

19.	Cables		As per Electrical Works
20.	Flow meter		Scientific Equipment (P) Ltd. Hyderabad , System Sensor
21.	Suction strainer		Leader, ZOLOTO, AUDCO, Castle
22.	Vibration eliminator connectors		Resistoflex, or equivalent
23.	Single phase preventor		L & T, GEC, SIEMENS
24.	G.I. Fittings	1239 Part I	Unik, K.S., Zoloto Zenith, JSL
25.	Yard Hydrant Stand Post, 4 way suction		Eversafe, Minimax, Newage, Getech, Superex

Note : Wherever makes have not been specified for certain items, the same shall be as per BIS and as per approval of Engineer

**END OF CIVIL, PHE & FIRE TECHNICAL
SPECIFICATIONS**

TECHNICAL SPECIFICATIONS

1.00 GENERAL SCOPE OF WORK

The scope of work shall cover internal and external electrical works for **CONSTRUCTION OF DISTRICT DRUG WAHEHOUSE, UNDER NATIONAL RURAL HEALTH MISSION SCHEME** .The scope of work covers electrical equipments as per BOQ. Also, supply, installation, testing and commissioning of electrical works of the project including the following main items/systems:

- i. Main LT , Capacitor panels (APFC), Rising mains, MV Panels.
- ii. DG sets including AMF panels etc.
- iii. MCB Distribution Boards.
- iv. Internal electrification through concealed MS conduit and provide light points, fan points, socket outlets etc. including supplying, installation, testing and commissioning of light fixtures, fans etc.
- v. Conduiting and wiring for telephone points including Main Telephone Distribution Boards (Tag Blocks), telephone outlets etc. complete with telephone cabling from tag blocks to telephone outlets including EPABX, telephone instruments etc.
- vi Conduiting and wiring for cable TV
- vii Conduiting for computer networking
- ix LT Cabling.
- x Earthing, safety equipments and misc items required for electrical installation complete in all respect.
- xi Out door lighting
- xii Testing and commissioning of all electrical installations
- xiii Enhancement/Sanctioning Electrical Load from State Electricity Board.
- xiv Submission of GA drawings of electrical equipments and getting approvals from Client/HSCC/Owner before manufacturing/fabrication.
- xv Obtaining approvals from Chief Electrical Inspectors, Local Electricity Supply Authority, Telecom Department, and any other statutory authorities for the complete scope.
- xvi contractor shall submit equipment drawing from manufacturer along with the layout etc. and working drawings for approval from HSCC Electrical Engineer before manufacture / commencement of work at site.

- xvii Contractor has to submit the working drawing of internal & external electrification based on our tender drawings for the approval of HSCC Electrical Engineer before commencement of work.
- xviii Contractor has to take the approval of DB schedule/drawing of each DB from HSCC.
- xix Incase, details of any electrical item/ system are left out, then kindly refer the CPWD specifications & approval from Engineer.

2.0 REGULATIONS AND STANDARDS

2.1 All equipments their installation, testing and commissioning shall conform latest CPWD/ IS specifications in all respects. Indian Standard Code of Practice for Electrical Wiring Installation IS:732-1989. It shall also be in conformity with Indian electricity Rules and the Regulations, National Electric Code, National Building Code, latest CPWD specifications amended up to date and requirements of the Local Electric Supply Authority. In general, all materials equipment and workmanship shall conform to the Indian Standards specifications and code. Mode of all measurement will be as per latest CPWD norms/ specifications Some of the applicable codes/standards are as under:

a)	CPWD General specifications for electrical works	Part-I (Internal)- 2013
b)	CPWD General specifications for electrical works	Part-II (External)-1995
c)	CPWD General specifications for electrical works	Part-III (Lifts & Escalators)-2003
d)	CPWD General specifications for electrical works	Part-IV (Substation)-2013
e)	CPWD General specifications for electrical works	Part VII (DG Sets) 2013
f)	CPWD Specification/norms for measurement	Latest revision
g)	Guide for marking of insulated conductors	IS 5578
h)	Guide for uniform system of marking and identification of conductor and apparatus terminals.	IS 11353
i)	Low voltage switchgear and control gear assemblies	S 8623 Part-1 to 3
j)	Specification for low voltage switchgear and control gear	IS 13947
k)	Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000V AC and 1200 V DC	IS 2675
l)	Code of practice for selection, Installation and maintenance of switchgear and control gear.	ISI 10118 Part – 1 – 4
m)	Low-voltage fuses for voltages not exceeding 1000V AC or 1500V DC	IS113703 Part-1&2
n)	PVC insulated (heavy duty) electric cables	IS 1554
o)	PVC insulated cables for working voltages upto and including 1100V.	IS 694
p)	Conduit for electrical installations	IS 9537

q)	Accessories for rigid steel conduits for electrical wiring	IS 3837
r)	Boxes for the enclosure of electrical accessories	IS 14772
s)	General and safety requirements for luminaries	IS 1913
t)	Code of practice for earthing	IS 3043
u)	Electrical accessories – circuit breakers for over current protection for household and similar installations.	IS 8828
v)	Low voltage switchgear and control gear	IS 13947 part 1 – 5
w)	Residual current operated circuit breakers	IS 12640
x)	Current Transformers	IS 2705
y)	Voltage Transformers	IS 3156
z)	Direct acting indicating analogue electrical measuring instruments and their accessories	IS 1248 part – 1 to 9
A1)	Control Switches (switching device for control and auxiliary circuits including contactor relays) for voltages upto and including 1000V ac and 1200V DC.	IS 13947 & IS 1336
B1)	ONAN Transformer	IS 11171

In case of contradiction in specification the priority of the documents shall be as follows:

CPWD/ IS specification, BOQ, drawings, Technical specifications

3.0 MAIN MV & FLOOR PANELS

3.1 GENERAL

Main/Sub Distribution Panels shall be indoor type, metal clad, floor mounted, free standing, totally enclosed, extensible type, air insulated, cubicle type for use on 415 Volts, 3 phase, 50 cycles system.

3.2 CONSTRUCTION

Main/Sub Panels shall be:

- i. Of metal enclosed, indoor, floor mounted, free standing construction (unless otherwise specified) type.
- ii. Made up of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.
- iii. Provide dust and damp protection.
- iv. Be readily extensible on both sides by the addition of vertical sections after removal of the end covers in case of Main Panels.
- v. All panels shall be front access type.

Main/Sub Panels shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as the effects of humidity, which are likely to be encountered in normal service.

Each vertical section shall comprise of the following:

- i. A front-framed structure of rolled/folded sheet steel channel section, of minimum 2 mm thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, moulded case circuit breaker, main horizontal busbars, vertical risers and other front mounted accessories. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 2 mm thickness and 100 mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.
- ii. A cable chamber housing the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.
- iii. A cover plate at the top of the vertical section, provided with a ventilating hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.
- iv. Front and rear doors fitted with dust excluding neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors,

generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

The height of the panels should not be more than 2400 mm for MV Panels. Operating handle of breaker in top most compartments shall not be higher than 1800 mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be less than 350mm.

Doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 1.6 mm thickness. All sheet panels shall be smoothly finished, leveled and free from flaws. The corners should be rounded. The apparatus and circuits in the power control centers (panels) shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

Apparatus forming part of the Main/Sub Panels shall have the following minimum clearances.

- | | | |
|------|----------------------------|---------|
| i. | Between phases | - 32 mm |
| ii. | Between phases and neutral | - 26 mm |
| iii. | Between phases and earth | - 26 mm |
| iv. | Between neutral and earth | - 26 mm |

When, for any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions.

Creepage distances shall comply with those specified in relevant standards.

All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of the high humidity, high temperature tropical ambient service conditions.

Functional units such as circuit breakers and moulded case circuit breakers shall be arranged in multi-tier formation, except that not more than two air circuit breakers shall be housed in a single vertical section. Cable entry for various feeders shall be from the rear. Panel shall be suitable for termination of bus duct for incoming breakers.

Metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

- i. Main busbars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.
- ii. Cable termination of one functional unit, when working on those of adjacent unit/units.

All doors/covers providing access to live power equipment/ circuits shall be provided with tool operated fasteners to prevent unauthorized access.

Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

3.3 METAL TREATMENT & FINISH

All steel work used in the construction of the Main/Sub Panels should have undergone a rigorous metal treatment process as follows:-

- i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.
- ii. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.
- iii. A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.
- iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.
- v. Drying with compressed air in a dust free atmosphere.
- vi. Panel shall be powder coated with epoxy based powder paint after the above process so as to render the material suitable for corrosive environment.
- vii. Paint shade shall be Pebble (light) grey, shade no RAL 7032 unless otherwise specified.

3.4 BUSBARS

The busbars shall be air insulated and made of high conductivity, high strength aluminum alloy complying with the requirement of IS-5082.

The busbars shall be suitable braced with non-hygroscopic SMC supports to provide a through fault withstand capacity of 25kA RMS symmetrical for one second. The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent busbars. Large clearances and Creepage distances shall be provided on the busbar system to minimize possibilities of fault.

The Main/Sub Panels shall be designed that the cables are not directly terminated on the terminals of breaker etc. but on cable termination links. Capacity of aluminum busbars shall be considered as 0.8 Amp per sqmm. of cross sectional area of the busbar. The main busbars shall have continuous current rating throughout the length of Panels. The cross section of neutral busbars shall be same as that of phase busbar for busbars of capacity up to 200Amp; for higher capacity the neutral busbar shall not be less than half (50%) the cross section of that the phase busbars. The busbar system shall consist of main horizontal busbar and auxiliary vertical busbars run in busbar alley/chamber on either side in which the circuit could be arranged/connected with front access.

