AN ISO 9001 & 14001 COMPANY

TENDER DOCUMENT

TENDER No: DLI/CON/759/590

FOR

Construction of 100 bedded Hospital at Bhilai, Chhattisgarh for Employees State Insurance Corporation (ESIC).

VOLUME – II

ADDITIONAL CONDITIONS OF CONTRACT (ACC), TECHNICAL SPECIFICATION, APPROVED MAKES
Specifications

INSTRUCTION TO BIDDERS:

- All items of work under this contract shall be executed strictly to fulfill the requirements laid down under “Basis of Design” in the specifications. Type of equipment, material specification, methods of installation and testing and type of control shall be in accordance with the specifications, approved shop drawings and the relevant Indian Standards, however capacity of each component and their quantities shall be such as to fulfill the above mentioned requirement.

- The unit rate of all equipments or materials shall include cost in RUPEES for equipment and materials including all taxes and duties and also including forwarding, freight, insurance and transport into contractor’s store at site, storage – installation, testing, balancing, commissioning and other works required.

- The rate of each item of work included in the schedule of quantities shall, unless expressly stated otherwise, include cost of:
  - All materials, fixing materials, accessories, appliances tools, plants, equipment, transport, labor and incidentals required in preparation for and in the full and entire execution, testing, balancing, commissioning and completion of work called for in the item and as per Specifications and Drawings.

- Wastage on materials and labour.

- Loading, transporting, unloading, handling/ double handling, hoisting to all levels, setting, fitting and fixing in position, protecting, disposal of debris and all other labor necessary in and or the full and entire execution and for the job in accordance with the contract documents, good practice and recognize principles.

- Liabilities, obligations, whether such requirements are mentioned in the item or not. The specifications and drawings where available, are to be read as complimentary to and part of the Scheduled of Quantities and any work called for in one shall be required for all.

- All requirements of Specifications, whether such requirements are mentioned in the item or not. The Specifications and Drawings where available, are to be read as complimentary to and part of the Scheduled of Quantities and any work called for in one shall be taken as required for all.

- In the event of conflict between Schedule of Quantities and other documents including the Specifications, the most stringent shall apply. The interpretation of the Consultant/ project manager shall be final and binding.

- All equipments, quantities and technical data indicated in this Schedule are for the Contractor’s guidance only, these are based on the documents prepared by the Consultant. This schedule must be read in conjunction with other documents. The contractor shall be paid for the actual quantity of work executed by him in accordance with the approved Shop Drawings at the contract rates.

- The schedule shall be fully priced and the extensions and totals duly checked. The rates for all items shall be filled in INK including NIL items.

- No alteration whatsoever is to be made to the text or quantities of this Schedule unless such alteration is authorized in writing by consultant. Any such alterations, notes or additions shall unless authorized in writing, be disregarded when tender documents are considered.

- In the event of an error occurring in the amount of the schedule, as a result of wrong extension of the unit rate and quantity, the unit rate quoted by the tendered shall be regarded as firm and the extensions shall be amended on the basis of rates.
- Any error in totaling in the amount column and in carrying forward total shall be corrected. Any error, in description or in quantity, omission of items from this Schedule shall not vitiate this Contract but shall be corrected and deemed to be variation required buy the Consultant/ Project Manager.

- Rates have been called for a number of items of works, as alternatives which, for the present do not form part of the total value of tender. However the rates for these items shall be quoted, with due care so that in the event of choice of an alternative item of work, said rate shall form part of the contract any way

- The contractor shall procure and bring Materials/ Equipment to the site only on then basis of drawings approved for construction and shop drawings and not on the basis of Schedule of quantities which are provisional only. This also applies to the Contractor’s requisition for owner supplied materials.

- The mode of measurement shall be as specified in this book.

- The most important aspect is the INTENT of the specification. This needs to be followed, and the contractor shall do all that is required to meet the intent. The acoustics, vibration control form a major requirement of this intent, besides the functional requirements.
Specification

BASIC MECHANICAL (H.V.A.C.) REQUIREMENTS

1. REFERENCES
   A  BIS: Bureau of Indian Standards (Shall supercede for all ambiguity)
   B  ARI: Air conditioning and Refrigeration Institute (ARI-575)
   C  ASHRAE: American Society of Heating Refrigeration & Air conditioning Engineers
   D  ASME: American Society for Mechanical Engineers (ASME-Section-VIII)
   E  UL: Underwriters’ Laboratories Inc.
   F  Local Fire Codes and standard practices (Minimum) or NFPA. (If specified)

2. SUBMITTALS
   A  Under provisions of sample approval before the commencement of the project.
   B  Includes products mentioned in the Approved list of manufacturers as per the mode of approval mentioned in the list.
   C  Submit shop drawings and product data grouped to include complete submittals of related Systems, products, and accessories in a single submittal
   D  SHOP DRAWINGS
      Submit a copy of the shop drawings, including :
      1. Automatic temperature /Pressure control system.
      2. Concrete pads and foundations for the chiller.
      3. Trench locations if any.
      4. Operating and shipment weights.
      5. Chiller handling physical clearances on site.
      6. Sleeve location if any.
      7. Ventilation requirement (If any).
      8. Location of wall mounted equipment (If any)
      9. Any other structural inputs.
E

**BROCHURES:** Submit manufacturer’s product data and brochure including:
1. Complete description.
2. Illustrations.
3. Rating data, accessories, and dimensional data.
4. Capacities stated in the terms specified.
5. ARI certified computer generated selection as per conditions of the NIT (If Required).

F

**REGULATORY REQUIREMENTS**
Liaison/Approvals from the bodies mentioned below (or any other) if required shall be taken by the supplier on behalf of the client and at his own cost.
1. Customs/etc.
2. Local Fire Authority (As applicable)
3. LOCAL CODES
4. ARI (For certification of the chiller capacity as per conditions-of-contract)
5. ASHRAE

**DESIGN PARAMETERS**

**Water-Cooled Chillers:**
Performance rating of the chilling units shall be based on following design parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature of chilled water entering chiller</td>
<td>54°F (12.2°C)</td>
</tr>
<tr>
<td>Temperature of chilled water leaving chiller</td>
<td>44°F (6.6°C)</td>
</tr>
<tr>
<td>Fouling factor for chiller in FPS unit</td>
<td>0.0005</td>
</tr>
<tr>
<td>Temperature of condenser water entering condenser</td>
<td>90°F (32.2°C)</td>
</tr>
<tr>
<td>Temperature of condenser water leaving condenser</td>
<td>97.5°F (36.3°C)</td>
</tr>
<tr>
<td>Fouling factor for condenser in FPS unit</td>
<td>0.001</td>
</tr>
</tbody>
</table>

**Refrigerant for Chilling Units:**
HFC (R-134a)

**Power Consumption @ Full Load at tender conditions:** Shall not be more than or equal to 0.75 Ikw/TR.

**NPLV:** Shall be less than 0.39 Ikw/TR.

**Procedure for calculations shall be as per AHRI guidelines.**

**COP @ Conditions:** Shall be as per latest relevant ECBC standards.
( Minimum 5.4 COP)
EQUIPMENTS

WATER COOLED SCREW CHILLING MACHINE

SPECIFICATION--INTENT SHEET

1. ACCEPTABLE MANUFACTURERS
   A. As per list of approved manufacturers in annexures.

1.2 REFRIGERANTS
   A. Acceptable refrigerants: R-134a

TEST CERTIFICATES AT MANUFACTURERS TEST BED

It is necessary for the AC contractor to furnish detailed certificates of AIR Certified tests bed in the factory before dispatch of water chilling units. The AC contractor not conforming & complying with this condition shall render his offer liable for rejection.

2. WATER COOLED SCREW CHILLING UNITS

2.1 SCOPE

The scope of this section comprises the supply erection, testing and commissioning of the water chilling units conforming to these specification and in accordance with the requirements of the schedule of Equipment (3 Nos. 100TR Screw chiller (2W+1S))

2.2 QUALITY ASSURANCE

Compressor shall be dynamically balanced by the manufacture and over-speed tested by the manufacture at a minimum of 120% design operating speed. Each compressor assembly shall undergo a mechanical run-in test to check proper operation of various components and to verify that vibration levels, oil pressure /temperatures, and efficiency are within acceptable limits and designed for working pressure of 350 psig.

The cooler shall be designed for working pressure of 235 psig on refrigerant side and condenser shall be designed for 350 psig working pressure. The waterside of each heat exchanger shall be hydro-statically tested at 1.5 times rated working pressure.

Prior to shipment the chiller controls shall be power tested to verify proper control operation in the presence of the client/representative of client. (This is for Above 220 TR Capacity)

CHILLER EQUIPMENT

The water chilling units shall be complete in all respect and shall generally comply with the specifications as given in the following paragraphs. Each water chilling unit shall comprise of the followings:
- Semi-hermetic Screw Compressor with motor, base plate, drive guard, Starter
- Condenser with accessories and support.
- Cooler with accessories and support.
- Steel frame for mounting above components.
- Control panel with listed controls.
- Accessories as specified.
- Refrigerant piping to interconnect the above.
- Full charge of refrigerant and oil.
2.3 COMPRESSOR
The chilling machine shall have Positive displacement, Hermetic/semi-hermetic mono/twin screw type compressor of high performance type. Compressor section joints shall be sealed using O-Rings in lieu of gaskets to reduce the occurrence of refrigerant leakage.

The chiller shall be suitable for R-134a and shall be suitable for storage of refrigerant in chiller during servicing with variable refrigerant metering. The compressor casing shall be cast iron with design pressure rating of 300 psig or higher.

The compressor/motor shall be designed to operate at 2960 RPM input speed and 50Hz, 415 volts +/- 10%, 3 phase AC supply.

Capacity control:
Microprocessor activated slide valve, controlled by external solenoid valves via microcomputer control panel, fully modulating control from 100% to 25% of the capacity.

Oil System:
The oil feeding system shall be operated by differential oil pressure without using any electrical mechanism.

Safeties: High pressure switch, low pressure switch, high motor winding temperature, freeze protection thermostat, three-phase over current relay, reverse phase protection relay, pressure relief valve.

In the event of instantaneous power failure and resumption of power less than 3 minutes, the chiller should re-start automatically.

2.4 MOTOR
High efficiency screw compressor motor shall be of the single speed, non-reversing, and squirrel cage induction type suitable for 415 volts +/-10%, 50Hz. Motor designed speed shall be 2960 rpm at 50 Hz. Motor starter shall be star-delta type/with variable frequency drive (VFD) starter.

Motor shall be suitable for operation in a refrigerant atmosphere and shall be cooled by atomized refrigerant in contact with a motor windings.

Motor stator shall be for arranged for service or removal with only minor compressor disassembly and without breaking of main refrigerant piping connections. Full load operation of the motor shall not exceed nameplate rating.

2.5 WATER COOLED CONDENSER
Condenser shall be of shell and tube construction, each in separate shells. Both heat exchangers shall be fabricated with high-performance tubing, steel shell and tube sheets with fabricated steel water boxes. Water boxes shall be nozzle-in-head types with stubout nozzles having victaulic grooves to allow for use of victualic coupling.

Tubing shall be copper, high-efficiency type, with integral internal and external enhancement. Tubes shall be nominal ¾ inch OD with nominal wall thickness of 0.025 inch measured at the root of the fin. Tubes shall be rolled in to tube sheets and shall be
individually replaceable. Tube sheet holes shall be double grooved for joint structural integrity.

Water boxes and nozzle connections shall be designed for 235-psig minimum working pressure, unless otherwise noted. Nozzles should have grooves to allow use of Victuilaric couplings. The waterside of each heat exchanger shall be hydro-statically tested at least 1.5 times rated working pressure.

Pressure relief valves shall be installed on each heat exchanger.

Water boxes shall have vents, drains and covers to permit tube cleaning. A temperature sensor shall be factory installed in each water nozzle.

Cooler shall be designed so as to prevent liquid refrigerant entering the compressor. Tubes shall be individually replaceable from either end of the heat exchanger without affecting the strength and durability of the tube sheet and without causing leakage in adjacent tubes.

Hydrostatic, vacuum & pressure testing of the assembled chillers to ensure leak integrity.

2.6 EVAPORATOR
The evaporator shall be shell and tube dry-expansion type. It shall be designed for a working pressure of 235 psig.

The copper tubes shall be seamless of thermo fin corrugated tube. Tubing shall be copper, high-efficiency type, with integral internal and external enhancement. Tubes shall be nominal ¾ inch OD with nominal wall thickness of 0.025 inch measured at the root of the fin. Tubes shall be rolled into tube sheets and shall be individually replaceable. Tube sheet holes shall be double grooved for joint structural integrity.

The evaporator shell shall be factory insulated with 19 mm thick polyethylene.

The chiller shall be designed so as to prevent liquid refrigerant entering the compressor. Tubes shall be individually replaceable from either end of the heat exchanger without affecting the strength and durability of the tube sheet and without causing leakage in adjacent tubes.

Hydrostatic, vacuum & pressure testing of the assembled chillers to ensure leak integrity.

2.7 REFRIGERANT CIRCUITS
A multiple orifice control system, consisting of an electronically controlled expansion valve and a fixed orifice, to maintain proper refrigerant flow.

The chiller shall have Single or multiple compressors for capacity above 70 TR to 190TR with independent refrigeration cycle.

Chillers of 200 TR and above capacity shall have necessarily minimum 2 compressors with two separate modules to take advantage of 100% inbuilt flexibility and redundancy.

2.8 CONTROL PANEL
The chiller shall be provided with a factory installed and wired microprocessor control center with individual replaceable modular component construction. Component included shall be main processor / input-output module, power supply, and starter management module, relay board, temperature and pressure (thermistors and transducer) sensors.

The control center shall have a 16-line by 40/80-character alphanumeric liquid crystal display, four function keys, stop button, and alarm light. The microprocessor shall be configurable to display either English or SI metric units.
The default standard display screen shall simultaneously indicate the following information:

Date & time of day.
Chiller operating hours.
Entering chilled water temperature.
Leaving chilled water temperature.
Evaporator refrigerant temperature.
Condenser refrigerant temperature.
Oil supply pressure.
Percent motor rated load amps (RLA).

The default screen shall be display unless there is no manual activity at the control console for 15 minutes.

The microprocessor based panel besides providing the various features already elaborated earlier in this section shall also provide the following for compatibility with the building automation system:

- Start / Stop from remote.
- Run Status
- Trip Alarm
- Chilled water temperature reset
- Alarm indication for each cycle
- Current limitation control
- Automatic start after instantaneous power failure

The Microprocessor control panel should have a provision for connecting the unit to BMS.

The four function keys shall be software driven within the status, schedule, set point and service menu structures (as described below).

2.9 STATUS FUNCTION:-

In addition to the default screen, status screens shall be accessible to view the status of every point monitored by the control centre including:-

Evaporator pressure.
Condenser pressure.
Compressor discharge temperature.
Bearing oil supply temperature.
Motor winding temperature.
Number of compressor starts.

Control points settings.

Discrete output status of various device

16 spare input channels.

Compressor motor starter status.

2.10 SCHEDULE FUNCTION:

The Chiller shall start-up and shut down shall be manual or automatic. Automatic operation is activated by the user establishing an occupancy schedule based on a 365-days real time battery clock the small automatically start and stop the chiller according to a configurable stored time. Clock shall have battery back up. Two 365-days occupancy schedule, each with a minimum of 8 separate occupied / unoccupied periods may be scheduled by the user. The period can have any day of the week or holiday assigned to the occupied or unoccupied periods.

The chiller control panel shall have provision to be started and stopped from a software command of building management system.

2.11 SETPOINT FUNCTION:

The control shall provide the capability to view and change the leaving chilled water set point, entering chilled water set point, and demand limit set point shall be entered, stored, viewed or changed by depressing the set point function key.

2.12 SERVICE FUNCTION:

By depressing the service function key and entering a four-digit password the operator shall be able to:

View the alarm history file which contains up to 25 alarm/alert messages with time and date stamp.

Execute the chiller controls test function for quick identification malfunctioning components.

View/modify chiller configuration.

View/modify chiller occupancy periods.

View/modify system time and date.

View/modify schedule holiday periods.

View/modify override periods.

Capacity control of Microprocessor activated slide valve, controlled by external solenoid valves via micro-computer control panel, fully modulating control from 100% to 25% of the capacity (+/-0.5% degree F) of desired chilled water temperature without hunting or overshooting the set point.

The microprocessor shall automatically activate and interlock the chilled water pump, chiller activation.

Upon request to start the compressor, the control system shall start the chilled water pump.
condenser fans, verify that flow has been established, and then compare leaving chilled water temperature with the chilled water set point.

The control system shall include two compressor timers to protect the motor from rapid cycling, a 15 minutes minimum start to start time and a 1 minute minimum stop to start time. In addition the compressor shall be inhibited from restarting from if more then 8 manual starts within a 12-hour period have occurred.

The control system shall automatically cycle the compressor off to minimize energy whenever the leaving chilled water temperature is 5 degree F below the desired chilled water set point. The chilled water pump shall remain on, and when the leaving chilled water temperature rise above the set point by user configured amount, the compressor shall automatically be recycled back on. During the shut down period, a message shall be displayed informing the operator a recycle restart is pending.

The control centre shall monitor line voltage and if loss of voltage, high or low line voltage, or single cycle dropout is sensed, the chiller shall shut down. Upon restoration of line voltage, if the auto restart after power flyer algorithm is enabled in the configuration mode, the chiller shall automatically restart and resume the mode of operation prior to shutdown. The control centre shall allow reset of chilled water temperature rise across the evaporator. Optional input/output module shall be provided so the following can also be achieved:

Chilled water reset based on 4-20 mA signal.
Chilled water reset based on a remote temperature sensor (such as out door air)
Remote start/stop.
When reset is active an message shall be displayed indicating the type reset in effect.

The control center shall limit amp draw of the compressor to the rated load amps or to a value lower based on the following criteria:

demand limit based on a user input ranging from 40%to 100% of compressor rated load amps.
Demand limit based on external 4-20 mA signal.

When demand limit is active a message shall be displayed indicating the sources of the demand signal.

2.13 SAFETIES

Unit shall automatically shutdown when any of the following condition occur.(Each of these protective limits shall require manual rest and cause an alarm message to be displayed on the LCD screen informing the operator of the shutdown cause)

- Motor over current/ overload.
- Over voltage.
- Under voltage.
- Single cycle dropout.
- Bearing oil high temperature.
- Low evaporator refrigerant temperature.
• High condenser pressure.
• High motor temperature.
• High compressor discharge temperature.
• Low oil pressure.
• Compressor surge protection.
• Loss of cooler water flow.
• Starter fault.

Shall not required manual reset or cause an alarm if auto-reset after power failure is enabled.

The control system shall detect condition, which approach protective limits and take self corrective action prior to an alarm occurring. The system shall automatically reduce chiller capacity when any of the following are out normal operating range:

• High condenser pressure.
• Low evaporator refrigerant temperature.
• High motor temperature.
• High motor amps.

During the capacity override period, a pre alarm alert message shall be displayed informing the operator which condition is causing the capacity override. Once the condition as again within acceptable limits, the override condition shall be terminated and the chiller will revert to normal chilled water control. If during either condition the protective limit is reached, the chiller will shut down and message will be displayed informing the operator which condition caused the shut down and alarm.

2.14 DIAGNOSTIC AND SERVICE
The control system shall execute a series of pre-start checks whenever a start command is received to determine if pressures and timers are within pre-start limits thereby allowing startup to proceed. If any of the limits are exceeded an alert message will be displayed informing the operator of the cause of the pre-start alert.

A self-diagnostic control tested shall be an integral part of the control system to allow quick identification of abnormal system condition and malfunctioning chiller components. Once the control test has been initiated, all pressure and temperature sensors shall be checked to ensure they are within normal operating range. A pump test will automatically energise the chilled water pump. The control system will confirm water flows have been established and required operator confirmation prior to proceeding to the next test.

A manual control test shall permit individual selection and test of control components and inputs in addition to the automated control test. A thermistor test and transducer test shall allow display on the LCD screen of the actual reading of each transducer and each thermistor installed on the chiller. All sensors shall have quick disconnects to allow replacement of the sensor with out replacement of entire sensor wire.

FACTORY RUN TEST
Pressure and leak test of individual components before and after unit assembly. Complete factory run test of individual components before and after unit assembly.

**SHIPMENT**

Units shall be shipped fully assembled and wired ready for operation after field connection of power supply, electric interlocks and system water piping. The unit shall be factory charged with refrigerant.

The microprocessor based panel besides providing the various features already elaborated earlier in this section shall also provide the following for compatibility with the building automation system:

- Start / Stop from remote.
- Run Status
- Trip Alarm
- Chilled water temperature reset
- Capacity control.

**SOUND LEVEL**

The Overall sound level of the unit shall not exceed 82 dB measured at a point of 3 m from the center of machine surface and 1.5 m from the floor level.

**VIBRATION ISOLATION**

Chiller manufacture shall furnish spring isolators for mounting equipment on MS Gurder plate form or on RCC slab.
HOT WATER GENERATOR

SUBMITTALS
Submit product data including dimensions as shown in the tender drawings, ratings as mentioned in the tender document, and performance data for review.

PERFORMANCE
Certify unit components, in accordance with the specifications.

PRODUCTS
ACCEPTABLE MANUFACTURERS
As per approved makes enlisted in the annexures.
This is the intent of the specification, thus, the spirit of this guideline is to be understood and followed.

GENERAL
Hot water generator shall be vertical/horizontal in construction and suitable for floor installation.

The entire hot water generator shall be factor assembled and tested requiring only connection to water inlet, outlet and electrical main supply. Hot water generator shall be equipped with sufficient number of flanges and electrical immersion heaters.

The pressure vessel shall be constructed as per BIS standards (MS-sheet not less than 10 mm thick-IS-226), and flanges shall conform to Table BS-10. Top lids shall be dish type MS Flange IS-226, filter elements shall be 1 mm thick stainless steel having 3 mm perforation, bottom support shall be 4 No. vertical supports of MS channel 100x50, and the vessel shall be tested at 21 kg/Sq cm, and insulated on all sides with 50mm thick fibre glass cladded with 0.6mm aluminium sheet.

Automatic and Safety Controls
The following automatic and safety controls shall be provided with hot water generator.

b) High Temperature Water Outlet.
c) Step Controller.
d) Recycling Relay.
e) ON-OFF Switch Thermostats.
f) Pilot Light Low Water Cut OFF.

Hot water generators shall be equipped with all other necessary controls. All basic controls and terminals shall be located in an integral control cabinet factory wired and tested.
Hot water generator shall be suitable for 415±10% volts, 50Hz, 3 phase power supply. The heater shall be connected in a manner to provide capacity as follows:
## Intents of Specification

<table>
<thead>
<tr>
<th>Capacity</th>
<th>No. of steps</th>
<th>No. of Thermostats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 100 KW</td>
<td>2 Steps</td>
<td>3</td>
</tr>
<tr>
<td>101 KW to 300 KW</td>
<td>3 Steps</td>
<td>6</td>
</tr>
<tr>
<td>301 KW to 600 KW</td>
<td>4 Steps</td>
<td>8</td>
</tr>
<tr>
<td>601 KW to 1000 KW</td>
<td>8 Steps With step controller</td>
<td></td>
</tr>
</tbody>
</table>
### TECHNICAL DATA

<table>
<thead>
<tr>
<th>#</th>
<th>ITEM DESCRIPTION</th>
<th>TO BE FILLED BY VENDOR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I.</strong></td>
<td>Water-cooled Screw Chilling Machine</td>
<td></td>
</tr>
<tr>
<td><strong>a. GENERAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Make</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Country of Origin</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Type (Semi-Hermetic / Hermetic / Open)</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Model No.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Refrigerant</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Overall dimension mm</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Operating Weight (Kg.)</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>No. of compressor per Machine</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Capacity of machine at 6.7°C chiller water entering temp.</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Noise level at 1 Meter along perimeter</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Clearance required from wall</td>
<td></td>
</tr>
<tr>
<td><strong>II.</strong></td>
<td>Compressor</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Vertical or horizontal</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Type of drive (Direct or gear)</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Displacement at max. speed-CM³/H</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Saturated suction temperature deg. C</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Operating speed RPM.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Capacity of Chilling Unit at design conditions-Kcal/hr.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Total power consumed at design conditions-KW</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Degree of sub-cooling on which above capacities are based degree C.</td>
<td></td>
</tr>
<tr>
<td>9.1</td>
<td>Chilled water in-degree C</td>
<td></td>
</tr>
<tr>
<td>9.2</td>
<td>Chilled water out-degree C</td>
<td></td>
</tr>
<tr>
<td>9.3</td>
<td>Chilled water flow-Cu M/Hr</td>
<td></td>
</tr>
<tr>
<td>9.3</td>
<td>Condenser water out-degree C</td>
<td></td>
</tr>
</tbody>
</table>
9.4 Condenser water In-degree C
9.5 Condenser water flow–Cu M./HR
9.6 Pressure Drop
9.4.1 Chiller-mWC
10. I KW / TR actual at ARI relief on part load
10.1 100%
10.2 75%
10.3 50%
10.5 25%

III. CAPACITY CONTROL
1. Type of capacity control
2. Range of capacity variation

IV. CONDENSER
1. Model
2. No. of condensers & circuits
3. Total heat transfer area (SQMT)
   3.1 Water Side : NA
   3.2 Refrigerant Side: NA
4. No. of Passes
5. Water velocity in tube - M/Sec
6. Tube dia. (Inner / Outer) mm
7. Tube - Wall thickness (finning type) mm
8. Number of tubes.
9. Length of tubes (NB) mm
10. Length of condenser (mm)
11. Shell dia. OD (mm)
12. Shell thickness (mm)
13. Fouling factor (FPS)
14. Heat rejection capacity Kcal / Hr
V. CHILLER

1. Model
2. Type
3. Total heat transfer area (SQM)

Water Side:

Refrigerant Side:

4. Water velocity in tubes - M/Sec
5. Refrigerant Evaporating temp.
6. Tube diameter (Inner/Outer) mm
7. Tube - Fin Thickness mm
8. Number of tubes (Tube material)
9. Insulation Material & Thickness mm
10. No of passes
11. Heat rejection Kcal/Hr
12. Fouling factor (FPS)

VI. DRIVE

1. Make of motor
2. Type of motor
3. Rating – KW (HP)
4. Protection
5. Insulation Class
6. Speed RPM
7. Voltage / Frequency fluctuation permissible
8. Full load current (Amps)
9. Starting current (Amps)
10. Locked rotor current (Amps)
11. Type of vibration isolator for compressor motor
12. Power factor at various load conditions
13. Level of harmonics filtered at source.

VII. MATERIAL OF CONSTRUCTION

1. Impeller
2. Casing
3. Shaft
4. Bearing
5. Mechanical seal
6. Condenser shell
7. Condenser tubes
8. Condenser tube sheet
9. Chiller shell
10. Chiller tube
11. Chiller tube sheet

VIII. MOTOR STARTER
1. Make of motor
2. Type
3. Model
4. Current Limit (%)
5. Ambient temp.

IX. HOT WATER GENERATOR
1. Model
2. Make
3. Type
4. Total Steps of Heaters
5. Water velocity in HWG Shell - M /Sec
6. Electrical Immersion Heaters- Thickness mm
7. Insulation Material & Thickness mm
1. INSTRUCTION TO BIDDERS

- All items of work under this contract shall be executed strictly to fulfill the requirements laid down under “Basis of Design” in the specifications. Type of equipment, material specification, methods of installation and testing and type of control shall be in accordance with the specifications, approved shop drawings and the relevant Indian Standards, however capacity of each component and their quantities shall be such as to fulfill the above mentioned requirement.

- The unit rate of all equipments or materials shall include cost in RUPEES for equipment and materials including all taxes and duties and also including forwarding, freight, insurance and transport into contractor’s store at site, storage–installation, testing, balancing, commissioning and other works required.

- The rate of each item of work included in the schedule of quantities shall, unless expressly stated otherwise, include cost of:
  - All materials, fixing materials, accessories, appliances tools, plants, equipment, transport, labor and incidentals required in preparation for and in the full and entire execution, testing, balancing, commissioning and completion of work called for in the item and as per Specifications and Drawings.
  - Wastage on materials and labor.
  - Loading, transporting, unloading, handling/ double handling, hoisting to all levels, setting, fitting and fixing in position, protecting, disposal of debris and all other labor necessary in and or the full and entire execution and for the job in accordance with the contract documents, good practice and recognize principles.
  - Liabilities, obligations, whether such requirements are mentioned in the item or not. The specifications and drawings where available, are to be read as complimentary to and part of the Scheduled of Quantities and any work called for in one shall be required for all.
  - All requirements of Specifications, whether such requirements are mentioned in the item or not. The Specifications and Drawings where available, are to be read as complimentary to and part of the Scheduled of Quantities and any work called for in one shall be taken as required for all.

- In the event of conflict between Schedule of Quantities and other documents including the Specifications, the most stringent shall apply. The interpretation of the Consultant/ project manager shall be final and binding.

- All equipments, quantities and technical data indicated in this Schedule are for the Contractor’s guidance only, these are based on the documents prepared by the Consultant. This schedule must be read in conjunction with other documents. The contractor shall be paid for the actual quantity of work executed by him in accordance with the approved Shop Drawings at the contract rates.

- The schedule shall be fully priced and the extensions and totals duly checked. The rates for all items shall be filled in INK including NIL items.

- Any error in totaling in the amount column and in carrying forward total shall be corrected. Any error, in description or in quantity, omission of items from this Schedule.
shall not vitiate this Contract but shall be corrected and deemed to be variation required buy the Consultant/ Project Manager.

- Rates have been called for a number of items of works, as alternatives, which, for the present do not form part of the total value of tender. However the rates for these items shall be quoted, with due care so that in the event of choice of an alternative item of work, said rate shall form part of the contract any way

- The contractor shall procure and bring Materials/ Equipment to the site only on then basis of drawings approved for construction and shop drawings and not on the basis of Schedule of quantities, which are provisional only. This also applies to the Contractor’s requisition for owner-supplied materials.

- THE MODE OF MEASUREMENT SHALL BE AS SPECIFIED IN THIS BOOK.

- THE MOST IMPORTANT ASPECT IS THE INTENT OF THE SPECIFICATION. THIS NEEDS TO BE FOLLOWED AND THE CONTRACTOR SHALL DO ALL THAT IS REQUIRED TO MEET THE INTENT. THE ACOUSTICS, VIBRATION CONTROL FORM A MAJOR REQUIREMENT OF THIS INTENT, BESIDES THE FUNCTIONAL REQUIREMENTS.
2. BASIC MECHANICAL REQUIREMENTS

This Section includes Basic mechanical requirements specifically applicable to HVAC System

2.1 REFERENCES / STANDARDS:

2.1.1 National Building Code of India –2005
2.1.2 ANSI: American National Standard institute (Wherever applicable)
2.1.3 BIS: Bureau of Indian Standards (This code will supercede in case of any ambiguity or misinterpretation)
2.1.4 ARI: Air conditioning and Refrigeration Institute (for chiller certification).
2.1.5 ASHRAE: American Society of Heating Refrigeration and Air conditioning Engineers.
   Systems & Equipment 2004
   Application 2003.
2.1.6 ASME: American Society for Mechanical Engineers
2.1.7 SMACNA / BIS: For Duct construction standards.
2.1.8 UL: Underwriters’ Laboratories INC. for fire protection and ratings / testing
2.1.9 Air filters as per ASHRAE Standard 52.1 – 1992
2.1.10 Indoor Air Quality as per ASHRAE Standard 62.1 – 2007/2010 (NA, or Its as per client decision)
2.1.11 Motors, cabling, wiring and accessories as per BIS codes / IE Rules / IS codes
2.1.12 Recognised / approved manufacturer’s standards.
2.1.13 Motors, cabling, wiring and accessories as per BIS codes/ IE Rules / IS codes / ITC Electrical Guidelines

2.2 SUBMITTALS: To cross check the Heat Load Estimations / Design Data Summary and point out any discrepancy at the time of bidding.

2.2.1 Under provisions of sample approval before the commencement of the project.
2.2.2 Includes products mentioned in the Approved list of manufacturers as per the mode of approval mentioned in the list.
2.2.3 Submit shop drawings and product data grouped to include complete submittals of related Systems products, and accessories in a single submittal.
2.3 **SHOP DRAWINGS**

Submit a copy of the shop drawings, including:

2.3.1 Actual duct routes after the site survey.
2.3.2 Automatic temperature /Pressure control system.
2.3.3 Inertia pads and foundations for the various equipments.
2.3.4 Fire protection systems (Fire / Smoke dampers: Motorized) (Relief dampers, smoke extract system, pressurization system)
2.3.5 Layout of the AHU / Plant room including dimensions of the room and the foundations and the sizes and all necessary construction details required on site.
2.3.6 Location of the allied equipments and the requirements from other agencies.
2.3.7 Trench locations if any.
2.3.8 Sump location and size.
2.3.9 Sleeve location if any.
2.3.10 Ventilation air / exhaust air locations.
2.3.11 Location of wall mounted equipment (If any)
2.3.12 Any structural inputs.

2.4 **Brochures:**

Submit manufacturer’s product data and brochure including:

2.4.1 Complete description.
2.4.2 Illustrations.
2.4.3 Rating data, accessories, dimensional data.
2.4.4 Capacities stated in the terms specified.
2.4.5 Performance curves of the fans and pumps.

2.5 **PROJECT/SITE CONDITIONS**

Mechanical layouts indicated on drawings are diagrammatical. Co-ordination (final) shall be required with other trades prior to installation. Install all works as shown on the drawings, unless prevented by project conditions.

Prepare drawings showing proposed rearrangement of work to meet the project conditions, Obtain permission from of architect / consultant before proceeding.

Place anchors, sleeves and supports prior to pouring concrete on installation of masonry works.

Keep roads and site clear of debris and scrap.
**PROJECT BIDDING BRIEF**

**3-BASIS OF DESIGN**

3.1 **Location:**
- Site Location: Bhilai (Chhattisgarh)
- Geographic Location (Kolkata): 21.14 Deg N Latitude

3.2 **Outdoor Design Conditions:**
Outdoor Design Conditions for Bhilai (Chhattisgarh) have been considered, based on weather data recorded by ISHRAE Handbook, as follows:

3.2.1 **Summer**
- Dry Bulb Temperature: 110 Deg. F
- Wet Bulb Temperature: 77 Deg. F

3.2.2 **Monsoon**
- Dry Bulb Temperature: 92 Deg. F
- Wet Bulb Temperature: 83 Deg. F

3.2.3 **Winter**
- Dry Bulb Temperature: 50 Deg. F
- Wet Bulb Temperature: 45 Deg. F

3.3 **Indoor controlled environment conditions:**
These conditions have been summarized in the design data summary sheet.

3.4 **Mechanical Ventilation System:**
Following are the design parameters and conditions for mechanically ventilated spaces, to maintain the indoor air quality and pressure relationships.

<table>
<thead>
<tr>
<th>Space</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public and executive Toilets</td>
<td>To be maintained at a negative pressure with respect to adjacent areas. Air to be transferred through air transfer grilles located on the wall or the doors. 12-15 total air changes would be maintained.</td>
</tr>
<tr>
<td>Service / dry Pantry</td>
<td>To be maintained at a negative pressure with respect to adjacent areas. Air to be transferred through air transfer grilles located on the wall or the doors. 5-10 total air changes would be maintained.</td>
</tr>
<tr>
<td>Room Type</td>
<td>Specification</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Plant rooms (Pump/HVAC)</td>
<td>Positively ventilated (displacement). Air washers/Replenishment air fans with filters for 20 total air changes would be used. Rooms to be maintained at negative pressure with respect to surrounding areas. The same air would be removed by means of a dedicated exhaust fan.</td>
</tr>
<tr>
<td>Kitchen (if any)</td>
<td>Minimum of 35 ACPH supply air, thru evaporative cooler, and 40 ACPH mechanical exhaust through a rigid media air scrubber. (To be read in conjunction with the air requirement based upon exhaust hood design and sizes). Minimum capture velocity across hoods to be maintained as 100 FPM.</td>
</tr>
<tr>
<td>Basement Parking (If Any)</td>
<td>Normal ventilation : 12 ACPH exhaust Fire smoke evacuation : 12 ACPH exhaust</td>
</tr>
</tbody>
</table>
PROJECT BIDDING BRIEF

4-DESIGN PARAMETERS

4.1 **Chillers:**

4.1.1 Performance rating of the chilling units shall be based on following design parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature of chilled water entering chiller</td>
<td>54°F (12.2°C)</td>
</tr>
<tr>
<td>Temperature of chilled water leaving chiller</td>
<td>44°F (6.6°C)</td>
</tr>
<tr>
<td>Fouling factor for chiller in FPS unit</td>
<td>0.0005</td>
</tr>
<tr>
<td>Fouling factor for condenser in FPS unit</td>
<td>0.001</td>
</tr>
<tr>
<td>Refrigerant for Chilling Units</td>
<td>HFC (R134a)</td>
</tr>
</tbody>
</table>

4.2 **Air Handling Units**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum velocity across pre-filters</td>
<td>110 M / Min.</td>
</tr>
<tr>
<td>Maximum face velocity across cooling coils</td>
<td>152 M / Min.</td>
</tr>
<tr>
<td>Maximum fan outlet velocity for fans above 300mm dia</td>
<td>550 M / Min.</td>
</tr>
<tr>
<td>Maximum fan speed for fans upto 300 mm dia</td>
<td>1450 RPM</td>
</tr>
<tr>
<td>Maximum fan speed for fans above 300 mm dia</td>
<td>1000 RPM</td>
</tr>
</tbody>
</table>

4.3 **Centrifugal Fans**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum fan outlet velocity for fans upto 450 mm dia</td>
<td>550 M / Min.</td>
</tr>
<tr>
<td>Maximum fan outlet velocity for fans above 450 mm dia</td>
<td>700 M / Min.</td>
</tr>
<tr>
<td>Maximum fan speed for fans upto 450 mm dia</td>
<td>1450 RPM</td>
</tr>
<tr>
<td>Maximum fan speed for fans above 450 mm dia</td>
<td>1000 RPM</td>
</tr>
</tbody>
</table>

4.4 **Pipe Sizing**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Velocity</td>
<td>2.5 M / Sec</td>
</tr>
<tr>
<td>Maximum Friction</td>
<td>5 M / 100 M Run</td>
</tr>
</tbody>
</table>

4.5 **Duct Design**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum flow velocity</td>
<td>7.5 M / Sec</td>
</tr>
<tr>
<td>Maximum Friction</td>
<td>1 cm WG/100 m run or (0.1 inch per 100 Ft)</td>
</tr>
<tr>
<td>Maximum Velocity at supply air outlet</td>
<td>2.5 mps (500 FPM)</td>
</tr>
</tbody>
</table>
5-PAINTING AND SERVICE IDENTIFICATION

SCOPE
The scope of this section comprises of identification of service for each piece of equipment and allied works.

5.1 VALVE TAGS AND CHARTS
5.1.1 Each valve shall be provided with a tag indicating the service being controlled together with a reference number corresponding with that shown on the valve chart and as fitted drawings. The labels shall be made from 3 ply (Black/White/Black) trifoliate material showing white letter and figures on a black background. Labels to be tied to each valve with chromium plated linked chain.

5.1.2 A wall mounted glass covered plan to the Architect / Engineer shall be provided and displayed in each plant room showing the plant layout with pipe work. Valve diagram and valve schedule indicating size. Service duty etc.

5.1.3 Pipe work and duct work shall be identified by color bands 150 mm. Wide or color triangles of at least 150 mm / side. The bands of triangles shall be applied at termination points. Junction, entries and exits of plant room. Walls and duct, and control point to readily identify the service but spacing shall not exceed 5.0 meters.

5.2 Pipe Work Service:-
For pipe work service and its insulation the color of the bands shall be company with BS. 1710:1971.

Basic color for pipe line identification:-

<table>
<thead>
<tr>
<th>Pipe Line Contents</th>
<th>BS 4800 Color Reference</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>12 D 45</td>
<td>Green</td>
</tr>
<tr>
<td>Steam</td>
<td>10 A 03</td>
<td>Grey</td>
</tr>
<tr>
<td>Oils</td>
<td>06 C 39</td>
<td>Brown</td>
</tr>
<tr>
<td>Gas</td>
<td>08 C 35</td>
<td>Yellow/brown</td>
</tr>
<tr>
<td>Air</td>
<td>20 E 51</td>
<td>Blue</td>
</tr>
<tr>
<td>Drainage</td>
<td>00 E 53</td>
<td>Black</td>
</tr>
<tr>
<td>Electrical</td>
<td>06 E 51</td>
<td>Orange</td>
</tr>
</tbody>
</table>
Color code indicator bands shall be applied as color band over the basic identification color in the various combination as listed below:-

<table>
<thead>
<tr>
<th>Pipe Duty</th>
<th>Color Bands to BS. 4800</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.2.1 Water service</strong></td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td>00 E 55</td>
</tr>
<tr>
<td>Ventilation/ drinking</td>
<td>18 E 53</td>
</tr>
<tr>
<td>Boiler feed</td>
<td>04 D 45/ 00 E 55 / 04 D 45</td>
</tr>
<tr>
<td>Condensate</td>
<td>04 D 45/ 14 E 53/ 04 D 45</td>
</tr>
<tr>
<td>Chilled</td>
<td>00 D 55/ 14 E 53/ 00 D 45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe Duty</th>
<th>Color Bands to BS. 4800</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.2.2 Central heating service</strong></td>
<td></td>
</tr>
<tr>
<td>Below 100 degree C</td>
<td>18 E 55/04 d 45 / 18 E 53</td>
</tr>
<tr>
<td>Above 100 degree C</td>
<td>04 D 45/ 18 E 53/ 04 D 45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe Duty</th>
<th>Color Bands to BS. 4800</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.2.3 Cold water storage</strong></td>
<td></td>
</tr>
<tr>
<td>Tanks</td>
<td>00 E 55/18 E 53/ 00 E 55</td>
</tr>
<tr>
<td>Hot water supply</td>
<td>00 E 55/ 04 D 45/00 E 55</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe Duty</th>
<th>Color Bands to BS. 4800</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.2.4 Steam service</strong></td>
<td>Basic Color Only</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe Duty</th>
<th>Color Bands to BS. 4800</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.2.5 Drainage and other fluids:</strong></td>
<td>Basic Color Only</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe Duty</th>
<th>Color Bands to BS. 4800</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.2.6 Electrical service:</strong></td>
<td>Basic Color Only</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipe Duty</th>
<th>Color Bands to BS. 4800</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.2.7 In addition to the color band specified above all pipe work shall be legibly marked with black or white latter to indicate the type service and the direction of flow. Identified as follow:-</strong></td>
<td></td>
</tr>
<tr>
<td>High temperature hot water</td>
<td>HTHW</td>
</tr>
<tr>
<td>Medium temperature hot water</td>
<td>MTHW</td>
</tr>
<tr>
<td>Low temperature hot water</td>
<td>LTHW</td>
</tr>
<tr>
<td>Chilled water</td>
<td>CHW</td>
</tr>
<tr>
<td>Steam</td>
<td>ST</td>
</tr>
<tr>
<td>Condensate</td>
<td>CN</td>
</tr>
</tbody>
</table>

Pipe shall have the letter F and R added to indicate flow and return respectively as well as directional arrows.
5.3 Duct work service:
For duct work service and its insulation the colour of the triangles shall comply with BS. 1710 : 1971. the size of the symbol will depend on the size of duct and the viewing distance but the minimum size should not be less than 150 mm length per side. One apex of the triangle shall point of the direction of air flow.

<table>
<thead>
<tr>
<th>Service</th>
<th>Color</th>
<th>BS. 4800 Color Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditioned air</td>
<td>Red and Blue</td>
<td>04 E 53/ 18 E 53</td>
</tr>
<tr>
<td>Ward air</td>
<td>Yellow</td>
<td>10 E 53</td>
</tr>
<tr>
<td>Ventilation air</td>
<td>Green</td>
<td>14 E 53</td>
</tr>
<tr>
<td>Exhaust / extract</td>
<td>Gray</td>
<td>AA 0 09</td>
</tr>
<tr>
<td>Recalculated air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foul air</td>
<td>Brown</td>
<td>06 C 39</td>
</tr>
<tr>
<td>Dual duct system hot</td>
<td>Red</td>
<td>04 E 53</td>
</tr>
<tr>
<td>Supply air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold supply air</td>
<td>Blue</td>
<td>18 E 53</td>
</tr>
</tbody>
</table>

In addition to the color triangle specified above all duct work shall be legibly marked with black or white letter to indicate the type of service identified as follows:-

Supply air  S
Return air  R
Ventilation air  F
Exhaust air  E

The color banding and triangle shall be manufactured from self adhesive cellulose tape laminated with a layer of transparent ethyl cellulose tape.
**PROJECT BIDDING BRIEF**

**6-GOOD ENGINEERING PRACTICES FOR HVAC WORKS**

6.0 **Mechanical noise control:** All good engineering practices involved in controlling the noise of equipment within permissible limits shall be adopted by the contractor.

**Vibration Control:** All good engineering practices involved in controlling the vibrations of equipment within permissible limits shall be adopted by the contractor.

Equipment at the best operating parameters and acoustical performance alongwith the necessary isolation devices for vibration control shall be adopted by the manufacturer and the contractor.

6.1 **INTENT in general pertaining to this section is as follows:**

The vibration isolators for certain equipments although have been specified and quantified in the BOQ, how-ever, as a precautionary measure, if any additional safeties are required to fulfill the intent of this basic mechanical requirement, then the same shall be provided by the manufacturer/contractor, at no additional cost.

6.1.1 Mechanical service shall generally be designed and installed with provisions to contain noise and the transmission of vibration generated by moving plant and equipment schedules to achieve acceptable noise rating specified for occupied areas.

6.1.2 In addition to the provision specified in the specification particulars attention must be given to the following detail at time of ordering plant and equipment and their installation:-

6.1.2.1 All moving plant, machinery and apparatus be statically and dynamically balance at manufactures work and certificate issued.

6.1.2.2 The isolation of moving plant. Machinery and apparatus including lines equipment from the building structure.

6.1.2.3 Where duct work and pipe work service pass though walls floor and ceiling or where supported shall be surrounded with a resilient acoustic absorbing material to prevent contract with the structure and minimize the outbreak of noise from plant room.

6.1.2.3 The reduction of noise breakout from plant room and the section of externally mounted equipment and plant to meet ambient noise level requirement of the specifications.
6.1.2.4 Electrical conduits and connection to all moving plant and equipment shall be carried out in flexible conduit and cable to prevent the transmission of vibration to the structure and nullify the provision of anti-vibration mountings.

6.1.2.5 All duct connection to fans shall incorporate flexible connections. Except in cases where these are fitted integral within air handing unit.

6.1.2.6 All resilient acoustic absorbing materials shall be non flammable vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.

6.1.2.7 Where practicable silencer shall be built into walls and floor to prevent the flanking of noise the duct work system and their penetrations sealed in the manner previously described.

6.1.2.8 Where this is not feasible the exposed surface of the duct work between the silencer and the wall subjected to noise infiltration shall be acoustically clad as specified.
7-SYSTEM DESCRIPTION

7.1 General:

7.1.1 Central Chilled water air conditioning system is envisaged for the said premise for maintaining year round inside environmental conditions pertaining to temperature / humidity / Air Quality / Air cleanliness etc.

7.1.2 The system shall consist of 3 nos. 100 TR (2 working +01 standby) number Water cooled Screw chilling machines working in conjunction with dedicated chilled/Hot water pumps (having a redundant pump on each circuit). Pumping system shall be primary and secondary pumping system , Primary pumps fixed speed type and secondary pumps with VFD for chilled/Hot water circuit. And For Winter Heating the system shall consist of 2 nos. 200 KW Hot water Generator (1Working+1 standby) with chilled water circuit link with chilled/Hot water circuit in plant room with isolate valves. The Plant shall be install at ground and cooling tower at plant room terrace/Ground.

7.1.3 Various Air handlers / Fan Coil Units are placed at suitable location and shall be fed with chilled water to effect cooling by means of chilled water piping traveling in the dedicated chilled water risers. The cooling towers shall be of forced/induced draft type and are located on the basement terrace .The return air shall be collected in the void above the false ceiling or ducted and brought back to the AHU rooms for necessary filtration and re-circulation after mixing with the ventilation air.

7.1.4 Combined smoke and fire dampers shall be provided at suitable location in the supply air ducts and return air spaces at AHU rooms. All fire escape staircases shall be provided with pressurization system consisting of fans installed on terrace. These fans shall be actuated upon receiving signal from the fire panel.

7.1.5 The exposed roof shall be insulated by other agencies as per the requirement detailed in system design criteria.

7.1.6 One coil (Two pipe) system is proposed for all areas at all floors as like ICU,OT's,NICU etc.and all fan coils .

7.2 Chilled Water Generation and Distribution:

The chilled water generation plant (i.e. chillers, chilled water pumps) are installed at 1st basement lvl. Chilled water shall be made available at the specified temperature and pressure to all the above–mentioned area Air handlers to effect the air conditioning of the said space.

The system design is based on variable volume water flow concept. The contractor shall provide Two port control valves on all the AHUs/FCUs. The flow of water through the said AHUs/FCUs shall be controlled by the modulating motor depending upon the set point of the return air thermostat.

The design chilled water temperatures are:

- Chilled water flow : 6.6 Deg C
- Chilled water return : 12.2 Deg C
8.0 ACOUSTICS MEASURES FOR NOISE CONTROL AND VIBRATION CONTROL MEASURES:

8.1 INTENT in general pertaining to this section is as follows:
The vibration isolators for certain equipments although have been specified and quantified in the BOQ (If Any), however, as a precautionary measure, if any additional safeties are required to fulfill the intent of this basic mechanical requirement, then the same shall be provided by the manufacturer/contractor, at no additional cost.

8.2 STANDARD
The testing of the all noise control equipment and the method use in measuring the noise rating of air conditioning plant and equipment shall be in accordance with the relevant section of the following British standards unless otherwise stated:

BS 4718 : 1971 Method of test of silencer for air distribution systems.

BS 2750: Parts 1-9:1980 Laboratory and field measurement of airborne sound insulation of various building element. Recommendation for field laboratory measurement of airborne and impact sound transmission in building.

BS 3638 : 1987 Method of measurement of sound adsorption in a reverberation room.


8.3 INTENT in general pertaining to this section is as follows:

8.3.1 Mechanical service shall generally be designed and installed with provisions to contain noise and the transmission of vibration generated by moving plant and equipment schedules to achieve acceptable noise rating specified for occupied areas.

8.3.2 In addition to the provision specified in the specification particulars attention must be given to the following detail at time of ordering plant and equipment and their installation.
8.3.3 All moving plant, machinery and apparatus be statically and dynamically balance at manufactures work and certificate issued.

8.3.4 The isolation of moving plant. Machinery and apparatus including lines equipment from the building structure.

8.3.5 Where duct work and pipe work service pass though walls floor and ceiling or where supported shall be surrounded with a resilient acoustic absorbing material to prevent contract with the structure and minimize the outbreak of noise from plant room.

8.3.6 The reduction of noise breakout from plant room and the section of externally mounted equipment and plant to meet ambient noise level requirement of the specifications.

8.3.7 Electrical conduits and connection to all moving plant and equipment shall be carried out in flexible conduit and cable to prevent the transmission of vibration to the structure and nullify the provision of anti – vibration mountings.

8.3.8 All duct connection to fans shall incorporate flexible connections. Except in cases where these are fitted integral within air handing unit.

8.3.9 All resilient acoustic absorbing materials shall be non flammable vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.

8.3.10 Where practicable silencer shall be built into walls and floor to prevent the flanking of noise the duct work system and their penetrations sealed in the manner previously described.
Where this is not feasible the exposed surface of the duct–work between the silencer and the wall subjected to noise infiltration shall be acoustically clad as specified.
AIR SIDE EQUIPMENT & ASSOCIATED WORKS

L-1 ENTHALPY RECOVERY WHEEL WITH SUPPLY AIR AND EXH. AIR FAN SECTION

1 SCOPE

The scope of this section comprises of the supply of double-skin “Dedicated Outdoor Air Units conforming to the following specifications. The manufacturer or their principals shall have at least 10 years of designing and manufacturing experience directly in the product i.e. energy recovery devices, with a two tier, two air stream unit design in India. The heat recovery wheel, Passive Desiccant Dehumidification Wheel & Coil box should be from the same manufacturer. The manufacturer of the wheel should have manufacturing units in India.

2 TYPE

The Dedicated Outdoor Air units shall be two stream units in double skin construction, comprising of supply air section, return air section and Heat Recovery Section. The supply air section shall include the following sections if defined in the Bill Of Quantities:

3 CAPACITY

The Dedicated Outdoor Air units shall be of such capacities and static pressures as mentioned in the Bill of Quantities.

4 CASING (Recommended –standard AHU casing specifications)

The units shall be made of extruded Aluminium hollow profile frames. The profile box size shall be of thermal break type. The unit should be devoid of any welded construction and should be of cabinet type. All the frames should be assembled using glass fibre reinforced nylon joints/corners to make a self-supporting frame. The Casing leakage shall be in accordance with relevant EUROVENT standard that is CLASS B. Casing Strength shall be Class-1A.

The panels shall be of double skin construction with both inner and outer steel sheets being minimum 0.8mm thick. Outside sheet shall be pre coated & plasticized and inner sheet will be galvanized with 43 mm thick fire retardant, PUF insulation.

The Inspection and access panels shall be hinged type. The hinges shall be casted, powder coated Zinc alloy. Flushed Locks and Handles shall be of glass fibre reinforced polyamide. Other panels will be screwed on to the frame with sealant and soft rubber gasket thus making the joints air tight. All screws used for panel fixing shall be covered with PVC caps.

Special hollow gaskets and seals shall be used on inspection doors and to create separation between the airstreams to ensure negligible air leakage and mixing. The entire casing shall be mounted on galvanized channel. Condensate drain pan shall be fabricated from 18 g GSS/SS construction.

HVAC Consultant: AD CONSULTANTS
OUTDOOR VERSION

For Outdoor Installation units have factory installed galvanized sheet metal roof. Exhaust air hood with bird screen will be provided for exhaust air & intake louvers will be provided for intake sections.

Exhaust Air hood & roof shall be shipped separately due to shipping restrictions.

5 SUPPLY AIR SECTION

The supply air section shall comprise of the following:

5.1 FAN SECTION (Recommended –standard AHU Fan specifications)

The fan shall be backward curved plenum type. Fan performance shall be based on test accordance with AMCA standard. The Plenum fans use backward curved blade wheel, made of cold rolled steel sheet, protected with polyester powder coating finish. Inlet cones are die-formed from galvanized steel sheet. These cones provide smooth airflow into the wheel for even loading.

Structural components of the plenum fans are made of galvanized steel sheet and sections, electrically welded, with the exception of the larger sized models, which use hot rolled steel sections protected with polyester powder coating finish.

5.2 MOTOR AND DRIVE (Recommended –standard AHU motor and drive specifications)

Fan motor shall be energy efficient and suitable for 415±10% volts, 50 cycles, 3 phase squirrel cage, totally enclosed fan cooled with IP – 55 protection. Motor shall be designed for quiet operation. Drive shall be direct driven and suitable for VFD.

5.3 FILTER SECTION (Recommended –standard AHU Filter specifications)

The filter section shall be normally designed for deep folded disposable synthetic prefilters (Panel Type) for Class EU3. The filter elements shall be mounted on rails and shall be easily pulled out for replacement. The rails shall be provided with efficient gaskets to minimize the risk of leakage.

5.4 FINE FILTER SECTION (If Specified in BOQ) (Recommended – standard AHU fine filter specifications)

The Fine filter section shall be normally designed for washable synthetic non-woven media Fine filters (Bag Type) for Class F7. The filter elements shall be mounted on rails and shall be easily pulled out for replacement. The rails shall be provided with efficient gaskets to minimize the risk of leakage.

5.5 MIXING SECTION (If Specified in BOQ) (Recommended –standard AHU mixing box specifications)

The casing for mixing shall be as described in 4.0. The mixing section shall have built in dampers made up of aluminum profiles with leakage Class III. The damper blades shall be controlled with plastic gear wheels and silicone gaskets shall be provided between the blades. Inspection hatch shall be provided.
5.6 **COOLING COIL SECTION** (If Specified in BOQ) (Recommended –standard AHU cooling coil specifications)

Cooling coil section shall be provided with cooling coil. Coil shall be capable desired dew point. Coil shall be chilled water type or direct expansion depending on the desired dew point.

Coil shall be rated in ARI Certified. Coil shall be mounted in powder coated holding racks. Water coil supply and return connection shall be extended to the unit exterior. Cooling coil shall be mounted on a insulated SS drain pan.

5.7 **DAMPER SECTION**

Damper section shall contain a built in damper of aluminium profile with leakage class III. The damper blades shall be connected with plastic gear wheels with a gasket of silicon rubber to produce tightness between the blades. The Dampers shall have provision for damper actuator mounting.

6 **RETURN AIR SECTION**

The return air section shall comprise of above sections. The specification for this section shall remain same as defined in 5.1, 5.2 & 5.3.

7 **HEAT RECOVERY SECTION**

The Heat Recovery section shall include enthalpy wheels and shall have minimum recovery of 75 % of total heat, i.e both sensible and latent (each being 75 %). Necessary computerized selection of the wheel should be provided along with the bid to justify the same. The wheel shall be made of pure aluminium foil coated with molecular sieve desiccant with pore diameter of 3Å. The cross contamination between the two air streams shall be nil and leakage less than 0.04%. The vertical and radial run of the wheel shall be less than 1 mm per meter of diameter. The wheels shall have non contact labyrinth seals for effective sealing between the two air streams.

Detailed specification for the wheel shall be as per 8.0 i.e. “HEAT RECOVERY WHEEL”

8 **Heat Recovery Wheel specifications:**

Rotor/wheel matrix shall have following Matrix —

The substrate: The substrate or wheel matrix should be made of pure aluminum foil so as to allow.

a) quick and efficient uptake of thermal energy.

b) sufficient mass for optimum heat transfer.

c) maximum sensible heat recovery at a relatively low rotational speed of 20 to 25 rpm.

d) The heat recovery unit shall be designed for ambient temperature of DBT=108 °F & WBT = 78 °F and return air temperature of DBT=77°F & RH=60% for Summer conditions & DBT=90 °F & WBT = 86 °F and return air temperature of DBT=77 °F & RH=60% for Monsoon conditions.

The substrate shall not be made from any material which is combustible or supports combustion like synthetic fibrous media.
The wheel shall have minimum 75% both Sensible and Latent Balanced Effectiveness as per AHRI 1060.

The wheel has to be certified as per DIN EN ISO 846 with 0% fungal and bacterial growth at 95% Relative humidity and above.

Fire rating: NFPA - 90A certification with 0% for Flame spread classification should be confirmed by manufacturer.

The Wheel shall be AHRI certified in accordance with standard 1060 and carry the AHRI certification stamp.

The product shall be produced in an ISO certified facility

NECESSARY SOFTWARE SELECTION OF THE WHEEL HAS TO BE ENCLOSED TO JUSTIFY THE PRESSURE DROP AND EFFICIENCY CALCULATIONS. THE SELECTION SOFTWARE SHALL SHOW HRW PERFORMANCE IN SUMMER, MONSOON & WINTER.

**The Desiccant:** The desiccant should be water molecule selective and non-migratory.

The desiccant shall be molecular sieve 3Å, (certified by a third party lab to have an internal pore diameter of 3Å), so as to keep the cross contamination to absolute minimum and also ensure the exclusion of contaminants from the air streams, while transferring the water vapour molecules.

The desiccant, of sufficient mass which should not be less than 5 kg per 1000 cfm of air, should be coated with non masking porous binder adhesive on the aluminum substrate so as to allow quick and easy uptake and release of water vapour. A confirmation has to be provided by manufacturer of wheel to this effect. A matrix with desiccants impregnated in non metallic substrates, such as synthetic fibre, glass fibre, etc. will not be accepted.

The rotor/wheel matrix shall have equal sensible and latent recovery.

The weight of desiccant coating and the mass of aluminum foil shall be in a ratio so as to ensure equal recovery of both sensible and latent heat over the operating range. Accordingly, a rotor matrix which has an etched or oxidised surface to make a desiccant on a metal foil and results in insufficient latent recovery and hence unequal recovery, or a rotor matrix made from desiccant integrated in a synthetic fibre matrix which result in insufficient sensible recovery, high rotation speed, and unequal recovery, will not be accepted.

**Rotor:** With optimum heat and mass through matrix formed by desiccant, of sufficient mass, coated on an aluminum foil, the rotor should rotate at lower than 20 to 25 RPM, thereby also ensuring long life of belts and reduced wear and tear of seals.

The rotor shall be made of alternate flat and corrugated aluminum foil of uniform width.

The rotor honeycomb matrix foil should be so wound and adhered (full node line adhesive to be provided) so as to make a structurally very strong and rigid media which shall not get cracked, deformed etc. due to change of temperature or humidity.

The rotor having a diameter upto 2400 mm shall have spokes to reinforce the matrix. The internal threaded rod type spokes shall not be acceptable as it weakens the wheel structural strength thereby reducing the service life. From 2000 mm diameter upwards, the option of a special wing structure, to prevent the rotors from wobbling or deforming due to the successive pressure differentials, will be available.
Sectioned wheels, with pie segments, capable of being assembled in the field, shall be available as an option, above 2600 mm in diameter.

Wheels above 3400 mm in diameter shall be segmented and provided with wing structures spokes and flanged rim. The segmented wheels shall be provided with field rotation adjustment mechanism.

The HRW hub shall be fabricated out of heavy duty steel in order to have high mechanical strength. Light duty Aluminum hub shall not be accepted.

The surface of the wheel/rotor should be highly polished (FACED) to ensure that the vertical run out does not exceed \( \pm 1 \) mm for every 1 metre diameter, thereby ensuring, negligible leakage, if labyrinth non contact seals are provided, and minimal drag, if contact wiper seals are provided.

The radial run out also shall not exceed \( \pm 1 \) mm for every 1 meter diameter, thereby minimising the leakage/drag on the radial seals, and minimise the fluctuation in the tension of the drive belt.

The number of wraps (of alternative corrugated and flat foil) for every inch of rotor radii shall be very consistent so as to ensure uniform air flow and performance over the entire face in the air stream. Flute height and pitch will be consistent to a very tight tolerance to ensure uniform pressure drop and uniform airflows across the rotor face.

The rotor shall be a non clogging aluminum media, having a multitude of narrow aluminum foil channels, thus ensuring a laminar flow, and will allow particles upto 800 microns to pass through it.

The media shall be cleanable with compressed air, or low pressure steam or light detergent, without degrading the latent recovery.

**The Cassette / casing**

The recovery wheel cassette/casing shall be manufactured from tubular / sheet metal structure to provide a self supporting rigid structure, complete with access panels, purge sector, rotor, bearings, seals, drive mechanism complete with belt. The sheet metal should be coated with a special corrosion inhibitor coating and a certificate for the same should be provided.

The rotor/wheel should have a field adjustable purge mechanism to provide definite separation of airflow minimising the carryover of bacteria, dust and other pollutants, from the exhaust air to the supply air. It shall be possible, with proper adjustment, to limit cross contamination to less than 0.04% of that of the exhaust air concentration.

The face and radial seals shall be four (4) pass non contact labyrinth seals / brush seals for effective sealing between the two air streams, and also for a minimum wear and tear ensuring long life of the seals.

**PERFORMANCE TESTING**

The HRW manufacturer shall have in-house test facilities for performance testing of HRWs. If required the manufacturer shall be able to offer type testing of HRWs at their works and submit a type test report.

The manufacturer shall have test facilities for carry over testing at the same facilities where HRWs are manufactured.
PART 1  GENERAL

2  Related Work
2.1.1 AHU Construction
2.1.2 Motors
2.1.3 Vibration Insulation
2.1.4 Filters and Dampers of AHU
2.1.5 HVAC Air Test and Balancing

2.2  Submittals
Submit product data including dimensions as shown in the tender drawings, ratings as mentioned in the tender document and performance data for review

2.3  Performance
2.3.1 Select unit components, in accordance with the specifications
2.3.2 Select coils in accordance with ARI standard 410. Substantiate performance
All AHU’s shall be Euro vent certified.

PART 2  PRODUCTS

2.4  Acceptable Manufacturers
As per approved list of manufacturers in the annexure

2.5  General
Fabricate draw through / Blow through type air handling units as specified in the BOQ, suitable for the scheduled air pressure operations.

The air handling units shall be double skin construction, draw–thru / Blow through type comprising of various sections such as filter section, chilled water coil section, fan section mixing box, thermal break profile, and a weather proof canopy, as per details given in Drawings and Schedule of Quantity. All dampers on the weather exposed Air handlers shall be of Aluminum construction and having an aerofoil profile.
2.6 **Basic Relevant Design Parameters for Air Handlers**

<table>
<thead>
<tr>
<th>#</th>
<th>Parameter</th>
<th>Outer Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maximum face velocity across pre-filters.</td>
<td>150 M/Min</td>
</tr>
<tr>
<td>2</td>
<td>Maximum face velocity across cooling/Heating coil.</td>
<td>152 M/Min</td>
</tr>
<tr>
<td>3</td>
<td>Maximum fan outlet velocity.</td>
<td>550 M/Min</td>
</tr>
<tr>
<td>4</td>
<td>Maximum fan speed (Above 300 mm dia)</td>
<td>1000 RPM</td>
</tr>
<tr>
<td>5</td>
<td>Fans up to 300 mm dia</td>
<td>1440 RPM</td>
</tr>
<tr>
<td>6</td>
<td>Maximum fan motor speed</td>
<td>1440 RPM</td>
</tr>
</tbody>
</table>

2.7 **Centrifugal Fans**

- Maximum fan outlet velocity for fans upto 450 mm dia : 550 M / Min.
- Maximum fan outlet velocity for fans above 450 mm dia : 700 M / Min.
- Maximum fan speed for fans upto 450 mm dia : 1450 RPM
- Maximum fan speed for fans above 450 mm dia : 1000 RPM

Provide vibration isolators, duly selected for deflection and operating weight.

2.8 **Capacity**

The air handling capacities, maximum motor H. P., static pressure shall be as shown on Drawing and in Schedule of Quantity.

2.9 **Housing and Casing**

2.9.1 **Housing/Casing-Incase of Double Skin Construction**

2.9.1.2 The housing/casing of the air-handling unit shall be of double skin construction. The Framework shall be of Extruded Aluminum hollow sections. All the frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong & self-supporting framework for various sections.

2.9.1.2 23+-1 mm thick Double Skin Panels shall be made of 0.60mm Pre-painted GSS / Pre-plastified / pre-painted GSS on outside and 0.60mm Galvanised sheet inside with P.U. insulation injected in between. These panels shall be screwed on to the frame work with soft rubber gasket fixed in built-in groove of aluminum frame in between to make the joints air tight. Each air handler shall have a leak proof viewing window and an inspection light. The inspection light switch shall be located outside the AHU.

2.9.1.3 Frame work for each section shall be jointed together with soft rubber gasket in between to make the joints air tight. Suitable air tight access doors/panels with Nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on Rolled Formed GSS channel frame work having pressure die cast aluminum jointers.

2.9.1.4 Insulation Drain Pan shall be constructed of 1.0mm SS (non welded) with necessary slope to facilitate fast removal of condensate. Necessary arrangement will be provided to slide the coil in the drain pan.

2.9.1.5 Air handlers suitable for out-door application shall have 40-43mm thick insulation of specified type in between the double skin panels. The metallic contacts shall have a thermal break profile of slide on type construction. Similar type of thermal break...
profiles shall be used for AHUs which have a mixing box but are not exposed to atmosphere and the recommended thickness of insulation shall be 25 mm thick.

2.9.2 Housing/Casing-Incase of Single Skin Construction

2.9.2.1 The housing/casing of the air handling unit shall be of single skin construction. The frame work shall be of Extruded Aluminium hollow sections. All the frame shall be assembled using pressure die cast aluminium joints to make a sturdy, strong & self supporting frame work for various sections.

2.9.2.2 Panels shall be made of 1.3 mm Pre-painted GSS / Pre-plastified / pre-painted GSS. These panels shall be screwed on to the frame work with soft rubber gasket fixed in built-in groove of aluminium frame in between to make the joints air tight.

2.9.2.3 Frame work for each section shall be jointed together with soft rubber gasket in between to make the joints air tight. Suitable air tight access doors/panels with Nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on Rolled Formed GSS channel frame work having pressure die cast aluminum jointers.

2.9.2.4 Drain Pan shall be constructed of 1.00 mm SS with necessary slope to facilitate fast removal of condensate. Necessary arrangement will be provided to slide the coil in the drain pan.

2.9.2.5 The blower and coil sections (including the sandwiched drain pan section) shall be thermally insulated with cross linked polyethylene foam / nitrile foam of 18 mm thickness.

2.10 Motor and Drive

Fan motors shall be 415 for 10% volts, 50 cycles, 3 phase, squirrel- cage, totally enclosed fan cooled with IP–55 protection. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement or direct driven fan. If belt driven than Belts shall be of the oil-resistant type.

2.11 Fan

The fan shall be backward/forward in curved, Plug/double inlet double width type. The wheel & housing shall be fabricated from heavy gauge galvanised steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame & pillow block heavy-duty ball bearings. The fan shall be selected for a noise level less than 70-80 db (A). The impeller & fan shaft shall be statically and dynamically balanced. The Fan outlet velocity shall not be more than 550 M/Min. Fan housing with motor shall be mounted on a common extruded aluminum base mounted in side the air handling housing on anti-vibration mounts. The fan outlet shall be connected to casing with the help of fire retardant fabric acting as a flexible connection for anti-vibration.

THE FAN WILL HAVE INLET GUIDE VANES WHEREVER VFD IS SPECIFIED TO BE INSTALLED
2.12 **Cooling / Heating Coils**

Chilled/hot water coil shall have 12.5 mm to 15 mm dia tubes minimum 27 G thick with aluminum fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face & surface areas shall be such as to ensure rated capacity from each unit & such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg per Sq. air pressure under water. Tube shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch (4 to 5 fins per cm).

2.13 **Filters**

Each unit shall be provided with a factory assembled filter section containing washable expanded viscous metal air filters having extruded aluminum frame. The media shall be supported with aluminum mesh on both sides. Filters face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels. In OT's AHU At Terminal HEPA Filter and in ICU's AHU Filter section with fine filter.

**HEPA Filter : (In AHU/ At Terminal)**

Filter Media: Micro fiber Glass paper (Deep Plated Panel Type / Mini Pleat Filter)

Media Support: Al. Foil

Frame Material: Al./SS

Max. Op. temp.: 120°C continuous, 150°C intermittent

Max. Humidity: 100% RH

Sealent: Epoxy Resin/PU

Gasket: Syn. Rubber/PE Foam/Silicon/Food Grade

Pressure Drop: Initial 14mm and final/drop conditions is 50 mm

Direction Of Air Flow: Flange to cassette/cassette to flange (Flange width 20/30mm)

DOP Efficiency: >99.97% @0.3u.

DOP n and scan test : As per Test Std. JIS-B9908 & JIS- K3801

Cleanable/Washable: Not cleanable/washable

**Micro VEE Filter : (In AHU)**

Filter Media: Non Woven Synthatic(Deep Pleated Panel/Pocket type)/Fire retardant Media

Media Support: Al./GI Mesh.(In OT's only Al. Mesh)

Frame Material: Al./SS

Max. Op. temp.: 80°C

Sealent: Epoxy Resin/PU

Gasket: Syn. Rubber/PE Foam/Silicon/Neoprene

Pressure Drop: Initial 5.5 mm and final/drop conditions is 20 mm

Direction Of Air Flow: Flange to cassette/cassette to flange (Flange width 30mm)

Average Efficiency: 40 to 50% (Approx. micron n 99% at 5 microns)

Test Methods of Efficiency : As per ASHRAE 52.1/EN 779

Cleanable/Washable: Cleaned by compressed air(Pressure Max. 5 Kg/cm²) or Dip
washed by any mild liquid detergent (Ensure Full Removal of detergent by repeated clean water wash, do not use any brush. Refix filters only when properly dried.)

2.14 **Safety Features**
Each Air Handling Unit must have safety features as under:
The Fan Access Door shall be equipped with micro–switch inter locked with fan motor to enable switching of the fan motor automatically in the event of door opening.

The Access Door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.

Fan and motor base shall be properly earthed

All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

2.15 **Performance Data**
Air handling units shall be selected for the lowest operating noise level (Not more than 70 dBA at 1 M from the AHU at a non-ducted condition) of the equipment. Fan performance rating and power consumption data, with operating points clearly indicating shall be submitted and verified at the time of testing commissioning of the installation.

2.16 **Testing**
Cooling/heating capacity of various air handling unit models shall be computed from the measurements of air–flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated mercury in glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

2.17 **Installation**
2.17.1 Rigidly install Air handlers and base rails on a concrete curb, pedestals of sufficient height to install proper size condensate drain pipe. **All ceiling suspended air handlers shall have additional vibration isolators (In addition to the fan isolator in the AHU casing), on the suspenders.**

2.17.2 Provide clearance at each unit for routine service and Coil removal, changing of filters, bearing greasing, opening of access doors, pulling of blower shaft, and removal of motors.

2.17.3 **Duct Work connection:** Duct connectors to each unit to allow for straight and smooth air flow. Do not install turns at the fan discharge which are in the opposite direction to the fan wheel rotation.

2.17.4 **Piping:** Support piping independently of coils and with adequate flexibility to prevent undue stress at coil header connections. Install service valves on both supply and
return pipes to coils so as to shut off the water supply, remove a small portion of pipe and enable the coil to be slid out easily.

2.18

REFER ACOUSTICS AND VIBRATION CONTROL CHAPTER IN THIS BOOK FOR INSTALLATION PRACTICES.

2.19

Accessories
The following accessories, although some of these mentioned separately in the BOQ are to form the part of the air handlers and the scope of supply, install, test and commission.

- Pre filters & Fine filters: Built in the cost of AHU
- Door limit switch: Built in the cost of AHU
- 2/3 way diverting motorized valves: Separately itemized in the BOQ
- Pressure gauges: Separately itemized in the BOQ
- Viewing window with inspection light and switch (switch to be mounted outside the AHU): Built in the cost of AHU
- Industrial thermometers: Separately itemized in the BOQ
AIR SIDE EQUIPMENT & ASSOCIATED WORKS

L-3
FAN COIL UNITS

PART 1 GENERAL

3.1 Related Work
3.1.1 FCU & Motors
3.1.2 Vibration Insulation
3.1.3 Filters
3.1.4 HVAC Air Test and Balancing

3.2 Submittals
Submit product data including dimensions as shown in the tender drawings, ratings as mentioned in the tender document and performance data for review.

3.3 Performance
3.3.1 Certify unit components, in accordance with the specifications
3.3.2 Certify coils in accordance with ARI standard 410. Substantiate performance

PART 2 PRODUCTS

3.4 Acceptable Manufacturers
As per approved list of manufacturers in the annexure

3.5 Scope
The scope of this section comprises the supply, erection, testing and commissioning of fan coil units conforming to these specifications and in accordance with the requirements of the Drawings and Schedule of Quantities.

3.6 Type
The fan coil units shall be vertical type of floor mounting, horizontal type of ceiling suspension, or bare units for completely recessed installation. Floor mounted vertical units shall discharge into a supply air plenum fitted with adjustable discharge grille supplying horizontally; ceiling suspended units shall have horizontal discharge, and horizontal units mounted within ceiling space shall have horizontal discharge. All units shall be complete with chilled water coil, one or more centrifugal fans and motor. Cleanable expanded viscous metal, double wall insulated condensate drain pan. Horizontal fan coil units shall be provided with auxiliary secondary condensate drain pan, irrespective of the schedule of quantities or the tender drawings.

3.7 Capacity
The air moving and coil capacities shall be shown on Drawings and indicated in Schedule of Quantities.
3.8 **Cabinets**
Cabinets shall be constructed of 1.25 mm thick die-formed CRCA sheet steel, bonderized and powder coated. Corners shall be rounded without break lines. The cabinet shall be of sufficient size to enclose all piping and control valves and shall have access doors to piping and controls. Access panel shall have positive locking fasteners for easy removal. Cabinets shall be provided with all floor mounted vertical units and ceiling suspended horizontal units. Horizontal units mounted within ceiling space shall be provided with a cabinet housing coil and fan section with provision to mount filters within the fan section.

3.9 **Interior Chassis**
The interior chassis shall be constructed of not less than 1.2 mm thick cold rolled steel and coated with a rust inhibiting paint. All fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. The fan deck shall be easily removable from FCU without disturbing the other installations.

3.10 **Drain Pan**
Primary drain pan shall be fabricated from 0.80 mm thick Stainless Steel with all corners welded and an additional inner bottom panel of 1.25 mm thick cold rolled galvanized sheet steel shall be provided to prevent damage to, and floatation of the bottom panel insulation. The pan shall be insulated with not less than 15mm thick expanded polyethylene insulation sandwiched between top and bottom panels to effectively prevent condensation. The pan shall be of sufficient size to catch all drips of condensation from any part of the unit. In all cases pan shall be large enough to cover cooling coil supply and return water headers and bends, and control valves. An extension condensate pan similar to primary drain pan shall be provided by the manufacturer of those units where coil connections are to be made on both ends of the coil.

3.11 **Auxiliary Condensate Drain Pan**
As shown on drawings/Schedule of Quantities horizontal fan coil units mounted within false ceiling space may be provided with an auxiliary condensate drain pan similar to primary drain pan in construction and sized larger than primary drain pan to catch all overflow in case primary drain pan outlet gets choked. Drain from auxiliary condensate drain pan shall be connected to the drain from primary drain pan through a tee connection and piped to the vertical risers.

3.12 **Cooling Coil**
All cooling coils shall be standard three-row staggered seamless copper tube with aluminum sine wave fins. Tubes shall be hydraulically expanded for mechanical bondage with fins mechanically. Tubes shall be minimum 10mm(3/8” Inch) OD and wall thickness shall be minimum 0.5 mm. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Each coil shall be provided with an air vent. All coils shall be factory tested at 21 KG per sq. cm. (300 psig) air pressure while submerged in water. Fin spacing shall be 4 to 5 fins per cm. Tubes shall be mechanically/hydraulically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in headers at a level higher than coils. The cooling coil shall be easily removable from backside of FCU without disturbing the other installations.
3.13 **Fan**  
Fans shall be centrifugal forward curve DIDW type, direct driven by a shaded pole motor.

3.14 **Motor**  
Motor shall be a 220±6% volt, 50 cycles single phase, six pole, shaded pole type, speed not exceeding 1000 rpm at maximum airflow. Motors shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides.

3.15 **Mixing Box**  
Wherever specified in the BOQ. This section, whenever asked for, shall effect into following:  
3.15.1 Totally insulated FCU downstream of coil, with 18mm NITRILE FOAM / CROSS LINKED POLYETHYLENE FOAM.  
3.15.2 Thermal break profile to avoid condensation  
3.15.3 Mixing box (insulated) with thermal break profile for inhibition of condensation.

3.16 **Installation**  
Ceiling suspended horizontal units and units mounted within the ceiling space shall be hung through Dunlop/Emerald make rubber-in-shear vibration isolator suspenders. (Refer the acoustics and vibration control chapter for this).

