sequence selector switch. RTCC shall be provided with lower push button & raise push button, tap change in progress & complete. A.C supply ON/OFF lamp indicator & AVR relay operated operation indication. Cubical panel shall be totally enclosed, floor mounting and fabricated with a framed structure with rolled/folded sheet steel channel section of minimum 2mm thickness. All the sheet steel work forming the exterior of RTCC panel shall be smoothly finished and all steel work used in

construction of RTCC panel shall undergone a regrious metal treatment process consisting of effective cleaning by hot alkaline degreasing solution followed by the cold water rinsing, pickling in dilute sulphuric acid to remove scales and rust formation, a recognized phosphating process , passivating in deoxidize to retain & augment the effects of phosphating, drying with compressed air and dust free atmosphere, primer coating with two coats of highly corrosion resistant primer applied under strictly controlled conditions and finished coatof stoving

19.00 TELEPHONE SYSTEM

19.01 Telephone point wiring

- (a) The point wiring shall be carried out with two pair telephone wire/cable, unarmoured, PVC insulated, 0.61 mm dia annealed tinned copper conductor (IS: 2532-1965) in suitable size conduit (one pair always remaining spare for one point)

Minimum Dia of Conduit for Internal/External Telephone Wiring - 20mm.

If more than one telephone point has to be provided at one point, multicore, unarmoured telephone cable shall be used (pairs required are equal to 2 No. of points) in suitable size of conduit.

- (b) The point shall commence from the main telephone tag box/sub tag box and would terminate at outlet box of point. Connection at both ends included in point wiring.
- (c) Fixing of conduit, conduit accessories draw out boxes and outlet box etc. in concealed/surface conduit works as that of wiring for light fixtures shall be applicable for telephone wiring conduit system also.
- (d) Joint in telephone wiring (between main tag box/sub tag box and outlet box of point) shall not be allowed and the contractor should bear the wastages of wire if resulted due to this special requirement of telephone system.
- (e) External/Internal telephone and intercom wiring can be drawn in the same conduit, provided after drawing wires, 50% of conduit cross sectional area is free. However, independent PVC insulated telephone wire of suitable pairs shall be used for external, internal and intercom.
- (f) To identify each pair of multipair telephone wire/cable, PVC indication numbers shall be put on both ends of pair just before termination.

19.02 Telephone Tag Boxes

These shall be of MS sheet 2 mm thick with connector suitable for telephone connection (as approved by ITI). It shall have hinged MS sheet cover.

LIST OF APPROVED MAKES FOR ELCTRICAL SYSTEM

Contractor shall use the materials of approved make as indicated below unless specified in BOQ or as approved by the HSCC electrical incharge.

The contractor shall ensure the correct selection of the approved make meeting the specifications and application duties. Before placing order for procurement, the sample of approved make shall be got verified for its suitability to the specification and application duty. However, HSCC electrical engineer (approving authority) reserves the right to opt for the best preferred listed make.

The contractor shall quote the rate for the material and equipment as per the list of approved makes and equipment as per the list of approved makes. In the event of the contractor wants to use alternate makes other than those stipulated for any reason , the contractor can send a proposal after ensuring that what he proposes at the least meets both the quality and safety standard of the stipulated makes, and the financial benefit that will occur to the client. He shall also stand full guarantee to his alternate proposal. The alternate makes can be used only after an approval accorded by the client/HSCC., whose decision will be final in this matter. Any financial implication incurred related with inspection will be borne by contractor.

S.No.	ITEM	MAKE
1.	Main LT Panel/ Synchronizing Panels/APFC panels /AC panels	CPRI Approved Panel Manufacturer (Test certificate of CPRI valid from January 2012 onward (Contractor must submit the documents for approval of manufacturer to HSCC/Client)
2.	11 KV VCB Panel Board	Siemens/L&T/ABB/Schneider/Kirlosker/Crompton Greaves/Control & Switchgear
3.	Transformer	Siemens/ABB/ Crompton /GE/ Voltamp
4.	Cast resin current Transformers:	AE/ Kappa/Control & switchgear/L&T/Gillbert & Maxwell
5.	Selector Switches:	L&T/ Salzer/KAYCEE/ Siemens/BCH
6.	Push button, Indicating Lamps LED:	L&T(Esbee)/Siemens, Schinder/BCH/Veshno/Teknik/RAAS
7.	Rubber Mats:	Jyoti or Equivalent
8.	Diesel Engine:	Cummins/ FG Wilson (Perkins)/ Caterpillar/ MTU/Kiroskar/Ashok Leyland/Greaves cotton
9.	Alternator:	Stamford/ AVK-SEGC/ Marathan/ Leroysoner, NGEF/ Crompton

10.	Anti-vibration mounting:	Gerb or equivalent make
11.	Dry Battery:	Panasonic/Hitachi/Mistubishi/Cummins/Exide
12.	Automatic Battery Charger:	Max Power/ Cossel/ Statcon/ Voltstat, Amarraja/HBL Knife
13	MV panels/Fire panel/AHU Panel	CPRI Approved Panel Manufacturer (Test certificate of CPRI valid from January 2012 onward (Contractor must submit the documents for approval of manufacturer to HSCC/Client)
14.	ACB	L &T 'U' Power(Omega)/ Siemens 3WL/ ABB/ Legrand(DMX) Schneider (MG- Master Pact)/ GE- Entelliguard /C&S
15.	Moulded case circuit Breaker	L&T- D sine/ Seimens-VL/ ABB-TMA/ Schneider(NSX-NS)/ GE record plus
16.	Power/auxiliary Contactors, timers, Relay, starters	ABB/ Schneider/ L&T/ Siemens/GE/C & S,
17.	AMF Relay	Control & switchgear/wood ward or approved by engineer incharge.
18.	SFU with HRC	L&T/ GE/ Siemens/Control & Switchgear/ ABB, Merlin-Gerlin/ CromptonGreaves/HPL(SOCOMECH)
19.	Change over switches/Isolators	Merlin Gerlin/ Crompton/ Siemens/ABB/HPL/GE
20.	Instruments (analogue)	L&T(Rishab)/ AE/ MECO/C &S
21.	Digital Meter	Enercon/ AE/ Secure/ Allan Bradely/L&T Motwane/Dukati (Imported) Meco/HPL/Trinity/Minilec /C &S
22.	Timers in Distribution board	Legrand/ Hagar/ Siemens/ ABB/ GE/C&S
23.	Battery (Maintenance Free VRLA Battery)	HBL Nife/ Exide/ Standard/Amar Raja/ Furakawa/ Panasonic

24.	MCB distribution Boards	L &T/Hager/Legrand/ Siemens/ ABB/GE/ Schenieder (MG)/Havells/C&S/Standard/IndoAsian
25.	RCCB	L & T /Hager/ Legrand/ Siemens / GE/Schenider (Merlin –Gerin)/C&S/Indo Asian/Standard
26.	11 KV LT XLPE cables	RPG/ Polycab/ NICCO/ UNIVERSAL/Rallison/KEI/Skytone/Batra Henlay
27.	Copper Control cable	Finolex/ Polycab/ NICCO/ Universal/ National/ Rallision/RR Cable/Batra Henlay
28.	Compression Glands & Lugs 11KV grade cables(Double compression gland)	Peeco/ Comet/ Dowells/ Siemens
29.	Copper/ Aluminum(Crimping Type cable lugs for 11KV cables	Asian/Dowells /Crystal/Jointwell or equivalent make
30.	Cable Joints (Heat Shrinkable) HT cable termination	Raychem/3M/Cabseal
31.	Cable Trays	Steelways/ Bharti/ Unitech /Maheshwari/or approved by HSCC
32.	Galvanized/PVC Raceways and raceways accessories	Steelways/ Bharti/ Schneider(MG)/Legrand
33.	Light fitting	Philips/ Wipro/ Bajaj/ GE/ Crompton Greaves/Control & Switchgear/ Kesalec Schreder/Anchor(Panasonic)/ Twinkle/ Anchor/
34.	Lamps	Philips/ Osram/ GE/Anchor (Panasonic)/
35.	GI / MS conduit ISI marked	BEC/ AKG/ Steel Kraft

36.	PVC conduit	BEC/ AKG
37.	Steel conduit accessories (ISI as approved sample)	Sharma sales corporation, super sales corporation or equivalent.
38.	Modular Metal box for switch /socket	Havells/ MK/MDS/Anchor Roma/Northwest
39.	Copper conductor FRLS PVC insulated wires ISI marked	National/ Skyline/ Finolex/ Havells/ L&T/KEI / R R cable/Rallison/Skytone/Batra Henlay
40.	Modular Switches & sockets Outlets	Havell's (Crabtree)/ MK- Wraparound/Hagger/Wipro Legrand (Myrius/ Anchor-Roma(Tersa,woods,viola)/ Northwest
41.	Metal clad Socket outlets With boxes	L & T Hager/ Siemens/ Merlin Gerin/ ABB MDS / BCH /Havells
42.	Lighting protection	Erico/Galaxy electrode /Earth plus or equivalent
43.	UPS system	Hitachi/ Siemens/ Amarraja / Etone powerware/Emerson/APC (Schneider) /PCI LTD
44.	Street Light poles	Jindal/ Bombay poles/ Bajaj /Twinkle/ Pierlite or equivalent
45.	Electronic Ballast	Philips/ Wipro/Osram/Bajaj/Crompton
46.	Ceiling fans	Crompton Greaves/ Bajaj/ Orient/ Alastom/ Usha
47.	Main PC with CPU monitor	HP/ Compaq/Del
48.	Auto manual changeover switches (3Way)	Kaycee/L&T/ Schnieder
49.	Public address system	Bosch/ Bose/ Haristasa/Honey well /Harman/JBL/Shure
50.	CCTV camera	Honeywell/ Schnider electric (Pelco)/DVTEL/Bosch/Siemens/Johson control
51.	Fire Detection System	Honeywell- Notifier/GENT/ Thorn/Bosch/Siemens/Cease fire (Hochiki)

- | | | |
|-----|---|--|
| 52. | Portable fire extinguisher | Minimax/Agnidevices/Superex/Ceasefire/Eversafe |
| 53. | EPABX system | Avaya/ Siemens/Alcatel/Erricsion/Panasonic |
| 54. | Telephone cables
/communication cables | AT & T/ Fusion /Polymers/Finolex/Delton
Skyline/Skytone |
| 55. | Nurse Call bell system | Omnitech automations/Process care system or
equivalent as per spect |

END OF TECHNICAL SPECIFICATION

DETAILED SPECIFICATIONS

SYSTEM DESIGN DATA

1.0 General

The system design, basis of design, estimated requirements and other relevant data are outlined in this section. The specifications and specific requirements are outlined in the subsequent sections.

2.0 Location

Proposed '100/50 Bed hospital' located at Various Districts of Chhattisgarh(CG).

3.0 Scope of work

The work proposed under this tender includes Supply, Installation, testing & commissioning of Air Cooled package type DX units, Packaged, High Wall Split, Windows type and Ductable Split type Air-conditioning system and ventilation fans for the Hospital Block.

4.0 Basis of design

4.1 Assumptions

Following assumptions have been made for calculation of air conditioning cooling load of the building Areas.

- i. All exposed roof of A/C areas will be thermally insulated with 50 mm thick expanded polystyrene or equivalent insulation.
- ii. Construction of walls will be:

External walls	:	9 inch thick brick masonry, plastered inside and outside.
Internal walls	:	4.5 inch thick brick masonry, plastered inside and outside.
- iii. Glazing : Single pane transparent glass 1/4 inch thick

- iv. Lighting load : 2W/ sq.ft
- v Fresh air : - 2 Air changes per hour
- For OT's Air Cooled Package type DX unit with 5 ACPH fresh air.
- vi Occupancy : App.60- 100 Sq.ft per person or as per actuals.
- vii Equipment Load : As per standards
- viii Electrical power supply: 415V/3 Ph/ 50 Hz, AC power supply
- ix Humidity Control : Pan type Humidifier is considered only for OTs.
- x Winter Heating: : Winter heating have been considered in Package type DX units for OT areas and critical areas.

4.2 Outside Ambient conditions

Season	Dry Bulb temp (deg. F)	Wet Bulb temp. (deg.F)
Summer	110	75
Monsoon	95	83
Winter	45	41

- 4.3 Inside Conditions** For OT's : 72+/-2 deg F , 50-60% RH
Other areas and buildings: 75+/-2 deg F DB, 50-60% RH

5.0 System Design

- 5.1 To meet the air conditioned load during summer & monsoon, it is proposed to provide Window, Split and Ductable Split Type Air Conditioner. The Air cooled package type DX AHUs are considered for OT's air-conditioning.
- 5.2.1 Conditioned air shall be taken from the ductable split type air conditioner through GI/Aluminium ducting and supplied to conditioned areas through ceiling / wall mounted grilles / diffusers. Return / exhaust air shall be collected through similar grilles and diffusers and returned to ductable split AC through false ceiling /return air duct.

OPERATION THEATRES

- Operation theatres shall have independent air handling unit to prevent cross contamination.
- OT's shall be designed for recirculatory system with 5 air changes fresh air.
- The laminar flow air distribution system shall be followed. Air shall be supplied from ceiling level to flow uni directionally up to the operation table. The return air shall be collected from four corners of the room to prevent the contamination from recirculation in space.
- All ducting for OTs shall be of aluminium because GI duct can cause formation of flakes on contacting moisture that can be carried down stream.
- Both supply and return air shall be ducted.
- Three level filtration shall be adopted with pre-filters, fine filters and HEPA filters of following filtration efficiency :

Hepa Filters 99.97% down to 0.3 μ

Fine Filters 99% down to 5 μ

Pre Filters 90% down to 10 μ

All these filters shall be with aluminium frame to prevent formation of bacterial colonies. Epoxy resin shall be used to seal filter media with the framework.

OTs shall be maintained at positive pressure by supplying about 15% more air than return air to prevent any contamination from entering OT space.

AHUs with HEPA filters shall be designed for high static pressure to overcome high pressure drops

- 6.0 For fire safety fire dampers shall be provided in supply and return air ducts. All materials used for insulation shall be fire proof type. The split air conditioner & duct mounted inline fan motors shall also be interlocked with the central fire alarm system of the building such that in case of detection of smoke or fire by the fire alarm system, the units shall automatically shut off.

7.0 Items to be provided by other Agencies free of cost to AC contractor

- 7.1 Civil works such as trenches for piping, cables and making foundations of equipment etc.
- 7.2 Main 3 ph, 415 v, 50 hz, A.C. supply power supply up to each panel of Ductable Split AC.
- 7.3 Main 1 ph, 220 v, 50 hz, A.C. supply power supply within 1 metre for Window & Split AC.
- 7.4 Any kind of false ceiling, boxing.