Connections from the main busbars to functional circuit shall be arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Busbars to be colour coded with PVC sleeves.

3.5 SWITCHGEARS

Refer subhead 5.00 – LT switchgears

3.6 CABLE TERMINATIONS

Cable entries and terminals shall be provided in the Main/Sub Distribution Panels to suit the number, type and size of aluminium conductor power cables and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. A cable chamber 150 mm. high shall be provided at the bottom through out the length and depth of the MDB/SDB. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

3.7 LABELS

Labels shall be anodised aluminium with white engraving on black background shall be provided for each incoming and outgoing feeder of Main/Sub Distribution and all Panels.

3.8 TEST AT MANUFACTURES WORK

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates submitted.

3.9 TESTING AND COMMISSIONING

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine meggar test. Checks and tests shall include the following.

- a) Operation checks and lubrication of all moving parts.
- b) Interlocking function check.
- c) Insulation test: As per CPWD Specifications.
- d) Trip tests & protection gear test.

4.0 L.T. SWITCHGEARS

4.1 AIR CIRCUIT BREAKERS

4.1.1 GENERAL

Air circuit breakers shall be incorporated in Main Distribution Panels wherever specified. ACBs shall conform to IS 13947 (Part 2) & IEC 947 (2) in all respects. ACBs shall be suitable for operation on 415 volts, 3 phase, 50Hz, AC supply.

4.1.2 TYPE AND CONSTRUCTION

Air Circuit Breakers shall be of enclosed pattern, dead front type with 'trip free' operating mechanism. It shall have microprocessor based electronic release. Air Circuit Breakers shall be EDO type (Electrically drawout type unless otherwise specified) with horizontal drawout carriage. The ACBs shall be strong and robust in construction with suitable arrangements for anchoring when in fully engaged or fully drawn-out positions. The carriage or cradle on which the breakers are mounted shall be robust design made of fabricated steel, supported on rollers. Cradle shall also comprise of main and secondary separable contacts and all draw out mechanism in a completely fig welded assembly. There shall be no dependence upon the switchboard frame for any critical alignment. The withdrawal arrangement shall be such as to allow smooth and easy movement.

All the current carrying parts of the circuit breakers shall be silver plated, suitable arcing contacts shall be provided to protect the main contacts. The contacts shall be of spring loaded design. The sequence of operation of the contacts shall be such that arcing contacts 'make before' and break after' the main contacts. Arcing contacts shall be provided with efficient arc chutes on each pole and these shall be such suitable for being lifted out for inspection of main as well as arcing contacts. The contact tips and arc chutes shall be suitable for ready replacement. Self aligning isolating contacts shall be provided. The design of the breaker shall be such that all the components are easily accessible to inspection, maintenance and replacement. Interphase barriers shall be provided to prevent flashover between phases.

4.1.3 OPERATING MECHANISM.

Air Circuit breaker shall be provided with a quick-make, trip free operating mechanism, the operating mechanism shall be 'strain-free' spring operated. The operating handle shall be in front of the panel type. The design shall be such that the circuit breaker compartment door need not be opened while moving the breaker from completely connected, through test, into the disconnected position. Electrical operated breakers shall have a motor wound spring charged closing mechanism. Breaker operation shall be independent of the motor, which shall be used solely for charging the closing spring. The operating mechanism shall be such that the breaker is at all times free to open immediately and the trip coil is energised. Mechanical operation indicator shall be provided to show open and closed position of breaker. Electrically operated breakers shall be additionally provided with mechanical indication to show charged and discharged condition of charging spring. 24 volt DC supply through battery backup for closing and opening for tripping circuit.

Means shall be provided for slow closing and opening of the breaker for maintenance purposes and for manual charging and closing of electrically operating breakers during emergencies.

4.1.4 INTERLOCKING AND SAFETY ARRANGEMENT

Air Circuit Breakers shall be provided the following safety and interlocking arrangements:

- i. It shall not be possible for breaker to be withdrawn when in "ON" position.
- ii. It shall not be possible for the breaker to be switched on until it is either in fully inserted position or for testing purposes it is in fully isolated position.
- iii. The breaker shall be capable of being racked into 'testing', 'isolated' and 'maintenance' positions and kept locked in any of these positions.
- iv. A safety catch to ensure that the movement of the breaker, as it is withdrawn is checked before it is completely out of the cubicle.
- v. The operating mechanism shall provide for racking the breaker into connected, test and disconnected positions without operating compartment door. When cubicle door shall be open position, the breaker can be pulled out to a fourth position, maintenance, where free access shall be possible to all parts of the breaker.

4.1.5 RATING

The rating of the circuit breaker shall be as per the drawings and schedule of quantities. Rated service breaking capacity (Ics) of the breakers shall be 50kA unless otherwise specified at 415 volts. The rated making capacity shall be as per the relevant standard.

4.1.6 ACCESSORIES

The breaker shall be equipped with electronic microprocessor based release to provide over current & earth fault protection. The breaker shall be fitted with following accessories for control, signal and interlocking.

- i. Auxillary contacts 6 NO + 6 NC, of rating 16Amp at 415 volts 50Hz.
- ii. Shunt release for tripping the breaker remotely and shall be suitable for 240 volt/415 volt 50Hz with range of operation from 10% to 130% of rated voltage.
- iii. Micro switches shall be mounted on the cradle of draw out breaker to indicate the position of the breaker on the cradle.
 - a. Kit for test/isolated indication.
 - b. Kit for service position indication.
 - c. Kit for shutter assembly.
- iv. Accessories for following interlocking schemes shall be provided.
 - a. Accessory kit for locking the breaker in isolated position. This kit is useful for interlocking scheme as well as keeping personnel and equipment safe.
 - b. Door interlock kit: Panel or cubicle door cannot be opened with the ACB in Test or Service position.
 - c. Lockable trip push button.

4.1.7 MOUNTING

Circuit Breakers shall be mounted as per manufacturers' standard practice.

4.1.8 TESTING

Testing of each circuit breaker shall be carried out at the works as per IS 2516 and the original test certificate shall be furnished in triplicate. The tests shall incorporate at least the following.

- i. Impulse withstand test.
- ii. Power frequency withstand test.
- iii. Short circuit test.
- iv. Temperature - rise test under rated conditions.

4.2 MOULDED CASE CIRCUIT BREAKERS.

GENERAL

Moulded Case Circuit Breaker shall be incorporated in the Main/Sub Distribution Boards wherever specified. MCCBs shall conform to IS 13947 (Part 2) & IEC 947 (2) in all respects. MCCBs shall be suitable either for single-phase AC 230 volts or three phase 415 volts. All MCCBs shall have microprocessor based over current and short circuit releases with adjustable current setting from 0.4In to 1.0 In.

4.2.1 Technical Specifications

The MCCB should be current limiting type with trip time of less than 10 milli sec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ.

MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2 /IEC 60947-2 and should have test certificates for breaking capacities from independent test authorities CPRI / ERDA

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses.

The breaking capacity of MCCB shall be minimum 35KA / 50 KA or as specified in BOQ. The rated service breaking capacity should be equal to rated ultimate breaking capacities ($I_{cs}=I_{cu}$).

All MCCBs upto 200A ratings should be provided with Thermal Magnetic type release with adjustable Overload and fixed short circuit protections or specified as BOQ. MCCBs of ratings 250A & above shall be provided with Microprocessor based having inbuilt adjustable protections against Over Load (L), Short Circuit (S) and Ground Faults (G)] with time delay or specified as BOQ.

All MCCBs should be provided with the Rotary Operating Mechanism. The ROM should be with door interlock (with defeat feature) & padlock facility

MCCB should have Spreader links & Phase barriers as standard feature. Superior quality of engineering grade plastics confirming to glow wire Tests as Per IEC 60695-2-1 should be used for insulation purpose.

The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contacts.

4.2.2 FRAME SIZES

The MCCBs shall have the following frame sizes subject to meeting the fault level.

- | | | | |
|----|------------------------|-------|-------------|
| a. | Upto 100A rating | | 100A frame. |
| b. | Above 100A upto 200A | | 200A frame. |
| c. | Above 200A up to 250A | | 250A frame. |
| d. | Above 250A up to 400A | | 400A frame. |
| e. | Above 400A up to 630Aq | | 630A frame. |
| f. | Above 630A to 800A | | 800A frame. |

4.2.3 CONSTRUCTIONS

The MCCB's cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be quick make/quick break, trip-free type. The operating handle shall have suitable "ON", "OFF" "and" "tripped" indicators. Three phase MCCBs shall have common operating handle for simultaneous operation and tripping of all the three phases. MCCBS shall be provided with rotary handle.

Suitable extinguishing device shall be provided for each contact. Tripping unit shall be of thermal magnetic or static release type provided in each pole & connected by a common trip bar such that tripping of any pole operates all three poles to open simultaneously. MCCB shall be current limiting type.

Contact trips shall be made of suitable air resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

4.2.4 BREAKING CAPACITY

Unless otherwise specified, rated service breaking capacity of the Moulded Case Circuit Breakers shall be minimum 25kA.

4.2.5 TESTING

- a. Original test certificate of the MCCB as per Indian Standards (IS) 315-C-8370 shall be furnished.
- b. Pre-commissioning tests on the Main Distribution/Sub Distribution Board incorporating the MCCB shall be done as per standard.

4.3 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.

4.4 MEASURING INSTRUMENTS, METERING & PROTECTION

4.4.1 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.

4.4.2 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.

4.4.3 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.

4.4.4 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 & 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.

4.5 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.