3.20 **Accessories**  
3.20.1 All fan coil units shall be equipped with copper piping connections and manual air vent at the cooling coil. In addition, the following accessories may be required at fan coil units; their detailed specifications are given in individual sections and quantities separately in Schedule of Quantities.  
3.20.2 Wall mounted thermostat for individual unit, containing three speed ON and OFF control for fan speed and temperature control for summer/winter air conditioning.  
3.20.3 Motorized two/Three-way valve in water lines for individual unit, or for a group of fan coil units, as mentioned in the drawings.  
3.20.4 ‘Y’ strainer, globe valve as shown on drawings/Schedule of Quantities.

**HIGH STATIC FAN COIL UNITS SHALL HAVE SUFFICIENT EXTERNAL STATIC PRESSURE TO ALLOW FOR A MINIMUM OF 15 M (Equivalent) DUCT LENGTH.**
AIR SIDE EQUIPMENT & ASSOCIATED WORKS

L-4
AIR REGISTERS

SHEET METAL ACCESSORIES

PART 1 GENERAL

4.1 Work Included
4.1.1 Air Distribution Registers, grilles, diffusers.
4.1.2 Fire / Smoke Dampers
4.1.3 Access Doors
4.1.4 Outside Air Louvres
4.1.5 Flexible Ducts

4.2 Related Works
4.2.1 Ordinary Duct Work : GSS / Aluminum
4.2.2 Special Duct Work : For Kitchen / Exhaust

4.3 Quality Control
4.3.1 Air Diffusers/Grilles: As per ratings by Air Diffusion Council / As per approved manufacturer.
4.3.2 Fire / Smoke / Combination dampers : UL, NFPA 90A / 90 B.

4.4 Submittals
Submit manufacturer’s product data for review

PART 2 PRODUCTS

4.5 Grills / Diffusers / Fire-Smoke Dampers
4.5.1 Acceptable manufacturer : As per approved list.

4.5.2 Ceiling diffuser/Grilles shall be of Extruded aluminum construction as per the specifications detailed hereunder.
Jet nozzle diffusers are most suitable when large spaces need to be treated or when the ceiling is relatively high. They are often used in concert halls, museums, theatres, shopping centers, airports etc. The up to 45 degrees possible inclination of the jet helps directing the air to the right places. The diffusers are very efficient for both hot and cold air and they can be directed down or up accordingly to the supplied air temperature. Throws of more then 20 meters can be achieved.
4.5.3 **Air Register**

The scope of this section includes supplying, installation, testing, balancing and commissioning of various air distribution products as specified here under. All air distribution products shall have guaranteed performance rating as regards to air quantity, throw, noise level and pressure drop etc. Contractor has to provide selection curves at the time of supply.

4.5.4 **Supply and Return Registers and Ceiling Terminals**

Supply and return air registers and ceiling terminals shall be made of extruded aluminium section as specified in BOQ. The registers/terminals shall be either anodised or powder coated in finish as given in BOQ. Supply air registers/terminals shall be provided with screw operated opposed blade volume control device of extruded aluminium in mill finish. The registers shall be suitable for fixing arrangement concealed or visible screw as approved by architect/consultant.

All registers shall be selected as per selection curves and in consultation with architect/consultant. All registers shall have soft continuous rubber/foam gasket between the periphery of the registers/terminals and the surface on which it has to be mounted.

4.5.5 **Linear Registers**

Linear continuous supply or return air register shall be extruded aluminium construction with fixed horizontal bars at 0° or 15° inclination with one way or two way deflection and flanges on both sides. The thickness of fixed bar louvers shall be 5 mm in front and the flange shall be 20 mm wide with round edges. The register shall be suitable for concealed fixing and horizontal bars of the register shall be mechanically crimped from the back to hold them.

Volume control device of extruded aluminium construction in mill finish shall be provided in S.A. duct collars.

4.5.6 **Single Individual Adjustable Louvered Supply or Return Air Register**

Single individual adjustable horizontal/vertical supply or return air register shall be made of extruded aluminium construction. The louvers shall hold deflection settings under all conditions of velocity and pressure since mounted on Nylon bushes. The register shall have 20 mm wide flange all around with front screw fixing.

Volume control device of extruded aluminium/GI construction in mill finish shall be provided in S.A. duct collars.

4.5.7 **Double Adjustable Louvered Supply/Return Air Register with Horizontal / Vertical or Vertical/Horizontal Louver Arrangement**

The register shall be adjustable as each louver shall be pivoted to provide pattern with 0° to plus or minus 15° arc up to 30° deflection down towards. The louver shall hold deflection settings under all conditions of velocity and pressure. The Rear louver of the register shall be in black shade.
Volume control device of extruded aluminium construction with mill finish shall be provided in S.A. duct collars.

4.5.8 Rectangular Fixed Bar Register
Supply/Return air all side flange air register shall be extruded aluminium construction with fixed horizontal bars at 0° or 15° inclination with one way or two way deflection and flanges on both sides. The thickness of fixed bar louvers shall be 5 mm in front and the flange shall be 20 mm wide with roundedges. The register shall be suitable for concealed fixing and horizontal bars of the register shall be mechanically crimped from the back to hold them.

4.5.9 Exhaust Air Register
Exhaust air register shall be made of extruded aluminium with fixed horizontal louvers at 40° angle setting on a 20 mm louver pitch. The register shall have 20 mm wide flange with round edges all around. The register shall be suitable for front screw fixing.

Volume control device of extruded aluminium construction in mill finish shall be provided in S.A. duct collars.

4.5.10 Square Ceiling Air Terminals
Square/Rectangular ceiling air terminals shall be made of extruded aluminium construction with flush fixed pattern. The terminals shall have Anti-Smudge ring and spring loaded removable central core in various pattern for air flow direction. The terminal shall be mounted by concealed screw fixing arrangement. The supply air terminal to be supplied with Volume control device of extruded aluminium construction in mill finish. Laminar Air Flow Pattern Diffuser used in OT's.

4.5.11 Curved Blade Ceiling Terminals
Square /rectangular curved blade ceiling terminals shall be made of extruded aluminium. The terminals shall have individual adjustable blades mounted on nylon bushes which facilitate to adjust the direction of air as per site conditions. The terminals shall have 20 mm wide flanges all around and concealed screw fixing arrangement. The supply air register to be supplied with Volume control device of extruded aluminium construction in mill finish.

4.5.12 Volume Control Device
Opposed blade volume control device shall be made of all extruded aluminium construction in mill finish. Opposed blades shall be pivoted to extruded aluminium frame with Nylon bushes. Specially designed blade have an overlapping lip which ensure a tight closure.
4.5.13 **Ventilation Air Intake Louvers**
Ventilation air intake louvers 50 mm deep wherever required as per shop drawing will be made of extruded aluminium construction duly Anodised or Powder coated. Bird/insect screen will be provided with the intake louvers. The blades are inclined at 45° on a 40 mm blade pitch to minimise water ingress. The lowest blade of the assembly shall extended out slightly to facilitate disposal of rain water without falling in door/wall on which it is mounted.

Wherever specified, the intake louvers shall be provided with factory fitted all aluminium construction volume control dampers in mill finish.

4.5.14 **Storm Proof Louvers**
80mm deep wherever required as per shop drawing will be made of extruded aluminium construction. The blades are inclined at 45 degree on 75 mm blade pitch to minimise water ingress. The lowest blade of the assembly shall extended out slightly to facilitate disposal of rain water without falling in door/ wall on which it is mounted.

4.5.15 **Air Transfer Door Register**
Extruded aluminium construction air transfer door register will be provided as per approved shop drawings. The register will be complete with single /double register frame to be mounted on door panel from both sides. The central core shall be NO-SEE-THRU type. The register shall be anodised or powder coated as per Architect’s requirement. The register shall be provided with insect screen to prevent movement of insects from inside to outside or vice versa.

4.6 **Fire and Smoke Damper**
4.6.1 ACCEPTABLE MANUFACTURER : As per approved list in annexures.
4.6.2 DAMPER FIRE RATINGS: Minimum 120 minutes.
4.6.3 SMOKE DAMPER : Operator : Electric
4.6.4 COMBINATION FIRE AND SMOKE DAMPER : Operator : Electric

4.6.5 **Motorised Combined Smoke & Fire Dampers - Spring Return**
All Supply and Return Air Ducts at AHU room crossings and at all floor crossings shall be provided with approved make fire and smoke dampers of atleast 120 minutes fire rating certified by CBRI Roorkee as per UL 555:1973.

4.6.8 Fire Damper blades & outer frame shall be formed of 1.6MM galvanised sheet steel. The damper blade shall be in pivoted on both ends using chrome plated spindles in self lubricated bronze bushes. Stop seals will be provided on top and bottom of the damper housing made of 16 G galvanised sheet steel. For preventing smoke leakage side seals will be provided.
4.6.7 In normal position damper blade shall be held in open position with the help of a 24V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

4.6.8 The damper shall be actuated through electric actuator. The actuator shall be energised with the help of a signal from smoke detector (supplied by others) installed in AHU Room/R.A.Duct/Damper. The Fire Damper shall also close due to Temp. rise in S.A. Ducts thru the Electric Temp. sensor factory set at 165°F micro switches with bakelite base will be provided to stop fan motor and give open & close signal at remote panel in case of motorised actuator.

4.6.9 Each Damper in case of motorised Smoke-cum-Fire Damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from UPS or Emergency Power Supply to shown status of the damper (open or close), to allow remote testing of damper & indication in event of damper closure due to signal from smoke sensor/Temp. sensor & reset button. Additional Terminal will be provided to have signal (sound beep or visual) in Central Control Room.

4.6.10 Damper Actuator shall be spring return so as to close the damper in the event of power failure automatically and open the same in case of power being restored.

4.6.11 The Fire Dampers shall be mounted in fire rated wall with a duct sleeve 400MM long. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be Slip on type. Minimum thickness of G1 Sheet shall be 18 G.

4.6.12 The damper shall be installed in accordance with the installation method recommended by the manufacturer.

4.6.13 After installation of Fire Dampers, contractor will co-ordinate with the civil contractor on site and get the extra openings sealed, and then finally finish the installation by sealing the area, using approved make of mastic fire sealant.

4.7 Flexible Ducts
4.7.1 Insulated with 25 mm thick fibre glass insulation.

4.7.2 Seal off the insulation jacket at its ends and at joints with mastic, hard cast or similar material.

4.7.3 Complete insulation coverage up to the Terminal Air Unit.

4.7.4 No bends shall be made in flexible ducts with the centre line radius less than one and a half duct diameter, and only one bend shall occur per three feet length of duct.
AIR SIDE EQUIPMENT & ASSOCIATED WORKS

L- 5
VENTILATION FANS

PART 1 GENERAL
5.1 Related Work
5.1.1 Motors
5.1.2 Vibration Insulation

5.2 Submittals
5.2.1 Submit product data including dimensions as shown in the tender drawings, ratings as mentioned in the tender document, and performance data for review

PART 2 PRODUCTS
5.3 Acceptable Manufacturer's
As per list of approved manufacturers in annexures.
5.3.1 General
The contractor shall supply install, test and commission ventilation fans wherever shown on the drawings and as scheduled. The system shall be complete in all respects and comply with the specification given

5.3.2 Fans shall be of the type, size, arrangement and capacity as indicated in the schedule and/or as shown on the drawings


5.3.4 A computer printout of fan performance rating corresponding to the AMCA licensed data, with corrected ratings for altitude and temperature, fan operating speed, bearing life, etc. shall be submitted for approval.

5.3.5 All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly. A computer printout with the vibration spectrum analysis shall be attached to the fans.
5.3.6 Fan motors shall comply in all respects with continuous rating in accordance with IEC34 or equivalent. Motor bearings shall be of ball or roller type, grease or lubricant sealed for life. Fan and drive shall be earthed to prevent accumulation of static charge.

5.3.7 KITCHEN EXHAUST FAN SHALL BE OF BIFURCATED AXIAL OR SISW CENTRIFUGAL DIRECT OR BELT DRIVEN TYPE. DIDW CENTRIFUGAL AND DIRECT DRIVE AXIAL FLOW FAN WHERE BELTS OR MOTOR ARE IN THE AIR STREAM ARE NOT ACCEPTABLE.

5.3.8 FANS FOR ELEVATED TEMPERATURE (SMOKE SPILL DUTY) WITH COMPONENTS RATED FOR HIGH TEMPERATURE (250 DEG C, 2.0 HRS DUTY) SERVICE SHALL BE PROVIDED.

5.4 **Capacity**
The air handling capacities, maximum motor H. P, static pressure shall be as shown on Drawing and in Schedule of Quantity.

5.5 **Type:**
**Axial Flow Fans (Direct Drive)**
5.5.1 Fans shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal.

5.5.2 The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 “Laboratory Method of Testing Fans for Rating” and AMCA 300 “Reverberant Room Method for Sound Testing of fans”.

4.5.4 Fans shall be oven-baked with polyester coating for minimum thickness of 60 microns or hot-dipped galvanized.

5.5.5 Fan motor base support shall be properly secured (locked and sealed) to the fan housing and be of adjustable type to have precise control of motor shaft central position as well as running clearance between blade tips and casing.

5.5.6 Fans supplied shall be complete with factory fabricated mounting bracket (ceiling or foot mounted) and suction/discharge matching flanges as accessories.

5.5.7 All hubs shall be cast Aluminium alloy (Grade LM2) unless for Smoke spill Fans where high temperature (250 degree C, 2.0 Hr. Fire Duty) air is expected then Aluminum alloy or steel fan impeller blades are required. Otherwise impeller blade material with Polypropylene (PP), Glass-reinforced Polypropylene (PPG) and Glass-reinforced Polyamid (PAG), to provide self-balancing, anti-static, anti-sparking characteristic is preferable.
5.5.8 Running clearance between blade tips and casing shall not exceed 1% of the impeller diameter, and 2% for smoke spill high temperature fan where mechanical expansion coefficient is different from normal ambient temperature. Fan manufacturer shall provide the fan assembled with the same clearance between blade tips and casing of the tested prototype. Note that the air performance and pressure loss are greatly affected by this clearance.

5.5.9 Impellers shall be secured to the drive shaft by a key and keyway. Axial location shall be provided by a collar or shoulder on the drive shaft together with a retaining washer and screw fitted into a tapped hole at the end of the shaft and locked in position. Blades shall be secured in place to the angle setting by setscrews, locking nuts or setting pins.

5.5.10 Fan motor shall be totally enclosed and external terminal box of at least IP55 shall be provided.

5.5.11 Fan speed shall not exceed 1400 RPM.

5.6 Centrifugal Fans
5.6.1 Fans, forward or backward curved, SISW or DIDW, shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal.


5.6.2 All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly.

5.6.3 Fans shall be oven-baked with polyester coating for minimum thickness of 60 microns, unless the housing scroll and side frame is constructed from galvanized steel sheet (G.I.), Stainless Steel, Aluminum and etc.

5.6.4 Fans must be physically capable of operating safely at every point of rating at or below the “minimum performance” limit for that class as defined in AMCA standard 99-2408-69 “Performance Class of Operating Limits for Centrifugal Fans”.

5.6.5 Shafts shall be made of carbon steel (C45) machined and polished to tolerance of standard ISO 286–2–grade g6. Protective coat of anti-rusting shall be applied to all bare surfaces of the shafts at the factory.

5.6.6 Bearings shall be of self-alignment (concentric) type with adaptor sleeve bearing. Bearings of eccentric locking collar with grub screw type are not acceptable.
Bearing shall be maintenance free with permanently lubricated sealed ball bearing type. Bearing life shall be at least 75,000 hours based on basic rating life, L10 of ISO 281 standard. Calculation sheet of Bearing Life shall be submitted for approval.

5.6.7 Motor installed shall be of a minimum 130% of the fan power absorbed (Brake horsepower) and shall have sufficient torque available for starting and continuous operation.

5.6.8 Belts and pulleys shall be sized for a minimum 150% of the installed motor horsepower. The belt speed shall not exceed 30m/s. The pulley shall be of Taper Lock SPZ, SPA, SPB or SPC type. Conventional type of pulley is not acceptable. Both fan and motor pulley shall be balanced to the quality grade G.2.5.

5.7 **In-Line Centrifugal Duct Fan**

5.7.1 Fan shall be of SISW, **backward** curved centrifugal, direct driven type.

5.7.2 Casing shall be of Galvanized steel with Oven-baked epoxy coating. Impeller material shall be either Galvanized Steel or Glass Reinforced Polypropylene

5.7.3 Motor shall be external rotor type for power supply 220~240V/50Hz/Single Phase.

5.8 **Propeller Fan**

5.8.1 Fans shall be of the ring-mounted type and the blades constructed from heavy gauge metal. An aerodynamically designed bell mouth constructed from heavy gauge metal shall be provided. The fan speed shall not exceed 1400RPM at 50Hz operation.

5.8.2 Propeller fans shall be direct driven type, the motor either a single-phase capacitor start-run or a three-phase squirrel cage induction type. The motor shall have inbuilt inherent protection against overloading. Motor with shaded pole or centrifugal switch type is not acceptable

5.8.3 Bearings shall be maintenance free permanently lubricated type. Fans shall be complete with wire guards. External grilles, fan chambers and volume control damper shall be provided where indicated in the specification drawings.

5.9 **Ventilation Units (Fan Sections)**

5.9.1 The scope of this section, comprises the supply, erection, testing and commissioning of double / single skin construction Ventilation units, conforming of these specifications and in accordance with requirements of Drawings & of the Schedule of Quantities.
5.9.2 The Ventilation units shall be double/single skin construction, draw–thru type comprising of various sections such as plenum chamber (wherever the Exhaust Air is ducted) filter section and filter, fan section as per details given in Drawings and Schedule of Quantity.

5.10 Capacity
The air handling capacities, maximum motor H. P., static pressure shall be as shown on Drawing and in Schedule of Quantity.

5.11 Housing / Casing (Single Skin)
The housing/casing of the air handling unit shall be of Single skin construction. The frame work shall be of Extruded Aluminum hollow sections.

Frame work for each section shall be jointed together with soft rubber gasket in between to make the joints air tight. Suitable air tight access doors/panels with Nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on Rolled Formed GSS channel frame work.

5.12 Motor and Drive
Fan motors shall be 415 for 10% volts, 50 cycles, 3 phase, squirrel-cage, totally enclosed fan cooled with IP - 55 protection. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type.

5.13 Fan
The fan shall be backward curved, double inlet double width type. The wheel & housing shall be fabricated from heavy gauge galvanised steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame & pillow block heavy duty ball bearings.

The fan shall be selected for a noise level less than 80 db (A). The impeller & fan shaft shall be statically and dynamically balanced. The Fan outlet velocity shall not be more than 10.0 M/SEC. Fan housing with motor shall be mounted on a common base mounted in side the air handling housing on anti-vibration mounts. The fan outlet shall be connected to casing with the help of fire retardant fabric acting as a flexible connection for anti-vibration.

5.14 Filters
Each unit shall be provided with a factory assembled filter section containing washable synthetic type air filters having extruded aluminium frame as specified in BOQ. The media shall be supported with HDP mesh on one side and aluminium mesh on other side. Filters face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Whenever fine filter are required to be installed, unit shall be provided with factory fabricated plenum chamber in double skin construction as described above for casing specification. The fine filter shall incorporate pocket filters which will have an efficiency of not less than 95% by ASHRAE standard corresponding to Eurovent standard EU-5.

HVAC Consultant: AD CONSULTANTS
5.15 **Safety Features**
Each Ventilation Unit must have safety features as under:

5.15.1 The Fan Access Door shall be equipped with micro-switch inter locked with fan motor to enable switching of the fan motor automatically in the event of door opening.

5.15.2 The Access Door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.

5.15.3 Fan and motor base shall be properly earthed from the factory

5.15.4 All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

5.16 **Performance Data**
Ventilation units shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicating shall be submitted and verified at the time of testing commissioning of the installation.

5.17 **Testing**
Air-flow measurements shall be made by an anemometer and computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.
A I R  S I D E  E Q U I P M E N T  &  A S S O C I A T E D  W O R K S

L- 6
AIR WASHER–PACKAGED TYPE

PART 1 GENERAL

6.1 RELATED WORK
6.1.1 Supply, install, test and commission packaged type air washer as per specifications.
6.1.2 Associated equipment and material.
6.1.3 Mechanical System Installation and TAB.

6.2 WARRANTY
Manufacturer shall warrant equipment for a period of 18 months from date of shipment or One year from date of beneficial use by Owner

6.3 SUBMITTALS
6.3.1 Submit manufacturer’ product date for review
6.3.2 Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable

PART 2 PRODUCTS

6.4 ACCEPTABLE MANUFACTURERS
6.4.1 As per approved list of manufacturers in the annexure

6.4.2 GENERAL REQUIREMENTS
6.4.2.1 Statically and dynamically balance rotating parts
6.4.2.2 Construction to permit complete servicing without breaking any connections
6.4.2.3 Provide flanged pump connections
6.4.2.4 Provide mono–block pumps and strainers of adequate capacity.

6.5 GENERAL
The Evaporative Cooling Machine will be self contained and will consist of the following component parts listed in the following paragraphs. The entire unit shall be WEATHER PROOFED and CORROSION PROTECTED with 18 Ga SS 304 with FRP lining shall be provided to all the sections. as hereinafter specified. The unit shall have a horizontal monoblock self priming pump assembly to provide recirculated tank water and a pressurized flow via a piping system for proper pad and media water distribution. The unit shall be factory fabricated and will include
6.5.1 **BLOWER SECTION**

The blower section shall include Centrifugal Forward/backward Curved DiDW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be mounted C Channel frame and Cushy Foot Mounts. The fan shall have a capacity not less than the one specified in the catalogues and shall be constructed and rated based on delivery against the rated static pressure with the media and filters in place. The fan will be of riveted construction and made with GI sheet of required thickness. The fan wheel will be of the multiblade type and mounted on two self aligning pillow block bearings of the requisite size. The fan shall be run with the help of “V” Groove drives as per the recommendation of the drive supplier. The blower housing will of the pittsburg joint construction and the drive will be provided by a motor of adequate capacity. The motor plate will be constructed out of 12 Ga MS or heavier metal with slotted holes which permit belt adjustment in both the directions. The material used will be 16 Ga GI. The outlet velocity of the blowers will be kept low.

6.5.2 **EVAPORATIVE SECTION**

The wet section will have 16 Ga GI Tank with folded construction with the bolted openable sides in 16 Ga GI sheet. The section will be of welded construction. 200 mm thick Cooling pads will be provided designed @ 2.5 m/s to give 90% adiabatic efficiency. 2mm thick FRP specially fabricated header will be provided for the water distribution using 20 mm PVC perforated piping. All wet sections will include 5 layer 30 micron Aluminum Wire mesh filters of 50 mm thickness including the mounting channels for the same. 15 mm Brass Bleed off cock, 20 mm heavy duty Brass Float. PVC drain/overflow and bleed off outlet are standard on all wet sections.

18 Ga SS 304 with FRP lining shall be provided to all the sections.

6.5.3 Double skin construction similar to air handlers (except for internal sheet which shall be SS 304 with FRP lining) shall be provided. Panel will be 43 mm thick. Wherever exposed to atmosphere., otherwise the panel thickness shall be 23mm thick.
AIR SIDE EQUIPMENT & ASSOCIATED WORKS

L-7
AIR SCRUBBER RIGID MEDIA TYPE KITCHEN SCRUBBER

PART 1 GENERAL

7.1 RELATED WORK
7.1.1 Supply, install, test and commission kitchen air scrubber as per specifications.
7.1.2 Associated equipment and material.
7.1.3 Mechanical System Installation and TAB.

7.2 WARRANTY
Manufacturer shall warrant equipment for a period of 18 months from date of shipment or One year from date of beneficial use by Owner.

7.3 SUBMITTALS
7.3.1 Submit manufacturer’s product data for review.
7.3.2 Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

PART 2 PRODUCTS

7.4 ACCEPTABLE MANUFACTURERS
7.4.1 As per approved list of manufacturers in the annexure.

7.4.2 GENERAL REQUIREMENTS
7.4.2.1 Statically and dynamically balance rotating parts.
7.4.2.2 Construction to permit complete servicing without breaking any connections.
7.4.2.3 Provide flanged pump connections.
7.4.2.4 Provide monoblock pumps and strainers of adequate capacity.

7.5 The Kitchen Scrubber will be self-contained and will consist of the following component parts listed in the following paragraphs. The entire unit shall be WEATHER PROOFED and CORROSION PROTECTED 18 Ga SS 304 with FRP lining shall be provided to all the sections. as hereinafter specified. The unit shall be factory fabricated and will include...
7.5.1 **BLOWER SECTION**

The blower section shall be constructed out of 16 G GI sheet in folded construction and shall include **Centrifugal Forward/backward Curved DIDW fan wheel of totally GI Construction with Inlet Cones** and shall be complete with individual motor and drive and shall be mounted **C Channel frame and Cushy Foot or Spring Mounts**. The fan shall have a capacity not less than the one specified in the catalogues and shall be constructed and rated based on delivery against the rated static pressure with the media and filters in place. The fan will be of riveted construction and made with GI sheet of required thickness. The fan wheel will be of the multiblade type and mounted on two self-aligning pillow block bearings of the requisite size. The fan shall be run with the help of “V” Groove drives as per the recommendation of the drive supplier. The blower housing will of the pittsburg joint construction and the drive will be provided by a motor of adequate capacity. The motor plate will be constructed out of 12 Ga MS or heavier metal with slotted holes, which permit belt adjustment in both the directions. **The outlet velocity of the blowers will be kept low.**

7.5.2 **EVAPORATIVE / SCRUBBER SECTION**

The scrubber section will have 3 mm MS welded Tank with 1.2 mm FRP Lining and body with folded construction with the bolted openable sides in 16 G GI sheet. The Wet Section will contain A 50 mm thick RIGID MEDIA which will act as the cleaning media for the smoke and smell, this media banks will be designed @ 2.5 m/s to act as a DROP STOP eliminator.

7.5.3 **FILTER SECTION**

All wet sections will include 5 layer 30-micron Aluminum Wire mesh filters of 50 mm thickness including the mounting channels in 16 Ga GI for ease of removal and renewal of Filter cells. The filters to be designed at 2.5 m/s to give 90% efficiency down to 30 microns.

7.5.4 **PUMP**

The unit will have a three phase 440 volts ± 6% 50 c/s power supply monoblock self priming pump assembly to provide re-circulated tank water and a pressurized flow via a piping system for proper water distribution.
Air Purifier (PHI Cell):

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| 1. | DESCRIPTION:  
PHI (Photo Hydro Ionization) Technology | PHI cells to be installed preferably in the supply air stream in accordance with the selection chart in respect to each application so that 100 percent of the conditioned space is taken care of in respect of Microbial contamination (bacteria, virus and spores) and Gaseous contamination (VoC’s & Odors). Load factor sheet and calculation to be submitted. |
| 1.b | Air Flow Type:  
Longitudinal/transverse/parallel | PHI cells to be installed in air duct supporting a longitudinal/transverse/parallel air flow depending upon the requirement and easy accessibility. |
| 1.c | Air Flow Direction: | Towards UV Lamp assemblies. |
| 1.d | Lamp Assemblies Shape: | Cylindrical |
| 1.e | Diameter: | Overall Diameter of the equipment shall not be more than 4 inches. |
| 1.f | Ballast Diameter:  
5.5 inches | Ballast diameter shall not exceed 5.5 inches. |
| 1.g | Ballast, Wire Sets connecting Air Purifier, Lamp/  
Lamp Holder, Bushing and Powercord | The components of the equipment shall be conform to UL935, UL542, UL635, UL817, CSA, CE, EU and TUV certified. All relevant certifications to be submitted along with the technical data sheet, failing which it shall not stand qualified. |
| 1.h | Indicator | There will be one ballast, an indicator for each lamp that will show whether the PHI Cell is ON/OFF. The unit is designed to run 24x7. |
| 2. | ELECTRICAL ELEMENTS | The ballasts will be instant start, solid state electronic type, 220V/50 Hz. |
2. **Power Consumption:**

3. **INSTALLATION:**
   - Preferably Supply duct/plenum otherwise Return duct

4. **UV Lamp:**
   - The length of UV lamp shall not be greater than 14 inches.

4.a **Broad Spectrum UV Light:**
   - 100-380 NM UV Light

4.b **UV lamp Protective Covering:**
   - There is a Proprietary Protective Covering (PPC) on the UV light to protect against any accidental spill of mercury in HVAC duct.

5. **PERFORMANCE:**
   - The PHI technology features a broad spectrum UV light and a quad metallic target (copper, silver, rhodium and titanium) that combine to generate nature’s friendly oxidizers: Hydroxides, Hydro peroxides and Super oxide ions.

5.a **Hydrogen Peroxide (H2O2):**
   - Hydrogen peroxides are very effective in breaking down airborne and surface borne microbes, odor, VOCs and shall not exceed 0.02 ppm

5.b **Test results booklet:**
   - To be attached

6. **WARRANTY:**
   - Lamp Warranty: 23000 hours or 2 years (whichever is earlier)

7. **SELECTION**
   - The detailed selection chart vis-à-vis each application and CFM shall be submitted for approval, indicating model number and number units for each CFM.

8. **CERTIFICATION**
   - Conform to UL935, UL542, UL635, UL817, CSA, CE, EU and TUV certified. Certifications to be submitted along with the technical and load selection sheet.
AIR SIDE EQUIPMENT & ASSOCIATED WORKS

L–8
AIR DISTRIBUTION

PART 1  GENERAL

8.1 Sheet Metal Duct Works shall be carried out in accordance with either SMACNA or B.I.S. (IS 655) guidelines, as asked for in BOQ. SMACNA guidelines (upward modified in this specification) shall be adopted for factory fabricated ducts, and BIS Codes shall be adopted for site fabricated ducts.

8.2 Duct works material shall be as follows:
8.2.1 G.S.S. (Class VIII, 120 GSM of light coating zinc) minimum gage to be used is 24
8.2.2 Aluminum Minimum gage to be used is 22

8.3 Contractor shall prepare shop drawings, coordinated with the working drawings and the ceiling plans made by Architect.

8.4 Contractor shall fabricate, supply, install, test and balance air system and establish the air balance schedule.

8.5 Contractor shall include in his costing all supporting, suspension and air balancing devices.

8.6 Contractor shall follow the preamble to measurement mode appended to this document.

8.7 DUCT DESIGN PARAMETERS (Rectangular / Square)
8.7.1 Maximum Flow Velocity 1500 FPM 450 MPM
8.7.2 Maximum Friction 0.08 WG/100 FT Run 5MM WG/100 M Run
8.7.3 Maximum Velocity at SA outlet 500 FPM 150 MPM
8.7.4 Maximum flow velocity in exhaust duct 1800 FPM 550 MPM

8.8 GAUGES, BRACING BY SIZE OF DUCTS
All ducts shall be fabricated from galvanized steel / aluminum of the thickness, as indicated in relevant tables. Using the bracings, flanges and duct supports as specified in the said Tables.
8.9 DUCT FABRICATION SPECIFICATION
8.9.1 For Ducts with External SP up to 250 Pa

Table 1

<table>
<thead>
<tr>
<th>Rectangular Duct Section Length 1.2 m (4 ft.)</th>
<th>Duct G.S.</th>
<th>Minimum Duct Size</th>
<th>Pressure 250 Pa</th>
<th>Joint Type</th>
<th>Bracing Spacing (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1–750 mm</td>
<td>24</td>
<td>4 Bolt Transverse Duct Connector–E (TDC) with built in sealant</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>751–1000 mm</td>
<td>24</td>
<td>4 Bolt Transverse Duct Connector–E</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1001–1200 mm</td>
<td>24</td>
<td>4 Bolt TDC–E</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1201–1500 mm</td>
<td>24</td>
<td>4 Bolt TDC–H</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1501–1800 mm</td>
<td>22</td>
<td>4 Bolt TDC–H</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1801–2100 mm</td>
<td>20</td>
<td>4 Bolt TDC–J</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2101–2700 mm</td>
<td>18</td>
<td>4 Bolt TDC–J</td>
<td>600</td>
</tr>
</tbody>
</table>

8.9.2 For Ducts with External SP more than 250 Pa and up to 500 Pa

Table 2

<table>
<thead>
<tr>
<th>Rectangular Duct Section Length 1.2 m (4 ft.)</th>
<th>Duct G.S.</th>
<th>Minimum Duct Size</th>
<th>Pressure 500 Pa</th>
<th>Joint Type</th>
<th>Bracing Spacing (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>1–600 mm</td>
<td>24</td>
<td>4 Bolt Transverse Duct Connector–E (TDC) with built in sealant</td>
<td>NIL</td>
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<tr>
<td></td>
<td></td>
<td>601–750 mm</td>
<td>24</td>
<td>4 Bolt Transverse Duct Connector–E (TDC) with built in sealant</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>751–1000 mm</td>
<td>24</td>
<td>4 Bolt Transverse Duct Connector–E</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1001–1200 mm</td>
<td>22</td>
<td>4 Bolt TDC–E</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1201–1300 mm</td>
<td>20</td>
<td>4 Bolt TDC–H</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1301–1500 mm</td>
<td>18</td>
<td>4 Bolt TDC–J</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1501–1800 mm</td>
<td>18</td>
<td>4 Bolt TDC–J</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1801–2100 mm</td>
<td>18</td>
<td>4 Bolt TDC–J</td>
<td>NIL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2101–2250 mm</td>
<td>18</td>
<td>4 Bolt TDC–J</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2251–2400 mm</td>
<td>18</td>
<td>4 Bolt TDC–J</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2401–2700 mm</td>
<td>18</td>
<td>4 Bolt TDC–J</td>
<td>600</td>
</tr>
</tbody>
</table>
8.10 **TRANSVERSE CONNECTORS**
8.10.1 All transverse connectors shall be 4–bolt flanged system, with built–in sealant.
8.10.2 For site fabricated (to suit) ducts and all dampers shall have uniform type of flanges. To ensure this the Contractor shall deploy fabricated flanges on hand made ducts, using pop rivets / approved alternate.

8.11 **DUCT CONSTRUCTION / INSTALLATION**
8.11.1 All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.
8.11.2 Coil (Sheet Metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.
8.11.3 Ducts shall be straight, smooth on the inside with longitudinal seams shall be airtight, and at corners, only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.
8.11.4 All ducts shall have flanged / transverse joints as mentioned in Table 1 & 2. Ducts and accessories including insulation within ceiling spaces, visible from air-conditioned area shall be provided with two coats of mat black finish paint.
8.11.5 Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
8.11.6 Ducts shall be fabricated as per details shown in Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.
8.11.7 All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS/16 gauge aluminum, thoroughly stiffened with 25 mm x 25 mm x 3 mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45 cm x 45 cm in size.
8.11.8 Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
8.11.9 Self adhesive Neoprene rubber / UV resistant PVC foam lining 5 mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting.
installation.

8.11.10 Where duct lines pass through any masonry opening, the contractor shall provide an isolation barrier of expanded Polystyrene 25mm thick of TF quality.

8.11.11 Toilet exhaust ducts in case of guest rooms (hotels)/in–patient rooms (hospital Bed towers) shall have a “goose neck” collars to avoid/minimize cross talks etc.

8.12 ROUND DUCT CONSTRUCTION
8.12.1 Duct Fabrication:

8.12.1.1 Conference to SMACNA Guidelines

8.12.1.2 Provide spiral duct (factory fabricated)

8.12.1.3 Construction shall be as per ASTM A 527 and G.S.S. Grade VII shall be used for either insulated or non–insulated spiral ducts.

8.12.1.4 Locking arrangement of spiral lock seams shall be used for all duct sizes up to 1000mm diameter.

8.12.1.5 For any duct size beyond 1000mm dia, use welded longitudinal or spiral seam.

8.12.1.6 For duct line jointing, provide gasket joints (if asked for), or generally provide beaded sleeve joints.

8.12.1.7 For fitting, such as elbows / T–joints, use welded long radius elbows and welded, conical Tees.

8.12.1.8 Use Clevis hangers / universal supports for supporting arrangement. (Subjected to site approval).

8.13 SITE FABRICATED DUCT
8.13.1 Duct Materials

Ducting Material : GSS

All ducts shall be fabricated from galvanized steel sheets of the following thickness as indicated in Schedule of Quantities.

- Rectangular ducts upto 75cm 0.63mm
- Rectangular ducts 76 to 150cm and all round ducts 0.80mm
- Rectangular ducts 151 to 225cm 1.00mm
- Rectangular ducts greater than 225cm 1.25mm

### Table 3

<table>
<thead>
<tr>
<th>Duct Size</th>
<th>Sheet Thickness GSS</th>
<th>Sheet Thickness AL</th>
<th>Type of Joint</th>
<th>Bracing / flange size (mm)</th>
<th>Suspension rods size for Hangers (mm)</th>
<th>Supports MS (mm)</th>
<th>Distance between supports</th>
</tr>
</thead>
<tbody>
<tr>
<td>00–450</td>
<td>0.63</td>
<td>1.00</td>
<td>Factory Fabricated Flange</td>
<td>—</td>
<td>8</td>
<td>25x25x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>451–600</td>
<td>0.63</td>
<td>1.00</td>
<td>Factory Fabricated Flange</td>
<td>25x25x3</td>
<td>8</td>
<td>25x25x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>601–750</td>
<td>0.63</td>
<td>1.00</td>
<td>Factory Fabricated Flange</td>
<td>25x25x3</td>
<td>8</td>
<td>25x25x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>751–1000</td>
<td>0.80</td>
<td>1.00</td>
<td>Factory Fabricated Flange</td>
<td>25x25x3</td>
<td>8</td>
<td>30x30x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>1001–1500</td>
<td>0.80</td>
<td>1.00</td>
<td>Factory Fabricated Flange</td>
<td>30x30x3</td>
<td>8</td>
<td>40x40x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>1501–1800</td>
<td>1.00</td>
<td>1.25</td>
<td>Factory Fabricated Flange</td>
<td>40x40x3</td>
<td>10</td>
<td>40x40x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>1801–2250</td>
<td>1.00</td>
<td>1.25</td>
<td>Factory Fabricated Flange</td>
<td>50x50x3</td>
<td>10</td>
<td>50x50x6</td>
<td>2.5M</td>
</tr>
<tr>
<td>2250&gt;above</td>
<td>1.25</td>
<td>1.80</td>
<td>Factory Fabricated Flange</td>
<td>50x50x5</td>
<td>10</td>
<td>MS Channel</td>
<td>2.5M</td>
</tr>
</tbody>
</table>

* FACTORY FABRICATED FLANGES SUITABLE TO THE FLANGES SUPPLIED BY MANUFACTURER FOR SMACNA SPECIFICATION DUCT

### Table 4

<table>
<thead>
<tr>
<th>Duct Size</th>
<th>Sheet Thickness GSS</th>
<th>Sheet Thickness MS</th>
<th>Type of Joint</th>
<th>Bracing / flange size (mm)</th>
<th>Suspension rods size for Hangers (mm)</th>
<th>Supports MS (mm)</th>
<th>Distance between supports</th>
</tr>
</thead>
<tbody>
<tr>
<td>00–450</td>
<td>0.63</td>
<td>0.80</td>
<td>Factory Fabricated Flange</td>
<td>—</td>
<td>8</td>
<td>25x25x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>451–600</td>
<td>0.63</td>
<td>0.80</td>
<td>Factory Fabricated Flange</td>
<td>25x25x3</td>
<td>8</td>
<td>25x25x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>601–750</td>
<td>0.63</td>
<td>0.80</td>
<td>Factory Fabricated Flange</td>
<td>25x25x3</td>
<td>8</td>
<td>30x30x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>751–1000</td>
<td>0.80</td>
<td>1.00</td>
<td>Factory Fabricated Flange</td>
<td>30x30x3</td>
<td>8</td>
<td>40x40x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>1001–1500</td>
<td>0.80</td>
<td>1.00</td>
<td>Factory Fabricated Flange</td>
<td>40x40x3</td>
<td>10</td>
<td>40x40x3</td>
<td>2.5M</td>
</tr>
<tr>
<td>1501–1800</td>
<td>1.00</td>
<td>1.25</td>
<td>Factory Fabricated Flange</td>
<td>50x50x3</td>
<td>10</td>
<td>50x50x6</td>
<td>2.5M</td>
</tr>
<tr>
<td>1801–2250</td>
<td>1.00</td>
<td>1.25</td>
<td>Factory Fabricated Flange</td>
<td>50x50x5</td>
<td>10</td>
<td>MS Channel</td>
<td>2.5M</td>
</tr>
<tr>
<td>2250&gt;above</td>
<td>1.25</td>
<td>1.80</td>
<td>Factory Fabricated Flange</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

8.13.4 Aluminum ducting shall have flanges/bracing of Al extrusions.

8.13.5 Manufactures specification shall be submitted for approval for factory-fabricated ducts.
8.13.6 There shall be no metal-to-metal contact between ducts and its supports. Soft neoprene / foam gaskets of minimum 4mm thickness shall be provided between flanges and duct supports. The width of the gasket shall be the same as the flange size.

8.13.7 If any material as indicated above is not available then the next higher size shall be used after necessary approval from the consultant.

8.13.8 MS/Al pop rivets with round heads inside shall be used.

8.13.9 GI hexagonal nuts and bolts with washers shall be used for flanged joints.

8.13.10 All materials including anchor fasteners shall be approved by the consultant/architect/client prior to use.

8.14 Sheet metal ducts shall be fabricated out of galvanized steel sheets/Aluminum conforming to relevant BIS Codes. Sheets used shall be produced by Hot Dip Process and galvanizing shall be Class VIII Light Coating of zinc. Nominal 120 gm/M² of surface area.

8.15 All GI/Aluminum sheets shall be checked before dispatch for hardness/flexibility & water-marks. After fabrication if duct is found cracked or having water marks it shall be rejected.

8.16 All ducts shall be fabricated and installed in workmanlike manner, generally conforming to relevant BIS Codes. Round exposed ducts shall be die-formed for achieving perfect circle configuration.

8.16.1 Ducts so identified on the Drawings shall be acoustically lined with thermal insulation as described in the section “Insulation” and as indicated in Schedule of Quantities. Duct dimensions shown on Drawings are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of Quantities.

8.16.2 Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight.

8.16.3 All exposed ducts upto 60cm width within conditioned spaces shall halves slip joints no flanged joints. The internal ends of slip joints shall be in the direction of airflow. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.

8.16.4 Changes in dimensions and shape of ducts shall be gradual. Air-turns shall be installed in all vanes arranged to permit the air to make the turn without appreciable turbulence.

8.16.5 Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

8.16.6 All sheets metal connection, partitions and plenums required to confine the flow of air to and through the filters and fans shall be constructed of 18 gage GSS thoroughly stiffened with 25mmx25mmx3mm angle iron braces and fitted with all necessary inspection doors as
required to give access to all parts of the apparatus. Doors shall be not less than 45cmx45cm in size.

8.16.7 Rubber gasket 4mm thick shall be used between duct flanges instead of soft rubber in all ducting installation for complete sealing.

8.17 All ducts shall be installed generally as per tender. Drawings and in strict accordance with approved shop drawings to be prepared by the Contractor.

8.17.1 The Contractor shall provide and nearly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Owner’s site representative in all its parts and details.

8.17.2 All necessary allowances and provisions shall be made by the Contractor for beams, pipes or other obstructions in the building, whether or not the same are shown on the Drawings. Where necessary to avoid beams or to other structural work, plumbing or other pipes and or conduits, the ducts shall be transformed divided or curved to one side, (the required area being maintained) all as per the site requirements.

8.17.3 If a duct cannot be run as shown on the Drawings, the Contractor shall install the duct between the required points by any path available, in accordance with other services and as per approval of Owner’s site representatives.

8.17.4 All ductwork shall be provided with adequate hangers or supports to ensure rigid support and to prevent vibration. Spacing of duct supports shall not exceed 2.4m centers.

8.17.5 Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Owner’s site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion on delay to other Contractor’s work on the building.

8.17.6 Where ducts pass thorough brick or partition wall within the opening and crossing ducts provided with heavy flanged collars on each side of angle iron frame–work. So that duct crossing is made leak-proof.

8.17.7 All ducts shall be totally free from vibration under all conditions of operation whether duct work is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with two flexible connections, located close to the unit, in mutually perpendicular directions. Flexible connections shall be constructed of fire retarding flexible duct at least 10 cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supporters on both hands. The flexible connection shall be suitable for pressure at the point of installation.

8.18 **DAMPERS**

8.18.1 All dampers shall be louver dampers of robust construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.
8.18.2 Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting devices shall be made robust, easily operable and accessible through suitable access doors in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.

8.18.3 Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings for the proper volume control and balancing of the system.

8.19 **ACCESS DOORS**
8.19.1 All main work shall be accessible throughout using tight fitted hinged access doors. Doors shall be provided with neoprene rubber gaskets. Angle joints shall be provided with neoprene rubber gaskets for leak-tightness of the joints.

8.19.2 Access door / panels shall be provided at following places.

8.19.3 Any other places specifically mentioned in the drawing or if envisaged by the owner / consultants during execution stage.

8.19.4 In case access doors are to be installed in the insulated ducts, the access door panel shall be double skin construction with insulation filled in such that it can be operated without damaging the duct insulation.

8.20 **SPECIAL NOTES**
DUCT DIMENSIONS SHOWN ARE BARE DUCT SIZES, FOR ANY ACOUSTIC LINING / OR FOR THERMAL INSULATION TO PROVIDE CLEAR GAP BETWEEN DUCT AND FALSE CEILING, MAKE SUITABLE ALLOWANCES ACCORDINGLY.

8.21 **LEAKAGE TEST**
Test duct for leakage by using test kits containing test blowers, two U tube manometers, and calibrated curve attached to the orifice tube assembly.

The above mentioned test would be a pilot test, and subsequently, if the construction manager / consultant asked for then Halogen / Metal Halide damp test / smoke test could be carried out, prior to branch / collar works.

8.22 **AIR TEST AND BALANCE**
8.22.1 Prepare a format for the testing and balancing of air and correct the deficiencies found by the TAB agency (If involved).

8.22.2 Prepare a format for the testing and balancing of air and correct the deficiencies found by the TAB agency (If involved).

8.22.3 Measured air quantities at fan discharge and at various outlets shall be identical to or less than 5% in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is complete so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted for scrutiny and approval and four copies of the approved balance report shall be provided with complete documents.
8.23  MECHANICAL NOISE AND VIBRATION CONTROL
8.23.1  Flexible connections shall be provided on all duct work connections to fans, rotating plant and equipment isolated from structure and anti-vibration materials or mountings. Pipe work and duct work crossing building movement or construction joints shall be installed with flexible connections.

8.23.2  Flexible connection on duct work to fans etc. Shall be a minimum/maximum free length of 100mm / 200mm respectively to minimize noise transmission and noise break out. They shall be completely free from stress and shall not be required to accept any weight.

8.23.3  Thickness and strength of flexible connection materials shall be suitable to withstand the positive and negative fan pressure to which they will be subjected to and shall not allow perceptible leakage. The materials shall be durable, non flammable having food acoustical quality.

8.24  SILENCERS
8.24.1  Duct sound attenuators / silencers of the following specifications would be installed wherever asked for in the drawings and the BOQ.

8.24.2  All plant attenuators shall be selected to maintain noise criteria given in this specification.

8.24.3  The outer casing shall be out of min. 22G galvanised steel in accordance with ASHRE (ISI) recommendations for high pressure rectangular duct work. Seams shall be lock formed on pittsburg lock machine.

8.24.4  Interior elements of silencers shall be out of min. 22 G galvanised perforated steel.

8.24.5  Acoustic fill shall be Fibre glass of density not less than 48 kg/m3 sufficient to obtain specified acoustic performance and shall be packed under 10% compression to eliminate voids due to vibration and setting. Material shall be inert, vermin and moisture proof. All material of construction and acoustic fill shall be incombustible as per IS 3144.

8.24.6  All silencer shall be selected against a maximum allowable air pressure drop of 10mm. Air tight construction shall be provided by use of duct sealing compound at site by the air conditioning contractor.

8.24.7  Acoustic Performance Silencer acoustic ratings shall include insertion loss and self-noise power levels and shall meet or exceed minimum performance. Contractor shall provide computer selection for the silencer supplied at site which will indicate dB reduction at different octave band frequency.

8.24.8  Aerodynamic Performance Static pressure drop through silencers shall not exceed those listed in the silencer schedule at the indicated airflows.

8.24.9  Transitions Where transitions are required to adapt silencer dimensions to connecting duct work, they would be supplied by the installing contractor.
AIR SIDE EQUIPMENT & ASSOCIATED WORKS

HVAC SYSTEMS
TESTING ADJUSTING AND BALANCING (TAB)

9.1 **Scope**
9.1.1 Testing, adjusting and balancing of heating, ventilating and air-conditioning systems
9.1.2 Testing, adjusting and balancing of HVAC Hydronic systems.

9.2 **Comply with**
9.2.1 ASHRAE : 1995 HVAC Application
9.2.2 SMACNA : Manual for the Balancing and Adjustment of air distribution system

9.3 **Performance**
9.3.1 Verify design conformity.
9.3.2 Establish fluid flow rates, volumes and operating pressures.
9.3.3 Take electrical power readings for each motor.
9.3.4 Establish operating sound and vibration levels.
9.3.5 Adjust and balance to design parameters.
9.3.6 Record and report results as per the formats specified.

9.4 **Definitions**
9.4.1 **Test:** To determine quantitative performance of equipment.
9.4.2 **Adjust:** To regulate for specified fluid flow rates and air patterns at terminal equipment (e.g. reduce fan speed throttling etc).
9.4.3 **Balance:** To proportion within distribution system (sub-mains, branches and terminals) in accordance with design quantities.

9.5 The following procedures shall be directly followed in TESTING, ADJUSTING, AND BALANCING (TAB) of the total system.

9.5.1 Before commencement of each one of the TAB procedure explained hereunder, the contractor should intimate the HVAC consultant about his readiness to conduct the TAB procedures in the format prescribed by them.

9.5.2 To obtain accurate TAB results, it is essential that contractor shall at his own cost use the TAB instruments recommended in this specification.

9.6 **Description of Systems and Requirements**
9.6.1 Adjust and balance the following system to provide most energy efficient operation compatible with Owner’s selected operating conditions.
9.6.2 All supply, return and outside air systems.
9.6.3 All exhaust air systems.
9.6.4 All chilled water systems.
9.6.5 All cooling tower (condenser) water systems.
9.6.6 Emergency purge systems.

9.7 **Air Systems**

9.7.1 **Air Handling Performance**
The TAB procedure shall establish the right selection and performance of the AHUS with the following results:

9.7.1.1 Air-IN D.B and W.B temperature.
9.7.1.2 Air-OUT D.B and W.B temperature.
9.7.1.3 Dew Point air leaving.
9.7.1.4 Sensible heat flow.
9.7.1.5 Latent heat flow.
9.7.1.6 Sensible Heat factor.
9.7.1.7 Fan air volume.
9.7.1.8 Fan air out-let velocity.
9.7.1.9 Fan static pressure.
9.7.1.10 Fan power consumption.
9.7.1.11 Fan speed.

9.7.2 **Air Distribution**
9.7.2.1 Both supply and return air distribution for each AHU and for areas served by this AHU shall be determined and adjusted as necessary to provide design air quantities.

9.7.2.2 The above shall cover balancing of air through main and branch ducts utilizing telescoping probes of the TSI instruments, as specified; Electronic Rotating Vane Anemometers and Accubalance for grilles and diffusers, also from TSI and as specified.

9.7.3 **The Preparatory Work**
To conduct the above test, following preparatory works are required to be carried Out including the availability of consultants approved ducting layout drawings and submittals:

9.7.3.1 All outside air intake, return air and exhaust air dampers are in proper position.
9.7.3.2 All system volume dampers and fire dampers are in full open position.
9.7.3.3 All access doors are there & are airtight.
9.7.3.4 Grilles are installed and dampers are fully open.
9.7.3.5 Provision and accessibility of usage of TAB instruments for traverse measurements are available.
9.7.3.6 All windows, doors are in position.
9.7.3.7 Duct system are of proper construction, are equipped with turning vanes, joints are sealed etc.

9.8 **Hydronic System Balancing**

9.8.1 The Hydronic system involves the checking and balancing of all water pumps, piping net-work (mains & branches), the heat exchange equipment like cooling and heating coils, condensers and chillers, cooling towers etc., in order to provide design water flows.

9.8.2 **Preparation**
The essential preparation work, as under, must be done by the HVAC contractor prior to actual testing, adjusting and balancing of HVAC system.

9.8.3 **Ensure**
9.8.3.1 Availability of coordinated drawings and approved submittals and system sketch with design water flows specified thereon.
9.8.3.2 Hydronic system is free of leaks, is hydrostatically tested, is thoroughly cleaned, flushed and refilled.
9.8.3.3 Hydronic system is vented.

9.9 **Basic Procedure**
9.9.1 The contractor or his nominate TAB (Testing, Adjusting and Balancing) agency should confirm completion of the basic procedures and prepare checklists for readiness of system balance. Briefly:
9.9.2 Check pumps operation for proper rotation and motor current drawn etc.
9.9.3 Confirm that provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.
9.9.4 Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the preset position, if these valves are known. If not, shut all riser-balancing valves except the one intended to balance first.
9.9.5 Balancing work for both Chilled Water system and Condenser Water System to be carried out in a professional manner and test reports as enclosed, prepared and presented to the consultants for approval.
9.10 **Readiness for Commencement of T.A.B.**
Before starting of any of the tests, the readiness to do so should recorded as per the prescribed checklist.

9.11 **TAB Instruments**
9.11.1 Air measuring instruments
9.11.2 Microprocessor based.
9.11.3 VelociCalc Plus Meter, Model 8386, with capability to measuring dB and WB temperature, RH and Dew point. It has print out-put and data logging/downloading facility. This instrument also calculate the sensible, Latent & total hat flows and sensible heat factor.
9.11.4 TSI, VelociCalc meter model 8345 for velocity, dB temperature and Air Volume. Has instant printout capability of Air volume readings taken.
9.11.5 Pitot Tube.
9.11.6 TSI Electronic Rotary Vane Anemometer.
9.11.7 TSI Accubalance Flow Measuring Hood.
9.11.8 (All above items to have NIST (US Institute of Science and Technology) Calibration certificate).
9.11.9 **Hydronic Measuring Instrument:**
9.11.10 Measuring Instrument, for measurement of water flow, differential pressure and temperature. The instrument has a pressure gauge, a temperature gauge and a microcomputer.
9.11.11 U-Tube manometer.
9.11.12 Pressure gauge.
9.11.13 Differential pressure gauge.
9.11.14 **Rotation Measuring Instrument:**
Electronic Digital Tachometer.
9.11.15 **Temperature and RH Measuring Instrument:**
9.11.16 **Electrical Measuring Devices:**
9.11.16.1 Voltammeter.
9.11.16.2 Continuity Meter.

9.12 **Vibration and Noise Levels**
9.12.1 Vibration and alignment field measurements shall be taken for each circulating water pump water-chilling unit, and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, and other test as directed by the Project Manager. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard report forms.

9.12.2 The water chilling unit refrigeration system shall be tested for refrigerant and air leaks at least two times approximately six (6) months after start up and at the end of warranty period. The contractor shall certify the condition of the refrigeration system in writing after test. Any leaks detected shall be properly sealed and the above test period repeated. Soapsuds and Halide torch or electronic refrigerant detector shall be used for leak detection. Replace refrigerant and oil lost during warranty period at no cost to the Owner.

9.12.3 Sound level readings shall be taken at ten (10) locations in the building as selected by the Project Manager. The readings shall be taken on an Octave Band Analyzer in a manner acceptable to him. The Contractor shall submit test equipment data and reporting forms to the Project Manager for review. In order to reduce the ambient noise level the readings shall be taken at night. All test shall be performed in the presence of the Project Manager.
WATER SIDE EQUIPMENT & ASSOCIATED WORKS

PUMPS

PART 1 GENERAL

1.1 Related Work
1.1.1 Basic Material and Methods and mechanical requirements as discussed earlier.
1.1.2 Piping and fittings
1.1.3 Valves
1.1.4 Mechanical System Installation and TAB.

1.2 Warranty
Manufacturer shall warrant equipment for a period of 18 months form date of shipment or One year form date of beneficial use by Owner

1.3 Submittals
1.3.1 Submit manufacturer’s product date for review
1.3.2 Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable

PART 2 PRODUCTS

1.4 Acceptable Manufacturers
As per approved list of manufacturers in the annexure

1.5 General Requirements
1.5.1 Statically and dynamically balance rotating parts
1.5.2 Construction to permit complete servicing without breaking piping connections
1.5.3 Provide flanged pump connections
1.5.4 Construct pumps of bronze fitted construction with bronze impeller and carbon steel shafts. Ensure shaft deflection does not exceed 0.002” at sealing faces at maximum load
1.5.5 Hydrostatic test pump casing at one and one–half times the design working pressure
1.5.6 Construct pump casings of cast iron with replaceable bronze wearing rings and rated for 150 psig working pressure
1.5.7 Impeller diameter not to exceed 90% (ninety percent) of the maximum diameter for which pump curves are published
1.5.8 Coupling and Base Plate
1.5.8.1 Mount pump and motor on common steel base plate furnished by pump manufacturer.
1.5.8.2 Manufacturer to furnish and mount steel flexible coupling fasten metal coupling guard to pump base plate

1.5.9 Name Plate
1.5.9.1 Stainless steel on pump and motor securely fastened to casings

1.6 Scope
The scope of this selection comprises the supply, erection, testing and commissioning of water pumps conforming to these Specifications and in accordance with requirements of schedule of Quantities

1.7 Capacity
Water flow rates and head of the pumps shall be in accordance with the requirements of schedule of Quantities.

1.8 Type
The type and the size of all chilled water, condensing water, chilled water and condensate drain pumps for air conditioning applications shall be in accordance with requirements of Drawing and Schedule of Quantities.

1.9 Split Casing Pumps:
1.9.1 Pump casing shall be close-grained cast iron of heavy section, horizontally split making possible complete servicing of rotating parts without breaking piping or motors connections. Motor to pump connection shall be of the flexible coupling type. Suction passages shall be volute in form, promoting smooth entry to impeller and increased efficiency. Impeller shall be of CI construction, end suction, enclosed type, hydraulically balanced and passages smooth-finished for minimum friction and maximum efficiency (Not less than 65%). Shaft shall be steel, protected by gunmetal sleeves extending through stuffing boxes. Stuffing boxes shall be supported in ball/journal bearings, grease lubricated, contained in easily removable housing. Pumps shall be fitted with an air valve, two grease lubricators, drain plug and water seal connections Mechanical seals are necessary.

1.9.2 Motors shall be energy efficient, totally enclosed, fan-cooled, class-F insulation. Motor shall be specially designed for quiet operation and its speed not exceed 1440 rpm. The motor rating shall be such as to ensure non overloading of the motor throughout its capacity range. Motor shall be suitable for 415 +/-10% volts, 3 phase, 50 cycle AC, power supply.

1.9.3 Base shall be of a size suitable for the pump, motor and shaft and shall be constructed of cast iron or welded steel. Flexible coupling shall be protected by a guard mounted on the common base.

1.9.4 Installation: The pump shall be installed on a concrete foundation as shown in Approved–for construction shop drawings. (Refer acoustics and vibration control topic in this report for this)

1.9.5 Lubrication: Upon installation of the complete system and before testing, the pump shall be lubricated in strict accordance with the manufacturer’s instructions.
1.9.6 Pump Alignment

1.9.7 Split casing pumps, prior to testing shall be aligned with a dial indicator within 0.05mm deflection (radial), or as per manufacturer’s recommendation.

1.10 Monobloc Pumps
1.10.1 Monobloc end-suction design directly connected to motor shall be supplied when asked for. The pump casing shall be of cast iron construction and the Impeller shall be of bronze construction, hydraulically balanced and keyed to shaft. Stuffing boxes shall be integral with casing and water sealed. Shaft sleeve shall be of gun metal extending through stuffing boxes.

1.10.2 Motor shall be drip and splash proof, designed as integral part of pump. Motor shall be suitable for 415 ± 6% volts, 3 phase, 50 cycles AC power supply.

1.10.3 Painting: All pumps, motors and bases shall be supplied with approved finish. Shop coat of paint that have become marred during shipment or erection shall be cleaned off with mineral sprits, wire brushed and spot primed over the effected areas, then coated with enamel paint to match the adjoining areas.

1.10.4 Performance Data: Pump performance curves and power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation.

1.10.5 Testing adjusting and balancing: Pump performance shall be computed from the pump curves provided by manufacturer.

1.11 Inertia Bases for Pumps
1.11.1 The inertia base shall be an all welded mild steel channel frame the minimum depth of which shall be 1/12 of the longest span between isolator but not less than 150 mm filled with concrete the density of which shall 2300 kg/m3.

1.11.2 The inertia base shall be sufficiently large to provide support for all parts of the equipments, including any component which overhands the equipment base, such as suction and discharge elbows on centrifugal pumps.

1.11.3 The frame shall include pre-located equipment anchor bolts fixed into position and housed in a steel sleeve allowing minor bolts location adjustment.

1.11.4 Isolator support brackets shall be provided at 200 mm centers to ensure the concrete and frame is adequately stiffened against distortion.
WATER SIDE EQUIPMENT & ASSOCIATED WORKS

L-2

VARIABLE SPEED PUMPING SYSTEM (IF SPECIFIED)

2.1 SECTION INCLUDES
2.1.1 Variable Speed Pumping Package
2.1.2 Individual Components
2.1.3 Pump Control Panel
2.1.4 Adjustable Frequency Drive
2.1.5 Sensor Transmitters
2.1.6 Sequence of Operation

2.2 REFERENCES
2.2.1 Hydraulic Institute
2.2.2 ANSI - American National Standards Institute
2.2.3 NEMA - National Electrical Manufacturers Association
2.2.4 UL - Underwriters Laboratories. Inc.
2.2.5 ETL - Electrical Testing Laboratories
2.2.6 CSA - Canadian Standards Association
2.2.7 NEC - National Electrical Code
2.2.8 ISO - International Standards Organization
2.2.9 IEC - International Electro technical Commission

2.3 SUBMITTALS
Submittals shall include the following:
2.3.1 System summary sheet
2.3.2 Sequence of operation
2.3.3 Shop drawing indicating dimensions, required clearances and location and size of each field connection
2.3.4 Power and control wiring diagrams
2.3.5 System profile analysis including variable speed pump Curves and system curve. The analysis shall also include pump, motor and AFD efficiencies, job specific load profile, staging points, horsepower and kilowatt/hour consumption.
2.3.6 Pump data sheets
2.4 QUALITY ASSURANCE

2.4.1 The local supplier of Chilled Water Variable Speed Pumping System (VSPS) Must have relevant expertise in all aspects of design, application engineering, Installation, programming, interfacing, commissioning and after sales service.

2.4.2 Manufacturer shall be listed by Underwriter's Laboratories as a manufacturer of packaged pumping systems.

2.4.3 Bidders shall comply with all sections of this specification relating to packaged pumping systems. Any deviations from this specification shall be bid as a voluntary alternate clearly defined in writing. If no exceptions are noted, the supplier or contractor shall be bound by these specifications.

2.4.4 The bidder shall ensure the performance based upon the results of the approved softwares (w.i.z. ITT Bell and Gossett/Armstrong/Grundfoss)

2.5 ACCEPTABLE MANUFACTURERS

2.5.1 Subject to compliance with the specifications, the following manufacturers shall be acceptable:

ITT industries
Armstrong
Grundfoss

2.5.2 Responsibilities and Obligations of Contract

2.5.2.1 Furnish and install as shown on the plans an efficient secondary chilled water Pumping System.

2.5.2.2 The control system shall include as, a minimum, the programmable logic pump controller, adjustable frequency drive(s) and remote sensor/transmitters as indicated on the plans. Provide additional items as specified or as required to properly execute the sequence of operation.

2.5.2.3 The variable speed pump logic controller, adjustable frequency drive(s), AFD bypass (MUST!!!) and remote sensor / transmitter(s) shall ship as individual components to the job site.

2.5.2.4 Pump logic controller, adjustable frequency drives, sensor/transmitters and related equipment shall be installed by the mechanical contractor as shown on the plans.

2.5.2.5 Line voltage power wiring shall be installed by the electrical contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

2.5.2.6 Low voltage (24 VDC and 115 VAC) wiring shall be installed by the controls contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.
2.6 COMPONENTS

2.6.1 Pump Logic Controller

2.6.1.1 The Technologic pump logic controller assembly shall be listed by and bear the label of Underwriter's Laboratory, Inc. (UL) and Canadian Underwriter's Laboratory (CUL). The controller shall be specifically designed for variable speed pumping applications.

2.6.1.2 The controller shall function to a proven program (As mentioned earlier) that safeguards against damaging hydraulic conditions including:
- Pump low surges
- Hunting
- End of curve
- System over pressure

2.6.1.3 The pump logic controller shall be capable of receiving up to two discrete analog inputs from zone sensor/transmitter as indicated on the plans. It will then select the analogue signal that has deviated the greatest amount from its set point. This selected signal will be used as the command feedback input for a hydraulic stabilization function to minimize hunting. Each input signal shall be capable of maintaining a different set point value. Controller shall be capable of controlling up to three pumps in parallel.

2.6.1.4 The pump logic controller shall be capable of accepting an additional analog input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.

2.6.1.5 The hydraulic stabilization program shall utilize a proportional-integral-derivative control function. The proportional, integral and derivative values shall be user adjustable over an infinite range.

2.6.2 The pump logic controller shall be self prompting. All messages shall be displayed in plain English. The operator interface shall have the following features:

2.6.2.1 Multi-fault memory and recall last 10 faults and related operational data

2.6.2.2 Red fault light, Yellow warning light, and Green power on light

2.6.2.3 Soft-touch membrane keypad switches.

2.7 The display shall have four lines, with 20 characters on three lines and eight large characters on one line. Actual pump information shall be displayed indicating pump status.

2.8 Controller shall be capable of performing the following pressure booster function:
- Low suction pressure cut-out to protect the pumps against operating with insufficient suction pressure.

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High system pressure cut-out to protect the piping system against high pressure conditions.

No Flow Shut down to turn the pumps off automatically when system demand is low enough to be supplied by hydropneumatic tank. No flow shutdown shall require any external flow meters, flow switches, nor pressure switches to determine when a No Flow condition exists.

2.9 The following communication features shall be provided to the BAS:

- Remote system start / stop non-powered digital input
- Failure of any system component. Output closes to indicate alarm condition
- One 4-20 mA output with selectable output of
  2.9.1 Frequency
  2.9.2 Process variable
  2.9.3 Output current
  2.9.4 Output Power

2.10 The following communication features shall be provided to the Building automation System via an RS-485 port utilizing any open ended protocol (BACNET etc):

- Individual Analog Input
- Individual Zone Set points
- Individual Pump/AFD on/off status
- System percent speed
- System Start/stop command
- System operation mode
- Individual KW signals
- System flow, when optional flow sensor is provided

2.11 The Pump logic controller shall be a approved NEMA 1 Enclosure.

2.12 Adjustable Frequency Drive

2.12.1 The adjustable frequency drive(s) shall be pulse width modulation (PWM) type, microprocessor controlled design. Unit shall be the VLT 6000 series manufactured by Graham company

2.12.2 The AFD, including all factory installed options, be tested to UL standard 508. The AFD shall also meet C-UL and be CE marked and built to ISO 9001 standards

2.12.3 The AFD shall be housed in a NEMA 1 enclosure. AFF with plastic enclosure shall not be acceptable.
2.12.4 The AFD shall employ an advanced sine wave approximation and voltage vector control to allow operation at rated motor shaft output speed with no de-rating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life. Power factor shall be near unity regardless of speed or load.

2.12.5 The VFD shall have balanced DC link reactors to minimize power line harmonics. VFDs without a DC link reactor shall provide a 3% impedance line reactor.

2.12.6 Input and output power circuit switching can be done without interlocks or damage to the VFD.

2.12.7 The following customer modifiable adjustments shall be provided:
   - Accel time
   - Decel time
   - Minimum frequency
   - Maximum frequency

2.13 RS-485 communication for Johnson Controls N2 shall be available and provided as an option.

2.13.1 An automatic energy optimization selection feature shall be provided. This feature shall reduce voltages when lightly loaded and provide a 3% to 10% additional energy savings.

2.13.2 The AFD shall be suitable for elevations to 3300 feet above sea level without de-rating. Maximum operating ambient temperature shall not less than 104 degrees F. AFD shall be suitable for operation in environment up to 95% non-condensing humidity.

2.13.3 The AFD shall be capable of displaying the following information in plain English via an alphanumeric display:
   - Frequency
   - Voltage
   - Current
   - Kilowatts per hour
   - Fault identification
   - Percent torque
   - Percent Power
   - RPM

2.14 Sensor / Transmitters

Provide field mounted differential pressure sensor transmitter(s) as indicated in BOQ or on the plans. Unit shall transmit an isolated 4-20mA dc signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have a corrosion resistant steel body with 1/8" NPT process connection.
It shall have a NEMA 1 electrical enclosure capable of withstanding 450 PSI static pressure. Accuracy shall be within 0.5% of full span

2.15 Sequence of Operation

2.15.1 The system shall consist of a Technologic pump logic controller, multiple pump/AFD sets, with manual and automatic alternation and pump staging [ wherever applicable].

2.15.2 The pumping system shall start upon the closure of customer's contact when the pump logic controller Mode of Operation selector switch is in the REMOTE position

2.15.3 When the pump logic controller selector switch is in the LOCAL position, and start command on Tech 500 is given via operator interface, the pumping system shall operate automatically.

2.15.4 Sensor/transmitters shall be provided as indicated on the plans.

2.15.5 Each sensor/transmitter shall send a 4-20mA signal to the pump logic controller, indicative of process variable condition.

2.15.6 The pump logic controller shall compare each signal to the independent, engineer/user determined set points.

2.15.7 When all set points are satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.

2.15.8 The pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.

2.15.9 If the set point cannot be satisfied by the designated lead pump, the pump logic controller shall initiate a timed sequence of operation to stage a lag pump [wherever applicable].

2.15.10 The lag pump shall accelerate resulting in the lead pump(s) decelerating until they equalize in speed [wherever applicable]

2.15.11 Further change in process variable shall cause the pumps to change speed together [wherever applicable]

2.15.12 When the set point criteria can be safely satisfied with fewer pumps, the Technologic pump logic controller shall initiate a timed de-stage sequence and continue variable speed operation [wherever applicable].
2.15.13 As the worst case zone deviates from set point, the pump logic controller shall send the appropriate analog signal to the AFD to speed up or slow down the pump/motor.

2.15.14 In the event of a AFD fault, the pump logic controller automatically initiates a times sequence of events to start the redundant pump/AFD set in the variable speed mode. The redundant variable speed system shall be started through the pump logic controller.

2.15.15 Upon AFD fault(s), the pump controller shall display an alarm condition through a plain English message.

2.15.16 AFD fault indication shall be continuously displayed on the operator interface of the pump until the fault has been corrected and the controller has been manually reset.

2.15.17 In the event of the failure of a zone sensor/transmitter, its process variable signal shall be removed from the scan/compare program. Alternative zone sensor/transmitters, if available, shall remain in the scan/compare program for control.

2.15.18 Upon sensor failure a plain English warning message shall be displayed on the operator interface of the pump logic controller.

2.15.19 In the event of failure to receive all zone process variable signals, a user selectable number of AFDs shall maintain a user adjustable speed, reset shall be automatic upon correction of the zone failure.
WATER SIDE EQUIPMENT & ASSOCIATED WORKS

L-3

PIPING

PART 1  PIPING AND FITTINGS (CHILLED/CONDENSER WATER/CONDENSATE DRAIN PIPING)

3.1 Scope  Supply, laying of pipes, rectifier welding (refer item No. 7), including pipe fittings, valves and all necessary supporting and securing.

3.2 Standard  B.I.S.

3.3 Design Parameters  

<table>
<thead>
<tr>
<th>Maximum flow velocity</th>
<th>Maximum friction</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPS</td>
<td>MKS</td>
</tr>
<tr>
<td>8 FT/SEC</td>
<td>2.5M/SEC.</td>
</tr>
<tr>
<td>5 FT / 100ft</td>
<td>1M/ 30 M</td>
</tr>
<tr>
<td>Water Run</td>
<td>Water Run</td>
</tr>
</tbody>
</table>

3.4 Installation

3.4.1 Clean inside of pipe before installing it. Keep installed pipe clean and protect ends from foreign material by plugging or capping them.

3.4.2 Install pipe so that it does not interfere with openings of doors or apparatus, access to the equipment or to electrical equipment.

3.4.3 Do not install pipes in such a way that they will apply torque to pumps. After the pumps have been installed and the pumps have been operated, recheck and align pumps if required.

3.4.4 Run pipes in straight lines and square with the building. Install risers plumb. Make offsets only where indicated and where necessary.

3.4.5 Do not install water pipes in electric rooms, telephone rooms, transformer rooms, or elevator equipment room.

3.4.6 Insofar as possible, drainage piping shall not be installed overhead, whether exposed or above false ceiling in (any critical / sensitive areas), such as, delivery rooms, operating rooms, nurseries, food preparation centers, food servicing centers, electrical rooms, (wherever applicable), switch rooms, UPS rooms.

3.4.7 Provide flanged unions through out the pipe systems at all equipments. Make provisions for servicing and removal of equipment without dismantling the piping.

3.5 Grading Pipes for drainage:
Slope will not be less than 1/4” per 10’ for any drain pertaining to HVAC system. All condensate drain pipes will be installed with care for ease of maintenance and operations.

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3.6  **Piping Expansion**
3.6.1 Install piping to allow thermal expansion and contraction without injury to piping, equipment or structure.

3.6.2 Use loops or expansion joints where necessary and as where shown in drawings.

3.6.3 Provide pipe guides.

3.6.4 Where screwed piping is used, used caulked joints or expansion joints at intervals to allow expansion movement.

3.7  **Pipe Jointing**
3.7.1 **Welded Pipes**
3.7.1.1 Preparing Pipe ends (Reaming, Grinding to mill finish)
3.7.1.1.1 Machine cut pipe ends square.

3.7.1.2 Ream pipe ends, after cutting to full diameter, use rectifier for all welded joints as per B.I.S.

3.8  **Line welds, single V Butts type:**
3.8.2 Mill or machine bevel pipe at 37½° to within 1/16” of inside of inside wall, except that in field limited amount of pipe may be flame welded.

3.8.3 Pipe with a wall thickness of 3/16” or less need not be bevelled but may be welded by melting down into building up over abutting ends.

3.8.4 Separate abutting ends of joints before welding to permit complete fusion to bottom without overlapping.

3.8.5 Tack in two or more points before welding to maintain alignment and fusion weld.

3.8.6 Make all welds of sound metal, thoroughly fused into ends of pipe an to bottom of vee.

3.8.7 Build in excess of pipe wall to give reinforcement to one fourth pipe wall thickness.

3.8.8 Weld metal shall present a gradual increase in thickness from surface of pipe to center of weld.

3.8.9 Minimum weld width: Two and a half times the thickness of the pipe wall.

3.8.10 Use welding ells at turns in welded lines.

3.8.11 Do not weld pipe couplings in place of welded fittings for any branch connection.

3.9  **Threaded GI Pipes:**
3.9.1 Where pipe is to be threaded, die cut right hand, pipe stand, clean cut full depth, taper threads. Make threaded joints so that they will be leak-proof without caulking.
3.9.2 Apply a thin coat of lubricant to male threads only.

3.9.3 All pipes and valves shall be designed for 10kg/cm² test pressure. The pipe thickness shall conform to BIS standards and shall be 6mm thick.

3.9.4 Where welded steel piping is recommended, make the welds by rectifier (not using transformer welding) in accordance with the laid standards of BIS.

3.10 Weld-o-lets and thread-o-lets:
3.10.1 Scribe and cut openings in main pipes for welded branches accurately taking care to remove all plugs and cuttings from main pipe.

3.10.2 Full weld fillet welds for full depth of fillet, with additional beads to form well rounded connection as recommended by weld-o-let manufacturer.

3.10.3 Cut openings into pipes for welded connections accurately to give matched intersections.

3.10.4 Make welded fittings of same material with same pressure and temperature ratings as pipe with which they are used.

3.10.5 Make flanged connections to control valves, pump suction and specialties with BIS standard welding neck flanges. All other flange connections may be made with slip-on flanges provided they are seal welded on inside.

3.10.6 Fuse all fillet welds for flanges or fittings into pipe and plate for minimum distance of 1½ times pipe wall thickness and depth weld on 11/4 times pipe wall thickness.

3.11 Soldered and Brazed Joints
Make soft copper pipe joints with suitable flux and 95/5, lead free solder.

3.12 Piping Installation Specification
3.12.1 The drawings indicate schematically the size and location of pipes. Pipes runs and sizes may, however, be changed to meet the site conditions. The Contractor on award of the work, shall prepare detailed working drawings showing the cross section, longitudinal section, detail of fittings, locations of isolating drain and air valves etc. They must keep in view the specific openings in buildings and other structures through which the pipes are designed to pass.

3.12.2 Piping shall be properly supported on or suspended from stands, clamps, hangers etc. as specified and as required. The tenderer shall adequately design all the brackets, saddles, clamps, hangers etc. and be responsible for their structural integrity.

3.12.3 Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamp are of dissimilar material, a gasket shall be provided in between.
3.13 Spacing of pipe supports shall not exceed the following:

<table>
<thead>
<tr>
<th>Pipe size O.D.(mm)</th>
<th>Hanger Spacing (M)</th>
<th>Rod Size (mm)</th>
</tr>
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Table 3

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<th>Dia of Bolt Circle</th>
<th>No. of Bolts of Flanges</th>
<th>Dia of Bolts</th>
</tr>
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<tbody>
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<td>½</td>
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<td>½</td>
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<td>3/16</td>
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<tr>
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<td>%</td>
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<td>%</td>
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<td>7</td>
<td>4</td>
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</tr>
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<td>½</td>
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<td>8</td>
<td>%</td>
</tr>
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### Table 4

#### MS Flanges Table E

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<th>Pipe Size</th>
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<th>Thickness of Flanges</th>
<th>Dia of Bolt Circle</th>
<th>No. of Bolts of Flanges</th>
<th>Dia of Bolts</th>
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### Table 5

#### MS Flanges Table F

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<th>No. of Bolts of Flanges</th>
<th>Dia of Bolts</th>
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</tr>
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<td>¾</td>
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HVAC Consultant: AD CONSULTANTS
### Table 6: MS Flanges Table H

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<th>No. of Bolts of Flanges</th>
<th>Dia of Bolts</th>
</tr>
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<td>4</td>
<td>%</td>
</tr>
<tr>
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<td>½</td>
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<td>4</td>
<td>%</td>
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<td>4</td>
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<td>8</td>
<td>%</td>
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<tr>
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<td>14½</td>
<td>1¾</td>
<td>12½</td>
<td>12</td>
<td>¾</td>
</tr>
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<td>1³/₈</td>
<td>14</td>
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<td>¾</td>
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<tr>
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<td>15</td>
<td>12</td>
<td>¾</td>
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<td>14&quot;</td>
<td>21¾</td>
<td>¹³/₈</td>
<td>19½</td>
<td>16</td>
<td>¹¾</td>
</tr>
</tbody>
</table>

3.13.5 Pipe hangers shall be fixed on walls and ceilings by means of metallic rawl plugs.

3.14 Pipe hangers shall be fixed on walls and ceilings by means of metallic rawl plugs.

3.15 Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 12mm thick ribbed rubber pad or any other approved resilient material. Where pipes pass through the terrace. Riser shall also have a suitable concrete pipe support at the lowest point.