7.5 Making frames for fixing grilles & diffusers in false ceiling, boxing or in walls.

8.0 Drawings

The drawings forming part of these specifications provide a feasible scheme for locating the equipment and it is for the reference purpose only. The contractor may re-arrange the equipment for improving the layout and meeting the site conditions. All such changes shall however be subject to the architect's approval. These drawings are not meant to be working drawings which shall be prepared by the contractor as required.

9.0 Test Data

The complete HVAC system shall be tested as per the specifications given elsewhere and complete test data shall be furnished on prescribed data sheets:

10.0 Technical Data

The contractor shall furnish complete technical data, on the equipment offered as required under the heading 'Technical data'

11.0 Performance Guarantee

- 11.1 The contractor shall guarantee that the air conditioning plant shall maintain the desired inside temperature within +/- 2 % tolerance for the rooms supplied with Package AC.
- 11.2 The contractor shall guarantee that the capacity of various components as well as the whole system shall not be less than specified.
- 11.3 The contractor shall ensure that the system shall be free of vibrations and disturbing sounds.

Air cooled Package Type DX Units

1. Scope:

The section sets out the general requirements for factory built or assembled Air cooled condenser type Package DX Units complete with safety controls, instruments electrical installation including installation testing and commissioning

2. Components of Machines

Each Air cooled Package DX unit shall be complete with hermetic type compressor/s, Indoor Unit, Outdoor Unit, compressor motor, interconnecting refrigerant piping of required size from indoor to outdoor unit with necessary valves, strainers ,thermal insulation etc, refrigerant controls and accessories, gauge panel, motor starters, and electrical controls, safety controls and devices and first charge of refrigerant, oil etc.

3. Compressor

Compressor shall be multi cylinder semi hermetic/hermetic type complete with drive and motor, dynamically balanced removable cylinder sleeves, oil return check valves suction and oil strainers, discharge and suction shut-off valves, site glass etc .Compressor and motor assembly shall be installed on a spring mounted floating platform to provide quite vibration less operation. Compressor shall be provided with overload protection switches etc.

The compressor shall be enclosed in a hermetically sealed casing and shall be suitable for R-134a / R-410a.

4. Outdoor Unit (Air cooled Condenser)

The air cooled condenser coil shall be of heavy gauge suitable copper tubes with aluminium fins and condenser shall be so designed to give the required capacity for the specified peak ambient conditions. Suitable axial flow heavy duty condenser Fans for low speed quite operation shall be selected. The condenser Fan shall be suitable for 415 V/3Ph/AC supply. The casing shall be fabricated from galvanized steel, zinc phosphated and finished with baked enamel paint. The casing shall make the whole unit weather proof suitable for outdoor installation. The unit shall include a remote control assembly with thermostat and starting and speed switches. The necessary charge of refrigerant gas and lubricated oil shall be provided to run the system.

5. Indoor Unit (Double skin Air Handling unit)

The Indoor Unit/air handling units shall be double skin fully enclosed construction, draw-thru type and shall include flat filter section, fan section, coil section, Microvee /HEPA Filter section, and humidifier section etc with necessary vapour arrangement. The AHU shall be two tier type with the Microvee and HEPA

filter sections in the upper tier.

5.1 Fan Section

Fan shall be centrifugal with forward or backward inclined blades. Fan casing shall be made of galvanised steel sheet. Fan wheels shall be made of galvanised steel. Fan shaft shall be ground C40 carbon steel and supported in pre-greased ball bearings operating less than 75% of first critical speed. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. The fan shall be selected for a fan speed not exceeding 1000 rpm for fan dia of more than 350 mm .The fan outlet shall be connected with casing with the help of fire retardant canvas.

5.2 Coil Section

The cooling coil shall be of seamless copper tubes, the internal and outer dia of the cooling coil shall be as per the standards of the approved makes with aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across the coil shall not exceed 500 FPM. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of air flow.

The fins shall be uniformly bonded to the tubes by hydraulic mechanical expansion of the tubes. Fin spacing shall not exceed 5 fins per cm. The coiling coil assembly shall be on aluminium rails and nylon rollers for easy with drawl from either side.

5.3 Prefilters

Each unit shall be provided with a factory assembled filter sections containing washable synthetic type air filters. Filter framework shall be duly sealed and constructed from aluminium alloy. The media shall be supported with HDP mesh on one side and aluminium frame mesh on other side. Filters face velocity shall not exceed 500 FPM. Filters shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filters cells in bank. These cells shall be held within the frames by sliding the cells between guiding channels.

5.4 Humidifier Section

A separate humidifier section shall be provided in the AHU's in the lower tier. Pan humidifier shall be placed outside the AHU & within the AHU room & steam shall be supplied in the humidifier section.

5.5 Housing/ Casing

The housing /casing of the air handling unit shall be of double skin panels, sandwiched type with polyurethane foam insulation of 25 mm thickness (overall). The housing shall be so made that it can be delivered at site in the total/ semi knock down conditions depending upon the location. The frame work shall be of extruded aluminium hollow section duly powder coat painted/ anodized. All the frame shall be

assembled using mechanical joints to make a sturdy & strong frame work for various sections.

The outer sheet of panel shall be made of galvanised pre-plasticised sheet/powder coated CRC sheet of 0.80 mm thickness, and inner sheet of 0.63 mm thick GSS. These panels shall be bolted from inside on the frame with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight, suitable doors with chrome plated hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on steel channel frame work. Units shall have hinged, quick operating access door in the fan section etc. The access doors shall also be double skin type similar to the casing.

The special (Microvee and HEPA) filters shall be housed in a separate AHU upper tier casing of suitable size & length.

The enclosure shall be sized to accommodate the standard Microvee filter. The inspection doors shall have double synthetic rubber seals doors & locking arrangements. The gaps between filter frames & housing shall have synthetic rubber packing to eliminate any air leakage. All filter frames & metallic parts shall be made of Aluminium. The Microvee filter sections shall have provision for fixing a portable inclined manometer for taking filter pressure drop readings.

Drain pan shall be constructed of 18 gauge aluminium sheet with necessary slope to facilitate fast removal of condensate. It shall be isolated from the bottom floor panels through 12 mm thick kinny foam insulation or equivalent.

5.6 Fan Motor and Starter

The totally enclosed fan cooled squirrel cage fan motor shall have a minimum rating as given under "Schedule of Equipments and the starter rating shall match the motor rating and both control panel shall conform to the specifications under "Motors and Switchgears". Drive to fan shall be provided through belt-drive arrangement. Belts shall be of oil resistant type.

5.7 Controls

Each air handling unit shall be provided with a modulating valve motor and modulating thermostat, conforming to specifications under "Controls".

5.8 Accessories

Each indoor/air handling unit shall be complete with: -

Thermostats at coil inlet and outlet with display on microprocessor base control panel of the system.

Pressure gauges with cocks at inlet and outlet of the coil.

Drain line from unit to drain trap.

Flexible connection between fan outlet and duct.

Vibration isolators of high efficiency.

6.0 Refrigerant System

The air conditioning units shall be complete with pre-charged refrigerant line

including fittings, valves and thermostatic expansion valve. Automatic resetting type low and High Pressure cut outs shall be provided to safe guard the unit against abnormal operation.

7.0 Control, Instrumentation and Accessories

Each unit shall be equipped with but not restricted to the following

Crankcase heaters

High –low cut outs

Safe guard against short cycling of compressor

Insulated drain piping

Compressor and Fan motor starters with bi-mettalic overload relays with resting

Isolation valves for air cooled condensers in refrigerant lines

Expansion Valves

Vibration isolation Pads below the units

Double canvass connection b/w indoor unit and starting ducts

A snap acting type fixed differential double throw type air thermostat shall be provided to start and stop the compressor depending upon the air conditioned space requirements in addition to a manually operated switch. The thermostat shall be able to be adjusted from 18 0C to 260 0C with an increment of minimum 0.50C

All the moving parts in the units shall be mounted in the steel frame work with the help of suitable vibration isolators in order to ensure quite operation of the unit

8.0 Microvee filters (fine filters)

Microvee filters shall be of dry type. Filters media shall be made from washable nonwoven synthetic fibre replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminium frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiently of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.

9.0 High Efficiency Particulate Absolute (HEPA) Filters

HEPA filters shall be made in extended surface configuration of deep space folds of sub micron glass fibers. The filter media shall be housed in an aluminium sheet frame provided with double turned flanges and closed cell neoprene gasket. The filter media shall not absorb moisture, stretch, swell or undergo chemical change with moisture. The filter shall be resistant to fungus and bacterial growth. Filters shall be free from pin holes and other leaks.

The housing shall be designed to install the HEPA filters in the terminal locations in the false ceiling or in the duct plenum so that it is removed easily without risking the

infiltration of dust whatsoever. The arrangement for filters shall be strictly in accordance with the manufacturers recommendations and shall be approved by the engineer prior to fabrication and installation. The filters shall be protected with aluminium slotted protective grille from the bottom in case of installation of filters in false ceiling air terminals. All MS parts shall be derusted and shall be epoxy painted. The aluminium grilles shall be made from 1.6 mm aluminium sheets with minimum clear area of 60 percent. The grilles shall be anodised stove enamel painted as approved by the Engineer.

10.0 Refrigerant Piping:

The indoor and outdoor unit shall be interconnected by a suitable type seamless copper refrigerant liquid and suction lines using flared or brazed fittings. Necessary accessories shall be incorporated in the circuit.

Limitations:

The air velocity across the cooling coil shall not exceed 500 FPM.

The fan outlet velocity shall not exceed 1800 FPM.

The air velocity across the filters shall not exceed 500 fpm.

DUCTABLE SPLIT UNITS WITH AIR COOLED CONDENSERS

1.0 Scope

The scope of this section comprises the supply, installation, testing and commissioning of factory built self contained air cooled condenser type ductable split air conditioners complete in all respects and generally in conformity with these specifications, requirements of drawings Schedules of equipment and Bill of Quantities.

2.0 Components of Machines

Each ductable split air conditioners shall be complete with hermetic type compressor/s, DX type air cooled condenser, evaporator/ chiller, compressor motor, interconnecting refrigerant piping with valves and strainers etc. refrigerant controls and accessories, gauge panel, motor starters and electrical controls, safety controls and devices and first charge of refrigerant, oil etc.

3.0 Condensing Units

- 3.1 Each condensing units shall be complete unit with hermetic compressor/s, air cooled condenser, condenser fans with motors, internal piping , switches and internal wiring and shall be enclosed in a weather proof outdoor type housing.
- 3.2 The compressor shall be hermetic, with enclosed gas cooled motor. The compressors shall be suitable for R-134a / R-410a.
- 3.3 The condenser coil shall be air cooled type with aluminium fins and copper tubes and necessary refrigerant connections. The copper tubes shall not be less than 3/8" O.D.
- 3.4 The condenser air fans shall be propeller type direct driven, each complete with motor. The air quantity and area of the condenser shall be adequate for working in the specified out door conditions.
- 3.5 The casing shall be fabricated from galvanized steel, zinc phosphated and finished with baked enamel paint. The casing shall make the whole unit fully weather proof suitable for outdoor installation.
- 3.6 The unit shall include a remote control assembly with thermostat and starting and speed switches.
- 3.7 The necessary charge of refrigerant gas and lubricated oil shall be provided to run the system.

4.0 Ductable Cooling Unit:

- 4.1 The cooling unit shall be matched to the respective condensing unit and shall consist of cooling coil, blower, filters, outer casing, drain pan, accessories etc.

- 4.2 The cooling coil shall have copper tubes of not less than 3/8" o.d. and continuous aluminium plate fins with integral collars. The tubes shall be staggered in the direction of the air flow.
- 4.3 The fan section shall comprise of aluminium centrifugal blower/s, statically and dynamically balanced, motor, drive package, mounting arrangement etc.
- 4.4 The unit casing shall be made of galvanized steel, the casing shall be insulated to lower the noise level and eliminate condensation.

5.0 Refrigerant Piping

- 5.1 The condensing unit and evaporator unit shall be interconnected by type '1' seamless copper refrigerant liquid and suction lines using flared or brazed fittings. Necessary accessories shall be incorporated in the circuit.
- 5.2 Valves used in the Refrigerant piping shall be of the packed, back seated type and shall be of forged /cast brass/bronze construction. All joints of steel to steel piping shall be welded and steel to Brass/Copper shall be silver brazed. Care shall be taken to remove the burr and dirt from the pipe ends and form proper 'V' at the mating ends before welding.
- 5.3 Flare type compression fittings shall be allowed upto 15mm piping diameter only for which annealed copper tubing shall be used.
- 5.4 Refrigerant piping shall be complete with the following accessories (but not limited to)
 - 5.4.1) Hot Gas line muffler.
 - 5.4.2) Liquid line strainer cum drier with disposable type of cover, with a bypass line with valve.
 - 5.4.3) Liquid line sight glass.
 - 5.4.4) Liquid Line solenoid valve.
 - 5.4.5) Thermostatic expansion valve.
 - 5.4.6) Liquid line Refrigerant Grade valves as required.
 - 5.4.7) Shut off valves on compressor.
- 5.5 Refrigerant Suction Gas to liquid heat exchanger, if provided, shall be tube in tube type fabricated out of M.S. heavy class seamless pipes conforming to IS 1239.
- 5.6 The suction line shall be insulated with 6mm rubber foam insulation.

6.0 Fresh Air Take Arrangement

An adjustable manual damper of M.S. sheet along with bird screen, air inlet louvers shall be provided for fresh air entry.

7.0 Miscellaneous

- 7.1 The unit shall have control panel, housing the starting switches, contactor, relays etc.
- 7.2 Isolation pads shall be provided under the units
- 7.3 Drain line shall be provided from indoor unit upto drain point
- 7.4 Suitable M.S. angle iron supporting frame shall be provided for the condensing units and supporting arrangement for the indoor units.
- 7.5 Interconnecting power and control cabling shall be provided between condensing unit and evaporator unit and cabling between the main control panels to the units

8.0 Testing and Commissioning

- 8.1 The refrigeration system shall be thoroughly tested for any leaks by pressurising with dry nitrogen to a pressure of 350 PSIG. Each joint and flare connection shall be checked for any leakage with soap solution. Any leaks shall be rectified and the above process shall be repeated till no leak is detected. The pressure in the system should stand for 1 day.
- 8.2 The system shall then be vacuumized to 7.6mm Hg absolute and maintained at this level for 4 - 6 hours. Thereafter the vacuum pump shall be stopped and vacuum maintained for 24 hours. Pressure rise should not exceed 2.5mm of water absolute.
- 8.3 The vacuum shall then be broken with dry nitrogen and system again vacuumized to 7.6mm Hg maintained for 4 hours. This procedure shall be repeated for a third time before charging refrigerant gas.
- 8.4 The contractor shall set all safety and capacity controls and interlocks, properly and a record of all settings shall be furnished before commissioning the plants.
- 8.5 Testing and commissioning shall be carried out in the presence of Architect/Consultant or his representative to his entire satisfaction.