5.0 INTERNAL ELECTRIFICATION OF BUILDING

5.1 SCOPE

As specified in subhead 1.00

5.2 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 – 2013 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.

5.3 DISTRIBUTION BOARDS.

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 minimum 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 for residential and 100mA for Hospital and other 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 outgoings) 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.

5.4 METALLIC CONDUIT WIRING SYSTEM.

5.4.1 TYPE AND SIZE OF CONDUIT.

All conduit pipes shall be of ISI marked (IS:9537 Part-II/1989 amended upto date) 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 25 mm in diameter shall be used.

5.4.2 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.

5.4.3 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.

5.4.4 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.

5.4.5 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.

5.4.6 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.

In case of **PVC Conduit** it will be ISI marked HMS duty type, the PVC Conduit and Accessories will as per IS: 9537 Part III-1983 and IS:3419-1988 Amended up to date

5.4.7 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.

5.4.8 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.

5.4.9 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 3 pin type and 15 Amp socket shall be 5/6 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.

5.4.10 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.

5.4.11 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.

5.5 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.

5.5.1 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.

5.5.2 LOAD BALANCING

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

5.5.3 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.

5.5.4 CLASSIFICATION OF POINTS.

5.5.4.1 General

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

5.5.4.2 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).

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.

5.5.5. 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.

5.5.6 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 Linear basis from switchboard/15A power point to 5A point. Conduit of power SOCKET wiring can also be used for 5A socket outlet wiring, but both phase and neutral wires shall come directly from switchboard/power socketoutlet. 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 socket outlet 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 socket outlet wiring shall be done on basis under following two subheads:

- i) Directly from MCB-Distribution Board to the Socket Outlets
- ii) From One power socket outlet/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 linear 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.

5.5.7 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 - 2.5Sq.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

5.5.8 LIGHTING FIXTURE AND FANS

5.5.8.1 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.

5.5.9 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.

5.5.10 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.

5.5.11 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.

5.5.12 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.

5.5.13 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.

5.5.14 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

5.5.15 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.

6.0 LT CABLES

6.1 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.

6.2 MATERIAL

The L.T. power cable shall be XLPE Cable 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: 7098 (Part-I) with up to date amendments and ISI marked.

6.3 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.

6.4 INSPECTION

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

6.5 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.

6.6 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.

6.7 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.

7.0 CABLE TRAY

7.1 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.

7.2 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.

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

7.4 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.

7.5 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.

7.6 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.

7.7 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.

7.8 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.

- 7.9 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.
- 7.10 The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.
- 7.11 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.

8.0 EARTHING

8.1 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.

8.2 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.

8.3 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.

8.4 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.

8.5 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 cash 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.

8.6 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.

87 RESISTANCE TO EARTH

The resistance of earthing system shall not exceed 5 ohm.

8.8 Advance Chemical Gel Earthing System

The function of an earthing and bonding system is to provide an earthing system connection to which transformer neutrals or earthing impedances may be connected in order to pass the maximum fault current.

The proper earthing system also ensures no thermal or mechanical damage occurs on the equipment, thereby resulting in safety to operation and maintenance personnel. The earthing system also guarantees equipotential bonding such that there are no dangerous potential gradients developed across the system.

As it is stated in the various standards related to earthing, a safe grounding system has two main objectives:

1. To provide means to carry electric currents into the earth under normal and fault conditions without exceeding any operating and equipment limits or adversely affecting continuity of service.
2. To assure that a person in the vicinity of grounded facilities is not exposed to the danger of critical electrical shock.

The technical specification is considered inline to IS:3043-1987 (Reaffirmed 2001) – “Code of Practice for Earthing” issued by BIS (Bureau of Indian Standards), Government of India. Earthing resistance calculation is prepared in such a way that the earth pits are designed as per IS 3043 of using G.I. & Copper pipe earth electrode along with the carbon based backfill material of Carbofill grounding minerals.

G.I. pipe based earthing electrode shall be for electrical body applications & Copper pipe based earthing electrode shall be for electrical neutral applications. G.I. pipe earthing system: For a system upto a rating of 1000 KVA – the electrode shall be of Dual Pipe Technology chemrode of 3 mtrs long 50mm dia of outer pipe with the 25mm dia of inner pipe of 80-100 microns galvanized filled with highly conducting metallic compounds with the permanent sealings at both the ends with the lead terminal of 32x10mm size at the top. The length of the electrode shall be 3000mm excluding the lead terminal and the length of the lead terminal at the top shall be 100mm. The electrode shall be duly tested and certified by CPRI (Central Power Research Institute), for a RMS short-circuit current withstanding capacity of 30 KA and a peak short-circuit withstanding capacity of 60 KA.

G.I. pipe earthing system: For a system upto a rating of 2000 KVA – the electrode shall be of Dual Pipe Technology chemrode of 3 mtrs long 80mm dia of outer pipe with the 50mm dia of inner pipe of 80-100 microns galvanized filled with highly conducting metallic compounds with the permanent sealings at both the ends with the lead terminal of 50x10mm size at the top. The length of the electrode shall be 3000mm excluding the lead terminal and the length of the lead terminal at the top shall be 100mm. The electrode shall be duly tested and certified by CPRI (Central Power Research Institute), for a RMS short-circuit current withstanding capacity of 30 KA and a peak short-circuit withstanding capacity of 60 KA.

Copper pipe earthing system: For a system upto a rating of 1600 KVA – the electrode shall be of copper pipe chemrode of 3 mtrs long 63mm dia filled with highly conducting metallic compounds with the permanent sealings at both the ends. Top of the earth electrode is compressed to form an extended lead with 2 holes for connecting the strip/wire to the load.

Copper pipe earthing system: For a system upto a rating of 2000 KVA – the electrode shall be of copper pipe chemrode of 3 mtrs long 80mm dia filled with highly conducting metallic compounds with the permanent sealings at both the ends. Top of the earth electrode is compressed to form an extended lead with 2 holes for connecting the strip/wire to the load.

To ensure the moisture content and electrical conductivity, carbon based carbofill compound shall be used as a backfill compound. The carbofill compound shall be of low resistance & high conductivity in nature with carbon as a major content which dramatically lowers ground resistance system in difficult soil situations.

The carbon based backfill should not contain bentonite or concrete components, which in very dry conditions can cause shrinkage around the electrode, thus rendering it ineffective. pH adjusting agent shall maintain the pH value around the grounding material within the scope of protection. Carbon based compound carbofill should be an environment friendly and does no harm to the underground water.

Minimum 37.5 Kgs of carbon backfill compound shall be used along with each earthing electrode. The chemical backfill compound shall be tested & certified by any BIS (Bureau of Indian Standards).

On the ground level, an heavy duty weather proof environment friendly polyplastic earth pit chamber with cover of autolocking facility with the following dimensions - 254mm dia (top), 330mm dia (bottom) and 260mm height. 4 knock-out openings are provided for the easy interconnection of earth strips between the earth pits to form a grid.

At any cost, usage of salt & charcoal is strictly not permitted along with the chemical gel earthing system.

9.0 SAFETY EQUIPMENTS

9.1 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.

9.2 FIRST AID BOX

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

9.3 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.

9.4 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.

9.5 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.

9.6 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.

10.0 DIESEL GENERATOR SETS

10.1 INTENT OF SPECIFICATION

10.1.1 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.

10.2 SCOPE OF WORK:

TECHNICAL SPECIFICATIONS OF DG SETS & ASSOCIATED WORK

The Scope of work shall include under this specification design, manufacture, supply, loading, unloading, storage, installation, testing and commissioning of the Diesel engine alternator sets including labour, tools, tackles and plants, steel fabrication and items as prescribed below:

- ▶ Diesel engine alternator set complete with base frame and accessories.
- ▶ Engine mounted engine control integral panel duly wired up to terminal box for engine safeties with sensors and protection for inter facing with PLC/Microprocessor based relay.
- ▶ Fuel oil system including day service oil tank, piping, valves, filters etc. from engine to service day oil tank.
- ▶ Lube oil system with piping etc. (Pre-lube oil pump with controller if required).
- ▶ Cooling system with radiator, heavy duty suitable for 50⁰C operation complete with make up water tank.
- ▶ Exhaust emission shall meet EURO II norms without catalytic converter or online scrubber as required and residential silencer, exhaust piping with mineral wool insulation and aluminum cladding as called for.
- ▶ Steel fabricated structure/support/hanger including fixing, grouting and bolting etc.
- ▶ Painting of steel work.
- ▶ L.T. / Control cabling.

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

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

All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration.

Minor civil work is included in the contractor's scope of work. However, the responsibility of coordination with the civil and other contracting agencies ensuring completion of turnkey contract rests with the contractor and shall be certified.

Contractor shall co-ordinate with all other agencies working at site for interconnection and safety aspects.

Also the D.G. Supplier will furnish a combined guarantee minimum for one year from the date of successful commissioning for the entire equipment, In case there is any defect the free replacement of any part or in whole will be made immediately at not loss to Owner.

10.03 FEES & PERMITS

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

10.04 CODES & STANDARDS

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

Some of the applicable standards are listed below :

BS- 5514/ISO 3046/DIN 6271	Reciprocating internal combustion engines
BS – 4613	Electrical performance of rotating electrical machine
BS – 4999/5000	Applicable parts of BS 4999/5000
IEC-34-1/IS-4722/VDE 0530	Specification for rotating electrical machines.
IS – 4889	Method of determination of efficiency of rotating electrical machinery.
IS – 6491	Degrees of protection provided by enclosures for rotating electrical machinery.
IS – 4729	Measurement and evaluation of vibration of rotating electrical machines.
AIEE – 606	Recommended specification for speed governing (1959) of internal combustion engine generator units.
IS – 2705	Current transformers.
IS – 1248	Electrical indicating instruments.
IEEE – 115	Test procedure for synchronous machine.