3.16 Pipe sleeves of 50mm on larger diameter shall be provided wherever pipes pass through wall and the annular space filled with felt and finished with retaining rings having 90 minute fire rating and enough mastic properties to avoid any cracks or leaks at normal duty.

3.17 Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 1.80mm metal sheet shall be provided between insulation and the clamp saddle or roller extending at least 150mm on both sides of the clamp, saddle or roller.

3.18 Piping work shall be carried out with minimum disturbance to the other works being done at the site. A program of work shall be chalked out in consultation with the Engineer.

3.19 Piping layout shall take due care for expansion and contraction in pipes.

3.19.1 All piping work shall be carried out in a workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire
piping work shall be organized in consultation with other agencies work, so that laying of pipe supports, pipes and pressure testing for each area shall be carried out in stretch.

3.19.2 Cut-outs in the floor slabs for installing the various pipes are indicated in the Drawings. Contractor shall carefully examine the cut-outs provided and clearly point out where the cell-outs shown on the drawings do not meet with the requirements.

3.19.3 The Contractor shall make sure that the clamps, bracket, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansions joints where required.

3.19.4 All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.

3.19.5 Flanged inspection pieces 1.5 meter long, with bolted flanges on both sides, shall be provided no more than 30 meters centres where-ever shown in Approved-For-Construction shop drawings to facilitate future cleaning of all welded pipes.

3.19.6 All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint then wrapped with three layers of fibre glass tissue, each layer laid in bitumen.

3.19.7 Insulated buried pipes shall be cleaned, de-rusted then coated with rust resistance primer. Insulation shall be applied as per the section “Insulation”, wrapped with GI wire and covered with polyethylene sheet. Two coats (each 6mm thick) of cement plaster shall be applied over chicken wire mesh lath. Where indicated in Schedule of Quantities, buried insulated pipes shall be water-proofed using coat of Shali bond or approved adhesive, over the plastered surface, wrapping one layer of fiberglass RP tissue and one layer of roofing tar-felt with sufficient overlaps, set and sealed with the adhesive held in position by 16 page GI wire tied at 15 cm intervals.

3.19.8 Purge valves shall be provided at all high points in the piping system for venting. Air valves shall be 15 mm pipe size valves with screwed joints.

3.19.9 Discharge from the air valves shall be piped through an equal sized mild steel or galvanised steel pipe to the nearest drain or sump. These pipes shall be pitched towards drain points.

3.19.10 All piping shall be tested to hydrostatic test pressure of at least two and half times the maximum operating pressure, but less than 10 per kg per sq. cm gage for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified and gotten approved at site.

3.19.11 Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.

3.19.12 System may be tested in sections and such sections shall be securely capped, then retested for entire system.
3.20 All pipes using screwed fittings shall be accurately cut to the required size and threaded in accordance with IS:554/1955 and burrs removed before laying. Open ends of the piping shall be blocked to avoid entrance of foreign matter. Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.

3.21 Air valves shall be provided at all high points in the piping system for venting. Valves shall be of the double float type, with G.M./C.I. body, vulcanite balls, rubber seating etc. Air valves shall be of the sizes specified and shall be associated with an equal gate / ball valve with rising spindle.

<table>
<thead>
<tr>
<th>Mains</th>
<th>Air Valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 100mm dia</td>
<td>25mm dia</td>
</tr>
<tr>
<td>100mm to 300mm dia</td>
<td>32mm dia</td>
</tr>
<tr>
<td>Over 300mm dia</td>
<td>50mm dia</td>
</tr>
</tbody>
</table>

Discharge from the air valves shall be piped through an equal sizes GI pipe to the nearest drain or floor waste or as shown.

3.22 All buried pipes shall be cleaned and coated with zinc chromate primer and bituminous paint, then wrapped with two layers of RP tissue each layer laid in bitumen.

3.23 Drain shall be provided at all low points in the piping systems and shall be of the following sizes:

<table>
<thead>
<tr>
<th>Mains</th>
<th>Air Valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 300mm dia</td>
<td>25mm dia</td>
</tr>
<tr>
<td>Over 300mm dia</td>
<td>40mm dia</td>
</tr>
</tbody>
</table>

3.24 Drains shall be provided with gate valves of equal size with rising spindle. Drains shall be piped through equal size G.I. pipe to the nearest drain or floor waste or as shown on the drawings. Piping shall be pitched towards drain points.

3.25 All piping laid shall be as follows:

<table>
<thead>
<tr>
<th>Pipe size</th>
<th>Material</th>
<th>Joints and fittings</th>
<th>Sealing</th>
</tr>
</thead>
<tbody>
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<td>Screwed fitting</td>
<td>Non-hardening</td>
</tr>
<tr>
<td></td>
<td>Heavy class</td>
<td>Unions</td>
<td>Lubricant</td>
</tr>
<tr>
<td></td>
<td>IS:239/1964</td>
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<td>3mm, 3ply, rubber insertion</td>
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<tr>
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<td>Welded fittings</td>
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<td></td>
<td>Heavy class</td>
<td>Slip on flanges</td>
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<td></td>
<td>IS:239/1964</td>
<td>Screwed flanges</td>
<td>3mm, 3ply, rubber insertion</td>
</tr>
</tbody>
</table>
3.26 All piping shall be black steel unless otherwise stated. Pipes shall be given one primary casting of pressure ratings suitable for the piping system. Fittings used on welded piping shall be of the weldable type. Flanges shall be new and from standard manufacturers. Supply of flanges shall include bolts, washers gaskets, etc., as required.

3.27 Tee-off connection shall be through reducing tees, wherever possible. Otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be restored to.

3.28 All equipment and valve connections shall be through flanges (Welded or screwed for galvanized steel)

3.29 All welded piping is subject to the approval of the Consulting Engineer and sufficient number of flanges and unions shall be provided.

3.30 **Flexible pipe connectors**

Flexible connections shall be provided at each pump and chiller. These flexible connections shall have neoprene rubber coating resistant to weather, heat & oil to protect the body from atmospheric conditions. Beneath the cover, layer of durable high tensile cord shall be provided for reinforcing the supporting member between tube and cover. The tube shall be leak-proof, abrasion resistant, seamless lining of rubber. The joint of tubes shall not be affected by passing fluid. Metal retaining rings shall be provided for distributing the bolting pressure around the flanges and to prevent the bolts from damaging the rubber flanges when tightened. Control rods shall be provided to prevent damage to expansion joint due to excessive elongation or compression of piping systems. All expansion flanges shall be heavy duty application.

3.31 **Mechanical noise and vibration control**

3.31.1 Flexible connections shall be fitted to all pump suction and discharge connections, chillers and other vibrating equipment and where anti-vibration mounts and inertia basis are fitted.

3.31.2 Flexible connections shall be fitted to all cooler coil chilled water pipe work connections. Flexible connections shall allow freedom of movements of plant in all plans.

3.31.3 Making flanges to pipe work flexible connections shall be of the smooth faced weld-nick type.

3.31.4 Rubber Bellows shall be fitted as close to the sources of vibration at practicable. The pipe at the end of the bellows shall be a fixed point.

3.31.5 Rubber bellows shall be single convolution of multiply reinforced **EPDM** rubber with wire reinforced cuffs. Flanges shall be able to swivel and be removable. The date of manufacture shall be molded on the bellows. For tractability membranes shall have an indelible identification showing manufacturer, country of origin, the type and a batch number.
3.31.6 The bars with rubber top hat washers shall be used on bellows.

3.31.6.1 For working temperature up to 70 degree Celsius. The rubber bellows shall be tensile synthetic fiber reinforced.

3.31.6.2 For working temperature between 70° C. and 100° C. the bellows carcass shall be steel wire mesh reinforced throughout. Steel reinforced bellows shall be manufactured and approved to the Standards.

3.31.6.3 For temperatures above 100° C. bellows shall be multiply stainless steel with Van Stone ends swivel flanges. The overall length shall not exceed 130 mm.

3.31.6.4 Flexible connections with screwed connections shall be reinforced EPDM rubber hoses and shall have at least one full union to avoid torturing on installation.

3.31.6.5 Flexible pipe connections on chilled water systems shall be suitable for a working pressure of 10 bar and test pressure of 17 bar.

OR

Technical Specification of Pre-Insulated Pipe

PIPE

The pipe shall be MS ERW as specified in the Piping Section.

INSULATION

The pipe insulation shall be polyurethane foam with 36 kg/cu m minimum density, 90% minimum closed cell content, minimum compressive strength of 40 psi and initial thermal conductivity of 0.0154 Btu/hr.ft.°F. The insulation shall completely fill the annular space between the service pipe and jacket and shall be bonded to both, the service pipe & jacket.

The insulation (PUF) shall be provided to the minimum thickness with cladding of minimum thickness as specified below:
### UNDER GROUND PIPING & INSULATION EXECUTION:

Underground systems shall be buried in a trench of not less than 600 mm deeper than the top of the pipe & not less than 450mm wider than the combined OD of all piping systems. A minimum thickness of 600mm of compacted backfill over the top of the pipe is desirable.

Trench bottom shall have a minimum of 150mm of sand, pea gravel or specified backfill material, consolidated to suit operating weight & to act as a cushion for the piping.

**Buried piping:**
The outer protective insulation jacket shall be seamless, extruded, black, uv resistant, high-density polyethylene (HDPE). The minimum thickness of the HDPE jacket and PUF shall be as follows:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>MS Pipe dia. / (mm)</th>
<th>PUF Thickness / (mm)</th>
<th><strong>OPTION-A</strong> Thickness of G.I. (spirally wounded) Cladding / (Gauge)</th>
<th><strong>OPTION-B</strong> Thickness of AL. (spirally wounded) Cladding / (Gauge)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>20 mm</td>
<td>33</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>2.</td>
<td>25 mm</td>
<td>32</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>3.</td>
<td>32 mm</td>
<td>33</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>4.</td>
<td>40 mm</td>
<td>30</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>5.</td>
<td>50 mm</td>
<td>31</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>6.</td>
<td>65 mm</td>
<td>36</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>7.</td>
<td>80 mm</td>
<td>42</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>8.</td>
<td>100 mm</td>
<td>42</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>9.</td>
<td>125mm</td>
<td>41</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>10.</td>
<td>150 mm</td>
<td>41</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>11.</td>
<td>200 mm</td>
<td>52</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>12.</td>
<td>250 mm</td>
<td>62</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>13.</td>
<td>300 mm</td>
<td>51</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>14.</td>
<td>350 mm</td>
<td>46</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>15.</td>
<td>400 mm</td>
<td>46</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>16.</td>
<td>450mm</td>
<td>45</td>
<td>26g</td>
<td>24g</td>
</tr>
<tr>
<td>17.</td>
<td>500mm</td>
<td>57</td>
<td>24g</td>
<td>22g</td>
</tr>
<tr>
<td>18.</td>
<td>550mm</td>
<td>57</td>
<td>24g</td>
<td>22g</td>
</tr>
<tr>
<td>19.</td>
<td>600mm</td>
<td>57</td>
<td>24g</td>
<td>22g</td>
</tr>
<tr>
<td>20.</td>
<td>650mm</td>
<td>56</td>
<td>24g</td>
<td>22g</td>
</tr>
<tr>
<td>21.</td>
<td>700mm</td>
<td>56</td>
<td>24g</td>
<td>22g</td>
</tr>
<tr>
<td>22.</td>
<td>750mm</td>
<td>55</td>
<td>24g</td>
<td>22g</td>
</tr>
<tr>
<td>23.</td>
<td>800mm</td>
<td>55</td>
<td>24g</td>
<td>22g</td>
</tr>
</tbody>
</table>
However the exact thickness could vary marginally for underground piping based on the exact sizes of HDPE pipes available as per the chart given below:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>MS Pipe dia. (mm)</th>
<th>PUF Thickness (mm)</th>
<th>Thickness of HDPE Cladding (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>20 mm</td>
<td>29</td>
<td>2.5</td>
</tr>
<tr>
<td>2.</td>
<td>25 mm</td>
<td>36</td>
<td>2.5</td>
</tr>
<tr>
<td>3.</td>
<td>32 mm</td>
<td>31</td>
<td>2.5</td>
</tr>
<tr>
<td>4.</td>
<td>40 mm</td>
<td>36</td>
<td>2.5</td>
</tr>
<tr>
<td>5.</td>
<td>50 mm</td>
<td>37</td>
<td>3.0</td>
</tr>
<tr>
<td>6.</td>
<td>65 mm</td>
<td>39</td>
<td>3.0</td>
</tr>
<tr>
<td>7.</td>
<td>80 mm</td>
<td>43</td>
<td>3.0</td>
</tr>
<tr>
<td>8.</td>
<td>100 mm</td>
<td>40</td>
<td>3.2</td>
</tr>
<tr>
<td>9.</td>
<td>125 mm</td>
<td>39</td>
<td>3.5</td>
</tr>
<tr>
<td>10.</td>
<td>150 mm</td>
<td>53</td>
<td>4.4</td>
</tr>
<tr>
<td>11.</td>
<td>200 mm</td>
<td>63</td>
<td>5.0</td>
</tr>
<tr>
<td>12.</td>
<td>250 mm</td>
<td>57</td>
<td>6.3</td>
</tr>
<tr>
<td>13.</td>
<td>300 mm</td>
<td>58</td>
<td>7.0</td>
</tr>
<tr>
<td>14.</td>
<td>350 mm</td>
<td>64</td>
<td>7.8</td>
</tr>
<tr>
<td>15.</td>
<td>400 mm</td>
<td>68</td>
<td>8.8</td>
</tr>
<tr>
<td>16.</td>
<td>450 mm</td>
<td>77</td>
<td>9.8</td>
</tr>
<tr>
<td>17.</td>
<td>500 mm</td>
<td>50</td>
<td>11.1</td>
</tr>
<tr>
<td>18.</td>
<td>550 mm</td>
<td>65</td>
<td>11.1</td>
</tr>
<tr>
<td>19.</td>
<td>600 mm</td>
<td>83</td>
<td>12.5</td>
</tr>
<tr>
<td>20.</td>
<td>650 mm</td>
<td>58</td>
<td>12.5</td>
</tr>
<tr>
<td>21.</td>
<td>700 mm</td>
<td>82</td>
<td>13.0</td>
</tr>
<tr>
<td>22.</td>
<td>750 mm</td>
<td>104</td>
<td>15.0</td>
</tr>
<tr>
<td>23.</td>
<td>800 mm</td>
<td>79</td>
<td>15.0</td>
</tr>
</tbody>
</table>

Fitting can be fabricated at site over the carrier pipe and correct quantity of PUF shall be poured manually.

FIELD JOINTS INSULATION:

Field joints insulation shall consist of PUF poured manually in a site-fabricated GI cladding fixed around the joint.
**WATER SIDE EQUIPMENT & ASSOCIATED WORKS**

L- 4  
**VALVES & ACCESSORIES**

**PART 1: Balancing Valve (Manual–Double Regulating Type)**

4.1 Duty  
Chilled Water / HOT Water / Condenser Water

4.2 Pressure Rating  
PN–10/PN–16 (As specified in B.O.Q.)

4.3 pH Value  
Between 4 and 10

4.4 Material Specification

4.4.1 Hand Wheel  
CI-220

4.4.2 Body / Bonnet  
C.A.F. (CI 260  GG 25)

4.4.3 Body / Bonnet Bolts  
A 307, GR.B

4.4.4 Gland Packing  
Graphite asbestos

4.4.5 Stem Seal  
EPDM

4.4.6 Stem  
SS 410

4.4.7 Upper Disc.  
SS 410

4.4.8 Seat Seal  
EPDM (Site replaceable)

4.4.10 Dimensions as per Table  
Table –1 of this chapter

4.4.11 Tight Shut Off Type

4.4.12 Flanges drilled to IS 6392 (PN 16) Standards

4.5 General Description

4.5.1 Body and Bonnet shall be constructed of cast iron as per IS 210 Gr.260

4.5.2 Seat shall be erosion resistant stainless steel, with EPDM Seal, rendering it TIGHT SHUT OFF, and suitable for site replace ability.

4.5.3 The spindle shall be non–rising type, and its movement should be lockable/tamper proof type.
4.5.4 Micro-meter scale in the wheel should allow fine settings up to \(1/10^{th}\) of a hand wheel turn. The spindle should be lockable with a lock screw, allowing the limiting maximum opening of valve, to pre-determined position, while still allowing to use as shut-off valve.

4.6 **T.A.B. (Testing, Adjusting and Balancing)**

4.6.1 Measurement of pressure drops and flow rate should be possible using the body taps and quarter turn cocks.

4.6.2 Digital measurements compatibility is a pre-requisite.

4.6.3 Published ‘K’ factor of valve for different hand wheel turns should be available.

![Diagram](image.png)

**TABLE – 1**

<table>
<thead>
<tr>
<th>Nominal Size</th>
<th>DN (mm)</th>
<th>080 (3&quot;)</th>
<th>100 (4&quot;)</th>
<th>125 (5&quot;)</th>
<th>150 (6&quot;)</th>
<th>200 (8&quot;)</th>
<th>250 (10&quot;)</th>
<th>300 (12&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>mm</td>
<td>310</td>
<td>350</td>
<td>400</td>
<td>480</td>
<td>600</td>
<td>730</td>
<td>850</td>
</tr>
<tr>
<td>ØD</td>
<td>mm</td>
<td>200</td>
<td>220</td>
<td>250</td>
<td>285</td>
<td>340</td>
<td>405</td>
<td>460</td>
</tr>
<tr>
<td>H</td>
<td>mm</td>
<td>290</td>
<td>410</td>
<td>450</td>
<td>490</td>
<td>590</td>
<td>760</td>
<td>820</td>
</tr>
<tr>
<td>ØC</td>
<td>mm</td>
<td>175</td>
<td>225</td>
<td>225</td>
<td>300</td>
<td>400</td>
<td>480</td>
<td>480</td>
</tr>
<tr>
<td>Stroke</td>
<td>mm</td>
<td>32</td>
<td>40</td>
<td>49</td>
<td>57</td>
<td>69</td>
<td>80</td>
<td>96</td>
</tr>
<tr>
<td>Hand wheel Turns</td>
<td></td>
<td>8</td>
<td>10</td>
<td>12.25</td>
<td>14.25</td>
<td>11.25</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Weight</td>
<td>Kg.</td>
<td>22.5</td>
<td>38</td>
<td>55</td>
<td>76</td>
<td>119</td>
<td>220</td>
<td>315</td>
</tr>
</tbody>
</table>

HVAC Consultant: AD CONSULTANTS
PART 2: **BUTTERFLY VALVE**

4.7 Duty Chilled Water / HOT Water / Condenser Water

4.7.1 Pressure Rating Confirm to BS:5155 PN–10/PN–16 & API–609

4.7.2 pH Value Between 4 and 10

4.8 **Material Specification**

4.8.1 Single piece construction

4.8.2 Body liner to be integrally molded. Tight shut–off designed

4.8.3 Stem to be designed for best flow efficiency and structural stability

4.8.4 Material of construction of stem to be S.S. (AISI 410) High tensile grade

4.8.5 Stem sealing arrangement should not have gland packing

4.8.6 For sizes between 50mm to 600mm – used standard wafer valves

4.8.7 Provide Hand Lever operated valves with locking arrangement for every 10° turn for valves up to NB200mm

4.8.8 Gear operated (Manual) valves for sized NB250mm and more.

4.8.9 Refer TABLE for physical dimension detail

4.9 **General Description: Valve shall confirm to following intent:**

4.9.1 Single body caste

4.9.2 Body construction material should be graded cast iron

4.9.3 Disc. Construction material should be Stainless steel.

4.9.4 Disc. Seat should be an integral liner made of EDPM / Nitrite rubber, tight shut–off design

4.9.5 Valves more than NB 350 mm shall allow for seat replacement at site.
### General Description: Valve Installation Dimension

#### Installation Dimensions

![Diagram of valve installation dimensions]

**TABLE – 2**

(All Dimensions in mm)

<table>
<thead>
<tr>
<th>Valve</th>
<th>Approx. Gr. Wt. Kg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB 50 (2&quot;)</td>
<td>3.5</td>
</tr>
<tr>
<td>NB 65 (2.5&quot;)</td>
<td>4.0</td>
</tr>
<tr>
<td>NB 80 (3&quot;)</td>
<td>4.5</td>
</tr>
<tr>
<td>NB 100 (4&quot;)</td>
<td>6.2</td>
</tr>
<tr>
<td>NB 125 (5&quot;)</td>
<td>7.7</td>
</tr>
<tr>
<td>NB 150 (6&quot;)</td>
<td>9.0</td>
</tr>
<tr>
<td>NB 200 (8&quot;)</td>
<td>14.0</td>
</tr>
<tr>
<td>NB 250 (10&quot;)</td>
<td>30.0</td>
</tr>
<tr>
<td>NB 300 (12&quot;)</td>
<td>44.0</td>
</tr>
<tr>
<td>NB 350 (14&quot;)</td>
<td>50.0</td>
</tr>
<tr>
<td>NB 400 (16&quot;)</td>
<td>72.0</td>
</tr>
<tr>
<td>NB 450 (18&quot;)</td>
<td>95.0</td>
</tr>
<tr>
<td>NB 500 (20&quot;)</td>
<td>120.0</td>
</tr>
<tr>
<td>NB 600 (24&quot;)</td>
<td>210.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NB 50 (2&quot;)</td>
<td>113</td>
<td>68</td>
<td>43</td>
<td>97</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>237</td>
<td>3.5</td>
</tr>
<tr>
<td>NB 65 (2.5&quot;)</td>
<td>121</td>
<td>74</td>
<td>46</td>
<td>110</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>237</td>
<td>4.0</td>
</tr>
<tr>
<td>NB 80 (3&quot;)</td>
<td>128</td>
<td>81</td>
<td>46</td>
<td>129</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>237</td>
<td>4.5</td>
</tr>
<tr>
<td>NB 100 (4&quot;)</td>
<td>146</td>
<td>96</td>
<td>52</td>
<td>161</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>237</td>
<td>6.2</td>
</tr>
<tr>
<td>NB 125 (5&quot;)</td>
<td>158</td>
<td>114</td>
<td>56</td>
<td>188</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>237</td>
<td>7.7</td>
</tr>
<tr>
<td>NB 150 (6&quot;)</td>
<td>174</td>
<td>132</td>
<td>56</td>
<td>212</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>300/350</td>
<td>9.0</td>
</tr>
<tr>
<td>NB 200 (8&quot;)</td>
<td>198</td>
<td>165</td>
<td>60</td>
<td>269</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>400/500</td>
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</tr>
<tr>
<td>NB 250 (10&quot;)</td>
<td>245</td>
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<td>68</td>
<td>320</td>
<td>300</td>
<td>175</td>
<td>61</td>
<td>283</td>
<td>-</td>
<td>30.0</td>
</tr>
<tr>
<td>NB 300 (12&quot;)</td>
<td>275</td>
<td>240</td>
<td>78</td>
<td>370</td>
<td>300</td>
<td>175</td>
<td>61</td>
<td>313</td>
<td>-</td>
<td>44.0</td>
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<tr>
<td>NB 350 (14&quot;)</td>
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<td>92/78&quot;</td>
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<td>300</td>
<td>175</td>
<td>61</td>
<td>343</td>
<td>-</td>
<td>50.0</td>
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<tr>
<td>NB 400 (16&quot;)</td>
<td>335</td>
<td>295</td>
<td>102</td>
<td>487</td>
<td>450</td>
<td>265</td>
<td>117</td>
<td>408</td>
<td>-</td>
<td>72.0</td>
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<tr>
<td>NB 450 (18&quot;)</td>
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<td>325</td>
<td>114</td>
<td>539</td>
<td>450</td>
<td>265</td>
<td>117</td>
<td>459</td>
<td>-</td>
<td>95.0</td>
</tr>
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<td>NB 500 (20&quot;)</td>
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<td>360</td>
<td>127</td>
<td>592</td>
<td>450</td>
<td>265</td>
<td>117</td>
<td>489</td>
<td>-</td>
<td>120.0</td>
</tr>
<tr>
<td>NB 600 (24&quot;)</td>
<td>506</td>
<td>435</td>
<td>154</td>
<td>695</td>
<td>450</td>
<td>265</td>
<td>117</td>
<td>579</td>
<td>-</td>
<td>210.0</td>
</tr>
</tbody>
</table>
PART 3: DUAL PLATE CHECK VALVE

4.11.1 Duty: Chilled Water / HOT Water / Condenser Water
4.11.2 Pressure Rating: Confirm to BS:5155 PN–10/PN–16 & API–609
4.11.2 pH Value: Between 4 and 10

Material Specification

4.12.1 Dual plate with independent springs in a central hinge pin, to allow for reduced hammer and non-slam
4.12.2 Value design should confirm to APS–594 and API–6D
4.12.3 One piece body, cast cut of graded C.I.
4.12.4 Disc. Shall be stainless steel
4.12.5 Seat to be made of Nitrite rubber

PART 4: STRAINERS (POT / Y / SUCTION DIFFUSERS)

4.13 Pot Strainer

4.13.1 Body: C.I/MS (IS:2062) ‘refer Table–3’
### Intent of Specifications

**HVAC Consultant:** AD CONSULTANTS

### TABLE 3
**Stainless steel (304) material, 1mm thick**

<table>
<thead>
<tr>
<th>Plate Thickness (mm)</th>
<th>Pipe Size (mm)</th>
<th>Pot Size (mm)</th>
<th>Pot HT (mm)</th>
<th>Basket Dia (mm)</th>
<th>Basket HT (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>50</td>
<td>300</td>
<td>400</td>
<td>200</td>
<td>240</td>
</tr>
<tr>
<td>8</td>
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<td>330</td>
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<tr>
<td>12</td>
<td>150</td>
<td>540</td>
<td>700</td>
<td>360</td>
<td>390</td>
</tr>
<tr>
<td>12</td>
<td>200</td>
<td>610</td>
<td>815</td>
<td>400</td>
<td>470</td>
</tr>
<tr>
<td>12</td>
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<td>800</td>
<td>955</td>
<td>550</td>
<td>510</td>
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<td>12</td>
<td>300</td>
<td>1000</td>
<td>1105</td>
<td>750</td>
<td>580</td>
</tr>
<tr>
<td>12</td>
<td>350</td>
<td>1190</td>
<td>1300</td>
<td>895</td>
<td>678</td>
</tr>
<tr>
<td>12</td>
<td>400</td>
<td>1350</td>
<td>1500</td>
<td>1020</td>
<td>785</td>
</tr>
<tr>
<td>12</td>
<td>450</td>
<td>1518</td>
<td>1700</td>
<td>1060</td>
<td>890</td>
</tr>
<tr>
<td>12</td>
<td>500</td>
<td>1690</td>
<td>1800</td>
<td>1100</td>
<td>900</td>
</tr>
</tbody>
</table>

### TABLE 4
**M.S. Fabricated 150 LB Rating ‘Y’ Type Strainer**

<table>
<thead>
<tr>
<th>Line Size (NB)</th>
<th>25</th>
<th>50</th>
<th>65</th>
<th>80</th>
<th>100</th>
<th>125</th>
<th>150</th>
<th>200</th>
<th>250</th>
<th>300</th>
</tr>
</thead>
<tbody>
<tr>
<td>“A” Strainer body length</td>
<td>225</td>
<td>260</td>
<td>375</td>
<td>380</td>
<td>425</td>
<td>525</td>
<td>600</td>
<td>750</td>
<td>800</td>
<td>850</td>
</tr>
<tr>
<td>“B” Basket length</td>
<td>150</td>
<td>180</td>
<td>230</td>
<td>230</td>
<td>300</td>
<td>340</td>
<td>380</td>
<td>475</td>
<td>525</td>
<td>575</td>
</tr>
</tbody>
</table>

### TABLE 5
**M.S. Fabricated 150 / 300 LB Rating Pot Strainer**

| Line Size (NB) | 50 | 80 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 500 |
|----------------|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| “A” | 400 | 450 | 500 | 700 | 815 | 955 | 1105 | 1300 | 1500 | 1700 | 1800 | 2200 |
| “B” | 300 | 350 | 450 | 540 | 610 | 800 | 1000 | 1350 | 1520 | 1690 | 2000 |
| “C” | 240 | 250 | 280 | 390 | 470 | 510 | 580 | 680 | 785 | 890 | 900 | 1160 |
| “D” | 20  | 250 | 300 | 360 | 400 | 550 | 750 | 895 | 1020 | 1060 | 1100 | 1500 |
| “E” | 500 | 500 | 700 | 800 | 900 | 1200 | 1500 | 1590 | 1850 | 2090 | 2290 | 2600 |

### 4.14 Pressure Rating
Test pressure of PN 14 / PN 16 / as specified for valves etc. in the BOQ.

### 4.15 Screen
Stainless steel (SS 304) (non magnetic), 1mm thick with 3mm perforation

### 4.16 Filtration Area
NOT Less than 75%

### 4.17 Filtration bucket
Brass ring on tap, rested on disc welded to the main body
4.18 Powerful magnet at bottom, to attract weld burrs in the piping network to be located at the bottom of the body, and shall have a clean out provision.

4.19 Flush down arrangement, with a butterfly / gate valve shall be provided.

4.20 Clearance of almost 300mm from the ground should be maintained by using ISMC 100x50.

4.21 Auto Air Vent with a ball valve isolator shall be provided, to purge accidental air entrapment.

4.22 Top lid shall be provided with a swivel arrangement, having a stainless steel screw and a wheel of C.I.–260, along with a hub and bearing arrangement. The lid shall be comply to M.S.–IS 2062 construction, with a lip and gasket ting arrangement.

PART 4: ACCESSORIES

4.23 Closed Expansion Tank

4.23.1 Closed vessel expansion tank where-ever specified will be of M. S. construction with interchangeable EPDM – BUTYL rubber membrane. The expansion tank shall be complete with safety relief valve, pressure reducing valve and pressure gauge.

4.23.2 The tank will be of pressure rating to suit the system pressure and will be sized to adequately compensate for water expansion due to operating temperature variations.

4.23.3 For chilled water application, it will insulated with 75-mm thick insulating material of expanded polystyrene and cladded with 26G-alluminium sheet.

4.24 Air Separators

4.24.1 The centrifugal air-separator will of M.S. construction with flanged connections. The air separator will be adequately sized to achieve maximum air-seperation. It will be provided with an automatic air-vent at the top.

4.24.2 For chilled water application, it will insulated with 50-mm thick insulation to the specifications and clad with 26G-alluminium cladding.

4.24.3 The equipment shall be complete with a make-up pump of suitable rating and all other accessories and interconnecting piping, electrical cabling / panel (if required to operate the pump).

4.25 Binder Test Point

4.25.1 Binder test point shall be installed at the inlet and outlet of each pump, balancing valve and heat exchange equipment like Chiller, Condenser, Cooling Tower, Water Cooling Coil, Boiler. Test Points shall also be provided at different locations in the water pipe line to facilitate pressure measurement.

4.25.2 Test Point shall be of brass construction, 1/4” BSP with NEOPRENE sealing bushes and shall be provided with screwed cover.
4.26 **Suction Diffuser**

4.26.1 Suction diffuser shall be installed at the inlet of each pump. Suction Guide shall have cast iron body, outlet guide vanes, removable SS. Strainer and fine mesh brass S.S. start-up filter. The specifications for the Y-strainers shall be read in conjunction with this chapter (Refer table 4 for strainer body length etc.

4.26.2 The Contractor shall inspect the strainer prior to start-up of the pump and shall remove the fine mesh brass filter after short running period. Space shall be provided for removal of strainer and for connection of blow down valve.

4.27 **Gate valves**

Gate valves shall conform to IS : 780/1969, flanges to IS : 1536 or as required. Valves shall have non-rising spindles unless otherwise specified and shall be suitable for 21 Kg/Sq.cm test pressure. Tail pieces shall be used where required.

4.28 **Pressure Gauges (where-ever asked for)**

4.28.1 Pressure guage shall be not less than 100mm dia. dial, and of appropriate range and be complete with shut off gauge cocks, isolating valves etc. duly calibrated before installation.

4.28.2 Supply and return of chillers and condensers

4.28.3 Suction and discharge of heat exchangers

4.28.4 Inlet and outlet of heat exchangers.

4.28 Care shall be taken to protect pressure guage during pressure testing.

4.29 **Thermometers (where-ever asked for)**

4.29.1 Thermometers shall be either 100mm dia dial or direct reading industrial type of appropriate range duly calibrated before installation.

4.29.2 Thermometers shall be installed in separable wells.

4.29.3 Thermometers shall be provided at the following locations and as indicated on the drawings

4.29.3.1 Stem type thermometer on supply and return of chillers and condensers.

4.29.3.2 Direct reading industrial type thermometers on supply and return at air handling units.
High rangeability control valve/ pressure independent dynamic balancing cum control for Air handling Units

The scope of this section comprises the supply, erection, testing and commissioning of automatic control Valve of High range ability with flow limit by Delta temperature control and conforming to these Specifications and in accordance with the requirements of Drawings and Schedule of Quantities.

a. Control Valves for AHU’s

Two way modulating control valve for each air handling units shall be provided in chilled water line at each air handling unit as shown on the Drawings and included in Schedule of Quantities. The valve shall be balanced ,high rangeability, globe type of cast iron construction, of PN 16 rating with flanged connections. The valve shall have a minimum stroke of 15 mm and rangeability of 300.

The valve actuator shall be electronic, motorized, modulating type with linear stroke of minimum 15 mm stroke, operating on 24Vac and 0-10 Vdc or 4-20 mA control signal. The actuator shall have provision for 0-10v dc position feedback signal and manual operation mode also. It shall be possible to operate the valve manually and the actuator shall switch back to auto mode when the power is restored. The valve actuator housing shall have IP 54 protection.

The actuator should be suitable for a valve close-up pressure of 1.5 times the pump head or a minimum of 4 bars.

Each valve shall be controlled by a space temperature sensor with a provision to limit the flow through the control valve based on temperature difference across the coil.

b. Electronic temperature Controller for AHU’s

The temperature controller shall be electronic, microprocessor based with LCD display working on 24 V AC with 0-10V dc output. It shall be capable of accepting inputs from three NTC temperature sensors. One temperature sensor for space temperature measurement and the other two temperature sensors for coil inlet and outlet water temperature for flow limit by delta T control. The controller shall be capable of comparing the signals and selecting the lower output to prevent excessive water flow through coil.

In case of BMS, controller shall accept 0-10 v dc signal from BMS.
MECHANICAL INSULATION

MECHANICAL SYSTEMS INSULATION

PART 1 GENERAL

1.1 DEFINITIONS
1.1.1 Exposed: Equipment, ducts, piping etc. in areas, which will be visible without removing ceilings or access panels.
1.1.2 Concealed: Installed above false ceiling, in walls or chases or trenches.
1.1.3 Outdoors: Exposed to weather or ambient conditions.
1.1.4 Underground: Buried.

1.2 CERTIFICATION / QUALITY ASSURANCE
1.2.1 Insulation, adhesives, coatings, sealant, tapes, shall have a flame spread rating of 25 or less and smoke development of 50 or less in accordance with UL 723.
1.2.2 Materials shall meet the requirements of BIS / NBC / DFS / Local code.

1.3 SUBMITTALS
1.3.1 Submit manufacturer’s product data and installation procedures for review.

PART 2 PRODUCTS

1.4 PIPE AND EQUIPMENT INSULATION
Provide factory pre-molded of material specified in section type insulation material for pipes and equipment.

1.5 MATERIAL: NITRILE RUBBER FOAM
1.5.1 Insulation material shall be Closed Cell Elastomeric Nitrile Rubber or ethylene foam.
1.5.2 Density of Material shall be between 35 to 60 Kg/m3.
1.5.3 Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m°K at an average temperature of 0°C.
1.5.4 The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.

1.5.5 Water vapour permeability shall not exceed 0.017 Perm inch \( (2.48 \times 10^{-14} \text{ Kg/m.s.Pa}) \), i.e. Moisture Diffusion Resistance Factor or \( \mu \) value should be minimum 7000.

1.5.6 Thickness of the insulation shall be as specified for the individual application.

1.6 CHILLED WATER PIPE LINE INSULATION

All chilled water piping and chilled water equipment shall be insulated in the manner specified here under:

1.7 APPLICATION OF INSULATION

1.7.1 All chilled water, refrigerant and condensate drain pipe shall be insulated in the manner specified herein. An air gap of 25 mm shall be present between adjacent insulation surfaces carrying chilled water or refrigerant. Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc. Nitrile Rubber insulation shall be applied as follows:

1.7.2 Insulating material in tube form shall be sleeved on the pipes.

1.7.3 On existing piping, slit opened tube of the insulating material (slit with a very sharp knife in a straight line) shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer.

1.7.4 Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards centre.

1.7.5 Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.

1.7.6 The insulation shall be continuous over the entire run of piping, fittings and valves.

1.7.7 All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

1.7.8 THE DETAILED APPLICATION SPECIFICATIONS ARE AS MENTIONED SEPARATELY. THE MANUFACTURER’S TRAINED INSTALLER SHOULD ONLY BE USED FOR INSTALLATION.
1.8 **RECOMMENDED ADHESIVE**
In all cases, self adhesive nitrile foam / cross linked polyethylene foam shall be used. No site application of adhesive would be permissible.

1.9 **PUMP INSULATION**
Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and application shall be same as above. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

1.10 **SHELL INSULATION**
The chiller shells shall be factory insulated in accordance with the manufacturer’s standards.

1.11 **COLD WATER AND EXPANSION TANK INSULATION**
Cold water tank, and chilled water expansion tank shall be insulated as per the above mentioned practices.

1.12 **INSTALLATION EXPOSED DIRECTLY TO SUNLIGHT**
For installations exposed to sunlight, after giving 36 hours curing time for the adhesive finish the surface with 22 G aluminum cladding.

1.13 **RECOMMENDED THICKNESS OF NITRILE FOAM / CROSS LINKED POLYETHYLENE FOAM BASED UPON DUTY CONDITIONS FOR COASTAL AREAS**

Design Basis: Condensation Control in coastal areas:

Ambient / surrounding condition : Out door / Attic & Un-conditioned spaces.

Design Conditions: 28.3 Deg. C & 90% RH (as per ASHRAE guidelines)

1.14 **CHILLED WATER PIPING**

<table>
<thead>
<tr>
<th>Pipe line surface temperature: 7 Deg C</th>
<th>Required Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe NB (mm)</td>
<td></td>
</tr>
<tr>
<td>25 to 40</td>
<td>32</td>
</tr>
<tr>
<td>50 to 150</td>
<td>38</td>
</tr>
<tr>
<td>200 to 600</td>
<td>44</td>
</tr>
<tr>
<td>Cold Water Tank</td>
<td>44</td>
</tr>
</tbody>
</table>
1.15  REFRIGERANT PIPING  
Line temperature: 3 Deg C  
<table>
<thead>
<tr>
<th>Pipe NB (mm)</th>
<th>Required Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 50</td>
<td>38</td>
</tr>
<tr>
<td>Up to 100</td>
<td>44</td>
</tr>
</tbody>
</table>

1.16  CONDENSATE DRAIN PIPING  
Pipe surface temperature: 15 Deg C  
<table>
<thead>
<tr>
<th>Pipe NB (mm)</th>
<th>Required Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 50</td>
<td>38</td>
</tr>
</tbody>
</table>

1.17  RECOMMENDED THICKNESS OF NITRILE FOAM / CROSS LINKED POLYETHYLENE FOAM BASED UPON DUTY CONDITIONS FOR NON-COASTAL AREAS  
CHILLED WATER PIPING  
Pipe line surface temperature: 7 Deg C  
<table>
<thead>
<tr>
<th>Pipe NB (mm)</th>
<th>Required Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 to 32</td>
<td>19</td>
</tr>
<tr>
<td>upto 600</td>
<td>32</td>
</tr>
<tr>
<td>Cold Water Tank</td>
<td>32</td>
</tr>
</tbody>
</table>

1.18  DUCT–LINE THERMAL INSULATION  
External thermal insulation shall be provided as follow:  
The thickness of the nitrile rubber shall be as mentioned below and in the in the schedule of quantity. Following installation procedure should be adopted:  

1.19  Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.  
1.20  Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubbers sheets to size with sufficient allowance in dimension.  
1.21  Material shall be fitted under compression and no stretching of material should be allowed.  
1.22  A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface.  
1.23  When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.  
1.23.1  All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.  
1.23.2  The adhesive shall be strictly as recommended by the manufacturer.
1.23.3 The detailed Application specifications are as per the manufacturer’s recommendation.

1.24 RECOMMENDED THICKNESS OF NITRILE FOAM / CROSS LINKED POLYETHYLENE FOAM BASED UPON DUTY CONDITIONS FOR COASTAL AREAS

Supply air duct (Line temperature : 14 Deg C) : Use 25 mm thickness
Return air duct (Line temperature : 22 Deg C) : Use 9 mm thickness

1.25 RECOMMENDED THICKNESS OF NITRILE FOAM / CROSS LINKED POLYETHYLENE FOAM BASED UPON DUTY CONDITIONS FOR NON-COASTAL AREAS

Supply air duct (Line temperature : 14 Deg C) : Use 19 mm thickness
Return air duct (Line temperature : 22 Deg C) : Use 9 mm thickness
Supply Air Duct in Return Air Path
(Line Temp. 14 Deg.C) : Use 9 mm thickness

1.26 DUCT LINING

Acoustical lining of duct wherever specified shall be applied as follows : (As per BOQ Specified)

1.26.1 Fix G.S. sheet channel frame work of 22 gauge 25mm wide x depth equal to thickness of insulation at 600mm center, screwed to the sheet metal by means of brass metal screws.

1.26.2 Supply and fix rigid fibber glass slab or other approved equivalent material (Accosound)in the GS sheet channel frame work with joints well butted together.

1.26.3 Cover insulation with R.P. tissue.

1.26.4 Finally cover the insulation with 28 SWAG perforated aluminum sheet having atleast 20% perforation with joints overlapped and screwed to the GS sheet channel frame by means of brass metal screws, to produce an even surface.

1.27 AHU ROOM / PLANT ROOM LINING

Acoustical lining of plant room or AHU room wherever specified shall be applied as under. (As per BOQ Specified)

1.27.1 Fix G.S. sheet channel frame work of 22 gauge 25mm wide x depth equal to the thickness of insulation at 600mm centre, screwed to the sheet metal by brass metal screws.

1.27.2 Supply and fix fibre glass crown 200 or other approved equivalent material in the G.S. sheet channel frame work with joints well butted together. cover insulation with R.P. tissue.
Finally cover the insulation with 24SWG perforated aluminum sheet having at least 20% perforation with joints overlapping and screwed to the G.S. sheet channel frame by means of brass metal screws, to produce an even surface.

1.28 **EXPOSED DUCT THERMAL INSULATION**
Duct insulation shall be applied as follows (As per BOQ specified)

1.28.1 Apply hot bitumen 85/25 over the surface after cleaning the ducts.

1.28.2 Rigid extruded polystyrene 50 mm thick insulation material to be fixed tightly to the surface with joints well butted and secured.

1.28.3 Cover the insulation with 24 gauge x 19 mm GI wire mesh with necessary overlapping.

1.28.4 Apply 2 layers of 1:3 sand cement plaster mixed with waterproofing compound each of 10 mm thickness achieving smooth surface finish.

1.28.5 Apply 2 coats of synthetic paint of approved shade.

1.29 **EXPOSED ROOF THERMAL INSULATION**
1.29.1 Under-deck insulation for exposed roof shall be carried out in the manner specified hereunder or as per BOQ specified.

1.29.2 Application of Insulation

1.29.3 Exposed roof shall be insulated with rigid pre-formed sections of extruded polystyrene foam of 32 kG/CuM, 25 mm thick.

1.29.4 **Insulation shall be applied as follows**
1.29.4.1 The underside of the ceiling shall be thoroughly cleaned with wire brush and rendered free from all foreign matter and dirt.

1.29.4.2 Metal screws shall be fixed with rawl plugs to form a grid work of 100mm x 500 mm. 22G GI wire shall be tied to each screw with 2 equal ends.

1.29.4.3.1 One coat of shalicoat compound shall be applied on the cleaned surface of the slab, and a coat of CPRX compound shall be applied to the extruded polystyrene foam slabs.

1.29.4.3.2 After applying the coat of CPRX compound, the extruded polystyrene rigid sections 25 mm thick shall be tightly fixed to the surface.

1.29.4.4 The joints of the interface of the slabs shall be sealed with CPRX compound and finished 25 mm thick.

1.30 **FIRE BREAKS IN INSULATION**
Fire breaks shall be provided in all ducts (for internal lining / External thermal insulation) after a run of 10 M (Centre to Centre). Fire breaks in insulation simply mean that there will be a discontinuity of the insulating material in form of a MS angle of a minimum of 50mm x 50mm x 3mm size. At the interface of the MS angle
and the insulating material, proper care of tucking in of the insulating material shall be taken, so as to prevent erosion.

1.31 **PIPE AND EQUIPMENT INSULATION**

Provide factory pre-molded of material specified in section type insulation material for pipes and equipment.

1.31.1 Expanded poly-styrene
1.31.2 Chilled water pipe line insulation
1.31.3 All chilled water piping and chilled water equipment shall be insulated in the manner specified hereunder:

1.32 **Application of Insulation**

No insulation shall be applied on pipes until the pipes are satisfactorily tested, as specified in section “PIPING”.

Chilled water pipes shall be insulated with rigid preformed sections of Expanded polystyrene or equal approved insulation with density not less than 20 kg/Cum of the following thickness:

<table>
<thead>
<tr>
<th>Temp. Range</th>
<th>Pipe Dia</th>
<th>Thickness (PUF/EP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(degree C)</td>
<td>(mm)</td>
<td>(mm)</td>
</tr>
<tr>
<td>1.1-3.9</td>
<td>12-75</td>
<td>50/75</td>
</tr>
<tr>
<td></td>
<td>100-300</td>
<td>75/100</td>
</tr>
<tr>
<td>4.4-12.2</td>
<td>12-200</td>
<td>30/50</td>
</tr>
<tr>
<td></td>
<td>Over 200</td>
<td>50/75</td>
</tr>
<tr>
<td>12.8-15.6</td>
<td>All Sizes</td>
<td>25/40</td>
</tr>
</tbody>
</table>

1.33 **Cold insulations on pipes shall be applied as follows**: -

1.33.1 Pipes shall be thoroughly cleaned with wire brush and rendered free from all foreign matter and grease.

1.33.2 One coat of Zinc Chromate premier and two coats of CPRX compound shall be applied on the pipe.

1.33.3 Expanded polystyrene rigid sections shall be fixed tightly to the surface. All joints to be sealed properly with CRPX compound. Covered with a layer of polythene vapor barrier.

1.33.4 Insulated surface shall be finished with sand cement plaster in the BOQ.

1.33.5 Condensate piping and refrigerant piping shall be insulated in the manner specified above.

1.33.6 All valves, fittings, strainers etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and applied generally in the manner specified above, valve bonnets, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

1.33.7 Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and applied generally in the manner specified above. Care
shall be taken to apply the insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

1.33.8 Tanks, wherever required in chilled water piping system i.e. expansion tanks shall be insulated to same thickness as for the pipes to which they are connected. The mode of the insulation shall generally be as above.

1.33.9 PUF HIGH DENSITY SADDLES TO BE USED FOR SUPPORT OF PIPES. THE DENSITY AND THICKNESS SHALL BE NOT LESS THAN 80 Kg / CuM.

1.40 THERMAL INSULATION OF DUCT:
BLANKET TYPE DUCT INSULATION (GLASS WOOL)

1.40.1 Insulating material shall be glasswool, resin bonded fiberglass, or other approved equal, reinforced, foil faced, Kraft vapor barrier pre-laminated with aluminum foil. The Thermal conductivity of the insulation material shall not exceed 0.034 K.Cal per hr-sq. metre - degree C/metre or 0.27 Btu/hr-sq. ft - degree F/inch at 32 degree C (90 degree F)mean temperature, and density shall not be less than 24 Kg/cubic metre. Thickness of the insulation shall be as specified for the individual application. Samples of insulation material shall be submitted for approval.

1.40.2 ACCEPTABLE MANUFACTURERS AS PER LIST OF APPROVED MAKES

1.40.3 Use on the following services:
1.40.3.1 Unlined conditioned supply air ducts : 2" thick (in case of ducted return air). 1" thick in case of non ducted return air.

1.40.3.2 Unlined return air ducts : 1" thick.

1.40.3.3 Application procedure
Duct insulation shall be applied as follows:
1.40.3.3.1 Apply CPRX Compound over the surface after cleaning the ducts

1.40.3.3.2 Fibre glass, factory laminated with Aluminum foil of approved make in specified thickness to be fixed tightly to the surface with joints well butted and secured.

1.40.3.3.3 All joints shall be sealed with 2" wide transparent adhesive based tape as recommended.

1.40.3.3.4 The insulation material on the duct should be finally secured with PVC straps.
HVAC RELATED ELECTRICAL INSTALLATION

L-1  GENERAL

1.1  DEFINITION

1.1.2  Concealed: Installed above false ceiling, in walls or chases or trenches.

1.1.3  Out doors: Exposed to weather or ambient conditions.

1.1.4  Underground: Burried.

1.2.1  CERTIFICATION / QUALITY ASSURANCE

As per the specified norms detailed in the length of this section. Materials shall meet the requirements of BIS / NBC / Local codes.

1.3  SUBMITTALS

1.3.1  Submit manufacturer's product data and installation procedures for review.

STANDARD SPECIFICATION ON ELECTRICAL MOTORS AND STARTERS

This section deals with supply, installation, testing and commissioning of all types of motors used for pumps, air handlers, compressors, cooling towers etc. The motor installation, wiring & its control shall be carried out in accordance with the specifications as detailed below.

MOTORS

MAKE OF MOTORS

The make of motors shall be as specified in List of Approved Make.

a) The motor shall be of the following design and should run at all loads without any appreciable noise or hum.

i) Totally enclosed fan cooled Sq. Cage.

ii) Screen protected drip proof wound Sq. Cage motor.

Enclosure and type of motor shall depend upon duty and usage unless otherwise specified.

b) The winding of motors shall be class 'F' insulation and suitable for local conditions. The insulation of motors shall confirm to IS:325/1978.

c) All motors shall comply with IS:12615:2011 or Based on IEC 60034:30 foot mounted motors.

d) The rating of the motor shall be as indicated in the Schedule of Equipment & Bill of Quantities should be as per IE3 Type. The motors shall be selected on the basis of ambient temperatures and allowable maximum temperature rise.

e) Motor above 1HP shall be three phase unless otherwise specified.

f) All motors shall be rated for continuous duty as per IS:325. Motor shall be suitable for operation on 415 volts ± 10% volts, 50 ± 5% Hz AC supply (or 230 ± 10% volts, 50 ± 5% Hz for single phase AC supply).

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118
g) Motors shall be provided with cable box to receive Aluminum conductors, PVC insulated, PVC sheathed and armoured cables suitable rised cable eatery berries with in if required shall be provided for easy-ness of cable termination and adequate space.

h) All motors shall be provided with combination of ‘Ball and Roller Bearing’. Suitable grease nipples for regreasing the bearing shall be provided.

i) Motors above 0.25 HP shall be provided with overload protection. Motors above 100 HP shall be provided with thermal protection and thermistor detector in the starter winding.

j) The starter current and the type of starter to be used shall be as follows (unless otherwise specified)

<table>
<thead>
<tr>
<th>Type of motor</th>
<th>Starting Current</th>
<th>Starting Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Sq. Cage motor</td>
<td>up to 7.5 hp</td>
<td>600% of full load D.O.L</td>
</tr>
<tr>
<td>above 10.0 hp</td>
<td>up to 60 hp</td>
<td>250% of full load Star / Delta</td>
</tr>
<tr>
<td>75 HP &amp; above</td>
<td>current</td>
<td>200% of full load Closed transition Star / Delta</td>
</tr>
</tbody>
</table>

MOTOR STARTERS

a) All starter shall confirm to IS: 13947. The starter shall be enclosed in sheet metal enclosure, which would be dust vermin proof.

b) All starter should have suitable range of voltage and frequency.

c) All starter shall have integral stop/start push button of international colour code.

d) Contactor shall have number of poles as required for appropriate duty. Contacts should be made of solid silver faced & shall be suitable for at least 40 contacts per hours.

e) In event of power failure, the starter should automatically disconnect.

f) All starters shall be provided with thermal over load relay.

g) All star delta starters shall have adjustable timers.

h) Terminal blocks with integral insulating barrier shall be provided for each starter.

i) All starters shall be provided as specified in Bill of Quantities. All starter shall be compatible to the drive and driven equipment.

j) Extra contact for interlocking purpose shall be provided in the starter.

INSTALLATION OF MOTORS

a) The motor and drive machine shall be fixed on slide rails to facilitate belt and other adjustments.

b) Vibration isolation arrangement shall be provided.

c) The installation of motor shall be carried out as per IS:900.

d) The motor with driving equipment shall be mounted on foundation and connected to each other with flexible coupling with guard in condenser & chilled water pumps.

e) All motor shall be wired as per specifications. Earthing of motor frame shall be done with GI strips as specified in ‘Bill of Quantities’.

f) All motors shall be tested at manufacturer’s works as per I.S. standard and test certificates shall be furnished.

g) All motors after installation shall be tested at site for vibrations, heating and electrical insulation resistance by AC contractor.
GENERAL

WORK INCLUDED

2.1.1 Panel Board Enclosures, Switch Gear and Accessories

2.1.2 Internal wiring, control terminal blocks, name plates / labels and painting

RELATED WORK AND OBLIGATIONS

2.1.3.1 The general requirements apply to work specified in this section.

2.1.3.2 Examine all the other sections of the specification for requirements, which may affect work of this section.

2.1.3.3 Co-ordinate works with all other trades affecting, or affected by activities of this section. Co-operate with such other trades to assure the steady progress of all operations under the contract.

GENERAL REQUIREMENTS

This specification covers requirements for Supply, Erection, Testing and Commissioning of MV Panel Boards. The equipment offered by the Contractor shall be complete in all respects. Any material and component not specifically stated in this specification but which is necessary for trouble free operation of the equipment and accessories specifically excluded. All such equipment / accessories shall be supplied without any extra cost. Also, all similar components shall be interchangeable and shall be of the same type and rating for easy maintenance and low spare inventory.

SIZES OF POWER CABLES

The following size of power cabling shall be used only:

<table>
<thead>
<tr>
<th>HP of Motors</th>
<th>Cable size</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Up to 5 HP</td>
<td>3c x 4 sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>b) 5 to 7.5 HP</td>
<td>3c x 6sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>c) 10 to 15 HP</td>
<td>2no. 3c x 6sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>d) 20 to 25 HP</td>
<td>2 nos. 3 x 16sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>e) 30 to 35 HP</td>
<td>2 nos. 3c x 25sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>f) 40 to 50 HP</td>
<td>2 nos. 3c x 35sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>g) 60 HP</td>
<td>2 nos. 3c x 35sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>h) 75 HP 2 nos.</td>
<td>3cx 50sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>i) 100 HP 2 nos.</td>
<td>3cx 70sq.mm aluminium conductor armoured cable.</td>
</tr>
<tr>
<td>j) 125 HP 2 nos.</td>
<td>3cx 95sq.mm aluminium conductor armoured cable.</td>
</tr>
</tbody>
</table>

CAPACITY OF RELAYS AND CONTACTS

The following capacity relays and contacts shall be used for various rating of motors:

<table>
<thead>
<tr>
<th>Type of Starter Contactor Overload Relay</th>
<th>Current Phase</th>
<th>Relay Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) 50/60 HP Motor</td>
<td>Star Delta Starter 65 Amp. 30 - 50 Amp.</td>
<td></td>
</tr>
<tr>
<td>b) 40 HP Motor</td>
<td>Star Delta Starter 45 Amp. 20-33 Amp.</td>
<td></td>
</tr>
<tr>
<td>c) 30 HP Motor</td>
<td>Star Delta Starter 45 Amp. 20-33 Amp.</td>
<td></td>
</tr>
<tr>
<td>d) 25 HP Motor</td>
<td>Star Delta Starter 32 Amp. 14-23 Amp.</td>
<td></td>
</tr>
<tr>
<td>e) 20 HP Motor</td>
<td>Star Delta Starter 32 Amp. 14-23 Amp.</td>
<td></td>
</tr>
<tr>
<td>f) 15 HP Motor</td>
<td>Star Delta Starter 25 Amp. 9-15 Amp.</td>
<td></td>
</tr>
<tr>
<td>g) 10 HP Motor</td>
<td>Star Delta Starter 16 Amp. 6-10 Amp.</td>
<td></td>
</tr>
<tr>
<td>h) 7.5 HP Motor</td>
<td>D.O.L. Starter 16 Amp. 9-15 Amp.</td>
<td></td>
</tr>
</tbody>
</table>
i) 5 HP Motor & D.O.L. Starter 16 Amp. 6-10 Amp.

**EARTHING**
The earthing of all equipments shall be carried out by Copper strips / wires as mentioned in Bill of Quantities. All panels / three phase motors shall be earthed with two number distinct and independent Copper strips / wires of the following sizes:

1. Motor upto 5.5 KW 3 sq. mm Copper Wire
2. Motor 7.5 to 12 KW 4 sq. mm Copper Wire
3. Motor 12 to 50 KW 25 x 3 mm Copper Strip
4. Motor 51 to 89 KW 32 x 6 mm Copper Strip

The earthing connections shall be connected to main earth station or main earth grid. The earth connections shall be connected to equipments after removal of paint, grease etc.

**POTENTIAL FREE CONTACTS**
The AC contractor shall provide fire shunt relay contact in his panel wherever necessary either it is specified in the Schedule of Quantities or not free of cost along with auto / manual mode selector switch in the outgoing feeder for AHU Fan, Ventilation & Pressurization fan etc. to take fire input signal (Potential Free Contact).

**2.1.5 CODES AND STANDARDS**
Compliance with all applicable Indian standards, Indian Electricity Act and Indian Electricity rules.

2.1.5.1 IS 5: Colors for ready-mixed paints and enamels.
2.1.5.2 IS 375 / 1963: Making and arrangement for switchgear, busbars, main connections & auxiliary wiring
2.1.5.3 IS 694: PVC insulated cables for working voltages up to and including 1100V.
2.1.5.4 IS 13779: A.C. Static Electricity Meters.
2.1.5.5 IS 1248: Electrical Indicating instruments.
2.1.5.6 IS 1567 / 1960: Metal clad switches (Current rating not exceeding 100A)
2.1.5.7 IS 1951 / 1916: Polyvinyl chloride sleeving for electric purposes.
2.1.5.8 IS 2147 / IS 12063: Degree of protection provided by enclosures for low voltage switchgear and control gear.
2.1.5.9 IS 2675 / 1966: Enclosed distribution fuse boards and conduits for voltage not exceeding 1000 Volts.
2.1.5.10 IS 13947 (Part-2): A.C. Circuit breakers.
2.1.5.11 IS 8828: Miniature Circuit breakers.
2.1.5.12 IS 12640: Residual Current Operated Circuit breakers.
2.1.5.13 IS 2448 / 1962: Adhesive insulating tapes.
2.1.5.14 IS 2551: Danger Notice Plates.
2.1.5.15 IS 2705: Current Transformers.
2.1.5.16 IS 2208 / 1962: HRC Cartridge fuses links up to 650 Volts.
<table>
<thead>
<tr>
<th>Specification Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 13947 (Part-4, Sec-1)</td>
<td>Contactors and motors starter for voltages not exceeding 1000 V AC or 1200 V DC.</td>
</tr>
<tr>
<td>IS 13947 (Part-5, Sec-1)</td>
<td>Control Circuit Devices and Switching Elements</td>
</tr>
<tr>
<td>IS 13947 (Part-1&amp;5)</td>
<td>Actuators, Indicators</td>
</tr>
<tr>
<td>IS 13947 (Part-1&amp;5)</td>
<td>Timers</td>
</tr>
<tr>
<td>IS 13947 (Part-3)</td>
<td>Switch Disconnector Fuse, Changeover Switches</td>
</tr>
<tr>
<td>IS 3043</td>
<td>Code of practice for earthing.</td>
</tr>
<tr>
<td>IS 3072</td>
<td>Installation and Maintenance of switchgear.</td>
</tr>
<tr>
<td>IS 3202</td>
<td>Code of practice for climate proofing of electrical equipment.</td>
</tr>
<tr>
<td>IS 3231/ IS 8686</td>
<td>Electrical relays for power system protection.</td>
</tr>
<tr>
<td>IS 4237</td>
<td>General requirements for switchgear and control gear for voltages not exceeding 1000 V.</td>
</tr>
<tr>
<td>IS 5082</td>
<td>Wrought Aluminum &amp; Al alloy for electrical purposes.</td>
</tr>
<tr>
<td>IS 6875</td>
<td>Switches and push-buttons.</td>
</tr>
<tr>
<td>IS 8623</td>
<td>Specification for factory built assemblies of switchgear &amp; control gear for voltages up to &amp; including 1000 V AC.</td>
</tr>
<tr>
<td>IS 13703 (Part-2)</td>
<td>HRC Cartridge fuses.</td>
</tr>
<tr>
<td>IS 10118</td>
<td>Code of practice for selection, installation and maintenance of switchgear and control gear.</td>
</tr>
<tr>
<td>IS 11353</td>
<td>Guide for uniform system of marking and identification of conductors and apparatus terminals.</td>
</tr>
<tr>
<td>IS 12021</td>
<td>Specification of control transformers</td>
</tr>
</tbody>
</table>

Equipment inline with any other authoritative / internationally recognized standards such as IEC, British, USA and German etc. shall also be considered if it ensures performance equivalent or superior to Indian Standards. Prior approval shall be obtained from Consultant for use of this equipment / material. In such cases the decision of Consultant shall be final and binding.

**QUALITY ASSURANCE**

Manufacturers regularly engaged in manufacture of panel boards and enclosures, of types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installation shall be carried out by a firm with at least 5 years of successful
installation experience on projects with electrical installation work similar to that required for project.

2.1.7 **GUARANTEE**
Manufacturer shall provide guarantee for work under this section. However, such guarantee shall be in addition to and not in lieu of all other liabilities which manufacturer and Contractor may have by other provisions of the contract document.

The Panel Boards shall be guaranteed against trouble free operation, defective workmanship, materials and design for a period of 18 months from the date of supply or 12 months from the date of erection and commissioning, whichever is earlier. Any defects during this period shall be rectified free of cost.

2.1.8 **SUBMITTALS**
2.1.8.1 Contractor to submit general arrangement diagrams with front, side, top and bottom view and inside view.

2.1.8.2 General arrangement diagrams shall include outline and dimensions, voltage, main bus capacity, circuit breaker details and their arrangement / sizes.

2.1.8.3 All drawings shall also indicate location / description of all operating / indicating components mounted on the front / rear of the panel for all feeders / starters.

2.1.8.4 Typical control schematic diagram for each type giving designation to be refereed on Single Line Diagram.

2.1.8.5 Terminal block details for all feeders / starters power and control terminals provided for external as well as internal wiring connections.

2.1.8.6 Panel board foundations with necessary dimensions.

2.1.8.7 Details of shipping sections along with all dimensions.

2.1.8.8 Bill of material giving make / rating / catalogue number of all components of the complete switch board.

2.1.9 **DELIVERY**
All panels shall be carefully packed to avoid damage during transit. Panel boards shall be wrapped in polyethylene sheets for local shipment, whereas for outstation delivery in addition to polyethylene sheet the panels shall be packed in wooden crates to prevent damage to the finish.
LIST OF BUREAU OF INDIAN STANDARDS CODES

<table>
<thead>
<tr>
<th>IS</th>
<th>Code Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS : 1239 (Part - I) - 1979</td>
<td>Mild steel tube</td>
<td></td>
</tr>
<tr>
<td>IS : 1239 (Part - II) - 1982</td>
<td>Mild steel Tubulars and other Wrought steel pipe fittings</td>
<td></td>
</tr>
<tr>
<td>IS : 4736 - 1968</td>
<td>Hot-dip zinc coatings on steel tubes</td>
<td></td>
</tr>
<tr>
<td>IS : 823 - 1964</td>
<td>Code of procedure for manual metal arc welding of mild steel</td>
<td></td>
</tr>
<tr>
<td>IS : 780 - 1980</td>
<td>Sluice valves for water works purposes</td>
<td></td>
</tr>
<tr>
<td>IS : 778 - 1980</td>
<td>Copper alloy gate, lobe and checks Valves for water works purposes</td>
<td></td>
</tr>
<tr>
<td>IS : 1536 - 1976</td>
<td>Flanges configuration</td>
<td></td>
</tr>
<tr>
<td>IS : 5312 (Part-I) - 1984</td>
<td>Swing - check type reflux Non Return valves for water works</td>
<td></td>
</tr>
<tr>
<td>IS : 2379 - 1963</td>
<td>Colour code for the identification of pipelines</td>
<td></td>
</tr>
<tr>
<td>IS : 554 - 1975</td>
<td>Dimensions for pipe threads where pressure tight joints are required on the threads.</td>
<td></td>
</tr>
<tr>
<td>IS : 655 - 1963</td>
<td>Metal air ducts</td>
<td></td>
</tr>
<tr>
<td>IS : 4064 - (Part -II) - 1978</td>
<td>Specific requirements for the direct switching of individual motors.</td>
<td></td>
</tr>
<tr>
<td>IS : 3854-1969</td>
<td>Switches for domestic &amp; similar Purpose</td>
<td></td>
</tr>
<tr>
<td>IS : 694-1977</td>
<td>PVC insulated (HD) electric cables For working voltage upto and Including 1100 Volts.</td>
<td></td>
</tr>
<tr>
<td>IS : 9224 (Part II) - 1979</td>
<td>HRC cartridge fuse links upto 650 volts.</td>
<td></td>
</tr>
<tr>
<td>IS : 8544 (Part-I to IV)-1979</td>
<td>Starters</td>
<td></td>
</tr>
<tr>
<td>IS : 732 (Part-III)-1982</td>
<td>Inspection and testing of</td>
<td></td>
</tr>
</tbody>
</table>
### Intent of Specifications

In case of any revision in above BIS code, the REVISED one shall only be applicable.

<table>
<thead>
<tr>
<th>IS</th>
<th>Standard Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS :</td>
<td>659-1964</td>
<td>Air Conditioning (Safety Code)</td>
</tr>
<tr>
<td>IS :</td>
<td>660-1963</td>
<td>Mechanical Refrigeration (Safety Code)</td>
</tr>
<tr>
<td>IS :</td>
<td>3103-1975</td>
<td>Code of practice for Industrial Ventilation</td>
</tr>
<tr>
<td>IS :</td>
<td>7240-1981</td>
<td>Application &amp; Finishing of thermal insulation material</td>
</tr>
</tbody>
</table>
PREAMBLE TO MODE OF MEASUREMENT

IS 655 / SMACNA (AS ASKED FOR IN THE BOQ) SHALL BE ADOPTED FOR THE CONSTRUCTION PROCEDURES/ SPECIFICATIONS IN DUE ESSENCE OF THESE GUIDELINES ALSO.

3.1 All equipment described hereafter, shall be in accordance with the specifications.

3.2 All equipment shall be selected and installed for the lowest Operating noise level.

3.3 Supply of various equipment shall include all expenses for correspondence with manufacturers, submission of shop drawings, documents and their approval by the Consulting Engineer, procurement of equipment, transportation, shipping, payment of all taxes and levies, storage, supply of equipment at the point of installation, furnishing all technical literature required, replacement of defective components, and warranty obligations for the individual equipment.

3.4 Installation of various equipment shall include all material and labor associated with hoisting and lowering of equipment in position, insulation of the components and vibration isolation as required, grouting and anchoring or suspension arrangements and all incidentals associated with the installation as per the specifications and manufacturer's recommendation.

3.5 Vibration isolators as specified or as recommended by the manufacturer shall be installed with each component. Performance ratings, power consumption and power data for each component shall be verified at the time of testing and commissioning of the installation, against the data submitted with the tenders.

3.6 Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

3.7 Testing and commissioning shall include furnishing all labour, materials, equipments, instruments, and incidentals necessary for complete testing of each component as per the specifications and manufacturer's recommendations, submission of test results to the Consulting Engineer and obtaining their approval and submission of necessary documents and completion drawings.

3.8 All ducts shall be fabricated and installed conforming to the relevant Indian standards, approved shop drawings and the specifications.

3.9 Duct installation shall include fabricating and installing the ducts, splitter dampers, turning vanes, and distribution grids within the ducts in position, and providing, installing and making air tight all joints with slips, bonded felt insertions, nuts, bolts.
and screws as required. In addition multi-louvered manually adjustable dampers shall be provided in various branch ducts as required or shown on drawings for proper balancing of air flows.

3.10 All registers and diffusers shall be provided with a soft continuous rubber gaskets between their periphery and the surface on which these have to be mounted.

3.11 Registers and diffusers shall be given, at the factory, a rust resistant primer coat and enamel paint finish of approved color.

3.12 After completion of the installation, the entire air distribution system shall be tested for air leaks and balanced in accordance with the specifications.

3.13 **Mode of Measurement**

The mode of measurement for the various item, unless otherwise specified, shall be as follows:

3.13.1 **Ducting**

3.13.1.1 Payment for ducting shall be made on the basis of the external surface area of the ducting including all material and labor for installed duct.

3.13.1.2 The rates per sq. ft. of the external surface shall include flanges, gaskets for joints, bolts and nuts, duct supports and hangers, vibration isolation pads or suspenders, flexible connection, inspection doors, dampers, turning vanes, and any other item which will be required to complete the duct installation except external insulation and acoustic lining.

3.13.1.3 The external area shall be calculated by measuring the overall width and depth (including the corner joints) in the center of the duct section and overall length of each duct section from flange face in case of duct lengths with uniform cross section. Total area will be arrived at by adding up the areas of all duct sections.

3.13.1.4 In case of taper pieces average width and depth will be worked out as follows;

\[ W_1 = \text{Width of small cross section} \]
\[ W_2 = \text{Width of large cross section} \]
\[ D_1 = \text{Depth of small cross section} \]
\[ D_2 = \text{Depth of large cross section} \]

\[ \text{Average width} = \frac{W_1 + W_2}{2} \]
\[ \text{Average Depth} = \frac{D_1 + D_2}{2} \]

3.13.1.5 Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct sections fitted with angle iron flanges, otherwise at the bottom of the flange where flanges are of duct sheet.

3.13.1.6 For the circular pieces the diameter of the section mid-way between large and small diameters shall be measured and adopted as the mean diameter for calculating the surface at the taper piece.
3.13.1.7 For the face length of taper piece shall be the mean of the lengths measured face to face from the centre of the width and depth flanges.

3.13.1.8 Duct measurements for calculation of area shall be taken before application of insulation.

3.13.1.9 For the special pieces like bends, branches, and tees etc. same principle of area measurement as for linear lengths shall be adopted except for bends and elbows, the length of which shall be the average of the lengths of inner and outer periphery along with curvature or angle of the piece.

3.13.2 **Duct Insulation**
This item is provided separately for various thickness and shall be paid for on area basis of un–insulated duct. The area of the duct to be insulated shall be measured before application of insulation.

3.13.3 **Un–insulated Piping**
Payment for un–insulated piping shall be made on the basis of linear measurement including all materials and labor for installed pipe. The linear rate per meter / feet for each nominal diameter shall include all pipe fittings, flanges, unions, nominal diameter shall include all pipe fittings, flanges, unions, gaskets for joints, bolts and nuts, pipe supports and hangers, vibration isolation devices or suspenders flexible connections and any other item required to complete the pipe installation except valves of any kind and strainers. The length of the pipe section with flanges shall be from flange face to flange face.

For fitting like bends, elbows, branches and tees, etc. Same principle of linear measurement as for pipe sections shall be adopted except for bends, the length of which shall be the average of the lengths of inner and outer periphery along the curvature.

3.13.4 **Valves / Strainer**
Payment will be made on unit basis.

All quantities indicated in this schedule are for Contractor's guidance only.
TECHNICA DATA

(TO BE FURNISHED BY BIDDER IN METRIC SYSTEM ONLY)

Please mention the make and country of origin of all the equipments.

1. AIRCOOLED DUCTABLE UNITS
   a) Nominal capacity TR :

   b) Actual Capacity of split type air
      Cooled ductable split unit at
      Operating conditions of air entering
      at 32.2 DEG.C :

   c) Type of compressor :

   d) Make/model of compressor :

   e) Number of compressors/ unit :

   f) Nominal air quantity CMH :

   g) HP of blower motor :

   h) Make of motor :

   i) External static Pressure of Indoor
      Units in MM :

   j) Noise level of Indoor unit at 1mt away
      From unit in DB :

   i) Is programmable micro processor :
      Panel Included or not. :

2. COOLING COIL
   a) Face area of cooling coil SMT :

   b) Fins/cm :

   c) No. of rows deep :

   d) HP of blower motor :

3. CONDENSOR COIL OUTDOOR UNIT.

HVAC Consultant: AD CONSULTANTS
a) Face area SMT :
b) No. of fins/cm.
c) Heat rejection kcal/hr :
d) Capacity of each fan CMH
e) Fan HP.
f) Total air quantity discharged/unit CMH
g) Noise level of outdoor unit at 1mt away from unit in DB :
h) Number of fans per outdoor unit
i) Type of Fan
j) RPM of Fan :
k) Type and make of motor

4. Unit dimensions
a) Out door unit in mm LxWxH :
b) Indoor unit in mm LxWxH

5. Air filters no. and size
a) Electric supply, voltage and Frequency
b) Permissible voltage & frequency Variations :

6. Bare Weight Kgs. :
a) Outdoor unit
b) Indoor unit
7. Actual Capacity & IKW/ TR at Operating conditions
2. CONTROLS

**Makes**

a) Three way Mixing Valve  
   With Actuator (Part of BMS work) :

b) Pressure gauge :

c) Thermometers :

3. PIPES

a) Make :

b) Class :

4. VALVES

Make

a) Check Valve :

b) Butterfly Valve :

b) Balancing Valve :

d) Y-Strainer :

4.1 Material/Gauge/Perforation of basket & Make

i) Pot Strainer :

ii) Suction strainer :

5. GRILLS/DIFFUSERS/DAMPERS

Please indicate make/material/gauge of the following:

<table>
<thead>
<tr>
<th>Make</th>
<th>Material</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

a) Duct Dampers :

b) Grills/Diffusers :

c) Fire Dampers :

d) Smoke & Temperature Sensor :

6. DUCT INSULATION

a) Manufacturers Name :

b) Material :

c) Density Kg. Per Cmt :

d) Thermal Conductivity Kcal/Hr.Deg.C :

HVAC Consultant: AD CONSULTANTS
7 DUCT LINING

a) Manufacturers Name : 

b) Material : 

c) Density Kg. Per Cmt : 

d) Thermal Conductivity Kcal/Hr.Deg.C : 

8 PIPE INSULATION

a) Manufacturers Name : 

b) Material : 

c) Density Kg. Per Cmt : 

d) Thermal Conductivity Kcal/Hr.Deg.C : 

9 ELECTRICAL ACCESSORIES

a) Panel Manufacturer’s name

10 DOUBLE SKINNED AIR-HANDLING UNITS

<table>
<thead>
<tr>
<th>TAG NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
</tr>
<tr>
<td>a) Make of AHU</td>
</tr>
<tr>
<td>b) Capacity CMH</td>
</tr>
</tbody>
</table>
| c) Material/Gauge Casing  
  Drain Pan |
| d) Over all size (LxBxH) mt |
| e) Type of AHU, vertical/  
  horizontal/Ceiling suspended |
| f) Over all weight in Kg. |

| B. COOLING COIL |
| a) Make |
| b) Material of Tube/Fins |
| c) No. of Fins/cm |
| d) No. of Rows deep |
| e) Dia of Tubes (mm) |
| f) Face Area (SMT) |
| g) Cooling Capacity (Kcal/hr.) |
| h) Chilled Water Flow Rates LPM |
| i) Face Velocity MPS |
| j) Test Pressure Kgs./Sq.cm |

| C. FILTER SECTION |
| a) Make |
| b) Type of Filters |
### TAG NO.

<table>
<thead>
<tr>
<th>TAG NO.</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>c)</td>
<td>No. of Filters</td>
</tr>
<tr>
<td>d)</td>
<td>Size of Filters</td>
</tr>
<tr>
<td>e)</td>
<td>Air Velocity through Filter EPM</td>
</tr>
<tr>
<td>f)</td>
<td>Efficiency of Filter %</td>
</tr>
</tbody>
</table>

### D. FAN & FAN MOTOR

| a)      | Make of Fans & Motor |
| b)      | Type of Fan |
| c)      | No. of Fan |
| d)      | Width and dia of fans (mm) |
| e)      | Type of Blade |
| f)      | Air Quantity CMH |
| g)      | Static Pressure in wg |
| h)      | Fan Discharge Velocity |
| i)      | Type of Balancing |
| j)      | Brake Horse Power in HP |
| k)      | Hose Power of Motor in HP |
| l)      | Motor RPM |
| m)      | Fan Speed |
| n)      | Type of Drive Ball  
  Driven/Direct Driven |
### 11. TYPE OF WATER PUMP

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Pump Water Flow LPM</td>
<td>:</td>
</tr>
<tr>
<td>b) Pump Head M</td>
<td>:</td>
</tr>
<tr>
<td>c) Pump RPM</td>
<td>:</td>
</tr>
<tr>
<td>d) Motor Rating KW</td>
<td>:</td>
</tr>
<tr>
<td>e) Pump RPM</td>
<td>:</td>
</tr>
</tbody>
</table>

### 12. AXIAL FANS / SISW FANS / INLINE FANS

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Make</td>
<td>:</td>
</tr>
<tr>
<td>b) Model</td>
<td>:</td>
</tr>
<tr>
<td>c) Type</td>
<td>:</td>
</tr>
<tr>
<td>d) Air Flow</td>
<td>:</td>
</tr>
<tr>
<td>e) Static Pressure</td>
<td>:</td>
</tr>
<tr>
<td>f) BHP</td>
<td>:</td>
</tr>
<tr>
<td>g) Motor KW</td>
<td>:</td>
</tr>
<tr>
<td>h) Speed RPM</td>
<td>:</td>
</tr>
<tr>
<td>i) Noise Level dBA</td>
<td>:</td>
</tr>
<tr>
<td>j) Performance Curve</td>
<td>:</td>
</tr>
<tr>
<td>k) Fan blade Adjustable</td>
<td>:</td>
</tr>
<tr>
<td>l) Motor Non Overloading</td>
<td>:</td>
</tr>
<tr>
<td>m) Local disconnect switch</td>
<td>:</td>
</tr>
<tr>
<td>n) Material of blade</td>
<td>:</td>
</tr>
<tr>
<td>o) Material of casing</td>
<td>:</td>
</tr>
<tr>
<td>p) Type of Starter</td>
<td>:</td>
</tr>
</tbody>
</table>
# INDEX

<table>
<thead>
<tr>
<th>S. No.</th>
<th>DESCRIPTION</th>
<th>PAGE No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>General Specifications</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Special Conditions of Contract</td>
<td>2-4</td>
</tr>
<tr>
<td>2.</td>
<td>General Description</td>
<td>5-6</td>
</tr>
<tr>
<td></td>
<td><strong>Technical Specifications</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Wiring</td>
<td>7-26</td>
</tr>
<tr>
<td>2.</td>
<td>MCB Distribution Boards</td>
<td>27-28</td>
</tr>
<tr>
<td>3.</td>
<td>Luminaires and Lamps</td>
<td>29-31</td>
</tr>
<tr>
<td>4.</td>
<td>Earthing</td>
<td>32-37</td>
</tr>
<tr>
<td>5.</td>
<td>Lightning Arrestor</td>
<td>38-44</td>
</tr>
<tr>
<td>6.</td>
<td>Telephone and Computer System Wiring &amp; Conduiting</td>
<td>45-52</td>
</tr>
<tr>
<td>7.</td>
<td>LT Power Distribution Cables</td>
<td>53-60</td>
</tr>
<tr>
<td>8.</td>
<td>Inspection and Testing</td>
<td>61-63</td>
</tr>
<tr>
<td>9.</td>
<td>Drawings and Documents by Contractor</td>
<td>64-66</td>
</tr>
<tr>
<td>10.</td>
<td>Safety Requirements</td>
<td>67</td>
</tr>
</tbody>
</table>
GENERAL SPECIFICATIONS

1.0 SPECIAL CONDITIONS OF CONTRACT:

1.1 Contract:

1.1.1 These Special Conditions shall be considered as an extension and not as limitation of the obligations of the Contractor.