9.0 Painting

All equipments, including mounting frames and interconnected piping etc shall be painted with two coats of approved enamel paint.

HEATING & REHEATING SYSTEM

1. General:

The electric heating system and hot water heating system shall comply with the specifications as laid down.

2. Electric Heaters:

- 2.1 The heaters shall be enclosed type with external fins for heat radiation.
- 2.2 The heating element shall be of superior grade Nichrome wire of required resistance for the specified capacity.
- 2.3 The heating element shall be enclosed in aluminium sheet casing with suitable insulator blocks to prevent grounding.
- 2.4 The aluminium casing shall have aluminium fins spaced at least 4 inch. The fins should have a snug tight fit over the casing.
- 2.5 The heater terminals shall be secured at one end through insulated connectors.
- 2.6 The individual heater shall be secured at one end through insulated connectors.
- 2.7 The heater shall be supplied in sets of 3 heaters, for balanced loading of 3 phase and neutral supply.

3. Heater Frames :

Each bank of heaters shall be mounted on aluminium angle frame work of suitable size and length to suit the heaters.

4. Contactors :

Each bank or banks of heaters shall be controlled through a contactor of ample rating and having a 220 volt holding coil. The contractor shall be indication lamps etc. as specified. The heaters shall be interlocked electrically with the fan so that these are shut off in the event of fans break down.

5. **Heating Thermostats:**

Each group of heaters shall be controlled by one single stage for preheater and one two stage snap acting heating thermostat for reheaters.

6. **Humidistat:**

There shall be one snap acting dehumidifying humidistat in parallel with the single stage heating thermostat. They shall be used for reheater control in monsoon.

7. **Safety Thermostat:**

Each group of heaters in a unit shall be provided with a heating safety thermostat having manual reset.

8. **Controls:**

The safety thermostat and other controls shall be interlocked with the motor and shall be as specified under controls.

Pan Type Humidifier

Type :

The pan type humidifier shall be closed type and connected to the supply air duct for introduction of steam when required.

Construction

The body of the humidifier shall be fabricated out of stainless steel sheet at least 2mm thick with all joints welded with stainless steel welding rods and all edges rounded off. The pan shall be made completely air tight and leak proof. On top of the pan an openable cover shall be provided for maintenance of internal components.

The humidifier shall be externally insulated with Resin bonded fibreglass of density not less than 32 Kg/cub.m and then cladded with 0.8 mm thick aluminium sheet.

The humidifier shall have two chambers with two banks of heaters. One bank of heaters shall always remain ON when the AHU is in operation to maintain the temperature of water between 60 - 70 deg. C and the other bank should come on when there is signal from the humidistat for humidification.

The electric heaters shall be submersible type made out of incloy sheeth and brass/bronze flanges. The heaters shall be of suitable rating to produce instant steam when required.

Electrical panel (Pan type Humidifier)

The electrical panel box shall be made of 16 GCRC sheet and painted with heat and water resistant paint. All switchgears and internal components of the panel shall be of L&T/Seimens/EE make only.

Controls and accessories:

The humidifier shall be complete with following controls and accessories:

- a. Water proof light in the tank
- b. Water level indicator
- c. Low water level cut-off switch
- d. Float valve with bronze ball
- e. Make up , quick fill and drain connections
- f. Safety thermostats.
- g. Fault indication lamp.

AIR COOLED SPLIT AIR CONDITIONER

1 SCOPE

Scope of this sub-section comprises the supply, erection, testing and commissioning of Air-cooled split air conditioners confirming to these specifications and in accordance with the technical 'schedule of equipment' and 'bill of quantities'.

2. TECHNICAL SPECIFICATIONS

The split type air conditioners shall have an actual operating capacity as required in the specifications. The tenderer shall clearly indicate the MAKE/MODEL/ACTUAL capacity of the units under actual working conditions and also enclose the manufacturer's literature and clearly mark the models of the units and complete selection data.

3. CONDENSING UNITS

The condensing unit will be provided with single or two serviceable hermetically sealed compressors suitable for $415 \pm 10\%$ volts, 3 phase, 50 HZ. The unit will be capable of providing the specified design minimum refrigeration capacity at design ambient conditions, without the help of any addition of water. The unit should be suitable for location in the open exposed roof outside weather without any damage/rust in the casing and other parts.

The compressor shall be hermetic, with enclosed gas cooled motor. The compressor's shall be suitable for R-22.

The condenser coil shall be air cooled type with aluminium fins and copper tubes and necessary refrigerant connections. The copper tubes shall not be less than 1/2" O.D.

The condenser air fan(s) shall be propeller type direct driven, each complete with motor. The air quantity and area of the condenser shall be adequate for working in the specified outdoor conditions.

The casing shall be fabricated from galvanised steel, zinc phosphated and finished with baked enamel paint. The casing shall make the whole unit fully weather proof, suitable for outdoor installation.

The necessary change of refrigerant gas and lubricated oil shall be provided to run the system.

4. EVAPORATIVE UNIT

The evaporative unit shall be as specified in Technical Schedule of Equipment complete with cooling coil of adequate size, synthetic fibre cleanable filters minimum 25 mm thick with face velocity not exceeding 106 mpm, centrifugal blower. the casing shall be heavy gauge sheet smoothly finished and fully protected against rusting.

5. REFRIGERANT PIPING

The condensing unit and evaporator unit shall be interconnected by type '1' seamless copper refrigerant liquid and suction lines using flared or brazed fittings. Necessary accessories shall be incorporated in the circuit.

The suction line shall be insulated with 6 mm rubber foam insulation.

6. **MISCELLANEOUS**

The unit shall have control panel, housing the starting switches, contactor, relays etc.

Isolation pads shall be provided under the units.

Drain line shall be provided from a coil up to drain trap.

Suitable M.S. angle iron supporting frame shall be provided for the condensing unit and supporting arrangement for the indoor units.

Interconnecting power and control cabling shall be provided between condensing unit and evaporator unit

7. **INSTALLATION**

The proposed location of the condensing units and the evaporative units as shown in the tender drawings are tentative. Actual location will be decided in consultation with the architect and the refrigerant piping of lengths as required will be provided by AC contractor within the quoted price. The installation shall be carried out in accordance with the best engineering practices to the complete satisfaction of the consultant to ensure proper return, and installation free from vibration and noise considered objectionable. Apart from other operational and safety controls provision will be made for manual reset with HP/LP cut out and for non-recycling control relay.

8 **TESTING**

The actual refrigeration capacity of the evaporative unit as tested at site shall not be below the capacity under the specific conditions as contained in the manufacturer's literature forming a part of the contract - but in no case less than the capacity specified in the tender.

9. **PAINTING**

The AC contractor shall be responsible to restore the equipment to original condition in case of any scratches or damages to the equipment up to the time of the handing over the same to the owner.

10. **TECHNICAL DATA TO ACCOMPANY BIDS**

Tenderer shall submit with tender complete technical data for selection of various components supported by the relevant literature

VENTILATION FANS

1. General:

The ventilation fans shall be complete in all respects and shall generally comply with the following specifications given below:

2. Exhaust Fans:

- 2.1 The exhaust fans shall be propeller type with steel hub and blades, mounted directly on the shaft of a totally enclosed motor.
- 2.2 The fan blades shall be of pressed steel of aerofoil design for high efficiency and static pressure.
- 2.3 The mounting frame shall be of cast/sheet steel with steel brackets to connect the frame, with the fan/motor assembly. Rubber mounts shall be provided between the mounting frame and the mounting brackets.
- 2.4 The fan motor shall be to totally enclosed squirrel cage type.

3. Centrifugal Blowers:

- 3.1 The centrifugal blowers shall be double/single inlet, double/single width, non-overloading type, of suitable construction. The blower performance must be rated in accordance with approved test codes and procedures.
- 3.2 The blower housing comprising of scroll & side plates shall be accurately cut, heavy gauge all welded sectional construction and reinforced with angle bracings. Outlets shall be flanged to assure proper duct connections. Inlet cones shall be spun venturi type or curved vane type to ensure smooth air entry. The base frame shall be of angle iron in bolted/welded construction.
- 3.3 Impeller shall be fabricated from sheet steel with backward curved, properly designed blades, heavy c.i. hub and shall be both dynamically and statically balanced, to a close tolerance for quiet and vibration free performance.
- 3.4 Shaft shall be of hot rolled steel or forged steel, sized adequately, but in no case less than 40 mm dia-meter and shall be accurately ground and polished to a close tolerance.
- 3.5 Bearings shall be self aligning, heavy duty ball or tapered roller type with integral dust and grease seals.

- 3.6 After assembly, the complete fan shall be painted with rust proof primer and two coats of synthetic enamel paint.
- 3.7 Fan having wheel diameter of 1220 mm or more, shall be supplied with split, bolted housing for convenience of handling and installation.

4. **Blower Drive Assembly:**

- 4.1 Drive assembly for each blower shall consist of blower pulley, motor pulley, a set of 'V' belts, belt guards, and belt tension adjusting device.
- 4.2 Pulleys shall be selected to provide the required speed. They shall be multi-groove type, with section and grooves selected to transmit 33% more load than the required power and shall be statically balanced.
- 4.3 The belt guards shall be of m.s. sheet with angle iron reinforcement and expanded metal screen.

5. **Exhaust Blowers (Fan Section of AHU)**

- 5.1 The exhaust fans (fan section of AHU) shall be as described in under AHU.

6. **Motors and Starters:**

- 6.1 The motor for each blower shall be squirrel cage induction type and conform to specifications as given under section on control panel, motors and switchgear. The motor h.p. shall be at least 20% more than the limit load of fan and of minimum rating as given under 'Schedule of Equipments'.

7. **Limitation:**

The air velocity limits are as follows :

- 7.1 Velocity at blower outlet shall not exceed 12.5 mps.

8.0 **AXIAL FLOW FANS**

Casing shall be constructed of heavy gauge sheet steel. Casing shall be provided with hinged door enabling easy replacement of wheel, shaft and bearings. A small inspection door with handle and neoprene gasket shall also be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be de-rusted, cleaned, primed and finish coated with enamel paint.

- ii) Rotor hub and blades shall be of cast aluminium, or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blade mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control maybe manually readjustable at site, upon installation, for obtaining actual airflow values, as specified.
- iii) Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be in accordance with para 6.6. (V) and 13.9. The speed of fan shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1450 RPM for fans with impeller diameter of 450 mm and less.
- iv) Drive to fan shall be provided through belt drive with adjustable motor sheaves and belt guard or direct driven. Belt shall be oil resistant type.

CONTROLS

1.0 General

- 1.1 The various controls listed below shall be electrically operated and generally comply with the specifications listed below.
- 1.2 In case of low voltage controls, necessary step down transformers shall be provided with each control as required.

2.0 Modulating Humidistat

The humidistat for humidification shall be snap acting type as per clause 2.5.

2.1 Snap Acting Humidistat

The humidistat for humidification shall be snap acting type with an adjustable differential. The sensing element shall be horse of hair or other accurate device.

2.2 Reheat Thermostat

The reheat thermostat shall be 2 stage snap acting type for room mounting, with 1 deg. C differential.

2.3 Winter Heating Thermostats

The winter heating thermostat shall be to stage snap acting type for room mounting with 1 deg. c differential.

3 Refrigerant Control

3.1 Expansion Valve

The thermostatic expansion valve shall be with external equaliser lines and capillary with "Bulb" for producing super heat.

3.1 Solenoid Valves

The solenoid valve shall be pilot operated with packless seat to ensure leak proof shut off. The pressure drop across the valve shall not exceed 5 psig.

3.2 Temperature Control

- 3.2.1 The water temperature controller shall be snap acting capillary type with a range of 0° F. to 100° F. and a temperature differential of 2deg f adjustable in the field.

3.3 Safety Controls

3.3.1 Antifreeze Thermostat

The antifreeze thermostat shall be snap action type with a range of -12° c. to +10° c. It should be complete with a reset button to prevent restarting of the compressor.

3.3.2 High and Low Pressure Cutout

The high and low pressure cutout shall be of snap acting type with adjustable set point and differential and range suitable for R-22/R-134a pressure. The high pressure cutout should also have a reset button to prevent restarting of the compressor.

3.3.3 Oil Failure Switch

The oil failure switch if required shall be snap acting type with suitable adjustable range and differential and complete with reset button. It should also have a time delay relay for start up of the compressor.

4.0 Gauges

The water pressure gauges shall be of robust construction with minimum 100 mm dial, of suitable range and occupancy calibrated.

5.0 Thermometers

The thermometers shall be mercury filled industrial stem type, with metal casing and threaded fixing arrangement.

MOTOR & SWITCHGEARS MOTOR STARTERS CONTROL PANELS

1.0 General

The motors and switchgears required for various items shall generally be as per specifications given below. All electric motors shall be suitable for 3 phase, 50 cycles 415 volts A.C. supply.

2.0 Control Panel

2.1 These panels should be floor/wall mounted, sheet steel clad, modular construction, cubicle design, compartmentalised. These panels shall comprise of incoming & outgoing feeders (circuit breakers, fuse switch units/switch fuse units, contactor starters with overload relays, single phasing preventor etc. as indicated in the drawings.

2.2 The panels shall be provided wherever necessary with necessary interlocks designed to prevent incorrect operation and to ensure safety of operating personnel and equipment.

2.3 All feeders are to be operated from the front and they shall be interlocked suitably. Padlocking arrangement and interlock defeating device shall also be provided. Each module shall have separate door and partition plate. The feeder incomer switches shall be interlocking with the door so that the door can only be opened when switch is in 'off' position. The doors and covers shall be provided with thick gaskets to make it dust tight. All the door covers shall be provided with synthetic rubber gaskets to make it dust tight. Feeder name tags shall be provided.

2.4 Air Circuit Breaker and Fuse Switch Units

The circuit breaker shall be air break fully draw out type equipped with arc chutes and their face barriers of proper design. The continuous current rating of the circuit breakers shall be as given in the detailed technical specifications. The circuit breakers shall have a breaking capacity of 31 MVA at 415 volts, 50 hz ac & they shall be able to withstand full fault current for one second.