10.05 DESIGN

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the contractor shall be complete in all respects. Any material or accessories, which may not have been specifically mentioned, but which are usual and necessary for the satisfactory and trouble free operation and maintenance of the equipment shall be provided without any extra cost to the purchaser.

10.06 PERFORMANCE REQUIREMENT

The equipment shall be capable of delivering power continuously at the generator

Terminal, a net output not less than the specified value at 0.8-0.95 p.f. excluding auxiliary power (shall be included over and above), when operating under the site ambient conditions described in this specification. Gen Set should be capable of taking 100 % step load & it should be able to take full load in less than 25 sec. from start. (The set shall be suitable for prime duty).

The design parameters of the generator and excitation system shall be chosen that the set is stable while running at any load between no – load and full load and also during starting of motors. It should also have isosynchronous speed control with load sensing governing system suitable for parallel running of D.G. sets.

Engine should be heavy duty four strokes, turbo charged after cooler ‘V’ construction/in line electric start. Engine should have minimum lube oil change period 300 Hrs. Bidders are required to offer the Duplex filter system for lube oil and fuel oil in case of non compliance.

The set shall have vibration limit less than 250 microns (as per BS:4999 Part – 142)& noise level shall be (105-110 db (a) at 1 mtr) under all conditions of load. The set shall be dynamically balanced. The set shall be mounted directly on the inertia foundation or with foundation bolts/AVM pads etc. as required. The efficient residential silencer shall be provided with or without catalytic converter on-line scrubber & the set shall meet EURO-II norms for D.G Sets, for the exhaust. Air inlet shall also be provided.

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

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

The engine shall be stationary, compression ignition, totally enclosed, water cooled, 4 stroke direct injection, cold battery starting, turbo charged and low temperature with after cooled Radiator Cooled 1500 RPM in accordance to BS 5514 and IS: 10002 complete with all accessories.

The D.G. engine shall be suitable for black start & should be able to pick up 100% load within 25 seconds.

The DG engine & the batteries shall be designed to take up at least six starting attempts beyond which the system shall be protected by means of an over crank relay. Calculations for battery sizing and battery charger capacity shall be submitted for review of the consultants. The successful bidder will submit shop drawing of the equipments/accessories selected for this work for the approval of Consultant/Employer.

10.07 SERVICE INTERVAL AND OPERATION

The set shall be capable of running at full load for not less than 300 hrs continuously. The change period both for the lube oil, lube oil filters shall be minimum 300 Hours of operations, in the event the change period for above consumables false short below the specified time period as above, bidders are required to quote for duplex type filters with oil make up systems.

The time to Top overhaul, major overhaul & maintenance schedules shall be specified by the bidders.

10.08 DIESEL ENGINE - CONSTRUCCION

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

- ☞ M.S. base frame with anti-vibration mountings.
- ☞ Crankcase – Aluminium alloys.
- ☞ Crank shaft, connecting rods –Forged Alloy Steel.
- ☞ Pistion – AL alloy casting.
- ☞ Piston rings – Alloy Steel.

- ☞ Engine Block – Cast Iron
- ☞ Cylinder Liner – Cast Iron

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

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

All externally mounted hardware shall be high tensile steel only.

The normal speed of the engine shall be 1500 RPM and the direction of rotation shall be clearly marked on the set.

The engine shall be fitted with an exhaust gas driven turbo charger of air / water cooled type complete with its own self contained lubricating system. The turbo-charger shall be positioned at the free end of the engine preferably

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

Fuel injection and valves shall not require frequent adjustment while in service.

All filters like fuel, lubrication oil, by pass etc shall be provided in the engine and shall be dry, paper element type.

Starting system shall be 24V DC comprising of batteries, Voltage regulator and arrangement for initial charging of batteries.

Bed Plate

The bed plate shall be fabricated from M.S. channel. The welding shall be radio graphed, and the entire fabrication shall be stress relieved after welding. The bed plate shall have integral well ribbed diaphragms for supporting the main bearing housings.

Crank Case

The crank case shall be steel construction with heavy steel plates to form water compartments around the cylinder. To facilitate access for purpose of inspection, inspection ports shall be provided.

Lube-Oil Priming Pump

An A.C. motor driven intermittent operation lube-oil priming pump shall be provided. This shall also include necessary piping, fitting instruments etc. for lubrication system along with clock timers if required.

Crank Shaft

The crank shaft shall be made of high tensile strength steel forging, and shall have a suitable flange to which the flywheel shall be bolted.

The bearing journals and fillets shall be induction hardened; and fully balanced.

Main And Big End Bearings

The main and big end bearings shall be detachable shells of high grade bearing material, and shall be pre-finished.

Connecting Rods

The connecting rods shall be of high grade drop forged steel I - beam section, centre to centre length. The rods shall be rifle drilled for pressure lubrication of piston pin. The rod shall be tapered at piston pin end provided to reduce unit pressures. The piston pin of suitable diameter shall be full floating and made of tubular steel, and retained by a snap ring.

Cylinder Liners

The cylinder liners shall be replaceable wet liners, cast iron alloy, and provided with specially machined grooves in their bores to give an oil retaining surface. These liners shall be easily replaceable without re-boring the block.

Piston

The piston shall be made of forged aluminum alloy, cam ground and machined on outer surface. The piston shall be fitted with an oil scraper ring, and compression rings of hardened cast iron alloy. The piston shall be oil cooled.

Camshaft

The camshaft shall be of induction hardened steel alloy with gear drive, and one of this shall be provided for each block of cylinders.

Exhaust Manifold

The exhaust manifold shall be multi-branch, of insulated design utilizing Ni-resist casting.

Flywheel

The flywheel, which shall conform to requirements of NEMA/ASA/BS codes, shall be made of mild steel statically balanced after machining and shall have graduated markings around the periphery / markings for checking of the valves can also be located on the vibration damper. Barring slots shall be provided around the flywheel rim for hand-barring/ alternatively a suitable barring arrangement should be provided.

Governing System

The governor shall be Isochronous, electronic digital type with a steady state frequency variation of $\pm 0.25\%$. The transient performance shall comply with ISO 8528-5, Class G3 requirements.

It should be possible to adjust the over speed settings on the governor by means of digital signals Manual adjustments for over speed trip settings are not preferred.

10.09 HEAT EXCHANGER

The DG Set should be equipped with a Heat Exchanger for suitable operation.

10.10 ALARMS/TRIP (AUDIO AND VISUAL)

The following Alarm/Trip indications shall be provided as minimum with first stage as pre alarm & second stage as trip:

- ❖ High water temperature.
- ❖ Low lube oil pressure.
- ❖ Low fuel level.
- ❖ Low coolant level.
- ❖ Over crank
- ❖ Over speed

10.11 OTHER AUXILIARY EQUIPMENT/SERVICES

These shall be complete include the following:-

Silencer

Exhaust Silencer shall be residential type to reduce the noise level. Values for Pressure drop across the silencers to be indicated by the vendor.

Cooling

The engine shall be water cooled Radiator/heat exchanger type. Adequately designed for ambient conditions, 50 deg C.

10.12 DAY SERVICE FUEL TANK

Day service fuel tank shall be made of 2 mm thick MS sheet of 990 litres capacity for each set with all accessories such as oil level indicator, inlet pipe connection, outlet pipe connection, trough to collect spilt oil, air vent pipe with air filter, manhole with cover, low level and full level float valve arrangements with all fittings, interconnections between tanks and engine. The tank shall be provided with suitable calibration scale. The Fuel to be used for trials and acceptance tests shall be high speed diesel. First fill of 990 litres HSD per DG set required coolant and lube oil is included in the scope of this contract at no. extra cost.

10.13 PAINTING

The Contractor shall paint all exposed metal parts and equipment supplied by him. All sheet metal work shall undergo a process of phosphating, passivating and then sprayed with high corrosion resistant primer. The finishing treatment shall be of two coats of synthetic enamel paint of approved color. All piping shall be color coded.

10.14 ALTERNATOR

The alternator shall be brushless synchronous and suitable for 3 phase 415 Volts, 4 wire, 50 Hz, 0.8 p.f., 1500 RPM.

The alternator shall be suitable for coupling directly to the diesel engine It shall be Drip proof, screen protected as per IP 23. The alternator shall be single bearing type & self ventilating. The alternators shall be continuously rated and shall have class 'H' insulation with a temperature rise restricted to that of class F designed and built to withstand tropical conditions. It shall generally conform to BS: 5000 (part - 99) / standards listed above. The alternator shall be suitable for sustaining a 10% overload for 1 hour in any 12 hour period without injury. The terminal arrangement for alternator shall be suitable for Cable connections of adequate size to deliver the full load of the alternator.

The alternator shall also have a solid state type digital voltage regulator (D.V.R.) suitable for single running with control limits of 1% from no load to full load under normal load changes. It shall be of static type and complete with cross current compensation. The regulator shall be provided with voltage adjusting potentiometer, and shall be complete with all alarm contacts, internal wiring, etc.

The Engine and Alternator shall be direct coupled and mounted on a common rigid fabricated steel base frame with suitable vibration isolation system.

EXCITOR

Self excited, self regulated and providing alternator output regulation at plus or minus 0.25%. The alternator shall be provided with a pilot-excited, permanent magnet-excited generator (PMG) for superior short circuit capabilities. Bidders to specify sustained short circuit current capabilities for up to 10 seconds.