1.1.2 The said contract comprises furnishing of all labor, materials, equipment and transportation and to do all things necessary to provide a complete installation in full working order including all that is reasonably inferred as necessary to the proposed construction, completion and putting in operation of a system of the type and extent described in the drawings and specifications, including any necessary adjustment or correction. The work shall be complete in every respect, including painting. All necessary precautions shall be taken against damage from leakage and condensation. The installation shall be tested and approved, satisfactory to the Engineer-in-Charge and in accordance with local laws covering the installation of the type and extent described in the drawings and specifications.

1.1.3 The contractor shall provide without any extra charge all items whether specifically mentioned or not but which are usual or required to make a complete working plant and to ensure safe and satisfactory operation. All apparatus, appliance, materials or labor which may be necessary to complete the work in accordance with the intent or purposes of these specifications shall be considered to be in the scope of work and shall be furnished without extra charges, as if fully described and called for in these specifications and/or shown on plans. In case of doubt, the Tenderer shall clearly point out his interpretation of specifications and drawings.

1.1.4 The Contractors shall include in their tender, sales tax, octroi or any other charges or fees leviable by the local authority and it shall be assumed that the Contractor’s rates cover all such taxes and no separate claim for these shall be entertained.

1.1.5 Time shall be considered as the essence of the Contract. The Contractor shall agree to commence and complete the work as provided in the Time schedule for procurement and installation in the conditions of the contract.

1.2 Drawings and Literature:

1.2.1 Before proceeding with the work, the Contractor shall submit for approval, general layout and assembly drawings and such additional assembly and sub-assembly detailed drawings as necessary to demonstrate fully that all parts of the apparatus to be furnished will conform to the Specifications.

1.2.2 The Contractor shall furnish for check and scrutiny three (3) advance sets of prints of the layout, assembly and erection drawings as per the Bar Chart prepared by Contractor and approved by Engineer-in-Charge. Six (6) final sets of drawings incorporating the modifications suggested in advance copies by Engineer-in-Charge shall be made in the drawings after they have been approved by the Engineer-in-Charge without his prior consent.

1.2.3 All drawings necessary for assembly, erection, maintenance, repair
and operation of the equipment shall be furnished. Different parts shall be suitably numbered for identification and ordering of spare parts.

1.2.4 Approval of drawings by the Engineer-in-Charge shall not relieve the Contractor of any part of his obligation to meet all the requirements of the contract or of the correctness of his drawings. The Contractor shall be responsible for and pay for all alterations of the works due to discrepancies or omissions in the drawings or other particulars supplied by him whether such drawings have been approved by the Engineer-in-Charge or not.

1.2.5 After approval of the drawings, the Contractor shall furnish a set of tracings of the approved drawings.

1.2.6 Six copies of a comprehensive manual for use by the Owner/Engineer-in-Charge before and during erection and subsequent operation and maintenance of the plant shall also be furnished after approval of the Contract drawings.

1.2.7 Drawings have been prepared by the Consultant showing the area allocated for equipment’s. The machine room and equipment layout as shown on the drawings represent a feasible scheme. Apparatus may be re-arranged in the space allocated subject to approval of the Engineer-in-Charge.

1.2.8 These drawings are not meant as working Drawings. The Contractor shall prepare working drawings and get them approved by the Engineer-in-Charge in sets as specified above.

1.2.9 The Tenderer shall point out all deviations from the drawings and specifications in their Tenders.

1.2.10 Drawings are made on the basis of Indian make equipment/material. The Contractor shall ensure that imported equipment / material shall fit in the space provided in the layout.

1.3 **Guarantee:**

1.3.1 The Contractor shall guarantee that all equipments shall be free from any defect due to defective materials and/or bad workmanship and that the equipment shall operate satisfactorily. The performance and efficiencies of the equipment, individually and as a whole shall be valid for a period of twelve (12) months after taking over and issue of certificate of virtual completion. Any parts found defective shall be replaced free of all costs by the Contractor. This period shall be known as the Defects Liability Period and shall be reckoned from the date the Engineer-in-Charge certifies the virtual completion of the installation. The services of the Contractor's personnel if requisitioned during this period of rectification of any defect shall be made available free of any cost to the Engineer-in-Charge.

1.3.2 If the defects be not remedied within a reasonable time the Engineer-in-Charge may proceed to do so at the contractor's risk and expense without prejudice to any other right.

1.3.3 The Contractor shall guarantee the installation as specified in the Specifications and the drawings.

1.3.4 The Contractor shall also guarantee that the performance of various equipments, individually, shall not be less than the specified ratings when working under the operating conditions given for the respective items.
1.4 **Maintenance & Training:**

1.4.1 The Contractor shall without any extra cost carry out for a period of 12 (Twelve) months after the installation is taken over by the Owner all routine and special maintenance of the plant and attend to any difficulties and defects that may arise in the operation of the plant.

1.4.2 The Contractor shall associate with him during the erection and during the defects liability period, the Owner’s maintenance staff to familiarize them with the operation and maintenance of the plant.

1.4.3 If required by the Engineer-in-Charge the contractor shall agree to train members of the Owner’s maintenance staff either at his or the sub-contractor’s work or at such other place or places as may be considered suitable by the Engineer-in-Charge.

1.5 **Rejection of Defective Plant:**

1.5.1 If the completed plant or any portion thereof, before it is taken over, or during the defects liability period, be found defective, or fails to fulfill the intent of these specifications, the Contractor shall on receipt of notice from the Engineer-in-Charge forthwith make defective plant good. Should he fail to do so within a time considered reasonable by the Engineer-in-Charge, the Owner may reject and replace at the risk and expense of the Contractor the whole or any portion of the plant, which is defective or fails to fulfill the requirements of the Contract.

1.5.2 The Owner shall have the right to operate all equipments if in operating condition, whether or not such equipments have been accepted as complete and satisfactory. Repairs and alterations shall be made at such times-directed by the Engineer-in-Charge.

1.6 **Inspection and Testing:**

1.6.1 The Engineer-in-Charge or his authorized representative shall have full power to inspect the materials and workmanship of the plant at the Contractor's works or at any place from which the material or equipment is obtained. Acceptance of any material or equipment shall in no way relieve the Contractor of his responsibility for meeting the requirements of the specifications.

1.6.2 Routine and type tests for the various items of equipment shall be performed at the Contractor's works and tests certificate furnished. If required by the Engineer-in-Charge, the Contractor shall permit the Owner's authorized representative to be present during any of the tests. After installation has been virtually completed, the Contractor shall carry out under the direction and in the presence of the Engineer-in-Charge such tests and inspection as have been specified, or as the Engineer-in-Charge shall consider necessary to determine whether or not the full intent of the requirements of the plans and specifications have been fulfilled. In case the work does not meet the full intent of the specifications and further tests are considered necessary, the Contractor shall carry them out and bear the expenses thereof.
2.0 **GENERAL DESCRIPTION:**

2.1 **Scope:**

2.1.1 These specifications together with the Engineer’s plans cover the Electrical System works for Internal Electrical Works.

2.2 **Extent of Work**

2.2.1 Supply, laying, testing and commissioning of under mentioned items shall form a part of contractor’s scope of work.

a) Wiring for Internal Distribution.
b) Lighting fixtures.
c) Complete Power Wiring to socket Outlets, Power equipments etc.
d) Cables and Cable Laying.
e) Distribution Boards and Sub-panels for Inverter System.
f) Fire Alarm System Works
g) UPS System
h) Earthing

2.2.2 This specification states the requirements for the supplying, assembling, fixing in position, connecting, inspecting, testing and leaving in working order new, modified or additional electrical installations.

2.2.3 The work shall comprise the whole of labour and unless otherwise indicated all the materials necessary to form a “complete installation’ and such tests, adjustments and commissioning as are prescribed in subsequent clauses and as may otherwise be required to give an effective working installation to satisfaction of the Engineer-in-Charge.

2.2.4 The words “complete installation“ shall mean not only the items of electrical equipment conveyed by these specifications, but all the incidental sundry components necessary for the complete execution of works and for proper operation of the installation, whether or not these sundry components are mentioned in detail in tender documents issued in connection with the contract.

2.2.5 Adequate protection of equipment during transit shall be provided by manufacturers and the contractor shall ensure adequate protection on site. The contractor shall advise the Engineer-in-Charge of any damage that occurs to equipment including finishes and shall carry out repairs as directed by the Engineer-in-Charge.

2.3 **Drawings:**

2.3.1 Drawings have been prepared by the consultants, for all the above items of work. The tenderer shall submit his quotation strictly in accordance with these specifications and drawings.

2.3.2 Drawings and documents shall be provided by the consultant. The rearrangement of the equipments shall be done by the Contractor with the approval of Engineer-in-Charge if necessary. The shop drawings shall be prepared by the Contractor in accordance with section “DRAWINGS AND DOCUMENTS BY CONTRACTOR” and got them approved by the consultant or Engineer-in-Charge.
2.4 **Regulations:**

2.4.1 Each installation shall comply with all the relevant statutory requirements and regulations including the following:

- a) Regulations under the Electricity Acts:
- b) Factories Acts and Regulations:
- c) Health and Safety at work etc. Act and regulations:
- d) Regulations for Electrical Installations” issued by the Institution of Electrical Engineers including all the appendices contained therein and referred to herein as the “IEE Wiring Regulations”
- e) Regulations and requirements of Indian Telecom and the local electricity, gas and water Undertakings.

2.5 **Standards:**

2.5.1 The complete installation shall comply with all relevant Indian Standards, Indian Codes of Practice, where indicated, with other Standards and specifications and all amendments thereto. The relevant issues shall be those current three months before the date for return of tender, unless alternative dates are indicated.

2.5.2 Where practicable, each item of equipment shall be clearly and indelibly marked to indicate the standard with which it complies. Alternatively, a certificate of compliance shall be provided.

2.5.3 Where equipment or services are indicated to be manufactured or provided under a particular certification, licensing or quality assurance scheme, the manufacturer or supplier shall be a current participant in the relevant scheme. A certificate of compliance shall be provided.

2.5.4 Equipment not manufactured in the India shall be of a standard, which ensures its compliance with all appropriate IS Standards.

2.6 **Approval:**

2.6.1 The Engineer-in-Charge’s approval shall not relieve the contractor of his contractual responsibilities and obligations. The contractor shall be responsible for discrepancies, errors or omissions on drawings or other documentation supplied by him, whether they have been approved by the Engineer-in-Charge or not due to incorrect information given in writing by the Engineer-in-Charge. The Contractor shall be responsible for ensuring that equipment complies with the specified requirements.
GENERAL SPECIFICATIONS

1.0 WIRING:

1.1 Scope:

1.1.1 The scope of this section covers the supply, erection, testing and commissioning of conduits & wiring for lighting and power. Wiring shall be carried out in accordance with relevant I.S. rules and regulations.

1.2 System of wiring:

1.2.1 All lights and power wiring shall be carried out in surface conduits or recess wiring in conduits or floor ducts as specified in the BOQ.

1.2.2 I.E.E. regulations shall be applicable for all material and workmanship.

1.2.3 The wiring to be carried out in such a manner that specified 'Power' wiring shall be kept separate and distinct from 'Lighting' wiring. The wiring shall be done on the distribution system with main and branch distribution boards at convenient physical and electrical centers as shown in drawings. All conductors shall be run as far as possible along the walls and ceiling and above false ceiling so as it can be easily accessible and capable of being thoroughly inspected. In all types of wiring, due consideration shall be given for neatness and good appearance.

1.2.4 The balancing of load in three wire or poly phases installations shall be arranged beforehand to the satisfaction of Engineer-in-charge. Circuits on opposite side of a three-wire system or on different phase of poly phase system shall be kept apart at a minimum distance of 2m (6.6 ft.) unless they are enclosed in earthed metal casing suitably marked to indicate the risk of dangerous shock due to voltage between the conductors contained in them. In large or important areas, light and socket outlet points shall be distributed over more than one circuit as directed.

1.2.5 Medium pressure wiring and associated apparatus shall comply in all respects with the requirements of IEE rules.

1.2.6 No wiring shall be carried out until the appropriate tests required in Section "Inspection and Testing" have been done and the Engineer-in-Charge has given his clearance for wiring to commence.

1.2.7 At expansion joints, adequate slack shall be left in the cables.

1.2.8 Where conduits are installed for wiring by others, a draw wire shall be provided between each draw-in position.

1.2.9 Cables forming part of communication circuits shall have identification sleeves at their terminations. Identification shall be consistent with the relevant wiring diagrams.

1.3 Joints & Looping Back:

1.3.1 The wiring shall be done in a 'looping System'. Phase or live conductors shall be looped at the switch box and neutral/earth conductor can be looped either from the light, fan or socket outlet.
1.3.2 No bare or twist joints shall be made at intermediate points in the through run of cables, unless the length of final sub circuit or sub-main or main is more than the length of the standard coil given by the manufacturer of the cable.

1.3.3 Termination of multistrand conductors shall be done using suitable crimping type thimbles.

1.4 **Rigid Steel Conduits and Conduit Accessories**

1.4.1 All rigid conduit pipes shall be of steel and be ISI marked. The wall thickness shall be not less than 1.6mm (16 SWG) for conduits up to 32 mm dia and not less than 2mm (14 SWG) for conduits above 32 mm dia. These shall be solid drawn or reamed by welding, and finished with galvanized or stove enameled surface.

1.4.2 The maximum number of PVC insulated cables conforming to IS : 694-1990 that can be drawn in one conduit is given size wise in Table-I and the number of cables per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run. No steel conduit less than 20mm in diameter shall be used.

1.4.3 The conduit wiring system shall be complete in all respects including their accessories.

1.4.4 All conduit accessories shall be of threaded type, and under no circumstances pin grip type or clamp grip type accessories shall be used. Bends, couplers etc. shall be solid type in recessed type of works and may be solid or inspection type as required, in surface type of works. Saddles for surface conduit work on wall shall not be less than 0.55 mm (24 guage) for conduits upto 25 mm dia and not less than 0.9 mm (20 guage) for larger diameter (as per Table-II). The corresponding widths shall be 19 mm & 25mm.

1.4.5 Unless otherwise indicated, protection against corrosion of conduits and conduit fittings for general use inside buildings shall be of Class 2.

1.4.6 Adaptable and circular conduit boxes with their covers shall provide a minimum degree of protection of IP41 when used inside building and IP44 when used outside buildings or at other locations as indicated.

1.4.7 When conduit boxes are installed flush with the building fabric, overlapping covers shall be fitted.

1.4.8 Flexible steel conduit for general use inside buildings shall be of type A with protection against corrosion equivalent to Class 2. Adaptors shall be of solid type.

1.4.9 Unless otherwise indicated, accessory boxes used with steel conduit shall be made of metal.

1.4.10 Accessory boxes shall be suitable for flush or surface mounting, as indicated. Unless otherwise indicated, metal boxes for general use inside buildings shall be of steel of medium category against corrosion.

1.4.11 Accessory boxes shall be of adequate depth to accommodate the accessories without causing compression of the cables. Generally, boxes shall be 75 mm deep, but for lighting switches installed flush in plaster finish with multi-cored sheathed cables, 65 mm depth boxes may be used.
1.4.12 Earthing terminals shall be fixed inside each accessory box and on the grids of grid switches. The earthing terminal of each grid shall be connected by a separate protective conductor to the earthing terminal of the box.

1.4.13 Front plates of accessories shall be of material and finish as indicated, but generally finish of various types of accessories in the same area shall match. For flush mounting, plates shall overlap the boxes. For surface mounting, plate shall match the profile of box, without overlap.

1.4.14 Where pilot lamps are required, they shall comprise a neon lamp with resistor and a red colored lens, unless otherwise indicated.

1.4.15 Accessories with their boxes and front plates shall provide a minimum degree of protection of IP41 when used inside buildings and IP54 when used outside buildings or at other locations where indicated.

1.4.16 Accessory boxes shall be fixed to the fabric of building, independent of connecting cables or conduits. Where the accessories have a minimum degree of protection of IP54, the fixings shall not reduce that protection.

1.5 Installation: Common for Recessed and Surface Conduit work

1.5.1 Conduit Joints

a) The conduit work of each circuit or section shall be completed before the cables are drawn in.

b) Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Threads on conduit pipes in all cases shall be between 13mm to 19mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.

c) Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.

d) The Engineer-in-charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc. after they have been prepared shall be submitted for inspection before being fixed.

e) No bare threaded portion of conduit pipe shall be allowed unless such bare threaded portion is treated with anti-corrosive preservative or covered with approved plastic compound.

1.5.2 Bends in Conduits

a) All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 cm, or alternatively, by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast iron inspection boxes, whichever is most suitable.

b) No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

c) Conduit fittings shall be avoided as far as possible on conduit system exposed to weather. Where necessary, solid type fittings shall be used.
1.5.3 Other Requirements

a) If the protective finish of any material has been damaged, those materials shall either not be used or any remedial work shall be approved by the Engineer-in-Charge before use. Conduits shall be clean and free from oil.

b) Steel Conduits shall be connected by means of a coupler and an externally screwed bush. Bushes shall be tightened by using spanners. Pliers and toothed wrenches shall not be used.

c) Where a terminal block is to be accommodated in a circular conduit box, an extension ring shall be fitted to the box, of sufficient depth to ensure adequate space for the terminal block and cables.

d) The length of thread on the ends of steel conduits shall match that in the conduit fittings or equipment and exposed threads will not be permitted. Running couplings with backnuts may be used with conduit having Class 2 protection, but where the protection is Class 4 only, manufactured running joints will be accepted. Exposed thread on running couplings shall be given a coat of zinc paint.

e) Conduit shall be cold bent on site with a suitable bending tool and sand filling, without deforming its cross section.

f) Draw in Conduit boxes shall be incorporated at intervals not exceeding the following:

<table>
<thead>
<tr>
<th>Description</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight run</td>
<td>10 m;</td>
</tr>
<tr>
<td>Run with one or two bends</td>
<td>10 m;</td>
</tr>
<tr>
<td>Run with three bends</td>
<td>5 m;</td>
</tr>
<tr>
<td>Run with four bends</td>
<td>5 m;</td>
</tr>
</tbody>
</table>

g) Unless otherwise indicated, conduit buried in concrete shall have at least 30mm depth of cover; it shall be securely fixed to prevent movement during pouring and vibrating of the concrete. Conduit in plaster shall have at least 5 mm depth of cover.

h) Where conduits cross expansion and settlement joints occur in the building structure, suitable provision shall be made to allow for movement of the structure. The Contractor shall submit his proposals for the approval of Engineer-in-Charge.

i) Where conduit passes through an external wall, a conduit box shall be fitted on the inside of the wall and after wiring, filled with an inert permanently plastic compound having a high insulation value.

j) Conduit shall be installed in screeds only where indicated or after receipt of the Engineer-in-Charge's approval. Conduit boxes in floors, other than for agreed outlets will not be permitted.

k) Open ends of conduit shall be temporarily plugged immediately after installation to prevent ingress of water and solid materials.

l) Method to be used for forming fire barriers at fire resistant structural elements such as floors and walls shall be submitted for
the Engineer-in-Charge's approval.

m) Installed conduits shall be cleaned internally with a swab before cables are drawn-in.

n) If the protective finish of conduit is damaged after fixing, the damage shall be made good in a manner approved by Engineer-in-Charge.

1.6 Installation-Additional requirements for Surface Conduit work

1.6.1 Painting before erection

a) The outer surface of conduit including all bends, unions, tees, junction boxes, etc. forming part of the conduit system, shall be adequately protected against rust when such system is exposed to weather, by being painted with 2 coats of red oxide paint applied before they are fixed.

1.6.2 Fixing conduit on surface

a) Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one metre, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30 cm from the center of such fittings. The minimum width and thickness of the ordinary clips or the girder clips for different sizes of conduits shall be as given in Table-II.

b) Where conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles clips or clamps as required by the Engineer in charge.

c) In long distance straight run of conduit, inspection type couplers at reasonable intervals shall be provided, or running threads with couplers and jam nuts shall be provided.

1.7 Installation-Additional requirements for Recessed Conduit work

1.7.1 Making Chase

a) The Chase in the wall shall be neatly made, and of ample dimensions to permit the conduit to be fixed in the manner desired.

b) In the case of buildings under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

c) 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.

1.7.2 Fixing Conduits in Chase

a) The conduit pipe shall be fixed by means of stipples, j-hooks, or
by means of saddles, not more than 60 cm apart, or by any other approved means of fixing.

b) All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against rust.

1.7.3 Fixing Conduit in RCC work

a) The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent taming of the same.

b) Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius which will permit easy drawing in of conductors.

c) Location of inspection/junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

1.7.4 Fixing Inspection boxes

a) Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary.

b) These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be per IS: 2667-1977.

c) Suitable ventilating holes shall be provided in the inspection box covers if directed.

1.8 PVC Conduit and Conduit Accessories:

1.8.1 All non-metallic conduit pipes and accessories shall be of suitable material complying with IS:2509-1973 and IS:3419-1989 for rigid conduits and IS:9537-2000 for flexible conduits. The interior of the conduits shall be free from obstructions. The rigid conduit pipes shall be ISI marked.

1.8.2 The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter. The dimensional details of rigid non-metallic conduits are given in Table-III.

1.8.3 No non-metallic conduit less than 20 mm in diameter shall be used.

1.8.4 The conduit wiring system shall be complete in all respect including accessories.

1.8.5 Rigid conduit accessories shall be normally of grip type.

1.8.6 Flexible conduit accessories shall be of threaded type.

1.8.7 Bends, couplers etc. shall be solid type in recessed type of works, and may be solid or inspection type as required, in surface type of works.
1.8.8 Saddles for fixing conduits shall be heavy gauge non-metallic type with base.

1.8.9 The maximum number of PVC insulated cables conforming to IS: 694-1990 that can be drawn in one conduit is given size wise in Table-1 and the number of cables per conduit shall be exceeded. Conduit sizes shall be selected accordingly in each run.

1.8.10 The erection of conduits of each section shall be completed before the cables are drawn in.

1.9 **Installation—Common aspects for both recessed and surface conduit works:**

1.9.1 Conduit Joints

   a) All joints shall be sealed/cemented with an approved cement. Damaged conduit pipes/ fittings shall not be used in the work. Cut ends of conduit pipes shall have no sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.

   b) The Engineer-in-charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc. after they have been prepared, shall be submitted for inspection before being fixed.

1.9.2 Bends in Conduit

   a) All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.

   b) Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

   c) Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

1.10 **Installation—Additional requirements for surface conduit work**

   a) Conduit pipes shall be fixed by heavy gauge non-metallic saddles with base, secured to suitable approved plugs with screws in an approved manner, at an interval of not more than 60 cm, but on either side of couplers or bends or similar fittings, saddles shall be fixed at a closer distance from the centre of such fittings. Slotted PVC saddles may also be used where the PVC pipe can be pushed in through the slots. The Minimum width and thickness of the ordinary clips or the girder clips for different sizes of conduits shall be as given in Table-II.

   b) Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips as required by the Engineer-in-charge. Where it is not possible to use these for fixing, suitable clamps with bolts and nuts shall be used.
c) If the conduit pipes are liable to mechanical damage, they shall be adequately protected.

1.11 **Installation-Additional requirements for recessed conduit work**

1.11.1 **Make Chase**

a) The chase in the wall shall be neatly made, and of ample dimensions to permit the conduit to be fixed in the manner desired.

b) In the case of buildings under construction, the conduits shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.

c) 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.

1.11.2 **Fixing Conduit in Chase**

a) The conduit pipe shall be fixed by means of staples, or by means of non-metallic saddles, placed at not more than 60 cm apart, or shall be fixed by any other approved means of fixing.

b) At either side of the bends, saddles/staples shall be fixed at a distance of 15 cm from the centre of the bends.

1.11.3 **Erection in RCC work**

a) The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent taming of the same.

b) Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius which will permit easy drawing in of conductors.

c) Location of inspection/ junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

1.11.4 **Fixing of Inspection Boxes**

a) Suitable inspection boxes to the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary.

b) These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be per IS: 2667-1988.

c) Suitable ventilating holes shall be provided in the inspection box covers if directed.
1.12 **Under Floor Trunking:**

1.12.1 Under Floor Trunking for convenience outlet points, telephone outlets and computer outlet points shall be provided as per details given in drawings. Ducts will be manufactured from GI/MS as mentioned in BOQ with a reinforcing web as per relevant BS or relevant standards of the country of manufacture.

1.12.2 Triple compartment system for convenience outlets, telephone outlets and computer data outlets will be provided as specified in the BOQ. Two types of trunking shall be provided, flush floor system with removable modular covers and removable compartment partitions and Under Floor tracks as shown in the drawings or as specified in the BOQ.

1.12.3 Service outlet boxes and junction boxes shall be constructed from same finish as the ducting, with top frames adjustable for height at each corner. Segregation of compartments of the ducting shall be maintained through the boxes.

1.12.4 Each service outlet box shall have outlet units as indicated. Segregation shall be provided between power outlets and telephone outlets, with separate lids and each section shall be fitted with a cable guard or grommet. The complete assembly shall comply with requirements of Indian Telecom.

1.12.5 Lids of service outlet boxes and floor ducting shall be of same make unless otherwise indicated. Lids shall be arranged to accommodate the finish as indicated.

1.12.6 Under floor ducting shall be straight and level and adjusted in height to relate to the finished floor level, as indicated.

1.12.7 Where ducting cross expansion and settlement joints occur in the building structure, suitable provision shall be made to allow for movement of the structure. The Contractor shall submit his proposals for the approval of Engineer-in-Charge.

1.12.8 Open ends of ducts shall be temporarily plugged immediately after installation to prevent ingress of water and solid materials. The boxes of under floor ducting shall be fitted with temporary lids immediately after they are installed and they shall be maintained as effective protection against ingress of water and solid material until the permanent lids are fitted after screeding is complete.

1.12.9 Method to be used for forming fire barriers at fire resistant structural elements such as floors and walls shall be submitted for the Engineer-in-Charge's approval.

1.12.10 Installed ducts shall be cleaned internally with a swab before cables are drawn-in.

1.12.11 If the protective finish of ducting is damaged after fixing, the damage shall be made good in a manner approved by Engineer-in-Charge.

1.13 **Routes and Segregation:**

1.13.1 In case the routes of conduit and ducting are not shown on the drawings, they shall be determined by the Contractor and approved by Engineer-in-Charge before work is started. This requirement shall apply where the conduit or duct is concealed within the building fabric.
as well as where they are on the surface.

1.13.2 Conduit and ducting shall be parallel with lines of building construction and properly aligned except where conduit is permitted in floor screeds. Conduit buried in wall finishes shall run vertically only, unless Engineer-in-Charge gives approval to deviate from this requirement.

1.13.3 A minimum clearance of 150 mm between conduits shall be allowed from any equipment/ Low current services conduit like telephone / Computer / CCTV/ pipe work or duct work. Distance shall be measured from the external surface of any lagging. In event of difficulty in achieving this requirement, Engineer-in-Charge shall be informed.

1.14 **Wires:**

1.14.1 The type and size of wires shall be as indicated in the BOQ. All the material supplied and used by the contractor shall be new. Wires shall have copper conductors unless otherwise specified, and the size shall be as per IS standards unless specified.

1.14.2 All wires shall comply with relevant IS. Type of wire to be used shall be as specified in the BOQ.

1.14.3 The colour identification of wires shall comply with the IEE wiring regulations for all category of circuits. Core identification colours shall extend throughout the length of PVC insulated wires. Core identification for sound distribution or public address systems shall be in grey colour.

1.14.4 Wires shall be protected throughout their length by trunking, ducting, conduit and equipment enclosures. Framework or partitions may be used, but only where indicated or with the approval of Engineer-in-Charge.

1.14.5 Wires carrying direct current may, if desired, be bunched whatever their polarity, but wires carrying alternating current, if installed in metal conduit shall always be bunched so that the out going and return wires are drawn into the same conduit.

1.14.6 Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit.

1.14.7 Wires shall comply with relevant IS for LV & ELV circuits.

1.14.8 Where conduits cross expansion and settlement joints in the building structure, suitable provision shall be made to allow for movement of the structure. The Contractor shall submit his proposals for the approval of the Engineer-in-Charge.

1.14.9 Conduits entering voids shall terminate not less than 22 mm clear of the building fabric. Open ends of conduit shall be temporarily plugged immediately after they are installed to prevent ingress of water and solid materials.

1.14.10 Where wires pass through joints, the number and size of holes shall allow for easy withdrawal and replacement of cables. The diameter of holes shall not exceed 1/6th the depth of the joints. They shall be approximately on the centre line and shall be not less than 75 mm between centres. Joints shall not be notched.

1.14.11 The method to be used for forming fire barriers at fire resistant structural elements such as floors and walls shall be submitted for
the Engineer-in-Charge's approval.

1.14.12 Where wires enter a metal enclosure, they shall be protected by grommets or secured by wires clamps.

1.14.13 Wires shall be looped between outlet points and as far as practicable, intermediate joints shall not be used.

1.14.14 Wires fixed to the surface, except in ducts, shall be protected up to a height of 1500 mm by high impact PVC channel.

1.14.15 Wires shall have identification sleeves at their terminations.

1.14.16 Identification shall be consistent with the relevant wiring diagrams.

1.15 **Switches:**

1.15.1 Switches shall be single pole unless otherwise indicated. Their current ratings shall be as indicated, allowance being made for any inductive or capacitive load.

1.15.2 Wall mounted switches located inside buildings shall have rocker type actuating members unless otherwise indicated. Where mounted adjacent to one another, they shall be grouped in a multi gang box with a common front plate.

1.15.3 Pull cord operated switches shall be fixed to white moulded plastic mounting blocks, which in turn shall be fixed to a circular conduit box. Where the conduit boxes are flush with the finish, mounting block shall overlap them. Pull cords shall be white or natural colour and the lower end shall terminate in a moulding of rubber or plastic material.

1.16 **Socket Outlets:**

1.16.1 Socket outlets shall be of type and rating as indicated. Pilot contacts shall be provided where indicated.

1.16.2 Socket outlets shall be switched where indicated. On socket outlets rated at 16A and located inside buildings, the switches shall be single pole and have rocker type actuating members unless otherwise indicated.

1.16.3 Socket outlets for wet locations shall be provided with covers, which shall be screwed on. Any cover required to achieve total enclosure and to ensure the required degree of protection against moisture shall be securely fixed to socket outlet.

1.16.4 Sockets/ Telephone/ TV/ CCTV/ Music / Shaver Socket outlets shall be of the type as mentioned in the BOQ.

1.17 **Plugs:**

1.17.1 ISI marked Plugs shall be provided as indicated. Plug bodies shall be of metal, plastic or other material as indicated.

1.17.2 Plugs rated at 16A shall be of a non-resilient material unless otherwise indicated.

1.17.3 Fuse plugs shall be fitted with fuses rated as indicated.

1.18 **Terminal Blocks:**
1.18.1 Conductors shall be clamped between metal surface and no screws shall make direct contact with conductors.

1.18.2 The design shall be such as to maintain sufficient contact pressure to ensure connections on negligible impedance at all times.

1.18.3 Metal in contact with conductors shall be 85% copper alloy and any screws shall be of metal that is electrolytically compatible with the copper alloy. The moulded housing shall be an insulating material suitable for the maximum operating temperature of the conductor.

1.19 **Mounting Heights:**

1.19.1 Mounting heights shall be as follows unless otherwise indicated in the drawings, where decision shall be obtained by contractor before start of work.

1.19.2 Where difficulty in locating accessories or equipment occurs the Engineer-in-Charge shall be informed.

1.20 **Supports and Fixings:**

1.20.1 Support shall be positioned within 300 mm of each bend and conduit box. Conduit boxes shall be fixed to fabric of building independent of the conduit. Where the conduit boxes have a minimum degree of protection of IP44, the fixing shall not reduce that protection.

1.20.2 Conduits shall be fixed in accordance with under mentioned Table. No shot firing shall be used and no drilling or welding of structural steel work shall be done without the approval of Engineer-in-Charge.

1.21 **Protective Conductor:**

1.21.1 Protective conductor shall be drawn through ducting and non-screwed metallic conduit.

1.21.2 Where live conductors terminate at or loop into terminals adjacent to an appliance or accessory, the protective conductor shall be terminated. Properly using earth studs, earth terminal block etc. so the case may be.

1.21.3 A protective conductor shall be installed within each length of steel conduit and connected to an earthing terminal at each end of the conduit.

1.22 **Outlet Boxes**

1.22.1 16 SWG MS/G.I. boxes of the required sizes shall be provided to house the Switch/sockets/Telephone/TV/Computer outlets as may be required/mentioned in BOQ. These shall be so designed that there is ample space at the rear and at the sides to accommodate conductors at the conduit entries. These shall be completely concealed leaving edges flush with wall surface unless mentioned otherwise. Should the outlets have mounting grid plates, adequate supports shall be provided.

1.22.2 Screws and nuts shall be cadmium or zinc electroplated or passivated.

1.23 **Draw Boxes/Inspection Boxes**

1.23.1 16 SWG Mild Steel/GI draw/inspection boxes of adequate dimensions
minimum size 75 mm x 75 mm shall be provided at convenient points on walls to facilitate long runs of conductors. They will be completely concealed with 3 mm Perspex/ hylam covers flush with plate work. These boxes will, as far as possible, be located where found suitable by the Engineer-in-Charge.

1.24 Protection of Conduits

1.24.1 To safeguard against filling up with plaster etc. all the outlet and switch boxes will be provided with temporary covers and plugs within the tendered cost which shall be replaced by sheet / plate covers as required. All screwed and socketed joints shall be made fully watertight by the use of white lead for steel conduits.

1.25 Cleaning of Conduit Runs

1.25.1 The entire conduit system including outlets and boxes shall be thoroughly cleaned after completion of erection and before drawing in of cables.

1.26 Laying of Dummy Conduit

1.26.1 The dummy conduits shall be the same as conduits for Electrical work and as specified before. The minimum size shall be 20 mm dia. Junction boxes shall be provided at distance not exceeding 10 m. The Contractor must make such modifications as the system designer / manufacturer desires in consultation with the Owners / Architects. These conduits shall be provided with steel draw boxes of at least 14 SWG.

1.27 Fish Wires

1.27.1 To facilitate drawing of wiring through conduits/G.I./Steel pipes etc.. G.I. fish wire of 14 SWG, wherever needed, shall be provided along with recessed conduit/pipes without any extra cost.
Table – I
Maximum number of PVC insulated 650/1100 V Grade Aluminium/Copper conductor

<table>
<thead>
<tr>
<th>Nominal Cross sectional area of cond. in sq.</th>
<th>20m</th>
<th>25mm</th>
<th>32mm</th>
<th>38m</th>
<th>51mm</th>
<th>64mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>B</td>
<td>S</td>
<td>B</td>
<td>S</td>
<td>B</td>
</tr>
<tr>
<td>20m</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
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<tr>
<td>25mm</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>30mm</td>
<td>12</td>
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<td>35mm</td>
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<td>40mm</td>
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<td>45mm</td>
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<tr>
<td>50mm</td>
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<tr>
<td>60mm</td>
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<td>-</td>
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<td>65mm</td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>70mm</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
</tbody>
</table>

NOTE:-
1. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cable.
2. The columns headed ‘S’ apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns 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.

---

TABLE-II

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>Size of conduit</th>
<th>Width</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 mm</td>
<td>19 mm</td>
<td>0.9mm (20 SWG)</td>
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</table>
## Internal Electrical Technical Specification

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Models</td>
</tr>
<tr>
<td>2</td>
<td>Type</td>
</tr>
<tr>
<td>3</td>
<td>Protection radius</td>
</tr>
<tr>
<td>4</td>
<td>Applied Standards</td>
</tr>
<tr>
<td>5</td>
<td>Test and Certificates</td>
</tr>
<tr>
<td>6</td>
<td>Material of manufacture</td>
</tr>
<tr>
<td>7</td>
<td>Lightning Impulse Current (10/350)</td>
</tr>
<tr>
<td>8</td>
<td>Discharging Efficiency</td>
</tr>
<tr>
<td>9</td>
<td>External Power Supply</td>
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<tr>
<td>10</td>
<td>Atmospheric Condition</td>
</tr>
<tr>
<td>11</td>
<td>Maintenance</td>
</tr>
</tbody>
</table>

### S. No. | Features | Qualifying Minimum Requirements | Vendor Compliance | Specifications offered |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1</td>
<td>Technology</td>
<td>The UPS should be Digital Signal Processing CANbus Technology, True On-line Double Conversion, using IGBT as switching devices for both Rectifier and Inverter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.2</td>
<td>Rectifier technology</td>
<td>The rectifier/charger shall be a only high-frequency PWM design, using Insulated Gate Bi-polar Transistors (IGBTs). The UPS should have Inverter current mode technology.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.2</td>
<td>The System Components:</td>
<td>The desired configuration shall consist of the following main components: Each UNINTERRUPTIBLE POWER MODULES includes a Rectifier, Inverter, and Battery Charger. Battery string(s) in matching Battery Cabinets.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.2 Modes of Operation

The topology shall be Double Conversion True On-Line.

2.3 UNINTERRUPTIBLE POWER MODULES

Modes of Operation:

Each UNINTERRUPTIBLE POWER MODULES shall operate as an on-line, fully automatic system in the following modes:

Normal: Utilizing commercial AC power, the critical load shall be continuously supplied by the Inverter. The Inverter shall power the load while regulating both voltage and frequency. The Rectifier shall derive power from the commercial AC source and shall supply DC power to the Inverter. Simultaneously, the Battery Charger shall charge the battery.

2.4 Power Failure:

Battery: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source.

Recharge: Upon restoration of the AC source, the Charger shall recharge the batteries and simultaneously the Rectifier shall provide power to the Inverter. This shall be an automatic function and shall cause no

2.5 Bypass

If the UNINTERRUPTIBLE POWER MODULES must be taken out of the Normal mode for overload, load fault, or internal failures, the static bypass switch shall automatically transfer the critical load to the commercial AC power. Return from Bypass mode to Normal mode of operation shall be automatic. No-break transfer to and from Bypass mode shall be capable of being initiated manually from the front panel.
# Internal Electrical Technical Specification

## 2.6 Cooling System

Scientific Cooling with Redundant cooling fans. Since the installation is critical, the air filters to be provided on the front grid to simplify maintenance activity even in dusty environments.

## 2.7 UPS

The UPS configuration shall consist of the following monitor and control capability:

1. Control panel with status indicators.
2. Alarm and metering display.
4. Communication ports.

**Battery management system:** The UPS shall contain a battery management system which has the following features:

- The battery management system shall provide battery time remaining while operating in normal mode and battery mode. Battery time available information shall be displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information shall be available.
- The battery management system shall automatically test the battery(s) to ensure that the battery is capable of providing greater than 80% of its rated capacity. Testing the batteries shall not jeopardize the operation of the critical load. Upon detection of the battery string(s) not capable of providing 80%, the UPS system shall

## 2.8 Component Accessibilit

All the critical components should be accessible.

<table>
<thead>
<tr>
<th>3</th>
<th>Input</th>
<th>Mains/Local DG Set Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Input</td>
<td>415 VAC 3 phase, 4 wires</td>
</tr>
<tr>
<td>5</td>
<td>Input Voltage</td>
<td>415 VAC, -15% to +10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>6</td>
<td>Input Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>7</td>
<td>Input Frequency Range</td>
<td>45 HZ TO 55 HZ</td>
</tr>
<tr>
<td>8</td>
<td>Input Current</td>
<td>&lt; 3-5% at 100% load</td>
</tr>
<tr>
<td>9</td>
<td>Input Power</td>
<td>0.99 at 100% load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.99 at 50% load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.99 at 25% load</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Active rectifier “IGBT” technology with Automatic Power Factor Correction Feature.</td>
</tr>
<tr>
<td>10</td>
<td>Rated Output Capacity per each UNINTERRUPTIBLE</td>
<td>60kva/54kw</td>
</tr>
<tr>
<td>11</td>
<td>Output Voltage</td>
<td>380/400/415 VAC 3 phase, 4 wires</td>
</tr>
<tr>
<td>11.1</td>
<td>Output Voltage Regulation</td>
<td>± 1% - For 100% static load,</td>
</tr>
<tr>
<td>11.2</td>
<td></td>
<td>± 5% dynamic 100% load change,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recovery time &lt; 3 m sec.</td>
</tr>
<tr>
<td>13</td>
<td>Inverter Efficiency</td>
<td>93% &lt;= 40KVA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>96% &gt; 40KVA</td>
</tr>
<tr>
<td>14</td>
<td>Overall efficiency</td>
<td>93% &lt;= 40KVA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>94% &gt; 40KVA</td>
</tr>
<tr>
<td>16</td>
<td>Remote Emergency Power off</td>
<td>Remote Emergency Power off (REPO) to be provided</td>
</tr>
<tr>
<td>17</td>
<td>Battery type</td>
<td>Sealed Maintenance Free</td>
</tr>
<tr>
<td></td>
<td>Battery make</td>
<td>Rocket / U-plus / Base/Amaron with Advanced</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>19</td>
<td>Desired Backup</td>
<td>Sealed Maintenance Free battery bank to give total 15 minutes backup</td>
</tr>
<tr>
<td>20</td>
<td>Battery management</td>
<td>Advance Battery Management for: Periodic Battery Test Controlling Charging Time and Current Increase in Battery Life Faster recharging than average boost charging when required. Protection : Battery low Cut-off without draining</td>
</tr>
<tr>
<td>21</td>
<td>LCD Panel</td>
<td>The UPS should have LCD panel for measuring Output voltages, Output currents and Frequency, Battery Voltage and charging / Discharging</td>
</tr>
<tr>
<td>22</td>
<td>RS232 interface</td>
<td>1 Nos. RS232 interface to be provided</td>
</tr>
<tr>
<td>23</td>
<td>ISO</td>
<td>ISO-14001</td>
</tr>
<tr>
<td>No.</td>
<td>Standards &amp; Certifications Required</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IEC 62040-1-1 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-1: General and safety requirements for UPS used in operator access areas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IEC 62040-1-2 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1-2: General and safety requirements for UPS used in restricted access locations.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IEEE 587 (ANSI C62.41) Category A &amp; B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.</td>
<td></td>
</tr>
</tbody>
</table>
2.0 MCB DISTRIBUTION BOARDS:

2.1 Scope:

2.1.1 The scope of this section covers Supply, installation, testing and commissioning of Miniature circuit breaker boards and Miniature Circuit breakers. Miniature circuit breaker boards shall comply with BS 5486 part 12 a clause 2.2 and 2.3. They shall have a fault withstand classification of class 1 unless otherwise indicated.

2.2 MCB Distribution Boards

2.2.1 These distribution boards shall be used for control of all lighting/power circuits and shall consist of single / double / Triple Pole / Triple Pole and Neutral / Four Pole Miniature Circuit Breakers Mounted in double cover design, dust tight, heavy gauge sheet steel enclosures preferably zinc coated with powder coating finish.

2.2.2 Distribution Boards shall be flush or surface pattern according to the requirements of their location and shall incorporate isolators / MCB and circuit switches as specified in bill of quantities.

2.2.3 All MCBs shall be connected to the electrolytic copper busbars with direct bolted connections.

2.2.4 Earthing bar and neutral bars shall be provided having sufficient ways to enable each cable to be connected to a separate terminal. Neutral connections shall be corresponding in position to phase connections.

2.2.5 Distribution boards shall have phase barriers and PVC ducts for all interior wiring. All distribution boards shall have removable end plates at top and bottom and handles with provision for locking.

2.2.6 Phase barriers shall be provided in the 3-phase distribution Boards.

2.2.7 In TP&N distribution boards, neutral busbars shall have one outgoing terminal for each outgoing circuit.

2.2.8 Size of SDB shall be selected to cater to extra space on the bus for mounting ELCBs in addition to number of outgoing MCBs specified in the BOQ.

2.2.9 A multi-terminal bar for the circuit protective conductors shall be provided for both insulated and metal cased boards, with one terminal for each outgoing circuit. It shall be directly connected to the earthing terminal without dependence on the exposed conductive parts of the enclosure.

2.2.10 Identification of each MCB way shall be by numbering. Identification in the neutral busbar and protective conductor bar shall clearly relate each terminal to its respective MCB way.

2.2.11 Spare MCB ways shall be provided as indicated in BOQ. Where specific ratings are indicated, MCB shall be incorporated otherwise the ways shall be left blank but suitable for future additions. Suitable number of blanking plates shall be fixed in the DB if the space for MCB is left blank.

2.2.12 A separate Junction box of min. height of 150 mm shall be provided for extra lengths of outgoing circuit wires on Top/Bottom (as required) to avoid jumbling of wires within the main section of SDB. The junction box will be properly earthed alongwith the SDB.
2.2.13 MCB DBs shall be factory fabricated of reputed manufacture and the make shall be as specified in BOQ/ List of approval.

2.3 **Miniature Circuit Breakers**

2.3.1 Miniature circuit breakers shall be designed and tested strictly in accordance with the relevant parts of Indian standards and shall consist of spring accelerated quick-make and quick break action mechanism fitted in moulded cases of high dielectric strength plastic or urea. Fixed and moving contacts shall have silver tungsten contacts.

2.3.2 Miniature circuit breakers used shall be of “B” Series for Normal lighting circuits and Normal Power/Geyser Loads. For AC loads, Tungsten lamps fittings, Sodium/Mercury Discharge lamps “C” Series shall be used unless otherwise specified.

2.3.3 Miniature circuit breakers shall have a minimum breaking capacity of 10 KA at 415 V unless otherwise specified.

2.3.4 Make of MCB shall be as specified in the BOQ / List of Approved Makes.

2.4 **ELCBs**

2.4.1 ELCBs shall be designed and tested strictly in accordance with the relevant parts of Indian standards. Fixed and moving contacts shall have silver tungsten contacts.

2.4.2 ELCBs used shall be of Rating and sensitivity as specified in the BOQ.

2.4.3 ELCBs shall be ordinarily be for Earth Leakage protection unless otherwise specified.

2.4.4 Make of ELCB shall be as specified in BOQ/ List of approved makes.
3.0 **LUMINAIRES AND LAMPS:**

3.1 **Scope:**

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

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

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

3.2 **General Requirements:**

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

3.2.2 The luminaries and lamps shall be fixed in a neat workman like manner, true to level and in accordance with manufacturer’s instructions.

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

3.3 **Luminaries:**

3.3.1 Luminaries shall comply with relevant IS.

3.3.2 Unless otherwise indicated, enclosure of luminaries shall provide a minimum degree of protection of IP20 when located within buildings and IP 44 when located outside buildings, but luminaries mounted externally; and less than 2 M above finished ground or paved level shall be IP 54 unless specified in BOQ.

3.3.3 Unless otherwise indicated, luminaries, both with and without built-in ballast or transformers shall be suitable for direct mounting on normally flammable surface.

3.3.4 Where specific requirements related to flame propagation and flammability of translucent covers are indicated, certificates of tests shall be submitted to the Engineer-in-Charge. The tests shall comply with relevant IS.

3.3.5 Terminal blocks for connection of the supply cables shall be of adequate size for the size of conductors forming the loop in wiring unless separate tails are required. Wherever indicated, the terminal block shall incorporate a fuse of suitable type and rating.

3.3.6 Ballasts for tubular fluorescent lamps shall have a maximum value of harmonics complying with the colour headed “without H Marking” in Table VII of BS 288. Power factor correction shall be provided and this shall not be less than 0.85 lagging unless otherwise indicated.

3.3.7 Translucent covers and reflective surfaces shall be clean at the completion of the works.
3.4 **Lamps:**

3.4.1 Lamps shall be of the type and ratings as indicated.

3.4.2 All lamps shall be supplied and installed by the contractor unless otherwise directed.

3.4.3 Lamp caps shall be suitable for the lamp holders listed socket by means of a locking ring.

3.5 **Support and Fixings:**

3.5.1 Where fluorescent luminaries 1200 mm or more in length are supported directly by the conduit system, they shall be fixed to two circular conduit boxes both of which shall form an integral part of the conduit system.

3.5.2 Where the weight of a luminaire is supported by a conduit box or cable trunking, the fixing of the conduit box or trunking shall be adequate for the purpose and approved by Engineer-in-Charge.

3.5.3 Luminaires fitted with tungsten filament lamps and having metal back plates shall not be fixed directly to conduit box in which thermoplastic material is the principal load bearing member.

3.5.4 Support of luminaires from cable trunking shall be by means of proprietary clamps or brackets.

3.5.5 Where luminaires are supported from the structure other than by the conduit system, the supports shall be adequate for the purpose and approved by Engineer-in-Charge.

3.5.6 Luminaires mounted on or recessed into suspended ceilings shall not support luminaires unless specifically shown and approved.

3.5.7 For wall mounted luminaires, the mounting height shall be 1900 mm above finished floor level, measured to the center of the conduit box, unless otherwise indicated.

3.6 **Wiring Connections:**

3.6.1 Where luminaires, are fixed at places other than circular conduit boxes or are supported by pedants or chains, the final circuit wiring shall terminate at a terminal block in the conduit box.

3.6.2 Where luminaires having fluorescent tubes are fixed direct to circular conduit boxes, the final circuit wiring may be terminated within the luminaire unless otherwise indicated. The wiring shall enter each luminaire at the conduit entry nearest to the terminal block and where a loop in wiring system is used, leave by the same entry; wiring shall not pass through a luminaire unless the approval of the Engineer-in-Charge.

3.6.3 Where luminaires are mounted on or recessed into a suspended ceiling, connection shall be by flexible cord from a plug-in ceiling rose unless otherwise indicated. The plug-in ceiling rose shall be located not more than 500 mm from the access in the ceiling and shall be firmly supported, unless otherwise approved by the Engineer-in-Charge.

3.6.4 Cables and flexible cords for final connections to luminaries shall be suitable for the operating temperature of the luminaire.
3.6.5 The size of final connection cables or flexible cords shall be as indicated.

3.6.6 Cables and cords passing close to a ballast within a luminaire shall be suitable for the operating temperature of the ballast.

3.6.7 A protective conductor shall connect the earthing terminal or earthing contact of each luminaire to an earthing terminal incorporated in the adjacent conduit box. Where the final connection is by flexible cord, the protective conductor shall form part of the cord.
4.0 **Earthing:**

**Scope:**
This chapter covers the essential requirements of earthing system components and their installation. This shall be read with Appendix F, which lays down criteria for their design.

For details not covered in these specifications IS code of Practice on earthing (IS 3043:1987) shall be referred to.

4.1 **Application**

4.1.1 The electrical distribution system in the Department is with earthed neutral (i.e. neutral earthed at the transformer / generator end). In addition to the neutral earthing, provision is made for earthing the metallic body of equipments and non-current carrying metallic components in the sub-station, as well as in the internal/external electrical installations.

4.1.2 Earthing system is also required for lightning protection, computer installations and hospital operation theaters, etc. for functional reasons.

4.1.3 Earthing requirements are laid down in Indian Electricity Rules, 1956, as amended from time to time, and in the Regulations of the Electricity Supply Authority concerned. These shall be complied with.

4.1.4 Application for Internal E.I.

a) Every sub-main will have earth continuity conductor to run along with sub-main wiring. In case of 3-phase sub-main wiring two earth continuity conductors shall be provided.

b) Every circuit will have its earth continuity conductor to run along with circuit wiring. In case of 3-phase circuit two earth continuity conductors shall be provided.

c) Looping of earth is allowed only in case of point wiring.

d) When 2/3 power outlets are looped to one circuit, earth looping of these outlets is permissible.

4.2 **Types of Electrodes & Material**

4.2.1 Earth Electrodes

i. **Types**

The type of earth electrode shall be any of the following, as specified. (For selection criteria in designs, Appendix F may be referred to).

a) Pipe earth electrode.

b) Plate earth electrode.

c) Strip or conductor earth electrode.
ii. Electrode Materials and Dimensions

a) The materials and minimum sizes of earth electrodes shall be as per Table IX (revised).

b) GI pipe electrodes 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 2 m of length from the bottom.

c) The length of the buried strip or conductor earth electrode shall be not less than 15 m. This length shall suitably be increased if necessary, on the basis of the information available about soil resistance, so that the required earth resistance is obtained. Prior approval of the Engineer-in-charge shall be taken for any such increase in length.

d) All hardware items used for connecting the earthing conductor with the electrode shall be of GI in the case of GI pipe and GI plate earth electrodes, and forged tinned brass in case of copper plate electrodes.

4.2.2 Earthing Conductor & Sizes

a) The earthing conductor (protective conductor from earth electrode up to the main earthing terminal/earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper, and in the form of wire or strip as specified.

b) The size of earthing conductor shall be specified, but this shall not be less than the following (For calculating the size of the earthing conductor in design, Appendix F para 3.5.1).
   - 4 mm dia. (8 SWG) copper wire,
   - 25 mm x 4 mm in the case of GI strip, or
   - 20 mm x 3 mm in the case of copper strip

c) Earthing conductor larger than the following sectional areas need not be used, unless otherwise specified.
   - 150 sq.mm. in case of GI, or
   - 100 sq.mm. in case of copper.
4.2.3 **Earth Continuity / Loop Earthing Conductor & Sizes**

The material and size of protective conductors shall be as specified below (for criteria in design of these Appendix F may be referred to):

<table>
<thead>
<tr>
<th>Size of phase conductor</th>
<th>Size of protective conductor of the same material as phase conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 4 sq.mm.</td>
<td>Same size as that of phase conductor</td>
</tr>
<tr>
<td>Above 4 sq.mm. up to 16 sq.mm.</td>
<td>Same size as that of phase conductor</td>
</tr>
<tr>
<td>Above 16 sq.mm. up to 35 sq.mm.</td>
<td>16 sq.mm.</td>
</tr>
<tr>
<td>Above 35 sq.mm.</td>
<td>Half of the phase conductor</td>
</tr>
</tbody>
</table>

4.3 **Location for Earth Electrodes**

4.3.1 Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building, with the prior approval of the Engineer-in-charge.

4.3.2 The location of the earth electrode will be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and roadways, should be avoided for locating earth electrodes.

4.4 **Installation**

4.4.1 **Electrodes**

i. **Various Types of Electrodes**

a) .
   o Pipe electrode shall be buried in the ground vertically with its top at not less than 20 cm below the ground level.

   o In locations where the full length of pipe electrode is not possible to be installed due to meeting a water table, hard soil or rock, the electrode may be of reduced length, provided the required earth resistance result is achieved with or without additional electrodes, or any alternative method of earthing may be adopted, with the prior approval of the Engineer-in-charge. Pipe electrodes may also be installed in horizontal formation in such exceptional cases.

b) Plate electrode shall be buried in ground with its faces vertical, and its top not less than 3.0 m below the ground level.
c) When more than one electrode (plate/pipe) is to be installed, a separation of not less than 2 m shall be maintained between two adjacent electrodes.

d) .
   o The strip or conductor electrode shall be buried in trench not less than 0.5 m deep.
   o If conditions necessitate the use of more than one strip or conductor electrode, they shall be laid as widely distributed as possible, in a single straight trench where feasible, or preferably in a number of trenches radiating from one point.
   o If the electrode cannot be laid in a straight length, it may be laid in a zigzag manner with a deviation upto 45 degrees from the axis of the strip. It can also be laid in the form of an arc with curvature more than 1 m or a polygon.

ii. Artificial Treatment of Soil

   a) When artificial treatment of soil is to be resorted to, the same shall be specified in the schedule of work. The electrode shall be surrounded by charcoal / coke and salt. In such cases, excavation for earth electrode shall be increased as per the dimensions indicated in these figures.

iii. Watering Arrangement

   a) In the case of plate earth electrodes, a watering pipe 20 mm dia. Medium class pipe shall be provided and attached to the electrodes. A funnel with mesh shall be provided on the top of this pipe for watering the earth.
   b) In the case of pipe electrodes, a 40 mm x 20 mm reducer shall be used for fixing the funnel with mesh.
   c) The watering funnel attachment shall be housed in a masonry enclosure of size not less than 30 cm x 30 cm x 30 cm.
   d) A cast iron / MS frame with MS cover, 6 mm thick, and having locking arrangement shall be suitably embedded in the masonry enclosure.

4.4.2 Earthing Conductor (Main Earthing Lead)

   a) In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.
   b) In the case of pipe earth electrode, wire type earthing conductor shall be secured using a through bolt, nuts and washers and
terminating socket.
c) A double C-clamp arrangement shall be provided for terminating tape type earthing conductor with GI watering pipe coupled to the pipe earth electrode. Galvanized “C” shaped strips, bolts, washers, nuts and check nuts of adequate size shall be used for the purpose.
d) The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15 mm dia. GI pipe in the case of wire, and by 40 mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth in due coordination with the building work.
e) The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by:
   o Soldered or preferably crimped lug, bolt, nut and washer in the case of wire
   o Bolt, nut and washer in case of strip conductor. In the case of substations or alternators, the termination shall be made on the earthing terminal of the neutral point on the equipment and/or the earth bus, as the case may be.

4.4.3 Loop Earthing/ Earth Continuity Conductor

a) Earth terminal of every switchboard in the distribution system shall be bonded to the earth bar/ terminal of the upstream switch board by protective conductor(s).
b) Two protective conductors shall be provided for a switchboard carrying a 3-phase switchgear thereon.
c) Loop earthing of individual units will not be however necessary in the case of cubicle type switchboards.
d) The earth connector in every distribution board (DB) shall be securely connected to the earth stud/ earth bar of the corresponding switch board by a protective conductor.
e) The earth pin of socket outlets as well as metallic body of fan regulators shall be connected to the earth stud in switch boxes by protective conductor. Where the switch boxes are of non-metallic type, these shall be looped at the socket earth terminals, or at an independent screwed connector inside the switch box. Twisted earth connections shall not be accepted in any case.

4.5 Earth Resistance

a) The earth resistance at each electrode shall be measured. No
earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be up to 8 ohms.

b) Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode(s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the Engineer-in-charge.

4.6 **Marking**

a) Earth bars/terminals at all switch boards shall be marked permanently, either as “E” or as

b) Main earthing terminal shall be marked “SAFETY EARTH – DO NOT DISCONNECT”.

4.7 **Use of Residual Current Devices (RCDs)**

An extract on selection and application of RCDs (also known as RCCBs) from IS 12640: 1988 is given at Appendix G. Provision of RCD shall be specified in individual cases keeping in view the type, use, importance, system of earthing and nature of electrical installations to be protected by the RCCBs, requirements of the local electric supply company, etc. The sensitivity shall be 30 mA, 100 mA, 300 mA, or 500 mA, as specified.

<table>
<thead>
<tr>
<th>Type of Electrodes</th>
<th>Material</th>
<th>Size</th>
</tr>
</thead>
</table>
| Pipe               | GI medium class | 40 mm dia  
4.50 m long  
(without any joint) |
| Plate              | (i) GI  
(ii) Copper | 60 cm x 60 cm x 6 mm thick  
60 cm x 60 cm x 3 mm thick |
| Strip              | (i) GI  
(ii) Copper | 100 sq. mm section  
40 sq. mm section |
| Conductor          | (i) Copper | 4 mm dia (8 SWG) |
5.0 **PROTECTION OF BUILDING AGAINST LIGHTNING**

**Scope**

This chapter covers the detailed requirements of installation of lightning conductor system for protection of buildings against lightning. The principles of this type of protection are outlined in Appendix H to these specifications. For details not covered in these specifications, reference may be made to IS 2309 : 1989.

5.1 **Application**

This system shall be provided where specified. The decision whether or not to provide this system should be taken by the competent authority considering all relevant factors as per Appendix H.

5.2 **Principal Components**

The principal components of a lightning protective system are :-

a) Air terminations,

b) Down conductors,

c) Joint and bonds,

d) Testing joints,

e) Earth terminations, and

f) Earth electrodes.

5.3 **Materials**

5.3.1 The materials of air terminations, down conductors, earth termination etc. of the protective system shall be reliably resistant to corrosion, or be adequately protected against corrosion. The material shall be one of the following, as specified.

a) Copper: Solid or flat copper strip of at least 98% conductivity conforming to relevant I.S. Specifications shall be used.

b) Copper Clad Steel: Copper clad steel with copper covering permanently and effectively welded to the steel core shall be used. The proportion of copper and steel shall be such that the conductance of the material is not less than 30% of conductance of the solid copper of the same total cross-sectional area.

c) Galvanized Steel: Steel thoroughly protected against corrosion by a zinc coating shall be used.

d) Aluminium: Aluminium, 99% pure, and with sufficient mechanical strength, and protected against corrosion shall be used.
5.3.2 Aluminium should not be used underground, or in direct contact with walls.

5.3.3 All air terminations shall be of GI and all down conductors shall be of GI or aluminium, except where the atmospheric conditions necessitate the use of copper or copper clad steel for air terminations and down conductors.

5.3.4 The recommended shape and minimum sizes of conductors for use above and below ground are given in Tables X and XI respectively.

5.4 Layout

5.4.1 The system design and layout shall be done in accordance with IS 2309: 1989 and specified in the tender documents. The work shall be carried out accordingly satisfying at the same time, the requirements of clauses 8.4.2 to 8.4.3.

5.4.2 Air Terminations

a) Air termination networks may consist of vertical or horizontal conductors, or combinations of both. For the purpose of lightning protection, the vertical and horizontal conductors are considered equivalent and the use of pointed air terminations, or vertical finial is, therefore, not regarded as essential.

b) A vertical air termination, where provided, need not have more than one point, and shall project at least 30 cm, above the object, salient point or network on which it is fixed.

c) For a flat roof, horizontal air termination along the outer perimeter of the roof shall be used. For a roof of larger area a network of parallel horizontal conductors shall be installed. No part of the roof should be more than 9 m from the nearest horizontal protective conductor.

d) Horizontal air terminations should be carried along the contours such as ridges, parapets and edges of flat roofs, and, where necessary, over flat surfaces, in such a way as to join each air termination to the rest, and should themselves form a closed network.

e) All metallic projections including reinforcement, on or above the main surface of the roof which are connected to the general mass of the earth, should be bonded and form a part of the air termination network.

f) If portions of a structure vary considerably in height, any necessary air terminations or air termination network for the lower portions should be bonded to the down conductors of the taller portions, in addition to their own down conductors.
5.4.3 Down Conductors

(a) The number and spacing of down conductors shall be as specified, or as directed by the Engineer-in-charge.

(b) Routing
   - A down conductor should follow the most direct path possible between the air terminal network and the earth termination network. Where more than one down conductor is used, the conductors should be arranged as evenly as practicable around the outside walls of the structures.
   - The walls of light wells may be used for fixing down conductors, but lift shafts should not be used for this purpose.
   - Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors, but cannot replace them, such connections should have disconnecting joints.
   - In deciding on the routing of the down conductor, its accessibility for inspection testing and maintenance should be taken into consideration.

(c) Provision when External Route is Not Available
   - Where the provision of external routes for down conductors is impracticable, for example, in buildings of cantilever construction from the first floor upwards, down conductors should not follow the outside contours of the building. To do so would create a hazard to persons standing under the overhang. In such cases, the down conductors may be housed in an air space provided by a non-metallic and non-combustible internal duct and taken straight down to the ground.
   - Any suitable covered recess, not smaller than 76 mm x 13 mm, or any suitable vertical service duct running the full height of the building may be used for this purpose, provided it does not contain an unarmoured or a non-metal sheathed cable.
   - In cases where an unrestricted duct is used, seals at each floor level may be required for fire protection. As far as possible, access to the interior of the duct should be available.

5.4.4 The lightning protective system should be so installed that it does not spoil the architectural or aesthetic beauty of the building.

5.5 Installation

5.5.1 General
a) The entire lightning protective system should be mechanically strong to withstand the mechanical forces produced in the event of a lightning strike.
b) Conductors shall be securely attached to the building, or other object to be protected by fasteners, which shall be substantial in construction, not subject to breakage, and shall be of galvanized steel or other suitable materials, with suitable precautions to avoid corrosion.
c) The lightning conductors shall be secured not more than 1.2 m apart for horizontal run, and 1 m for vertical run.

5.5.2 Air Terminations

All air terminals shall be effectively secured against overturning either by attachment to the object to be protected, or by means of substantial bracings and fixings which shall be permanently and rigidly attached to the building. The method and nature of the fixings should be simple, solid and permanent, due attention being given to the climatic conditions and possible corrosion.

5.5.3 Down Conductors

a) The down conductor system must, where practicable, be directly routed from the air termination to the earth termination network, and as far as possible, be symmetrically placed around the outside walls of the structure starting from the corners. In all cases consideration to side flashing must always be given.
b) Practical reasons may not sometimes allow the most direct route to be followed. While sharp bends, such as arise at the end of roof are inescapable (and hence permissible), reentrant loops in a conductor can produce high inductive voltage drops so that the lightning discharge may jump across the open side of a loop. As a rough guide, this risk may arise when the length of the conductor forming the loop exceeds 8 times the width of the openside of the loop.
  o When large re-entrant loops as defined above cannot be avoided, such as the case of some cornices or parapets, the conductors should be arranged in such a way that the distance across the open side of a loop complies with the requirement indicated above. Alternatively, such cornices or parapets should be provided with holes through which the conductor can pass freely.

c) Bonding to Prevent Side Flashing
  o Any metal in, or forming a part of the structure, or any building
services having metallic parts which are in contact with the general mass of the earth, should be either isolated from, or bonded to the down conductor. This also applies to all exposed large metal items having any dimension greater than 2 m whether connected to the earth or not.

5.5.4 Joints and Bonds

i. Joints

a) A lightning protective system should have as few joints as possible.
b) Joints should be mechanically and electrically effective, for example, clamped, screwed, bolted, crimped, riveted or welded.
c) With overlapping joints, the length of the overlap should not be less than 20 mm for all types of conductors.
d) Contact surfaces should first be cleaned, and then inhibited from oxidation with a suitable non-corrosive compound.
e) Joints of dissimilar metals should be protected against corrosion or erosion from the elements, or the environment and should present an adequate contact area.

ii. Bonds

a) Bonds have to join a variety of metallic parts of different shapes and composition, and cannot therefore be of a standard form.
b) There is the constant problem of corrosion and careful attention must be given to the metals involved, i.e. the metal from which the bond is made, and those of the items being bonded.
c) The bond must be mechanically and electrically effective, and protected from corrosion in, and erosion by the operating environment.
d) External metal on, or forming part of a structure, may have to discharge the full lightning current, and its bond to the lightning protective system should have a cross-sectional area not less than that employed for the main conductors.
e) Structures supporting overhead electric supply, telephone and other lines must not be bonded to a lightning protective system without the permission of the appropriate authority.
f) Gas pipe in no case shall be bonded to the lightning protective earth termination system.

5.5.5 Test Joints

Each down conductor should be provided with a test joint in such a position that, while not inviting unauthorized interference, it is
convenient for use when testing.

5.5.6 Earth Termination Network

a) An earth station comprising one or more earth electrodes as required, should be connected to each down conductor. This shall be specified.

b) Each of the earth stations should have a resistance not exceeding the product given by 10 ohms multiplied by the number of earth electrodes to be provided therein. The whole of the lightning protective system, including any ring earth, should have a combined resistance to earth not exceeding 10 ohms without taking account of any bonding.

c) If the value obtained for the whole of the lightning protection system exceeds 10 ohms, a reduction can be achieved by extending or adding to the electrodes, or by interconnecting the individual earth terminations of the down conductors by a conductor installed below ground, sometimes referred to as a ring conductor. Buried ring conductors laid in this manner are considered to be an integral part of the earth termination network, and should be taken into account when assessing the overall value of resistance to earth of the installation.

d) A reduction of the resistance to the earth to a value below 10 ohms has the advantage of further reducing the potential gradient around the earth electrode when discharging lightning current. It also further reduces the risk of side flashing to metal in, or of structure.

e) Earth electrodes should be capable of being isolated and a reference earth point should be provided for testing purposes.
### TABLE X
Shapes and Minimum Sizes of Conductors for Use Above Ground
[Clause 9.3.4]

<table>
<thead>
<tr>
<th>SI. No.</th>
<th>Material and Shape</th>
<th>Minimum Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Round copper wire or copper clad</td>
<td>6 mm diameter</td>
</tr>
<tr>
<td>2.</td>
<td>Stranded copper wire</td>
<td>50 sq. mm or (7/3.00 mm dia)</td>
</tr>
<tr>
<td>3.</td>
<td>Copper strip</td>
<td>20 mm x 3 mm</td>
</tr>
<tr>
<td>4.</td>
<td>Galvanized iron strip</td>
<td>20 mm x 3 mm</td>
</tr>
<tr>
<td>5.</td>
<td>Round aluminium wire</td>
<td>8 mm diameter</td>
</tr>
<tr>
<td>6.</td>
<td>Aluminium strip</td>
<td>25 mm x 3 mm</td>
</tr>
</tbody>
</table>

### TABLE XI
Shapes and Minimum Sizes of Conductors for Use Below Ground
[Clause 9.3.4]

<table>
<thead>
<tr>
<th>SI. No.</th>
<th>Material and Shape</th>
<th>Minimum Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Round copper wire or copper clad</td>
<td>8 mm diameter</td>
</tr>
<tr>
<td>2.</td>
<td>Copper strip</td>
<td>32 mm x 6 mm</td>
</tr>
<tr>
<td>3.</td>
<td>Round galvanized iron wire</td>
<td>10 mm x 6 mm</td>
</tr>
<tr>
<td>4.</td>
<td>Galvanized iron strip</td>
<td>32 mm x 6 mm</td>
</tr>
</tbody>
</table>
6.0  TELEPHONE AND COMPUTER SYSTEM WIRING & CONDUITING:

GENERAL:

6.1 The electrical Installation work shall be carried out in accordance with Indian Standard Code of practice. 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 becomes applicable to the installation. Electrical work in general shall be carried out as per following CPWD Specifications.

General Specifications for Electrical Works:


6.2 Wherever this specification 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.

TELEPHONE SYSTEM WIRING AND CONDUITING:

6.3 Intent of Specification

6.3.1 These specifications are intended to cover the Cabling and under floor raceway work and conduiting (wherever required) for Telephone & Intercom System. It is not the intent to specify completely herein all aspects of design, constructional features of equipment and details of the work to be carried out, but nevertheless the intent of the specification is to ensure that the equipment and work shall conform in all respects to the relevant Bureau of Indian Standard Specifications, Codes of Practice, and other statutory regulations as may be applicable and to high standards of engineering, design and workmanship. The equipment and work shall perform in continuous operation in a manner acceptable to the Employer who will interpret the meaning of the specifications and drawings and shall have the right to reject or accept any equipment or work which in their assessment is not complete to meet the requirements of these specifications and/ or applicable Codes and Standards.

6.4 Scope of Work

6.4.1 The scope of work under these specifications shall include the design and manufacture (wherever required), work’s testing, supply, storage, erection, site testing and commissioning of the following:

a) All conduit work including Junction Boxes, outlet boxes and wiring & cabling of telephone & intercom system etc. as specified.

b) Boxes & cover plates for telephone outlets as specified.

c) Supplying and laying/fixing of main Telephone cables and Tag Blocks as per the BOQ and line diagrams.

d) To do the ferruling and identification of all multi core cables / Cat-5(e) / Cat-6 at both the ends of each cable.
e) To do the testing of new & existing telephone cables & tag blocks (if already existing) before the start of work and intimate the condition of the same to the employer

6.5 Technical Specifications for Cables:

6.5.1 Jelly Filled Cables (Armoured / Unarmoured)

a) These cables shall be manufactured in accordance with the P&T specifications No. ITD-S/WT-129 D, S/WT-143 B.

b) The constructional details, technical properties shall be governed by the Deptt. Of Telecommunications specification No. G/CUG-01/02. Feb. 96 and amended upto date.

6.5.2 Unarmoured Telephone Cables & Wires

a) All Telephone unarmoured cables & wires shall be manufactured in accordance with the relevant latest I.S specifications and ITD Specifications no. ITD-S/WS-113 C, S/WS-114 C

6.5.3 Cat-6 UTP Cable

a) Category-6 UTP cable shall be as specified in the Computer section of these specifications

6.6 Telephone Outlets:

6.6.1 Telephone Outlets shall be modular plate type accessories with RJ-11/RJ-45 Telephone Outlet as specified in the BOQ. Cover plate shall match in shape & finish with other light and power accessories.

6.6.2 Front Cover Plates shall match the Existing type and size of the gang box.

COMPUTER SYSTEM WIRING & CONDUITING:

6.7 Intent of Specification

6.7.1 These specifications are intended to cover the Conduiting & Cabling work for Computer System. It is not the intent to specify completely herein all aspects of design, constructional features of equipment and details of the work to be carried out, but nevertheless the intent of the specification is to ensure that the equipment and work shall conform in all respects to the relevant Bureau of Indian Standard Specifications, Codes of Practice, and other statutory regulations as may be applicable and to high standards of engineering, design and workmanship. The equipment and work shall perform in continuous operation in a manner acceptable to the Engineer-in-charge who will interpret the meaning of the specifications and drawings and shall have the right to reject or accept any equipment or work which in their assessment is not complete to meet the requirements of these specifications and / or applicable Codes and Standards.
6.8 **Scope of Work**

The scope of work under this specification shall include the design, manufacture (wherever required), work’s testing, supply, storage, erection, site testing and commissioning of the following:

a) All conduit work including Junction Boxes, outlet boxes and wiring and cabling for computer system as specified.

b) Boxes and cover plates for computer outlets as specified.

c) Supplying and laying of main computer wire (OFC cable) as per line diagram and copper cable for point outlets.

d) Supply, installation & connecting of Patch Panel & Mounting cords, Racks and Switches etc.

e) To connect and help in commissioning of switches, back bone switch its peripheral main server and desktop etc., as and when received at the site through enhanced Cat 6 cables along with connector wherever required.

f) To do the ferruling and identification of all the Cat 6 cables for all the workstations and switches/Hubs.

g) To get the certification for 15 years of the complete system from the Competent Authorities after commissioning of the system.

h) Handing over of one tool for cramping of RJ 45 connector and cable (tool kit) to the institute.

6.9 **Completion Drawings**

After the completion of the work and before issuance of virtual completion, the Contractor shall submit to the Institute, client/department completion drawings drawn at approved scale indicating the complete system as installed. These drawings shall give the following:

a) Run and size of conduits, raceways, location of inspection, Junction and pull boxes.

b) Number and size of conductors in each conduit for computer wiring.

c) Location of outlets and patch panels.

d) Location and details of main switches and other particulars.

e) Complete schematic drawings as installed showing all connections in the complete computer system.

f) Layout and particulars of all cable runs size and type of cables, mode of installation, etc. as installed.

6.10 **Copper Components**

All the items/components used for the installation shall meet the requirement of TIA/EIA T568A, T568B, ISO/IEC 11081.
6.10.1 Category 6 Unshielded Twisted Pair Cable

The category 6 UTP LAN cable shall be four pair copper cable suitable for more than 1000 Mbps speed, designed and constructed as per specifications laid down by the EIA of USA.

6.10.2 Cords

The patch cords/mounting cords and the category 6 UTP cables shall be as follows:

Conductor: 24 awg. Stranded bare copper for patch/mounting cords.

24 awg. Solid bare copper for category 6 LAN cable.

Insulation: Plyolefin/Polyethylene for both.

Jacket: PVC for both.

6.10.3 Test Certificate

The test certificate and the EIA standards/ specifications for all above components used for the structured cabling shall be submitted along with the tender.

6.10.4 Testing of equipments/Installation

After completion of installation, the structure cabling work shall have to be tested as per EIA standards for its suitability for use at minimum 1000 Mbps, by using suitable equipment like scanner etc. in the presence of employer’s /client’s/department’s engineer. The test results shall be tabulated in a format and submitted. In case any part of the work does not comply with the standards specified by EIA or fails the tests, the same has to be redone without any extra charge.

6.11 Fiber Optic

All the items, components for F.O cable used for the installation & commissioning shall meet the requirement of TIA 568A, IEEE 802.3Z and VL 1666 as amended up to date. The performance specifications shall be measured in accordance with EIA fiber optic test procedure. Each Fiber Cable shall be marked with Aluminum Foil Marker at both ends.

6.12 Drawing of Conductors

The drawing and jointing of insulated wires shall be executed with due regard to the following precautions:

a) While drawing insulated wires into the conduits, care shall be taken to avoid scratches and kinks which cause breakage of conductors.

b) There shall be no sharp bends less than 90 degrees.

c) Insulation shall be shaved off for a length of 15 mm at the end of wire like sharpening of a pencil and it shall not be removed by cutting it square or wringing.
d) PVC insulated wire ends before connection shall be properly soldered (at least 15 mm length) with suitable soldering material.

e) All looped joints shall be soldered and connected through terminal block/connector

f) The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less.

g) Conductors having nominal cross sectional area exceeding 10 Sq. mm shall always be provided with cable sockets.

h) At all bolted terminals, brass flat washer of large area and approved steel spring washers shall be used.

i) Brass nuts and bolts shall be used for all connections.

j) Only certified wiremen and cable jointers shall be employed to do jointing work.

k) All wires shall bear the manufacturer’s label and shall be brought to site in new and original packages.

l) 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.

m) Before the wires are drawn into the conduits, they shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction by forcing dry compressed air through the conduits.

6.13 Authorization from principles:

a) Bidder shall submit an undertaking from the manufacturers/OEM towards successful performance of contract including Warranty and subsequent Maintenance Spares & Warranty for all LAN Active / Passive Equipments.

b) Minimum Seven (7) years support commitment (spare parts) has to be given for active networking components by OEM and Fifteen (15) years for passive items in this reference. Authorization letter from respective OEM should be attached with bid.

c) The undertaking shall be submitted along with the Technical Bid, failing which the bid is liable to be rejected.