2.5 The circuit breaker shall be provided with manually operated spring closing mechanism. The operating mechanism shall be trip-free throughout the breaker travel. The breaker shall be equipped with inside 'on' & 'off' position indicator mechanism and so located that the position of the circuit breaker i.e. whether closed or open, is indicated on the front door of the compartment. The 'on' & 'off' trip indicating lights shall also be provided for each breaker feeder.

2.6 The moving portion of the circuit breaker shall be so interlocked that it is not possible to isolate it and draw out from the service position or to plug it in from the isolated position when the circuit breaker is closed. The interlock being provided shall be

such as to prevent operation of a circuit breaker unless it is fully plugged in or fully isolated and is locked correctly in either of the two positions.

- 2.7 The circuit breaker compartment doors shall be so interlocked as to prevent access to the breaker while in the plugged in position. However special means shall be provided for undoing this interlocked in an emergency.
- 2.8 The draw out feature shall clearly provided three distinct positions of the circuit breaker viz., 'service', 'test' & isolated. Inadvertent withdrawal of a circuit breaker removable unit too far beyond its supports shall be prevented by a suitably interlock, the design shall provide for the testing of breaker in the test positions i.e. when the breaker's moving unit is in fully disconnected position and the secondary circuit remains connected or energised. The secondary connections between the fixed and removable units shall be provided with means of spring loaded sliding type contacts to make the breaker fully draw out type.
- 2.9 The circuit breaker unit shall be provided with complete range of releases including the overload releases and release for short circuit protection.
- 2.10 The circuit breaker shall be provided with necessary auxiliary contacts with 2 No. spare contacts. All contacts shall be wired upto the terminal board.
- 2.11 The fuse switch unit shall be of load break heavy duty, industrial design and of double break pattern with quick make and quick break mechanism, however, the design shall be such that it shall ensure positive opening even if quick break action is lost due to spring stretching or breaking.
- 2.12 The 'on' and 'off' position of the switch handle shall be distinctly indicated and interlocks shall be provided to ensure that switch cover can not be opened unless the switch is in the 'off' position.
- 2.13 The fuse switch units shall be provided with non-deteriorating type of HRC cartridge fuse link and having rupturing capacity not less than 31 MVA at 415 volts.
- 2.14 All live parts inside switch shall be properly shrouded and inter phase barriers shall be provided. Design of the switch handles shall be such that they do not protrude out of the panel in the manner so as to prevent free passage of operating personnel. Design with normal conventional position of switch handle up in 'on' position & down in 'off' position shall be preferred.

2.15 **415 Volts Bus Bars**

The 415 volts main bus-bar shall have continuous current rating as indicated in the specification or equivalent standard rating of at least 50 percent of these of the phase bus bars. The bar and its connections shall be so arranged and supported as to withstand without any damage or deformation, the specific short-circuit current. The bus bars shall be braced and supported on reinforced fibre glass support and shall be of electrolytic grade type E 91e of IS: 5082. These bus bars shall withstand 43.12 ka for one second during short circuit conditions. The bus bars shall be colour coded with PVC tapes or insulating painting for identification purposes. The bus bars shall

be sleeved with special type heat shrinkable PVC sleeving.

- 2.15.2 The main three phase and neutral horizontal bus bar shall be located in top isolating chamber extending throughout the length of the switch board. Bus bars shall have withstand capacity of 43.12 ka RMS and shall be mounted on reinforced fibre glass supports at intervals suitable for prescribed conditions of short circuit and other standards. The neutral bus bar shall run all along the length of the board.
- 2.15.3 Power shall be distributed to the outgoing or incoming control units in each section by a set of vertical bus bars three phase and neutral. The vertical bus bars shall be isolated from control compartments by suitable metallic barriers or by insulating sleeve on each bus and supported in liberally designed reinforced fibre glass insulating plates spaced as per standards suitable joints shrouds detachable type shall be provided on bus bar joints.
- 2.15.4 Bus supports shall be resistant low absorption type moulded insulation of high impact strength and high creep age surface.
- 2.15.5 All bus work shall be braced to withstand without damage a short circuit current of 43.12 ka symmetrical for one second.
- 2.15.6 The vertical bus bars for different sets of panels shall be connection should not be painted.

2.16 **Instruments and Meters**

- 2.16.1 Current transformer shall comply with the requirements of IS: 2705. They shall have ratio outputs and accuracies as specified or required as shown in single line diagram.
- 2.16.2 All indicating instruments shall be of industrial pattern and should be provided as shown in the single line diagram.
- 2.16.3 All instruments shall be switch board type flush mounted with proper scale dimensions so as to be clearly visible to the operators standing on the floor. The instruments shall be provided with front of board zero adjuster shall be not preferably be mounted at heights lower than one meter and higher than two meters above the floor level.
- 2.16.4 The operating handles, meters, instruments etc. shall be mounted at the front of the switch board. Approved means shall be provided for locking the control switch/operating handles in the open position. For fuse switch gear section of the switch board, meters where specifications shall be mounted in such a manner that it is possible to readily identify the meters for individual units and the arrangements does not create hindrance to maintenance of individual units without having to shut down the bus.
- 2.16.5 All wires carried within the switch gear enclosure shall be PVC insulated and shall be neatly arranged to be readily accessible and to facilitate easy replacement. Only PVC copper cables shall be used for all power and control inter connections. The cables of 660 volts shall be used. Trained copper cables lugs shall be used. All small wires

shall be colour coded and provided with numbered ferrules for easy identification of circuits. As far as possible, each essential circuit shall be connected within the respective switch gear unit. Control wiring terminal shall preferably be near the panel.

3.0 Cable Termination

- 3.1 The cables entries and terminals shall be provided in the switch board to suit the number, type and size of aluminium conductor cables as given in the line diagrams. Cable entries shall be so designed as to avoid damage to cables and there shall be sufficient space to avoid short bending of cables. The positions of the cable lugs and terminals shall be such that the cable could be neatly drawn and connected through one meter deep trench below the switch gear and the jointing carried out in a convenient and satisfactory manner. The cable entry, design panel, cable boxes and terminals and their locations will have to be approved by the engineer/owner. However the access for cabling shall preferably be from the back of the switch board. The panels shall be provided with control transformers of suitable VA rating along with control bus and hr fuses from control supply to contractors.
- 3.2 The cables socket shall be of copper and of crimping type. Cables risers shall be adequately supported to withstand the effects of rated short circuit current without damage.
- 3.3 Cable glands of sizes as required shall be provided at all cable entry points in the bottom plate. The glands shall form part of switch board.

4.0 Indication

Each incoming and outgoing feeder units shall be provided with 'on' 'off' indicating lamps of standard conventional colour coding.

5.0 Subsidiary Panels

Subsidiary panels shall be provided wherever required such as AHU room, air washer room. The construction of these panels should be similar to the main panel and shall have all related accessories.

6.0 Contactor Starters

6.1 Star Delta Starter

The star delta starter shall be air break automatic contactor starter provided with main contactor, star contactor, delta contactor, timer and automatic change over from start to delta, bimetallic over load relay, operating coil, start/stop push button, single phasing preventor, auxiliary make and break contacts, indicating lamps etc. The contactor shall quick make, quick break, double break consisting of robust silver contacts. The coil voltage shall be 415 volts ac at 50 hz. The starter shall be provided with trip indication light and overload reset push button for overload relay.

6.2 **DOL Contactor Starter**

The contactor shall be air break type coil operate, dol contractor starter, provides with cables entries, ambient temperature compensated bimetallic over load relay, single phasing preventor, solenoid coil, start and stop push buttons, 8 auxiliary make and break contacts, indicating lamps etc. The contactors shall be quick make quick make and quick break, double break type consisting of robust silver contacts. The coil voltage shall be 440 volts at 50 c/s. The starter shall be provide with trip indication light and over load reset bush button for overload relay.

DUCT WORK AND OUTLETS

1.0. General

- 1.1 The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, exhaust system ready for operation as per drawings.
- 1.2 Except as otherwise specified all duct work and related items shall be in accordance with these specifications.
- 1.3 Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

2.0 Duct materials

- 2.1 The ducts shall be fabricated from galvanized steel sheets class VIII GSS sheets conforming to IS:277-1962 (revised) or aluminium sheets conforming to IS:737-1955 (wherever aluminium ducts are specified) .
- 2.2 All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in is: 655-1963 with amendment-i (1971 edition)

The thickness of the sheet shall be as follows: -

	size of duct	sheet thickness		type of joints	bracing if any
		GI	Aluminium		
2.2.1	Upto 750mm	0.63 mm	0.80 mm	GI flange	
2.2.2	751 mm to 1000 mm	0.80 mm	1.00 mm	25x25x3 mm angle iron frame with 8 mm dia. nuts & bolts.	25x25x3 mm at the rate of 1
2.2.3	1001 mm to 1500 mm	0.80 mm	1.00 mm	40x40x5 mm angle iron frame with 8 mm dia. nuts & bolts.	40x40x3 mm at the rate of 1
2.2.4	1501 mm to 2250 mm	1.00 mm	1.50 mm	50x50x5 mm angle iron	40x40x3 mm at the rate of 1.2

to be cross
braced
diagonally with 10
mm dia nuts &
bolts at 125
mm centre.

- 2.2.5 2251 mm and
above 1.25 mm 1.80 mm 50x50x6 mm 40x40x3 mm at
angle iron the rate of 1.6
frame with
10 mm nuts
& bolts at
125 mm centre.

- 2.3 The gauges, joints and bracings for sheet metal duct work shall further conform with the provisions as shown on the drawings.
- 2.4 Ducts larger than 450 mm shall be cross broken, duct sections upto 12 00 mm length may be used with bracing angles omitted.
- 2.5 Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 deg. Angle from the axis of the main duct unless otherwise approved by the engineer-in-charge.
- 2.6 All ducts shall be supported from the ceiling/slab by means of M.S..rods of 9 mm (3/8") dia with M.S. angle at the bottom.

3.0. Installations

- 3.1 During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of engineer-in-charge.
- 3.2 Great care should be taken ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.
- 3.3 All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. all joints shall be tight and shall be made in the direction of air flow.

The ducts shall be reinforced where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

- 3.4 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice the sheet metal gauges and fabrication procedures as given in IS specifications shall be adhered to and shall be considered as an integral part of these specifications.

- 3.5 The duct work shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted airconditioning duct design and subject to the approval of the engineer-in-charge. The contractor shall verify all measurements at building and shall notify the engineer-in-charge of any difficulty in carrying out his work before fabrication.
- 3.6 Sponge rubber of approved equal gaskets shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. sheet metal connections shall be made to walls and floors by means of galvanized steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. sheet metal connections shall be as shown in the drawings or as directed by engineer-in-charge.
- 3.7 The ducts shall be supported from the structure by means of suitable supports grouted in the R.C.C. work. The type of support should meet the approval of the engineer-in-charge and should involve minimum damage or breakage. In no case the duct will be rested upon the false ceiling/boxing or on supports grouted in the wall.
- 3.8 Flanges and supports are to be black, mild steel and are to be primer coated on all surfaces before erection and painted with aluminium thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
- 3.9 Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by engineer-in-charge.
- 3.10 Joints requiring bolting or riveting may be fixed by hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All fixing must have a permanently non-corrosive finish such as cadmium plating or galvanizing as appropriate. Spot welds and bronze welds are to be coated on all surfaces with zinc rich paint, as approved by engineer-in-charge.
- 3.11 The flexible joints are to be fitted to the suction and delivery of all fans the material is to be normally double heavy canvass or as directed by engineer-in-charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.
- 3.12 The flexible joints are to be not less than 75 mm and not more than 250 mm between faces.
- 3.13 The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

4.0 Dampers

- 4.1 At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided. Dampers shall be two gauges heavier than gauge of the

large duct, and shall be rigid in construction to the passage of air.

- 4.2 The volume dampers shall be of an approved type, lever operated and complete with locking devices which will permit the dampers to be adjusted and locked in any positions.
- 4.3 The dampers shall be of splitter, butterfly or louver type. the damper blade shall not be less than 1.25 mm (18) gauge, reinforced with 25 mm angles 3 mm thick along any unsupported side longer than 250 mm angles shall not interface with the operation of dampers, nor cause any turbulence.
- 4.4 Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.5 mm steel and blades shall not be over 225 mm wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 mm thickness with fine mesh spacing.
- 4.5 Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and thumb screw lock. Provide damper rod and damper block with upset screws.
- 4.6 After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.
- 4.7 The fire dampers shall be provided wherever shown on the drawings. The damper shall be multi blade type as per drawings. The blades shall be minimum 1.6 mm thick mild steel. The frame shall be of 1.6 mm thickness. Other materials shall be as per the drawings attached and shall include return spring, locking device, fusible link etc.

5.0 Access panel

A hinged and gasketed access panel shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct work.

6.0 Miscellaneous

- 6.1 All ducts above 450 mm are to be cross broken to provide rigidity to the ducts.
- 6.2 All duct work joints are to be true right angle or approaching with all sharp edges removed.
- 6.3 Sponge rubber gaskets also to be provided behind the flange of all grilles.
- 6.4 Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.
- 6.5 Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by engineer-in-charge.

- 6.6 Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.
- 6.7 Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations additional supports are to be provided where required for rigidity or as directed by engineer-in-charge.
- 6.8 The ducts should be routed directly with a minimum of directional change.
- 6.9 The duct work shall be provided with additional supports/hangers, wherever required or as directed by the engineer-in-charge, at no extra cost.
- 6.10 All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of aluminium paint after the erection, at no extra cost.
- 6.11 All angle iron flanges to be welded electrically and holes to be drilled.
- 6.12 All the angle iron flanges to be connected to the GSS ducts by rivets at 100 mm centres.
- 6.13 All the flanged joints, to have a 4 mm thick felt packing stack to the flanges with shellac varnish. the holes in the felt packing are to be burnt through.
- 6.14 The G.S.S. ducts should be lapped 6 mm across the flanges.
- 6.15 The ducts should be supported by approved type supports at a distance not exceeding 2.4 metres.
- 6.16 Sheet metal connection pieces, partitions and plenums required, shall be constructed of 1.25 (18 gauge) sheet thoroughly stiffened with 25 mm x 25 mm angle iron braces and fitted with access doors.

7.0 Grilles

- 7.1 The supply and return air grilles shall be fabricated from aluminium extruded sections the supply air grilles shall have single/double louvers. The front and rear louvers shall be of extruded section, fixed/adjustable type the return air grille shall have single horizontal extruded section fixed louvers the grilles may or may not be with an outer frame.
- 7.2 The grilles shall have opposed blade dampers of GI. black sheets, which shall be key operated from the grille face wherever required.
- 7.3 The damper blades shall be of 0.80 mm (22 gauge) G.I. black sheets and shaped to form air tight joints the frame work for dampers shall be fabricated from 1.00 mm (18 gauge) M.S. black sheet the grill flange shall be fabricated out of 25 x 25 x1.5 mm aluminium angle grilles longer than 450 mm shall have intermediate supports for the horizontal louvers.