The alternator shall be provided with sealed Barings to give minimum service life of 40,000 Hours. The Bidders to specify the maximum rating of the motor that can be started direct on line without any base load, with 50% base load, restricting the Voltage depth to 20%.

INSTRUMENTATION

Instrumentation shall be provided and mounted on the Generator Set to monitor the following:

- ❖ Engine Speed
- ❖ Oil Pressure
- ❖ Water Temperature.

A Gauge Board shall be provided with all the indicators grouped together. The generator shall be provided with a microprocessor-based controller with a facility for remote start, remote annunciation, auto synchronizing and remote communication capability through the telephone /GSM network. It should be possible to monitor the parameters of the engine and the alternator and display the status of the faults on the DG set if any and generate a complete report on the PC individually or on a network. The following minimum monitoring & protection is required for the alternators.

Alternator Monitoring

- ☞ Current. (I1, I2, I3)
- ☞ Frequency
- ☞ Voltage (L-L & L-N)
- ☞ KVA
- ☞ KVAR
- ☞ Power Factor
- ☞ Percentage alternator duty heavily i.e. actual load / KW rating.

The Generator shall be protected against the following electrical faults

- Overload and short circuit
- Ground fault
- Over current
- Over frequency
- Under frequency
- Under Voltage
- Over Voltage
- Reverse power protection.

It should be possible to read the data i.e. Parameters and Shutdown status locally on the D.G Set. All the above Parameters should be displayed on The Local Control Panel through appropriate meters and status on faults should be indicated through a facia annunciator. It should be possible to display all the functions as above on a personal computer.

10.15 EXHAUST SILENCER PIPING

The exhaust silencer piping system shall be of heavy duty MS pipes conforming to Class - B. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendations of the manufacturer. Exhaust pipe along with silencer inside the building shall be provided with mineral wool insulation with chicken mesh wrapping and 26 SWG aluminum cladding. All terminal connections and pipes joint shall be of welded construction. The terminals of sizes 2" and above shall be butt welded, and of sizes 1.5" and below shall be socket welded, complete with flanges, jointing and fasteners. This welding shall be done as per relevant ASME/ASA codes. The Contractor will have to indicate beforehand the

welding procedure he proposes to use. After confirmation by the Project Manager the procedure which is finalised shall be strictly adhered to.

10.16 TESTS AT MANUFACTURER'S WORK

The following tests shall be performed at manufacture's works prior to packing and dispatch to site and test reports for the same shall be furnished.

On DG Set

- ▶ Maximum power load capacity.
- ▶ Maximum motor starting capacity
- ▶ Endurance test.
- ▶ Fuel consumption at full load, 50% load, 75% load and 25% load.
- ▶ Engine - Alternator cooling air flow
- ▶ Load acceptance Test

On the Alternator

- ▶ High voltage tests on stator and rotor windings.
- ▶ Insulation resistance of stator and rotor windings.
- ▶ Temperature rise test.
- ▶ Measurement of resistance of stator and rotor windings.
- ▶ Measurement of losses.
- ▶ Mechanical balance.
- ▶ Load rejection and over speed tests.
- ▶ Stator voltage and current tests.
- ▶ Stator phase sequence check.

All routine test as per IS/BS codes shall be conducted on alternator, exciter and AVR.DG Panel shall be part of main L.T. Panel, supplied by the Owner. However DG supplier shall do the coordination and provide all the inputs required for successful operation.

10.17 INSPECTION AND TESTING AT SITE

All pre-commissioning and commissioning test and checks shall be carried out at site. The Contractor shall be required to produce manufacturer's test certificate for the particular batch of materials supplied to him by the manufacturers. The test carried out shall be as per the relevant standards. For examination and testing of materials and the works at site, the Contractor shall provide necessary testing and gauging equipment as required. All such testing and gauging equipment shall be tested for calibration at any approved laboratory as required by the Project Manager. The Contractor shall give notice well in advance to the Project Manager before commencement of any site testing. All materials like consumable stores, fuel oil grease, lubricating oil etc. required for the trails shall be arranged by the contractor. The Contractor shall make all necessary hook-ups to carry out tests at site and shall furnish necessary fuel. The complete installation should be initially started and checked out for operational compliance by manufacturer's representative.

10.18 TRIALS (AT SITE)

Preliminary Trials

After completion of erection of generating sets and before carrying out main trials, preliminary site trials shall be conducted in the presence of the Project Manager. Such trials shall include the

checking and adjustments of all instrument relays, timers, interlocks and meters. Insulation resistance of stator, rotor and exciter windings shall be checked and reading recorded. A check shall be made for the satisfactory working of all auxiliary motors and their starting accessories supplied with the set.

Main Trials

The main trials shall include over 8 hours continuous run at full load. D.G. Panel shall be tested for automatic operation by injecting proper current and voltage by a separate source. The satisfactory working of automatic operation shall be tested and necessary adjustments shall be done for relays in the presence of the Project Manager and the results shall be recorded in the test sheet at 30 minutes intervals. Alternator efficiencies as determined in works test shall be used as the basis of calculation for fuel consumption rate. A tolerance of 5% shall be allowed on the fuel oil consumption to cover possible errors in measurement. Tests providing the satisfactory performance of all safety and operating controls shall be carried out. Governor trials shall be carried out as laid down in BS: 5514. Alternator insulation resistance and commutation check shall be as per BS: 5000. Starting time of sets shall be tested at least five times after sufficient time intervals to allow for cold start. On completion of tests, inspection doors shall be removed and running gears inspected and alignment checked. Any further reasonable trial as suggested by the Project Manager shall be carried out with no extra charges. All instruments, materials and labour required for carrying out the trials shall be provided by the Contractor. Test sheets of trials shall be forwarded in quadruplicate to PROJECT MANAGER.

10.19 TEST WITNESS

Tests shall be performed in the presence of Project Manager. The contractor shall give at least thirty (30) days advance notice of the date when the tests are proposed to be carried out.

10.20 PERFORMANCE REQUIREMENT

The D.G. set shall operate upto 110% of rated speed, without undue vibration and noise. The unit shall be capable of delivering rated output at 0.8 p.f. at the generator terminals (after derating of the engine due to site conditions).As soon as the set attains rated speed the transient voltage drop at the generator terminal shall not exceed 15% of rated value.

GURANTEED TECHNICAL PARTICULARS OF DG

1.1	ENGINE	
	Rating	
	i) Minimum Engine Rating	Matching
	ii) Altitude (m)	Less than 1000m above mean sea level
	iii) Air humidity	30% Min. 95% Max.
	iv) Air temperature (°C)	Minimum 42
		Maximum 50
		Average 40
	v) Duty	Prime Continuous rating duty at specif ambient air Temperature of 45°C

	vi) Standard	BS 5514 and IS 3046
1.2	Overload capacity for one hour	10% over the continuous rating. In 12 hours continuous running.
1.3	GOVERNOR	Electronic Isochronous digital type
1.4	Starting i) Method ii) No. of auto starts iii) Selectivity	Electric 3 (three) Auto/Manual/Test
1.5	Cooling System i) Heat exchanger/Radiator	Yes
1.6	Exhaust System i) Silencer ii) Flexible connection iii) Scrubber	1 No or more as required Residential type. 1 No for each exhaust pipe near the engine. Nil.
1.7	Safety Controls Instruments i) Two-point thermostat ii) High water temperature iii) Low oil pressure iv) Fuel level low v) Oil Pressure gauge vi) Water temperature gauge vii) Hour counter	Audible & visible alarm Trip engine with trip indication Audible visible alarm Trip engine Audible & visible alarm Yes, required Yes, required Yes, required
1.8	Sundry fittings i) Vibration mounts	Yes, required with vibration, isolation efficiency up to 95% or more.
2.0	ALTERNATOR	
2.1	Rating at 40 Deg. C (ambient air Temp.) Continuons duty	Alternative - I 1400 KVA, (1200 KW), 10% over load for 1 hour in 12 hours
2.2	Minimum efficiency %	94.00
2.3	Enclosure	IP – 21 or better
2.4	Winding	Class H
2.5	Cooling	IC 01 IS-6362
2.6	Excitation System	Brush less exciter with rotating diode assem
2.7	Over speed %	120

2.8	Transient response & Response voltage dip	Bidders to specify largest motor to be star on DOL with no base load & with 5 base load, TVD to be restricted to 20%.
2.9	Sustained short circuit	Bidders to specify maximum SC capability 10 seconds
2.10	Terminal Box	Suitable for Al / Cu Bus duct deliver the rated current.
3.0	FUEL OIL FACILITY	
3.1	Day tank (14 SWG steel)	990 litres complete with, over flow, drain, filter and gauge glass and level controller etc.
3.3	Piping	From day tank to engine set
4.0	COOLING	Heat exchanger/Radiator type
5.0	ACOUSTIC ENCLOSURE DETAILS	
	Structure	MS Press bent 2 mm
5.1	PANELS	
	Type	Steel Fabricated double wall insulated panel
	Panel Thickness	75 mm thick
	Outer Sheet	1.75 mm thick minimum CRC Sheet
	Inner Sheet	1.00 mm thick CRC Perforated Sheet
	Frame & Stiffener	2mm thick CRC Sheet
5.2	INSULATION	
	Type	Rock wool of reputed make.
	Thickness	75 mm thick
	Density	96 Kg/m ³
	Anti droning	HDPE Sheet
	Thickness	6mm thick
5.3	AIR CIRCULATION SYSTEM	
A	AIR Intake	
	Type	Axial Flow Fan
	Make	Techno Mac or Equivalent
	RPM	1440/2800
	Motor	KIRLOSKAR/SIMENS/ABB/Cummins Equivalent
B	Air Exhaust System	

	Type	Axial Flow Fan
	Make	Reputed Make
	Speed	1400/2800 RPM
	Motor	KIRLOSKAR or Equivalent
	Qty.	1 No. For Air Exhaust
5.4	SILENCER HOOD INTAKE	
	Type	Air Intake Hood
	Qty	2 Nos.
	Design	With Acoustic Splitter & Baffles Insulated Hood Cover
	FINISHING	Weather Proof “ POWDER COATED “
	Sound Reduction (min)	Insertion loss of 25 db(A) at one mtr.
5.5	Protection CT's for each DG set	
	3 nos of cast resin CT's requires at alternator side including the bus extension and the box for differen protection .	
	3 nos spare CT's to be supply by the vendor of the same specification a.	