COMMON SPECIFICATIONS FOR THE ABOVE WORKS:

6.14 Scope of Work

6.14.1 The scope of work shall also include all civil works associated with erection of the equipment and making good and painting the civil works as required.

6.14.2 The Contractor shall include for the supply of entire materials in accordance with these specifications and the whole of the work of fixing necessary material for the complete installation as set down in these specifications and with the accompanying schedules of work and drawings. Materials and components not specifically stated in the specifications and / or bill of materials or noted on the drawings but which are necessary for satisfactory installation and operation of the
system shall be deemed to have been included in the scope of work.

6.15 **Specifications And Schedules**

6.15.1 The Specifications and Schedule of quantities shall be considered as part of this contract and any work or materials shown in schedule and not called for in the specifications or vice versa, shall be executed as if specially called for in both. The drawings indicate the extent and general arrangement of outlets, Junction Boxes etc. and are essentially diagrammatic.

6.15.2 The work shall be installed as indicated on the drawings. However, any minor changes found essential to coordinate the installation of this work with other trades shall be made without any additional cost to the employer. The data given herein and on the drawings is as exact as could be secured, but its complete accuracy is not guaranteed. The drawings are for the guidance of the Contractor. Exact locations, distances and levels will be governed by the site conditions.

6.16 **Departure from Specifications**

6.16.1 Should the tenderer wish to depart from the provisions in these specifications, such departure shall be listed in a separate schedule with full particulars and reasons for the same. No conditions or departures from specifications etc. will be accepted after decisions are communicated by the Engineer-in-charge.

6.17 **Materials and Equipment**

All materials and equipment shall be of the approved make and design. Only the best quality materials and equipment shall be used. The materials and equipment shall conform to relevant Standards.

6.17.1 Approved Makes of Material

Approved List of makes of material are indicated in the annexure to the Specifications. Only such material shall be used. Alternative makes shall be used only with the specific written approval of the Engineer-in-charge.

6.17.2 Samples

A list of items of materials and equipment, together with a sample of each shall be submitted to the Engineer-in-charge within 15 days of the award of the Contract.

Samples and drawings of equipment shall not be departed from without the written instructions of the Engineer-in-charge. Approvals given by the Engineer-in-charge to any samples or drawings submitted by the Contractor shall not in any way exonerate the Contractor from his liability to carry out the work in accordance with the terms of the contract.

6.17.3 Substitute Materials

Any item which is proposed as a substitution, shall be accompanied by all technical data given sizes, particulars of materials and the manufacturer’s name. At the time of the submission of proposed substitution the Contractor shall state the credit, if any, due to the Client. In the event the substitution is approved, changes and
substitutions shall be requested in writing and approvals obtained in writing from the Engineer-in-charge.

6.17.4 Manufacturer’s Instructions
Where manufacturers have furnished specific instructions, relating to the materials used in this covering points not specially mentioned in these documents, manufacturers instructions shall be brought to the notice of the Engineer-in-charge for further instructions in the matter.

6.17.5 Interchangeability
All similar parts and / or equipments shall be interchangeable with one and other.

6.17.6 Material Testing
The Employer shall have full powers to require the materials of work to be tested by an independent agency at the Contractor’s expense in order to prove their soundness and adequacy.

6.18 Drawings
6.18.1 Prior to the laying and fixing of the conduits, the Contractor shall submit to the Engineer-in-charge detailed shop drawings of the conduit network and get the same approved. The shop drawing shall indicate number, size and route of the conduits, location of junction/inspection/pull boxes, location and size of outlet boxes and number and size of wires carried in each conduit.

6.18.2 The Contractor shall prepare and submit for the approval of Engineer-in-charge detailed shop drawings of all Junction Boxes, special pull boxes and any other requirement to be fabricated by the Contractor within 10 days of signing of the contract.

6.18.3 General Arrangement drawing giving details of cable, size and type of cables, number of cables, equipment, mode of installation etc.

6.19 Cleaning, Final Painting and Marking
6.19.1 All exposed steel work not actually embedded will be painted as instructed. All tag blocks shall be properly labeled and numbered. The scope of work shall include the same without any extra charge. The Contractor shall be required to clean all equipment under erection as well as the work area and site at regular intervals to the satisfaction of the Engineer-in-charge. In case the cleaning is not to the satisfaction of Engineer-in-charge the same will have to be done again at the Contractor’s Cost.

6.20 Completion Certificate
6.20.1 On completion of the wiring & cabling, a certificate shall be furnished by the Contractor countersigned by the Licensed Supervisor, under whose direct supervision, the installation was carried out. The contractor shall get the certification of the Competent authority for the complete system after commissioning.

6.21 Works Inspection
6.21.1 Prior to shipment of equipment, the Engineer-in-charge reserves the right to inspect the same at the manufacturers works and the Contractor shall provide and secure for the Engineer-in-charge and
his authorized representative every reasonable access and facility at the manufacturer's works for inspection.

6.22 **Co-Ordination of Work at Site**

6.22.1 The Contractor shall work in co-ordination with other agencies at site and shall arrange to place the conduits/inserts etc. in the masonry and concrete as required, as other works proceed. Any hold up of the building or other works because of delay in placing the conduits/inserts etc. or otherwise shall be the responsibility of the Contractor and shall make him liable for damages as may be considered and levied by the Engineer-in-charge.

6.23 **Partial Occupation of Premises**

6.23.1 During progress of the work completed portions of the building/floor may be occupied and put to use by the Client. The Contractor shall however remain fully responsible for the maintenance of the installations till the entire work covered by this Contract is satisfactorily completed by him and taken over by the Institute.

6.24 **Appointment of Sub Contractors**

6.24.1 The main contractor shall get the name of the telephone/computer wiring sub-contractors approved from the Engineer-in-charge before the work is taken up computer in hand. The sub-contractor shall be licensed electrical contractor and shall be registered Contractor of P&T/DOT for Telephone and Computer Wiring.

6.25 **CONDUIT**

6.25.1 Conduiting shall be done as per the relevant head in the specifications.

6.26 **LIST OF APPLICABLE STANDARDS**

1. TIA/EIA-568-A/B-2-1
2. TIA/EIA-569
3. EIA/TIA-TSB-67
4. UL 1863/UL 497A/UL 94V-0
5. ULC- C22.2
6. ISO 9001:2002 and 14001
7. ANSI/TIA/EIA-607
8. NFPA-70
9. IEEE802 / IEEE802.3 / IEEE 802.3Z
11. Underwriters Laboratories Cable Certification
7.0 **LT POWER DISTRIBUTION CABLES:**

7.1 **Scope:**

7.1.1 The scope of this section covers the supply, laying, testing and commissioning of overhead and underground LT cables as specified in Bill of Quantities.

7.2 **LV cables:**

7.2.1 Cables shall be PVC/XLPE insulated and shall be of 650/1100 volts grade or as specified and shall have been manufactured confirming to BS 6346 and Indian Standard Specifications IS-694 and IS-1554 as applicable. These shall be of approved types accepted by the Fire Insurance Association of India for use in Industrial risks and to the following specifications. The contractor shall submit the Manufacturer’s catalogues giving electrical characteristics of the cables.

7.2.2 The fire retardant low smoke (FRLS) cables shall be 650/1100V grade multicore having annealed tinned copper wires, insulated with special polymeric material suitable to withstand 150 degree for 30 minutes, cores laid up melinex taped, special low halogen and low smoke elastomeric material inner sheathed black, armoured with G.I. Wires/cast steel strips, melinex taped outer sheathed with special low halogen and low smoke elastomeric material unless otherwise specified.

7.3 **Multi-core cables:**

7.3.1 These shall be as specified and small comprise of plain, circular, solid/ stranded Al conductors. PVC insulated and having an inner sheath of PVC compound, galvanized flat steel tape or round steel wire, armouring and PVC sheath overall and shall comply with IS:.1554-1961.

7.4 **Flexible cables:**

7.4.1 Twin flexible cables used for pendants and connections to other lighting fixtures shall have cross-section area or should be of 0.001sq. Inch (equivalent to 23/0.0076) or larger and be insulated in accordance with relevant IS specifications. The metric equivalent size for 23/0.0076 wherever mentioned may be noted as 23/0.20mm. All wires and cable shall be of FRLS type.

7.5 **Jointing and Terminating Cables:**

7.5.1 Joints and terminations shall comply with the following clauses as appropriate to the type of cable. The Engineer-in-Charge shall be informed where it is proposed to install joints that are not indicated.

7.5.2 The Engineer-in-Charge shall be given evidence that the joint or termination manufacturer has stated the materials to be employed are suitable for the type of cable to be jointed or terminated.

7.5.3 Cable shall not be cut until the jointing or terminating commences and the work shall precede continuity until it is completed. All necessary precautions shall be taken to prevent damage and ingress of moisture and impurities; cable ends shall be free from moisture before jointing commences. Where circumstances prevent, completion the cable ends shall be sealed. In the case of lead sheathed...
cables this shall be by plumbing and for aluminium sheathed cables by hermetically sealing.

7.5.4 The Contractor shall employ for this work, staff who is fully qualified and competent or the types of joints and terminations to be made.

7.5.5 Core identification shall be matched at each joint without twisting or crossing of the cores. Where numbered cores are jointed to coloured all cable runs and on sites with existing installations consistent with the system already in use.

7.5.6 For joints in armoured cables, a bonding conductor shall be connected across the armouring. A split ferrule shall be placed under the armouring to prevent deformation of the cable by the clamp.

7.5.7 At terminations, armouring and metal sheaths shall be connected directly to the external earthing terminal of the equipment by a bonding conductor. For LV cables the bonding conductor shall have a cross sectional area in accordance with Table 54P of IEE wiring Regulations. Metal sheaths of single core cables shall be bonded and earthed at one point only, as indicated, insulated glands shall be used at the open-circuit end or ends.

7.5.8 At terminations, cable tails shall be formed by separating and bringing out the cores. Each tail shall be long enough to connect to the terminals of the equipment.

7.5.9 At the terminations of single core cables, gland plates shall comply with relevant clause. For three phase circuits the phase conductors shall be arranged, if possible, in trefoil formation where they pass through the enclosure of equipment.

7.5.10 Core identification at terminations shall be by coloured or numbered plastic stretch or shrink ferrules.

7.5.11 Continuity of spare cores shall be maintained at joints and at terminations, the cores shall be connected to spare terminals.

7.5.12 Solder shall be used only for connecting or terminating paper-insulated cables. All other connections and terminations shall be by means of compression fittings or mechanical clamps.

7.5.13 Compression connectors and associated dies for compression tools shall be of correct type and size. Tools shall be so designed that the correct compression must be applied before it can be released.

7.6 **Cable Identification:**

7.6.1 For multi core cables, PVC ferrule type indicators or tags shall be provided at both ends for core identification. For phase identification of 2/3/3.5/4 core cables, coloured PVC tapes shall be used at both ends.

7.6.2 All cables shall be provided with aluminium tags of approved design, spaced not less than 7.5 meters. Apart and these shall contain the following:
   - Feeder No.
   - Size
   - No. of Cores
7.7 **Sleeves, Tapes and Sealing Compounds:**

7.7.1 Sleeves shall be of the shrink type applied cold by mechanical device or by the use of heat, they shall provide a sufficient thickness of insulation to suit the particular application.

7.7.2 Insulating tapes used in joints and terminations shall be compatible with and have a temperature rating and insulating property not less than the cable insulation. They shall be complying with BS 3925.

7.7.3 Impregnated cotton tapes shall be double selvedged.

7.7.4 All tapes shall be stored in sealed containers until required.

7.7.5 Resin filling should be, as far as is reasonably practicable, safe and without risk to health. Each pack shall include warnings as to any hazards in its use, e.g. dermatic or toxic properties with details of precautions, which the user must take to minimize these.

7.7.6 Hot pouring sealing compound shall be hard setting and comply with BS 1858:1973 (1986). Selection of the compound shall take account of the ambient temperature of installation as well as characteristics of the joint.

7.7.7 Care shall be taken to prevent voids occurring in consequence of too rapid cooling.

7.7.8 Resin filling shall be used with PVC/ XLPE type cables and hot poured compound shall be used with paper insulated lead covered cables.

7.8 **Cable Supports:**

7.8.1 Unless otherwise indicated the type of cable supports used shall be selected by the Contractor to suit the circumstances of the installation, but they shall comply with these specifications and the following preferences shall be taken into account:

<table>
<thead>
<tr>
<th>For horizontal runs</th>
<th>Cable Tray</th>
</tr>
</thead>
<tbody>
<tr>
<td>For vertical runs</td>
<td>Clabber Cleats</td>
</tr>
<tr>
<td>Where marshalling of cables occur e.g. at switchboards</td>
<td>Cable Racks</td>
</tr>
</tbody>
</table>

7.8.2 Unless otherwise indicated all ferrous metal for cable tray, cable racks, and cable ladder, cable hangers and their fixings and suspensions shall have a galvanized finish.

7.8.3 For general use inside buildings the galvanised finish shall be a coating equivalent to and not less than type G275 to BS 2989, but manufacturer’s standard finishes will be accepted for slotted angles. All metal exposed during fabrication shall be given a coat of zinc-rich paint, brushed on or finished to match the manufacturer’s finish.

7.8.4 Metal cable tray shall be used unless otherwise indicated and it shall comply with these specifications where cables are laid in the cable tray they shall be secured by ties, each tie securing the cables of only one circuit. The ties shall be of a proprietary type not requiring screws or bolts for fixing the use of wire or similar material will not be permitted. Ties shall be spaced at not greater than 600 mm along each cable and within 100 mm of each bend or set.
7.8.5 Where cable tray is installed in the veritable plane, cables shall be supported by cable cleats.

7.8.6 Cable tray shall be fixed at regular intervals not exceeding 1200 mm and at 225 mm from bends and intersections. A minimum clear space of 20 mm shall be left behind all cable trays.

7.9 **Cable cleats:**

7.9.1 Cable cleats shall be made from materials, which are resistant to corrosion without the need for treatment of special finish.

7.9.2 Cable cleats shall be of a size such that they can be tightened down to grip the cables without exerting undue pressure or strain on them. For vertical cable two bolt cable cleats shall be used which shall grip the cables firmly enough to prevent them slipping.

7.9.3 The spacing of cable cleats shall comply with the IEE Wiring Regulations. At bends in the cable, cleats shall be located immediately on each side.

7.10 **Cable Racks:**

7.10.1 Cable racks shall comply with these specifications and shall be constructed from proprietary systems using channel sections with return lips and compatible fixing accessories, factory formed cable ladder may also be used.

7.10.2 Cable shall be fixed to the racks and ladders by cable cleats.

7.11 **Cable Hangers:**

7.11.1 Cable hangers shall be used only where indicated. They shall be made from mild steel flat bar complying with these specifications.

7.12 **Suspensions and Fixings:**

7.12.1 It is preferred that proprietary suspension systems comprising channel sections with return lips and compatible fixing accessories or slotted angles should be used, Where necessary fixing may be fabricated from mild steel flat bar. Metal arc welding shall comply with BS 5135.

7.12.2 Unless otherwise indicated fixing to the building fabric shall comply with table below:

<table>
<thead>
<tr>
<th>Building fabrics</th>
<th>Type Fixing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Steel work</td>
<td>Purpose made clamps (Type to be approved by Engineer-in-Charge)</td>
</tr>
<tr>
<td>Non-structural steel work</td>
<td>Bolts, Washers and nuts.</td>
</tr>
<tr>
<td>Expanding anchors</td>
<td>Concrete brick or building Blocks</td>
</tr>
<tr>
<td>Timber</td>
<td>Coach bolts</td>
</tr>
</tbody>
</table>

*Note:* Where cable cleats are fixed direct to concrete, brick or building block, fiber plugs and screws may be used as appropriate.

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56 | P a g e 56
7.12.3 No shot firing shall be used and no drilling or welding of structural steel shall be done without approval of the Engineer-in-Charge.

7.12.4 Suspensions and fixings shall be comply with relevant clause.

7.12.5 Bolts, nuts, washers and screws shall be cadmium or zinc Electroplated or passivated.

7.13 **Bonding:**

7.13.1 Supplementary bonding shall be installed between component parts of cable trays, racks or ladders where the method of mechanical connection does not provide permanent and reliable metal to metal joints of negligible impedance.

7.14 **Cable Installation:**

7.14.1 Unless the routes of cables are indicated on drawings, they shall be determined by the contractor and approved by the Engineer-in-Charge before work is started.

7.14.2 Cable installation on the surface shall be parallel with the lines of building construction and properly aligned.

7.14.3 A minimum clearance of 150mm shall be allowed from any equipment, pipe work or duct work. The distance shall be measured from external surface of any lagging.

7.14.4 In the event of difficulty in achieving these requirements, Engineer-in-Charge shall be informed.

7.14.5 Spacing between cables shall comply with relevant table, but where indicated account must be taken of any grouping necessary to maintain the current carrying capacities of cables.

7.14.6 Space shall be allowed along cables routes for future additions where indicated and cable supports shall be of adequate size for the ultimate load.

7.14.7 Adequate space shall be left between cable runs, the building fabrics and other services to allow for future removal or installation of cables.

7.14.8 Cables shall be adequately supported by one of the methods specified in clause 9.8 throughout cable ducts or are buried direct in the ground. Fixing direct to building fabric by cable cleats may be adopted for single runs subject to the approval of Engineer-in-Charge, and where indicated.

7.14.9 Cables shall be supported within 30mm of their termination at equipment; the weight of the cable shall not be carried by the terminal box gland.

7.14.10 Where cables cross expansion and settlement joints in the building structure, they shall be fixed 300 mm each side of the joint and sufficient slack left between to allow for movement. Where the cables are buried in the building fabric suitable provision shall be made to allow for movement of the structure. The contractor shall submit his proposals for approval of Engineer-in-Charge.
7.15 **Handling of cables:**

7.15.1 Cables shall be handled with care and every effort made to avoid damage to the cables, to other services and to building fabric. Recommendations or instructions available from the cable manufacturers concerning the installation of cables shall be taken into account. In particular co-axial cable shall not be bent in radius less than six times the overall diameter. Any damage shall be reported immediately to Engineer-in-Charge.

7.16 **Marking of cables:**

7.16.1 Cables located in switch rooms, ducts and spaces designated solely for electrical services or have orange over sheaths, they shall be identified by adhesive bands coloured orange, complying with BS 1711. The bands shall not be less than 100 mm long, located at least once within each separate compartment through which the cables pass at intervals not exceeding 12 m.

7.16.2 Except where cables are buried or enclosed in conduit, trunking or ducting, they shall be permanently identified by discs. Discs shall be of laminated plastic materials with black characters on white. Characters shall be not less than 3 mm high. The inscription shall indicate nominal voltage, designation of load, number and cross sectional area of cores and rated voltage of cable.

7.16.3 Cable identification discs shall be attached to the cables with ties. Discs shall be located within 500 mm of terminations and joints, at least once within each separate compartment through which cables pass and at intervals not exceeding 24 m, they shall coincide with the colour bands.

7.17 **Laying Cables in Ground:**

7.17.1 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 meters. Cables shall be laid at depth of 0.75 meters below ground level. The Bricks and 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.

7.17.2 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 be 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 meter long loop shall be provided at both end of cable.

7.18 **Laying in Pipes / Closed Ducts:**

7.18.1 The size of the pipe shall be decided by the Engineer-in-Charge and shall not be less than 10 cm, in diameter for a single cable and not less than 15 cm for more than one cable. These pipes shall be laid directly in ground without any special bed except for SW pipe which shall be laid over 10 cm, thick cement concrete 1:5:10 (1 cement : 5 coarse sand: 10 graded stone aggregate of 40 mm nominal size) bed. No sand cushioning or tiles need be used in such situations. Unless otherwise specified, the top surface of pipes shall be at a minimum
depth of 1m from the ground level when laid under roads, pavements etc.

7.18.2 Where steel pipes are employed for protection of single core cables feeding A.C. load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of poly phase system.

7.18.3 The pipes on road crossings shall preferably be on the skew to reduce the angle of bend as the cable enters and leaves the crossing. This is particularly important for high voltage cables.

7.18.4 Manholes of adequate size as decided by the Engineer-in-Charge shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design.

7.18.5 Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing.

7.18.6 Pipe for cable entries to the building shall slope downwards from the building and suitably sealed to prevent entry of water inside the building. Further the mouth of the pipes at the building end shall be suitably sealed to avoid entry of water.

7.18.7 All chases and passages necessary for the laying of service cable connections to buildings shall be cut as required and made good to the original finish and to the satisfaction of the Engineer-in-Charge.

7.18.8 Cable grips / draw wires and winches etc. may be employed for drawing cables through pipes/closed ducts etc.

7.19 **Laying in Open Ducts:**

7.19.1 Open ducts with suitable removable covers shall be preferred in substations, switch rooms, plant rooms, workshops etc.

7.19.2 The cable ducts should be of suitable dimensions so that the cables can be conveniently laid. If necessary, cables may be fixed with clamps on the walls of the duct or taken in troughs in duct. The duct should be covered with removable slabs or chequered plates.

7.19.3 Ducts may be filled with dry sand after the cable is laid and covered as above or finished with cement plaster specially in high voltage applications.

7.19.4 Splices or joints of any type shall not be permitted inside the ducts.

7.19.5 As far as possible laying of cables with different voltage ratings in the same duct shall be avoided.

7.19.6 Where considered necessary, hooks or racks shall be provided for supporting the cables in masonary / concrete cable ducts, cable troughs. Otherwise cables shall be laid direct in the trench or trough etc. While deciding the layout of cables in such ducts, care should be exercised to ensure that unnecessary crossing of cables is avoided.
7.20 **Protection of Cables:**

7.20.1 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 cables 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.
8.0 **INSPECTION AND TESTING:**

8.1 **General:**

8.1.1 Inspection and testing shall be done in accordance with the IEE Wiring Regulations, the requirements of this Section and as indicated.

8.1.2 Inspection shall include a physical check that all equipment has been securely fixed and that all electrical connections are mechanically sound.

8.1.3 In addition to the test at the completion of each installation, certain tests shall be done during the progress of the Works as required by relevant clauses of these specifications.

8.2 **Information:**

8.2.1 For equipment supplied under the contract, the Contractor shall obtain from manufacturers the time/current characteristics of all protective devices for automatic disconnection of supply and provide copies to the Engineer-in-Charge and to the person or persons carrying out the inspection and testing, in addition to meeting the requirements of clause.

8.3 **Testing Methods:**

8.3.1 The Engineer-in-Charge shall be notified of the method to be used for each type of test and the notification shall be given not less than 28 days before the final tests are to be made. The tests shall be carried out in accordance with the methods set out in the IEE Wiring Regulations, subject to the requirements of following clauses.

8.3.2 For testing, continuity of protective conductors and equipotential bonding AC source shall be used unless the Engineer-in-Charge agrees otherwise.

8.3.3 The method used to verify the effectiveness of the protection afforded by a residual current-operated device shall give the operating time and the current used shall not exceed 100% of the nominal setting of the device. For a fault voltage operated device, the test voltage between the exposed conductive part and earth shall not exceed 50 volts. In addition to the tests simulating an appropriate fault condition, any test facility incorporated in the device shall be operated to test its effectiveness.

8.3.4 High Voltage tests on LV cables and factor assemblies shall comply with the requirements for site testing in the appropriate British Standards.

8.3.5 Alternative methods to those set out in the IEE Wiring Regulations may be proposed for the approval of the Engineer-in-Charge, but they shall be not less effective than those in the Regulations.

8.3.6 Where necessary to prevent damage to components of equipment, the equipment shall be disconnected for the duration of the relevant tests.

8.4 **Power Cables:**

8.4.1 Tests shall be made immediately on completion of the installation of power cables to demonstrate that the phase sequence is correct at all end connections.
8.4.2 Where indicated, LV cables shall be tested at high voltage in accordance with these specifications.

8.4.3 LV cables not required to be high voltage tested, shall be tested for insulation resistance as soon as their installation is complete. The test voltage shall be 500V DC for installations rated up to 500V and 1000V DC for installations rated up to 1000V. Tests shall cover all permutations between each conductor, screen, metallic sheath, armour and earth.

8.4.4 The over sheaths of cables laid underground shall be given a voltage withstand test after backfilling of the trenches is complete but before termination.

8.5 **Control and Communication Cables:**

8.5.1 Cables shall be tested as soon as their installation is complete to ensure that the cores are continuous and they have not been crossed and the insulation resistance is satisfactory. Insulation tests shall cover all permutations between each conductor, screen, metallic sheath, armour and earth.

8.5.2 For polyethylene and dry paper-insulated communications cables, the insulation resistance for each conductor shall be not less than 1500 $L$ mega ohms, where $L$ is the cable length in Kilometres. The measured resistance of each conductor shall not exceed the calculated resistance by more than 5%; the calculated value will be made available by the Engineer-in-Charge.

8.6 **Conduit And Trunking:**

8.6.1 Where conduit is cast in situ in reinforced concrete, it shall be checked for freedom from blockage and steel conduit shall be tested for electrical continuity as soon as the shuttering has been removed.

8.6.2 Steel conduit and bus duct systems shall be inspected and tested before any wiring is installed; under floor ducting shall be inspected and tested before screeding.

8.7 **Earth Electrodes:**

8.7.1 The resistance of each earth electrode, whether for earthing of protective conductors, lightning protection or an electrical system, shall be checked immediately after installation of the electrodes and the results submitted to the Engineer-in-Charge.

8.8 **Earth Fault loop impedances:**

8.8.1 The measured earth fault loop impedance for each circuit shall be checked against the maximum value as indicated.

8.8.2 Where the maximum value is exceeded the Engineer-in-Charge shall be informed.

8.9 **Records And Certificates:**

8.9.1 Inspection and test results shall be recorded on the forms provided by the Authority. Two copies shall be submitted to the Engineer-in-Charge within 7 days of each test.

8.9.2 When all inspections and tests results are satisfactory, a Completion
Certificate and an Inspection certificate shall be given to the Engineer-in-Charge not later than the date of completion of the works. The certificates shall be given in the form laid down in the IEE Wiring Regulations for electrical installations and BS 5266 for emergency lighting systems.

8.9.3 The values of prospective short-circuit current and earth fault loop impedance at the origin of the installation shall be recorded on the Inspection certificates.
9.0 **DRAWINGS AND DOCUMENTS BY CONTRACTOR:**

9.1 **Extent of Provision:**

9.1.1 Unless otherwise indicated, the Contractor shall provide the shop drawings and documents specified these specifications.

9.1.2 General layout drawings shall be drawn to a scale of 1:50 and detailed layout assembly drawings to a scale of 1:20. If more details is necessary scales of 1:10, 1:2 and 1:1 may be used.

9.1.3 The numbers of sets of drawings and documents to be supplied shall be as indicated.

9.2 **Shop Drawings and Documents:**

9.2.1 Shop drawings and documents including diagrams and schedules shall show the details of the Contractor’s proposals for the execution of the works and shall include everything necessary for the following purposes:

   a) To illustrate in details, the arrangement of the various sections of the works and to identify the various components;

   b) To integrate the works with the detail of the building and other installations.

9.2.2 Shop drawings shall include:

   a) General layout drawings showing the location of all equipment including cable; cable tray, conduit ducting and earth electrodes;

   b) Detailed layout drawings showing the location of all equipment including cable, cable tray, conduit and ducting in switch rooms and plant rooms;

   c) Assembly drawings of factory Built equipment and site built assemblies;

   d) Detailed layout drawings showing the connection of cable and conduit to equipment;

   e) Detailed layout drawings showing the connections through ceiling voids and vertical shafts;

   f) System diagrams, circuit diagrams and wiring diagrams for all installations and equipment.

9.2.3 Diagrams shall comply with relevant IS. Interconnection diagrams shall indicate the type of cable, conductor size and terminal numbering.

9.3 **Builder's Work Drawings:**

9.3.1 Builder's work drawings shall show fully dimension details of all builders work required in connection with the works together with the overall size and weight of equipment.

9.3.2 Where the Engineer-in-Charge agrees, holes may be marked out on site instead of being shown on drawings.
9.4 **As Built Drawings:**

9.4.1 As-built drawings, including diagrams and schedules shall show all the information necessary so that each installation can be operated, maintained, inspected and tested so as to prevent danger, as far as is reasonably practicable. They shall incorporate the information necessary for the identification of the devices performing the functions of protection, isolation and switching, and their locations. The value of prospective short-circuit current and earth fault loop impedance at the origin of the installation shall be recorded on the appropriate system diagram.

9.4.2 Circuit details including loading, route, destination and where buried, the depth below finished ground level shall be shown for each cable, conduit, and ducting. Conductor size and material and the type of insulation of all cables shall be shown together with the number of cores in each cable, the number of cables in each conduit, trunking or ducting. Where identification is by colour of insulation or sheath, this shall be shown. Joints and draw boxes shall be shown.

9.4.3 Where incoming supply cables are installed by others, they shall also be shown as described above.

9.4.4 Drawings shall indicate whether conduit or ducting is surface mounted, concealed in ceiling, spaces in wall chases, in floor screeds or cast in mtu.

9.4.5 All earthing conductors, main equi-potential bounding conductors, main earthing terminal or protective conductors and supplementary equi-potential bonding conductor shall be identified with function, origin route, destination, conductor size and material, type of insulation and where buried, the depth below finished ground level test points shall be indicated.

9.4.6 Earth electrodes shall be identified to their types, dimensions, material and depth below finished ground level. The nature of the soil and any treatment that has been given to it or special fill that has been used in the installation shall be identified.

9.4.7 Details of each item of equipment including luminaires shall include electrical characteristics, classification, degree of protection against ingress of solids and liquids, class of protection against corrosion and manufacturer's name and reference.

9.4.8 Diagrams shall comply with relevant clauses of these specifications and they shall be supplemented with physical arrangement drawings to assist the location and identification of component parts of equipment.

9.4.9 During the course of the works, the contractor shall maintain a fully detailed record of all changes to ensure that the as-installed drawings are in all respects accurate.

9.4.10 Each drawing shall be in accordance with relevant IS to ensure suitability for micro- filming and shall be on durable translucent material, other than paper, of a standard size AO to A4 in accordance with relevant IS. The words 'AS-BUILT' shall be place in 19 mm block letters adjacent to the title block of each drawing together with the name of the site and the section of the works, the title of the installation, the date of completion of the works, the Authority's contract number and the name of the Contractor.

9.4.11 A draft of each as built drawing shall be submitted to the Engineer-in-Charge before final issue is made.
9.5 **Maintenance and Operating Instructions:**

9.5.1 For each electrical installation, system and individual equipment forming part of the works, the maintenance and operating instructions shall include:

a) A description of the extent and manner of operation, including duration periods of standby systems;

b) A description of the method used for compliance with Regulation 413-3 of the IEE wiring Regulations together with time/current characteristics for all protective devices or automatic disconnection of supply.

c) Copy of the inspection certificate and all the test records.

d) A copy of any certificates of compliance with relevant standards or schemes as may be required.

e) Comprehensive instructions for the switching on, operation, switching off and isolation, and for dealing with emergency conditions.

f) Instructions for any precautionary measures necessary.

g) Instructions for servicing, including frequency and materials to be used, to maintain the equipment in good and safe condition.

h) The names and addresses of suppliers of all major components together with the type and model reference, serial number, duty rating and the order number and date.

9.5.2 Maintenance and operating instructions shall be indexed and contained in ring binders with stiff covers. The name of the site and the Authority's contract number shall be printed on the front and spine with, where more than one volume is necessary, a suitable identification title. The date of completion of the works shall be included on a flyleaf.

9.5.3 Copies of manufacturer's data may be incorporated to supplement the descriptions and instructions required in relevant clause but shall not replace them. Only data relevant to the works shall be included. Where non relevant data appears on the same sheet, it shall be cleared marked to show that it is not applicable. The data shall be cross referenced within the text and included in the index; if possible, it shall be contained in the ring binders, but where this is not possible, suitably protected box files or folder shall be provided, identified in accordance with relevant clause.

9.5.4 A draft of the maintenance and operating instruction shall be submitted to the Engineer-in-Charge before the final documents are issued.
10.0 SAFETY REQUIREMENTS:

10.1 Scope:

10.1.1 Safety procedures as laid down in Indian Standards shall be strictly followed during erection and commissioning.

10.1.2 The safety provisions required under the IEE Rules shall be provided for which no extra payment shall be made.
SPECIFICATION FOR ELECTRICAL WORK

1.0 This specification is intended to cover electrical work for ESIC HOSPITAL AT BHILAI

1.02 It is not the intent to specify completely herein all aspects of design and constructional features of equipments and details of the work to be carried out, nevertheless, the equipment and work shall conform in all respects to high standards of Engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the owner who will interpret the meaning of the specifications and drawings and shall have right to reject or accept any work or material which in his assessment is not complete to meet the requirement of this specifications and or applicable code and standards mentioned elsewhere where in this specifications.

2.00 SCOPE OF WORK

The scope of work under this specification shall include design manufacture, testing, supply, and storage, erection, testing & commissioning of following items of external electrification with making connection to the out going panels

i) 1000 KVA (IS1180-Star-I )33KV / 433v transformers with OLTC

ii) DG sets & Provision of metering along with AMF Panel

2.01 B) Services:

a) 33KV (switchboards) indoor VCB , HT & LT XLPE cables, cable trays, cable termination kit

b) 415 volt capacitor bank

c) External lighting (Supply, Erection)

d) Earthing system

h) All necessary approvals (electrical load approval from CHH.SEB / Approval from Local authority / Chief electrical inspector)

i) The scope of work shall also include all minor/civil works associated with erection of poles ,earthing and lightning protections system, lighting and power panels Distributions boards, Rising mains, cables & cables trays ,sealing of electric cables in entry and of the same

j) Materials and components not specifically mentioned in this specification, but necessary for satisfactory installation and operation of the system mentioned there in shall be deemed to have been included in the scope of work of this specification.

k) Data sheets for different equipment’s are enclosed at the end of specification, shall be furnished along with offer.

l) Lighting system for the indoor and outdoor areas of the building complete with switch boards, switches, receptacles, wires, conduit, earthing and their accessories etc. as required.

2.02 The abbreviations used in this specification / tender / drawing
Stand for:

a) V ... Volt
b) Amp ... Ampere
c) KV ... Kilo-volts
d) IEE ... Institute of Electrical Engineers, London
e) IC ... Iron Clad
f) M.S. ... Mild Steel
g) HRC ... High Rupturing Capacity
h) MCB ... Miniature Circuit Breaker
i) MCCB ... Moulded Case Circuit Breaker
j) ACB ... Air Circuit Breaker
k) OCB ... Oil Circuit Breaker
l) ELCB ... Earth Leakage Circuit Breaker
m) SFU ... Switch Fuse Unit
n) SP & NL ... Single Phase / Pole & Neutral Link
o) TP & NL ... Triple Pole & Neutral Link
p) IDMTL ... Inverse Definite Minimum Time Lag
q) D.B. ... Distribution Board
r) S.B. ... Switch Board
s) D.P. ... Double Pole
t) PVC ... Polyvinyl Chloride
u) S.S. ... Selector Switch
v) KWH ... Kilo-watt Hour
w) MDI ... Maximum Demand Indicator
x) O/C ... Over Current
y) E/F ... Earth fault
z) C.T. ... Current Transformer
i) PT/VT ... Potential transformer/ Voltage transformer
ii) VCB ... Vacuum Circuit Breaker.

2.03 FEES, PERMIT AND TESTS:

The contractor shall obtain all sanctions and permits required for the electrical installation work. All actual fee payable in this regard will be reimbursed against receipt / documentary evidence. On completion of the work, the contractor shall obtain and deliver to the consultant, certificates of final inspection and approval of Electrical Inspector and by local Electric Supply Authority. The consultant / Owner shall have full powers regarding the materials or work got tested by Independent agency at the electrical contractor's expense in order to prove their soundness and adequacy.
2.04 The installation shall comply in all respects with the requirements of Indian Electricity Act, 1910 as amended up to date, Indian Electricity Rules, 1956, there-under and special requirements, if any of the State Electricity Boards etc.

a) For Local administration, the tenderer / contractor is liable to furnish the list of authorised licensed persons/employed/deputed to carry out the works / perform the assigned duties to full fill the requirements of Rule No. 3 of IER - 1956, as amended up to date.

A. DRAWINGS

i) A drawing showing general layout of distribution as such are enclosed with this pacifications or can be seen at Consultant / Architect office. These drawings are meant to give a general idea to bidder regarding the nature of work covered by these specifications.

ii) No information / data shown / not shown in these drawings shall not relieve the contractor of his responsibility to carry out the work as per these specifications and or construction drawings released after the award of work. Prices shall not be subject to variation after award of work, due to differences between drawings and actual constructions drawings released from time to time.

`iii) The contractor shall prepare and submit to the consultant for his approval detailed shop drawings, of HT panel / Transformers, capacitor bank and DC circle including, earthing etc. within 7 days of award of work. All work shall be carried out on the approvals of these drawings. However, approval of these drawings does not relieve the contractor of his responsibility to meet with the intent of the specifications.
33 KV, HT VACUUM CIRCUIT BREAKER PANEL

1.0 SCOPE:-
This section covers design, manufacturing, supply, installation, testing and commissioning of 33 KV HT indoor types, **Three panels extendable to Four panel board** Vacuum Circuit Breaker switch board (one incomer and two outgoing Vacuum Circuit Breaker panels and provision of two panel board for future extension).

2.0 FUNCTIONAL REQUIREMENT
The incoming Vacuum Circuit Breaker shall receive the incoming 33 KV HT supply from U.P.S.E.B. feeder and the four numbers of outgoing (one for future extension) Vacuum Circuit Breaker Panels board are meant for operating three numbers of indoor type distribution transformers and one number for Technical block.

3.0 STANDARDS
HT panels with accessories shall be designed to conform to the requirements of the following Indian Standard Specifications with upto date amendments:

(i) IEC-60265, IEC 60129 IEC 60056 IEC 60694 IEC 60298  
(ii) IS:2147 – Degree of protection provided by enclosures for low voltage switchgear and control gear.  
(iii) IS:2705 – Current transformers  
(iv) IS:3156 – Voltage transformers

4.0 DESIGN
The Vacuum Circuit Breaker switch board shall be sheet steel clad, totally enclosed, dust and vermin proof, indoor type, rigid, free standing, floor mounted, powder coated and shall be suitable for operation on 33 KV ± 10%, 3 phase, 50 Hz ± 5%, AC system. Each Vacuum Circuit Breaker Panel section shall be designed and provided with 630 Amps. Vacuum Circuit Breaker and associated switchgear / system / accessories like switchgear, bus-bar, potential transformer unit, instrumentation, protective devices etc. The Vacuum Circuit Breaker shall generally be conforming to above mention IEC and meet the following requirements, unless otherwise specified.

5.0 CONSTRUCTION

5.1 MATERIAL
In general the HT Vacuum Circuit Breaker switchboard shall be fabricated CRCA sheet steel material and thickness of the sheet steel (14 SWG) shall be as per manufacturer’s standard constructional features.

5.2 STRUCTURE
- Breaker section
- Metering & Indication sections
- Bus bar Chambers
- Cable Compartment
- Potential transformer compartment
- Relay & Auxiliary equipment

5.3 DEGREE OF PROTECTION (IP CLASS)
Degree of protection for HT Vacuum Circuit Breaker switch board shall be as per IECs as mentioned above.
5.4 OTHER TECHNICAL REQUIREMENTS

i. The general arrangement shall be got approved before manufacture.
ii. Panels shall be fabricated in various shipping sections, which when coupled together shall form continuous front matched switchboards.
iii. The panels shall be extendable on both sides. Suitable provision shall be made for extending the bus bars on both sides.
iv. Each feeder compartment shall have a hinged door.
v. All doors shall have neoprene gaskets. Adequate protection shall be provided so that ingress of dust and moisture encountered in indoor installation shall not in any amount be sufficient to interfere with the satisfactory operation of enclosed equipment.
vi. All switches, indicating instruments etc., shall be flush mounted.
vii. All the switchgear and components shall be brand new, genuine and free from manufacturing, transit defects.
viii. All the items and their quantity shall be as per Technical particulars and SOQ / BOQ.
ix. Insulation materials used shall have excellent insulation properties compatible to the system parameters with good mechanical, electrical strength to withstand electrical and mechanical stresses and shall be fire resistant.
x. Extension of auxiliary power supply and control accessories if any required is included in the scope of work.

6.0 Vacuum Circuit Breaker SWITCH BOARD COMPONENTS

6.1 Vacuum Circuit Breaker

6.1.1 The Vacuum Circuit Breaker shall be mounted in a common compartment.
6.1.2 The rated current of Vacuum Circuit Breaker for incomer section and as well as outgoing sections shall be 630 amps.

6.1.3 Vacuum Circuit Breaker shall have the following features:-

i. A motor operated spring charged closing mechanism and time required to charge the closing spring fully shall not exceed 15 sec.
ii. Manual stored energy mechanism and handle etc. shall be as per OEM’s standard.
iii. Breaker closing options both electrically and manually (to close the breaker, the closing spring can be unlatched mechanically by means of the local “closed” push button or electrically by remote control).
iv. Appropriate mechanism suitable for repeated auto re-closing duty.
v. Parameters of SF6 gas shall be as per IEC-376.
vi. Other features, accessories, protective devices etc. to be provided shall be as per technical particulars, SOQ/BOQ and OEM’s standard.

6.2 BUS BARS
The bus bar shall be air insulated, covered with special heat shrinkable insulation sleeves, hard drawn Tinned Copper strip rates for minimum 630 amps. Triple pole.

6.3 POTENTIAL TRANSFORMER
6.3.1 Potential transformer shall be provided only in the incomer Vacuum Circuit Breaker panel section.
6.3.2 Potential transformers shall conform to IS:3156. The ratio type VA burden, accuracy class etc. shall be as per technical particulars.

6.4 CURRENT TRANSFORMER
Current transformers shall conform to IS:2705 (Part-III) – 1964. The ratio, VA burden, accuracy class etc. for metering and protection CTs shall be as per Technical particulars. The CTs shall be double ratio, single core type. 2 sets of CTs shall be provided in each panel (01 set of metering and 01 set for protection).

6.5 PROTECTIVE DEVICE

Protective devices to be provided in each Vacuum Circuit Breaker Panel shall be as per technical particulars. 3 OC + 1 EF (IDMTL) relay shall be numerical and communicable type. All auxiliary relays, master trip relay, trip circuit supervision relay, transformer protection relay etc. shall be non-numerical non communicable type.

6.6 METERING

The Vacuum Circuit Breaker Switch board shall be provided with the following metering facilities:

i. One set of suitable range digital voltmeter; digital ammeter and digital frequency meter shall be provided in incomer VCB panel (Single unit to read, above two or more parameters is not acceptable).

ii. Each outgoing Insulated Vacuum Circuit Breaker panel shall be provided with one set of suitable range digital ammeter and power factor meter of standard range.

iii. The digital voltmeters and digital ammeters shall have in built selector switch as per the original manufacturer’s standard.

iv. In addition to (i), the incomer breaker panel section shall be provided with one number intelligent multifunction digital meter to read A, V, KVA, KW, KVAR, KVAH, KVARH, Hz, PF etc.

6.7 LAMP PROTECTION

Unless otherwise specified all the indicating lamps shall be LED type.

All indicating lamps shall be clear type with appropriate color lenses ensuring clarity of color.

6.8 CONTROL WIRING

Shall be done with minimum 2.5 sq.mm. Tinned Copper cable.

6.9 CABLE BOX

Cable box for the incoming and outgoing power cables shall be bottom straight entry type and shall be provided on back side of the panel and complete with gland plate etc., suitable for upto 3 core 300 sq.mm. 11 KV XLPE/Paper/PVC insulated and sheathed, aluminium conductor armoured cable.

6.10 ACCESSORIES

Unless otherwise specified, following minimum accessories shall be supplied along with the Circuit Breaker Panel.

i. Operational handle

ii. Integral earthing OEM’s standard design is acceptable.

7.0 SAFETY SYSTEMS
The system shall have the following safety features:

- Independent safety shutters for upper and lower disconnect contacts.
- An interlock to ensure the circuit insertion to or withdrawal from SERVICE position only when it is OPEN.
- Padlocking arrangement for shutters.
- Interlock shall be provided such that breaker closing is prevented in intermediate position between service and test / isolated positions.
- Mechanical interlock to prevent breaker truck racking in/out when breaker is closed position.
- Breaker can be inserted only when control plug and socket is in position control plug & socket can be removed only in isolated position.
- Arrangement for emergency tripping without opening the cubicle door shall be provided.
- Pressure release flaps at the top of the panel at safe height or it shall be as per original manufacturer’s standard. Separate circuit breaker, bus bar and cable compartments.
- Foolproof interlocks as per IS/IEC.
- LT & HT compartments to be fully segregated for ease in operation and maximum safety.

8.0 PAINTING

Painting of panels /switchboard shall be grey with appropriate shade as per manufacturer’s standard.

9.0 INSTALLATION

Following shall be the part of the installation works

- Shifting of the unit(s) from place of storage to place of installation.
- Un packing
- Verification for transit damages / availability of all items including accessories, operating handles, instruction manuals, drawings, test certificates etc. and taking necessary action where needed.
- Assembling different sections / units when sent separately.
- Positioning of the units as per the drawings / site requirements.
- Alignment checks
- Grouting / securing to the floor / foundations / base channels etc. for stable installations.
- Undertaking all related minor civil, mechanical works like chipping, plastering, cutting, welding, drilling etc.
- Taking all necessary safety precautions for the equipment as well as personnel.
- Touching up damaged painting portions.
- Making connection to Earth of the unit.
- Connecting and ensuring efficiency termination of cables as per BOQ using proper size cable lugs, glands and appropriate size GI / Zinc passivated hardware with spring washes and plate washers at appropriate locations (smaller size bolts not to be used for bigger holes in cables lugs/ switch gears to avoid weak electrical connections). Scope of cable termination shall be measured separately.
- Ensuring proper tightness of all joints, connections.
- Providing proper supporting / protection arrangement to the cables / units etc. to avoid undue stress on the termination / joints.
- Providing required instruction / information / caution / name plates for easy operation and maintenance.
- Provision of interlocks where needed.
Following proper codes like IS and sound engineering practices.

- Obtaining requisite statutory approval, licences etc. where applicable
- Performance pre-commissioning checks and ensuring proper functioning of all the systems.
- Satisfactory commissioning the equipment/system
- Documentation

10.0 TESTS

10.1 FACTORY TESTS

Following routine / acceptance and types shall be done at factory.

10.1.1 The panels shall be checked and tested after fabrication, assembling and wiring at factory as per the following:

**Checks**

1. Manufacturer of panel as per the agreement SOQ/BOQ and related specifications.
2. Compliance of using approved makes.
3. Manufactured as per approved drawings.
4. Inspection for any damages.

**Tests**

The following are the routine tests:

a) Measurement of resistance of the main circuits
b) Operation tests
c) One minute power frequency voltage dry withstand tests on the circuit breakers
d) One minute power frequency voltage dry withstand tests on auxiliary circuit.
e) Functional test for all safety and control.

10.2 TYPE TESTS

The type test certificate as per IS for similar panel shall be submitted.

10.3 SITE TESTS

In addition to the tests at manufacturer’s premises, all relevant pre-commissioning checks and tests shall be done at site before energizing the switch board.

Following shall be minimum checks/tests to be done at site.

1) Physical inspection for breakages/damages/orderliness.
2) Insulation resistance test with 5 KV meggar.
3) Earth continuity test
4) Tightness of joints/connections/terminations.
5) Safety checks
6) General operation/ performance checks

All test results are to be recorded and reports should be submitted to the department.
10.4 CALIBRATIONS

All the protective relays shall be calibrated and test certificate shall be submitted.

10.5 TEST CERTIFICATES

Following test certificates shall be submitted by the agency:

1. Test certificate for the routine / acceptance tests.
2. Test certificate for the type tests such as temperature rise test, short circuit withstand test, degree of protection for similar panels.
3. Test certificates for the calibrations.

11.0 INSPECTION

The panels shall be inspected at the factory by the Engineer-in-charge or his/her authorized representative.

Tests shall be preformed in presence of AAI representative if so desired by the Airport Authority. The contractor shall give at least fifteen days advance notice in such case.

12.0 COMMISSIONING

After the completion of installation and testing works, the panel(s) shall be commissioned.

13.0 COMPLETION PLANS

On completion of work, the contractor shall submit 3 sets of following as built drawings / documents.

- General arrangement, layout drawings with dimensions, plans, sections etc.
- Single line diagram
- Control & schematic diagram
- Bill of quantities indicating makes, technical specs, quantity etc.
- Data sheets
- Control logic (where applicable)
- Details of inventory
- Equipment name place details
- Installation & maintenance manuals.
- Test certificates (factory tests, site tests)
- Guarantee / Warranty certificates (where applicable)

14.0 OTHERS

14.1 MAKES: - The makes of the items shall be as per the list of approved makes enclosed in the tender documents. Where makes have not been given, they shall be of ISI/superior quality and got to be approved by the Engineer-in-charge before using in the works.

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>I/C</th>
<th>O/G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel Qty--&gt;</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Vacuum Circuit Breaker ( Horizontal Draw out Horizontal Isolation type )</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33KV, 1250A, 25KA, VCB Panel with CU. <strong>Bus bar</strong></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>230V, AC, Motorized Mechanism</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

33KV, Indoor, 1No. Incoming and 2 Nos. Outgoing VCB -EXTINSIBLE
<table>
<thead>
<tr>
<th><strong>Degree of Protection</strong></th>
<th>IP4X</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Paint Shade</strong></td>
<td>RAL 7035</td>
</tr>
<tr>
<td><strong>Electrical release coils</strong></td>
<td>– 24/48VoltDC</td>
</tr>
<tr>
<td><strong>EPOXY RESIN CAST V.T.</strong></td>
<td></td>
</tr>
<tr>
<td>PT 3Ph, 3-Limb, 1 No., 33KV/110V/110V</td>
<td></td>
</tr>
<tr>
<td>Class-1, Burden-100 VA, Feeder Connected. With HRC Fuse</td>
<td></td>
</tr>
<tr>
<td><strong>EPOXY RESIN CAST,1-Ph CT (STR-25KA / 1 Sec):</strong></td>
<td></td>
</tr>
<tr>
<td>100/50/5+5A, CL-1/5P10, Burden-15VA metering and protection</td>
<td>3</td>
</tr>
<tr>
<td>60/30/5+5A,B CL-1/5P10, Burden-15VA metering and protection</td>
<td>0</td>
</tr>
<tr>
<td><strong>METERS (RISHABH /CONSERV/ MECO /L&amp;T)</strong></td>
<td></td>
</tr>
<tr>
<td>Ammeter – Digital 96 sq mm with S/S</td>
<td>1</td>
</tr>
<tr>
<td>Voltmeter – Digital 96 sq mm With S/S</td>
<td>1</td>
</tr>
<tr>
<td><strong>INDICATING LAMPS</strong></td>
<td></td>
</tr>
<tr>
<td>(TEKNIK/L&amp;T-ESBEE/BINAY)</td>
<td></td>
</tr>
<tr>
<td>BREAKER ON – Red</td>
<td>1</td>
</tr>
<tr>
<td>BREAKER OFF – GREEN</td>
<td>1</td>
</tr>
<tr>
<td>AUTO TRIP INDICATION – Amber</td>
<td>1</td>
</tr>
<tr>
<td>TRIP CIRCUIT Healthy - White</td>
<td>1</td>
</tr>
<tr>
<td>SPRING Charged – Blue</td>
<td>1</td>
</tr>
<tr>
<td>Phase indication - R, Y, B</td>
<td>3</td>
</tr>
<tr>
<td><strong>ACCESSORIES</strong></td>
<td></td>
</tr>
<tr>
<td>Push Button for trip circuit healthy check</td>
<td>1</td>
</tr>
<tr>
<td>Trip Neutral Close Switch, lockable</td>
<td>1</td>
</tr>
<tr>
<td>Panel Space Heater with Thermostat &amp; switch</td>
<td>1</td>
</tr>
<tr>
<td>Panel Illumination Lamp with Switch</td>
<td>1</td>
</tr>
<tr>
<td>3 Pin Plug with switch</td>
<td>1</td>
</tr>
<tr>
<td>6 N/O &amp; 6N/C</td>
<td>1</td>
</tr>
<tr>
<td><strong>RELAYS-ELECTRO MECH. / STATIC/Numerical</strong></td>
<td></td>
</tr>
<tr>
<td>IDMT 3 O/C +1 E/F Relay of Numerical microprocessor CGL141</td>
<td>1</td>
</tr>
<tr>
<td>Auxiliary relay ( AVAA-33 )</td>
<td>0</td>
</tr>
<tr>
<td>6- window annunciation</td>
<td>1</td>
</tr>
<tr>
<td>Incoming and outgoing Cable entry will be from bottom side</td>
<td>1</td>
</tr>
<tr>
<td>Power pack 24 / 110V</td>
<td>1</td>
</tr>
</tbody>
</table>
1.0 TECHNICAL SPECIFICATION FOR TRANSFORMERS

SCOPE—This specification covers the supply and delivery of outdoor type oil immersed, naturally cooled Integral distribution transformer with OLTC. The schedule of requirements enclosed with this specification given quantity requirements, rated KVA and voltage ratio etc.

1.1.1 This section covers the technical specification of the following transformers:

The equipment shall be manufactured in the manner set out in this specification or where not set out, to the reasonable satisfaction of the PURCHASER.

1.1.2 All fittings and accessories or apparatus which may have not been specifically mentioned below, but which are necessary and essential for the efficient working of the equipment, shall be deemed to be included in the scope.

1.2 Standards

1.2.1 The design, material, construction, manufacture, inspection, testing and performance of the transformers shall comply with all currently applicable statutes, regulations and safety codes.

1.2.2 Except as otherwise stated, the transformers and associated accessories shall conform in all respects to the latest issues of standards as given below:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS:335</td>
<td>New insulating oils</td>
</tr>
<tr>
<td>IS:1271</td>
<td>Thermal evaluation and classification of electrical insulation</td>
</tr>
<tr>
<td>IS:2026</td>
<td>Power transformers</td>
</tr>
<tr>
<td>IS:2099</td>
<td>Bushings for alternating voltages above 1000V</td>
</tr>
<tr>
<td>IS:2705</td>
<td>Current transformers</td>
</tr>
<tr>
<td>IS:3639</td>
<td>Fittings and accessories for power transformers</td>
</tr>
<tr>
<td>IS:6600</td>
<td>Guide for loading of oil immersed transformers</td>
</tr>
<tr>
<td>IS:8468</td>
<td>On load tap changers</td>
</tr>
<tr>
<td>IEC:71</td>
<td>Coordination of Insulation</td>
</tr>
<tr>
<td>IEC:85</td>
<td>Thermal evaluation &amp; classification of electrical insulations</td>
</tr>
<tr>
<td>IEC:137</td>
<td>Bushings for Alternating Voltages above 1000 V</td>
</tr>
<tr>
<td>IEC:185</td>
<td>Current Transformers</td>
</tr>
<tr>
<td>IEC:214</td>
<td>On load tap changers</td>
</tr>
<tr>
<td>IEC:270</td>
<td>Partial discharge requirement</td>
</tr>
</tbody>
</table>
Wherever the relevant IS Standards are not applicable, specification of CBIP / BSS / IEC may be adopted.

Deviations if any from the specification / standards shall be clearly explained.

The electrical installation shall meet the requirement of Indian Electricity Act 1910, Electricity (Supply) Act 1948, Indian Electricity Rules 1956 as amended upto date.

### Insulation

1.3.1 The insulation requirement of windings shall be

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Voltage (kV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal voltage</td>
<td>0.433</td>
</tr>
<tr>
<td>Highest system voltage (RMS)</td>
<td>1.1</td>
</tr>
<tr>
<td>Lighting impulse (peak)</td>
<td>-</td>
</tr>
<tr>
<td>Short duration power frequency withstand voltage</td>
<td>3</td>
</tr>
</tbody>
</table>

### Temperature Rise

1.4.1 The transformer shall be capable of operating continuously at full rating without exceeding the temperature limits specified below:

1.4.1.1 Temperature rise of top oil measured by thermometer, for ONAN cooling: 50°C

1.4.1.2 Temperature rise of winding measured by resistance, for ONAN cooling: 55°C

1.4.2 The ambient temperature (maximum) of cooling medium (Air) is 50°C.

### Duty Requirement

1.5.1 The transformer and all its accessories like current transformers, bushings etc., shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuit to earth and of short circuits at the terminals of any winding for a period of 2 seconds. Transformer shall be capable of withstanding thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any winding.

1.5.2 The transformer shall be capable of being loaded in accordance with
IS:1180. There shall be no limitation imposed by bushings, tap-changer etc.

1.5.3 The overload capacity of the transformer and their emergency short time ratings called for in schedule shall be furnished.

1.5.4 The transformer shall be suitable for continuous operation with a frequency variation of ± 5% without exceeding the specified temperature rise.

1.5.5 The transformer shall be capable of being operated without danger on any tapping at the rated MVA with voltage variation of ± 10% corresponding to the voltage of that tapping and at the same time with a frequency of 3% below normal.

1.5.6 Similar ratio transformers shall operate satisfactorily in parallel with each other.

1.5.7 The noise-level, when energised at normal voltage and frequency, shall not exceed, when measured under standard conditions, the value specified by CBIP.

1.5.8 The maximum flux density in any part of the core and yokes at normal voltage and frequency shall be such that the flux density under over voltage conditions shall not exceed the maximum permissible values for the type of core and yoke material used.

1.5.9 Transformers shall be capable of operating under natural cooled condition to the specified capacity. Transformers shall be capable of operating continuously in accordance with the application standard loading guide at their rated kVA and at any of the specified voltage ratios.

1.6 Impedances

1.6.1 The percentage impedance voltage at principal tapping on the ratio primary / secondary MVA base shall be as per IS 1180. The recommended impedance at 75ºC for 1000 kva is 5%

1.7 Losses for 1000 kva , 33 KV /0.433 kv Transformer losses *(No Load Loss + Load Loss)*

**Star-1**= on 50 percent load =2999.25 watt and
100 percent Load = 8277.5 watt

**Star-2**= on 50 percent load =2816.5 watt and
100 percent Load = 7525 watt

**Star-3**= on 50 percent load =2644.5 watt and
100 percent Load = 6841.3 watt

1.7.1 The no-load loss in kW at the rated voltage and frequency and the load loss in kW at the rated voltage, rated frequency, rated output and at 75 Deg.C shall be quoted by the bidder.

1.7.2 If the test figures exceed the quoted values, the transformer will be rejected.
1.8 Constructional Features

1.8.1 The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs.

1.8.2 All materials used shall be of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations in temperature and atmospheric conditions, arising under working conditions, without undue distortion or deterioration or setting up of undue stresses in any part and also without affecting the strength and suitability of the various parts for the work which they have to perform.

1.8.3 No patching, plugging, shimming or other such means of overcoming defects, discrepancies or errors will be accepted.

1.8.4 Corresponding parts liable for replacement shall be interchangeable.

1.8.5 All outdoor apparatus, including bushing insulators with their mounting shall be designed so as to avoid pocket in which water can collect.

1.8.6 Surface, which are in contact with oil, shall not be galvanised or cadmium plated.

1.8.7 Labels or plates of non-corrosive material shall be provided for all apparatus such as relays, switches and fuses, contained in any cubicle or marshalling kiosks.

1.8.8 Steel bolts and nuts exposed to atmosphere shall be with suitable finishes like cadmium or zinc plating.

1.8.9 Before painting or filling with oil, ungalvanised parts shall be completely cleaned and freed from rust, scale and greases, and all external surface cavities on castings shall be filled by metal pasting.

1.8.10 The interior of transformer tank and other oil filled chambers and internal structural steel work shall be cleaned of all scale and rust by shot-blasting or sand-blasting. These surfaces shall be painted with not less than two coats of hot oil resisting varnish or paint. Un-exposed welds need not be painted.

1.8.11 Similarly, the outer surface shall also be cleaned of all scale and rust by shot / sand blasting and then the primary coat shall be applied, immediately after cleaning. The second coat shall be of epoxy paint of shade conforming to Shade 632 of IS: 5 (admiralty grey). Before dispatch, the transformer shall be given another final coat of epoxy paint.

1.8.12 All interior surfaces of mechanism chambers and kiosks except those which have received anti corrosion treatment, shall receive three coats of paint, applied to the thoroughly cleaned metal surface. The final coat shall be of a light coloured anti-condensation mixture.

1.8.13 Metal parts not accessible for painting shall be made of corrosion resistant material.

1.9 Core
1.9.1 The cores shall be constructed from high grade, cold rolled, non-ageing, high permeability, low loss super grain oriented, silicon steel laminations. The maximum flux density in the core shall be less than 1.7 Tesla at 100% terminal voltage.

1.9.2 Oil ducts shall be provided, where necessary, to ensure adequate cooling. The winding structure and major insulation shall not obstruct the free flow of oil through such ducts.

1.9.3 The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000V AC for one minute.

1.9.4 All parts of the core shall be of robust design, capable of withstanding any shocks to which they may be subjected during lifting, transport, installation and service.

1.9.5 All steel sections, used for supporting the core, shall be thoroughly sand blasted or shot blasted after cutting, drilling and welding.

1.9.6 Adequate lifting lugs shall be provided to enable the core and windings to be lifted.

1.9.7 Adequate provision shall be made to prevent movement of the core and winding, relative to the tank, during transport and installation.

1.9.8 The supporting frame work of the core shall be so designed as to avoid the presence of pockets which would prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.

1.10 Windings

1.10.1 The conductor shall be of electrolytic grade copper and windings made in dust-proof atmosphere.

1.10.2 Coils of the windings of identical voltage and ratings shall be interchangeable.

1.10.3 The windings shall be designed to reduce the out of balance forces in the transformer to a minimum. They shall withstand the impulse and power frequency test voltages as specified in this specification.

1.10.4 The insulation of transformer windings and connections shall be free from insulating composition, liable to soften, ooze out, shrink or collapse and be non-catalytic and chemically inactive in transformer oil during service.

1.10.5 The stacks of windings shall receive adequate shrinkage treatment before final assembly. Adjustable devices shall be provided for taking up any possible shrinkage of coils in service.

1.10.6 Coils shall be supported at frequent intervals by means of wedge type insulation spacers permanently secured in place and arranged to ensure proper oil circulation. To ensure permanent tightness of winding assembly, the insulation spacers shall be dried and compressed at high pressure before use.

1.10.7 Adequate insulation and clearances between high voltage windings and low
voltage windings shall be provided. All clearances of windings and other live parts shall be adequate for the normal voltage of operation plus 10%.

1.10.8 The coil clamping arrangement and the finished dimensions of any oil duct shall be such as not to impede the free circulation of oil through the ducts.

1.10.9 The strip conductor wound on edge shall not have a width exceeding six times its thickness.

1.10.10 The connections of all windings shall be braced.

1.11 Tank and Tank Accessories

1.11.1 Tank Construction

1.11.1.1 The transformer tank shall be of conventional type. The transformer tank and cover shall be fabricated from good quality low carbon steel of adequate thickness and shall be designed to withstand lifting of the complete transformer with the tank filled with oil by crane or jacks and transportation by road or rail without over straining any joints and without causing subsequent leakage of oil. Adequate stiffeners shall be provided, wherever necessary, for tank plates.

1.11.1.2 The base of such tank shall be so designed that it shall be possible to move the complete transformer by skidding in any direction without injury using plates or rails.

1.11.1.3 The tank shall be capable of withstanding filling by vacuum, continuous internal pressure of 35 kN / Sq.meter over normal hydrostatic pressure of oil, short circuit forces and full vacuum for drying out purpose.

1.11.1.4 Adequate space shall be provided at the bottom of the tank for collection of sediments. Suitable guides shall be provided for positioning various parts during assembly or dismantling.

1.11.1.5 The base (if of channel construction) and tank stiffeners shall be designed to prevent retention of water.

1.11.2 Tank Cover

1.11.2.1 The detachable tank cover shall be designed for adequate strength, to prevent distortion when lifted, and to prevent collection of water on any part. It must be separate from the core and coil and shall be capable of being lifted separately from the tank for inspecting the core and winding at site. Inspection openings shall be provided, as necessary to give easy access to bushings, core and windings, OLTC, earth connection etc. Each inspection opening shall be of ample size for the purpose for which it is provided and atleast two openings, one at each end of the tank, shall be provided.

1.11.2.2 Temperature indicator pockets shall be fitted with a captive screwed top to prevent ingress of water.

1.12 Oil

1.12.1 The transformer and all associated oil filled equipment shall be supplied along with sufficient quantity of oil, free from moisture and having uniform
quality throughout for the first filling of the tank, conservator, coolers and radiators, in addition to topping-up requirement, in non-returnable containers, suitable for outdoor storage. No inhibitors shall be used in the oil. The transformer oil is required for first filling at site (excluding the oil absorbed by winding, insulation, etc.)

1.12.2 The oil shall conform to IS:335 of latest issue.

1.12.3 The design and materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.

1.13 Axles and Wheels

1.13.1 The transformers are to be provided with bi-directional wheels and axles of suitable dimensions and so supported that under any service condition, they shall not deflect sufficiently to interfere with the movement of the transformer, complete with oil. Suitable locking arrangements shall be provided to prevent the accidental movement of the transformer. The wheel is to be of plain roller type.

1.14 Conservator Vessel, Oil Gauge and Breathers

1.14.1 A conservator shall be provided in such a position, as not to obstruct the electrical connections to the transformer, having a capacity between the highest and the lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment from the minimum ambient temperature to 100°C. The minimum indicated oil level, shall be with the feed pipe from the main tank covered with not less than 15 mm depth of oil and the indicated range of oil level shall be from minimum to maximum.

1.14.2 Accessories

1.14.2.1 One end of the conservator shall have bolted cover, so that it can be removed for cleaning purposes.

1.14.2.2 Magnetic type oil gauge, having

a. Low oil level alarm contacts of 0.5 amp.

b. Dial, showing minimum, maximum and normal (at 30°C) oil levels shall be provided.

1.14.2.3 Oil filling hole and drain valve

1.14.2.4 Breather

1.14.3 The oil connection from the transformer tank to the conservator vessel shall be through Bucholz Relay (with shut off vales on both sides)

1.15 Pressure Relief Device

1.15.1 The pressure relief device shall be of sufficient size for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall be operated at a static pressure of less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of rain.
1.16  Earthing Arrangements

1.16.1  All metal parts of the transformer with exception of the individual core laminations, core bolts and associated individual clamping plates shall be earthed to the tank by means of copper strap.

1.16.2  Two earthing terminals (at diagonally opposite bottom corners of the tank), capable of carrying the short circuit current for 4 seconds without injurious heating, shall be provided with clamp type terminal.

1.17  Rating and diagram plates

1.17.1.1  A rating plate, bearing the data specified in the appropriate clause of IS:1180.

1.17.1.2  A diagram plate, showing the internal connections and also the voltage vector relationship of the several windings in accordance with IS:2026 and in addition a plan view of the transformer giving the correct physical relationship of the terminals. No load voltage shall also be indicated for each tap.

1.18  Joints and Gaskets

1.18.1  All bolted connections shall be fitted with weather-proof, hot oil-resistant gaskets in between, for complete oil tightness. Special attention shall be given to the oil-tight joints between the tank and the cover and the bushing and other outlets to prevent ingress of water into or leakage of oil even under hot condition from the tank.

1.19  Terminal Arrangement

1.19.1  Outdoor Bushing or Cable box or flange for bus duct, as per site requirement, which will be specified in the specific requirement.

1.19.1.1  180° orientation for the HV and LV terminations.

1.20  On load tap Changer

1.20.1  Where asked for, transformer shall be provided with on load tap changing mechanism on HV side for accommodating variation of the voltage variation on HV side. All tapings shall be designed for full power rating.

1.20.2  The tap changer shall be designed for suitable remote control operation from switch board in the control room in addition to being capable of local manual as well as local electrical operation. The on load tap changer shall include the following:

1.20.2.1  An oil immersed tap selector and arcing switch or arc suppressing tap selector, provided with reactor or resister for reduction of make and break arcing voltages, over loads and short circuits.

1.20.2.2  Motor driven mechanism.

1.20.2.3  Control and protection devices.

1.20.2.4  Local tap changer position indicator
1.20.2.5 Manual operating device.

1.20.2.6 Auto voltage regulator.

1.20.3 The OLTC chambers shall have oil filling valve, drain plug, relief vent & level glass. The compartment shall be provided with a means of releasing the gas produced by the arcing.

1.20.4 It shall be so designed to prevent the oil in the arc switching compartment from mixing with the oil in the transformer tank.

1.20.5 It is preferable that the contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips replaceable.

1.20.6 Provision with suitable valve shall be made for equalisation of diverted compartment and main tank during application of vacuum at site.

1.20.7 The tap changer shall be capable of permitting parallel operation with other transformers of the same type. The operation cubicle has to be supplied and the OLTC gear shall be capable of operating in parallel. OLTC shall be provided with the following modes of operation:

- Local-manual
- Local-electrical
- Remote-electrical

1.20.7.1 Necessary interlock blocking independent control when the units are in parallel, shall be provided.

1.20.7.2 An out-of-step device shall be provided for each transformer which shall be arranged to prevent further tap changing when transformers in a group operating in 'parallel control' are one tap out-of-step.

1.20.8 Mechanical Control

1.20.8.1 The transformer shall give full load output on all taps. The manual operating device shall be removable.

1.20.8.2 Tap changing indicator

1.20.8.3 Mechanical operation counter

1.20.8.4 Mechanical stops to prevent over-cranking of the mechanism beyond extreme tap position.

1.20.9 Electrical Control

1.20.9.1 Control circuit shall incorporate the following:

a. Local-electrical operation
b. Remote-electrical operation

1.20.9.2 The remote indoor on load tap changer control cubicle (RTCC cubicle) shall
be of free standing type, and shall be painted with two coats of epoxy primer of shade RAL 7032 (pebble / flint grey). It shall have AVR and Tap position indicator.

1.20.9.3 Tapping Ranges and Tapping Methods
1.20.9.4 The standard tapping ranges, when taps are provided, shall be as follows:

<table>
<thead>
<tr>
<th>Winding-tapped</th>
<th>HV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of tap positions</td>
<td>17</td>
</tr>
<tr>
<td>Number of tap step</td>
<td>16</td>
</tr>
<tr>
<td>Voltage variations</td>
<td>+ 5 percent to -15% in steps of 1.25 percent</td>
</tr>
</tbody>
</table>

1.21 Off-Circuit Tap Changer - not required

1.22 Cooling

1.22.1 The transformer shall be supplied with the requisite number of radiators.

1.22.2 Radiators and coolers shall be so designed as to avoid pockets in which moisture may collect and shall withstand the pressure test. They shall be accessible for cleaning and painting, to prevent accumulation of water on the outer surface to completely drain oil from the tank, to ensure against formation of gas pockets when the tank is being filled.

1.22.3 Radiators, connected directly to the tank, shall be detachable and shall be provided with machined or ground flanged inlet and outlet branches with facilities provided for draining and filling of each radiator.

1.22.4 Valves shall be provided on the tank at each point of connection to the tank.

1.22.4.1 A valve at each point of connection to the transformer tank.

1.23 Temperature Controllers

1.23.1 The transformers shall be provided with one oil temperature indicator, fitted with maximum pointer and two sets of electrical contacts circuit. The contacts should have mercury switches.

1.23.2 The transformers shall also be provided with winding temperature indicators, as specified, fitted with maximum pointer and 2 sets of electrical contacts. The contacts should have mercury switches.

1.23.3 The temperature indicators shall be of dial type (not less than 150 mm dia) and of robust pattern.

1.23.4 The temperature indicator shall be fitted in a tank mounted, weather proof, marshalling box.

1.23.5 Connections shall be brought out from the device to terminals placed inside the marshalling box.

1.24 Marshalling Box

1.24.1 Tank mounted, sheet steel vermin and weather proof marshalling box, shall be provided with a controlled metal clad heater to accommodate the
following equipment. Cubicle illumination shall be envisaged.

1.24.2 Wiring shall be done neatly from various points to the marshalling box.

1.25 Control Wiring, Terminal Boards, Fuses etc.

1.25.1 All wiring connections, terminal boards and MCBs shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the board ends of stranded wire shall be sweated together to prevent creepage of oil along the wire.

1.25.2 There shall be no possibility of oil entering into the connection boxes, used for cables or wiring.

1.25.3 Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non-rusting metal cleats of the limited compression type. All wiring to a panel shall be taken from suitable terminal boards.

1.25.4 Where conduits are used, the runs shall be laid with suitable falls, and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

1.26 Fittings and Accessories

1.26.1 The fittings and accessories mentioned here are the minimum requirement and any other fitting which is generally required for satisfactory operation of the transformer is deemed to be included.

1.27 Factory Assembly and Tests

1.27.1 All Routine tests as per IS:2026 of latest issue shall be carried out on all the transformers, in the presence of representatives from PURCHASER. The PURCHASER shall have the right to test the transformer at neutral agency or test the transformer at SUPPLIER's works through external agency.

1.27.1.1 Temperature rise test shall be carried on one transformer

1.27.1.2 Test report of similar / nearby rating for Impulse voltage withstand test on all 3 phases, with chopped and full wave.

1.28 Rejection

1.28.1 The transformer may be rejected, if during the tests, any of the following conditions arose:

1.28.1.1 No load losses exceed the guaranteed value beyond tolerances, specified.

1.28.1.2 Load losses exceed the guaranteed value beyond tolerances, specified.

1.28.1.3 Impedance value exceeds by the guaranteed value by ±10%.

1.28.1.4 Oil or winding temperature rise exceeds the specified value.
1.28.1.5 Transformer fails on power frequency voltage withstand test.

1.28.1.6 Transformer is proved to have been manufactured not in accordance with the agreed specification and approved drawing
STANDARDS AND CODES
Updated and current Indian Standard Specifications and Codes of Practice will apply to the equipment and the work covered by the scope of this contract.

Low Voltage switchgear Assemblies IEC 61439-1/IS 8623
Low Voltage switchgear & control gear IEC 60947 /IS 13947: 1993
Part I : General rules
Part II : Circuit Breakers
Part III : Switches, disconnectors, switch disconnectors and fuse combination units
Part IV : Contactor and Motor starters
Part V : Control circuit devices and switching elements

Degree of Protection of Enclosures for low voltage switchgear. IEC60529 /IS 2147: 1962

3. SWITCHBOARDS
3.1 General

☐ The LV switchboards shall be as per the standards IEC 61439-1. The switchboards and the associated equipment including switchgear, control gear, Busbar supports, Busbar orientation, Busbar links etc shall be identical in construction to the assembly which has undergone the type test. The drawings of the type-tested assemblies shall be made available for inspection.

☐ The designs of the switchboards should be with switchgear manufacturer, and all the mechanical drawings must be available in the factory beforehand.

☐ Switchboards shall have a short circuit level withstand as per Schedule of Quantities and drawings.

☐ The enclosures shall be designed to take care of normal stress as well as abnormal electro-mechanical stress due to short circuit conditions. All covers and doors provided shall offer adequate safety to operating persons and provide ingress protection of IP 42 unless otherwise stated. Ventilating openings and vent outlets, if provided, shall be arranged such that same ingress protection of IP 42 is retained. Suitable pressure relief devices shall be provided to minimize danger to operator during internal fault conditions.

☐ The switchboard along with ACBs and connections should have been be type tested design at CPRI /Independent international test house for short circuit, temperature rise, protective earth short circuit test and dielectric tests of the ratings required.

☐ For operator safety IP2 X (touch proof) protection to be available even after opening the feeder compartment door. The compartmentalization to be achieved by using metal separators, use of PVC sheet / Hylem sheets shall not be allowed.

☐ As specified in the BOM the switchboard shall be form 4b, for form of separation only metallic covers shall be used, Hylem / PVC sheets shall not be allowed.

3.2 Switchboard Configuration

☐ The Switchboard shall be configured with Air Circuit Breakers, MCCB’s, MCB’s and other equipment as called for in the schedule of quantities.
The MCCBs shall be arranged in multi-tier formation whereas the Air Circuit Breakers shall be arranged in Single or Double tier formation only to facilitate operation and maintenance.

The Switchboards shall be of adequate size with a provision of spare space to accommodate possible future additional switch gear. Impulse withstand of the panel shall be 12KV

3.3 Constructional Features
- The Switchboards shall be metal clad totally enclosed, floor mounted free standing type of modular extensible design suitable for indoor mounting.
- Switchboards construction shall employ the principle of compartmentalized and segregation for each circuit.
- Incomer and bus section panels or sections shall be separate and independent and shall not be wired with sections required for feeder. The incomer panel shall be suitable for receiving bus trunking or MV cable of size specified.
- Switchboards shall be made up of requisite vertical sections, which when coupled together, shall form continuous dead front switchboards.
- Switchboard shall be readily extensible on both sides by addition of vertical sections after removal of the end covers.
- The switchboards shall be designed for use in high ambient temperature and humid tropical conditions as specified. Ease of inspections, cleaning and repairs while maintaining continuity of operation shall be provided in the design.
- Metal based neoprene gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide a degree of protection of IP 42/IP 54 as stipulated in schedule of quantities. The unused openings within the switchboards shall be closed using suitable grommets.

Degree of Protection shall be IP54 Upto 2000A and IP42 above 2000A
- Special care to be taken to ensure effective earthing of the frame and doors of the switchboards
- Each vertical section shall be provided with a rear or side cable chamber housing the cable end connections and power/control cable terminations. There should be generous availability of space for ease of installation and maintenance with adequate safety for working in one vertical section without coming into contact with any live parts. The design of the switchboard shall allow standard extension chambers if required to accommodate cables.
- Some switchboards may be required to be installed against the wall, for such application-documented designs shall be available.
- Switchboard panels and cubicles shall be fabricated with CRCA Sheet Steel of thickness not less than 2.0 mm and shall be folded and braced as necessary to provide a rigid support for all components. The doors and covers shall be fabricated from CRCA sheet steel of thickness not less than 2 mm. Joints of any kind in sheet metal shall be seam welded and all welding slag ground off and welding pits wiped smooth with plumber metal.
- All panels and covers shall be properly fitted and square with the frame. The holes in the panel shall be correctly positioned.
Switchboard shall be provided with “Danger Notice Plate” conforming to relevant Indian Standards.

3.4 Switchboard Dimensional Limitations
- The overall height of the switchboard shall be limited to 2400 mm for all the Busbar ratings and type of switchboards. Panel should have integral base frame of 75mm, hence total panel height should not be more than 2475mm.
- The height of the operating handle, push buttons etc shall be restricted between 300 mm and 2000 mm from finished floor level.
- Other dimensional limits if any are specified separately.