8.0 Diffusers

- 8.1 The ceiling type round or square diffusers shall be of extruded aluminium sections with flush or step down face, as specified with fixed pattern and round neck.
- 8.2 The diffusers shall be die formed for proper air diffusion.
- 8.3 All supply diffusers shall be provided with m.s. sheet dampers, with knurled knobs for adjustment from the bottom.

9.0 Linear Grille

- 9.1 The linear grille shall be of extruded aluminium sections flush mounted with single or double direction air flow adjustment louvers..
- 9.2 The diffusers shall be die formed for proper air diffusion.

11.0 Painting

- 11.1 All grilles, and diffusers shall be anodised or powder coated as per the requirements of the interior decorators to the approved colour to suit the interiors
- 11.2 All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matt finish.
- 11.3 All grilles, diffusers and registers shall be provided with rubber gasket between flanges and the wall or ceiling.

12.0 Testing

- 12.1 After completion, all duct system shall be tested for air leakage.
- 12.2 The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance of air quantity through each outlet shall be submitted to the engineer-in-charge for approval.

PIPE WORK

1. General:

All piping work shall conform to quality standards and shall be carried out as per specifications and details given hereunder: -

2. Arrangement and Alignment of Piping:

- 2.1 All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the engineer-in-charge.
- 2.2 The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.
- 2.3 All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route this contractor shall reroute his pipes as required to avoid interference, at the discretion of the engineer-in-charge.
- 2.4 All piping shall be carefully installed to provide for proper alignment, slope and expansion.
- 2.5 The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.
- 2.6 Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.
- 2.7 Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor excessive in length, but shall be installed neatly, carefully bent at all changes in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.
- 2.8 The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

3. Testing:

- 3.1 In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall the piping, equipment or appliances be subjected to pressures exceeding their test ratings.
- 3.2 The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank-offs or flanges.

- 3.3 After tests have been completed the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.
- 3.4 All piping shall be tested to hydraulic test pressure of at least one and half times the maximum operating pressure but not less than 10 kg/sq.cm for a period of not less than 12 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the engineer-in-charge, without any extra cost.
- 3.5 All the piping systems shall be tested in the presence of the engineer-in-charge or their authorised representative. Advance notice of test dates shall be given and all equipments, labour, materials required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire systems are found to be satisfactory to the above authority. The tests shall be carried out for a part of work if required by engineer-in-charge in order to avoid hindrance in the work of the insulation contractor.
- 3.6 All steam and condensate pipes shall be tested and proven tight under hydrostatic pressure of 20 kg/sq. cm, unless otherwise stated, for a minimum period of 4 hours without drop in pressure.
- 3.7 Miscellaneous piping, tests with air at 10.5 kg/sq.cm for a minimum of 24 hours without drop in pressure.
- 3.8 The contractor shall make sure that proper noiseless circulation is achieved through all piping systems. If due to poor bond, proper circulation is not achieved, the contractor shall bear all expenses for carrying out the rectification work including finishing of floors, walls and ceiling damaged in the process of rectifications.
- 3.9 The contractor shall provide all labours and materials to make provision for removing water and throwing it at the proper place, during the testing or/and after the testing to avoid damages to employer or other contractors ' properties. Any damages caused by the contractor to the employer or other contractors' properties, shall be borne by the contractor.

4. **Copper Piping:**

- 4.1 Heavy gauge soft copper tubing, type m shall be used to make connections to equipment, wherever required or specified by engineer-in-charge.
- 4.2 Flare fittings e.g. flare nuts, tees, elbows, reducers etc. shall all be of brass.

5. **Refrigerant Piping:**

- 5.1 The refrigerant circuit piping shall be heavy class m.s the fittings shall be heavy class. The pipes and fittings shall be connected by means of welded joints. The connections to gauges, controls etc. shall be with soft copper tubing and flare fittings.
- 5.2 The refrigerant valves, required in the circuit shall be as follows.

	Valve Size	Valve Material	Type of Connections
5.2.1	upto 12 mm	brass/packless type	flare fittings
5.2.2	16mm & above	brass/steel packed type	brazed/welded

Note :- all valves shall be tested against leaks upto 20 kg/sq.cm.

5.3 The strainers for the refrigerant liquid line shall be 'y' type with gun metal body and bronze filter screen of fine mesh. The filter screen shall be easily removable type without dismantling the strainer from the circuit.

5.4 The moisture indicator in the liquid line shall have leak proof glass on opposite sides to permit easy inspection of the liquid refrigerant.

6. **Drain Piping:**

6.1 The drain piping shall be medium class galvanised steel as per is 1239/1979.

6.2 The fittings shall be of 'R' brand or equal forged with screwed connections.

6.3 The gate valves shall be of gun metal as described earlier.

6.4 Pipe crosses shall be provided at bends, to permit easy cleaning of drain line.

6.5 The drain line shall be provided upto the nearest drain trap and pitched towards the trap.

6.6 Drain lines shall be provided at all the lowest points in the system, as well as at equipments, where leakage of water is likely to occur, or to remove condensate and water from pump glands.

7. **Painting:**

7.1 All pipes supports, hangers, etc., shall be given two coats of red oxide primer.

7.2 All pipes, which are not to be insulated, shall then be given one coat of finish paint, of a type and colour, as approved by the engineer-in-charge.

INSULATION

1.0 General

The insulation of water piping, air handling units, ducting, chillers etc., shall be carried out as per specifications given below:

2.0 Materials

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere.

2.1 Pipe Insulation

The insulation for chilled water/ hot water and drain piping, chillers, pump etc. shall be carried out from 'TF' quality expanded polystyrene having a 'K' value of 0.014 kcal/hr/°C at mean temperature of 10°C and a density of 20 to 24 kgs/ cub.m.

2.2 Other Insulation

2.2.1 The material for acoustic treatment of ducts, rooms, roofs etc. shall be resin bonded fibre glass, as described earlier, conforming to I.S. 8183 of 1976. the density of fibre glass shall be 32 kg/cub.m and the material shall be in the form of slabs of uniform density. The 'K' value at 10°C. shall not be less than 0.028 kcal/mhr/°C. Facing shall be provided with 0.5 mm perforated aluminium sheet held with G.I. nuts bolts or nailed to the batten work as required.

2.2.2 The materials for duct insulation shall be resin bonded glass wool, as described earlier but conforming to I.S. 8183 of 1976. The density of insulation shall not be less than 24 kg/cub/m. and material shall be in the form of blankets/rolls of uniform thickness. The 'K' value at 10°C. shall not be less than 0.03 kcal/m hr/deg.C.

3.0 Air Handling Units

3.1 The casing of the sheet metal type air handling unit from the beginning of the fan section till the end of the coil section, including the drain pan, shall all be insulated.

3.2 The insulation shall be 12 mm polyethylene flexible sheets.

3.3 The insulation shall first be fixed to the casing by applying cold sticking compound both to the surface and the insulation and all joints shall be sealed completely.

4.0 Cold Equipment Insulation

4.1 The complete shell of the Chiller as well as its two heads, the chilled water pumps, and high pressure AHU's shall all be insulated.

4.2 The insulation shall be 'TF' quality expanded polystyrene as below:

i) Chillers - 100 mm

ii) High pressure AHUs - 50 mm

iii) Chilled water pumps - 50 mm

4.3 All insulation excepting Chiller heads shall be covered with 0.63 mm 12 mm wire netting and finished with 12 mm thick sand cement plaster.

4.4 The insulation on the two end heads of the Chiller shall be covered with 0.80 mm G.I. casing to permit easy removal.

4.5 **Insulation (Chiller)**

4.5.1 The cooler surface shall first be cleaned with wire brush.

4.5.2 Then one layer of cold setting compound shall be applied.

4.5.3 The insulation shall then be fixed in two layers, staggering the joints and sealing them with cold setting adhesive.

4.5.4 The insulation shall then be covered with 0.63 mm 19 mm mesh wire netting which shall be fixed to the insulation with brass 'U' nails.

4.5.5 The final finish shall be 12 mm sand cement plaster which shall be applied in two layers of 6 mm each and trowelled to a smooth round finish.

4.5.6 After the insulation is fixed on the head as above, it shall then be covered with a properly shaped jacket of 0.80 mm G.I. sheet. Pump casing shall be finished with aluminium cladding.

4.6 **Insulation (Others)**

The AHUs and the chilled water pumps shall be insulated as above in 4.5 and finished with plaster excepting that the insulation of 30 mm shall be fixed in a single layer.

5.0 **Chilled/Hot Water Piping/Drain Piping**

5.1 The chilled/hot water and drain pipes shall be insulated with 'TF' quality expanded polystyrene. The thickness of the insulation for chilled/hot water pipes will be 50 mm and for drain pipes will be 25 mm.

5.2 Preformed pipe sections shall be used for pipes up to and including 350 mm dia.

5.3 Pipes above 350 mm dia. shall be insulated with insulation slabs cut in mitred sections.

5.4 **Installation**

Chilled/Hot Water and Drain Piping

- 5.4.1 The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.
- 5.4.2 The pipes shall be treated with a coat of cold setting compound.
- 5.4.3 The insulation preformed section shall be fixed tightly to the surface taking care to seal all joints.
- 5.4.4 All joints along the circumference of the pipe sections shall be sealed with adhesive.
- 5.4.5 The insulation than shall be covered with 0.63 mm x 19 mm mesh wire netting than finally finished with 12 mm sand cement plaster in two layers of 6 mm each and given to a smooth round finish.
- 5.4.6 Insulation on pipes in areas exposed to weather or underground shall additionally be covered with tar-felt sheets manufactured by shalimar tar products (1935) ltd. and fixed with G.I. wires of 1.0 mm. The tar felt sheet shall be stuck with bitumen r 85/25.

6.0 Refrigerant Piping

- 6.1 The suction line of refrigerant piping shall be insulated with 50 mm thick expanded polystyrene as specified for chilled/hot water pipe lines.

7.0 Ducting

- 7.1 The air handling ducts shall be insulated with resin bonded glass wool with density not below 24 kg/cub.m.
- 7.2 Duct insulation thickness shall be as follows:

Duct in conditioned space	-	25 mm thick
Duct in unconditioned space	-	50 mm thick
Duct with treated fresh air	-	50 mm thick

7.3 Installation

- 7.3.1 Clean the surface with a wire brush and make it free from rust and oil.
- 7.3.2 Apply one coat of cold setting compound.
- 7.3.3 Wrap the duct with insulation blankets of the thickness mentioned in item 7.2 above and then with 250 g polythene sheet and covered with 0.1mm thick .aluminium sheet using 50 mm wide aluminium adhesive tape of Johnson make.
- 7.3.4 Reinforce and tie with G.I. wire of 1.0 mm at intervals of 450 mm.

7.3.5 The ducts in areas exposed to the weather shall be additionally covered with one layer of tar felt b.h. the tar felt shall be stuck with bitumen r 85/40 or 80/25.

8.0 Acoustic Lining

8.1 The acoustic lining shall consist of 25 mm resin bonded glass wool board of density 48 kg/cub.m (min) then it shall be covered by 0.5 mm perforated aluminium sheets having 3 mm perforation at 6 mm centres.

8.2 Installation

8.2.1 The duct surface shall first be cleaned from inside.

8.2.2 The insulation boards shall be wrapped in glass cloth of 7 mil thickness with the end stitched.

8.2.3 Then the boards shall be fixed inside the duct.

8.2.4 The insulation shall then be covered with 0.5 mm perforated aluminium sheets.

8.2.5 The sheet and the insulation shall be secured to the duct by means of cadmium plated bolts, nuts and washers. The ends should be completely sealed off, so that no insulation material is exposed.

9.0 Walls and Ceiling Acoustic Treatments of Plant Rooms and A.H.U. Room

9.1 Material

Resin bonded glass wool of density 32 kg/cub m of 50mm thickness.

10.0 Installation

10.1 Fix 40 mm x 50 mm g.i. sheet channel at 0.5 mtr interval longitudinally then fix cross battens at 1.0 mtr centre using suitable gutties, and brass screws. The battens & gutties shall be treated with fire retardant chemical before fixing.

10.2 Fill each rectangle with 50 mm glass wool wrapped in glass cloth.

10.3 Tie with 24 gauge G.I. wires at 300 mm intervals.

10.4 Then cover with 26 gauges (0.50 mm) perforated G.I. sheet having 3mm perforations at 6 mm centres. Overlap all joints and provide beading of 25 mm by 2 mm flats.

ELECTRIC WIRING

1.0 General

The electric wiring of motors for compressors, pumps, air handling units etc. As well as controls, heaters etc. and earthing of all equipment shall be carried out as per specifications given hereunder.

2.0 Wiring for Motors, Heaters etc.

2.1 The wiring for above equipment shall be carried out in pvc armoured cables conforming to I.S.:1554.

2.2 The PVC armoured power cable for use on 415 volts system shall be 3 or 3.5 core with aluminium conductors and be of 1100 volts grade, as per is 1554 part is-1964. The cross section of the cable shall be to suit the load or rating of the equipment. The cable shall be aluminium conductor PVC insulated single wire/strip armoured with overall PVC sheathing.

2.2.1 The cables shall be laid as per I.S. -1255/1967, Indian standard code of practice.

2.2.2 The cables shall be laid, as per drawings or along a short and convenient route between switch board and the equipment, either in trenches, on wall or on trays. Hangers, supported from the slab. Cable routing shall be checked on the site to avoid interference with structure, equipment etc. Where more than one cables are running close to each other, proper spacing should be provided between them Cables shall be laid in suitable metallic trays suspended from ceiling, or mounted on walls, or laid directly in ground or clamped on structures, as may be required. Cable ducts shall not be provided in plant rooms. Cable trays shall be fabricated from slotted angle/solid angles to make ladder type cable tray, designed with adequate dimensions for proper heat dissipation and also access to the cables. Alternatively, cable trays may be of steel sheet with adequate structural strength and rigidity, with necessary ventilation holes therein. In both the cases, necessary supports and suspenders shall be provided by the Air-conditioning Contractor as required.

2.2.3 The radius of bends of the cable should not be less than 12 times the radius of cable to prevent undue stress and damage at the bends, the cables should be supported and fixed on M.S. supports, when running in trenches, wall or ceiling suspended hangers when laid under ground the cables should be covered with sand and protected with cement concrete covering. Suitable G.I. pipe shall be used wherever cable is laid across road, crossing of other services and when passing through R.C.C.