Notes: Deviation if any, from the data sheet shall be specifically brought out by the tenderer and no extra payment will be made if any deviation .

10.21 COOLING TOWERS AND WATER CIRCULATING EQUIPMENT

10.21.1 GENERAL

The various items of the water circulating system shall be complete in all respect and comply with the specification given below. The total sound intensity with all fans in operation shall not practically exceed 65 db at the distance of 3 mtrs, from all around the cooling towers.

10.21.2 COOLING TOWERS (FRP CONSTRUCTION)

The cooling towers shall be of FRP, Vertical induced draft type complete with FRP basin FRP body, fan and motor assembly, fill media, distribution pipes etc.

10.21.3 GENERAL CONSTRUCTION

The body shall be made of FRP (Fibre glass reinforced plastic) section of equal segments, all bolted together. The surface on both inside and outside shall be smooth, for minimum air resistance. The fan deck shall form an integral part of the body. The structural strength of the body shall be sufficient to withstand wind velocities upto 60 m / sec. Vibrations and earth quake.

The water basin shall also be of F.R.P. Having an auxiliary suction tank, at the bottom. The basin shall be complete with connections for drain, overflow, makeup water, quickfill and float valve, plus hot dipped galvanized stainer.

The support structure for the tower shall be of mild steel duly hot dipped galvanized.

The water diffusion deck shall be of rigid PVC fill in Honeycomb design, arranged in a suitable pattern for ease of replacement. PVC fills shall be of high efficiency.

The colour of the cooling tower body shall be of the owner / architect choice.

10.21.4 WATER DISTRIBUTION SYSTEM

The hot water shall be distributed through a sprinkle system consisting of PVC sprinkler pipes, which shall be mounted on the top of the main supply stand pipe.

Each cooling tower shall have twin header system coupled with gravity flow distribution system.

10.21.5 FAN ASSEMBLY

The fan shall be of axial flow type with cast aluminium multiple blades of aerofil design and adjustable pitch. The fan assembly shall be statically balanced. The fan outlet velocity shall not be less than 10 m/s and the tip speed shall be below 4500m / minutes.

The fan shall be directly mounted on the motor or through speed reduction gears. In the latter case, the housing shall be of heavy cast iron, construction with large oil reservoir.

The fan motors shall be totally enclosed fan cooled squirrel cage type conforming to I.P. 55 Protection for outdoor operation.

The fan guard shall be hot dipped galvanized with wire mesh screen to prevent bird nesting during idling period.

10.21.6 LADDER

All towers, whose height exceeds 2.5 mtrs, shall be provided with a ladder, made out of hot dipped galvanized M.S. Tubes.

10.21.7 PUMP SETS

The pump sets shall be mono block type with end suction and top discharge flanged connections directly mounted on the drippro of squirrel cage induction motors and suitable starter as specified.

The impeller shall be of Bronze, single entry shrouded design, and properly balanced.

Water seal shall be of mechanical type to minimize water leakage and should be easily serviceable in the field.

Motor and starter shall conform to relevant specifications and of rating given in 'schedule of quantities'.

10.21.8 MISCELLANEOUS

The following items to be provided:

Water pressure gauge at inlet and outlet of each pump complete with gauge cocks and connected tubing. (To be priced separately)

Vibration isolation pads for each pumps.

Drain line from each pumps upto drain pilt,(priced saperately).

10.21.9 INSTALLATION AND TESTS

The cooling towers shall be mounted on the beam/ steel structure member, provided Contractor and shall be unconnected with the roof slab. All nuts / bolts etc. for mounting shall be provided by thE Contractor.

On installation of the capacity of the cooling towers shall be checked by measuring water flow rate, water IN and OUT temperature and the ambient W.B. Temperature and then computing the capacity and efficiency.

The pumps sets shall be mounted on cement concrete foundation which shall be provided by HVAC contractor including grouting nuts, bolts, channels etc. shall be provided by the contractor.

On installation the capacity of the pumps shall be cheked by measuring water flow. Motor current and pressure difference at inlet and outlet. The reading shall be recorded to compare actual performance with the specified data.

Magnetic level switches shall be provided for low level alarm, in each cooling tower.

10.21.10 PIPE WORK

General :

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

Pipes

All pipes in sizes 200 shall M.S. E.R.W. tube (black steel) heavy class as per I.S. 1239-79, Part -1 with amendment-I of January '81. All pipes above 150 mm dia shall be minimum 6.4 mm thick.

Fittings :

The dimensions of the fittings shall conform to I.S. 1239/69 Part-II unless otherwise indicated, in the specifications.

All bends in sizes upto and including 150 mm dia, shall be ready, made of heavy duty, wrought steel of appropriate class.

All bends in sizes 200 mm and larger dia, shall be fabricated from pipes of the same dia and thickness, with a minimum of 4 sections, and having a minimum centre line radius of 1.5 diameter of pipes.

All fittings such as branches reducers etc. in all sizes shall be fabricated from pipes of the same dia. And thickness and its length should be at least twice the dia of the pipe.

The branches may be welded straight to the main line without making a saprate fitting, where specified on drawings or required by engineer-in-charge.

Blank ends are to be formed with flanged joints and 6 mm thick blank between flange pair for 150 mm and over, in case where, a future extension is to be made otherwise blan and discs of 6 mm thickness are to be welded on, with additional cross stiffners from 50mm x 50mm M.S. Heavy angles, for sizes upto 350mm. All ends larger than 400 mm dia shall have dished ends.

Flanges.

All flanges shall be of mild steel as per I.S. 6392/71 and shall be steel slip-on-type, welded to the pipes, flanges thickness shall be to suit class-II pressures.

Flanges may be tack welded into position, but all final welding shall be done with joints dismounted. 3 mm thick gaskets shall be used with all flanges joints. The gaskets shall be fibre reinforced rubber as approved by the Engineer-in-charge. Special adhesive compound shall be used between flanges of steam, air and gas lines.

Flanges shall be used as follows :-

Counter flanges for equipment having flanges connections.

Flanged pairs shall be used on all such equipment, which may require to be isolated or removed for service e.g. Pumps, refrigeration machines air handling units etc.

All thread valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main line for repair/replacement.

Valve :

Butterfly Valves

The butterfly valve shall consist of cast iron body preferably in two piece construction.

The discs shall consist of disc pivot and driving stem shall be in one piece centrally located.

The valve seat shall be synthetic material suitable for water duty. It shall line the whole body.

The discs should move in slides bearing o both ends with 'o' ring to prevent leakage.

The handle should have arrangement for locking in any set position.

All gate valves and check valves upto & including 65 mm dia shall be of gunmetal screwed type, conforming to class 2 of I.S. 778. and shall be with I.S.I marking and certification.

All gate valves and check valves upto 80 mm dia and above shall be of cast iron flanged type, conforming to class 2 of I.S. 780/69 (for sizes upto 350 mm) and of I.S. 2906/69 (for sizes 350 mm and above) marking and certification.

All gauge cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).

All drain valves shall be of gunmetal with a hose union connection of one hand.

All valves on the supply of fan coil units shall be of gunmetal ball type with integral water strainers, having (BSP) fpt inlet and flare type MPT outlet connection.

All valves on the return line of fan coil units shall be as in 5.6 but without integral water strainer.

Balancing Valves :

The balancing valves upto 80 mm dia shall be of gunmetal screwed type conforming to B.S. 5154 or equivalent specifications.

The valves shall be cast gunmetal ASTM B-62 and complete with non rising spindle. PTFE disc seal cast metal hand wheel.

The port opening shall permit precise regulation of flow rate, by accurately measuring the pressure drop across the port.

The valves shall be complete with two ports for connection to a mercury manometer, to measure the pressure drop, as well as a drain port.

The spindle shall have shielded screw to set the flow at the desired level.

The valves shall be used wherever specified.

Strainers :

The strainers shall either be pot type or 'Y' type with cast iron or fabricated steel body, tested upto pressure applicable for the valves as shown on the drawings.

The strainers shall have a perforated bronze sheet screen with 3 mm perforation and with a permanent magnet, to catch iron fillings.

Pot strainers shall be provided with flanged connection and 'Y' strainers shall be provided with flanged ends.

The strainers shall be designed to facilitate easy removal of filter screen for cleaning without disconnection of pipe line.

Jointing

All pipes line shall be welded type.

Square cut plain ends will be welded for pipes upto and including 100 mm dia.

All pipes 125 mm dia or larger will be beveled by 35 deg before welding.

Miscellaneous :

Provide all pipe work as required to make the apparatus connection complete and ready for regular and safe operation. Unless otherwise noted, connect all apparatus and equipment in accordance with manufacture's standard details, as approved by Engineer-in-charge.

Unless otherwise specified, pitch the lines of piping as follows:-

All condensation drainage, including air handling unit and fan coil unit shall be pitched in the direction of flow to ensure adequate drainage, with an adequate trap seal to prevent leakage of air due to static pressure developed by airconditioning units. Pitch, 20 mm per meter wherever possible, but not less than 10 mm per meter.