3.5 Switchboard Compartmentalization
- For compartmentalized switchboards, separate totally enclosed compartments shall be provided for horizontal busbars, vertical busbars, ACBs, MCCBs, and cable alloys.
- The main board shall be with Form 4b Construction.
- Earthed metal or insulated shutters shall be provided between drawout and fixed portion of the switchgear such that no live parts are accessible with equipment drawn out. Degree of protection within compartments shall be atleast IP 2X.
- Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position.
- For all Circuit Breakers separate and adequate compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, busbars and connections.
- For Some MCCB feeders for critical loads like UPS it may be required to have operation only after opening the door, all other facilities like pad lockable rotary handle to be provided for such feeder. It shall be possible to do this change during execution of order.
- Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be located in front of switchgear only.
- A horizontal wire way with screwed cover shall be provided at the top to take interconnecting control wiring between vertical sections.
- Separate cable compartments running the height of the switchboard in the case of front access boards shall be provided for incoming and outgoing cables.
- Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

3.6 Switchboard Bus Bars
- Busbars shall be made of high conductivity, and high strength Aluminum E91 grade Busbars shall be of rectangular cross sections, not more than 6mm thickness better suitable for full load current for phase bus bars and half/ full rated current for neutral bus bar or as stipulated in schedule of quantities. Busbar shall be suitable to withstand the stresses of fault level as specified in schedule of quantities.
The bus bar system may comprise of a system of main horizontal bus bars and auxiliary vertical bus bars run in bus bar alloy on either side in which the circuit could be arranged with front access for cable entrances.

The bus bars shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports able to withstand operating temperature of 110°C at regular intervals, to withstand the forces arising from a fault level as stipulated in schedule of quantities. The material and the spacing of the Busbar supports should be same as per the type tested assembly.

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirement. The material for auxiliary supply bus will be insulated electrolytic copper. Wires.

Clearances between phases should be in line with IEC.

### 3.7 Switchboard Interconnection

- All connection and tap offs shall be through adequately sized connectors appropriate for fault level at location. This shall include tap off to feeders and instrument/control transformers.
- For unit ratings upto 250 amps, PVC insulated 105 dg withstand, copper conductor wires of adequate size to carry full load current shall be used. The terminations of such interconnections shall be crimped. Solid connections shall be used for all rating of above 250 amps.
- All connections, tappings, clamping, shall be made in an approved manner to ensure minimum contact resistance. All connections shall be firmly bolted and clamp with even tension. Before assembly joint surfaces shall be filed or finished to remove burrs, dents and oxides and silvered to maintain good continuity at all joints. All screws, bolts, washers shall be zinc plated. Only 8.8 grade nuts and bolts shall be used for busbar connections.

### 3.8 Drawout Features

Air Circuit Breakers shall be provided in fully drawout cubicles, unless otherwise stated. These cubicles shall be such that drawout is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. Mechanical latches shall be integrated in ACB at service, test and isolated position to ensure that Breaker is firmly latched in respective position. It shall not be possible to move the breaker from the position unless latch is manually operated.

### 3.9 Instrument Accommodation

- All voltmeter and ammeter and other instruments shall be flushed mounted type of size 96 sq. mm conforming to class 1.5 to IS 1248 for accuracy. All voltmeter shall be protected with MPCBs.
- Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment door for which a separate and adequate compartment shall be provided and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switchboard.
- For MCBs, instruments and indicating lamps can be provided on the compartment doors.
- The current transformers for metering and for protection shall be mounted on the solid copper/aluminium busbars with proper supports.
On all the incomers of switch boards ON/OFF indicators lamps shall be provided suitable for operation on AC 230 volts supply. All lamps shall be protected by MCBs.

For Incomer and important outgoing feeders comprehensive power meters shall be provided which shall display A, V, Pf, Hz, Kw, KVA, KVAR, KWh, Kvarh, average and maximum values, demand values, THD on current and Voltages. Also add on modules for RS485 port, programmable contacts, analogue output etc to link to BMS/SCADA system (Considered features of Merlin Gerin PM500).

3.10 Wiring
All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labeled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 2.5 sq. mm. Runs of wires shall be neatly bunched and suitably supported and clamped. Means shall be provided for easy identification of wires. Identification ferrules shall used at both end of wires. All control wires meant for external connections are to be brought out on a terminal board. The cables and control wires shall be suitable for withstanding 105 deg C.

3.11 Space Heaters
Anti-condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 230 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 50 C. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a general rule, the heaters shall be placed at the bottom of the cubicle.

3.12 Ventilation Fans
The Switchboard shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 4500 amp and above. The fan shall be interlocked with switchgear operation. The degree of enclosure protection to be maintained even with Fans.

3.13 Earthing
Continuous earth bus sized for prospective fault current to be provided with arrangement for connecting to station earth at two points. Hinged doors / frames to be connected to earth through adequately sized flexible braids.

3.14 Sheet Steel Treatment And Painting
Sheet steel used in the fabrication of switchboards shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognized phosphating process after which a coat of primer paint compactively with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 50 micron thickness, of sheet approved by Engineer-in-Charge shall then be provided.

3.15 Name Plates And Labels
Suitable engraved white on black name plates and identification labels of metal for all Switchboards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

3.16 Type test reports.
Switchboard configurations offered shall be CPRI /Independent international test house tested for all the tests as per IEC61439-1 and internal arc tests. Copies of the test certificates shall be submitted with the tender.

3.17 Testing at Works
Copies of type test carried out at ACB/ MCCB manufacturers works and routine tests carried out at the switchboard fabricators shop shall be furnished along with the delivery.
of the switchboards. Engineer-in-Charge reserves the right to get the switchboard inspected by their representative at fabricators works prior to dispatch to site to witness the followings.

a) Physical variation and dimensional check
b) Verification of bill of material
c) Functional check
d) HV test
e) IR test

4 Internal Arc Testing
Internal arc test to be conducted & successfully passed by panels in order to ensure the protection of people and equipment as described in the technical report IEC61641-V2. Internal Arc Certification should be minimum 65KA for 0.3s for Horizontal Busbar, Vertical Busbar, Cable chamber.

5. SWITCHGEAR

5.1 LT Air Circuit Breakers

5.1.1 General
□ The circuit breakers shall be of the air break type, robust and compact design suitable for indoor mounting and shall comply with the requirement IEC 60947-1 and 2. Rupturing capacity shall be as stipulated in Schedule of quantities. Heat loss per pole shall be low.

□ The breaker shall comply with the isolation function requirement of IEC 60 947-2 section 7.12 to be marked as suitable for isolation / disconnection to facilitate safety of operating personal while the breaker is in use.

□ The breaker shall provide class II insulation between the front panel and internal power circuits to avoid any accidental contact with the live main current carrying path with the front cover open.

□ Protective devices, metering, CTs, PTs, push buttons and indicating lamps shall be provided as per schedule of quantities.

5.1.2 Constructional Features

□ The Circuit Breaker shall be flush front, metal clad, horizontal draw-out pattern, three/four pole as required and fully interlocked. Each Circuit Breaker shall be housed in a separate compartment enclosed on all sides.

□ The Circuit Breaker cradle shall be designed and constructed to permit smooth withdrawal and insertion. The movement shall be free of jerks, easy to operate. Mechanical Latch to be provided to identify the Isolated , test & service position of breaker to prevent over racking.

□ All current carrying parts in the breaker shall be silver plated and suitable arcing contacts shall be provided to protect the main contacts which shall be separate from the main contacts and easily replaceable. In addition, Arc chutes shall be provided for each pole, and these shall be suitable for being lifted out for the inspection of the main and the arcing contacts.

□ The circuit breaker shall have indication of mechanical wear of contacts enabling visible indication of contact life.

□ Self aligning cluster type isolating contacts shall be provided for the Circuit Breaker, with automatically operated shutters to screen live cluster contacts when the Breaker is withdrawn from the cubicle. Sliding connections including those for the auxiliary contacts
and control wiring shall also be of the self aligning type. The fixed portion of the sliding
connections shall have easy access for maintenance purposes.

□ There shall be flexibility in changing the types of terminals at site to suit the bus bar
orientation if required.

□ **The frame of the circuit breaker shall be uniform upto 4000Amps.**

□ The cubicle for housing the Breaker shall be free standing dead front pattern, fabricated
from the best quality sheet steel.

**5.1.3 Operating Mechanism**

□ The Circuit Breaker shall be trip free with independent manual spring operated or motor
wound spring operated mechanism as specified and with mechanical ON/OFF indication.
The operating mechanism shall be such that the circuit breaker is at all times free to open
immediately the trip coil is energised. The breaker shall be provided with in built
antipumping mechanism.

□ The closing time shall be less than or equal to 70 ms to ensure faster closing of the
breaker. And tripping time should be less than 30 ms to reduce the let through energy in
the event of fault.

□ The operating handle and mechanical trip push button shall be at the front of and
integral with the Circuit Breaker.

□ There shall be mechanical indicator on the front panel for ‘Ready to close’ situation for
the breaker by checking all interlockings.

□ The Circuit Breaker shall have the following four distinct and separate positions which
shall be indicated on the face of the panel. The breaker shall get latched in each of three
position namely Service, Test and Isolated, operator to de latch before racking in/out to
other position

"Service" -- Both main and secondary isolating contacts closed
"Test" -- Main isolating contacts open and secondary isolating contacts closed
"Isolated" -- Both main and secondary isolating contacts open

"Maintenance" -- Circuit Breaker fully outside the panel ready for maintenance

**5.1.4 Circuit Breaker Interlocking**

□ Sequence type strain free interlocks shall be provided to ensure the following:

□ It shall not be possible for the Breaker to be withdrawn from the cubicle when in the
"ON" position. To achieve this, suitable mechanism shall be provided to lock the Breaker in
the tripped position before the Breaker is isolated.

□ It shall not be possible for the Breaker to be switched "ON" until it is either in the fully
inserted position or, for testing purposes, it is in the fully isolated position.

□ It shall not be possible for the Circuit Breaker to be plugged in unless it is in the OFF
position.

□ A safety latch shall be provided to ensure that the movement of the Breaker, as it is
withdrawn, is checked before it is completely out of the cubicle, thus preventing its
accidental fall due to its weight.
Mechanical and electrical antipumping devices shall be incorporated in the ACB's as required.

5.1.5 Circuit Breaker Auxiliary Contacts

The Circuit Breaker shall have suitable free / minimum 6 NO/NC auxiliary contacts rated at 10 amps 415 volts 50 Hz. These contacts shall be approachable from the front for connecting all external wiring from the front. They shall close before the main contacts when the Circuit Breaker is plugged in and vice versa when the Circuit Breaker is Drawn Out of the cubicle.

Electrical Auxiliaries

- All electrical auxiliaries, including the spring charging gear motor shall be installable on site without requiring adjustment or any tools other than a screw driver

- The auxiliaries shall be placed in a compartment which under normal operating conditions, shall not contain any conducting parts capable of entering into electrical contact with the circuit breaker poles. It shall be possible to connect all auxiliary wiring from the front of the circuit breaker.

5.1.6 Circuit breaker Releases

The Air Circuit Breakers should have microprocessor release. The Incoming circuit breaker to be equipped with the microprocessor based release with adjustable short circuit protection with adjustable time delay, Overcurrent protection, and adjustable earth fault protection with adjustable time delay. The release should have graphical display showing the IDMT curve. It should have have bar graph display of all electrical parameters like V, A, W, VAR, VA, Wh, VARh, Vah. It should be possible to store tripping history of last ten faults with time and date of fault and the type of fault with values.

The outgoing ACBs should have microprocessor based Release with Short circuit and overload protections with Display of current. The bar graph to show percentage loading of the breaker to be available.

- On line setting of the parameters should be possible.
- The setting of the ACB should be possible digitally as well as with dial settings with the help of screwdriver. Option of communication port on all types of the releases, even if the same is not specified at the time of ordering.
- As an option it should be possible to have programmable contacts if required at later date.

5.1.7 Earthing

The frame of the Circuit Breaker shall be positively earthed when the Circuit Breaker is racked into the cubicle.

6. MOULDED CASE CIRCUIT BREAKERS

6.1 General

- The circuit breakers shall comply with the requirement of IEC 60 947 / IS 13947 : 1993. MCCBs shall be suitable for nominal voltage of 3 phase 690 Volts AC 50 HZ supply.

- The circuit breaker shall comply with the isolation function requirement of IEC 60 947-2 section 7.1.2 to be marked as suitable for isolation / disconnection to facilitate safety of operating personnel while the breaker is in use.

- The circuit breaker shall provide class II insulation between the front cover and internal power circuits to avoid any accidental contact with the live main current carrying path with the front cover open.

- The MCCBs shall be of double break contacts
6.2 Constructional features
- The MCCBs shall be made of halogen free high strength heat resisting and flame retardant thermo setting insulating material.
- Three phase MCCBs shall have a common handle for simultaneous operation and tripping of all the three phases.
- The contact tips shall be made of suitable arc resistant sintered alloy. Terminals shall be of liberal design with adequate clearances.
- Suitable arc extinguishing devices shall be provided for each contact.

6.3 Operating mechanism
- The operating handle of the MCCBs shall be quick make / break, trip free type.
- The operating handle of the MCCBs shall have suitable, ON, OFF and TRIPPED indicators.
- The operating handle and mechanical trip push button shall be at the front of and integral with the circuit breaker.
- MCCBs shall be capable of limiting the fault currents. The maximum thermal I^2t shall be indicated by the manufacturer. These characteristics shall allow high cascading performance with MCCBs / MCBs downstream.
- MCCBs shall comprise of the mechanism designed to trip the circuit breaker in the event of high value short circuit currents.
- The electrical endurance of MCCBs shall be more or equal to that specified by IEC 60 947-2 standard.
- Earth fault protection if specified should be an integral part of the breaker, direct operating type & adjustable.
- MCCBs range shall have established and documented discrimination charts readily available.
- MCCBs should be of the same family.
- For optimum selection of the ratings and breaking capacities, range MCCBs should have established cascading charts to enhance capacity of the downstream MCCBs.
- For Main switchboard, PLUG-IN type, motorised MCCBs to be used.

6.4 Circuit Breaker Interlocking
MCCBs shall be provided with following interlocking devices.
- Handle interlock to prevent unnecessary manipulations of the breaker.
- Door interlock to prevent door being opened when the breaker is in ON position.
- Deinterlocking device to open the door even if the breaker is in ON position.

6.5 Circuit breaker auxiliaries
The circuit breaker shall be provided with following accessories, if specified in drawings/schedule of quantities.
- Under voltage trip
- Shunt trip
- Alarm switch
- Auxiliary switch

6.6 Type test certificate
The contractor shall submit type test certificate from a international recognized test house for the circuit breakers offered.

7.0 MINIATURE CIRCUIT BREAKERS
The MCB’s shall be of the completely moulded design suitable for operation at 240/415 Volts 50 Hz system.
The MCB’s shall have a rupturing capacity of 10 KA at 0.5 p.f..
The MCB’s shall have inverse time delayed thermal overload and instantaneous magnetic short circuit protection.
POWER FACTOR IMPROVEMENT SYSTEM

SCOPE
This specification covers the requirements of design, manufacture, test and supply of APFC Panel with Detuned Filters (Switch able in Steps) complete with all accessories for efficient and trouble-free operation.

CODES AND STANDARDS
All Panels covered under this specification shall be designed, manufactured and tested in accordance with relevant standards and their latest amendments: IS 13340-1993, IS 13341-1992, IEC 60831-1+2.

GENERAL
440V capacitor banks are intended for supplying compensating leading VARs, thereby improving the overall power factor. Capacitor units shall be mounted inside the APFC panel, in separate cubicles. APFC panels with detuned filters complete with necessary controls, protections and accessories as per the specific requirements listed in this specification shall be supplied.

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

ENCLOSURE
The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shade/s. The thickness of powder coating should be minimum 60-80 microns. Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary. The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors. 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.

APFC RELAY
Microprocessor based APFC relay (Intelligent VAr controller) shall sense the PF in the system and automatically switch ON / OFF the capacitor unit or stage 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 parameters, Minimum threshold setting of 1% of CT current.

CAPACITORS
The Capacitor should comply with the following standards and their latest amendments: IS 13340-1993, IS 13341-1992, IEC 60831-1+2
General Specifications: 3 phase, Delta connected, must be designed to withstand system over voltage, increased voltage due to series reactor and harmonics. The combined kvar
output for reactor and capacitor combination shall be designed at 440V AC. Capacitor should be 3 Phase Delta connected for suitable voltage & KVAR 50 HZ

Capacitor type : Super Heavy Duty mixed dielectric low loss with double side metalized tissue paper oil impregnated and self healing type with bi-axially oriented polypropylene film. The dielectric shall be combination of capacitor tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable impregnant. Capacitor should be fitted with safety device like Pressure sensitive Disconnector. The Capacitor should be low loss type (Total losses should not exceed 0.5 W/ kVAR).

1. Over voltage +10% (12h / 24h), + 15% (30m / 24h), + 20% (5m), +30% (1m) as per Clause 6.1 of IS 13340-1993.
2. Over current : 2.5 x In
3. Peak Inrush current withstand : 350 x In
4. Total watt-losses including discharge resistors : ≤ 0.45 W / kV Ar.
5. Temperature category : ( -)25 deg.C to 70 deg.C.
6. Capacitors 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.
7. Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminum conductor armoured cables as specified.
8. Two separate earthing terminals shall be provided for earth connection of each bank.

DETUNED FILTER
LV Harmonic Filters shall be used with power capacitors to mitigate harmonics, improve power factor and avoid electrical resonance in LV electrical networks. The low voltage filter reactor shall be series type having a three phase, iron core copper wound construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 60076. The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin.

The reactor shall be tested using a separate source voltage test of 3.0kV (coil to core) for 1 minute as per IEC 60076/3.

SWITCHGEAR & PROTECTION
Incomer switchgear shall be TP&N breaker appropriate rating. Suitable capacitor duty contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection. Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

All capacitors shall be suitably protected against over current and short circuit by suitably rated HRC Fuses/ MCCB as mentioned in BOQ.
Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures up to 125 deg.C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc. Suitable bus links for input supply cable termination shall be provided.

**CONTROL CIRCUIT & GENERAL PROTECTION**
The control circuit shall be duly protected by using suitable rating MCB. An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset). Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire. 440 V caution board on the panel shall be provided.

**INSTALLATION**
Capacitors banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards. All interconnections in the control panel shall be checked before commissioning. Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.

**TESTING AND COMMISSIONING**
The Manufacturer shall furnish the reports of type tests carried out on capacitors within 5 years of the date of bid opening. Tests shall be as per specification and relevant standards conducted on identical components/systems to those offered/proposed to be supplied under this contract. Type test report from external agency such as CPRI/ERDA to be submitted for Capacitor & Reactor.

All routine tests shall be carried out as per applicable standards.

**DATA SHEET**

<table>
<thead>
<tr>
<th>System conditions:</th>
<th>440 V, 3 phase, 50 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>System neutral</td>
<td>Solidly earthed</td>
</tr>
<tr>
<td>Location</td>
<td>Indoor</td>
</tr>
<tr>
<td>Mounting</td>
<td>Free standing, floor mounting assembly</td>
</tr>
<tr>
<td>Design ambient temperature</td>
<td>50 Degree C</td>
</tr>
<tr>
<td>Min. thickness of sheet metal</td>
<td>2.0 mm</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP42</td>
</tr>
<tr>
<td>Cable Entry</td>
<td>Top / Bottom</td>
</tr>
<tr>
<td>Capacitors connected</td>
<td>Mixed Dielectric low loss, Delta</td>
</tr>
<tr>
<td>Total power loss of capacitor unit</td>
<td>&lt; 0.5 W kVAR</td>
</tr>
<tr>
<td>Space heater, cubicle illumination</td>
<td>Yes lamp provided</td>
</tr>
<tr>
<td>Paint Shade</td>
<td>RAL7032</td>
</tr>
<tr>
<td>APFC Relay</td>
<td>Micro processor based</td>
</tr>
</tbody>
</table>
Acceptance tests : As per IS 13340-1993

Components to be mounted and wired : Relays, contactors, Auto/ Manual selector switches, indicating instruments, timers, status indicating lamps, push button, fuses etc. required for satisfactory operation.

CABLE TRAYS :
Fabrication and installing following size of preforted MS. cable trays including horizontal and vertical bends, reducers, tee, crossmembers and other accessories as required and duly susspended from the ceiling with MS 12mm rod suspenders and including painting etc. as required

The cable trays in Two-side rail system in a variety of materials and finishes. The cable trays are fabricated in mild steel and also can be provided in pre-galvanized steel, hot dip galvanized and painted with grey color enamel or powder coated as per the requirement.

The standard length of a single piece of cable tray is 2500 mm. Flanges of the tray can be manufactured according to requirement.

TECHNICAL SPECIFICATION

<table>
<thead>
<tr>
<th>Materials</th>
<th>Mild Steel, Aluminium, Stainless Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish</td>
<td>Hot dip galvanised, Self colour, Redoxide, Enamel painted.</td>
</tr>
<tr>
<td>Length</td>
<td>Standard length of tray is 2500 / 3000mm</td>
</tr>
<tr>
<td>Steel</td>
<td>As per IS:2062 / 1079</td>
</tr>
<tr>
<td>Galvanising</td>
<td>As per IS: 2629 / 4759</td>
</tr>
</tbody>
</table>
PREAMBLE TO THE SCHEDULE OF QUANTITIES

1. The Tender shall be on item rate basis which shall include the cost of material, labour, taxes, duties and all other testing and commissioning in accordance with the relevant drawings, specifications and relevant IS Codes and including the fees for inspection together with the liabilities and obligations as detailed in the general conditions of the contract.

2. The prices shall remain firm and free from any variations due to rise and fall in the cost of materials and labour or any other price variation whatsoever whether during the stipulated period of execution or during the extended period of completion if any, except direct statutory increase by the act of the Government or local bodies.

3. The rates shall remain valid for any variations in the estimated quantities given in the BOQ.

4. In order to facilitate the technical scrutiny of various quotations, the tenderers must provide along with their quotations detailed technical particulars, catalogues and erection drawings for various items under different parts specified in the BOQ.

5. The power supply shall be 3-phase, 4 wire, 415/240V, 50 Hz AC. All consuming devices shall be suitable for the voltage and frequency mentioned above.

6. The contractor shall supply all consumables necessary for commissioning of the equipment.

7. The drawings and specifications lay down minimum standard of equipment workmanship, deviations if any shall be clearly stated.

8. All equipment and the installation shall be tested as specified and a test certificate in the prescribed form as required by the local supply authorities shall be furnished.

9. The entire and the installation shall be guaranteed against defective material or workmanship for a period of 12 months from the date the installation has been commissioned and taken over by the owners. During the guarantee period the contractor free of cost shall rectify all the defects.

10. The successful tenderer shall submit shop drawings for all the L.T/H.T switchboards to the Architects for approval. The approval of these drawings will not absolve the contractor of the responsibility of the correctness of these drawings. Six copies of these approved drawings shall be supplied to the Architects for their distribution to the various agencies at site, at no cost to the Employer.

11. The successful tenderer shall arrange water and power connected required for the work at their own cost.
12. The tenderers must acquaint themselves with the rigours of the site conditions and take all the aforesaid and foregoing factors while quoting the rates, and no extras will be allowed on any grounds arising out of or relating to the aforesaid and foregoing.

13. The successful tenderer shall include in his rates painting of all equipment with three coats of synthetic enamel paint to match the surroundings.

14. Upon completion of the whole work the contractor shall furnish to the Architects three copies of the as built drawings along with the original tracings without a cost to the owners.

15. The tenderers must arrange all the necessary sanctions/approvals from the electrical Inspector at his own cost.

16. The materials of the first preference shall be used and the contractor may excuse himself for not doing so only, if the required range as per BOQ is not being manufactured by that manufacturer. A letter from the respective manufacturer shall support the proof in such cases. Samples of all fittings and other accessories should have Architect’s approval.

17. Necessary formalities to obtain the energy meters from the Electricity Board etc. is the responsibility of the contractor.

18. The tenderer if any regarding this tender this tender should be clarified the clarification before submitting the offer. No claims for items will be entertained later on during the execution of the work arising out of interpretation of various tender/schedule items.

19. For any civil work connected with the owners can issue this tender cement on chargeable basis.

20. Obtaining of temporary construction power supply for this work is the responsibility of the contractor to his own cost.

21. No built up store shall be provided by the owners, only a space shall be provided for contractor to build his own store.

22. Dismantling of store and cleaning of the area will be the responsibility of the contractor.

23. The client will not take any responsibility for any theft, damage or loss etc. before the entire installation is tested, commissioned and handed over.

24. The client reserves the right to split up the work and award the job to different parties.

25. No price variation or escalation clause will be accepted or entertained at any time later on.

26. The work shall be done as per PWD/CPWD norms or as specified and as per the Engineer-in-charge.

27. The Vendor will indemnify the Owners against any sub-contractor or labour disputes.
28. All the incoming and outgoing cable to various panels to be from top/bottom side inlets and outlets as per requirement.

**TERMS OF PAYMENT**

1. 40% on Delivery at Site
2. 30% against Erection
3. 15% on Commissioning
4. 10% on testing
5. 5% to be released after 12 months on completion of defect liability period.

OWNER

CONTRACTOR
COMPLETION/TEST CERTIFICATE

I/WE certify that the installation detail below has been installed by me/us and tested and that to the best of my/our knowledge and belief it complies with Indian Electrical Rules, 1956, as well as the C.P.W.D. General specifications of Electrical works 1994.

Electrical Installation at __________________________________________

Voltage and System of Supply _______________________________________

1. Particular of work:
   (a) Internal Electrical Installation
      No. Total Load Type or System of Wiring.
      i) Light Point
      ii) Fan point
      iii) Plug Point
         a) 3 Pin 6Amps rating
         b) 3 Pin 16Amps rating
      (b) Other types of loads
         Description HP/ KW type of starting
         a) Motors
            I)  
            II)  
            III)  
         b) Other Plants: Lift etc.
         c) If the work involves installation of overhead line and/or underground cable
            a) I) Type and description of overhead line.
               II) Total length and No. of spans
               III) No. Of street lights and its description
            b) I) Total length of cable and its size.
               II) No. of joints:  End joint
                                 Tee joint
                                 Straight through joint:

2. Earthing
   i) Description of earthing electrode
   ii) No. of earth electrodes
   iii) Size of main earth lead

III Test Results:
   a) Insulation resistance of each Earth station.
      i) Insulation resistance of whole system of Earthing installation.
      ii) Insulation resistance between phase conductor and neutral:
          Between phase R and neutral  Megaohms
          Between phase Y and neutral  Megaohms
          Between phase B and neutral  Megaohms
iii) Insulation resistance between the phase conductors in case of polyphase supply.

- Between phase R and phase Y: Megaohms
- Between phase Y and phase B: Megaohms
- Between phase B and phase R: Megaohms

b) Polarity test.

Polarity of non-linked single pole branch switches.

c) Earth continuity test.

Maximum resistance between any point in the earth continuity conductor including metal conduits and main earthing lead: \(------\) ohms.

d) Earth Electrode resistance

Resistance of each earth electrode

i) \(\text{Ohms.}\)
ii) \(\text{Ohms.}\)
iii) \(\text{Ohms.}\)
iv) \(\text{Ohms.}\)

e) Lighting protection system

Resistance of the whole lighting protection system to earth before any bonding is effected with earth electrode and other metal parts of the structure: \(------\) ohms.

---

**Signature and Name of**

Signature and Name and Add.

Engineer (E) / Engineer-in-Charge of Contractor & seal of Contractor

Signature of Supervisor

Name and Address.
GENERAL SPECIFICATIONS FOR ELECTRICAL WORKS

(DG SETS)
## CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General</td>
<td>01-11</td>
</tr>
<tr>
<td>2</td>
<td>Technical</td>
<td>12-12</td>
</tr>
<tr>
<td>2.1</td>
<td>General</td>
<td>12-14</td>
</tr>
<tr>
<td>2.2</td>
<td>Diesel Engine</td>
<td>14-22</td>
</tr>
<tr>
<td>2.3</td>
<td>Alternator</td>
<td>22-24</td>
</tr>
<tr>
<td>2.4</td>
<td>AMF Panel, Batteries and Electrical System</td>
<td>24-32</td>
</tr>
<tr>
<td>2.5</td>
<td>Foundation</td>
<td>33-34</td>
</tr>
<tr>
<td>2.6</td>
<td>Acoustic Enclosure</td>
<td>34-37</td>
</tr>
<tr>
<td>3</td>
<td>Synchronization</td>
<td>38-40</td>
</tr>
<tr>
<td>4</td>
<td>Earthing</td>
<td>41-42</td>
</tr>
<tr>
<td>Appendix ‘I’</td>
<td>International Standard ISO 8525-Part-1</td>
<td>43-64</td>
</tr>
<tr>
<td>Appendix ‘II’</td>
<td>CPCB Norms for Noise Level</td>
<td>65-66</td>
</tr>
<tr>
<td>Appendix ‘III’</td>
<td>CPCB Norms for Emission Level</td>
<td>67-68</td>
</tr>
<tr>
<td>Appendix ‘IV’</td>
<td>Specimen NIT</td>
<td>69-93</td>
</tr>
<tr>
<td>Appendix ‘V’</td>
<td>List of relevant Indian Standards/International Standard</td>
<td>94-95</td>
</tr>
<tr>
<td>Appendix ‘VI’</td>
<td>Recommended Cable Sizes</td>
<td>96-96</td>
</tr>
<tr>
<td>Appendix Figures 1</td>
<td>Testing of DG Set at OEM works</td>
<td>97-98</td>
</tr>
<tr>
<td>Figures 2</td>
<td>Typical Genset Room Layout</td>
<td>99-99</td>
</tr>
<tr>
<td>Figures 2</td>
<td>Alternator Terminal Links</td>
<td>100-100</td>
</tr>
</tbody>
</table>
CHAPTER -1

GENERAL

1.1 INTRODUCTION

1.1.1 Scope

1.1.1.1 These specifications cover the general specifications pertaining to diesel engine driven generating sets & their installation.

1.1.1.2 These General Specifications cover the equipments and materials for the DG Sets, their testing and/or inspection as may be necessary before their dispatch from their respective works, their delivery at site, all preparatory works, assembling, installation and adjustments, commissioning, final testing, putting into operation and handing over of the complete system.

1.1.1.3 These General Specifications are subject to revision from time to time.

1.1.1.4 Each DG Set installation work has its own particular requirements. These General Specifications shall be supplemented with tender specifications as may be required for a particular work. The tender specifications, wherever they differ from these ‘General Specifications’, shall have over-riding value and shall be followed for that particular work. A specimen NIT for DG Set works is appended at Appendix ‘IV’ for general guidance.

1.1.2 Related Documents

These General Specifications shall be read in conjunction with the General conditions of contract. These General Specifications shall also be read in conjunction with the tender specifications, schedule of work, drawings and other documents connected with the work.

1.1.3 Site Information

The tenderer should, in his own interest, visit the site and familiarise himself with the site conditions before tendering. For any clarification, tenderer may discuss with the Engineer-in-Charge.
1.2 CONFORMITY WITH STATUTORY ACTS, RULES, STANDARDS AND CODES

(i) All components shall conform to relevant Indian Standard Specifications, wherever existing, amended to date. A list of such standards is appended in Appendix ‘V’.

(ii) All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and Indian Electricity Rules, 1956 as amended up to date. They shall also conform to CPWD General Specifications for Electrical works, Part-I (Internal), 2013 and Part-II (External), 1994 and Part IV (Sub-station), 2013, as amended up to date.

1.3 SAFETY CODES AND LABOUR REGULATIONS

(i) In respect of all labour employed directly or indirectly on the work for the performance of the contractor’s part of work, the contractor at his own expense, will arrange for the safety provisions as per the statutory provisions, B.I.S recommendations, factory act, workman’s compensation act, CPWD code and instructions issued from time to time. Failure to provide such safety requirements would make the tenderer liable for penalty for Rs. 200/- for each violation. In addition the Engineer-in-charge, shall be at liberty to make arrangements and provide facilities as aforesaid and recover the cost from the contractor.

(ii) The contractor shall provide necessary barriers, warning signals and other safety measures while executing the work of DG Set installation, cables etc. or wherever necessary so as to avoid accident. He shall also indemnify CPWD against claims for compensation arising out of negligence in this respect. Contractor shall be liable, in accordance with the Indian Law and Regulations for any accident occurring due to any cause. The department shall not be responsible for any accident occurred or damage incurred or claims arising there from during the execution of work. The contractor shall also provide all insurance including third party insurance as may be necessary to cover the risk. No extra payment would be made to the contractor due to the above provisions thereof.

1.4 WORKS TO BE ARRANGED BY THE DEPARTMENT

Unless otherwise specified in the tender documents, the following works shall be arranged by the Department:
(i) Space for accommodating all the equipments and components involved in the work. However, watch and ward shall be responsibility of the contractor.

(ii) Power supply (Single/three phase)

1.5 WORKS TO BE DONE BY THE CONTRACTOR

Unless otherwise mentioned in the tender documents, the following works shall be done by the contractor and therefore, their cost shall be deemed to be included in their tendered cost—whether specifically indicated in the schedule of work or not:

(i) Foundations for equipments including vibration isolation springs/ pads,

(ii) Making good all damages caused to the structure during installation and restoring the same to their original finish.

(iii) Minor building works necessary for installation of equipments, foundation trench for fuel line & cable, making of opening in walls or in floors and restoring them to their original condition/ finish and necessary grouting etc. as required.

(iv) All supports for exhaust & water pipes, chimney, bus trunking (if included in scope of contract), cables, anti- vibration pads etc. as are necessary.

(v) All electrical work and neutral earthing, body earthing, required for engine & alternator, main board/ control panels, and control wiring including loop earthing, if specified in Schedule of Work.

(vi) All pipes, bus trunking and/ or cable connections.

(vii) POL i.e. HSD oil and lub. oil for diesel engine for testing & commissioning for 12 hours i/c 1 hr of 10% overloading at OEA/ OEM works shall be arranged by the contractor. POL i.e. HSD oil and lub. oil for trial run of 4 Hrs. at site at available load shall be arranged by the department.

(viii) Painting of all exposed metal surfaces of equipments and components with appropriate colour.

(ix) Clearance/ Approval of the complete installation from CPCB/ State Pollution Control Board, Central Electricity Authority (CEA)/ Local Bodies and other licensing authorities, wherever required.
1.6 Rates:

1.6.1 The rates quoted by the tenderer, shall be firm and inclusive of all taxes (including works contract tax), duties and levies and all charges for packing, forwarding, insurance, freight and delivery, installation, testing, commissioning etc. at site including temporary constructional storage, risks, overhead charges, general liabilities/ obligations etc. but exclusive of Service Tax, which shall be reimbursed on production of documentary proof of actual payment against this contract/ work.

1.6.2 Octroi exemption certificate will be issued by the department if required by the contractor. However, the department is not liable to reimburse the octroi duty in case exemption certificates are not honoured by the concerned authorities.

1.6.3 The contractor has to carry out routine and preventive maintenance as per manufacturer’s standards for a period of 12 months from the date of handing over. However, all consumables (fuel/ lube oil etc.) including filters will be supplied by the department.

1.7 POWER SUPPLY AND WATER SUPPLY

1.7.1 Power Supply :

(i) Unless otherwise specified, 3 phase, 415 volts, 50 Hz power supply shall be provided by the department free of charge to the contractor at one point for installation at site suitable for 10KW load. Termination switchgear however, shall be provided by the contractor. Further extension if required shall be done by the contractor.

(ii) The contractor shall not use the power supply for any other purpose than that for which it is intended for. No major fabrication work shall be done at site. Power shall be used only for welding/ cutting works. The power supply shall be disconnected in case of such default and the contractor shall then have to arrange the required power supply at his cost

1.7.2 Water supply :

Water supply shall be made available to the contractor by the Department free of charge at one point
1.8 MACHINERY FOR ERECTION

All tools and tackles required for unloading / handling of equipments and materials at site, their assembly, erection, testing and commissioning shall be the responsibility of the contractor.

1.9 COMPLETENESS OF THE TENDER, SUBMISSION OF PROGRAMME, APPROVAL OF DRAWINGS AND COMMENCEMENT OF WORK

(i) Completeness of the tender

All sundry equipments, fittings, assemblies, accessories, hardware items, foundation bolts, supports, termination lugs for electrical connections, cable glands, junction boxes and all other sundry items for proper assembly and installation of the various equipments and components of the work shall be deemed to have been included in the tender, irrespective of the fact that whether such items are specifically mentioned in tender documents or not.

(ii) Submission of programme

Within fifteen days from the date of receipt of the letter of acceptance, the successful tenderer shall submit his programme for submission of drawings, supply of equipment, installation, testing, commissioning and handing over of the installation to the Engineer-in-Charge. This programme shall be framed keeping in view the building progress.

(iii) Submission of Drawings

The contractor shall submit the drawings to the Engineer-in-Charge as per clause 1.19 of this specification for approval before start of work.

(iv) Commencement of Work

The contractor shall commence work as soon as the drawings submitted by him are approved. The drawings are to be submitted by the contractor within 15 days of stipulated date of start, and shall be approved by the Engineer-in-Charge within 10 days of receipt in his office.

1.10 DISPATCH OF MATERIALS TO SITE AND THEIR SAFE CUSTODY

The contractor shall dispatch materials to site in consultation with the Engineer-in-Charge. Suitable lockable storage accommodation shall be made available free of charge temporarily. Watch & ward however, shall be the responsibility of contractor.
Programme of dispatch of material shall be framed keeping in view the building progress. Safe custody of all equipment/items supplied by the contractor shall be the responsibility of the contractor till final taking over by the department.

1.11 CO-ORDINATION WITH OTHER AGENCIES

The contractor shall co-ordinate with all other agencies involved in the work so that the work of other agencies is not hampered due to delay in his work.

1.12 Indemnity:

The successful tenderer shall at all times indemnify the department, consequent on this works contract. The successful tenderer shall be liable, in accordance with the Indian Law and Regulations for any accident occurring due to any cause and the contractor shall be responsible for any accident or damage incurred or claims arising there from on the department during the period of erection, construction and putting into operation the equipments and ancillary equipment under the supervision of the successful tenderer in so far as the latter is responsible. The successful tenderer shall also provide all insurance including third party insurance as may be necessary to cover the risk. No extra payment would be made to the successful tenderer on account of the above.

1.13 QUALITY OF MATERIALS AND WORKMANSHIP

(i) The components of the installation shall be of such design so as to satisfactorily function under all conditions of operation.

(ii) The entire work of manufacture/fabrication, assembly and installation shall conform to sound engineering practice. The entire installation shall be such as to cause minimum transmission of noise and vibration to the building structure.

(iii) All equipment and materials to be used in work shall be manufactured in factories of good repute having excellent track record of quality manufacturing, performance and proper after sales service.

1.14 CARE OF THE BUILDING

Care shall be taken by the contractor during execution of the work to avoid damage to the building. He shall be responsible for repairing all such damages and restoring the same to the original finish at his cost. He shall also remove all unwanted and waste materials arising out of the installation from the site of work from time to time.
1.15 INSPECTION AND TESTING:

1.15.1 The successful tenderer will arrange staff/fuel/POL for test run at his cost.

1.15.2 Inspection and Testing of DG sets of capacity more than 200 KVA

1.15.2.1 For DG sets of capacity more than 200 KVA, testing shall necessarily be carried out at factory/manufacturer premises in presence of representative of the Department.

1.15.2.2 For testing, following procedure will be followed: All major items/equipments i.e. engine & alternator in assembled condition, associated electrical control panels etc. shall be offered for inspection and testing at factory/manufacturers works. The successful tenderer shall give a notice of minimum two weeks for carrying out such tests. The Engineer-in-charge/or his authorized representative shall witness such inspection & testing at mutually agreed date. The cost of the representative’s visit to the factory will be borne by the Department.

1.15.2.3 The department also reserves the right to inspect the fabrication job at factory and the successful tenderer has to make arrangements for the same.

1.15.2.4 DG set will be tested on load of unity power factor for the rated KW rating. During testing, each of the D.G. sets covered under scope of work, shall be operated for a period of 12 hours on the rated KW at DG set’s KW rating including one hour on 10% overload after continuous run of the 12 Hours. During testing all controls/operations safeties will be checked and proper record will be maintained. Any defect/abnormality noticed during testing shall be rectified. The testing will be declared successful only when no abnormality/failure is noticed during the testing. The DG set will be cleared for dispatch to site only when the testing is declared successful by authorised representative/Engineer-in-Charge.

1.15.3 Inspection and Testing of DG sets of capacity equal to or less than 200 KVA

1.15.3.1 For DG sets of capacity equal to or less than 200 KVA, testing shall necessarily be carried out at site. However, initial inspection can be done at factory/manufacturer works before dispatch at site of work at the discretion of Engineer-in-Charge as per details given at 1.15.2.2 above. All major items/equipment i.e. engine & alternator in assembled condition,
Electrical control panel etc. shall be offered for initial inspection at factory/ manufacturers works. The cost of the Engineer’s visit to the factory will be borne by the Department. After initial inspection, DG Set and associated Electrical panel equipments shall be cleared for dispatch at site.

1.15.3.2 Copies of all documents of routine and type test certificates of the equipment, carried out at the manufacturers premises shall be furnished to the Engineer-in-charge and consignee.

1.15.3.3 After completion of the installation work in all respects, the contractor shall offer the DG Sets for testing. Testing shall be carried out exactly as per Clause 1.15.2.4 mentioned above.

1.15.3.4 The requirement of testing of DG Set at manufacturer’s premises, in presence of representative of the Department, can be dispensed with/ waived off, keeping in view the exigency of works, with the prior approval of the Chief Engineer. However, test certificates of the particular DG Set on full load, as mentioned in Clause 1.15.2.4 above, shall be submitted at the time of delivery of DG Set at site.

1.15.5 Trial Run/ Running-in-Period

After successful testing of the DG Set, a trial run at available load will be carried out for 120 Hours or 15 Days whichever is earlier. The DG Set will be operated and a log of all relevant parameters will be maintained during this period. The arrangement of staff for trial run/ running in period will be made by the successful tenderer. However, diesel shall be provided by Department. The contractor will be free to carry out necessary adjustments. The DG Set will be said to have successfully completed the trial run, if no break-down or abnormal/ unsatisfactory operation of any component of the entire installation included in the scope of work of the contract, occurs during this period. After this the DG Set will be made available for beneficial use. After the DG Set has operated without any major break-down/ trouble, it shall be taken over by the department subject to guarantee clause of the contract. This date of taking over of the DG Set, after trouble free operation during the trial run/ running-in period, shall be the date of acceptance/ taking over.

1.15.6 Safety measures

All equipments shall incorporate suitable safety provisions to ensure safety of the operating personnel as per manufacturers’ standard practice.
1.16 STATUTORY CLEARANCE(S)

Approval/ clearance of the complete installation shall be obtained by the contractor from CPCB/ State pollution Control Boards/ Local Bodies/ Central Electricity Authority(CEA)/ other licensing authorities wherever required. However, application shall be made by Department and any statutory fee, as applicable, shall be paid by Department directly to the govt. authorities concerned.

1.17 GUARANTEE

All equipments shall be guaranteed, against unsatisfactory performance and/ or break down due to defective design, workmanship or material, for a period of 12 months from the date of taking over the installation by the department. The equipments or components, or any part thereof, so found defective during guarantee period shall be forthwith repaired or replaced free of cost, to the satisfaction of the Engineer-in-Charge. In case it is felt by the department that undue delay is being caused by the contractor in attending the defect/ fault removed, the same will be got done by the department at the risk and cost of the contractor. The decision of the Engineer-in-charge in this regard shall be final.

1.18 PAYMENT TERMS

1.18.1 The following percentage of contract rates shall be payable against the stages of work shown herein:

<table>
<thead>
<tr>
<th>Stage of work</th>
<th>Engine-Alternator Set &amp; AMF Panel</th>
<th>All other items</th>
</tr>
</thead>
<tbody>
<tr>
<td>I After initial inspection (wher-ever specified) &amp; delivery at site in good condition on pro-rata basis</td>
<td>85%</td>
<td>75%</td>
</tr>
<tr>
<td>II On completion of pro-rata installation</td>
<td>10 %</td>
<td>20 %</td>
</tr>
<tr>
<td>III On commissioning and completion of successful running in period &amp; taking over of the DG set by the department.</td>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>
1.18.2 Deduction of Security Deposit shall be governed by standard/ relevant clauses of CPWD-7/8.

1.19 TENDER DRAWINGS, DRAWINGS FOR APPROVAL & COMPLETION DRAWINGS

1.19.1 Tender Drawings

The drawings appended with the tender documents are intended to show space allotted for various equipments. The equipments offered shall be suitable for installation in the spaces shown in these drawings.

1.19.2 Drawings for approval on award of the work

The contractor shall prepare & submit three sets of following drawings and get them approved from the Engineer-in-charge before the start of the work. The approval of drawings however does not absolve the contractor not to supply the equipments/ materials as per agreement, if there is any contradiction between the approved drawings and agreement.

(a) Lay out drawings of the equipments to be installed including control cables, fuel/ lube oil pipes and supports/ structure for exhaust piping, Chimney and bus ducts/ cable trays.

(b) Drawings including section, showing the details of erection of entire equipments.

(c) Electrical wiring diagrams from engine-alternator set to Electrical control panel, Electrical control panel to essential LT board including the sizes and capacities of the various electrical/ control cables and equipment.

(d) Dimensioned drawings of Acoustic enclosure/ Engine- Alternator set and Electrical control panel.

(e) Drawings showing details of supports for pipes, chimney cable trays, ducts etc.

(f) Any other drawings relevant to the work.

1.19.2.1 Drawings/Documents to be furnished on completion of Installation-

Two sets of the following laminated drawings shall be submitted by the contractor while handing over the installation to the Department. Out of these three, one set
shall be laminated on a hard base for display in the DG set room/room where AMF panel is installed. One set shall be displayed in Junior Engineer’s room. In addition, drawings will be given on Compact Disc(CD):

(a) DG set installation drawings giving complete details of all the equipments, including their foundations.

(b) Line diagram and layout of all electrical control/AMF panels giving switchgear ratings and their disposition, cable feeder sizes and their layout.

(c) Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits in AMF panel/PCC.

1.19.3.2

(i) Manufacturer’s technical catalogues of all equipments and accessories.

(ii) Operation and maintenance manual of all major equipments, detailing all adjustments, operation and maintenance procedure.

1.20 AFTER SALES SERVICES

The contractor shall ensure adequate and prompt after sales service free of cost during guarantee period, and against payment after the guarantee period is over, in the form of maintenance, spares and personnel as and when required during normal life span of the equipments and shall minimize the breakdown period. In case of equipment supplied by other manufacturers the firm shall furnish a guarantee from the manufacturer for the same before the DG Set installation is taken over.
Chapter 2
Technical

2.1 Scope: This section deals with unloading procedures, location, standard capacities and climatic conditions for DG set installation.

2.1.1 UNLOADING:

2.1.1.1 Gensets without Acoustic Enclosure:

2.1.1.1.1 Genset should not be lifted from engine and alternator hooks. These are designed for lifting individual items only. Normally, provision for Genset lifting is provided on base-rails. The Genset should be unloaded from base rail by lifting with proper Genset lifting tackle or nylon sling/steel rope of suitable capacity and crane so as to ensure no damage to oil sump, air cleaner, radiator pipes etc.

2.1.1.2 Genset should be covered with polyethylene or tarpaulin during installation to ensure that water does not enter inside.

2.1.1.3 Spreader bar/ spacer plate of suitable size may be required to avoid damages to Genset components.

2.1.1.2 DG set with Acoustic enclosures are provided with lifting hooks.

2.1.2 Location

2.1.2.1 DG Sets with acoustic enclosure

DG sets up to 1000 KVA capacity are required to be supplied with acoustic enclosure as per CPCB norms. DG Set with acoustic enclosure shall preferably be installed outside the building (including terrace subject to structural feasibility) & location should be finalized in consultation with the Architect. However, DG set should be as near to the substation as possible i.e. as near to Essential LT Panel as possible. Associated AMF panel/ Electrical panel of the DG Set can be located inside the acoustic enclosure or outside the acoustic enclosure as per manufacturer standard. In case, AMF/ Electrical panel has to be installed outside the acoustic enclosure, location of room to house AMF/ Electrical panel should be decided in consultation with the Architect so that it shall be as near to the acoustic enclosure as possible. Specially, in case of connection through bus trunking, care should be taken for aesthetics.
2.1.2.2 DG Sets without acoustic enclosure

2.1.2.2.1 In case of DG Sets beyond 1000KVA capacity i.e. when DG set is supplied without acoustic enclosure, room of appropriate size should be provided to house the DG Set. The DG set room should be as near to the substation as possible (i.e. as near to Essential LT Panel as possible). While deciding the room layout, typical 2-meters free space around Genset is recommended for proper heat dissipation and ease of service. However, to avoid hot air re-circulation, radiator cooled engines should have maximum possible space in the front. Minimum 1.5 meter free space is must. A typical Genset room is shown in Figure 1.

2.1.2.2.2 As far as possible, installation of DG Set should be avoided in basement. In Cases where installation of D.G. Set in basement is unavoidable, due care of supply of adequate amount of air required for proper operation of D.G. Set shall be taken.

2.1.3 Nominal ratings of DG Sets:

DG Sets are normally available in following standard capacities:

(Ratings in KVA)

<table>
<thead>
<tr>
<th>Capacity</th>
<th>7.5</th>
<th>10</th>
<th>12.5</th>
<th>15</th>
<th>17.5</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>50</th>
<th>62.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>KVA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>75</td>
<td>82.5</td>
<td>110</td>
<td>125</td>
<td>140</td>
<td>200</td>
<td>225</td>
<td>250</td>
<td>300</td>
<td>320</td>
<td>350</td>
<td>380</td>
</tr>
<tr>
<td>415</td>
<td>415</td>
<td>450</td>
<td>500</td>
<td>550</td>
<td>600</td>
<td>625</td>
<td>700</td>
<td>750</td>
<td>1010</td>
<td>1250</td>
<td>1500</td>
<td></td>
</tr>
</tbody>
</table>

Capacity output of DG Set should be specified in tender in terms of “Prime Power Rating at 0.85 load factor” as per Clause 13.3.2 of ISO-8528 (Part-1). Titled ‘Reciprocating internal combustion engine driven alternating current generating sets: Part-1: Application, ratings and performance’.(See Appendix ‘I’). However, depending upon the particular application & use, ‘Continuous’ or ‘Standby’ rating can be specified.

2.1.4 Climatic Conditions:

The output of DG Set shall be specified in tender documents under actual site conditions. The tenderer has to certify that the engine & alternator meets the capacity requirement after de-ration as per IS/ BIS.
2.1.5 DG Set upto 1000KVA capacity should be type tested for Noise and Emission norms/standards as per CPCB as per Appendix ‘II’ and Appendix ’III’.

2.2 Diesel Engine

**Scope:** This section covers engine rating, standard components of a diesel engine including exhaust piping.

2.2.1 **Diesel Engine**

2.2.1.1 **Engine Rating:**

The engine shall be of standard design of the original manufacturers. It should be 4 stroke cycles, water cooled, naturally aspirated/ turbo charged (as per manufacturer standard), diesel engine developing suitable BHP for giving a power rating as per ISO 8528- Part-1 in KVA at the load terminals of alternator at 1500 rpm at actual site conditions.

The engine shall be capable for delivering specified Prime Power rating at variable loads for PF of 0.8 lag with 10% overload available in excess of specified output for one hour in every 12 hours. The average load factor of the engine over period of 24 hours shall be 0.85 (85%) for prime power output.

The testing procedure shall be as mentioned in para 1.15.

The engine shall conform to IS:10000/ ISO 3046/ BS:649 /BS 5514 amended up to date.

2.2.1.2 Necessary certificate indicating the compliance of the above capacity requirement for the engine model so selected along with compliance of Noise and Emission norms as per latest CPCB guidelines for DG set capacity up to 1000KVA, should be furnished from the manufacturers along with the technical bid.(Refer Appendix ‘II’ for noise norms and Appendix ‘III’ for emission norms). However above 1000 KVA DG set, manufacturers shall furnish certificate that the Engine for the DG set complies with the CPCB Emission norms.

2.2.1.3 The engine shall be fitted with following accessories subject to the design of the manufacturer:

(i) Dynamically balanced Fly wheel

(ii) Necessary flexible coupling and guard for alternator and engine (applicable only for double bearing alternator)
(iii) Air cleaner (dry/ oil bath type) as per manufacturer standard,
(iv) A mechanical/ electronic governor to maintain engine speed at all conditions of load. (see Clause 2.2.1.4)
(v) Daily fuel service tank of minimum capacity as per Table below, fabricated from M.S. sheet with inlet, outlet connections air vent tap, drain plug and level indicator (gauge) M.S. fuel piping from tank to engine with valves, unions, reducers, flexible hose connection and floor mounting pedestals, twin fuel filters and fuel injectors. The location of the tank shall depend on standard manufacturers design.

**Table - I Recommended minimum capacity of daily fuel service tank:**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Capacity of DG set</th>
<th>Minimum Fuel Tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Upto 25 KVA</td>
<td>100 Litres</td>
</tr>
<tr>
<td>(ii)</td>
<td>Above 25 to 62.5 KVA</td>
<td>120 Litres</td>
</tr>
<tr>
<td>(iii)</td>
<td>Above 62.5 KVA to 125 KVA</td>
<td>225 Litres</td>
</tr>
<tr>
<td>(iv)</td>
<td>Above 125 KVA to 200 KVA</td>
<td>285 Litres</td>
</tr>
<tr>
<td>(v)</td>
<td>Above 200 KVA to 380 KVA</td>
<td>500 Litres</td>
</tr>
<tr>
<td>(vi)</td>
<td>Above 380 KVA to 500 KVA</td>
<td>700 Litres</td>
</tr>
<tr>
<td>(vii)</td>
<td>Above 500 KVA to 750 KVA</td>
<td>900 Litres</td>
</tr>
</tbody>
</table>

(vi) Dry exhaust manifold with suitable exhaust residential grade silencer to reduce the noise level.
(vii) Suitable self-starter for 12 V/ 24 V DC.
(viii) Battery charging alternator unit and voltage regulator, suitable for starting batteries, battery racks with interconnecting leads and terminals.
(ix) Necessary gear driven oil pump for lubricating oil, priming of engine bearing as well as fuel systems as per manufacturer recommendations.
(x) Naturally aspirated/ turbo charger (as per manufacturer standard)
(xi) Lubrication oil cooler
(xii) Lubrication oil filters with replaceable elements.
(xiii) Crank case heater as per manufacturer recommendations.
(xiv) Fuel injection: Engine should have suitable fuel injection system in order to achieve low fuel consumption.

(xv) Fuel control solenoid

(xvi) Fuel pump with engine speed adjustment.

(xvii) Engine Control Panel: fitted and having digital display for following:-

(a) Start/stop key switch.  (b) Lube oil pressure indication

(c) Water temp. indication  (d) RPM indication

(e) Engine Hours indications (f) Battery charging indication

(g) Low lub. Oil trip indication (h) High water temp. indication

(i) Over speed indication.

(xviii) All moving parts of the engine shall be mechanically guarded in such a manner that a human finger cannot touch any moving part.

(xix) Radiator/ Heat Exchanger System/ Remote Radiator(delete whichever is not applicable)

(xx) Any other item not included/ specified but is a standard design of the manufacturer

2.2.1.4 Governor:

Mechanical governor of class A2 for up to and including 200 KVA capacity and Electronic governor of class A1 for capacity above 200KVA, as per ISO 3046/ BS5514 with actuator shall be provided as per standard design of manufacturer. Governor shall be a self contained unit capable of monitoring speed.

2.2.1.5 Frequency variation:

The engine speed shall be so maintained that frequency variation at constant load including no load shall remain within a band of 1% of rated.

2.2.1.6 Fuel System:

It shall be fed through engine driven fuel pump. A replaceable element of fuel filter shall be suitably located to permit easy servicing. The daily service tank shall be complete with necessary supports, gauges, connecting pipe work etc. In case of Top
Mounted tanks, non return valves are must in fuel supply and return line of specified value. Pipe sealant should be used for sealing for all connections. No Teflon tape to be used. If piping length is more than 10 meters, detail engineering is required in consultation with OEM/ Manufacture

2.2.1.7 Lubricating oil system:

It shall be so designed that when the engine starts after a long shut down lubrication failure does not occur. Necessary priming pump for the lub. oil circuit as per recommendation of manufacturer shall be installed, to keep bearings primed. This pump shall be normally automatically operative on AC/ DC supply available with the set.

2.2.1.8 Starting system:

This shall comprise of necessary set of heavy duty batteries 12V/ 24V DC (as per manufacturer standard), and suitable starter motors, axial type gear to match with the toothed ring on the fly wheel. A timer in the control panel to protect the starter motor from excessively long cranking runs shall be suitably integrated with the engine protection system and shall be included within the scope of the work. Battery capacity shall be suitable for meeting the needs of starting system (as three attempt starting), as well as the requirements of control panel, indications and auxiliaries such as priming pump as applicable etc. The scope shall cover all cabling, terminals, including initial charging etc. The system shall be capable of starting the DG set within 20-30 sec., even in winter condition with an ambient temperature down to 0°C.

2.2.1.9 Battery Charger:

The battery charger shall be suitable to charge required numbers of batteries at 12V/ 24 volts complete with, transformer, rectifier, charge rate selector switch, indicating ammeter & voltmeter etc. Connections between the battery charger & batteries shall be provided with suitable copper leads with lugs etc.

2.2.1.10 Piping Work:

All pipe lines and fittings and accessories requirement inside the room/ enclosure and outside for exhaust piping shall be provided by the contractor. This shall include necessary flexible pieces in the exhaust, fuel, lub. oil and water lines as are necessary in view of the vibration isolation requirement in the installation. Piping of adequate size shall be used for lub. oil of the material as per manufacturer standard. However, only M.S. pipes for the exhaust shall be used. For fuel lines within the acoustic
enclosure, PVC braided pipe as per manufacturer recommendations can be used. However, for fuel lines outside the acoustics enclosure only MS pipe be used.

The pipe work shall be inclusive of all fittings and accessories required such as bends, reducers, elbows, flanges, flexible connections, necessary hardware etc. The installation shall cover clamps, supports, hangers etc. as are necessary for completing the work. However, the work shall be sectionalized with flanged connections as are necessary for easy isolation for purposes for maintenance of unit as approved by Engineer-in-charge.

2.2.1.11 Common bed plate:

Engine and alternator shall be directly coupled or coupled by means of flexoplate/flexible coupling as per manufacturer standard design and both units shall be mounted on a common bed plate together with all auxiliaries to ensure perfect alignment of engine and alternator with minimum vibrations. The bed plate shall be suitable for installation on suitable anti-vibration mounting system.

2.2.1.12 Exhaust System: (wherever Applicable)

2.2.1.12.1 Exhaust Piping:

All M.S. Pipes for exhaust lines shall be conforming to relevant IS. The runs forming part of factory assembly on the engine flexible connections up to exhaust silencer shall be exclusive of exhaust piping item. The work include necessary cladding of exhaust pipe work using 50mm thick Loosely bound resin(LBR)matress / mineral wool/ Rockwool, density not less than 120kg/m³ and aluminium cladding (0.6mm thick) for the complete portion. The exhaust pipe work includes necessary supports, foundation etc. to avoid any load & stress on turbo charger / exhaust piping. The exhaust pipe shall be *run along the existing wall of the building duly clamped/ supported on independent structure for which, the design and Drawing for such structure shall be got approved from the Engineer in charge.

2.2.1.12.2

(a) Exhaust system should create minimum back pressure.

(b) Number of bends should be kept minimum and smooth bends should be used to minimize back pressure.

(c) Pipe sleeve of larger dia. should be used while passing the pipe through concrete wall & gap should be filled with felt lining.
(d) Exhaust piping inside the Acoustic Enclosure/ Genset room should be lagged with asbestos rope along with aluminium sheet cladding / insulated as per clause 2.2.1.12.1 to avoid heat input to the room.

(e) Exhaust flexible shall have it’s free length when it is installed. For bigger engines, 2 flexible bellows can be used.

(f) For engines up to 500KVA, only one bellow is required. However, if exhaust pipe length is more than 7 m then additional bellow/ provision for expansion should be provided.

(g) ‘Schedule B’ MS pipes and long bend/elbows should be used.

(h) The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet/ windows etc.

(i) When tail end is horizontal, 45 Degree downward cut should be given at the end of the pipe to avoid rain water entry into exhaust piping.

(j) When tail end is vertical, there should be rain trap to avoid rain water entry. If rain cap is used, the distance between exhaust pipe and rain cap should be higher than diameter of pipe. Horizontal run of exhaust piping should slope downwards away from engine to the condensate trap. Silencer should be installed with drain plug at bottom.

2.2.1.12.3 Optimum Silencer Location:

Location of the silencer in exhaust system has very definite influence on both reduction of noise and back pressure imposed on the system. The preferred silencer locations are given in the Table below, where L is length of the total exhaust system measured from exhaust manifold in meters. Please note that locating the silencer as per optimum silencer location is not mandatory. For high rise buildings, suitable arrangements may have to be provided in consultation with acoustics engineer.

<table>
<thead>
<tr>
<th>Optimum Location of Silencer (In meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-line Engine</td>
</tr>
<tr>
<td>Best</td>
</tr>
<tr>
<td>Second best</td>
</tr>
<tr>
<td>Worst Location of Silencer</td>
</tr>
</tbody>
</table>
2.2.1.12.4 Exhaust stack height:

In order to dispose exhaust above building height, minimum exhaust stack height should be as follows:

(a) For DG set up to 1000KVA :-

\[ H = h + 0.2 \times \sqrt{KVA} \]

Where H = height of exhaust stack

h = height of building

(b) For DG set above 1000KVA :-

30m High or 3m above the building height, which ever is higher.

2.2.1.12.5

Care should be taken to ensure that no carbon particles emitted due to exhaust leakage enters and deposits on alternator windings and on open connections.

2.2.1.12.6 Support to Exhaust Piping:

Exhaust piping should be supported in such manner that load of exhaust piping is not exerted to turbocharger.

2.2.1.13 Air System:

It is preferable to provide vacuum indicator with all engines to indicate choked filter. Maximum air intake restrictions with clean and choked filters should be within prescribed limit as per OEM/manufacturer recommendation for the particular model of the engine. Gensets should be supplied with medium duty/ heavy duty air cleaners (specify one only). (Heavy duty air cleaner should be used for installations in dusty or polluted surroundings.)

2.2.1.14 Cooling System

2.2.1.14.1 System should be designed for ambient temperature of 40 Deg.C.

2.2.1.14.2 Water softening/ demineralizing plants should be used, if raw water quality is not acceptable.

2.2.1.14.3 Coolant should be used mixed with additive (in suitable proportion) as per recommendation of OEM/Manufacturer for various engine models.
2.2.1.14.4 Radiator fan flow should be free from any obstruction.

2.2.1.14.5 For radiator cooled DG Set, proper room ventilation should be planned at the time of construction of DG room.

2.2.1.14.6 Remote Radiator can be used in case of basement installation where fresh air may not be available. The proper location of remote radiator is very essential for the successful and efficient operation of remote radiator. In this the cooling media is ambient air. So in order to obtain maximum efficiency from remote radiator, it is necessary to get fresh air in its surrounding. The horizontal distance of remote radiator from engine should not exceed 10 Meter.

2.2.1.14.7 For the dusty or polluted surroundings (as radiator gets clogged) and/ or bigger capacity Gensets (say 1000KVA and above), installation of Cooling System with Heat Exchanger system may be used.

2.2.1.14.8 Optional items as under may be included as per site requirement at the discretion of Technical Sanctioning authority;

(i) Cooling System
   (a) Remote Radiator
   (b) Jacket Water Heater
   (c) Crankcase Oil Heater
   (d) After cooler jacket turbo charger electrical pre heat systems.

(ii) Fuel System
   (a) Fuel Water Separator
   (b) Auxiliary Fuel Pump

(iii) Exhaust System
   (a) Industrial Grade Muffler
   (b) Residential Grade Muffler
   (c) Critical Grade Muffler
   (d) Super Critical Grade Muffler
(iv) **Start System**

(a) Battery Warmer Plate

(b) Battery Charger
   - Automatic Float Equalizing
   - Trickle

### 2.3 Alternator

**Scope**: This section covers technical requirement of the alternator.

#### 2.3.1 Synchronous Alternator:

Self excited, screen protected, self regulated, brush less alternator, Horizontal foot mounted in Single/Double bearing construction (specify one only) suitable for the following:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated PF.</td>
<td>0.8 (lag)</td>
</tr>
<tr>
<td>Rated voltage</td>
<td>415 volts</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>No. of Phases</td>
<td>3</td>
</tr>
<tr>
<td>Enclosure</td>
<td>SPDP</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>IP-23</td>
</tr>
<tr>
<td>Ventilation</td>
<td>Self ventilated air cooled</td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>40°C Maximum</td>
</tr>
<tr>
<td>Insulation Class</td>
<td>F/H</td>
</tr>
<tr>
<td>Temperature Rise</td>
<td>Within class F/H limits at rated load</td>
</tr>
<tr>
<td>Voltage Regulation</td>
<td>+/- 1%</td>
</tr>
<tr>
<td>Voltage variation</td>
<td>+/- 5%</td>
</tr>
</tbody>
</table>

**Overload duration/capacity**: 10% for one hour in every 12 hours of continuous use.

**Frequency variation**: As defined by the Engine Governor (+/- 1%)
Excitation: Self / separately excited (Self excitation upto 750 KVA and separately excited system above 750 KVA)

Type of AVR: Electronic

Type of Bearing and Lubrication arrangement: Anti-friction bearings with Grease lubrication

Standard: IS-4722 & IEC:34 as amended upto date.

2.3.2 Alternator should be able to deliver output rating at actual Site conditions.

2.3.3 The alternator above 500KVA capacity shall be fitted with suitable Nos. Resistance Temperature Device (RTD) & Bearing Temperature Device (BTD) alongwith space heaters. The terminal of space heaters will be wired to terminal box and the temperature scanner shall be provided in control panel for scaling the winding and bearing temperature.

2.3.4 Excitation: The alternator shall be brushless type and shall be self/ Separately excited, self-regulated having static excitation facility. The exciter unit be mounted on the control panel or on the alternator assembly. The rectifier shall be suitable for operation at high ambient temperature at site.

2.3.5 Automatic Voltage Regulator (AVR): In order to maintain output terminal voltage constant within the regulation limits i.e. +/- 1%, Automatic voltage regulator unit shall be provided as per standard practice of manufacturer.

2.3.6 Fault tripping: In the event of any fault e.g. over voltage/ high bearing temperature/ high winding temperature or an external fault, the AVR shall remove the excitation voltage to the alternator. An emergency trip shall also be provided.

2.3.7 Standards: The alternator shall be in accordance with the following standards as are applicable.


2.3.8 Performance: Voltage dip shall not exceed 20% of the rated voltage for any step load or transient load as per ISO:8528 (Part-1 ). The winding shall not develop hot spots exceeding safe limits due to imbalance of 20% between any two phases from no load to full load.

23
The generator shall preferably be capable of withstanding a current equal to 1.5 times the rated current for a period of not more than 15 seconds as required vide clause 14.1.1 of IS 4722:1992.

The performance characteristics of the alternator shall be as below:

(a) Efficiency at full load 0.8 P.F. (i) Upto 25 KVA – not less than 82% (ii) Above 25 KVA and up to 62.5 KVA - not less than 86% (iii) above 62.5 KVA & up to 250 KVA – not less than 90% (iv) above 250 KVA – not less than 93.5%

(b) Total distortion factor

(i) 10% overload Less than 3 %
(ii) 50% overload One hour in every 12 hrs of continuous use.

2.3.9 Terminal Boxes:

Terminal boxes shall be suitable for U.G. cables/ Bus Trunking. The terminal box shall be suitable to withstand the mechanical and thermal stresses developed due to any short circuit at the terminals.

2.3.10 Earth Terminals:

2 Nos. earth terminals on opposite side with vibration proof connections, non-ferrous hardware etc. with galvanized plate and passivated washer of minimum size 12mm dia. hole shall be provided.

2.3.11 Space Heaters:

Alternators of capacity more than 500KVA shall be provided with suitable space heaters to maintain the winding temperature automatically such that it does not absorb moisture during long idle periods. The heater terminals shall be brought to a separate terminal box suitable for 230 V AC supply and a permanent caution notice shall be displayed.

2.4 Manual/ AMF Panel, Batteries and Electrical system

Scope: This section covers technical and functional requirements of Manual/ AMF Panel, Battery/ Electrical System
2.4.1 Location of Panel:

2.4.1.1 DG Set with acoustic enclosure: Associated AMF panel/ Manual panel of the DG Set can be located inside the acoustic enclosure or outside the acoustic enclosure as per manufacturer’s standard. In case, AMF/ Manual panel has to be installed outside the acoustic panel, location of room to house AMF/ Manual panel should be decided in consultation with the Architect as near to the acoustic enclosure as possible. In case of connection through bus trunking, care should be taken for aesthetics vis-à-vis surrounding.

2.4.1.2 DG Set without acoustic enclosure: In case of DG Sets is supplied without acoustic enclosure, Manual/AMF electrical control panel should be located inside the sub station building.

2.4.2 Type of Control Panel: Control panel shall be either manual type or AMF type as per the requirement of work to be decided by NIT approving authority.

2.4.2.1 Manual Control Panel: The control panel shall be fabricated out of 1.6mm sheet steel, totally enclosed, dust, damp and vermin proof wall mounted/ free standing floor mounted type with IP-53 degree of protection & front operated.

The Standard control panel shall consist the following instruments:

(a) Composite meter for digital display of :

   (i) Voltage
   (ii) Current
   (iii) Power factor (for 15 KVA and above)
   (iv) Frequency (for 15 KVA & above)
   (v) Energy Meter (for 15 KVA & above)

(b) HRC fuses of suitable rating.

(c) One MCB of suitable rating for DG sets up to 45 KVA rating or Switch Disconnector Fuse Unit (SDFU) for higher ratings.
(d) Push button-switch or ON/ OFF Switch for ON and OFF operation

(e) Pilot lamps one No. in case of single phase DG sets and 3 numbers in case of three phase DG sets.

(f) Battery charger complete with voltage regulator, Voltmeter and Ammeter for charging the battery from external mains. This will be in addition to the battery charging alternator or dynamo fitted on the engine.

(g) Instrument fuses.

All the components in the control panel shall be properly mounted, duly wired and labeled. Suitable terminals are to be provided for panel incoming and outgoing connections.

2.4.2.2 AMF Control Panel

2.4.2.2.1 General Features: The control panel shall be fabricated out of 1.6mm thick sheet steel, totally enclosed, dust, damp and vermin proof free standing floor mounted type & front operated. It shall be made into sections such that as far as feasible, there is no mixing of control, power, DC & AC functions in the same section and they are sufficiently segregated except where their bunching is necessary. Hinged doors shall be provided preferably double leaf for access for routine inspection from the rear. There is no objection to have single leaf hinged door in the front, all indication lamps, instruments meter etc. shall be flushed in the front. The degree of protection required will be IP-42 conforming to IS:2147.

2.4.2.2.2 Terminal blocks and wiring: Terminal blocks of robust type and generally not less than 15 Amps capacity, 250/500 V grade for DC upto 100V and 660/ 1100 volts grade for AC and rest of the junction shall be employed in such a manner so that they are freely accessible for maintenance. All control and small wiring from unit to unit inside the panel shall also be done with not less than 2.5 sqmm copper conductor PVC insulated and 660/ 1100 volts grade. Suitable colour coding can be adopted. Wiring system shall be neatly formed and run preferably, function wise and as far as feasible segregated voltage wise. All ends shall be identified with ferrules at the ends.
2.4.2.3 Labeling: All internal components shall be provided with suitable identification labels suitably engraved. Labels shall be fixed on buttons, indication lamps etc.

2.4.2.4 Painting: The entire panel shall be given primer coat after proper treatment and powder coating with 7 tanks process before assembly of various items.

2.4.2.5 Equipment requirements: The control cubical shall incorporate into assembly general equipment and systems as under:

(a) Control system equipments and components such as relays, contactors, timers, etc. both for automatic operation on main failure and as well as for manual operation.

(b) Equipment and components necessary for testing generating set’s healthiness with test mode and with load on mains.

(c) Necessary instruments and accessories such as voltmeter, power factor meter, KW meter, KWH meter, Ammeter, Frequency meter etc. in one energy analyzer unit with selector switch to obtain the reading of desired parameters.

(d) Necessary indication lamps, fuses, terminal blocks, push buttons, control switches etc. as required.

(e) Necessary engine/ generating set shut down devices due to faults / abnormalities.

(f) Necessary visual audio alarm indication and annunciation facility as specified.

(g) Necessary battery charger.

(h) Necessary excitation control and voltage regulating equipment. (Alternatively provided on the Alternator itself).

(i) Necessary over head bus trunking terminations all internal wiring, connections etc. as required.

(j) Breakers as specified in the schedule of work.

2.4.2.6 System Operation: The above mentioned facilities provided shall afford the following operational requirements.
2.4.2.6.1 Auto Mode:

(a) A line voltage monitor shall monitor supply voltage on each phase. When the mains supply voltage fails completely or falls below set value (variable between 80 to 95% of the normal value) on any phase, the monitor module shall initiate start-up of diesel engine. To avoid initiation due to momentary disturbance, a time delay adjustment between 0 to 5 second shall be incorporated in start-up initiation.

(b) A three attempt starting facility shall be provided 6 seconds ON, 5 seconds OFF, 6 seconds ON, 5 seconds OFF, 6 seconds ON, if at the end of the third attempt, the engine does not start, it shall be locked out of start, a master timer shall be provided for this function. Suitable adjustment timers be incorporated which will make it feasible to vary independently ON-OFF setting periods from 1-10 seconds. If alternator does not build up voltage after the first or second start as may be, further starting attempt will not be made until the starting facility is reset.

(c) Once the alternator has built up voltage, the alternator circuit breaker shall close connecting the load to the alternator. The load is now supplied by the alternator.

(d) When the main supply is restored and is healthy as sensed by the line voltage monitor setting, both for under voltage and unbalance, the system shall be monitored by a suitable timer which can be set between 1 minute to 10 minutes for the load to be transferred automatically to main supply.

(e) The diesel alternator set reverts to standby for next operation as per (a), (b) and (c) above.

2.4.2.6.2 Manual mode:

(a) In a manual mode, it shall be feasible to start-up the generator set by the operator on pressing the start push button.

(b) Three attempt starting facility shall be operative for the start-up function.

(c) Alternator circuit breakers close and trip operations shall also be through operator only by pressing the appropriate button on the panel and closure shall be feasible only after alternator has built up full voltage. If the load is already on ‘mains’, pressure on ‘close’ button shall be ineffective.

(d) Engine shut down, otherwise due to faults, shall be manual by pressing a ‘stop’ button.
2.4.2.6.3 Test mode:

(a) When under ‘test’ mode pressing of ‘test’ button shall complete the start up sequence simulation and start the engine. The simulation will be that of mains failure. Sequence I 2.4.2.6.1(a) and (b) shall be completed.

(b) Engine shall build up voltage but the set shall not take load by closing of alternator circuit breaker. When the load is on the mains, monitoring of performance for voltage/ frequency etc. shall be feasible without supply to load.

(c) If during test mode, the power supply has failed, the load shall automatically get transferred to alternator.

(d) Bringing the mode selector to auto position shall shut down the set as per sequence of 2.4.2.6.1 (d) provided main supply is ON. If the mains supply is not available at that time, the alternator shall take load as in (c) above.

2.4.2.7 Engine shut down and alternator protection equipment: Following shut down and protection system shall be integrated in the control panel.

(a) Engine:

(i) Low lubricating oil pressure shut down. This shall be inoperative during start up and acceleration period.

(ii) High coolant (water) temp. shut down.

(iii) Engine over speed shut down.

(b) Alternator Protection: Following protection arrangement shall be made:

(i) Over load

(ii) Short circuit

(iii) Earth fault

(iv) Over voltage

2.4.2.8 Monitoring and metering facilities:

(a) Necessary energy analyzer unit for visual monitoring of mains, alternator and load voltage, current, frequency, KWH, power factor, etc.

(b) A set of visual monitoring lamp indication for:

(i) Load on set

(ii) Load on mains
(iii) Set on test (Alternator on operation duty, Alternator on standby duty).

(iv) Set of lamp for engine shut down for over speed, low lub. Oil pressure and high coolant water temperature, overload trip of alternator, earth fault trip of alternator, engine lock out and failure to start etc. All these indications shall have an audio and visual alarm. When operator accepts the alarm, the hooter will be silenced and the fault indication will become steady until reset by operating a reset button.

2.4.2.2.9 **Operating devices:** A set of operation devices shall be incorporated in the front of panel as under:

(a) Master Engine Control Switch: This shall cut off in ‘OFF’ position DC control to the entire panel, thus preventing start-up of engine due to any cause. However, battery charger, lamp test button for testing the healthiness of indication lamps, DC volt meter / ammeter etc. shall be operative. It shall be feasible to lock the switch in OFF position for maintenance and shut down purposes.

(b) Operation selector switch OFF/AUTO/MANUAL/TEST position.

(c) Energy analyzer unit for display of various electrical parameters like voltage, current, frequency, KW, power factor, etc.

(d) A set of push button as specified.

(e) Relays, contactors, timers, circuit breakers as required.

(f) Necessary battery charger with boost/ trickle selector, DC voltmeter and DC ammeter.

2.4.2.2.10 **Compatibility with ‘Building Management System’(BMS):**

PLC compatibility and required nos. of Input/ Output terminals points should be provided in the AMF control panel.

2.4.3 **Battery/ Electrical System**

2.4.3.1 Batteries supplied with Genset are generally dry and uncharged. First charging of uncharged batteries is very important and should be done from authorized battery charging centre. Initial charging should be done for 72-80 hours.

2.4.3.2 Batteries should be placed on stands and relatively at cool place.
2.4.3.3 Battery capacity and copper cable sizes for various engine capacity are recommended as indicated in the table below. Cable sizes shown are for maximum length of 2m. If length is more, cable size should be selected in such a way that voltage drop does not exceed 2V. However capacity as recommended by manufacturer may be taken.

<table>
<thead>
<tr>
<th>DG Set Capacity</th>
<th>Battery Capacity(AH)</th>
<th>Cable Size(Material Copper)Sq. mm</th>
<th>Electrical System(Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 500 KVA</td>
<td>360</td>
<td>70</td>
<td>24</td>
</tr>
<tr>
<td>Above 125 KVA upto 500</td>
<td>180</td>
<td>70</td>
<td>12</td>
</tr>
<tr>
<td>Above 82.5 KVA upto 125</td>
<td>180</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>Above 62.5 KVA upto 82.5</td>
<td>150</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>Above 25 KVA upto 62.5</td>
<td>120</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>Upto 25 KVA</td>
<td>88</td>
<td>35</td>
<td>12</td>
</tr>
</tbody>
</table>

2.4.3.4 For AMF applications, a static battery charger working on mains supply is recommended to keep the batteries charged at all times.

2.4.3.5 1.5 Sq.mm copper wire should be used for wiring between junction box and Control Panel.

2.4.4 Cabling

2.4.4.1 Power cabling between alternator and control panel and control panel and change over switch to mains should be done with recommended cable sizes.

2.4.4.2 Typical cable sizes for 415 V application are provided in Appendix-VI.

2.4.4.3 As far as possible, for DG Set of capacity 750KVA &above connection between alternator to AMF panel &AMF Panel to Essential panel shall be through bus-trunking. For exposed/ outdoor bus trunking protection requirement should be IP-55.

2.4.4.4 If LT panel is part of tender of the DG Set jobs of 500 KVA &above, LT Panel specified, should be one of the reputed brands.