2.2.4 Wooden bushes shall be provided at the ends of pipes through which cables are taken.

3.0 Control Wiring

3.1 Control cables shall be 1100 volts grade as per is 1554 with copper conductor of 2.5 sq mm PVC insulated single wire/strip armoured with an overall PVC sheathing as per is 1554.

3.2 The cabling shall be carried out as per details given under 2.2 above.

4.0 Earthing

4.1 Pipe Earth Electrode

G.I. pipe shall be of medium class 40 mm dia 4.5 m long in length. Galvanising of the pipe shall conform to relevant is. G.I. pipe electrode shall be cut tapered at the bottom and provided with holes of 12 mm dia drilled not less than 7.5 cm from each other upto 2m of length from bottom. The electrode shall be buried in the ground vertically with its top not less than 20 cms below ground level.

4.2 Plate Earth Electrode

4.2.1 For plate electrode minimum dimensions of the electrode shall be as under:

- i. G.I. plate electrode : 60cm x 60cm x 6mm thick.
- ii. Copper plate electrode : 60cm x 60cm x 3mm thick.

4.2.2 The electrode shall be buried in ground with its faces vertical and top not less than 3 m below ground level.

4.2.3 In case of plate earth electrode a watering pipe of 20 mm dia of medium class GI pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on top of this pipe for watering the earth. In case of pipe electrode a 40mm x 20mm reducer shall be used for fixing the funnel. The watering funnel attachment shall be housed in masonry enclosure of not less than 30cm x 30cm x 30cm. A cast iron/ms frame with cover having locking arrangement shall be suitable embedded in the masonry enclosure.

4.3 Loop Earthing

4.3.1 Loop earthing shall be providing for all mountings of main board and other metal clad switches and db's with G.I. strip of size specified but not less than 14 swg copper or 12 swg gi or 4 sq mm aluminium wite. The earthing lead from electrode owner's shall be suitably protected from mechanical injury by a 15 mm dia GI pipe in case of wire and 40 mm dia medium class G.I. pipe in case of strip. Metallic covers or supports of all medium pressure or ht apparatus or conductor shall in all cases be connected to not less than two separate and distinct earths.

4.3.2 All equipment connected with electric supply shall also be provided with double earthing continuity conductors. The size of G.I. earthing conductors shall be :-

Earthing should be carried out as per IS-3043

Size of phase wire Sq.mm.	Size of G.I. conductor aluminium tape/wire (swg)
185	25 mm x 4 mm (strip)
150	25 mm x 4 mm (strip)

120

20 mm x 3 mm (strip)

Size of phase wire sq.mm	Size of G.I. conductor aluminium tape/wire (swg)
95	20 mm x 3 mm (strip)
70	4 swg
50	4 swg
35	6 swg
25-6	6 swg
4	8 swg

5.0 Miscellaneous

- 5.1 The final connections to the equipment shall be through flexible connections where the equipment is likely to be moved back and forth, such as on slide rails.
- 5.2 An isolator switch shall be provided at any motor which is separated from the main switch panel by a wall or partition or other barrier or is more than 15 metres away from the main panel.
- 5.3 Two separate and distinct earthing conduits shall be connected from the equipment upto the main switch board panel.
- 5.5 All exposed hangers etc. shall be given 2 coats of suitable paint of approved colour, when all work has been completed.

TESTS AT SITE

1.0 General

The contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the architect, in accordance with the provisions of the applicable ASHRAE standards or approved equal and furnish necessary test certificates from manufacturers.

2.0 Compressors Condensers/Chillers/Evaporators/Pumps etc.

- 2.1 Identification of materials in accordance with test certificates.
- 2.2 Inspection of various laboratory test certificates for physical properties and technical composition conducted on test samples of materials to be used for fabrication, forgings etc. for all important components of various equipment.
- 2.3 Hydraulic test for various components and assembled equipments at 1.5 times design pressure or double the operating pressure whichever is higher.
- 2.4 Pneumatic leak test after assemblies at design pressure
- 2.5 Static and dynamic balancing on electronic precision machine for rotating parts, links, impeller/crank shaft assemblies etc.
- 2.6 Inspection of assemblies and dis-assemblies of various parts of equipments and complete equipments themselves as desired by inspection engineer.
- 2.7 Noise level test for various rotating/reciprocating equipments.
- 2.8 Pressure drop test for condenser, chiller and evaporator.
- 2.9 Inspection of manufacturer's test certificates shall be supplied for all electrical motors.
- 2.10 Inspection of welding including welders qualifications as desired by inspection engineers.
- 2.11 For compressor assembly, electronic leak, air running test, pneumatic test with dry nitrogen and leak test in water.

3.0 Ductable Split Type Air Conditioners

3.1 Blowers

- 3.1.1 Identification of material in accordance with test certificates.
- 3.1.2 Dynamic/static balancing of impeller.
- 3.1.3 Performance test as per applicable codes.

3.2 **Coils**

3.2.1 Identification of material in accordance with test certificates.

3.2.2 Pneumatic test.

3.3 **Filters**

3.3.1 Manufacturer's test certificates also to be produced for the assembled A.H.U. final dimensional check will be done. Inspection will be done during assembly of components for quality of workmanship, painting etc.

Piping : materials check for specifications and size.

3.4 **Valves**

Hyd./Pneumatic test certificates.

3.5 **Motors**

Manufacturer's test certificate as per motor data sheet.

3.6 **Instruments and Controls**

Visual examination for operation.

4.0 **For Associates Works at Site**

4.1 All electrical items will be subjected to inspection at any stage during manufacturing activity. Routine electrical test as per relevant codes. Inspection of manufacturer's test certificates.

4.2 Inspection of raw materials to be used for fabrication and assembly and inspection of manufacturer's certificates.

4.3 Inspection of welding including welders qualification as desired by inspection engineers. Inspection of fabricated items.

4.4 Pressure testing of pipe fit used for the refrigerant and water services.

4.5 Pressure testing, leak testing of complete piping network for chilled water. Condenser water and refrigerant/services.

4.6 Vacuumising and gas/oil charging for refrigeration system.

4.7 Checking of electrical circuits (power & controls) and checking functioning of controls of refrigerant systems and other circuits of air conditioning plant.

4.8 Checking of calibration of controls and instrumentation

- 4.9 Checking of assemblies for electrical control panel, instruments panels, local panels (dimensional and functional) annunciator panels etc.
- 4.10 Inspection of complete electrical installation at site.
- 4.11 Installation of main equipments like compressor, condenser, chiller, evaporator.
- 4.12 Performance testing of complete A/C plant as per specifications.

5.0 The above inspection procedure is given for general guidance and information of vendors and inspection of purchaser/consultant is strictly not limited to these and inspection engineer of purchaser/consultant will have full right to have detailed inspection at any stage right from placement of order to completion of project as desired by inspection engineer, co-ordination of inspection agency of purchaser/consultant with his factory/sub-vendor's factory/erection site will be the sole responsibility of successful vendor after placement of order for complete air conditioning plant covered under these technical specifications.

6.0 Piping System

- 6.1 In general pressure tests shall be applied to piping only before connection of equipment and appliance. In no case shall piping, equipment or appliances be subjected to pressure exceeding their test ratings.
- 6.2 Tests shall be completed and approved before any insulation is applied.
- 6.3 After tests have been completed, the system shall be drained and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fittings, and debris.

7.0 Duct Work

- 7.1 All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus five percent (5%) of fan capacity.
- 7.2 Fire dampers, volume dampers and splitter dampers shall be tested for proper operation.

8.0 Balancing and Adjustment

All air handling ventilation equipment, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities indicated, at each inlet and outlet, on the drawings. If these air quantities cannot be delivered without exceeding the speed range of the sheaves or the available horse power, the architect shall be notified before proceeding with the balancing of air distribution system.

9.0 Electrical Equipment

- 9.1 All electrical equipment shall be cleaned and adjusted on site before application of power.

- 9.2 The following tests shall be carried out :
 - 9.2.1 Wire and cable continuity tests.
- 9.3 Insulation resistance tests, phase to phase and phase to earth, on all circuits and equipment, using a 500 volt meggar. The meggar reading shall be not less than one megohm.
- 9.4 Earth resistance between conduit system and earth must not exceed half (1/2) ohm.
- 9.5 Phasing out and phase rotation tests.
- 9.6 Operating tests on all protective relays to prove their correct operation before energising the main equipment.
- 9.7 Operating tests on all starters, circuit breakers, etc.

10.0 Performance Tests

- 10.1 The installation as a whole shall be balanced and tested upon completion, and all relevant information, including the following shall be submitted to the architects.
 - 10.1.1 Air volume passing through each unit, duct, grilles, and apertures.
 - 10.1.2 Differential pressure readings across each filter, fan and coil, and through each pump.
 - 10.1.3 Static pressure in each air duct.
 - 10.1.4 Electrical current readings, in amperes of full and average load running, and starting, together with name plate current of each electrical motor.
 - 10.1.5 Continuous recording over a specified period, of ambient wet and dry bulb temperatures under varying degrees of internal heat loads and use and occupation, in each zone of each part of the building.
- 10.2 Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream "on-coil" of each cooling coil. Also suction temperatures and pressures for each refrigerating unit. The current and voltage drawn by each machine.
- 10.3 Any other readings shall be taken which may subsequently be specified by the architect.

11.0 Miscellaneous

- 11.1 The above tests are mentioned herein for general guidance and information only but not by way of limitation to the provisions of conditions of contract and specification.
- 11.2 The date of commencement of all tests listed above shall be subject to the approval of the architect, and in accordance with the requirements of this specification.

- 11.3 The contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the architect requests such a test for determining specified or guaranteed data as given in the specification or on the drawings.
- 11.4 Any damage resulting from the tests shall be repaired and/or damaged material replaced, all the satisfaction of the architect.
- 11.5 In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.
- 11.6 The contractor must inform the architect when such tests are to be made, giving sufficient notice, in order that the architect or his nominated representative may be present.
- 11.7 Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the architect.
- 11.8 The contractor may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the architect, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

MODE OF MEASUREMENTS

1.0 Unit Prices in the Schedule of Quantities

- 1.1 The item description in the schedule of quantities is in the form of a condensed resume. The unit price shall be held to include every thing necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.
- 1.2 The unit price of the various items shall include the following:
 - 1.2.1 All equipment, machinery, apparatus and materials required as well as the cost of any tests which the consultant may request in addition to the tests generally required to prove quality and performance of equipment.
 - 1.2.2 All the labour required to supply and install the complete installation in accordance with the specifications.
 - 1.2.3 Use of any tools, equipment, machinery, lifting tackle, scaffolding, ladders etc. Required by the contractor to carry out his work.
 - 1.2.4 All the necessary measures to prevent the transmission of vibration.
 - 1.2.5 The necessary material to isolate equipment foundations from the building structure, wherever necessary.
 - 1.2.6 Storage and insurance of all equipment apparatus and materials.
- 1.3 The contractor's unit price shall include all equipment, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

2.0 Measurements of Sheet Metal Ducts, Grilles/Diffusers etc.

2.1 Sheet Metal Ducts

- 2.1.1 All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars, vanes & other fittings. Gaskets, nuts, bolts, vibration rotation pads are included in the basic duct items of the BOQ.
- 2.1.2 The unit of measurements shall be the finished sheet metal surface area in metres squares. No extra shall be allowed for lapse and wastages.
- 2.1.3 All the guide vanes, deflectors in duct elbows, branches, grille collars quadrant dampers etc. shall be measured for actual sheet metal surface and paid for at the same rate as duct of same thickness.

2.1.4 The unit duct price shall include all the duct hangers and supports, exposing of concrete reinforcement for supports and making good of the same as well as any materials and labour required to complete the duct frame.

2.2 Grilles/Diffusers

All grilles/diffusers as per tender requirements shall be treated as a lump sum item. Where extra grilles diffusers are ordered upto award of work, they should be measured as follows:

2.2.1 All measurements of grilles/diffusers shall be the actual neck size excluding the outer flanges.

2.2.2 The square or rectangular grilles/diffusers shall be measured in plain sq.m.

2.2.3 All round diffusers shall be measured by their diameters in cm.

2.2.4 All linear diffusers shall be measured as per actual length in metres.

3.0 Measurements of Piping, Fittings, Valves, Fabricated Items

3.1 Pipe (Including water piping, steam piping, oil piping, lpg gas piping, air piping, vacuum piping) etc.

3.1.1 All pipes shall be measured in linear metre (to the nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings e.g. tees, bends, reducers, elbows etc. deduction shall be made for valves in the line.

3.1.2 Exposing reinforcement in wall and ceiling and floors of possible and making good the same or installing anchor fasteners and inclusive of all items as specified in specifications and schedule of quantities.

3.1.3 Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by the project co-ordinator.

3.1.4 Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.

3.1.5 The length of the pipe for the purpose of payment will be taken through the centreline of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings for valves and flanges, section 3.2 below applies.

3.2 Valves and Flanges

3.2.1 All the extra ci & cm flanged valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length will be made wherever valves occur.

3.2.2 All gun metal (gate & globe) valves shall include two Nos. of flanges and two numbers 150 mm long ms nipples, with one side threaded matching one of the valves, and other welded to the M.S. slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp. grade and all items specified in the specifications.

3.2.3 The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps etc. and the connection made with an installed pipe line shall be included in the rates as per the B.O.Q.

3.3 **Structural Supports**

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required at site by project co-ordinator.

3.4 **Copper Connections for Fan Coil Units**

3.4.1 Copper connection assembly for making connections to the fan coil units shall be measured, as part of the fan coil unit price and shall include brass flare nuts, brass straight connector, brass tees, brass reducing fittings, fixing of automatic 3 way valve, making connections and leak testing, complete assembly as per specifications and drawings. Nothing extra shall be payable on account of any variation in the length of copper pipe.

4.0 **Insulation**

4.1 The measurement for vessels, piping, and ducts shall be made over the bare uninsulated surface area of the metal.

4.2 **Pipes, Ducts & Vessels**

4.2.1 **Pipes**

The measurements for installation of piping shall be made in linear metres through all valves, flanges, and fittings. Pipes/bends shall be measured along the centre line radius between tangent points. If the outer radius is r_1 and the inner radius is r_2 the centre line radius shall be measured as $(r_1+r_2)/2$. Measurement of all valves, flanges and fittings shall be measured with the running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/ routings. Fittings that connect two or more different sizes of pipe shall be measured.

4.2.2 **Ducts**

The measurements for insulation of ducts shall be made in actual square metres of bare uninsulated duct surface through all dampers, flanges and fittings. In case of

bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be for the surface dimension for the connecting duct, nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

4.2.3 **Vessels**

The area of standard dished and flat ends of vessels shall be the square of the diameter of the uninsulated body of the shell. Areas for other shapes shall be the actual calculated area. There shall be no deduction or additions for nozzles, handles ribs, dampers, expansion joints etc. All projections on vessels or tanks shall be measured separately as pipe/duct.