Drains from other equipments shall be pitched similarly without trap seal.

Provide valves and capped connections for all low points in piping system, where necessary or required for draining system. Provide isolating valves & drain valves in all risers to permit repairs without interfering with the rest of the system.

Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion. To facilitate the maintenance, repair and replacement.

Provide shut-off valves where indicated and for individual equipment, units at inlet and outlet, to permit unit removal for repairs, without interfering with the remainder of the system. Additional shut-off valves shall be provided as required to enable all systems to be fully sectionalized. By-pass and stop valves shall be provided for all automatic control valves as specified.

Arrange piping for maximum accessibility for maintenance and repair, locate valves for easy access and operation. No valves shall be installed with handles pointing down, unless unavoidable.

Cut the pipes accurately according to measurements, established site & Work into place without springing or forging.

Pipe supports shall be adjustable for height and primecoated with rust preventive paint

& finish coated with grey paint, both as approved by engineer-in-charge. The spacing of Pipe supports shall not be more than that specified below:-

Nominal pipe size mm	spacing (meters)		
15	1.25
20&25	2.00
32,30,50,&65	2.50
80,100,&125	2.50
150&Above	3.00

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic approved dash fasteners.

Insulated piping shall be in such a manner as not to put undue pressure on the insulation, such as providing teak wood block between pipe and support.

Where pipes are to be buried under ground, they should be coated with one coat of bituminous paints. The top of the pipes shall not be less than 75 cms. From the ground level. Where this is not practical permission of engineer-in-charge shall be obtained for burying pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15 cms. After the pipes have been laid and top sand cushion proved, the trench shall be refilled with the excavated soil, excess soil shall be removed from the site of work by the contractor.

Hangers & Supports :

Hangers & supports shall be provided and installed for the piping and tubing wherever indicated, required or otherwise specified. Wherever necessary, additional hangers and support shall be provided to prevent vibration or excessive deflection of piping and tubing.

All Hangers & supports shall be made of steel or other durable and non-combustible material, given two coats of primer red oxide and then painted with aluminium colour paint. Wood wire or perforated strap iron shall not be used as permanent hangers or supports.

Hangers shall be supported from structural steel, concrete inserts & pipe racks, as specifically approved.

No hangers shall be secured to underside of light weight roof decking and light weight floor glass.

Mechanical equipment shall be suspended midway between steel joists and panel points.

Drilling or punching of holes in steel joist members will not be permitted.

Sleeves :

Where pipes pass through floors, walls, etc provide Galvanized steel pipe sleeves 50 mm larger than outside diameter of pipe. Where pipes are insulated, sleeves shall be large enough to allow ample clearance for insulation.

Where pipes pass through outside walls or foundation, the space between pipe and sleeve shall be caulked with lead wool and oakum.

The centre of pipes shall be in the centre of sleeves, and sleeves shall be flush with the finished surface.

Expansion or Contraction :

The contractor shall provide for expansion and contraction of all piping installed by the use of swing connection and expansion loops.

Arrangement and alignment of Piping :

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.

The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceiling, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angle and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.

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

All piping shall be carefully installed to provide for proper alignment, slope and expansion

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

Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.

Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor Excessive in length, but shall be neatly, carefully bent at all change in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.

The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

Testing:

In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall the piping, appliance be subjects to pressures exceeding their test ratings.

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 blankoffs or flanges.

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 fitting shall be cleaned of all dirt, filling and debris.

All piping shall be tested yo 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 thw satisfaction of the engineer-in-charge, without any extra cost.

All the piping system shall be tested in the presence of the engineer-in-charge or their authorized representative. Advance notice of test dates shall be given 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.

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.

Miscellaneous piping, tests with air at 10.5kg/sq.cm for a minimum of 24 hours without drop in pressure.

The contractor shall make sure that proper noiseless circulation is 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.

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 contractor' properties, shall be borne by the contractor.

Painting:

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

All pipes, which are not to be insulated, shall then be given one coat of finish paint, of a type and colour, as per ISI code.

10.21.11 EXHAUST SILENCER PIPING

The exhaust silencer piping system shall be of heavy duty MS pipes conforming to class B. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendation of the manufacturer. MS screws flanges and bends shall be used as per site requirements. Exhaust pipe inside the building shall be lagged with heat resistive glass wool of 48 kg / mtr cube and then clad with Al. foil all along the pipe.

10.21.12 COOLING TOWER CAPACITIES

The cooling towers of adequate capacity to be installed at the terrace of the complex from where the common header of the cooling towers shall be brought down to the DG room in the basement. Soft water is required to be filled up in make up water tank for closed circuit cooling of engine. The contractor has to obtain the data from the Manufacturer for the requirement of the cooling tower capacity of the DG sets. The data for the Cummins engine is as followed:

DG Rating	Raw water Flow	Cooling Tower capacity	Recommened pipe size.
1500 KVA	1300 ltr / minute	150 TR	125mm
1010KVA	900 ltr / minute	100 TR	100mm dia.

The inlet temperature to the cooling tower shall be of 43.3 degree C.

The inlet temperature from cooling tower shall be of 32.3 degree C.

There shall be two common cooling tower for the DG sets. On the basis of data the size of common header and Pumps size min two nos with third no. standby shall be designed. The common header shall have temperature meters and butterfly/ Non return valves as required. While designing the Header of DG set shall be taken from the manufacturer.

10.22 Synchronisation System

10.22.01 The synchronisation panel shall be complete in all respects for auto operation of D.G. Sets as specified in BOQ. The minimum requirement for D.G. set operation shall be as detailed below, however, the vendor shall indicate in details the additional features and facilities being offered by them.

10.22.02 The parallel operation of D.G. set in Synchronization mode shall be completely through Cummins Engine Controller PCC 3.3/GCU/PLC. If synchronization & load sharing facility is inbuilt in engine controller require PLC for only load management facility. The PCCM shall be mounted on DG SETs outside the Building (the supplying and fixing of the PCCM is in the scope of Supplying and fixing of DG vendor Set). The PLC for the further operation shall be mounted on the Synchronizing panel with SLC 5/03 processor, kw transducer & suitable input /output card, 8 channel analog card Power Monitors – IV . The wiring between the DG Sets, PCCM and Synchronising Panel is in the scope of DG Vendor.

10.22.03 During the parallel operation, the system take care of the load sharing i.e. active and reactive both for all the D.G. sets. and issue soft commands for voltage / frequency raise / lower,

10.22.04 Depending upon the load requirements, the the system shall start / stop the D.G. sets.

10.22.05 Monitoring & logging of the electrical data and events through existing P C. This will be achieved by using microprocessor based PC controller or equivalent networking kits & required hardware like GCM, modlon convertor , communication cable.

10.22.06 Alarms and necessary remedial commands for D.G. and electrical system fault.

10.23.1 The following components shall be provided for each DG Set :

- a. Breaker control Switch except for DG Incomer.
- b. Automatic battery charger having inbuilt Trickle /boost facility selector switch for battery charger
- c. DC digital Ammeter and Voltmeter selector switch
- d. Auto/Manual selector switch for priming pump
- e. Breaker control switch (only for one number bus-coupler required)
- f. Indicating lamps (LED type) for following:
- g. R₁Y₁B, phase indication
- h. D.G breaker “ON”/”OFF” spring charged
- i. Neutral contactor “ON” /”OFF”

- j. Engine running
- k. Battery charger “ON”
- l. Control supply healthy
- m. Priming pump “ON” /”OFF”
- n. 8 window annunciator with alarm Accept/Test/Reset push buttons, Hooter.
- o. Temperature Scanners for RTD and BTD
- p. Beacon light
- q. Hour meter
- t 5 Nos Under voltage relay for mains feeder “
- r. 5 Nos Over Voltage relay for mains feeder “
- s. Stand by Earth fault relay “
- t. Reverse power relay (reactive) “
- u. Trip circuit supervision relay “
- v. Master trip relay “
- w. 5 H.P, DOL starter for oil priming pumps for D G Set
- x. Power factor meter (Analog)
- y. Frequency meter (Digital)
- z. Ammeter (Digital)
- aa. Voltmeter (Digital)
- bb. KW and KVA meter (Digital)
- cc. Kwh meter (Digital)
- dd. D.C. Ammeter (digital)
- ee. D.C.Voltmeter (digital)
- ff. Breaker Control Switch for bus coupler
- gg. Battery Charger on / off switch with boost and trickle charger facility
- hh. Trickle / booster charger selector, switch
- ii. Push buttons (lot)

- jj. P. T
- kk. Aux. Contactor (lot)
- ll. transducers

10.23.2 Automatic Generator Sequencing

- a) Automatically start & stop gensets based on plant load or bus on process demand.
- b) Configurable plant bus demand start / stop levels and timers.
- c) On line engine priority sequence configurability from any synch. Unit or PC to equalize run time of all DG sets.

11.0 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.

12.00 CAPACITOR PANEL

12.01 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. The panel shall include all the specified capacitor banks, switchgears, controller, filter reactors, control gears, busbars, meters, earthing, interconnections etc

12.02 RATING

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

12.03 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 (14%). 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.

12.04 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.