2.4.4.5 Overheating due to loose thimbling / undersize cables causes most of electrical failures, hence correct size of cable and thimbles should always be used, if cable is specified.
2.4.4.6 While terminating cables, avoid any tension on the bolts/ busbars. (if cable is specified)

While terminating R, Y & B phase notations should be maintained in the alternator and control panel for easy maintenance.

2.4.4.7 Crimped cables should be connected to alternator and control panel through cable glands, if cable is specified.

2.4.4.8 Multi-core copper cables should be used for inter connecting the engine controls with the switchgear and other equipments.

2.4.4.9 For AMF application, multicore 1.5 sq.mm flexible stranded copper cable for control cabling should be used.

2.4.4.10 It is recommended to support output cables on separate structure on ground so that weight of cables should not fall on alternator/ base rail.

2.4.4.11 External wirings, when provided for remote voltage / excitation monitoring / droop CT etc. shall be screened sheathed type. Maximum length of such wiring shall not exceed 5 meters.

2.4.4.12 Alternator Termination Links

2.4.4.12.1 For proper terminations between links and switchgear terminals, the contact area must be adequate. The following situations should also be avoided as they lead to creation of heat sources at the point of termination:

(i) Point contact arising out of improper position of links with switchgear terminals (Figure 2(i) ).

(ii) Gaps between busbars / links and terminals being remedied by connecting bolt / stud (Figure 2(ii) ). In such cases the bolt will carry the load current. Normally these bolts / studs are made of MS and hence are not designed to carry currents.

2.4.4.12.2 Adequate clearance between busbars / links at terminals should be maintained (IS:4232 may be referred to for guidelines).

Figure 2(iii) indicates the quality of different configurations.

2.4.4.12.3 Improper termination will lead to local heat generation which may lead to failure.
2.5 Foundation

Scope: This section covers details of foundations for DG set with or without acoustic enclosures.

2.5.1 Genset with acoustic enclosure:

(a) For DG Sets installed inside the DG Set Room - A PCC foundation (1:2:4, M-20 grade) of approximate depth 150mm above the finished Genset Room Floor level is required so as to provide leveled surface for placement of the acoustics enclosure. The length and breadth of foundation should be at least 250 mm more on all sides than the size of the enclosure. Genset should be mounted on AVM’s inside the enclosure.

(b) For DG Sets installed outside in open area - A PCC (1:2:4, M-20 grade) foundation of weight 2.5 times the operating weight of the Genset with enclosure or as recommended by the Genset manufacturer OEM/OEA, whichever is higher, is required to provided and is included in scope of work for SITC of Genset. 300 mm of this foundation height should be above the ground level. The length and breadth of foundation should be at least 250 mm more on all sides than the size of enclosure. Genset should be mounted on AVM’s inside the enclosure. Design of the foundation as recommended by the OEM shall be submitted by the contractor before execution of work along with the drawings as mentioned in section 1.19.

2.5.2 Genset without acoustic enclosure:

2.5.2.1 Genset should not be installed on loose sand or clay.

2.5.2.2 Foundation should be designed considering safe bearing capacity of soil. Vibration isolators (AVMs) should be provided to reduce vibration transmission to the surrounding structure.

2.5.2.3 Depths of PCC (Plain Cement Concrete) for typical soil condition have been shown in the table below. However structural engineer should be consulted to verify the data depending upon soil condition.
<table>
<thead>
<tr>
<th>DG set Capacity (KVA)</th>
<th>Typical Depth of PCC Foundation (For soil bearing capacity 5000 kg/sqm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>750-2000</td>
<td>600 mm</td>
</tr>
<tr>
<td>625</td>
<td>400 mm</td>
</tr>
<tr>
<td>320-500</td>
<td>400 mm</td>
</tr>
<tr>
<td>200-320</td>
<td>400 mm</td>
</tr>
<tr>
<td>82.5 -200</td>
<td>400 mm</td>
</tr>
<tr>
<td>Upto 82.5</td>
<td>200 mm</td>
</tr>
</tbody>
</table>

2.5.2.4 Foundation level should be checked diagonally as well as across the length for even flatness. The foundation should be within ± 0.5 Degree (angle) of any horizontal plane.

2.6 Acoustic Enclosure

Scope: This section covers technical requirements of the acoustic enclosures.

2.6.1 As per CPCB norms, restriction has been imposed for new DG sets upto 1000KVA for noise level (see Appendix - ‘II’). Therefore, in terms of these norms, acoustic enclosure should be type tested at the climatic conditions specified in para 2.1.4 through one of the authorized laboratory.

2.6.2 Installation

2.6.2.1 Acoustic enclosures are supplied with built in Anti Vibration Mountings (AVMs). As such Genset can be installed directly on the leveled surface.

2.6.2.2 Exhaust piping outlet should not be turned towards window / ventilator of home or occupied building. Provision of rain cap should be ensured.

2.6.2.3 The acoustic enclosure placement should be such that there is no restriction in front of air inlet and outlet from canopy.

2.6.3 Service Accessibility

2.6.3.1 Genset / Engine control panel should be visible from outside the enclosure.
2.6.3.2 Routine/periodical check on engine / alternator (filter replacement and tappet setting etc.) should be possible without dismantling acoustic enclosure.

2.6.3.3 For major repairs / overhaul, it may be required to dismantle the acoustic enclosure.

2.6.3.4 Sufficient space should be available around the Genset for inspection and service.

2.6.4 General Design Guidelines

2.6.4.1 To avoid re-circulation of hot air, durable sealing between radiator and canopy is must.

2.6.4.2 Ventilation fans are must for the Gensets cooled by heat-exchanger/cooling tower system.

2.6.4.3 Exhaust piping inside the enclosure must be lagged (except bellow).

2.6.4.4 Temperature rise inside the enclosure should not be more than 5°C for maximum ambient above 40°C and it should be below 10°C for ambient below 40°C.

2.6.4.5 There should be provision for oil, coolant drain and fill. Fuel tank should have provision for cleaning.

2.6.4.6 The enclosure should be designed to meet the total air requirement for the D.G. Set at full load at site conditions as recomended by the engine manufacturer.

2.6.5 Specifications for Acoustic Enclosure:

2.6.5.1 The acoustic enclosure shall be designed and manufactured confirming to relevant standards suitable for out door installation exposed to weather conditions, and to limit overall noise level to 75 dB (A) at a distance of 1 mtr. from the enclosure as per CPCB norms under free field conditions.

2.6.5.2 The construction should be such that it prevents entry of rain water splashing into the enclosure and allows free & quick flow of rain water to the ground in the event of heavy rain. The detailed construction shall confirm to the details as under:
2.6.5.3 The enclosure shall be fabricated out the CRCA sheet of thickness not less than 1.6mm on the outside cover with inside cover having not less than 0.6mm thick perforated powder coated CRCA sheet.

2.6.5.4 The hinged doors shall be made from not less than 16 SWG (1.6mm) thick CRCA sheet and will be made air tight with neoprene rubber gasket and heavy duty locks.

2.6.5.5 All sheet metal parts should be processed through 7-tank process.

2.6.5.6 The enclosure should be powder coated.

2.6.5.7 The enclosure should accommodate the daily service fuel tank of the D.G. Set to make the system compact. There should be provision of fuel gauge, which should show the level of the fuel even when the DG Set is not running. The gauge should be calibrated. The fuel tank should be filled from the outside as in automobiles and should be with a lockable cap.

2.6.5.8 The batteries should be accommodated in the enclosure in battery rack.

2.6.5.9 The canopy should be provided with high enclosure temperature safety device.

2.6.5.10 The acoustic lining should be made up of high quality insulation material i.e. rockwool/ glass/ mineral wool/ PU foam of appropriate thickness & density for sound absorption as per standard design of manufacturer’s to reduce the sound level as per CPCB norms. The insulation material shall be covered with fine glass fiber cloth and would be supported by perforated M. S. Sheet duly powder coated / GI sheet/ aluminium sheet.

2.6.5.11 The enclosure shall be provided with suitable size & No. of hinged type doors along the length of the enclosure on each side for easy access inside the acoustic enclosure for inspection, operation and maintenance purpose. Sufficient space will be provided inside the enclosure on all sides of the D.G. set for inspection, easy maintenance & repairs.

2.6.5.12 The canopy should be as compact as possible with good aesthetic look.

2.6.5.13 The complete enclosure shall be of modular construction.

2.6.5.14 The forced ventilation shall be as per manufacturer design using either engine radiator fan or additional blower fan(s). If the acoustic enclosure is
to be provided with forced ventilation then suitable size of axial flow fan (with motor and auto-start arrangement) and suitable size axial flow exhaust fan to take the hot air from the enclosure complete with necessary motors and auto start arrangement should be provided. The forced ventilation arrangement should be provided with auto stop arrangement to stop after 5 minutes of the stopping of D.G sets.

2.6.5.15 The acoustic enclosure should be suitable for cable connection/connection through bus-trunking. Such arrangements on acoustic enclosure should be water proof & dust-proof conforming to IP-65 protection.

2.6.5.16 The inside of enclosure should be provided with at least two nos. 28W- T5 fluorescent tube light luminaire controlled by a 5A switch for adequate lighting during servicing etc. of the DG Set. The power supply to this luminaire should be from the load side of the AMF Panel so that it can remain energized under all conditions.
CHAPTER-3
SYNCHRONIZATION

3.1 Scope

This section covers synchronization of DG sets as required (to be decided by NIT approving authority) and comprises of running of DG set in parallel i.e. their synchronization on common bus bar, auto load sharing and auto load management.

3.2 PLC panel

Operation of DG sets shall be monitored and controlled by PLC panel i.e. Programmable logic controller based logic panel. In case of mains failure, this logic panel shall control auto changeover from mains to DG Sets supply and interlocking of ACBs, auto synchronizing and auto Load management functions along with annunciation for alternator control and protection.

The logic Panel shall be provided with a total manual over ride facility. There shall be Smooth transfer of DG set operation from PLC to manual system & vice versa without any interruption/tripping. The logic panel shall be complete with all Auxiliary Relays. Timers, Contactors, Programmable logic controller, control wiring, interconnections etc. with 2.5 sq.mm. PVC insulated, 1.1 KV grade copper conductor wires.

3.3 CONTROL PHILOSOPHY

3.3.1 Automatic Start & Stop of Engine:

The system should come in operation after sensing of grid failure and automatically control the start & stop of engines, depending on the predefined load setting in the PLC. In case engine does not start in the first cranking, two more auto commands should be given with proper intervals. Even then if engine fails to start, indication must appear on MMI (Man Machine interface). In the event the engines are under loaded i.e. load sensed is capable of being catered by less than the capacity of running DG sets then command must be given to stop required number of excess DG sets after running idle for short duration. Provision to select no. of DG sets to be started and synchronised at no load to cope up with sudden load without tripping the DG’s should also be inbuilt into the system.
3.3.2 Automatic Synchronisation:

The facility of synchronisation will be available in both Auto & Manual mode. In normal circumstances the auto synchronisation will work, however if due to any reason auto synchronisation fails repeatedly the facility for Closer of ACB must be available automatically. In manual mode ACB will be closed by panel push button.

3.3.3 Automatic Load Sharing:

The load sharing will also be automatic, by sensing both active & reactive power.

3.3.4 Back up Protection:

The system should also have following inbuilt protection other than external relays in synchronization panel:

Reverse power, Reverse KVAR, Over Current, Under voltage, Over voltage, Under frequency, Over frequency, synchro-check & earth fault relay except differential relay. Due to any electrical fault PLC shall trigger the master trip relay.

These PLCs will be state of the art equipments using latest technology and of most rugged and reliable design. Since they shall be operating in the harsh & unfriendly environment of DG room, they will be suitable to operate trouble free in those conditions. The chosen equipment should be able to withstand high temperature, humidity & voltage fluctuations, thus making it suitable for the operating conditions described above.

3.5 Sequence of operation: The following sequence of operation shall be achieved through PLC based logic panel in addition to hardware interlocks as well as software interlocks:

(i) Selection of any generator as a lead generator to achieve the uniform running hours of all generators.

(ii) Three attempts to start the engine of lead generator. In case the engine fails to start or does not achieve the requisite speed within the predetermined time, PLC system declares engine of generator faulty. In this event PLC automatically selects next generator as the lead generator.

(iii) The PLC system automatically selects starting sequence of other generators on the basis of the lead generator being selected by the operator.
(iv) Before issuing close command to lead generator air circuit breaker, PLC checks that ACB of any other generator is not in close position. Then PLC system gives close command to lead generator ACB. The PLC system tries two times with interval of 5 secs. to close the ACB. Simultaneously, it also gives starting command to next generator engine in queue depending upon load.

(v) The speed, excitation, frequency and voltage of incoming generator is controlled identically as per the lead generator starting sequence described above, except closing of ACB.

(vi) When the lead generator KW crosses more than the 85% of rated capacity of DG set, the PLC system performs synchronization sequence for paralleling of generator prior to switching on of the ACB of 2nd generator. When the KW of 2nd generator crosses 80% of rated capacity of DG set then the PLC system performs synchronization sequence for paralleling of next generator prior to switching on the ACB of 3rd generator and similar sequence to be followed for other DG sets.

(vii) The last incoming generator ACB is tripped when PLC system senses that the total load on the system is less than the specified load and stops the engine after 5 minutes of idle running.

(viii) DG sets will start and stop automatically depending on the pre defined load setting in the PLC & also all DG sets will operate in load sharing mode.
CHAPTER-4

EARTHING

4.1 Earthing

Scope: This section covers the earthing requirement of DG Set installations. Copper plate earthing (Neutral Grounding) shall be provided for DG Sets of capacity 500KVA or above, whereas G.I. plate earthing (Neutral Grounding) shall be provided for DG Sets below 500KVA capacity. The body earthing shall generally be of G.I.

4.1.1 The generating set and all associated equipments control and switch gear and switch gear panels must be earthed before the set is put into operation.

4.1.2 Four numbers earth sets for each DG Sets are required as under:

- 2 earthing sets for Genset/ control panel body.
- 2 earthing sets for neutral.

In case there are more than one DG Set in one location, independent two nos. neutral earthing shall be provided for each DG set. However, two nos. earthing sets shall be common for the body earthing of DG Sets, Control Panel, AMF Panel and Essential LT Panel.

4.1.3 Earthing job should be carried out per General Specifications for Electrical Works(Part-1-Internal)-2013.

4.1.4 Copper or GI strips of suitable size shall be used for earthing as detailed hereunder for interconnection:

4.1.4.1 DG Set of 500KVA capacity or above:- Copper strip

4.1.4.2 DG Set below 500 KVA capacity:- GI strip

4.1.5 For Gensets with AVM’s between engine/ alternator and base rail, the body earthing must be done at the engine/ alternator and not at base-rail.

4.1.6 Genset should be earthed at two distinct points through a conductor strip having cross-section suitable to carry the short circuit (three phase dead short circuit with ground) current without burning out in conformity to General Specifications for Electrical Works (Part-1-Internal)-2013 in vogue.
4.1.7 Earth Bus: For body earthing, an earth-bus shall be provided.

4.1.8 In case, DG Set is being installed inside the substation building or near to the sub-station, for body-earthing of DG set, AMF Panel and Essential Panel, earth bus provided for sub-station shall be used.

4.1.9 Test joints should be provided for testing the earthing as and when required.

4.1.10 For further details of Earthing work, like size of plate/earth strip, depth of earthing, method etc., please refer “CPWD General Specifications For Electrical Works(Part-1-Internal), 2013 in vogue.”
APPENDIX –I

INTERNATIONAL STANDARD ISO 8528-PART 1
RECIROCATING INTERNAL COMBUTION ENGINE DRIVE
ALTERNATING CURRENT GENERATING SETS
PART 1
APPLICATION, RATINGS AND PERFORMANCE

Groupes electrogènes a courant alternant entrainés par moteurs alternatifs a combustion interne-
Partie 1 : Application, caractéristiques et performances
FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject on which a technical committee has been established has the right to be represented on that committee. International organization, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electro technical Commission (IEC) on all matters of electro technical standardization.

Draft international Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

International Standard ISO 8528-1 was prepared by Technical Committee ISO/TC 70, Internal combustion engines, Sub-Committee SC 2, Performance and tests.

ISO 8528 consists of the following parts, under the general title Reciprocating internal combusting engine driven alternating current generating sets.

- Part 1: Application, ratings and performance
- Part 2: Engines
- Part 3: Alternating current generators for generating sets
- Part 4: Controlgear and switchgear
- Part 5: Generating sets
- Part 6: Test methods
- Part 7: Technical declarations for specification and design
- Part 8: Low-power general purpose generating sets
- Part 9: Measurement and evaluation of mechanical vibration
- Part 10: Measurement of airborne noise —Enveloping surface method
- Part 11: Security generating sets with uninterruptible power systems

Parts 7, 8, 9 and 10 are in course of preparation. Part 11 is at an early stage of preparation and may be split into two parts.
1. SCOPE:

This part of ISO 8528 defines various classifications for the applications, ratings and performance which arise out of the combination of generating sets consisting of a reciprocating internal combustion (RIC) engine, alternating current (a.c.) generator, controlgear, switchgear and auxiliary equipment. It applies to a.c.-generating sets driven by RIC engines for land and marine use, excluding generating sets used on aircraft or to propel land vehicles and locomotives.

For some specific applications (for example, essential hospital supplies, high-rise buildings, etc.) supplementary requirements may be necessary. The provisions of this part of ISO 8528 should be regarded as a basis.

For other reciprocating-type prime movers (e.g. sewage-gas engines, steam engines), the provisions of this part of ISO 8528 should be used as a basis. The generating sets according to this International Standard are used to generate electrical power for continuous, peak-load and standby supplies. The classifications laid down in this part of ISO 8528 are intended to help understanding between manufacturer and customer.

2. NORMATIVE REFERENCES

The following standards contain provisions, which, through reference in this text, constitute provisions of this part of ISO 8528. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 8528 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and IO maintain registers of currently valid International Standards.


IEC 298:1990, A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 KV and up to and including 52 KV.


3. **SYMBOLS AND ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Power in kilowatts</td>
</tr>
<tr>
<td>Pr</td>
<td>Total barometric pressure, in kilopascals</td>
</tr>
<tr>
<td>Ter</td>
<td>Charge air coolant temperature, in kelvins</td>
</tr>
<tr>
<td>Tr</td>
<td>Air temperature, in kelvins</td>
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<tr>
<td>t</td>
<td>Time, in seconds</td>
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<tr>
<td>Ør</td>
<td>Relative humidity, as a percentage</td>
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<tr>
<td>a.c.</td>
<td>Alternating current</td>
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<tr>
<td>COP</td>
<td>Continuous power</td>
</tr>
<tr>
<td>LPT</td>
<td>Limited-time running power</td>
</tr>
<tr>
<td>PRP</td>
<td>Prime power</td>
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</tbody>
</table>
4. OTHER REGULATIONS AND ADDITIONAL REQUIREMENTS

4.1 For a.c. generating sets used on board ships and offshore Installations which have to comply with rules of a classification society, the additional requirements of the classification society shall be observed. The classification society shall be stated by the customer prior to placing of the order.

For a.c. generating sets operating in non-classed equipment, such additional requirements are in each case subject to agreement between the manufacturer and customer.

4.2 If special requirements from regulations of any other authority (e.g. inspecting and/or legislative authorities) have to be met, the authority shall be stated by the customer prior to placing of the order.

Any further additional requirements shall be subject to agreement between the manufacturer and customer.

5. GENERAL DESCRIPTION

5.1 Generating set:

A generating set consists of one or more RIC engines to produce mechanical energy and one or more generators to convert the mechanical energy into electrical energy together with components for transmitting the mechanical energy (e.g. couplings, gearbox) and, where applicable, bearing and mounting components.

5.1.1 Prime movers

These may be of two types:

- compression ignition engines, and - spark-ignition engines.

Depending on the application of the generating set the following criteria, among others may be important for the selection of the prime mover to be used:

- quality of fuel and fuel consumption;
- exhaust gas and noise emission;
- speed range;
- mass and dimensions;
- sudden loading and frequency behaviour;
- short-circuit characteristics of the generator;
- cooling systems;
- starting systems;
- maintenance;
- waste heat utilization.

5.1.2 Generators

These may be of two types: - synchronous generators, and - asynchronous generators.

Depending on the application of the generating set, the following criteria, among others, may be important for the selection of the generator to be used:

- voltage characteristics during starting, nominal operation and overload operation, as well as, after load changes taking into account the power factor;
- short-circuit behaviour (electrical, mechanical);
- efficiency;
- generator design and type of enclosure;
- parallel-operation behaviour;
- maintenance.

5.1.3 Controlgears and switchgears : Equipment for control, switching and monitoring is combined into controlgear and switchgear systems, for the operation of the generating set.

5.1.4 Auxiliaries : Auxiliaries are items of equipment essential for pre-operation of the generating set, such as

- starting system;
- air intake and exhaust gas systems;
- cooling system;
- lubricating oil system;
- fuel system (including fuel treatment where applicable);
- auxiliary electrical power supply.

5.2 **Power station**

A power station comprises one or more generating sets and their auxiliary equipment, the associated controlgear and switchgear and, where applicable, the place of installation (e.g. a building, an enclosure or special equipment for protection from the weather).

6. **APPLICATION CRITERIA**

6.1 **Modes of operation**

The mode of operation of the generating set may affect certain important characteristics (e.g. its economical and reliable operation, the intervals between maintenance and repair), and shall be taken into account by the customer when agreeing the requirements with the manufacturer (see also clause 11).

6.1.1 **Continuous operation**

Continuous operation is operation of a generating set without a time limit, but considering the maintenance period.

6.1.2 **Limited-time operation**

Limited-time operation is operation of the generating set for a limited time.

**NOTE 1**: The demand for electrical power from the connected equipment is supplied from the mains and only in the event of failure of the later is it supplied by an internal generating set. If there is a failure in the normal power supply, the internal generating set, operating as a back-up or emergency supply, provides a supply temporarily or for a limited time for:

(a) Safety equipment (e.g. during the evacuation of a building)

(b) Connected equipment which is important for the purposes of operation, to maintain emergency operation
The entire group of connected equipment or part thereof. The electrical power generated is used to cover a peak demand (peak-load operation). There is no mains supply and the generating set is only operated from time to time.

6.2 SITE CRITERIA

6.2.1 Land use

Land use covers generating sets, either fixed, transportable or mobile, which are used on land.

6.2.2 Marine use

Marine use covers generating sets used on board ships and offshore installations.

6.3 SINGLE AND PARALLEL OPERATION

Generating sets may have two types of operation, defined in 6.3.1 and 6.3.2.

6.3.1 Single operation

Single operation refers to a generating set, irrespective of its configuration or modes of start’up and control, which will operate as the sole source of electrical power and without the support of other sources of electrical supply.

6.3.2 Parallel operation

Parallel operation refers to the electrical connection of a generating set to another source of electrical supply with the same voltage, frequency and phase to share the power supply for the connected network. The characteristics of the mains supply, including range and variation of voltage, frequency, impedance of the network, etc., shall be stated by the customer.

6.3.2.1 Parallel operation by generating sets

In this type of operation, two or more generating sets are electrically connected (not mechanically connected) after having been brought into synchronism. Generating sets with different outputs and speeds can be used.
6.3.2.2 Operation in parallel with mains

In this type of operation, one or more parallel-operating generating sets (as described in 6.3.2.1) are electricity connected to a mains supply.

NOTES

2. In the case of a public mains, permission for parallel operation has to be obtained from the public electricity board. Protective equipment has to be harmonized.

3. This also applies to generating sets which, in order to check the start up, have to run supplying power into the mains for a time period laid down by the generating set manufacturer.

6.4 MODES OF START-UP AND CONTROL

The modes of start-up and control involved in the operation of a generating set are normally

- starting,
- monitoring,
- voltage and frequency adjusting and synchronization where applicable,
- switching, and
- stopping.

These can be fully or partly manual or automatic (see also ISO 8528-4).

6.4.1 Manual operation

Manual operation covers generating sets which are started and controlled manually.

6.4.2 Semi-automatic operation

Semi-automatic operation covers generating sets in which some of the functions are started and controlled manually and the remainder automatically.

6.4.3 Automatic operation

Automatic operation covers generating sets which are started and controlled automatically.
6.5. **START-UP TIME**

Start-up time is the time from the moment when power is first required to the moment when it is first available. It shall meet the demands of the particular application.

6.5.1 **Generating set with no specified start-up time**

This is a generating set where, due to the conditions under which it operates, the start-up time is of no importance. Such generating sets are normally started manually.

6.5.2 **Generating set with specified start-up time**

This is a generating set where the start-up time is specified; starting is normally automatic. Such generating sets may be further classified (see 6.5.2.1 to 6.5.2.3)

6.5.2.1 **Long-break set**

This is a generating set with a specified start-up time (defined in seconds). The time between a power supply failure and power from the generating set being available is fairly long. In this case the entire set is started from the stationary condition after power is demanded.

6.5.2.2 **Short Break set**

This is a generating set with running electrical machines where the power supply is interrupted while the necessary switchgear change-over takes place, for a time defined in milliseconds. A source of stored mechanical energy is used to supply power to the connected equipment for a short period necessary to start and accelerate the RIC engine.

6.5.2.3 **No-break set**

This is a generating set with continuous rating electrical machines that ensure an uninterrupted supply of power in the event of mains failure. A source of stored mechanical energy is unable to supply powers to the connected equipment for a short period and, where necessary to start and accelerate the RIC engine. As the drive is transferred from one power source to another there may be temporary deviation in frequency.

7. **PERFORMANCE CLASSES**

Four performance classes are specified to the various requirement of the supplied electrical systems see 7.1 to 7.4
7.1 Performance class G1
This is required for application where the connected loads are such that only basic parameters of image and frequency need to be specified.

EXAMPLES
General-purpose applications (lighting and other simple electrical loads).

7.2 Performance class G2
This is required for applications where the demands on voltage characteristics are very much the same as for the commercial power system. When load changes occur, there may be temporary but acceptable deviations of voltage and frequency.

EXAMPLES
Lighting systems, pumps, fans and hoists.

7.3 Performance class G3
This is required for applications where the connected equipment may make severe demands on frequency, voltage and waveform characteristics.

EXAMPLES
Telecommunications and thyristor-controlled loads. It should be especially recognized that both rectifier and thyristor-controlled loads may need special consideration with respect to their effect on generator-voltage waveform.

7.4 Performance class G4
This is required for applications where the demands made on the frequency, voltage and waveform characteristics are exceptionally severe.

EXAMPLES
Data-processing equipment of computer systems

8. INSTALLATION FEATURES
Requirements to meet local regulations may affect the design of the generating set. They shall be taken into account by the customer and manufacturer in addition to the installation features given in 8.1 to 8.5.

8.1 Installation configurations
The installation configurations in 8.1.1 to 8.1.3 may or may not have all necessary auxiliary equipment integrally mounted.
8.1.1 Fixed
This configuration includes all generating sets which are permanently installed.

8.1.2 Transportable
This configuration includes all generating sets not permanently installed or mobile.

8.1.3 Mobile
This configuration includes all generating sets having an integral chassis fitted with wheels whereby the generating set is mobile.

8.2 GENERATING SET CONFIGURATIONS
In order to simplify contractual information for various RIC engine driven generating set applications, some typical set configurations are given below:

- A: without baseframe;
- B: with baseframe;
- C: with baseframe, integrally mounted controlgear, switchgear and auxiliaries;
- D: configuration as given in C with enclosure (see also clause 9);
- E: configuration as given in C having an integral set of wheels or mounted on a trailer (see also 8.1.3).

8.3 TYPES OF MOUNTING : The type of mounting (see 8.3.1 to 8.3.3) should be agreed between the customer and the generating set manufacturer.

8.3.1 Rigid mounting
This is mounting the generating set without the use of resilient mountings. If foundations for mounting generating sets are set up on substrates of low elasticity, for example corktiles, with no resilient layers, inserted, the method of mounting is considered to be rigid.

8.3.2 Resilient mounting
This is mounting the generating set with the use of resilient mountings. For special application (e.g. marine or mobile), restrained resilient mountings may be required.
8.3.2.1 Fully resilient mounting

Fully resilient mounting is mounting the RIC engine and the generator resiliently on a baseframe or a foundation with components to provide insulation against vibration.

8.3.2.2 Semi-resilient mounting

Semi-resilient mounting is mounting the RIC engine resiliently with the use of components to provide insulation against vibration and mounting the generator rigidly on a baseframe or a foundation.

8.3.2.3 Mounting on resilient foundation

This is mounting the generating set on resilient foundation (damping mass) which is isolated from the load-bearing foundation by, for example, anti-vibration mounts.

8.4 CONNECTION BETWEEN ENGINE AND GENERATOR

The connection between the RIC engine and the a.c. generator is determined by the type of components transmitting the power and the assembly between the engine and the generator. It depends on the design of the engine, generator and mounting, the power and the speed.

8.4.1 Coupling arrangements

Typical coupling arrangements are rigid, torsionally rigid, flexible, torsionally flexible or clutch coupling.

8.4.2 Assembly arrangements

The assembly between the RIC engine and the generator may be with or without flange housing.

8.5 ADDITIONAL INSTALLATION FEATURES—WEATHER EFFECTS

8.5.1 Inside Installation

This is installation of the generating set in places where it is not exposed to the direct effects of weather. Consideration shall be given to maximum and minimum room temperatures.

8.5.2 Outside Installation with protection from weather

This may be subdivided into
- installation in a protective enclosure;
- installation under a protective roof.

8.5.3 **Open-air Installation**

This is installation in the open, fully exposed to the weather.

9. **EMISSIONS**

When a generating set operates, it produces emissions including noise, vibration, heat, waste gases and electromagnetic disturbances. Any applicable legislation relating to the protection of the environment and to the health and safety of personnel shall be taken into account by the manufacturer and customer at the time of agreeing a performance specification.

10. **STANDARD REFERENCE CONDITIONS**

In determining the rates power of the generating set, it should be noted that different standard reference conditions apply to the engine, a.c. generator and switchgear. For conditions on site, see clause 11.

10.1 For the rated power of the RIC engine, the following standard reference conditions apply in accordance with ISO 3046-1:

- total barometric pressure, $p_r : 100$ kPa (1 000 mbar)
- air temperature, $T_r : 298$ K (25°C)
- relative humidity, $\varphi_r : 30\%$
- charge air coolant temperature, $T_{cr} : 298$ K (25°C)

10.2 For the rated power of the a.c. generator, the following standard reference conditions apply in accordance with IEC 34-1 and ISO 8528-3:

- Cooling air temperature : below 313 K (40°C)
- coolant temperature at cooler inlet: below 298 K (25°C)
- Altitude: up to 1000 m above sea level.

10.3 For the ratings of the controlgear and switchgear equipment, the following standard reference conditions apply in accordance with IEC 298 IEC 439-1 and IEC 439-2:

- ambient temperature, temporary maximum 313 K (40°C)
relative humidity: 50% at 313 K (40°C)
-altitude: up to 2000 m above sea level

11. SITE CONDITIONS

The site conditions under which a generating set is required to operate may affect certain characteristics of the set; they shall be taken into account by the customer and manufacturer.

These conditions shall be clearly defined by the customer and any particular hazardous conditions, such as explosive atmospheres or flammable gases, shall be described. Such characteristics may include but are not limited to those indicated in 11.1 to 11.9.

NOTE 5:
In cases where the site conditions are unknown, and if not otherwise specified, the following nominal site conditions should be used:
- total barometric pressure: 89.9 kPa (for altitude above sea level 1000 m)
- ambient temperature: 313 K (40°C)
- relative humidity: 60%

11.1 Ambient temperature

The customer shall inform the manufacturer of the upper and the lower ambient temperature limits at which the generating set will operate.

11.2 Altitude

The customer shall inform the manufacturer of the altitude above sea level at which the generating set will operate. However, it is preferable to have exact values of the barometric pressure on site.

11.3 Humidity

The customer shall inform the manufacturer of the humidity values related to the temperature and pressure on site (see 11.1 and 11.2).

11.4 Sand and dust

The customer shall inform the manufacturer if a generating set is required to operate in a sandy, dusty or other physically polluted atmosphere, as special requirements
may be necessary in order to obtain satisfactory performance and operation. Any increased maintenance due to these conditions should be noted by the customer.

11.5 **Marine environment**

Special consideration is necessary when generating sets are required to operate in a marine environment. This may also apply to generating sets on land but operated at a coastal site. The environment shall be clearly stated by the customer.

11.6 **Shock and Imposed vibration**

If the generating set is required to operate under conditions where shock and/or vibration may occur (for example, earthquake on the one hand and externally imposed vibration from adjacent reciprocating machinery on the other), this shall be clearly stated by the customer.

11.7 **Chemical pollution**

If the generating set is required to operate under conditions where chemical pollution exists, the nature and extent of this shall be clearly stated by the customer.

11.8 **Radiation**

Various kinds of radiation may affect some of the components of the generating set, and such components may need special protection and/or a special maintenance programme. Any such condition of operating shall be specified by the customer.

11.9 **Cooling water/liquid**

If the generating set has water/liquid cooled heat exchangers, the customer shall state the minimum and maximum temperatures (and, where necessary, the chemical composition and quantity) of the secondary (external) transfer liquid.

12. **POWERADJUSTMENT FOR AMBIENT CONDITIONS**

To determine the appropriate generating set ratings, the customer shall specify the operating conditions prevailing at the site.

(a) site barometric pressure (highest and lowest readings available or, if no pressure data are available, the altitude above sea level);

(b) the monthly mean, minimum and maximum air temperatures during the hottest and coldest months of the year;
(c) the highest and lowest ambient air temperatures around the engine;
(d) the relative humidity (or alternatively the water vapour pressure or the wet and dry bulb temperature) ruling at the maximum temperature conditions;
(e) the maximum and minimum temperatures of the cooling water available.

When the operating conditions differ from the standard reference conditions given in clause 10, any necessary adjustment to the RIC engine, a.c. generator or switchgear rating shall be made in order to determine the rated power of the generating set.

For generating sets to be installed on board ships intended for unrestricted service, according to the International Association of Classification Societies (IACS), the rated power shall be based on the nominal ambient conditions as specified in ISO 3046-1: 1986, 7.4.2.

13. POWER RATING

13.1 General

The power of the generating set is the power output available at the generating set terminals excluding the electrical power absorbed by the essential independent auxiliaries. (See also ISO 8528-2:1993, 5.1 and ISO 8528-3:1993, clause 5.)

13.2 Power ratings

Power ratings of generating sets shall be expressed in kilowatts at rated frequency and a power factor (cos Θ) of 0.8 lagging unless otherwise stated.

The power rating classifications are necessary for the generating set manufacturer’s declaration concerning the power which the generating set will deliver under the stated operating conditions.

13.3 Kinds of power output

The generating set manufacturer shall be responsible for determining the power output according to 13.3.1 to 13.3.3 {see figures (i) to (iii)} in accordance with the service and maintenance schedule specified by the engine, a.c. generator and controlgear and switchgear manufacturers.

For all kinds of power output, defined in 13.3.1 to 133.3.3, it is necessary to provide additional engine power for governing purpose only (e.g. transient load conditions and suddenly applied load). This additional engine power is usually 10% of the rated power of the generating set and shall not be used for the supply of electrical consumers.

This additional engine power is not identical to the overload power for RIC engines as defined in ISO 3046-1.
The power limit of a generating set (see figures (i) to (iii)) depends on the power limit of the RIC engine, e.g. fuel stop power, taking into account the efficiency of the a.c. generator.

13.3.1 Continuous power (COP)

Continuous power is that which a generating set is capable of delivering continuously for an unlimited number of hours per year between the stated maintenance intervals and under stated ambient conditions, the maintenance being carried out as prescribed by the manufacturers. (See figure II).

13.3.2 Prime Power (PRP)

Prime power is the maximum power available during a variable power sequence, which may be run for an unlimited number of hours per year, between stated maintenance intervals and under the stated ambient conditions, the maintenance being carried out as prescribed by the manufacturers.

The permissible average power output \( P_{pp} \) (See figure(ii) during a 24 h period shall not exceed some percentage of the prime power to be stated by the RIC engine manufacturer. When determining the actual average power output \( P_{pa} \), powers of less than 30% of the prime power shall be taken as 30% and time at standstill shall not be counted.

The actual average power, \( P_{pa} \) is calculated as follows:

\[
P_{pa} = \frac{P_1 t_1 + P_2 t_2 + P_3 t_3 + \ldots + P_n t_n}{t_1 + t_2 + \ldots + t_n}
\]

where \( P_1, P_2, \ldots, P_n \) is the power at the \( t_1, t_2, \ldots, t_n \).

NOTES:

6. The Customer should be made aware that if any of these conditions are not fulfilled the RIC engine life will be reduced.

7. Time periods at standstill do not enter into the formula.

8. The period of running at prime power is expected to be long enough to enable the generator to reach thermally stable conditions.
13.3.3 **Limited-time running power (LTP)**

The limited-time running power is the maximum power which a generating set is capable of delivering for up to 500 h per year of which a maximum of 300 h is continuous running, between stated maintenance intervals and under the stated ambient conditions, the maintenance being carried out as prescribed by the RIC engine manufacturers. It is accepted that operation at this rating will affect the life of the set. (See figure (iii).)

**NOTES:**

9. The period of running at limited-time running power is expected to be long enough to enable the generator to reach thermally stable conditions.

10. The customer should be made aware that if any of these conditions are not fulfilled the RIC engine life will be reduced.
14 OPERATING PERFORMANCE

14.1 Starting temperature

The RIC engine manufacturer shall state the minimum temperatures at which the generating set will start with the starting system and start aids - provided.

14.2 Load acceptance

When load is suddenly applied to a generating set there will be transient deviation in voltage and frequency. The magnitude of these deviations will depend both on the magnitudes of the active power (in kilowatts) and reactive power (in kilovars) changes, relative to the total available capacity and to the dynamic characteristics of the generating set (See also ISO 8528-5 and ISO 8582-5).

If load acceptance capability is an important requirement, then it shall be clearly stated by the customer.

14.3 Cyclic Irregularity

The cyclic irregularity imposed on the generator by the RIC engine combustion process may cause modulation of the voltage. (See ISO 8528-3).
14.4 Generator temperature rise

The temperature rise of the generator windings of a generating set may be an important factor limiting the long-term reliability of a generating set. An increase in allowable temperature rise may be possible if the generating set is to be used on a limited time basis.

14.5 Fuel and Lubricating oil consumption

The manufacturer shall state the consumption of fuel and lubricating oil, if verification of fuel consumption is required, the method of measurement shall be agreed between the customer and manufacturer, as outlined in ISO 3046-1. Statements of fuel consumption shall be made with reference to the electrical power available at the terminals, taking into account the electrical power required for the essential independent auxiliaries (see ISO 3046-1) and the power loss in the a.c. generator for a given power and power factor. The lower calorific value of the fuel shall be stated.

14.6 Minimum running hours

The capacity of fuel and lubricating oil tanks may impose a limit on the generating set running hours. The manufacturer shall state the minimum running hours together with power delivered of the generating set without replenishment, if such tanks are provided.

14.7 Regulation

14.7.1 Frequency regulation

The steady-state and transient frequency regulation may be an important requirement when specifying the performance of a generating set. If this is the case, then it shall be clearly stated by the customer.

14.7.2 Voltage regulation

It is necessary to consider both steady/state and transient voltage regulation when specifying a generating set. It must also be noted that the nature of the load current waveforms imposed on the generating set may affect the voltage waveform and the steady-state voltage accuracy. If voltage regulation is an important requirement, then it shall be clearly stated by the customer.
Appendix II

CPCB NORMS FOR NOISE LEVEL
(This is download from website of CPCB)
SYSTEM & PROCEDURE FOR COMPLIANCE WITH NOISE LIMITS
FOR DIESEL GENERATOR SETS (UPTO 1000 KVA)

1. SCOPE

This document lays down the system & procedure for compliance with noise limits for new diesel generator sets (upto 1000 KVA) vide notification G.S.R.371 (E), dated 17th May,2002, at serial no.94 (paragraph 1 & 3) issued by the Ministry of Environment and Forests, Government of India. The details are covered as under:

Part - I : Noise Limits, Applicability and Other Requirements
Part - II: Certification System & Procedure
Part - III: Test Procedure

2. CONTENTS

PART I: NOISE LIMITS, APPLICABILITY AND REQUIREMENTS

PART II: CERTIFICATION SYSTEM AND PROCEDURE

1.0 Model Family
2.0 Selection of Certification Agency
3.0 Application for Type Approval
4.0 Type Approval.
5.0 Certificate of Type Approval
6.0 Modifications in the Product Model
7.0 Verification of Conformity of Production (COP)
8.0 Sample size and Decision Criteria for Verification of COP
9.0 Certificate for Conformity of Production
10.0 Consequences of Non-Compliance
PART III: TEST EQUIPMENT AND PROCEDURE

1.0 General

2.0 Procedure

ANNEXURE – I Application for Type Approval

ANNEXURE – II Certificate of Type Approval (Specimen)

ANNEXURE – III Certificate of Conformity of Production (Specimen)

ANNEXURE - A
APPENDIX ‘III’

CPCB NORMS FOR EMISSION LEVEL

(This is download from website of CPCB)

SYSTEM & PROCEDURE FOR COMPLIANCE TO EMISSION LIMITS FOR NEW DIESEL ENGINES (UP TO 800 KW) FOR GENSET APPLICATIONS

1. SCOPE

This document lays down the requirements, system & procedure for compliance to the rules vide notification no. G.S.R. 371 (E), dated 17th May, 2002, at serial no. 95, for emission limits for new diesel engines (up to 800 kW) for genset applications, issued by Ministry of Environment and Forests, Government of India. The details are covered as under:

Part I - Emission Limits, Applicability and Other Requirements

Part II - Certification System and Procedures

Part III - Testing Equipments and Procedures

2. CONTENTS

PART I : EMISSION LIMITS, APPLICABILITY AND OTHER REQUIREMENTS

PART II : CERTIFICATION SYSTEM AND PROCEDURE

1. Model Family
2. Selection of Certification Agency
3. Application for Type Approval
4. Type Approval
5. Certificate of Type Approval
6. Modifications in the Engine Model
7. Verification of Conformity of Production (COP)
8. Sample Size and Decision Criteria for Verification of COP
9. Certificate of COP Verification
10. Consequences of Non-Compliance

67
PART III : TEST EQUIPMENT AND PROCEDURES

ANNEXURE - I : Test Fuel Specifications

ANNEXURE - II : Application for Type Approval / Description to be given at the time of COP

ANNEXURE - III : Certificate of Type Approval (specimen)

ANNEXURE - III : Certificate of Type Approval (specimen)

ANNEXURE - IV : Certificate of Conformity of Production (specimen)
COMMERCIAL AND ADDITIONAL CONDITIONS

1.0 General

1.1 This specification covers manufacture, testing as may be necessary before dispatch, delivery at site, all preparatory work, assembly and installation, commissioning putting into operation of DG Sets.

1.2 Location

The DG Set will be installed at —————————— (To be filled by NIT approving authority)

1.3 The work shall be executed as per CPWD General Specifications for Electrical Works (Part VII DG Sets–2013), as per relevant IS and as per directions of Engineer-in-Charge. These additional specifications are to be read in conjunction with above and in case of variations, specifications given in this Additional conditions shall apply. However, nothing extra shall be paid on account of these additional specifications & conditions as the same are to be read alongwith schedule of quantities for the work.

1.4 The tenderer should in his own interest visit the site and familiarises himself with the site conditions before tendering.

1.5 No T&P shall be issued by the Department and nothing extra shall be paid on account of this.

2.0 Commercial Conditions

2.1 Type of contract

The work to be awarded by this tender shall be treated as indivisible works contract.

2.2 Submission and opening of Tenders:

2.2.1 The tender is in two parts:

(a) Part I – Technical cum commercial Bid

(b) Part II – Price Bid

2.2.2 Tender documents consisting of Part-I & Part-II (i.e. Technical-cum-commercial Bid and Price Bid) will be issued against application accompanied with earnest money in prescribed format to only eligible contractors and who are pre-qualified by the competent authority.
2.2.3 The date of sale, receipt and opening of the sealed technical-cum-commercial bids will be notified to all such tenderers in advance. The technical-cum-commercial part will have to be submitted by the tenderers complete with the following:

Complete tender documents (Part-I), as purchased from CPWD or downloaded from website including the schedule of work (without indicating the price) duly signed in token of acceptance of all terms and conditions along with Part-II (Price Bid). Prices should be indicated/filled only in “price Bid” part and should be placed in separate sealed envelope clearly super scribed “Price-Bid”. The tenderers will have to fill up their rates only in the price bid issued by the department. Tenders in which the price bids are given in any other format are liable to be rejected. The abstract of cost will be required to be filled in.

Complete technical particulars of all equipment & materials as per list attached.

2.2.4 The tenderers are advised not to deviate from the technical specifications/ items, commercial terms and conditions of NIT like terms of payment, guarantee, arbitration clause, escalation etc.

2.2.5 The Part-I of the tender documents i.e. Technical cum Commercial bid only, shall be opened on the due date and time, as specified in form CPWD-6 in the presence of tenderers or their authorised representatives.

2.2.6 Scrutiny/ evaluation of the Technical-cum-commercial bid shall be done by the department in consultation with any agency as deemed necessary. In case it is found that the technical-cum-commercial bid of a tenderer is not in line with NIT specifications, requirements and/or contains many deviations, the department reserves the right to reject the technical bid of such firm (s) without making any reference to the tenderer (s).

2.2.7 Necessary clarifications required by the department shall have to be furnished by the tenderer within the time given by the department for the same. The tenderer will have to depute his representative to discuss with the officer(s) of the department as and when so desired. In case, in the opinion of the department a tenderer is taking undue long time in furnishing the desired clarifications, his bid will be rejected without making any reference.

2.2.8 After obtaining clarifications from all the tenderers, the department may modify the technical & commercial conditions/ specifications if required, and will intimate the same to the tenderers, whose technical cum commercial bids are acceptable. At
the same time, date and time of opening of price-bid will also be intimated. A tenderer will also not be allowed to withdraw or modify any condition at a time after the technical bids have been accepted and the decision to open the price bid has been taken by the department unless revised bid is allowed due to measure changes made during negotiations on technical-bid.

2.2.9 The part II of the tender i.e. price bid will be opened by the Executive Engineer (E) in the presence of the interested representatives of the tenderers who wish to be present.

2.2.10 The department reserves the right to reject any or all the price bids and call for fresh prices/ tenders as the case may be without assigning any reason.

2.2.11 **Validity**

Tenders shall be valid for acceptance for a period as prescribed in CPWD-6 from the date of opening of price bid.

2.2.12 **Completion of period**

The completion period indicated in the tender documents is for the entire work of planning, designing, supplying, installation, testing, commissioning and handing over of the entire job to the satisfaction of the Engineer-in-charge.
## ACCEPTABLE MAKES

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Item</th>
<th>Makes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engine</td>
<td>:</td>
</tr>
<tr>
<td>2</td>
<td>Alternator</td>
<td>:</td>
</tr>
<tr>
<td>3</td>
<td>Relays</td>
<td>:</td>
</tr>
<tr>
<td>4</td>
<td>Contactors</td>
<td>:</td>
</tr>
<tr>
<td>5</td>
<td>M.S. Pipes</td>
<td>:</td>
</tr>
<tr>
<td>6</td>
<td>Anti Vibrations Mountings</td>
<td>:</td>
</tr>
<tr>
<td>7</td>
<td>Batteries</td>
<td>:</td>
</tr>
<tr>
<td>8</td>
<td>Control Cables and other Cables</td>
<td>:</td>
</tr>
<tr>
<td>9</td>
<td>Power Cable</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>ACBs</td>
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</tr>
<tr>
<td>11</td>
<td>Switch Disconnector Fuse Units(SDFUs)</td>
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</tr>
<tr>
<td>12</td>
<td>Ammeter / Voltmeter</td>
<td>:</td>
</tr>
<tr>
<td>13</td>
<td>Current Transformer</td>
<td>:</td>
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<td>14</td>
<td>Glass Wool</td>
<td>:</td>
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<tr>
<td>15</td>
<td>Cable Tray</td>
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</table>
## APPENDIX-V

### List of relevant Indian/International Standards

#### (A) Generating Set

<table>
<thead>
<tr>
<th>Standard</th>
<th>Part</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 8528</td>
<td>Part-I</td>
<td>Application, rating and performances.</td>
</tr>
<tr>
<td></td>
<td>Part-II</td>
<td>Engines</td>
</tr>
<tr>
<td></td>
<td>Part-III</td>
<td>A.C. Generator for generating set</td>
</tr>
<tr>
<td></td>
<td>Part-IV</td>
<td>Control gear &amp; switch gear</td>
</tr>
<tr>
<td></td>
<td>Part-V</td>
<td>Generating Sets</td>
</tr>
<tr>
<td></td>
<td>Part-VI</td>
<td>Test methods</td>
</tr>
<tr>
<td></td>
<td>Part-VII</td>
<td>Technical declaration for specification and design</td>
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<tr>
<td></td>
<td>Part-VIII</td>
<td>Low power general purpose generating sets</td>
</tr>
<tr>
<td></td>
<td>Part-IX</td>
<td>Measurement and evaluation of mechanical vibration</td>
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<tr>
<td></td>
<td>Part-X</td>
<td>Measurement of Airborne Noise - Enveloping surface method</td>
</tr>
<tr>
<td></td>
<td>Part-XI</td>
<td>Security generating sets with uninterruptible power system</td>
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</tbody>
</table>

#### (B) Engines

<table>
<thead>
<tr>
<th>Standard</th>
<th>Part</th>
<th>Description</th>
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<tbody>
<tr>
<td>IS 10000</td>
<td>Part-I 1980</td>
<td>Methods of tests for I.C. Engines Part - I - Glossary of terms relating of test method</td>
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<tr>
<td></td>
<td>Part-II 1980</td>
<td>Standard reference condition</td>
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<tr>
<td></td>
<td>Part-III 1980</td>
<td>Measurements for testing units and limits of accuracy</td>
</tr>
<tr>
<td></td>
<td>Part-IV 1980</td>
<td>Declaration of Power, Efficiency, fuel consumption, lubricating oil consumption</td>
</tr>
<tr>
<td></td>
<td>Part-V</td>
<td>Preparation for tests and measurement of wear</td>
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<tr>
<td></td>
<td>Part-VI</td>
<td>Recording of test results</td>
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<tr>
<td></td>
<td>Part-VII</td>
<td>Governing test for constant speed engines and selection of engines for use with electrical generators</td>
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<tr>
<td></td>
<td>Part-VIII</td>
<td>Performance tests</td>
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<tr>
<td></td>
<td>Part-IX</td>
<td>Endurance test</td>
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<td></td>
<td>Part-10</td>
<td>Tests for smoke level, limit and correction for smoke level for variable speed</td>
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<td></td>
<td>Part-11</td>
<td>Information to be supplied by the purchaser to the manufacturer and information to be supplied by the manufacturer along with the engine</td>
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<tr>
<td></td>
<td>Part-12</td>
<td>Specimen test certificates</td>
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<tr>
<td>BS 5514</td>
<td>Part-13</td>
<td>Recommendations on nature of tests required for functional changes in critical components</td>
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<td></td>
<td>Part 5 - 1979</td>
<td>Reciprocating Internal Combustion engines, performance, torsional vibrations</td>
</tr>
<tr>
<td>ISO-3046</td>
<td>Part V 2001</td>
<td>Declaration of powers, fuel and lubrication oil</td>
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<td></td>
<td>Part-I 2002</td>
<td>Economical performance of the generating set</td>
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### Alternator

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>IS 4889/BS - 269</td>
<td>For declaring efficiency of electrical machines.</td>
</tr>
<tr>
<td>IS 4722 - 1992</td>
<td>Capability of machine to withstand over current/overload.</td>
</tr>
<tr>
<td>IS – 13364 Part I 1992</td>
<td>Alternator - Voltage Regulation upto 20 KVA</td>
</tr>
<tr>
<td>IS – 13364 Part II 1992</td>
<td>Alternator - Voltage Regulation above 20 KVA to 80 KVA</td>
</tr>
<tr>
<td>IEC34-1-1983</td>
<td>Rotating Electrical machines - Rating &amp; Performance</td>
</tr>
<tr>
<td>IP – 21 IS - 4691/85</td>
<td>Alternator (Degree of Protection)</td>
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</table>

### Acoustic Enclosure

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
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<tr>
<td>ISO 3744 1998 (E)</td>
<td>Acoustics - Determination of sound power levels of noise sources.</td>
</tr>
</tbody>
</table>

### Control Panel/ AMF Panel

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS -2147 1962</td>
<td>Degree of protection.</td>
</tr>
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</table>
SPECIFICATION FOR NURSE CALL SYSTEM

1 PART 1 GENERAL

1.01 OVERVIEW

A. Provide a complete working Nurse/Patient Communications Network based upon the specification outlined here to include all necessary devices that provide the functions listed in this specification for ESIC HOSPITAL BHILAI -This facility will be referenced as the OWNER in this specification.

B. All Nurse Communications Network devices shall be UL-1069 listed. This includes routers, hubs, switches, fiber optic cables and room control devices. The nurse call network shall be an FDA Registered Class II (or higher) medical device and the system’s manufacturer shall be an FDA Registered Operator. Field wiring shall be CAT 6 cable, control wiring for power distributions and very long runs, and utilize an optional fiber backbone (when distances exceed normal Ethernet limitations). All station equipment shall use plug on connectors and all switches, routers and controllers shall utilize standard RJ-45 modular connections. All remote devices utilizing standard structured cabling shall be capable of PoE (Power over Ethernet) or power supplied within the CAT 6 cable jacket. Systems which require separate DC power to devices, remote power supplies, or heavy DC wiring to each individual room shall not be accepted. Wiring shall be capable of either being installed in conduit or cable trays, where shown on the plans. Nurse Communications cabling may be run along with other low voltage and data cables where permitted by code. Nurse Communications cabling to be separated out from any high voltage AC or DC wiring that exceeds 90 volts, or which violates any national or local electrical code. Computers, data servers and hospital network work is neither/nor part of this project.

SCOPE

1.02 ESIC HOSPITAL BHILAI is furnishing and installing a new nurse call system with the design based on a Rauland-Borg Responder Nurse Call system to connect to existing nurse call system as directed by RSS. Nurse Call system and components to be furnished and installed by the local system vendor. All conduit, wire, back boxes, AC power and associated electrical work shall be furnished and installed by the Electrical Contractor. Nurse Call terminal cabinets are to be furnished by the nurse call system vendor and installed by the electrical contractor. Elevations of Nurse Call devices are to be determined by the Architect prior to installation. The Architect will provide a drawing of the typical nurse call device locations.
Other vendors must be pre-qualified twenty (20) days prior to bid. Alternate manufacturer to furnish and install a complete, working nurse call system for owners review and shall remain the property of the owner. Pre-submission and pre-approval does not guarantee system acceptance. Removal of any existing nurse call devices are to be included in this project and be done by a local Certified Rauland Borg System integrator. If any other manufacturer is pre-approved they must include the cost from an authorized local Rauland distributor to perform all the work associated with the demolition of the existing Nurse call System. Contact Ronco Specialized Systems, Inc. (RSS) at 803-739-8959 for information and pricing required for demolition.

B. General Construction work associated with the nurse call system is not part of this scope of work. The electrical contractor, not the system supplier or product manufacturer, shall furnish and install all conduit, back boxes, raceways, modified device plates and critical power branch circuit wiring.

1.03 QUALIFICATIONS

A. Authorized Distributor for product supplied. Authorized Distributor Letter from manufacturer required upon request of specifying authority. Proof of a local service center (within 20 miles of the facility) complete with certified technicians must be provided to the owner. Factory certifications for a minimum of 3 technicians that work at the local service center must be provided. No system will be approved without the certificates from the technicians. Local service center must provide 24/7 – 365 day service and have the ability to have a factory authorized technician on site (if required within 1 hour after the first service call is made.

1.04 SYSTEM DESCRIPTION

A. System hardware shall consist of a nurse call network comprised of VoIP nurse consoles, nurse call network controllers, power supplies, battery back up, dome lights, zone dome lights, duty stations, staff stations, staff terminals, high security plates, high security push buttons, and water resistant high security push buttons, key lock switches, nurse call cabinets, 990 call priorities, and wiring. Optional staff registration buttons and pull cord stations with audio, pillow speakers with and without TV and lighting controls, reporting software as manufactured by the nurse call manufacturer shall be currently available for implementation on future projects. All necessary equipment required to meet the intent of these specifications shall be supplied and installed to provide a complete and operating nurse call system. Optional software is not to be included, however must be currently available and supported by the local systems integrator.
B. System hardware and firmware shall be the product of a Rauland-Borg with a proven history of product reliability and sole control over all source code. Manufacturer shall provide, free of charge, product firmware/software upgrades for a period of one year from date of installation for any product feature enhancements. Manufacturer shall provide a 5 year warranty on all manufactured hardware. All communications shall be full duplex audio, not only on handsets, but all loud speaking devices, including staff and duty stations. All wall mounted stations shall be flush mounted using snap tight cover plates. Sub plates shall be slotted and adjustable for trimming the mounting for “squearing” the vertical and horizontal fit. All screws shall be hidden.

C. All main nurse call equipment shall be installed in Wall Mount Cabinets as manufactured by the Nurse Call Manufacturer #RSS-351102 or RSS-NC2828.

1.05 SUBMITTALS

A. Any supplying contractor proposing equipment which is not the base standard for this specification must provide full submittals at the time of bid. This option shall be exercised at the discretion of the OWNER/specifying authority.

B. Prior to submission of bid, the supplying contractor shall submit six (6) complete submittal sets. These sets are to be submitted in a three ring binder, a continuous spiral binder, or plastic binding that allows the booklet to lie flat while open. Each booklet shall consist of the following:

Page 1: Name of supplying contractor and project name.

Page 2: In the following order, a listing of: component quantities, equipment manufacturer, model number, and description of each component being supplied. If equipment being supplied is not the specified equipment manufacturer’s model, alongside the submitted model number and description, list the specification paragraph that corresponds to the equivalent specified model.

Page 3: Recently dated support letter from manufacturer stating that the supplying contractor is an Authorized Distributor of the product being supplied.

Page 4: Statement that warranty hardware from manufacturer for 5 years or statement of vendor extending manufacturer’s original warranty to 5 years.

Page 5: Copy of the installing technician(s) certificate of completion from the manufacturer’s training school for the equipment being proposed.
One catalog sheet per product of equipment listed on page 2; in the exact order as listed on page 2. Each catalog sheet shall describe mechanical, electrical and functional equipment specifications. The catalog sheet must also include a photograph of the product. Photocopy duplications of the manufacturer’s original equipment catalog sheets will be allowed as long as they provide adequate clarity of both the printed word and graphics/pictures. Submittals that are not of adequate clarity or content may be rejected and re-submission may not be allowed.

Provide all inter-equipment wiring diagrams and drawings necessary to install the equipment being supplied. The Architectural and Nurse Call drawings will be provided to the Electrical contractor in AutoCAD (.dwg format) at no cost to the Electrical Contractor for submittal preparation. These shop drawings will show all wiring types by wire gauge, conductors and wire manufacturer. Owner to furnish AutoCAD floor plans prior to submittal preparation.

1.06 PROJECT SITE VISIT

It is the responsibility of all prospective contractors to make an adequate inspection of the project site. Any contractor not registered as having attended the mandatory site visit tour will be disqualified and any bid proposal will automatically be rejected.

1.07 SCHEDULING

It is the responsibility of the contractor to coordinate all work with the other trades for scheduling, rough-in, and finishing all work specified. The coordination of the Nurse Call system is to be done by the general contractor and the electrical contractor with other trades. Nurse call system supplier shall provide all the over device information and conduit information in a “riser type” format. The actual conduit routings shall be shown on the floor plans by the electrical contractor not the nurse call system supplier.

1.08 WARRANTY

A. The supplying contractor shall provide a warranty on the system which shall include all necessary labor and equipment to maintain the system(s) in full operation for a period of one year from the date of acceptance.

B. Manufacturer shall provide product firmware/software upgrades throughout the 1 year warranty period for any product feature fixes.
C. The system supplier will provide the owner with any additional license fees at the 9 month date (from system turnover/final system inspection) and the owner will be responsible for any additional software maintenance fees for the software that is provided with this project.

D. In addition, the equipment (parts) warranty for all core system components including control / switching equipment, power supplies, sub-stations, and nurse consoles shall extend to a total of at least five (5) years from the date the parts are delivered.

E. After the acceptance of the system(s) service shall be provided on the following basis:

**Emergency Service** - Provided **24 hours a day.** When a **total or catastrophic failure** of equipment is reported to contractor, within **2 hours of notification**, a service person will be on site. (An example of a catastrophic failure would be a hub failure or a nurse console failure.)

**Routine Service** - Provided **within 4 business hours** (9 a.m. to 5 p.m., Monday through Friday, excluding holidays) **of notification.** When a minor failure of equipment is reported to contractor, a service person will be on site within 24 hours of notification. (An example of a minor failure includes peripheral equipment such as control stations, entertainment speakers, corridor lights, pull-cord stations, etc. which normally affect only one patient or patient room.)

1.09 **MAINTENANCE**

A. Provide the cost of tuition for ONE person designated by the OWNER to attend a service school held by the equipment manufacturer. Transportation to this school will be borne by the OWNER. Lodging, breakfast and lunch to be borne by the OWNER not the manufacturer or supplying contractor.

B. The OWNER may choose to have the supplying contractor maintain the system(s) at an additional cost to the OWNER. The level of service provided during the maintenance contract period would be the same as the warranty period for routine and emergency service. All labor and equipment costs would be covered under this contract. Supplying contractor must state exact billing amounts, billing periods and all costs associated with this maintenance agreement and list any items that would not be covered under the service/maintenance agreement. Firmware/software upgrades would be available with a software maintenance agreement. This agreement will need to
be compiled separately 10 months after the date of the nurse call system acceptance.

2 PART 2 PRODUCTS

2.01 MANUFACTURERS

The products specified shall be new and of the standard manufacture of a single reputable manufacturer. As a reference of standard and quality, functionality and operation, it is the request of the OWNER that bids be based on equipment manufactured by Rauland-Borg Corporation or an approved equal as this is an expansion of the existing Nurse Call system and the existing Nurse Call must be connected to the nurse call system being installed as part of this project. All connections to be done by Ronco Specialized Systems or approved equal and the cost for any required connections to the existing Rauland Nurse Call System shall be included in the cost of this project. Change orders will not be paid by the owner for any and all connections to existing nurse call system and are the complete responsibility of the system supplier. Prior approval required as listed in other sections of the nurse call specification.

2.02 NURSE CALL NETWORK WIRING

All Nurse Call Network wiring shall be only CAT 6. The entire Nurse Call System shall be installed in conduit and PVC cable shall be utilized. Plenum cable is not part of this project and if it is required additional costs will apply. System shall be capable of injecting DC power into a CAT 6 run, for additional rooms, or long runs, by running a separate DC cable pair to a remote location.

2.03 NURSE CALL CONTROLLER(S)

A. Furnish as shown on the drawings or as required by the nurse call manufacturer nurse call network controller. Each controller shall provide the following:

1. Non-blocking, duplex communications between consoles and rooms, sub stations, within each 6 station loop. Provide four loops for a total of 12 dynamically allocated speech paths.

2. CAT 6 wiring standard utilizing PoE (Power over Ethernet) between console and nurse call controllers and local wiring to power room station equipment and dome lights.

3. VoIP audio to Nurse Call Network, VoIP Nurse Console, VoIP digital audio stream out to rooms without IP overhead signaling.
4. Up to 96 corridor lights can be operated with a single controller.

B. Controller must be life safety grade meaning that it shall not require regular rebooting for continued basic functions of system and it shall be possible for controller to act as a stand alone controller should loss of network communication occur.

2.04 VoIP Nurse Consoles

A. Furnish as shown on plans, a UL-1069 listed VoIP nurse console capable of the following functions:

1. Full duplex audio
2. Color display
3. 12 or 24 hours time display and synchronization to hospital standard network time from the nurse call gateway server including any daylight savings time changes supported by the network.
4. Display up to 3 incoming calls each with an individual elapsed timer which increments time since call was placed. Also provide the ability to scroll to see more incoming calls.
5. Power over Ethernet powered connection to UL-1069 listed Ethernet controller. No local power supplies required.
6. Choice of hands-free duplex communications through built in speaker and separate microphone or private handset conversation.
7. Ability to create up to 32 soft keys, user-configurable, with 4 buttons, 8 screens deep.
8. Console shall be interactive with an associated PC workstation (user provided) without the necessity of any interconnection to the PC. The work process relationship shall be software defined through the network connections.
10. Ability to block all nurse call loudspeaker paging to facilitate a low noise patient environment. Password protection can be enabled to only allow authorized access to audio paging.
11. Ability to swing an individual room or any group of rooms by touching one labeled touch point. Room(s) and consoles may be located anywhere within hospital nurse/patient communications network.
12. Console can be programmed to be the receiver of any call that is not answered by another console, or can be programmed to receive any call from a console that has failed or has been unplugged, or otherwise not receiving the call (call orphaning).
13. Ability to dial through built in keypad.

14. Self-contained unit which shall not occupy more than 88 square inches of desk space and is desk or wall-mountable.

15. Support manual Staff Follow functions. When Staff Follow is enabled, call-tones for a prescribed area will automatically be forwarded to the room station speaker where staff members are located. Staff location may be determined manually by entering the room number into the console or automatically using staff register stations or registration via RTLS. Pressing the call button on that station shall silence the tones. When a new call is placed, the tones shall automatically be restored.

16. Furnish and install two Staff Terminals #RSS-351300-ST on this project. One to be installed at the police desk on the first floor by ER and one at the nurse station.

2.05 HIGH SECURITY STAFF STATION

Provide as shown on plans a staff station. Unit shall provide two-way hands free duplex intercom to its assigned nurse console(s) by pushing a call-in button. Station shall support an optional module to feature bed side rail control on station to indicate bed connection. LED on station shall indicate bed connection. Unit shall mount in a standard 3-gang electrical box. Steel, welded and powder coated cover plate shall be provided per direction of RSS.

2.06 DUTY STATION

Provide as shown on plans a duty station. Unit shall provide remote annunciation of assigned patient stations and sub-stations via 4 LED’s and multiple call tones. Duty station faceplate LED’s shall mimic corridor light activity for the assigned nursing area. Also provides two-way duplex intercom to the assigned nurse console(s) through separate speaker and microphone. Call tones generated at duty station must be identical and repeat in synch with tones produced at closest nurse console. It shall be possible to mute the call in tone, without cancelling call. The next call in, assigned to this duty station, will un-mute the station. Muting feature may be defeated in those jurisdictions that do not allow muting of duty station. The duty station shall be capable of being programmed for a specific time that a day/night mode takes place, allowing a volume change to the call-in tones. This feature is required to minimize noise for patients. Unit shall mount in a standard 3-gang electrical box.

2.07 HIGH SECURITY STEEL COVER PLATE
Provide as shown on plans a high security steel cover plate that is a 3 gang, 0.60”, painted cold roll steel plate, designed to protect the R5 Staff Station when used in psychiatric wards or other high security hospital areas. The plate incorporates a vandal resistant switch which is wired to the R5KLS and is used to initiate an emergency call from the room. The plate installs over the R5 Staff Station without drilling or modification to the station.

2.08 KEY LOCK STATION

Provide as shown on plans a key lock station that is a flush-mounted unit for us in a psychiatric ward or other high security hospital area. It is generally positioned outside the entrance to a room or ward and is used to activate and emergency pushbutton located in the room. A built-in “LED” indicator will illuminate when a staff member turns the key to the “on” position, activating the entrance station and (optional) initiating a “Locking Station” priority call at the nurse console. A “Monitor” LED will illuminate when the nurse console is actively monitoring the room station. If a staff member should require assistance while in the room, a pushbutton is available to initiate an emergency call. When an emergency call is placed, a built-in “LED” and sounder will annunciate the call at the key lock station. Additionally, the call will be placed through the nurse call system, announciating the on the nurse call console. The call is terminated when the staff member leaves the room and turns the key lock station to the “off” position.

2.09 CORRIDOR LIGHTS AND DOMELESS CONTROLLERS

A. Provide as shown on plans, the proper type of corridor light or domeless controller. Corridor lights shall contain four sections, each lighted by a long life, RGB LED capable of producing 7 colors. Each section shall have a diffusion lens which allows for 180 degree horizontal visibility of call lights. The corridor lights shall be capable of the following:
   1. All segments of corridor light can indicate a call in any of the following 7 colors: Blue, Red, White, Green, Orange, Yellow, or Pink.
   2. Custom call patterns (any combination of light segments, such as all segments blue for code blue).
   3. Flash any single color or strobe the sections of the light in any color pattern.

B. Intelligence in the corridor light and domeless controller shall support up to 16 room devices and allow for the ability of any room station to be associated with any other room in the system. This allows special functions where needed, such as associated call stations and cancelling options, (i.e. door monitoring).

C. Domeless controllers shall have all the function of the corridor light, less LED’s.
D. In the unexpected event of communications loss with the nurse call controller, corridor lights and domeless controllers shall enter a local room failsafe mode showing all calls in the hallway via the LED indicators.

E. Corridor lights and domeless controllers may be hot-swapped on the room-to-room communication line without the loss of communications to other devices on the local network.

3 PART 3 EXECUTION

3.01 SUPERVISION
A. Only factory certified installers shall install, service and maintain the specified network system.

B. Manufacturer shall have the equipment manufacturer’s engineer or their designated agent inspects the installation and operation of this network to determine that the network complies with all standards listed in Part 1.03.

3.02 TRAINING
Contractor shall provide thorough training of all nursing staff assigned to those nursing units receiving new networked nurse/patient communications equipment. This training shall be developed and implemented to address two different types of staff. Floor nurses/staff shall receive training from their perspective, and likewise, unit secretaries (or any person whose specific responsibilities include answering patient calls and dispatching staff) shall receive operational training from their perspective. A total of 16 on-site training hours shall be included in the cost of this project and must be done by a Factory Certified Trainer. The system supplier shall offer additional training to be quoted outside of this project.

3.03 WIRING
A. The system supplier shall terminate all wiring with manufacturer approved connectors and in accordance with the manufacturers’ recommendations.

B. All wiring shall be free from shorts and faults. Wiring shall be UL listed, NEC and NFPA 70, Article 25 approved.

C. Nurse patient communications network wiring shall not be run in the same conduit with other systems (i.e. Class 1 AC power distribution, fire alarm, entertainment systems, lighting controls, etc.).

3.04 ELECTRICAL POWER CONNECTIONS
A. It shall be the responsibility of the hospital to provide a minimum of two dedicated critical power branch circuits, 120 VAC, 60 HZ and the required conduit into the equipment cabinet. This power feed shall not have any other
devices connected directly to it. Circuit breakers shall be 20 AMPS and shall be located in the critical power electrical sub-panel labeled “nurse call” will control this circuit. This electrical circuit will be connected to the hospital’s emergency critical power system for automatic power switch over during loss of utility power.

B. The electrical contractor, not the nurse call system supplier shall connect all network system power supplies and equipment cabinets to a common earth ground utilizing a 14 AWG, or larger, solid conductor which is at minimum the same conductor size as the AC feed wires. The electrical contractor, not the equipment supplier is responsible for conduit, raceways and all associated electrical items to be done in accordance with the current codes and the requirements of the Authority Having Jurisdiction (AHJ).

3.05 ENVIRONMENTAL PROTECTION
Make certain that all network control equipment is accessible for service. Contractor shall notify specifying authority if designated equipment closet does not meet manufacturer’s requirements for heat, radiation or static electricity.

3.06 PROTECTION OF NETWORK DEVICES
Contractor shall protect network devices during unpacking and installation by wearing manufacturer approved ESD wrist straps tied to chassis ground. The wrist strap shall meet OSHA requirements for prevention of electrical shock, should technician come in contact with high voltage.

3.07 CLEANING AND PATCHING
A. It shall be the responsibility of the contractor to keep their work area clear of debris and clean area daily at completion of work.
B. It shall be the responsibility of the contractor to patch and paint any wall or surface that has been disturbed by the execution of this work.

3.08 DRAWINGS
The Electrical Contractor, not the system supplier, shall provide as built drawings of all installed network components and associated wiring on building plans. Final payment will be made by the owner prior to the submission of the as-built drawings and Owners and Maintenance manuals.
SPECIFICATION for SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF 3 x 100 KVA UPS SYSTEMS CONNECTED IN “PARALLEL REDUNDANT CONFIGURATION”

1. SCOPE

The scope of the work includes Supply, installation, testing, integration & commissioning of 3 x 100 KVA True On-line, double conversion, VFI technology, Fully Microprocessor controlled UPS systems working “Parallel redundant configuration”. & 3 nos 10 KVA UPS are individual / stand alone

The specification shall include design, manufacture, fabrication, assembly; proper packing for transportation delivery at site, unloading, storage, erection, integration with related equipments, and putting all 3 x 100 KVA UPS Systems together with all accessories and auxiliaries as specified hereinafter in a fully operational condition acceptable to the owner. The offered system shall be fully in compliance with the requirements stated herein.

The Contractor shall be responsible for engineering and providing all materials, equipments and services specified or otherwise, which are required to fulfill the intent of ensuring operability, maintainability, completeness and reliability of the total work covered under this specification within his quoted price.

The design manufacture, inspection, testing and installation of the UPS System covered under this specification shall conform to the latest international standards such as :

EN 62040-1 - General Safety Regulations.
EN 62040-2 - EMC Regulations.

2. APPLICATION :-

This UPS system is intended to provide electrical power supply on continuous and consistent basis for different loads in the environmental conditions given below: -

- a) Maximum temperature: 40 deg. C
- b) Minimum Temperature: 0 deg. C
- c) Altitude: 1000 meters above MSL
- d) Relative humidity: upto 95% (Non – Condensing)

3. SCOPE OF SUPPLY:

3 x 100 KVA UPS with Parallel redundant configuration”. And 3 nos 10 KVA UPS are individual

a) Each UPS module must have the following built in parts / features:-

* Rectifier cum charger (float cum boost)
* PWM technology based Inverter.
* Automatic Bi-directional Static switch
* Manual Bypass Switch.
* Inbuilt (Must) Galvanic inverter output isolation transformer.
* Fully Microprocessors Controlled circuitry.

- Provision for separate Input for rectifier and for Bypass
- Event Monitoring & Diagnostics: Last 500 events with exact date & time should be monitored from the front LCD panel of the UPS & last 2000 events on a PC if connected through a SNMP card on LAN. In case front panel does not have this facility a latest configuration based LAPTOP shall be mandatorily included & supplied by the vendor in their scope of supply.

- The input voltage window must be from 300 to 480 Volt without battery intervention. In case this is not a standard feature of the UPS system, a Servo stabilizer of suitable capacity should be included & supplied with each UPS unit matching this input requirement.

b. Rack Mounted External Battery Bank Sealed Maintenance Free (12 V SMF,VRLA) Lead Acid Battery Bank suitable for 20 minutes backup with each 3 x 100 KVA module & on full load. Battery Sizing calculation needs to be submitted as per the attached sheet.

4. EQUIPMENT ARRANGEMENT AND OPERATION:

4.1 SYSTEM CONFIGURATION:

The offered 3 x 100 KVA UPS units shall be connected in Parallel redundant configuration. The UPS system will be fully microprocessor controlled.

4.2 SYSTEM OPERATION:

a. Under normal operating conditions, the rectifier shall supply the 100% battery charge requirements and shall also supply the 100% inverter requirement, which shall provide the rated AC output continuously.

b. The UPS system will supply the regulated rated power through inverter at all the times in mains operation.

c. When the AC mains supply to the battery charger fail, the battery shall supply inverter demand with no break occurring in the AC output.

d. The UPS systems output voltage shall be maintained within specified tolerance (± 1%) for all forms of incoming AC mains supply conditions.

e. The UPS system should provide continuous rated output power through commercial mains, even at phase sequence reversal at the input side. If standard UPS system does not meet this criterion, then additional hardware should be included in the UPS system to meet the requirement.

Configuration Details:

The 3 x 100 KVA UPS systems will be working in Parallel redundant mode for Data Center system. Battery backup has to be 20 Mins. With each 3 x 100 KVA UPS module.

5.0 General
5.1 Summary
The scope of the work includes Supply, installation, testing, integration & commissioning of 3 x 100 KVA true on-line double conversion UPS system using with PWM IGBT technology. Fully Microprocessor controlled UPS system working in parallel N+1 redundant configuration. i.e. the Rectifier of the UPS system converts the input AC power to DC and then the inverter converts the DC into clean AC power.

The specification shall include design, manufacture, fabrication, assembly; proper packing for transportation delivery at site, unloading, storage, erection, integration with related equipments, and putting all the UPS Systems together with all accessories and auxiliaries as specified hereinafter in a fully operational condition acceptable to the owner. The offered system shall be fully in compliance with the requirements stated herein.

The Contractor shall be responsible for engineering and providing all materials, equipments and services specified or otherwise, which are required to fulfill the intent of ensuring operability, maintainability, completeness and reliability of the total work covered under this specification within his quoted price.

The design manufacture, inspection, testing and installation of the UPS System covered under this specification shall conform to the latest international standards. The Block diagram of the UPS system should be as shown in Block Schematic Fig. 1.

![Block Schematic Fig. 1](image-url)

**Fig-1**

The major items constituting of the blocks of the above schematic Fig.-1 are shown as below in Fig-1 (A).
The main circuit and the bypass can use the same or different sources as per the discretion of customer. The details of the above schematic are as given below:

Q1: Connects rectifier to Utility source
Q2: Connects bypass to Utility source
Q5: Connects UPS output to the Load
Q3BP: Connects bypass input source to the load switch (Maintenance Bypass)
KM: Battery Circuit Breaker
TR2: Galvanic Output Isolation Transformer (Delta- Zigzag)
REC: Rectifier Module
INV: Inverter Module

System Configuration and operation in normal conditions:

The utility source should be input at Q1 and should pass through the fuse, and inductor and into the high frequency rectifier, which will convert the AC power into DC power. The rectifier and charger function and should make use of soft start and microprocessor based control to improve the system immunity against surge, improve the stability of the DC bus voltage, reduce the charging current ripple and prolongs the battery life.

The output should be isolated from the load by Isolation transformer, static switch, fuse and isolators.
The bypass source should be input at Q2 and output through the bypass static switch as mentioned in above Fig-1 (A).

The main elements of the configurations are:
- Fully Microprocessor Controlled Rectifier
- Fully Microprocessor Controlled PWM IGBT Based Inverter
- Delta / Zig Zag Isolation Transformer at the O/P of the Inverter to provide Galvanic isolation and separating the I/P and O/P Neutral.
- Full Capacity Static Switch at the O/P of the Inverter
- Full Capacity Static Switch in the Bypass path
- Full Capacity Manual Bypass Switch
- SNMP card with each UPS module along with software

Please note that all the above mentioned elements should form a part of the UPS system and are to be in the same sequence as mentioned in the Fig.-1 (A) along with all the Isolators etc. within a Single Cabinet.

6 Modes of Operation

The UPS shall be able to operate as an on-line reverse transfer system in the following modes:

6.1. Normal mode

When the utility is normal, the UPS powers the load through the rectifier and inverter and charges the batteries at the same time, as shown in Bold Lines in Fig-2 (A).