4.3 **Accessories Insulation**

4.3.1 The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be uninsulated are in square metres.

4.3.2 In case of curved or irregular surfaces, measurements shall be taken along the curves.

4.3.3 The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

4.4 **Acoustic Duct Lining**

4.4.1 In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square metres shall be final for billing purposes.

4.4.2 The insulation/acoustic panels shall include cost of battens, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and materials required for completing the work.

SCHEDULE OF EQUIPMENT

1. Air cooled Package type DX Units(indoor and outdoor unit)

a)	Capacity (TR)	15
b)	Qty (cfm)	3500
c)	No of rows of coil (Minimum)	6
d)	No. of fins/cm of coil	5

2. DUCTABLE SPILIT TYPE AIR CONDITIONER

a)	Capacity (TR)	17
b)	Air Qty (cfm)	6800
c)	No of rows of coil (Minimum)	4
d)	No. of fins/cm of coil	5

3. HIGH WALL SPLIT AIR CONDITIONER

a)	Capacity (tons)	1.5TR	2TR
b)	Air Qty (cfm)	600	800
c)	No of rows of coil (Minimum)	3	3
d)	No. of fins/cm of coil	5	5

4. WINDOW AIRCONDITIONER

a)	Capacity (tons)	1.5TR	2TR
b)	Air Qty (cfm)	600	800
c)	No of rows of coil (Minimum)	4	4
d)	No. of fins/cm of coil	5	5

Propeller Fan : GEC(Alsthom)/Crompton Greaves/ Khaitan/Usha/Polar

Axial Fan : Krugger/ Flakt/ Nicotra

Pipes

GI : ITC/ Jindal/Tata/SAIL/HSL

MS upto 150 mm dia : ITC/ Jindal/Tata/SAIL/HSL

MS 200 to 300 dia : ITC/ Jindal/Tata/SAIL/HSL

GI Sheets : TATA/SAIL/Jindal/Bhushan Steel

Aluminium Sheet : Balco/Nalco/Hindalco

Grilles/Diffusers : Ravistar/Caryaire/ Mapro/Dynacraft

Fire dampers (Motorized) : Caryaire/Dynacraft / Ravistar

Electric Hot Water Generator : Rapid cool/Emerald/Khokar

Valves

Gate Valve : Leader/Divine/Sant/Bankim Sarkar

Butterfly Valves : Advance/Castle/Audco/Intervalve /Arrow/C&R

Balancing Valves : Advance/Castle/Audco/Arrow/C&R

Non-return Valves : Advance/Castle/Kirloskar/C&R/Arrow

Pot & Y- Strainer : Emerald/Sant/Rapid cool

Three way mixing valves : Stafea/Johnson/Honeywell/Danfoss/Anergy/Rapid controls

Two way motorized valve : Stafea/Johnson/Honeywell/Danfoss/Anergy /Rapid controls

Actuating motor for 3 way & 2 way valve : Stafea/Johnson/Honeywell/Danfoss/Anerg

Ball Valve with & without strainer : Rapid Control/Sant/Leader

Insulation

Fibre glass	:	FGP Ltd./UP Twiga/Kimmco / Owens Corning
Expanded Polystrene	:	Beardsell Ltd./ BASF/Styrene Packing/ Indian Packaging Industries/ Lloyd
Air Filters	:	Thermadyne/Klenzaid/Kirloskar /Anfilco/Johnflower/Dynafilter
Thermometers/Pressure Gauge	:	Fiebig/Emerald/H Guru/Japsin
Thermostats/Humidistats	:	Honeywell/Penn /Staefa/Johnson/ Anergy /Rapid Controls
Electric Strip Heaters	:	Escorts/Daspass
Controls	:	Honeywel/ Johnson / Staefa
Electric Panels	:	CPRI approved make (To be approved by HSCC)
Electric Motors	:	Siemens/ Kirloskar /ABB/ Bharat Bijlee/ Crompton Greaves
Starters/Contactors	:	L&T/ GE Power/ Siemens/ ABB
ACB/MCCB	:	L&T/ GE Power/ Siemens/ ABB
Switch Fuse/ Fuse Switch Units	:	L&T/ GE Power/ Siemens/ ABB
Cables		
Power Cables & Control cable	:	CCI/Universal/ICC/NICCO/INCAB/ National/ Rallison Cables
Lamps & Push Buttons Relays Current Transformer/ Ammeter/Voltmeter	:	L&T/GE/ Siemens/ Schneider

TECHNICAL SPECIFICATION OF OPERATION THEATRE (MAJOR) FOR CHATTISGARH

SCOPE OF WORK -

Supply construction, and commissioning of Operating Theatre (Major) in accordance with the specifications, bill of quantities and providing of free spare parts and service during Defect Liability Period.

1. CEILING SYSTEM

The prefabricated modular construction for 1.60 mm thick EGP backed by 12mm thick Gypsum board to provide seamless operating room to provide seamless operating Room. Factory made cutout in the ceiling panel for light fixtures. Aluminium Ducting inside the OT with Powder coated Aluminium Return air grills at four corners fitted with ducting connection to the outside of OT from AHU.

The ceiling suspension from concrete ceiling should be as:

Suspension elements : Suspension bracket with tension spring

Suspension Height: Continuously adjustable from 250 to 1100 mm

Stability: Permanent and non-stop after adjustment.

Material High quality galvanized steel

Laminar Flow Tent should be made of 1.5 mm thk Aluminium sheet and two layer monofilament diffuser Size 8ft x 6ft x 400mm ht. with dimmable fluorescent light. Tent shall be made so as Laminar Flow System to integrate with OT equipments and Duct connections with incoming duct-line to OT

Providing and laying Epoxy Coating, 300 microns thick over smoothly rendered surface. The treatment consists of surface preparation, priming with Epoxy Primer.

2. WALL WITH CORNER COVING

Providing and laying Epoxy wall Coating, 300 microns thick over smoothly rendered walls. The treatment consists of surface preparation, priming with Epoxy Primer. Walls should be smoothly rendered with Wall putty.

Extruded aluminium powder coated/Anodized clip on type covings for the entire wall to False ceiling. R-70.

3. SWING DOOR

44 mm thick doors made with Poly Urethane painted 0.8mm thick GPSP sheets on both sides with PUF as infill, 1.2 mm thick GPSP painted door frames totally flush with the wall, hardware like push plates, handles, door closure, double glazed view glass of std size, Stainless Steel Ball Bearing butt hinges and provision for concealed automatic door bottom Drop seal etc. Supply & Installation of double glazed view panels (1 Square ft. area) with flush design, with 6mm thick float glass fixed in double panel with necessary arrangements.

4. PERIPHERAL LIGHT

It should be fitted outside the air ceiling system area and flush with the ceiling in the operation theatre suitable to required illumination of 500 Lux inside the OT. Peripheral lights and clean room luminaries fitted in the frame should be 8 numbers in the OT. The fluorescent lamps shall be used with highly spectacular anodized Aluminum reflectors and optical antiglare system for adjustable light distribution. Luminaries cover made of highly resistant, disinfectant proof laminated safety glass with fine grained surface, glass pane with white powder coated steel frame. Luminary's body made of sheet steel, white, powder coated supplied ready for connection. The reflectors should be of high quality, cleanable and non deteriorating. Dimmable ballasts of reputed companies to be used and diffuser should be constructed with opaque acrylic diffuser material in aluminum frames/ SS frames. It should have flicker less design with color. Recess frames should be gas tight. The fitting should be flush with the ceiling and should be removable from top or bottom. Lighting units should be properly sealed with the ceiling by means of fillers and beadings so that all lighting units are airtight with ceiling panels. The light fitting should be uniformly and aesthetically distributed on the ceiling to provide uniform illumination in the OR. Peripheral lighting should be done according to IP54 protocol. Light should not interfere when green mode of Endoscopy is performed.

5. X-RAY FILM VIEWER

The two (2)-plate viewing 3 pieces of high frequency fluorescent lamps X-Ray Viewing Screen should be designed to provide flicker free luminance for clear film viewing. Each plate should be able to illuminate films upto 14"x17" size. 'Dimming is controlled using dimming ballast and PCB mounted inside the box. The mounting of the Screen should be installed flushed/hung with Operation theatre wall. The diffuser should diffuse the light evenly and to provide adequate luminance for film viewing. Body should be of extruded aluminum powder coated black with bacteria and disinfectant resistant finish. Proper spring loaded film clip with rollers should be provided to hold the films firmly and to remove the film without scratches. The X-Ray Film viewer should comply with relevant Electrical Safety Codes for High and Low voltage system.

6. DISTRIBUTION BOARD & ELECTRICAL WIRING, CONDUITING WITH FIXTURES INSIDE THE OPERATION THEATRE

All high voltage equipment should be installed in a separate enclosure. Electric Distribution Panel, UPS, Transformers, Mains, Relays, Circuit protective equipment, for all circuits of Operation theatre shall be installed in the remote cabinet. All electrical wiring should be terminated to the connectors mounted on rail and labeled with indelible labels. Individual fuse and miniature circuit breakers should protect all internal circuits. Complete schematic diagram drawing description should be enclosed with the equipment.

Laying of PVC conduits, Modular Switch Boxes, Modular Switches-sockets, Power and Light wiring including Earthing wire for all the lighting controls, Pendant and other equipment fixtures and fittings inside the theatre Wiring with low leakage current wires of FRLS wires should be as per requirements. Wiring for 250 volts single phase and neutral 6/16 Amps switched socket outlet with 4 sq.mm and 2.5 sq.mm PVC insulated copper conductor 1100 volts stranded flexible wires should be concealed with conduit. Installation of all electrical cabling must be of IS: 1554 (As per latest amendment) standard and wiring as per IS: 732 standard and proper earthing of OT and other accessories in the OT room as per standard guidelines of BIS. Fittings should be sealed on accordance with the standard IP54. Earthed equipotent bonding of all exposed metal work should be provided.

7. OPERATION THEATRE FLOORING (ANTISTATIC CONDUCTIVE TILES)

A floor should be provided, flat to within a tolerance of +/- 3mm over any 3-metre area. Onto this sub floor, a self-leveling compound should be laid prior to laying of the floor finish. Copper grounding strips (not less than 0.05mm thick, 50mm width) should be laid flat on the floor in the conductive adhesive and connect to copper wire of grounding. The floor finish in the operating room should be 2mm Conductive PVC tiles, laid on a semi conductive adhesive base. **The floor finish should terminate at the room perimeter passing over a concealed cove former and continuing up the wall for 100mm.** All joints should be thermal welded with electrodes of the same compatible material to provide a continuous sealed seamless surface.

8. PENDANT FOR ANESTHESIA

Should be double Arm Pendant with horizontal movement

One swivel arm of 850 mm

Swiveling angle should be 330°.

Anesthesia pendant should have medical outlets like Oxygen outlets X 2, Air(4 bar) X 2, Nitrous oxide X 2 and Vacuum outlet X 2, AGSS outlet X 1

Pendant should have eight 5A/15A combined electrical socket-10 Nos. Electrical socket should be of reputed make. One electrical socket should be connected with central UPS and should of different colors for easy identification.

Pendant should have two open shelves to keep Monitors/ESUs etc

Should have provision RJ 45 /cat 5 for telephone communication.
Should have provision RJ 45 /cat 6 for data communication.

9. **PENDANT FOR SURGEON**

Should be double Arm Pendant with horizontal movement

One swivel arm of 850 mm and another of 650 mm.

Swiveling angle should be 330°.

The swivel arms move only horizontally and the length in fully stretched position is
(850+650) = 1500mm

Surgeon's pendant should have 7 bar Surgical Air outlet x 1. Oxygen Outlet x 2, Vacuum Outlet x 2. Carbon dioxide outlet-1

Pendant should have eight 5A/15A combined electrical socket 10 Nos Electrical socket should be of reputed make. One electrical socket should be connected with central UPS and should of different colors for easy identification.

Surgeons pendant should have infusion management system.

Pendant should have two open shelves to keep Monitors/ESUs etc

Should have provision RJ 45 /cat 5 for telephone communication.

Should have provision RJ 45 /cat 6 for data communication.

10. **MEDICAL GAS PIPE LINE INSTALLATION**

Medical graded Copper pipes for Oxygen, Air(Medical & Surgical), Vacuum, Nitrous Oxide, Carbon di Oxide and AGSS Outlets inside the Operation Theatres from the manifold system should be provided.

Medical graded Copper pipes shall be solid drawn, tempered, seamless, phosphorous deoxidized, non-arsenic and degreased for oxygen service. Copper to Copper joints shall be made on site using silver-copper-phosphorous brazing alloy to BS-1845. Copper to brass or gunmetal joints shall not be made on site. Except for mechanical joints used for components, all metallic pipeline joints shall be brazed or welded. All pipelines shall be routed in such a way that their not exposed to a temperature less than 5 deg Celsius above the dew point of the gas distribution pressure. The chemical composition shall be as per BS-6017: 1981 Table 2, Cu-DHP grade. Distribution Copper Pipe manufactured as per BSEN:13348:2008 Each pipe shall be capped at both ends before supply. Pipeline shall be supported at interval to prevent sagging. Medical graded Copper Piping should be laid down from Pendant of OT to the Valve Box at the outside the Operation Theatre.

11. **Valve Box Assembly (5 Services)**

Valve Box should be made of Powder Coated M.S. Material.

Valve Box Assembly consisting of Lever operated quarter turn valve (i.e. 90 degree shut off ball valve- shall be manufactured by ISO 9001 company and factory degreased) with brass body and chrome plated brass ball.Brass fittings (Nut, Nipples and extruded brass Adapter) KE Type Seat Brass Block for pressure gauge

2" Dial gauges (0 - 10 kg/cm², 0 - 760mm Hg)
 Nylon Bush for copper pipes holding with the valve box
 Beeding for box lead
 Lockable cover with breakable glass so that during normal operation access shall be by key. But during emergency operation, access by breaking the glass panel.

12. VIEW WINDOW WITH BLINDS

View window with roller blinds sandwiched in two parallel toughened glasses of thickness 5 mm. The Window frame should be powder coated Aluminum of approved shape flush mounted with wall paneling. The entire assembly should be completely sealed and fitted with proper Aluminum profile. The assembled thickness of the Window should be 33 mm. The window blinds should be operated manually. The window should be sealed (Air tight)

13. CEILING OT LIGHT - (Imported)

Description: Dual Dome LED Surgical Lighting System

Operating Room Surgical Lighting System should provide an ideal combination of brightness, Maneuverability, and shadow resolution without sacrificing color accuracy through a energy efficient consistent LED technology with a unique faceted reflector design technology. Mounting Type Ceiling, Sterilizable Handle, Color temperature should be homogeneous at every illumination intensity and Control of illumination intensity.