12.05 CAPACITORS

The capacitor shall generally conform to IS: 13585:1994 and IEC 60931:2002

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. It should be rated for 525V for 14% detuned reactor. The KVAR of Capacitor banks should be increased proportionately for combination of Capacitor + reactor.
- ii. Capacitor type: The capacitor unit shall be Ultra Heavy Duty APP type. The dielectric should be made of polypropylene. Capacitor Impregnation shall be Oil Type. Capacitor should be fitted with safety device for each capacitor unit. 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 1 minute as per clause 6.1 of IEC 60931
- v. Over current: 2.5x I_n
- vi. Peak inrush current withstand: 400 x I_n
- 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 AYFY cable as specified.
- ix. Separate earthing terminal shall be provided for earth connection of each bank.

De-tuned Filter

- Detuned filter reactor shall be used along with power capacitors to mitigate harmonics, improve power factor and to avoid electrical resonance in LV electrical networks.
- The low voltage filter Copper reactor shall be series type having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 60076.
- The permitted tolerance of inductance shall be + 3% of rated inductance value.
- The limit of linearity of inductance of the filter reactor shall be as follows $1.8 \cdot I_n$ with $L=0.95 \cdot L_N$.
- The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuits in case of high operating temperatures.

12.05 SWITCHGEAR & PROTECTION:

Incomer switchgear will be as specified in BOQ. Suitable rated Power Contactors or Special Capacitor duty 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 thru 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.

12.06 TESTS AT MANUFACTURER'S WORKS:

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

12.07 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:

12.08 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

13.00 TELEPHONE SYSTEM

13.01 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.

13.02 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 ELECTRICAL 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 accrue 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 onwards (Contractor must submit the documents for approval of manufacturer to HSCC/ Clients)
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/ Perkins/ Caterpillar/ MTU/ Kiroskar/Ashok Leyland/Greaves cotten
9.	Alternator:	Stamford/ AVK-SEGC/ Marathan/ Leroysoner, NGEF/ Crompton

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| 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 onwards (Contractor must submit the documents for approval of manufacturer to HSCC/ Clients) |
| 14. | ACB | L &T 'U' Power(Omega)/ Siemens 3WL/ ABB/
Legrand(DMX) Schneider (MG- Master Pact)/ GE-
Entelliguard |
| 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/Legrand |
| 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 |
| 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
25.	RCCB	L & T /Hager/ Legrand/ Siemens / GE/Schenider (Merlin –Gerin)/C&S
26.	HT/ LT XLPE cables	/Polycab/ NICCO/ UNIVERSAL/Skytone/ Havells
27.	Copper Control cable	Finolex/ Polycab/ NICCO/ Universal/ National/ Rallision/RR Cable
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/ Ankur/ Decon.
34.	Lamps	Philips/ Osram/ GE/Anchor (Panasonic)/
35.	GI / MS conduit ISI marked	BEC/ AKG/ Steel Kraft

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| 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 / R R cable/Rallison/Skytone/polycab |
| 40. | Modular Switches & sockets Outlets | Havell's (Crabtree- Atena)/ MK- Wraparound/ Hagger/ 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) |

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| 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 'Drug Ware House' located at various districts of Chhattisgarh.

3.0 Scope of work

The work proposed under this tender includes Supply, Installation, testing & commissioning of Air Cooled Ductable Split AC units, High Wall Split, Windows type Air-conditioning system and ventilation fans for the Drug Ware House.

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 Occupancy : App.60- 100 Sq.ft per person or as per actuals.
- vi Equipment Load : As per standards
- vii Electrical power supply: 415V/3 Ph/ 50 Hz, AC power supply

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

office areas and Drug ware: 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.

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/ through open space.

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

6.1 Civil works such as trenches for piping, cables and making foundations of equipment etc.

6.2 Main 3 ph, 415 v, 50 hz, A.C. supply power supply up to each panel of Ductable Split AC.

6.3 Main 1 ph, 220 v, 50 hz, A.C. supply power supply within 1 metre for Window & Split AC.

- 6.4 Any kind of false ceiling, boxing.
- 6.5 Making frames for fixing grilles & diffusers in false ceiling, boxing or in walls.

7.0 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.

8.0 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:

9.0 Technical Data

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

10.0 Performance Guarantee

- 10.1 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.
- 10.2 The contractor shall guarantee that the capacity of various components as well as the whole system shall not be less than specified.
- 10.3 The contractor shall ensure that the system shall be free of vibrations and disturbing sounds.

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.

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' 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

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 $+10^{\circ}$ 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 wires 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 alive 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 to be cross	40x40x3 mm at the rate of 1.2

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 x 1.5 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 foam 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 upto 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)
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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, impellor/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)	8.5
b)	Qty (cfm)	3400
c)	No of rows of coil (Minimum)	6
d)	No. of fins/cm of coil	5

2. **HIGH WALL SPLIT AIR CONDITIONER**

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

3. **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

LIST OF APPROVED MAKES AND MANUFACTURERS

The subcontractors/makes/brands of equipment listed below are approved for installation. All items to be used in the works samples, catalogues and specifications are to be submitted by the contractor for approval of the Engineer. Only approved makes shall be used in the works. The approved samples shall be kept in the custody of the Engineer for comparison.

S.No	Material/Item	Approved Makes
1	Propeller Fans	GEC(Alsthom)/Crompton Greaves/ Khaitan/Usha/Polar
2	Window/split/ ductable AC	Carrier /Hitachi/Voltas/Bluestar/Daikin/Ogeneral
3	VRV/VRF	Carrier /Hitachi/Daikin/Ogeneral
4	Cassette Units-Chilled water based	Daikin/ETA/Media/Bluestar
5	Inline Fans	Flakt/Nicotra/Comefri/ Kruger/System Air/Ostberg
6	Electric Panel (Main)	As per electrical LT panel
7	MCB	Merlin Gerin, Legrand,Hager,Seimens,ABB/MDS Lexic
8	Earthing	JMV or as per CPWD specs.
9	MCCB/ACB	L&T(U-Power)/ GE Power (record plus)/ Siemens(3WL)/ ABB(E-Max)/ Schneider(Masterpact NW)
10	Push button starter	L&T/ GE Power/ Siemens/ ABB
11	Auxiliary Relays/Contactors	L&T/GE/ Siemens/ Schneider
12	Line Type Fuse	L&T/GE/ Siemens/ Schneider
13	Timer	Siemens/Cutler Hammer/ GEC Alsthom
14	Terminal Block	Elmex/ Comex/ HMI
15	Voltmeter/Ammeter	L&T/GE/ Siemens/ Schneider
16	Indicating lamps	L&T/GE/ Siemens/ Schneider
17	Selector Switches	Siemens/L&T/Kaycee/GE
18	Control Cables	CCI/Universal/ICC/NICCO/INCAB/ National/Rallison Cables/Tyco/Finolex
19	Power Cables	CCI/Universal/ICC/Finolex/INCAB/Rallison Cables/Polycab/RPG/Havels
20	Cable tray	Steelways,Bharti,MM.Engg,Asian ancillaries,Dolphin,MEM
21	Cable lugs	Dowells/Lotus/PEECO
22	Ducting & Grilles	
23	Factory fabricated duct	Zeco/ Ductofab/Rolastar/Technofab

24	G.I. Sheet Metal Duct	Jindal /National/ Tata/Sail
25	Spiral duct	Atco/Seven Star
26	Grilles/Diffusers/Volume Controller	Ravistar/Caryaire/Dynacraft
27	Fire Dampers UL listed	Caryaire/Dynacraft / Ravistar/Ruskin
28	Sound Attenuator	Caryaire/Dynacraft/Ravistar/Trox
29	G.I. Sheets	TATA/SAIL/Jindal/Bhushan Steel
30	Aluminium Sheets	Balco/Nalco/Hindalco
31	Stick Pins	Prima Seal/Air flow
	Insulation	
32	Expanded Polystyrene	Beardsell Ltd./ BASF/Styrene Packing/ Indian Packaging Industries/ Lloyd
33	Glass Wool	FGP Ltd./UP Twiga/Kimmco / Owens Corning
34	Polyurethane Foam	Malanpur /Superurethane
35	Crossed linked Polyethylene Foam	Trocellene / Aeroflex/Armacell/
36	Closed Cell Elastomeric Insulation	K-flex /Vedoflex/Armacell
37	Non woven fibre material	Mikron/ Du pont
38	Mineral wool	Rockwool India Pvt Ltd/ Lloyed Insulation
39	Pre-moulded PUF section for pipe & pipe supports	Malanpur/ Lloyd Insulation
40	Fibreglass rigid Board/Pipe section	FGP Ltd./UP Twiga/Kimmco / Owens Corning
41	Aluminium Tape	Johnson/Birla 3M/Garware
42	Thermostats	Honeywell/Johnson controls/Belimo/Danfoss/Siemens/Oventrop
43	Humidistat	Honeywell/Johnson control/ Belimo/Danfoss
44	Electric Strip Heaters	Escorts/Daspass
45	Safety Thermostat for Heaters	Honeywell/siemens/Danfoss/Belimo
	Paints	
46	Enamel	ICI/ Asian/ Nerolac/ Berger
47	Bituminous	Shalimar
48	Tarfelt (for underground chilled water pipe insulation)	Shalimar
49	Sensors(Pressure/Temperature)	Siemens/Honeywell/Johnson controls/ABB/Schneider
	Miscellaneous	
50	V Belt	Dunlop/Fenner

51	Anchor fastners	Fischer/Hilti
52	Dash fastner	Fischer/Hilti
53	Welding rods	Advani/L&T
54	Wire Rope duct supporting arrangement	Gripple
55	Flexible pipe connection	Dunlop/Kanwal/resistoflex
56	Vibration isolator	Resistoflex, Dunlup, Kanwal
57	Air Ozone	Ruks/Trimed/RGF
58	Fire Sealant	Birla 3M/Hilti/Promat
59	Copper Refrigerant Piping	Diamond/Star/Rajco