Such Lighting System should have the following technical specifications:

(a) Technical data for main dome: - 1nos.

- Bulb Type : LED
- Number of LEDs : Should be adequate enough for following minimum illumination level
- illumination level - 160.000 lux
- Rotation - 330- 360 degrees
- Vertical Adjustment Range - + 20 inch – 25 inch
- Color temperature - 4000 - 5000K
- Field Size Diameter Depth - 8 inch – 12 inch
- Average Color rendering index Ra - 95
- Life of Light Source > 30,000 Hrs.
- Dimming Range - 20% - 100%
- Operating/Storage Humidity - 10 – 95%
- Light Head diameter - 620 minimum

- b) Technical data for satellite dome - 1nos.
- Bulb Type : LED
 - Number of LEDs : Should be adequate enough for following minimum illumination level
 - illumination level - 110.000- 120000 lux
 - Rotation - 330- 360 degrees
 - Vertical Adjustment Range - + 20 inch – 25 inch
 - Color temperature - 4000 - 5000K
 - Field Size Diameter Depth - 8 inch – 12 inch
 - Average Color rendering index Ra - 95
 - Life of Light Source > 30,000 Hrs.
 - Dimming Range - 20% - 100%
 - Operating/Storage Humidity - 10 – 95%
 - Light Head diameter - 620 minimum
- Such Surgical Light should be compliant with relevant European CE /US FDA standards

System Configuration Accessories, spares and consumables

In addition to the above mentioned equipment/appliances, if the contractor thinks it necessary to include any other equipment/appliances, accessories etc. for the MGPS then that may be provided after approval from Engineer in-charge.

The sizes are approximate. Minor variations in sizes shall be acceptable subject to prior approval of the Engineer.

APPROVED MAKES

- | | | |
|----|---------------------------------|---|
| 1. | Ceiling System | MDD/MPS/Hi_Tek/MGI//EQUIVALENT |
| 2. | Peripheral Light | Philips/Wipro |
| 3. | Cable | SKYTONE/KEI/UNIVERSAL/NATIONAL/RR CABLE |
| 4. | PVC Pipe Class III with Fitting | FINOLEX/ SUPREME/ PRINCE/ ORI-PLAST |
| 5. | G.I. Sheet | TATA/ JINDAL /BHUSHAN/PASCO |
| 6. | MCCB/Contactor/Relay | L&T/ABB/SIEMENS/SCHNEIDER |
| 7. | Stainless Steel | TATA/SALEM/JINDAL/MUKUND/BHAYANDER/AMBICA |
| 8. | Copper Pipe | MEHTA/PRECISION/RAJCO |

Note:

- **All electrical accessories like cable wire, electrical outlets, switches etc, should be fire proof of reputed make, certified for electrical safety.**

- Wherever makes have not been specified for certain items, the same shall be as per BIS and as per approval of HSCC.
- The contractor should provide test certificate for all material used for construction of pre-fabricated OT
- The contractor shall be responsible for the complete works including submission of working drawing.
- The Contractor should provide complete Operation manual/Service manual for all systems and subsystems.
- Final electrical safety test, system test and calibration should be done by authorized person with test instruments.
- Training for seven working days should be provided to the staff & engineers of client by the Manufacturer
- The contractor should prepare and submit layout plan to HSCC for approval before beginning of supply and As-built drawing after installation.

TECHNICAL SPECIFICATION OF OPERATION THEATRE(MINOR) FOR CHATTISGARH

SCOPE OF WORK -

Supply construction, and commissioning of Operating Theatre (Minor) in accordance with the specifications, bill of quantities and providing of free spare parts and service during Defect Liability Period.

1. CEILING SYSTEM

The prefabricated modular construction for 1.60 mm thick EGP backed by 12mm thick Gypsum board to provide seamless operating room to provide seamless operating Room. Factory made cutout in the ceiling panel for light fixtures. Aluminium Ducting inside the OT with Powder coated Aluminium Return air grills at four corners fitted with ducting connection to the outside of OT.

The ceiling suspension from concrete ceiling should be as:
 Suspension elements : Suspension bracket with tension spring
 Suspension Height: Continuously adjustable from 250 to 1100 mm
 Stability: Permanent and non-stop after adjustment.
 Material High quality galvanized steel

Laminar Flow Tent should be made of 1.5 mm thk Aluminium sheet and two layer monofilament diffuser Size 8ft x 6ft x 400mm ht. with dimmable fluorescent light. Tent shall be made so as Laminar Flow System to integrate with OT equipments and Duct connections with incoming duct-line to OT from AHU.

Providing and laying Epoxy Coating, 300 microns thick over smoothly rendered surface. The treatment consists of surface preparation, priming with Epoxy Primer.

2. WALL WITH CORNER COVING

Providing and laying Epoxy wall Coating, 300 microns thick over smoothly rendered walls. The treatment consists of surface preparation, priming with Epoxy Primer. Walls should be smoothly rendered with Wall putty.

Extruded aluminium powder coated/Anodized clip on type coverings for the entire wall to False ceiling. R-70.

3. SWING DOOR

44 mm thick doors made with Poly Urethane painted 0.8mm thick GPSP sheets on both sides with PUF as infill, 1.2 mm thick GPSP painted door frames totally flush with the wall, hardware like push plates, handles, door closure, double glazed view glass of std size, Stainless Steel Ball Bearing butt hinges and provision for concealed automatic door bottom Drop seal etc. Supply & Installation of double glazed view panels (1 Square ft. area) with flush design, with 6mm thick float glass fixed in double panel with necessary arrangements.

4. PERIPHERAL LIGHT

It should be fitted outside the air ceiling system area and flush with the ceiling in the operation theatre suitable to required illumination of 500 Lux inside the OT. Peripheral lights and clean room luminaries fitted in the frame should be 8 numbers in the OT. The fluorescent lamps shall be used with highly spectacular anodized Aluminum reflectors and optical antiglare system for adjustable light distribution. Luminaries cover made of highly resistant, disinfectant proof laminated safety glass with fine grained surface, glass pane with white powder coated steel frame. Luminary's body made of sheet steel, white, powder coated supplied ready for connection. The reflectors should be of high quality, cleanable and non deteriorating. Dimmable ballasts of reputed companies to be used and diffuser should be constructed with opaque acrylic diffuser material in aluminum frames/ SS frames. It should have flicker less design with color. Recess frames should be gas tight. The fitting should be flush with the ceiling and should be removable from top or bottom. Lighting units should be properly sealed with the ceiling by means of fillers and beadings so that all lighting units are airtight with ceiling panels. The light fitting should be uniformly and aesthetically distributed on the ceiling to provide uniform illumination in the OR. Peripheral lighting should be done according to IP54 protocol. Light should not interfere when green mode of Endoscopy is performed.

5. X-RAY FILM VIEWER

The two (2)-plate viewing 3 pieces of high frequency fluorescent lamps X-Ray Viewing Screen should be designed to provide flicker free luminance for clear film viewing. Each plate should be able to illuminate films upto 14"x17" size. 'Dimming is controlled using dimming ballast and PCB mounted inside the box. The mounting of the Screen should be installed flushed/hung with Operation theatre wall. The diffuser should diffuse the light evenly and to provide adequate luminance for film viewing. Body should be of extruded aluminum powder coated black with bacteria and disinfectant resistant finish. Proper spring loaded film clip with rollers should be provided to holes of the films firmly and to remove the film without scratches. The X-Ray Film viewer should comply with relevant Electrical Safety Codes for High and Low voltage system.

6. DISTRIBUTION BOARD & ELECTRICAL WIRING, CONDUITING WITH FIXTURES INSIDE THE OPERATION THEATRE

Electrical Distribution Board along with all high voltage equipment should be installed in a separate enclosure. Electric Distribution Panel, UPS, Transformers, Mains, Relays, Circuit protective equipment, for all circuits of Operation theatre shall be installed in the remote cabinet. All electrical wiring should be terminated to the connectors mounted on rail and labeled with indelible labels. Individual fuse and miniature circuit breakers should protect all internal circuits. Complete schematic diagram drawing description should be enclosed with the equipment.

Laying of PVC conduits, Modular Switch Boxes, Modular Switches-sockets, Power and Light wiring including Earthing wire for all the lighting controls, Pendant and other equipment fixtures and fittings inside the theatre Wiring with low leakage current wires of FRLS wires should be as per requirements. Wiring for 250 volts single phase and neutral 6/16 Amps switched socket outlet with 4 sq.mm and 2.5 sq.mm PVC insulated copper conductor 1100 volts stranded flexible wires should be concealed with conduit. Installation of all electrical cabling must be of IS: 1554 (As per latest amendment) standard and wiring as per IS: 732 standard and proper earthing of OT and other accessories in the OT room as per standard guidelines of BIS. Fittings should be sealed on accordance with the standard IP54. Earthed equipotent bonding of all exposed metal work should be provided.

7. OPERATION THEATRE FLOORING (ANTISTATIC CONDUCTIVE TILES)

A floor should be provided, flat to within a tolerance of +/- 3mm over any 3-metre area. Onto this sub floor, a self-leveling compound should be laid prior to laying of the floor finish.

Copper grounding strips (not less than 0.05mm thick, 50mm width) should be laid flat on the floor in the conductive adhesive and connect to copper wire of grounding. The floor finish in the operating room should be 2mm Conductive PVC tiles, laid on a semi conductive adhesive base. The floor finish should terminate at the room perimeter

passing over a concealed cove former and continuing up the wall for 100mm. All joints should be thermal welded with electrodes of the same compatible material to provide a continuous sealed surface.

8. HORIZONTAL BED HEAD PANEL 1800 mm long

High Strength Anodised extruded Aluminium with inbuilt single railing. The chamber of Medical Gas Outlets should be made of anodized aluminium shall be powder coated as per the customer's choice. The panel should be designed to have as following:

- a). Medical outlets like Oxygen outlets X 2, Air(4 bar) X 2, Nitrous oxide X 2 and Vacuum outlet X 2, AGSS outlet X 1
- b) Electrical Sockets / Switches- 6 Nos

9. MEDICAL GAS PIPE LINE INSTALLATION

Medical graded Copper pipes for Oxygen, Air(Medical & Surgical), Vacuum, Nitrous Oxide, Carbon di Oxide and AGSS Outlets inside the Operation Theatres from the manifold system should be provided.

Medical graded Copper pipes shall be solid drawn, tempered, seamless, phosphorous deoxidized, non-arsenic and degreased for oxygen service. Copper to Copper joints shall be made on site using silver-copper-phosphorous brazing alloy to BS-1845. Copper to brass or gunmetal joints shall not be made on site. Except for mechanical joints used for components, all metallic pipeline joints shall be brazed or welded. All pipelines shall be routed in such a way that their not exposed to a temperature less than 5 deg Celsius above the dew point of the gas distribution pressure. The chemical composition shall be as per BS-6017: 1981 Table 2, Cu-DHP grade. Distribution Copper Pipe manufactured as per BSEN:13348:2008 Each pipe shall be capped at both ends before supply. Pipeline shall be supported at interval to prevent sagging. Medical graded Copper Piping should be laid down from Pendant of OT to the Valve Box at the outside the Operation Theatre.

10. Valve Box Assembly- 5 Services

Valve Box should be made of Powder Coated M.S. Material.

Valve Box Assembly consisting of Lever operated quarter turn valve (i.e. 90 degree shut off ball valve- shall be manufactured by ISO 9001 company and factory degreased) with brass body and chrome plated brass ball.Brass fittings (Nut, Nipples and extruded brass Adapter) KE Type Seat Brass Block for pressure gauge

2" Dial gauges (0 - 10 kg/cm², 0 - 760mm Hg)

Nylon Bush for copper pipes holding with the valve box

Beeding for box lead

Lockable cover with breakable glass so that during normal operation access shall be by key. But during emergency operation, access by breaking the glass panel.

11. CEILING OT LIGHT –HALOGEN

The unit should have reflector for optimum utilization of the dual reflector by means of targeted light direction technique with following specifications:

- Power supply : 230V, 50/60Hz
- Colour Temp. : 4200K
- Light intensity at 0.8m distance : 40000-45000lux
- Light field diameter : 180-200mm
- Colour rendering index Ra(1-8)-93
- Luminous efficacy in the light field : 290lm/w or more
- Power consumption : 12V/50W
- Working space : 27-173cm
- Lifetime of bulb : Atleast 2000hrs.
- Swivel radius : 960mm
- Vertical adjustment : 1250mm
- Weight : 20 kg.
- Should have CE certification for electricity safety

In addition to the above mentioned equipment/appliances, if the contractor thinks it necessary to include any other equipment/appliances, accessories etc. for the MGPS then that may be provided after approval from Engineer in-charge.

The sizes are approximate. Minor variations in sizes shall be acceptable subject to prior approval of the Engineer.

APPROVED MAKES

1.	Ceiling System	MDD/MPS/Hi_Tek/MGI/EQUIVALENT
2.	Peripheral Light	Philips/Wipro
3.	Ceiling OT Light	PHILIPS/UNITED SURGICAL/MAGNATEK/SURGITECH/EQUIVALENT
4.	Cable	SKYSTONE/KEI/UNIVERSAL/NATIONAL/RR CABLE
5.	PVC Pipe Class III with Fitting	FINOLEX/ SUPREME/ PRINCE/ ORI-PLAST
6.	G.I. Sheet	TATA/ JINDAL /BHUSHAN/PASCO
7.	MCCB/Contactor/Relay	L&T/ABB/SIEMENS/SCHNEIDER
8.	Stainless Steel	TATA/SALEM/JINDAL/MUKUND/BHAYANDER/AMBICA

Note:

- **All electrical accessories like cable wire, electrical outlets, switches etc, should be fire proof of reputed make, certified for electrical safety.**
- **Wherever makes have not been specified for certain items, the same shall be as per BIS and as per approval of HSCC.**
- **The contractor should provide test certificate for all material used for construction of pre-fabricated OT**
- **The contractor shall be responsible for the complete works including submission of working drawing.**
- **The Contractor should provide complete Operation manual/Service manual for all systems and subsystems.**
- **Final electrical safety test, system test and calibration should be done by authorized person with test instruments.**
- **Training for seven working days should be provided to the staff & engineers of client by the Manufacturer**
- **The contractor should prepare and submit layout plan to HSCC for approval before beginning of supply and As-built drawing after installation.**