Fig-2 (A)

6.2. Emergency/ Battery Mode - When the utility fails, the UPS system shall switch to battery mode without interruption and the battery will power the load through the inverter.

The UPS shall return to normal mode automatically when the utility returns to normal, shown in Bold Lines in Fig-2(B).

Fig.-2(B)
6.4. **Recharge** - Upon restoration of AC input power, during the ‘Emergency’ mode of operation, the rectifier/charger shall automatically restart, walk-in, and gradually assume the inverter and battery recharge loads.

.1. **Bypass** - In the event of an inverter overload, which last longer than the typical time, an output short circuit or a fault on the inverter, the UPS will transfer the load to bypass. There should be two kinds of bypass modes. In the first kind, the UPS can be set to return to normal mode automatically when the fault is cleared. In the second kind, the UPS is set to return to normal mode only with a manual transfer. However in this event, SBP will keep as disabled.

When the main UPS circuit fails, the battery is depleted or a severe fault occurs, the inverter shall be shut down and the system will remain in the bypass mode. The system can return to normal mode only with a manual reset after the fault is cleared, shown in **Bold Lines** in Fig-2(C).

![Fig.-2(C)](image)

**6.6. Maintenance Mode**

When the UPS has to undergo routine maintenance, the UPS shall be set to maintenance mode by switching on the maintenance bypass circuit breaker. The load will be powered from the maintenance bypass supply without interruption. During maintenance, the circuit breakers Q1, Q2, QF1 and Q5 should be switched off to ensure the safety of maintenance personnel. As shown in **Bold lines in Fig-2(D)**
6.6 Basic Functions
Battery Management Function - The UPS has advanced battery management functions including battery fault detection and backup time forecast. (Backup time left)

- **Soft Start Function** - Complete delay soft start function can reduce the surge to the UPS unit and utility source.

- **Alarm and Protection Function** - The UPS can generate audible and visual alarm through LCD, input/output contacts and network transmission. It can help maintenance personnel to locate and clear the faults that are sent out in time, accurately and in detail.

- **Automatic Re-start when Utility returns** - On failure of the input mains supply the UPS goes to battery mode. After the batteries are completely discharged the UPS system shuts down. It should automatically restart on the resumption of the input supply.

7 General

7.1 Summary
This specification defines the electrical and mechanical characteristics and requirements for a continuous-duty three-phase, solid-state, uninterruptible power supply (UPS) system. The UPS shall provide high-quality AC power for sensitive electronic equipment loads. Three UPS Systems shall be connected to run in Parallel redundant Current Sharing Mode so as to deliver uninterruptible power to 160 KVA Load, as per the attached Single Line Diagram (Annexure – 1)

7.2 SYSTEM DESCRIPTION

7.2.1 Design Requirements - UPS Module

**A. Voltage.**
Input / Out voltage specifications of the UPS shall be:

- **Rectifier Input**: 415 Volts, three-phase, 3-wire

- **Bypass Input**: 415 Volts, three-phase, 4-wire-plus-ground.

- **Output**: 415 Volts, three phase, 4-wire-plus-ground.
B. Surge Suppression
In compliance to IEEE std. C 62.41-1991, the UPS Systems should have Surge Suppressor at the input side.

C. Output Load Capacity
Specified output load capacity of each UPS Module shall be 3 x 100 KVA at 0.8 lagging power factor such that the active power delivering capacity must not be below 80 KW Rating and Reactive Power (KVAR) delivering Capacity must not be below 100 KVAR.

D. Battery Backup and Capacity
Each UPS Module shall be connected with its individual 100% rated Battery Bank consisting of Maintenance Free Valve Regulated Lead Acid (VRLA) 12 Volt Cells having 20 year designed float life. The common Battery Bank connected with UPS should be rated 100AH/12V X 30 Nos or as per. Sizing calculations of the Batteries should be done and furnished as per attached Annexure – 2, considering Inverter Efficiency not more than 92% and End Cell voltage of 1.67 VPC considering that each UPS, while powered by Batteries, will have to deliver to 80 KW Load for 20 minutes.

7.2.2 Modes of Operation
The UPS shall be designed to operate as an on-line, double conversion type UPS strictly as per the definition of IEC 62040-3 as follows:

A. Normal Operation - The critical AC load should be continuously supplied by the UPS inverter. The rectifier & charger should take power from the AC input source, convert it into suitable DC and supply to the Inverter as well as charge the Batteries on Automatic Float Mode cum Boost Mode.

B. Upon Mains Failure - Upon failure of AC input power, the critical AC load should continue to be supplied by the Inverter which, should obtain power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the AC input source.

C. Upon Mains Restoration - Upon restoration of AC input power, The Rectifier/Charger should automatically restart, walk-in and gradually take-over the supply to Inverter and charging to the Battery.

D. Static Bypass – Each UPS Module should have in-built 100% rated static Bypass Line. In two UPS Modules connected in Parallel redundant Current Sharing Mode, in the event of any fault in one UPS, the faulty UPS should isolate itself and the other two healthy UPS’s which normally shares the load 67%, should take-over the full load.

All the loads should be transferred to the Static Bypass Line of the UPS without any break if the input frequency is within 50 Hz +/- 2 Hz and with a break below 20 millisec. if the input frequency is beyond 50Hz +/-2 Hz for the following conditions:

i) If any one UPS fails simultaneously
ii) if overload beyond 150% for 30 Seconds is faced by the UPS
    iii) if both UPS senses over temperature (i.e, inverter heat sink temp. exceeding 85 Deg Celsius simultaneously
iv) If both the UPS Inverters are put-off
**E Maintenance Bypass** – Each UPS Module should have in-built 100% rated Maintenance Bypass Line of its own in addition to the 100% rated Static Bypass Lines

F Equal Current Sharing by the Static Bypass of all the three UPS - **Each UPS Module should compulsorily have in-built 100% rated Bypass Line Inductance as shown in attached Fig. 1, ensuring that Bypass Lines of the UPS’s share the total load current equally.**

### 7.2.3 PERFORMANCE REQUIREMENTS

1. **AC Input to UPS**
   - **A. Voltage Configuration**: Three-phase, 4-wire plus ground
   - **B. Voltage**: 380 / 400 / 415 V (User Selectable)
   - **C. Voltage Range**: 300 to 480 V.
   - **D. Frequency**: 50 Hz
   - **E. Frequency Tolerance**: 45-65 Hz

2. **AC Output, UPS Inverter**
   - **A. Voltage Configuration**: Three-phase, 4-wire plus ground
   - **B. Voltage**: 380 / 400 / 415 V (User selectable in steps of 1V from 380 to 415 V)
   - **C. Voltage Regulation**: +/- 1% steady state.
   - **D. Frequency**: Auto Sensing 50 Hz or 60 Hz,
   - **E. Frequency Slew Rate**: 1 Hz/sec
   - **F. Phase Displacement**: 120 Deg +/- 1 Electrical Degree for balanced load.
     - 120 Deg +/- 1 Electrical Deg. for 100% unbalanced load.
   - **G. Voltage Distortion**: < 2% for 100% linear loads
     - < 5% for 100% non-linear loads with 3:1 crest factor.
   - **H. Output Power Rating**: 3 x 100 KVA at 0.8 lagging power factor.
   - **I. Overload Capability (on Inverter) :**
     - 110% for 1 minutes
     - 125% for 30 seconds
     - 150% for 10 Seconds
   - **J. Voltage Transient Response** (for 0 – 100% load change) : < +/- 5%
   - **K. Transient Recovery Time** (for 0-100% load change): Recovery to nominal within 20 milliseconds

L. **Voltage imbalance :**
   - for Balanced load : <1%
   - for 100% unbalanced load : < 2%

### 7.3 ENVIRONMENTAL CONDITION
7.3.1 The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

**A. Operating Ambient temperature**

**UPS Module:** 0ºC to 40ºC  
**Battery:** 22 to 24 ºC

**B. Storage/Transport Ambient Temperature**

-25ºC to 70ºC

**C. Relative Humidity:** Upto 95% (Non Condensing) at 20ºC

**D. Altitude Operating:** to 1000 meters above Mean Sea Level.

7.4 UPS Delivery Submittals

Submittal upon UPS delivery shall include one instruction manual. Manual shall include a functional description of the equipment with block diagrams, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

7.5 Warranty

The manufacturer shall warrant all the supplied items against defects in materials and workmanship for 12 months after initial start-up or 18 months after ship date, whichever is earlier.

7.6 Quality Assurance

7.6.1 Manufacturer Qualifications

The vendor quoting for the job should have a minimum of five year’s first-hand experience in the design, manufacturing, and testing of solid-state UPS systems. Besides credentials of having supplied done more than 5 similar or bigger jobs, the firm should have ISO 9001 certifications as UPS System manufacturer.

7.6.2 Factory Testing

Before shipment, the manufacturer shall fully and completely test the system in India to ensure compliance with the major specifications.

8.0 PRODUCT

8.1 Fabrication

8.1.1 Materials

All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.

8.1.2 Construction and Mounting

The UPS unit, comprised of input isolator, rectifier/charger, inverter, static transfer switch, maintenance bypass switch, and static bypass input switch shall be housed in a free-standing steel enclosure with key-lockable doors. Front access only shall be required for expedient servicing, adjustments, and installation. The enclosure will be built to comply with IP20 when the doors are open. The UPS cabinet shall be cleaned, primed,
and painted with the manufacturer’s standard colour. The UPS shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be plug-in. Like assemblies and like components shall be interchangeable.

8.1.3 Cooling
Cooling of the UPS shall be forced-air. Low velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output. Temperature will be monitored by thermal sensors.

8.2 Components
8.2.1 Rectifier/Charger

A. General
The Rectifier cum Charger Unit should be of Three Phase, Fully controlled Rectifier Float cum Boost Type with settable Boost Timer and Current Limited. The Rectifiers should have Input and DC Current Limiting Circuitry. The Rectifier/Charger capacity should be atleast 50% higher than the Inverter Capacity. It should be capable of giving charging current upto maximum of 20% of the Battery AH Capacity, while simultaneously supplying full load current to inverter.

B. Input Current Walk-In
The rectifier/charger shall contain a timed walk-in circuit that causes the unit to gradually assume the load over a 20 second time interval after input voltage is applied.

C. DC Filter
The rectifier/charger shall have an output filter to minimize ripple voltage into the battery. The Ripple voltage should be less than 2%.

D. Battery Recharge
In addition to supplying power for the inverter load, the rectifier/charger shall be capable of providing battery charging current to recharge the battery properly. After the battery is recharged the rectifier/charger shall maintain the battery at full charge until the next emergency operation. The charging shall be an automatic cycle i.e boost to floating charge switching, with current measuring criteria and control during recharge. Both float and recharge voltages shall be adjustable. The charge voltage can also be manually controlled. Dynamic Temperature compensated Charging Facility should be there. The Rectifiers/Chargers should automatically increase the DC End-of-Discharge voltage level sensing lesser loads, in order to protect the batteries from over discharge beyond their AH Capacities.

8.2.2 Inverter

A. General
The Inverter should be Fully Microprocessor controlled Sine wave IGBT / PWM based employing High Switching Frequency, consisting of IGBT’s.

B. Overload Capability
The inverter shall be capable of supplying current and voltage for overload of 150% for 10 seconds A status indicator and audible alarm shall indicate overload operation. The UPS shall switch off its inverter output static switch when its overload capacity is exceeded.

C. Fault Clearing and Current Limit
Without bypass supply available to the inverter shall be capable of supplying an overload current of 200% of its full-load rating in excess of five Seconds. For greater currents or longer time duration, the inverter shall have electronic greater currents or longer time
duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The inverter shall be self-protecting against any magnitude of connected output overload (Vce Trip). Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses.

D. Output Frequency
The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall hold the inverter output frequency to +/- 0.01% for steady state and transient conditions.

E. Isolation Transformer: To isolate the input disturbances from the output side a double wound delta-zigzag transformer to galvanically isolate the input from output is mandatory to be included in the design at the output of the inverter. as shown in Figure 3 below. The isolation transformer will be connected as shown in the Fig 1(a). The combination of the inverter and Output isolation txr shall form a separately derived source wherein the Input neutral and the three Phases are completely isolated from the output neutral and the three phases.

8.2.3 Display and Controls
A. Monitoring and Control
The UPS shall be provided with a microprocessor based unit status display and controls section designed for convenient and reliable user operation. A system controls section designed for convenient and reliable user operation. A system power flow diagram, a

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Fig. – 3
percentage load and battery time remaining display shall be provided as part of the monitoring and controls sections which depicts a single line diagram of the UPS. Illuminated visual indicators shall be of the long-life light emitting diode (LED) type. All of the operator controls and monitors shall be located on the front of the UPS cabinet. The monitoring functions such as metering, and alarms shall be displayed on an alphanumeric LCD display. Additional features of the monitoring system shall include:

- Event Monitoring & Diagnostics: Last 500 events with exact date & time should be monitored from the front LCD panel of the UPS & last 2000 events on a PC if connected through a SNMP card on LAN. In case front panel does not have this facility a latest configuration based LAPTOP shall be mandatorily included & supplied by the vendor in their scope of supply.

B. Metering

The following parameters shall be displayed:
- DC Voltage
- Battery voltage
- Battery charge & discharge current
- Input voltage and frequency
- Output AC voltage line-to-line and line to neutral and % load used of nominal
- Output AC current for each phase and neutral
- Output frequency
- Active Power (kW) Apparent Power (kVA)
- Temperature - Ambient, battery, inverter and transformer

C. Warning and Alarm Messages

- Normal Operation Input breaker open
- Output breaker open Rect. breaker open
- Battery breaker open On Manual bypass
- Bypass absent Bypass over limits
- Bypass under limits Bypass freq. over limit
- Bypass Phase Rotation Bypass SCR fail
- Bypass inhibit Local Bypass inhibit remote
- Load on bypass On bypass due to over temp
- Rectifier off Local Rect. off remotely
- Rectifier Block Rectifier overload
- Rectifier over temp Rectifier Fuse fail
- Inverter off local Invert. off remotely
- Inverter block Inverter overload
- Inverter over temp Inverter out of sync
- Inverter over voltage Inverter under volts
- Inverter fuse fail D.C Volts High
- D.C Volts low Inverter no voltage
- InverterPeak Volts low Battery under test
- Battery test fail Discharge battery
- Battery E.O.D. Boost Charge
- DC Bus over volts Battery Low
- Battery Fuse Fail Bat. Fast over volt
- Bypass overuse Cut-off overload
- Cut-off over temp Cut-off emergency stop
- Overload Cut-off max overload

D. Controls

Four pushbuttons shall be located on the operator control panel.
- Enter
The push buttons shall permit the operator either to select options from a menu for display on the LCD winder or to change the value of some parameters. One push-button - alarm silence switch.

**E. Power Status Diagram**

A mimic panel shall be provided to depict a single line diagram of the UPS. Indicating lights shall be integrated within the single line diagram to illustrate the status of the UPS. The three LEDs shall indicate the following status:

- Bypass voltage OK
- Load on bypass
- Load on inverter

Power status diagram shall be an LED bar graph indicating % load with amber overload indication. Also an LED bar graph indicating % battery time remaining shall be included.

**F. COMMUNICATION FEATURES**

Each UPS should have RS-232 interface port for serial port communicability, MODBUS for BMS Connectivity and SNMP / Web Card for comprehensive web-based monitoring of UPS by multiple workstations through TCP/IP based LAN System OPTIONAL

**8.2.4 Static Transfer Switch**

**A. General**

A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be naturally commutated high-speed static (SCR type) device rated to conduct upto 100% of full load current, continuously. Such Switch should be connected at both the Static Bypass as well as the Inverter Output to enable the critical load to be connected to the inverter output or bypass power source. the static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.

**B. Uninterrupted Transfer**

The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:

- Inverter overload capacity exceeded
- Critical AC load overvoltage or under-voltage
- UPS fault condition.

The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:

- Inverter/bypass voltage difference exceeding pre-set limits
- Bypass frequency out of limits
- Bypass out-of-synchronization range with inverter output.

**C. Uninterrupted Retransfer**

Retransfer of the critical AC load from the bypass source to the invert output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following condition exists:

- Bypass out of synchronisation range with inverter output
- Inverter/bypass voltage difference exceeding pre-set limits
- Overload condition exists in excess of inverter full load rating
- UPS fault condition present.

8.2.5 Maintenance Bypass Isolator

A. General
A manually operated maintenance bypass isolator shall be incorporated into the UPS cabinet to directly connect the critical load to the input AC power source, bypassing the rectifier/charger, inverter, and static transfer switch. Transfer from Inverter to the Manual Bypass should be possible without any interruption to the Loads.

B. Maintenance Capability
With the critical load powered from the maintenance bypass circuit, it shall be possible to freely check out the operation of the rectifier/charger, invert, battery, and static transfer switch.

8.2.6 Bypass Line Inductances

A. General
An Inductance shall be incorporated into each UPS cabinet in the Bypass path connecting the critical load to the input AC power source, so as to equalize the currents shared by the Bypass paths of each UPS.

B. Load sharing by Bypass of each UPS
The inductances of all the UPS’s should be identical having matching impedance. They should be 100% rated.

8.2.7 Isolation Transformer at Output of Inverter
Each UPS should have in-built K-rated Delta-Zigzag, double wound galvanic Isolation Transformer at the output of its Inverter ensuring that at no point of time there is any electrical connection of the phase wires between the Input Supply going into the UPS and the Output Supply coming out of the UPS.

8.2.8 Battery path Protection
Battery Path MCCB should be provided with each UPS for connection between the UPS and its Battery Bank. The MCCB should be physically placed near the Battery Bank and should have thermal, magnetic as well as automatic remote tripping mechanism. In the event of any fire or emergency, it should be possible to immediately make the outputs of Rectifiers, Inverters and the battery banks devoid of electrical Potential by pressing the Emergency Stop button from UPS Front Panel.

8.2.09 Interconnecting Cables
Vendor shall provide all the interconnecting cables between Incoming MCCB Panel, the UPS Systems, the Battery banks and the Outgoing MCCB Panel.

8.3 PRODUCT STANDARDS
The UPS should be designed & manufactured in accordance to and as per the following international Standards:
ISO 9001Certification

9.0 FIELD ENGINEERING SUPPORT
The UPS manufacturer shall directly employ a national field service network staffed by factory trained field service engineers to provide start-up, maintenance and repair of the UPS equipment.

10.0 – Pre dispatch inspection of the UPS System:

The vendor must arrange a Pre Dispatch Inspection at their factory site in compliance with all the technical specification of this tender. The Pre Dispatch inspection shall be monitored by authorized technical officials of consultant and client. A joint report must be submitted along with the material. Any charges if any should be included / mentioned separately in the cost sheet.

ANNESURE - 2

Battery Sizing Calculations for 100 KVA UPS

<table>
<thead>
<tr>
<th>UPS Rating</th>
<th>:</th>
<th>KVA</th>
<th>100KVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Power Factor</td>
<td>:</td>
<td>P.F</td>
<td>0.8</td>
</tr>
<tr>
<td>Inverter Efficiency</td>
<td>:</td>
<td>H</td>
<td>0.92</td>
</tr>
<tr>
<td>DC Bus Voltage</td>
<td>:</td>
<td>BV</td>
<td>360</td>
</tr>
<tr>
<td>No. of Cells</td>
<td>:</td>
<td>N</td>
<td>180</td>
</tr>
<tr>
<td>K factor for 30 minutes backup.</td>
<td>:</td>
<td>K</td>
<td>1.26</td>
</tr>
<tr>
<td>Nominal Cell Voltage</td>
<td>:</td>
<td>NCV</td>
<td>12 V</td>
</tr>
<tr>
<td>End Cell Voltage</td>
<td>:</td>
<td>ECV</td>
<td>1.75V</td>
</tr>
<tr>
<td>Backup Time Requirement in minutes.</td>
<td>:</td>
<td>M</td>
<td>20 minutes with each UPS module.</td>
</tr>
</tbody>
</table>

Battery Rating, Ah = (KVA x 1000 x P.F)*K / (η x ECV x N)

Ah = (80 x 1000 x 0.8 x 1.26) / (0.94 x 1.75 x Vendor to specify)

Ah = **Vendor to specify**

The nearest Battery rating available is **Vendor to specify**.

Thus, the offered configuration with each 3 x 100 KVA UPS: **Vendor to specify**

Thus, the offered VAH of for each UPS module = **Vendor to specify**

80*1000*0.8=64000W
12*30*0.92=331.20
64000/331.20=193.23Ah req. for 60 minutes back up
Nearest Ah available is 100Ah
=100Ah*30No. of 12V required for approximate 20 Minutes backup
VAH = 100*30*12 = 36000 VAH

Or 36000/64000 = 0.56 * 60 = 20 minutes back up

For Three UPSs, the total VAH is 36000*3 = 108000.00VAH

Thus, the offered VAH of for three UPS modules
= 3 x Vendor to specify DC Bus Voltage x Vendor to specify AH rating = Vendor to specify VAH.
## 9.02 TECHNICAL PARAMETER FOR 100 KVA UPS

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>RATING 100 KVA</th>
<th>REMARK BY VENDERS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>(I) Input</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Voltage</td>
<td>380 / 400 / 415 V (3ø, 4 Wire)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Voltage Variation</td>
<td>350 to 460 V</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Frequency</td>
<td>50 or 60 Hz</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Frequency Variation</td>
<td>40 to 70 Hz</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Power Walk-in</td>
<td>20 Sec.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>(II) Output</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Voltage</td>
<td>380 / 400 / 415 V (Nominal), Selectable thru PC</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Frequency</td>
<td>50 or 60 Hz</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Power Factor</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Voltage Adjustment</td>
<td>± 15% of Nominal setting, Adjustable thru PC</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Voltage Variation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Balanced Load</td>
<td>±1%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100% Unbalanced Load</td>
<td>± 5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dynamic</td>
<td>±4%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Voltage Distortion (Linear Load)</td>
<td>&lt; 3%</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Phase Displacement:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Balanced Load</td>
<td>120° ± 1°</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unbalanced Load</td>
<td>120° ± 3°</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Frequency Variation (in Free-running mode)</td>
<td>±0.005%</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Synchronization Window</td>
<td>±1%, ±2%, ±5%, ±10%. Configuration through PC</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Slew Rate</td>
<td>1 Hz/ sec</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Overall Efficiency at 100% Load</td>
<td>&gt;90%</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Inverter Efficiency at 100%</td>
<td>&gt;92%</td>
<td></td>
</tr>
<tr>
<td>Load</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Overload</td>
<td>125% for 10 min 150% for 1 min</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Crest Factor</td>
<td>3:1</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Number of Systems that can be paralleled</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

(III) DC Link

<table>
<thead>
<tr>
<th>1</th>
<th>Battery Voltage</th>
<th>192Vx2V / 32Vx12V</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Low Battery Cut-off</td>
<td>1.67V/ Cell</td>
</tr>
</tbody>
</table>

(IV) Static By-pass

<table>
<thead>
<tr>
<th>1</th>
<th>Overload</th>
<th>10 times for 100ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Switching Time:</td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Inverter to By-pass:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overload</td>
<td>0 ms</td>
</tr>
<tr>
<td></td>
<td>Failure</td>
<td>&lt;1 ms</td>
</tr>
<tr>
<td></td>
<td>Command</td>
<td>0 ms</td>
</tr>
<tr>
<td>(ii)</td>
<td>By-pass to Inverter (Auto and Manual modes)</td>
<td>0 ms</td>
</tr>
</tbody>
</table>

(V) Battery Charger

| 1 | Charging Mode | CVCC with Float and Boost modes |

(VI) Protections

<table>
<thead>
<tr>
<th>1</th>
<th>Input Voltage</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Output Voltage</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Negative Sequence (Phase Reversal)</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Over Temperature</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Battery Over-charging</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>Battery Over-temperature</td>
<td>Yes*</td>
</tr>
<tr>
<td>7</td>
<td>Input In-rush Current</td>
<td>Yes (Soft Start)</td>
</tr>
<tr>
<td>8</td>
<td>Output Over-load</td>
<td>Yes (Electronic)</td>
</tr>
<tr>
<td>9</td>
<td>Reverse Power in paralleled UPS Systems</td>
<td>Yes</td>
</tr>
</tbody>
</table>

(VII) Man Machine Interface

<p>| 1 | Front Panel LCD Display | Yes |
| (i) | Displayed Parameters: |  |
|  | (a) Input Voltage (for each Phase) | Yes |
|  | (b) Input Current (for each Phase) | Yes |
| (c) Output Voltage (for each Phase) &amp; Yes |
| (d) Output Current (for each Phase) &amp; Yes |
| (e) Battery Voltage &amp; Yes |
| (f) Battery Current &amp; Yes |
| (g) Output Frequency &amp; Yes |
| (h) Input Frequency &amp; Yes |
| (ii) Displayed UPS Status: |
| (a) Converter/Rectifier - ON/OFF &amp; Yes |
| (b) Inverter - ON/OFF &amp; Yes |
| (c) Static Switch - On Mains/Inverter &amp; Yes |
| (d) Load - Within Limit/Over-load &amp; Yes |
| (e) Battery - On Float/Boost/Discharging &amp; Yes |
| 2 | Front Panel LED Indications: &amp; Yes |
| (i) Normal Mode &amp; Yes (Green LED) |
| (ii) Fault/Alarm Mode &amp; Yes (Red LED) |
| 3 | Front Panel Key-pad for Selection of Parameters &amp; Yes |
| 4 | Key Pad operated Controls: |
| (i) Inverter ON/OFF &amp; Yes |
| (ii) Transfer to By-pass &amp; Yes |
| (iii) Display Mode Selection &amp; Yes |
| (iv) Display Scroll &amp; Yes |
| (v) Output Voltage Adjustment &amp; Yes (Thru PC) |
| (vi) Data Setting/Enter Push Key &amp; Yes |
| 5 | Fault Alarm/Buzzer &amp; Yes |
| 6 | Front Panel Emergency OFF Control Switch &amp; Yes |
| 7 | Networking &amp; Monitoring Interface: |
| (i) Port for Communication with Stand-alone PC &amp; Yes (thru RS-232) |
| (ii) Port for Communicating via Local &amp;/or Global Network - LAN/WAN &amp; Yes (thru SNMP Adapter*) |
| (iii) | System Fault Monitoring Capacity - Min. 900 Events (Storage of Fault data on real date &amp; time basis) | Yes |
| (iv) | Windows compatible' Application software for On-line Monitoring &amp; Management of UPS | Yes (thru RS-232 &amp;/or SNMP Adapter*) |
| (VIII) | Applicable Standards |
| 1 | General UPS | IEC 801 - Part 2/ 3/ 4 IEC 146 - 4 |
| 2 | EMI/ EMC | EN 50091-2- Class A |
| 3 | Safety | EN 50091-1, IEC 950 |
| (IX) | Physical Parameters |
| 1 | Dimensions (HxWxD) (Smallest Foot Print preferable) | 910x2200x1150 |
| 2 | Weight | 600 Kg |
| 3 | Air Flow | 800 Cub m/hr |
| 4 | Cable Entry Point from Bottom (preferred) | Yes (from Bottom of UPS) |
| (X) | Environmental Conditions |
| 1 | Degree of Protection | IP – 21 |
| 2 | Operating Temperature | 0 To 40°C |
| 3 | Storage Temperature (Except Batteries) | -20°C To 70°C |
| 4 | Relative Humidity | 90% at 20°C 95% Non-condensing |
| 5 | Maximum Altitude above Sea-level | 1000 mtrs. |
| 6 | Audible Noise (at 1 meter distance) | &lt;70dBA |
| 7 | Cooling | Forced air |
| (XI) | Special Features |
| 1 | DSP based Control | Yes (FPGA) |
| 2 | Inverter Free-running at Fixed Frequency | Yes |
| 3 | Paralleling of UPS Systems (For Capacity Enhancement &amp;/or Redundancy - 100% or N+1) | Yes, Upto 8 Nos. |
| 4 | Option of Single Battery Bank for Multiple Paralleled UPS Systems | Yes |
| 5 | Remote Monitoring &amp; Control | Yes (RS-232/ SNMP*) |</p>
<table>
<thead>
<tr>
<th></th>
<th>Safe Shutting-down of the Network Computer Systems thru UPS Management Software</th>
<th>Yes (RS-232/ SNMP*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Fault-data Storage, Downloading and Analysis</td>
<td>Yes (RS-232/ SNMP*)</td>
</tr>
</tbody>
</table>

CONTRACTOR
PREAMBLE TO THE SCHEDULE OF QUANTITIES

1. The Tender shall be on item rate basis which shall include the cost of material, labour, taxes, duties and all other testing and commissioning in accordance with the relevant drawings, specifications and relevant IS Codes and including the fees for inspection together with the liabilities and obligations as detailed in the general conditions of the contract.

2. The prices shall remain firm and free from any variations due to rise and fall in the cost of materials and labour or any other price variation whatsoever whether during the stipulated period of execution or during the extended period of completion if any.

3. The rates shall remain valid for any variations in the estimated quantities
given in the BOQ.

4. In order to facilitate the technical scrutiny of various quotations, the tenderers must provide along with their quotations detailed technical particulars, catalogues and erection drawings for various items under different parts specified in the BOQ.

5. The power supply shall be 3-phase, 4 wire, 415/240V, 50 Hz AC. All consuming devices shall be suitable for the voltage and frequency mentioned above.

6. The contractor shall supply all consumables necessary for commissioning of the equipment.

7. The drawings and specifications lay down minimum standard of equipment workmanship, deviations if any shall be clearly stated.

8. All equipment and the installation shall be tested as specified and a test certificate in the prescribed form as required by the local supply authorities shall be furnished.

9. The entire and the installation shall be guaranteed against defective material or workmanship for a period of 12 months from the date the installation has been commissioned and taken over by the owners. During the guarantee period the contractor free of cost shall rectify all the defects.

10. The successful tenderer shall submit shop drawings for all the UPS and Battery Banks to the Consultant / Engineer-in-Charges for approval. The approval of these drawings will not absolve the contractor of the responsibility of the correctness of these drawings. Six copies of these approved drawings shall be supplied to the Consultant / Engineer-in-Charges for their distribution to the various agencies at site, at no cost to the Employer.

11. The successful tenderer shall arrange water and power connected required for the work at their own cost.
13. The tenderers must acquaint themselves with the rigours of the site conditions and take all the aforesaid and foregoing factors while quoting the rates, and no extras will be allowed on any grounds arising out of or relating to the aforesaid and foregoing.

14. The successful tenderer shall include in his rates painting of all equipment with three coats of synthetic enamel paint to match the surroundings.

15. Upon completion of the whole work the contractor shall furnish to the Consultant / Engineer-in-Charges three copies of the as built drawings along with the original tracings without a cost to the owners.

16. The tenderers must arrange all the necessary sanctions/approvals from the electrical Inspector at his own cost.

17. The materials of the first preference shall be used and the contractor may excuse himself for not doing so only, if the required range as per BOQ is not being manufactured by that manufacturer. A letter from the respective manufacturer shall support the proof in such cases. Samples of all fittings and other accessories should have Consultant / Engineer-in-Charge's approval.

18. Necessary formalities to obtain the energy meters from the Electricity Board etc. is the responsibility of the contractor.

19. The tenderer if any regarding this tender this tender should be clarified the clarification before submitting the offer. No claims for items will be entertained later on during the execution of the work arising out of interpretation of various tender/schedule items.

20. For any civil work connected with the owners can issue this tender cement on chargeable basis.

21. Obtaining of temporary construction power supply for this work is the responsibility of the contractor to his own cost.

22. No built up store shall be provided by the owners, only a space shall be provided for contractor to build his own store.

23. Dismantling of store and cleaning of the area will be the responsibility of the contractor.

24. The client will not take any responsibility for any theft, damage or loss etc. before the entire installation is tested, commissioned and handed over.

25. The client reserves the right to split up the work and award the job to different parties.

26. No price variation or escalation clause will be accepted or entertained at any time later on.
27. The work shall be done as per PWD/CPWD norms or as specified and as per the Engineer-in-charge.

28. The Vendor will indemnify the Owners against any sub-contractor or labour disputes.

29. All the incoming and outgoing cable to various panels to be from top/bottom side inlets and outlets as per requirement.

Signature of Contractor
SPECIFICATION

1.01 This specifications is intended to cover electrical work for ESIC HOSPITAL at BHILAI

1.02 It is not the intent to specify completely herein all aspects of design and constructional features of equipments and details of the work to be carried out, nevertheless, the equipment and work shall conform in all respects to high standards of Engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the owner who will interpret the meaning of the specifications and drawings and shall have right to reject or accept any work or material which in his assessment is not complete to meet the requirement of this specifications and or applicable code and standards mentioned elsewhere in this specifications.

2.00 SCOPE OF WORK

All material and labour whether specifically mentioned here and or in the BOQ or not shall be provided by the contractor to complete the tender work. The scope of work shall be the following in general but not limited to that:

1- Supply , installation, Testing and commissioning of 10 KVA UPS

2- Supply , installation, Testing and commissioning of All internal connection for each UPS to Battery Bank

3- Supply , installation, Testing and commissioning of All internal copper cable and Termination for UPS to Battery bank

2.02 FEES, PERMIT AND TESTS:

The contractor shall obtain all sanctions and permits required for the electrical installation work. All actual fee payable in this regard will be re-imbursed against receipt / documentary evidence. On completion of the work, the contractor shall obtain and deliver to the consultant, certificates of final inspection and approval of Electrical Inspector and by local Electric Supply Authority. The consultant / Owner shall have full powers regarding the materials or work got tested by Independent agency at the electrical contractor's expense in order to prove their soundness and adequacy.

2.04 The installation shall comply in all respects with the requirements of Indian Electricity Act, 1910 as amended up to date, Indian Electricity Rules, 1956, there-under and special requirements, if any of the State Electricity Boards etc.

a) For Local administration, the tenderer / contractor is liable to furnish the list of authorised licensed persons/employed/deputed to carry out the works / perform
the assigned duties to fully fulfill the requirements of Rule No. 3 of IER - 1956, as amended up to date.

A. DRAWINGS

i) A drawing showing general layout of distribution as such are enclosed with this pacifications or can be seen at Consultant / Consultant office. These drawings are meant to give a general idea to bidder regarding the nature of work covered by these specifications.

ii) No information / data shown / not shown in these drawings shall not relieve the contractor of his responsibility to carry out the work as per these specifications and or construction drawings released after the award of work. Prices shall not be subject to variation after award of work, due to differences between drawings and actual constructions drawings released from time to time.

`iii) The contractor shall prepare and submit to the consultant for his approval detailed shop drawings within 7 days of award of work. All work shall be carried out on the approvals of these drawings. However, approval of these drawings does not relieve the contractor of his responsibility to meet with the intent of the specifications.

iv) COMPLETION DRAWINGS

At the completion of the work and before issue of certificate of virtual completion, the contractor shall submit 6 sets of "As-Built" drawings of the work along with originals. These drawings must provide.

a) Location and details of distribution board, main switches, switch gear and other particulars.

b) A complete wiring diagram as installed and schematic drawings showing all connections in the complete electrical system.

c) Location of all earthing stations route and size of all earthing conductors.

d) Instructions, maintenance and operation manuals for equipments supplied.

e) Layout and particulars of all cables.

B. DRAWINGS

I) Drawing showing general layout of building and distribution as such are enclosed, All work to be carried out as shown in drawings.
II) No information / data shown / not shown in these drawings shall not relieve the contractor of his responsibility to carry out the work as per these specification and drawings.

III) Contractor shall prepare and submit to the Consultants for his approval detailed shop drawings, of all the system of wiring distribution boards, panel boards, earthing etc. within 15 days of award of work. All work shall be carried out on the approvals of these drawings. However, approval of these drawings does not relieve the contractor of his responsibility to meet with the intent of the specifications.

IV) COMPLETION DRAWINGS

At the completion of the work and before issue of certificate of virtual completion, the contractor shall submit to the consultant 6 sets of “As-Built” drawings of the work along with originals. These drawings must provide.

  a) Location of all earthing stations route and size of all earthing conductors.
  b) Instructions, maintenance and operation manuals for equipment are supplied.
  c) Layout and particulars of all cables.

2.04 MANUFACTURER’S INSTRUCTIONS:

Where manufacturers have furnished specific instructions, relating to the material/equipment’s to be used on this job, covering points not specifically mentioned in these documents, manufacturer’s instruction should be followed:

2.05 MATERIALS AND EQUIPMENTS

All the materials and equipment’s shall be of the approved make and design. Unless otherwise called for, only the best quality materials and equipment shall be used.

2.06 STORAGE-CUM-ERECTION INSURANCE

All the equipment’s and materials being supplied by the contractor shall be completely insured at his own cost from the time of dispatch from the manufacturer works up to the completion of erection, testing and commissioning at site and taking over by the client. It will be the responsibility of the Contractor to all claims with the Insurance Company in case of any damage, loss, theft, pill Faeroe or fire and the owner shall be kept informed about it. The losses, if any will have to be borne by the contractor, if the claims are not lodged and passed properly in time or if the same are not settled by the Insurance Company.

2.07 SITE CONDITIONS
All equipment’s shall be designed for an ambient temperature of 50 C and 100% Relative humidity. It is the responsibility of the contractor to survey the site and acquaint himself to prevailing site conditions before quoting.

2.08 PRICES

Prices shall remain firm and free from variation due to rise & fall in the cost of materials and labour during the stipulated period of execution and during extended period of completion, if any, except direct statutory increase by the act of Govt. or local bodies. Item rates shall remain valid for any variation in estimated quantities given in the schedule bill of quantities.

2.09 MEASUREMENTS

All measurements shall be taken in accordance with the Indian Standard Code for Electrical Installation in building method of measurements IS: 6988:1970 unless otherwise specified.

2.10 PAINTING OF ALL STEEL WORK

The steel used for fabrication of electrical/mechanical equipment should be stove enamelled created as per the detailed specifications given below:

a) Degreasing: All the steel components to be painted, should be effectively cleaned by alkaline degreasing.

b) Pickings: Oxide scale rust formations are to be removed in a hot bath of sulfuric acid. Pitting of the surface is to be prevented by the use of pickling in habits.

c) Cold Rinsing: The parts are then to be washed with cold water to remove all traces of acidic solution.

d) Phosphating: In order to attain durable paint coating the metal surface is to be given phosphating treatment by developing a phosphate layer on the surface. Preferably hot grinding solution is to be used in the phosphating plant.

e) Aestivating: This process is to be carried out by using deodilate solution.

f) Drying: The treated parts should then be dried in a hot chamber in dust free atmosphere to ensure that they are absolutely clear and dry before the paint is applied.

g) Primer Coating: The treated and dried parts are to be sprayed with high corrosion resistance primer.

h) Stove Drying: The primer coating is to be baked in an electrical heated, circulated area type storing oven.
I) Finishing Coat: The finishing paint coat is to be applied by spraying two coats of 15-micron thickness synthetic enamel of Grey shade.

2.11 CABLES:

The design, manufacture, testing and supply of the cable under this specification shall comply with latest edition of following standards.

IS : 8130 Conductors for insulated electrical cables and flexible cords.
IS : 5831 PVC insulation and sheath of electric cables.
IS : 3975 Mild steel wires, strips and tapes for armoring cables.
IS : 3961 Current rating of cables.
IS : 694 PVC insulated (heavy duty) electric cables for working voltage up to and including 1100 volts.

2.12 TECHNICAL REQUIREMENTS:

a) The cables shall be suitable for laying in racks, ducts, trenches conduits and under-ground buried installation with uncontrolled back fill and chances of flooding by water.

b) They shall be designed to with stand all mechanical, electrical and thermal stresses under steady state and transient operating condition.

c) The copper wires used for manufacturing the cables shall be true circular in shape before stranding and shall be of uniform ally good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade.

d) The cable should withstand the short circuit rating as prescribed by manufacturer with insulation screen/Armour insulated at one end. Bidder shall furnish calculation in support of capability to withstand the earth fault currents. The current carrying capacity of Armour and screen (as applicable) shall not be less than the earth fault current values and duration. Copper screen of each core shall be suitable for carrying full fault/earth current.

4.0 NAME PLATES & LABELS:

I) Panel and all modules shall be provided with prominent engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.
ii) All nameplates shall be non-rusting metal or 3 ply laminate, with white engraved lettering on black background. Inscription and lettering sizes shall be subject to Consultant approval.

iii) Suitable stenciled paint marks shall be provided inside the panel/module identification of all equipment’s in addition to the plastic sticker labels, if provided. These labels shall be partitioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring design.

5.0 WIRING:

Control and protective wiring shall be done with copper conductor HR PVC insulated 1100 volts grade multi-stranded 'flexible wire of 2.5 mm2 cross section. The colour coding shall be as latest edition of IS: 375. Each wire shall be identified by plastic ferrule. All wire termination shall be made with type connection. Wire shall not be taped or spilled between terminal points.

Terminal blocks shall preferably by grouped according to circuit function and each terminal block group shall have at least 20% spare capacity.

Not more than 2 (two) wires shall be connected to any terminal block.

6.0 PAINTING:

All steelwork shall be pretreated, intakes in accordance with clause painting. Finishing paint on panel shall be shade 692 (smoke grey) of IS: 5 over two coats of high quality red-oxide. The inside of the panel shall be glossy white.
7- **SPECIFICATION**

FOR SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF 10 KVA UPS SYSTEMS.

1. **SCOPE**

The scope of the work includes Supply, installation, testing, integration & commissioning of 10 KVA True On-line, double conversion, VFI technology, Fully Microprocessor controlled UPS systems.

The specification shall include design, manufacture, fabrication, assembly; proper packing for transportation delivery at site, unloading, storage, erection, integration with related equipments, and putting 10 KVA UPS with all accessories and auxiliaries as specified hereinafter in a fully operational condition acceptable to the owner. The offered system shall be fully in compliance with the requirements stated herein.

The Contractor shall be responsible for engineering and providing all materials, equipments and services specified or otherwise, which are required to fulfill the intent of ensuring operability, maintainability, completeness and reliability of the total work covered under this specification within his quoted price.

The design manufacture, inspection, testing and installation of the UPS System covered under this specification shall conform to the latest international standards such as :

EN 62040-1 - General Safety Regulations.
EN 62040-2 - EMC Regulations.

2. **APPLICATION** :-

This UPS system is intended to provide electrical power supply on continuous and consistent basis for different loads in the environmental conditions given below: -

a) Maximum temperature: 40 deg. C  
b) Minimum Temperature: 0 deg. C  
c) Altitude: 1000 meters above MSL  
d) Relative humidity: upto 95% (Non – Condensing)

3. **SCOPE OF SUPPLY**:  
10 KVA ONLINE UPS with Batteries.  
a) Each UPS module must have the following built in parts / features:-
**UPS SYSTEM FOR ESIC HOSPITAL BHILAI**

* Rectifier cum charger (float cum boost)
* PWM technology based Inverter.
* Automatic Bi-directional Static switch
* Manual Bypass Switch.
* Inbuilt (Must) Galvanic inverter output isolation transformer.
* Fully Microprocessors Controlled circuitry.

- Provision for separate Input for rectifier and for Bypass
- Event Monitoring & Diagnostics: Last 500 events with exact date & time should be monitored from the front LCD panel of the UPS & last 2000 events on a PC if connected through a SNMP card on LAN. In case front panel does not has this facility a latest configuration based LAPTOP shall be mandatorily included & supplied by the vendor in their scope of supply.

- The input voltage window must be from 160-270 Volts without battery intervention. In case this is not a standard feature of the UPS system, a Servo stabilizer of suitable capacity should be included & supplied with each UPS unit matching this input requirement.

b. Rack Mounted External Battery Bank Sealed Maintenance Free (12 V SMF, VRLA) Lead Acid Battery Bank suitable for 20 minutes backup with each 10 KVA module & on full load. Battery Sizing calculation needs to be submitted as per the attached sheet.

4. **EQUIPMENT ARRANGEMENT AND OPERATION :**

4.1 **SYSTEM CONFIGURATION:** -

The offered 10 KVA UPS units will be fully microprocessor controlled.

4.2 **SYSTEM OPERATION:** -

a. Under normal operating conditions, the rectifier shall supply the 100% battery charge requirements and shall also supply the 100% inverter requirement, which shall provide the rated AC output continuously.

b. The UPS system will supply the regulated rated power through inverter at all the times in mains operation.

c. When the AC mains supply to the battery charger fail, the battery shall supply inverter demand with no break occurring in the AC output.

d. The UPS systems output voltage shall be maintained within specified tolerance (± 1%) for all forms of incoming AC mains supply conditions.

e. The UPS system should provide continuous rated output power through commercial mains, even at phase sequence reversal at the input side. If standard UPS system does not meet this criterion, then additional hardware should be included in the UPS system to meet the requirement.

**Configuration Details:**

The 10 KVA UPS systems will be working at Battery backup has to be 20 Mins.

5.0 General
5.1 Summary
The scope of the work includes Supply, installation, testing, integration & commissioning of 10 KVA true on-line double conversion UPS system using with PWM IGBT technology. Fully Microprocessor controlled, i.e., the Rectifier of the UPS system converts the input AC power to DC and then the inverter converts the DC into clean AC power.

The specification shall include design, manufacture, fabrication, assembly; proper packing for transportation delivery at site, unloading, storage, erection, integration with related equipments, and putting all the UPS Systems together with all accessories and auxiliaries as specified hereinafter in a fully operational condition acceptable to the owner. The offered system shall be fully in compliance with the requirements stated herein.

The Contractor shall be responsible for engineering and providing all materials, equipments and services specified or otherwise, which are required to fulfill the intent of ensuring operability, maintainability, completeness and reliability of the total work covered under this specification within his quoted price.

The design manufacture, inspection, testing and installation of the UPS System covered under this specification shall conform to the latest international standards. The Block diagram of the UPS system should be as shown in Block Schematic Fig. 1.

![Block Diagram of UPS System](image)

Fig-1

The major items constituting of the blocks of the above schematic Fig.-1 are shown as below in Fig-1 (A).
The main circuit and the bypass can use the same or different sources as per the discretion of customer. The details of the above schematic are as given below:

Q1: Connects rectifier to Utility source
Q2: Connects bypass to Utility source
Q5: Connects UPS output to the Load
Q3BP: Connects bypass input source to the load switch (Maintenance Bypass)
KM: Battery Circuit Breaker
TR2: Galvanic Output Isolation Transformer (Delta- Zigzag)
REC: Rectifier Module
INV: Inverter Module

**System Configuration and operation in normal conditions:**

The utility source should be input at Q1 and should pass through the fuse, and inductor and into the high frequency rectifier, which will convert the AC power into DC power. The rectifier and charger function and should make use of soft start and microprocessor based control to improve the system immunity against surge, improve the stability of the DC bus voltage, reduce the charging current ripple and prolongs the battery life.

The output should be isolated from the load by Isolation transformer, static switch, fuse and isolators.
The bypass source should be input at Q2 and output through the bypass static switch as mentioned in above Fig-1 (A).

The main elements of the configurations are:
- Fully Microprocessor Controlled Rectifier
- Fully Microprocessor Controlled PWM IGBT Based Inverter
**Delta / Zig Zag Isolation Transformer at the O/P of the Inverter to provide Galvanic isolation and separating the I/P and O/P Neutral.**

- Full Capacity Static Switch at the O/P of the Inverter
- Full Capacity Static Switch in the Bypass path
- Full Capacity Manual Bypass Switch

*Please note that all the above mentioned elements should form a part of the UPS system and are to be in the same sequence as mentioned in the Fig.-1 (A) along with all the Isolators etc. within a Single Cabinet.*

**6 Modes of Operation**

The UPS shall be able to operate as an on-line reverse transfer system in the following modes:

6.1. Normal mode

When the utility is normal, the UPS powers the load through the rectifier and inverter and charges the batteries at the same time, as shown in *Bold Lines* in Fig-2 (A).

![Fig-2 (A)](image)

6.2. Emergency/ Battery Mode - When the utility fails, the UPS system shall switch to battery mode without interruption and the battery will power the load through the inverter.

The UPS shall return to normal mode automatically when the utility returns to normal, shown in *Bold Lines* in Fig-2(B).

![Fig.-2(B)](image)
6.4. **Recharge** - Upon restoration of AC input power, during the ‘Emergency’ mode of operation, the rectifier/charger shall automatically restart, walk-in, and gradually assume the inverter and battery recharge loads.

.1. **Bypass** - In the event of an inverter overload, which last longer than the typical time, an output short circuit or a fault on the inverter, the UPS will transfer the load to bypass. There should be two kinds of bypass modes. In the first kind, the UPS can be set to return to normal mode automatically when the fault is cleared. In the second kind, the UPS is set to return to normal mode only with a manual transfer. However in this event, SBP will keep as disabled.

When the main UPS circuit fails, the battery is depleted or a severe fault occurs, the inverter shall be shut down and the system will remain in the bypass mode. The system can return to normal mode only with a manual reset after the fault is cleared, shown in *Bold Lines* in Fig-2(C).

![Bypass Diagram](image)

**Fig.-2(C)**

6.6. **. Maintenance Mode**

When the UPS has to undergo routine maintenance, the UPS shall be set to maintenance mode by switching on the maintenance bypass circuit breaker. The load will be powered from the maintenance bypass supply without interruption. During maintenance, the circuit breakers Q1, Q2, QF1 and Q5 should be switched off to ensure the safety of maintenance personnel. As shown in *Bold lines in Fig-2(D)*.
6.6. **Basic Functions**

Battery Management Function - The UPS has advanced battery management functions including battery fault detection and backup time forecast. (Backup time left)

- **Soft Start Function** - Complete delay soft start function can reduce the surge to the UPS unit and utility source.

- **Alarm and Protection Function** - The UPS can generate audible and visual alarm through LCD, input/output contacts and network transmission. It can help maintenance personnel to locate and clear the faults that are sent out in time, accurately and in detail.

- **Automatic Re-start when Utility returns** – On failure of the input mains supply the UPS goes to battery mode. After the batteries are completely discharged the UPS system shuts down. It should automatically restart on the resumption of the input supply.

7. **General**

7.1 **Summary**

This specification defines the electrical and mechanical characteristics and requirements for a continuous-duty Single phase, solid-state, uninterruptible power supply (UPS) system. The UPS shall provide high-quality AC power for sensitive electronic equipment loads.

7.2 **SYSTEM DESCRIPTION**

7.2.1 **Design Requirements - UPS Module**

**A. Voltage.**

Input / Out voltage specifications of the UPS shall be:

- **Rectifier Input**: 230 Volts, Single-phase, 3-wire

- **Bypass Input**: 230 Volts, Single-phase, 2-wire-plus-ground.

- **Output**: 230 Volts, Single phase, 2-wire-plus-ground.
B. Surge Suppression
In compliance to IEEE std. C 62.41-1991, the UPS Systems should have Surge Suppressor at the input side.

C. Output Load Capacity
Specified output load capacity of each UPS Module shall be 10 KVA at 0.8 lagging power factor such that the active power delivering capacity must not be below 8 KW Rating.

D. Battery Backup and Capacity
Each UPS Module shall be connected with its individual 100% rated Battery Bank consisting of Maintenance Free Valve Regulated Lead Acid (VRLA) 12 Volt Cells having 3 year designed float life. The Battery Bank connected with UPS should be rated 26AH/12V X 15 Nos or as per Sizing calculations of the Batteries should be done and furnished as per attached Annexure – 2, considering Inverter Efficiency not more than 92% and End Cell voltage of 1.67 VPC considering that each UPS, while powered by Batteries, will have to deliver to 8 KW Load for 20 minutes.

7.2.2 Modes of Operation
The UPS shall be designed to operate as an on-line, double conversion type UPS strictly as per the definition of IEC 62040-3 as follows:

A. Normal Operation - The critical AC load should be continuously supplied by the UPS inverter. The rectifier & charger should take power from the AC input source, convert it into suitable DC and supply to the Inverter as well as charge the Batteries on Automatic Float Mode cum Boost Mode.

B. Upon Mains Failure - Upon failure of AC input power, the critical AC load should continue to be supplied by the Inverter which should obtain power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the AC input source.

C. Upon Mains Restoration - Upon restoration of AC input power, The Rectifier/Charger should automatically restart walk-in and gradually take-over the supply to Inverter and charging to the Battery.

D. Static Bypass – Each UPS Module should have in-built 100% rated static Bypass Line.

All the loads should be transferred to the Static Bypass Line of the UPS without any break if the input frequency is within 50 Hz +/- 2 Hz and with a break below 20 millisec. if the input frequency is beyond 50Hz +/-2 Hz for the following conditions:

i) If any one UPS fails simultaneously
ii) if overload beyond 150% for 30 Seconds is faced by the UPS
iii) If the UPS Inverters are put-off

E Maintenance Bypass – Each UPS Module should have in-built 100% rated Maintenance Bypass Line of its own in addition to the 100% rated Static Bypass Lines

F Equal Current Sharing by the Static Bypass of all the three UPS - Each UPS Module should compulsorily have in-built 100% rated Bypass Line Inductance as shown in
attached Fig. 1, ensuring that Bypass Lines of the UPS's share the total load current equally.

7.2.3 PERFORMANCE REQUIREMENTS

1. AC Input to UPS
   A. Voltage Configuration: Single-phase, 2-wire plus ground
   B. Voltage: 200 / 220 / 230 V (User Selectable)
   C. Voltage Range: 160 to 270V.
   D. Frequency: 50Hz
   E. Frequency Tolerance: 45-65 Hz

2. AC Output, UPS Inverter
   A. Voltage Configuration: Single-phase, 2-wire plus ground
   B. Voltage: 200/ 220 / 240 V (User selectable in steps of 1V from 200-240V)
   C. Voltage Regulation: +/- 1% steady state.
   D. Frequency: Auto Sensing 50 Hz or 60Hz,
   E. Frequency Slew Rate: 1Hz/sec
   G. Voltage Distortion: < 2% for 100% linear loads
      < 5% for 100% non-linear loads with 3:1 crest factor.
   H. Output Power Rating: 10 KVA at 0.8 lagging power factor.
   I. Overload Capability (on Inverter):
      • 110% for 1 minutes
      • 125% for 30 seconds
      • 150% for 10 Seconds
   J. Voltage Transient Response (for 0 – 100% load change): < +/- 5%
   K. Transient Recovery Time (for 0-100% load change): Recovery to nominal within 20milli- secs
   L. Voltage imbalance:
      • for Balanced load : <1%
      • for 100% unbalanced load : < 2%

7.3 ENVIRONMENTAL CONDITION

7.3.1 The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

   A. Operating Ambient temperature

   UPS Module: 0°C to 40°C
Battery: 22 to 24 °C

B. Storage/Transport Ambient Temperature
-25°C to 70°C

C. Relative Humidity: Upto 95% (Non Condensing) at 20°C

D. Altitude Operating: to 1000 meters above Mean Sea Level.

7.4 UPS Delivery Submittals
Submital upon UPS delivery shall include one instruction manual. Manual shall include a functional description of the equipment with block diagrams, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

7.5 Warranty
The manufacturer shall warrant all the supplied items against defects in materials and workmanship for 12 months after initial start-up or 18 months after ship date, whichever is earlier.

7.6 Quality Assurance

7.6.1 Manufacturer Qualifications
The vendor quoting for the job should have a minimum of five year’s first-hand experience in the design, manufacturing, and testing of solid-state UPS systems. Besides credentials of having supplied done more than 5 similar or bigger jobs, the firm should have ISO 9001 certifications as UPS System manufacturer.

7.6.2 Factory Testing
Before shipment, the manufacturer shall fully and completely test the system in India to ensure compliance with the major specifications.

8.0 PRODUCT

8.1 Fabrication

8.1.1 Materials
All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.

8.1.2 Construction and Mounting
The UPS unit, comprised of input isolator, rectifier/charger, inverter, static transfer switch, maintenance bypass switch, and static bypass input switch shall be housed in a free-standing steel enclosure with key-lockable doors. Front access only shall be required for expedient servicing, adjustments, and installation. The enclosure will be built to comply with IP20 when the doors are open. The UPS cabinet shall be cleaned, primed, and painted with the manufacturer’s standard color. The UPS shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be plug-in. Like assemblies and like components shall be interchangeable.

8.1.3 Cooling
Cooling of the UPS shall be forced-air. Low velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output. Temperature will be monitored by thermal sensors.

8.2 Components

8.2.1 Rectifier/Charger

A. General
The Rectifier cum Charger Unit should be of Three Phase, Fully controlled Rectifier Float cum Boost Type with settable Boost Timer and Current Limited. The Rectifiers should have Input and DC Current Limiting Circuitry. The Rectifier/Charger capacity should be at least 50% higher than the Inverter Capacity. It should be capable of giving charging current up to maximum of 20% of the Battery AH Capacity, while simultaneously supplying full load current to inverter.

B. Input Current Walk-In
The rectifier/charger shall contain a timed walk-in circuit that causes the unit to gradually assume the load over a 20 second time interval after input voltage is applied.

C. DC Filter
The rectifier/charger shall have an output filter to minimize ripple voltage into the battery. The Ripple voltage should be less than 2%.

D. Battery Recharge
In addition to supplying power for the inverter load, the rectifier/charger shall be capable of providing battery charging current to recharge the battery properly. After the battery is recharged the rectifier/charger shall maintain the battery at full charge until the next emergency operation. The charging shall be an automatic cycle i.e boost to floating charge switching, with current measuring criteria and control during recharge. Both float and recharge voltages shall be adjustable. The charge voltage can also be manually controlled. Dynamic Temperature compensated Charging Facility should be there. The Rectifiers/Chargers should automatically increase the DC End-of-Discharge voltage level sensing lesser loads, in order to protect the batteries from over discharge beyond their AH Capacities.

8.2.2 Inverter

A. General
The Inverter should be Fully Microprocessor controlled Sine wave IGBT / PWM based employing High Switching Frequency, consisting of IGBT's.

B. Overload Capability
The inverter shall be capable of supplying current and voltage for overload of 110% for 10 seconds A status indicator and audible alarm shall indicate overload operation. The UPS shall switch off its inverter output static switch when its overload capacity is exceeded.

C. Fault Clearing and Current Limit
Without bypass supply available to the inverter shall be capable of supplying an overload current of 200% of its full-load rating in excess of five Seconds. For greater currents or longer time duration, the inverter shall have electronic greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The inverter shall be self-protecting against any magnitude of connected output
overload (Vce Trip). Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses.

D. Output Frequency
The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall hold the inverter output frequency to +/- 0.01% for steady state and transient conditions.

E. Isolation Transformer: To isolate the input disturbances from the output side a double wound delta-zigzag transformer to galvanically isolate the input from output is mandatory to be included in the design at the output of the inverter, as shown the Figure 3 below. The isolation transformer will be connected as shown in the Fig 1(a). The combination of the inverter and Output isolation txr shall form a separately derived source wherein the Input neutral and the three Phases are completely isolated from the output neutral and the three phases.

8.2.3 Display and Controls
A. Monitoring and Control
The UPS shall be provided with a microprocessor based unit status display and controls section designed for convenient and reliable user operation. A system controls section designed for convenient and reliable user operation. A system power flow diagram, a percentage load and battery time remaining display shall be provided as part of the
monitoring and controls sections which depicts a single line diagram of the UPS. Illuminated visual indicators shall be of the long-life light emitting diode (LED) type. All of the operator controls and monitors shall be located on the front of the UPS cabinet. The monitoring functions such as metering, and alarms shall be displayed on an alphanumeric LCD display. Additional features of the monitoring system shall include:

### B. Metering

The following parameters shall be displayed:
- DC Voltage
- Battery charge & discharge current
- Input voltage and frequency
- Output AC voltage line-to-line and line to neutral and % load used of nominal
- Output AC current for each phase and neutral
- Output frequency

### C. Power Status Diagram

A mimic panel shall be provided to depict a single line diagram of the UPS. Indicating lights shall be integrated within the single line diagram to illustrate the status of the UPS. The three LEDs shall indicate the following status.
- Bypass voltage OK
- Load on bypass
- Load on inverter

Power status diagram shall be an LED bar graph indicating % load with amber overload indication. Also an LED bar graph indicating % battery time remaining shall be included.

### D. COMMUNICATION FEATURES

Each UPS should have RS-232 interface port for serial port communicability, MODBUS for BMS Connectivity and SNMP / Web Card for comprehensive web-based monitoring of UPS by multiple workstations through TCP/IP based LAN System

### 8.2.4 Static Transfer Switch

#### A. General

A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be naturally commutated high-speed static (SCR type) device rated to conduct up to 100% of full load current, continuously. Such Switch should be connected at both the Static Bypass as well as the Inverter Output to enable the critical load to be connected to the inverter output or bypass power source. the static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.
B. Uninterrupted Transfer
The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:

- Inverter overload capacity exceeded
- Critical AC load overvoltage or under-voltage
- UPS fault condition.

The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:

- Inverter/bypass voltage difference exceeding pre-set limits
- Bypass frequency out of limits
- Bypass out-of-synchronisation range with inverter output.

C. Uninterrupted Retransfer
Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following condition exists:

- Bypass out of synchronisation range with inverter output
- Inverter/bypass voltage difference exceeding pre-set limits
- Overload condition exists in excess of inverter full load rating
- UPS fault condition present.

8.2.5 Maintenance Bypass Isolator
A. General
A manually operated maintenance bypass isolator shall be incorporated into the UPS cabinet to directly connect the critical load to the input AC power source, bypassing the rectifier/charger, inverter, and static transfer switch. Transfer from Inverter to the Manual Bypass should be possible without any interruption to the Loads.

B. Maintenance Capability
With the critical load powered from the maintenance bypass circuit, it shall be possible to freely check out the operation of the rectifier/charger, invert, battery, and static transfer switch.

8.2.6 Bypass Line Inductances
A. General
An Inductance shall be incorporated into each UPS cabinet in the Bypass path connecting the critical load to the input AC power source, so as to equalize the currents shared by the Bypass paths of each UPS.

B. Load sharing by Bypass of each UPS
The inductances of all the UPS’s should be identical having matching impedance. They should be 100% rated.

8.2.7 Isolation Transformer at Output of Inverter
Each UPS should have in-built K-rated Delta-Zigzag, double wound galvanic Isolation Transformer at the output of its Inverter ensuring that at no point of time there is any electrical connection of the phase wires between the Input Supply going into the UPS and the Output Supply coming out of the UPS.
8.2.8 Battery path Protection
Battery Path MCCB should be provided with each UPS for connection between the UPS and its Battery Bank. The MCCB should be physically placed near the Battery Bank and should have thermal, magnetic as well as automatic remote tripping mechanism. In the event of any fire or emergency, it should be possible to immediately make the outputs of Rectifiers, Inverters and the battery banks devoid of electrical Potential by pressing the Emergency Stop button from UPS Front Panel.

8.2.09 Interconnecting Cables
Vendor shall provide all the interconnecting cables between Incoming MCCB Panel, the UPS Systems, the Battery banks and the Outgoing MCCB Panel.

8.3 PRODUCT STANDARDS
The UPS should be designed & manufactured in accordance to and as per the following international Standards:
ISO 9001Certification

9.0 FIELD ENGINEERING SUPPORT
The UPS manufacturer shall directly employ a national field service network staffed by factory trained field service engineers to provide start-up, maintenance and repair of the UPS equipment.

10.0 – Pre dispatch inspection of the UPS System :

The vendor must arrange a Pre Dispatch Inspection at their factory site in compliance with all the technical specification of this tender. The Pre Dispatch inspection shall be monitored by authorized technical officials of consultant and client. A joint report must be submitted along with the material. Any charges if any should be included / mentioned separately in the cost sheet.

ANNESURE - 2

Battery Sizing Calculations for 10 KVA UPS

<table>
<thead>
<tr>
<th>UPS Rating</th>
<th>KVA</th>
<th>10KVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Power Factor</td>
<td>P.F</td>
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</tr>
<tr>
<td>Inverter Efficiency</td>
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<td>0.92</td>
</tr>
<tr>
<td>DC Bus Voltage</td>
<td>BV</td>
<td>180</td>
</tr>
<tr>
<td>No. of Cells</td>
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<td>90</td>
</tr>
<tr>
<td>K factor for 30 minutes backup.</td>
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<td>1.26</td>
</tr>
<tr>
<td>Nominal Cell Voltage</td>
<td>:</td>
<td>NCV</td>
</tr>
<tr>
<td>----------------------</td>
<td>---</td>
<td>-----</td>
</tr>
<tr>
<td>End Cell Voltage</td>
<td>:</td>
<td>ECV</td>
</tr>
<tr>
<td>Backup Time Requirement in minutes.</td>
<td>:</td>
<td>M</td>
</tr>
</tbody>
</table>

$$\text{Battery Rating, } Ah = \frac{(\text{KVA} \times 1000 \times \text{P.F}) \times K}{(\eta \times \text{ECV} \times N)}$$

$$Ah = \frac{(10 \times 1000 \times 0.8 \times 1.26)}{(0.94 \times 1.75 \times 90)}$$

$$Ah = 68 \text{ Ah}$$

The nearest Battery rating available is 65 Ah.

Thus, the offered configuration with each 10 KVA UPS: 26 Ah

Thus, the offered VAH of for each UPS module = 4680 VAH

10*1000*0.8=8000W
12*15*0.92= 165.6
8000/165.6 = 48.3 Ah req.for60 minutes back up
Nearest Ah available is 65 Ah

= 26 Ah* 15 No. of 12V required for approximate 20 Minutes backup

VAH= 26*15*12= 4680 VAH

Or 4680/8000=0.59* 60= 35 minutes back up

Transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:

- Inverter overload capacity exceeded
- Critical AC load overvoltage or under-voltage
- UPS fault condition.

The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:

- Inverter/bypass voltage difference exceeding pre-set limits
- Bypass frequency out of limits
- Bypass out-of-synchronization range with inverter output.

C. Uninterrupted Retransfer

Retransfer of the critical AC load from the bypass source to the invert output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following condition exists:

- Bypass out of synchronisation range with inverter output
- Inverter/bypass voltage difference exceeding pre-set limits
- Overload condition exists in excess of inverter full load rating
- UPS fault condition present.

8.2.5 Maintenance Bypass Isolator

A. General
A manually operated maintenance bypass isolator shall be incorporated into the UPS cabinet to directly connect the critical load to the input AC power source, bypassing the rectifier/charger, inverter, and static transfer switch. Transfer from Inverter to the Manual Bypass should be possible without any interruption to the Loads.

B. Maintenance Capability
With the critical load powered from the maintenance bypass circuit, it shall be possible to freely check out the operation of the rectifier/charger, inverter, battery, and static transfer switch.

8.2.6 Bypass Line Inductances

A. General
An inductance shall be incorporated into each UPS cabinet in the Bypass path connecting the critical load to the input AC power source, so as to equalize the currents shared by the Bypass paths of each UPS.

B. Load sharing by Bypass of each UPS
The inductances of all the UPS’s should be identical having matching impedance. They should be 100% rated.

8.2.7 Isolation Transformer at Output of Inverter
Each UPS should have in-built K-rated Delta-Zigzag, double wound galvanic Isolation Transformer at the output of its Inverter ensuring that at no point of time there is any electrical connection of the phase wires between the Input Supply going into the UPS and the Output Supply coming out of the UPS.

8.2.8 Battery path Protection
Battery Path MCCB should be provided with each UPS for connection between the UPS and its Battery Bank. The MCCB should be physically placed near the Battery Bank and should have thermal, magnetic as well as automatic remote tripping mechanism. In the event of any fire or emergency, it should be possible to immediately make the outputs of Rectifiers, Inverters and the battery banks devoid of electrical Potential by pressing the Emergency Stop button from UPS Front Panel.

8.2.9 Interconnecting Cables
Vendor shall provide all the interconnecting cables between Incoming MCCB Panel, the UPS Systems, the Battery banks and the Outgoing MCCB Panel.

8.3 PRODUCT STANDARDS
The UPS should be designed & manufactured in accordance to and as per the following international Standards:
ISO 9001 Certification

9.0 FIELD ENGINEERING SUPPORT
The UPS manufacturer shall directly employ a national field service network staffed by factory trained field service engineers to provide start-up, maintenance and repair of the UPS equipment.

10.0 – **Pre dispatch inspection of the UPS System:**

The vendor must arrange a Pre Dispatch Inspection at their factory site in compliance with all the technical specification of this tender. The Pre Dispatch inspection shall be monitored by authorized technical officials of consultant and client. A joint report must be submitted along with the material. Any charges if any should be included / mentioned separately in the cost sheet.

**ANNESURE - 2**

**Battery Sizing Calculations for 10 KVA UPS**

<table>
<thead>
<tr>
<th>UPS Rating</th>
<th>KVA</th>
<th>10 KVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Power Factor</td>
<td>P.F</td>
<td>0.8</td>
</tr>
<tr>
<td>Inverter Efficiency</td>
<td>H</td>
<td>0.92</td>
</tr>
<tr>
<td>DC Bus Voltage</td>
<td>BV</td>
<td>180</td>
</tr>
<tr>
<td>No. of Cells</td>
<td>N</td>
<td>90</td>
</tr>
<tr>
<td>K factor for 30 minutes backup.</td>
<td>K</td>
<td>1.26</td>
</tr>
<tr>
<td>Nominal Cell Voltage</td>
<td>NCV</td>
<td>12 V</td>
</tr>
<tr>
<td>End Cell Voltage</td>
<td>ECV</td>
<td>1.75V</td>
</tr>
<tr>
<td>Backup Time Requirement in minutes.</td>
<td>M</td>
<td>20 minutes with each UPS module.</td>
</tr>
</tbody>
</table>

Battery Rating, \( Ah = \frac{(KVA \times 1000 \times P.F) \times K}{(\eta \times ECV \times N)} \)

\[ Ah = \frac{(10 \times 1000 \times 0.8 \times 1.26)}{(0.94 \times 1.75 \times 90)} \]

\[ Ah = 68 \]

The nearest Battery rating available is **65 Ah**.

Thus, the offered configuration with each 10 KVA UPS: **26 Ah 15 Nos for 20 Mins back up**

Thus, the offered VAH of for each UPS module = 4680 VAH
UPS SYSTEM FOR ESIC HOSPITAL BHILAI

10*1000*0.8=8000W
12*15*0.92=165.6
8000/165.6 =48.30Ah req.for 20 minutes back up
Nearest Ah available is 42 Ah
=26Ah* 15No. of 12V required for approximate 20 Minutes backup
VAH= 26*15*12= 4680 VAH

Or 4680/8000=0.6* 60= 36 minutes back up

9.01 TECHNICAL PARAMETER FOR 10 KVA UPS

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>RATING 10 KVA (1Ø/1Ø)</th>
<th>REMARK BY VENDERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(I)</td>
<td>Input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Voltage</td>
<td>200 / 220 / 230 V (1ø, 3 Wire)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Voltage Variation</td>
<td>160 to 270 V</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Frequency</td>
<td>50 Hz</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Frequency Variation</td>
<td>40 to 60Hz</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Power Walk-in</td>
<td>20 Sec.</td>
<td></td>
</tr>
<tr>
<td>(II)</td>
<td>Output</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Voltage</td>
<td>200 / 220 / 230 VAC</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Frequency</td>
<td>50 Hz</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Power Factor</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Voltage Adjustment</td>
<td>± 15% of Nominal setting, Adjustable thru PC</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Voltage Variation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Static Balanced Load</td>
<td>±1%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Static 100% Unbalanced Load</td>
<td>± 5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dynamic 100% Step Load</td>
<td>±4%</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Voltage Distortion (Linear Load)</td>
<td>&lt; 3%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Frequency Variation (in Free-running mode)</td>
<td>±0.005%</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Synchronization Window</td>
<td>±1%, ±2%, ±5%, ±10%. Configuration through PC</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Slew Rate</td>
<td>1 Hz/ sec</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Overall Efficiency at 100% Load</td>
<td>&gt;90%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inverter Efficiency at 100% Load</td>
<td>&gt;92%</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Overload</td>
<td>110% for 10 min 125% for 1 min</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Crest Factor</td>
<td>3:1</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Number of Systems that can be paralleled</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

(III) DC Link

1. Battery Voltage 180 VDC
2. Low Battery Cut-off 1.67V/ Cell

(IV) Static By-pass

1. Overload 10 times for 100ms
2. Switching Time:
   - Inverter to By-pass:
     - Inverter Overload (a) 0 ms
     - Inverter Failure (b) <1 ms
     - Manual Command (c) 0 ms
   - By-pass to Inverter (Auto and Manual modes) 0 ms

(V) Battery Charger

1. Charging Mode CVCC with Float and Boost modes

(VI) Protections

1. Input Voltage Yes
2. Output Voltage Yes
3. Negative Sequence (Phase Reversal) Yes
4. Over Temperature Yes
5. Battery Over-charging Yes
6. Input In-rush Current Yes (Soft Start)
7. Output Over-load Yes (Electronic)
8. Reverse Power in paralleled UPS Systems Yes

(VII) Man Machine Interface

1. Front Panel LCD Display Yes
   - Displayed Parameters:
     - (a) Input Voltage Yes
## UPS SYSTEM FOR ESIC HOSPITAL BHILAI

<table>
<thead>
<tr>
<th>(b) Input Current</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>(c) Output Voltage</td>
<td>Yes</td>
</tr>
<tr>
<td>(d) Output Current</td>
<td>Yes</td>
</tr>
<tr>
<td>(e) Battery Voltage</td>
<td>Yes</td>
</tr>
<tr>
<td>(f) Battery Current</td>
<td>Yes</td>
</tr>
<tr>
<td>(g) Output Frequency</td>
<td>Yes</td>
</tr>
<tr>
<td>(h) Input Frequency</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### (ii) Displayed UPS Status:

| (a) Converter/Rectifier - ON/OFF | Yes |
| (b) Inverter - ON/OFF | Yes |
| (c) Static Switch - On Mains/Inverter | Yes |
| (d) Load - Within Limit/ Over-load | Yes |
| (e) Battery - On Float/ Boost/ Discharging | Yes |

### 2 Front Panel LED Indications:

| (i) Normal Mode | Yes (Green LED) |
| (ii) Fault/Alarm Mode | Yes (Red LED) |

### 3 Front Panel Key-pad for Selection of Parameters

### 4 Key Pad operated Controls:

| (i) Inverter ON/OFF | Yes |
| (ii) Transfer to By-pass | Yes |
| (iii) Display Mode Selection | Yes |
| (iv) Display Scroll | Yes |
| (v) Output Voltage Adjustment | Yes (Thru PC) |
| (vi) Data Setting/Enter Push Key | Yes |

### 5 Fault Alarm/Buzzer

### 6 Front Panel Emergency OFF Control Switch

| Yes |
## UPS System for ESIC Hospital Bhilai

<table>
<thead>
<tr>
<th>(ii)</th>
<th>Port for Communicating via Local &amp;/or Global Network - LAN/ WAN</th>
<th>Yes (thru SNMP Adapter*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(iii)</td>
<td>System Fault Monitoring Capacity - Min. 900 Events (Storage of Fault data on real date &amp; time basis)</td>
<td>Yes</td>
</tr>
<tr>
<td>(iv)</td>
<td>Windows compatible' Application software for On-line Monitoring &amp; Management of UPS</td>
<td>Yes (thru RS-232 &amp;/or SNMP Adapter*)</td>
</tr>
<tr>
<td>(VIII)</td>
<td>Applicable Standards</td>
<td></td>
</tr>
</tbody>
</table>
| 1 | General UPS | IEC 801 - Part 2/3/4  
IEC 146 - 4 |
| 2 | EMI/ EMC | EN 50091-2- Class A |
| 3 | Safety | EN 50091-1, IEC 950 |
| (IX) | Physical Parameters | |
| 1 | Dimensions (HxWxD) (Smallest Foot Print preferable) | 910x2200x1150 |
| 2 | Weight | 600 Kg |
| 3 | Air Flow | 800 Cub m/hr |
| 4 | Cable Entry Point from Bottom (preferred) | Yes (from Bottom of UPS) |
| (X) | Environmental Conditions | |
| 1 | Degree of Protection | IP – 21 |
| 2 | Operating Temperature | 0 To 40°C |
| 3 | Storage Temperature (Except Batteries) | -20°C To 70°C |
| 4 | Relative Humidity | 90% at 20°C  
95% Non-condensing |
| 5 | Maximum Altitude above Sea-level | 1000 mtrs. |
| 6 | Audible Noise (at 1 meter distance) | <70dBA |
| 7 | Cooling | Forced air |
| (XI) | Special Features | |
| 1 | DSP based Control | Yes (FPGA) |
| 2 | Inverter Free-running at Fixed Frequency | Yes |
Paralleling of UPS Systems (For Capacity Enhancement &/or Redundancy - 100% or N+1) | Yes, Upto 5 Nos.  
---|---  
Option of Single Battery Bank for Multiple Paralleled UPS Systems | Yes  
Remote Monitoring & Control | Yes (RS-232/ SNMP*) Optional  

**PREAMBLE TO THE SCHEDULE OF QUANTITIES**

1. The Tender shall be on item rate basis which shall include the cost of material, labour, taxes, duties and all other testing and commissioning in accordance with the relevant drawings, specifications and relevant IS Codes and including the fees for inspection together with the liabilities and obligations as detailed in the general conditions of the contract.

2. The prices shall remain firm and free from any variations due to rise and fall in the cost of materials and labour or any other price variation whatsoever during the stipulated period of execution or during the extended period of completion if any.

3. The rates shall remain valid for any variations in the estimated quantities.

4. given in the BOQ.

5. In order to facilitate the technical scrutiny of various quotations, the tenderers must provide along with their quotations detailed technical particulars, catalogues and erection drawings for various items under different parts specified in the BOQ.

6. The power supply shall be 3-phase, 4 wire, 415/240V, 50 Hz AC. All consuming devices shall be suitable for the voltage and frequency mentioned above.

7. The contractor shall supply all consumables necessary for commissioning of the equipment.

8. The drawings and specifications lay down minimum standard of equipment workmanship, deviations if any shall be clearly stated.

9. All equipment and the installation shall be tested as specified and a test certificate in the prescribed form as required by the local supply authorities shall be furnished.
10. The entire and the installation shall be guaranteed against defective material or workmanship for a period of 12 months from the date the installation has been commissioned and taken over by the owners. During the guarantee period the contractor free of cost shall rectify all the defects.

11. The successful tenderer shall submit shop drawings for all the UPS and Battery Banks to the Consultant / Engineer-in-Charges for approval. The approval of these drawings will not absolve the contractor of the responsibility of the correctness of these drawings. Six copies of these approved drawings shall be supplied to the Consultant / Engineer-in-Charges for their distribution to the various agencies at site, at no cost to the Employer.

12. The successful tenderer shall arrange water and power connected required for the work at their own cost.

13. The tenderers must acquaint themselves with the rigours of the site conditions and take all the aforesaid and foregoing factors while quoting the rates, and no extras will be allowed on any grounds arising out of or relating to the aforesaid and foregoing.

14. The successful tenderer shall include in his rates painting of all equipment with three coats of synthetic enamel paint to match the surroundings.

15. Upon completion of the whole work the contractor shall furnish to the Consultant / Engineer-in-Charges three copies of the as built drawings along with the original tracings without a cost to the owners.

16. The tenderers must arrange all the necessary sanctions/approvals from the electrical Inspector at his own cost.

17. The materials of the first preference shall be used and the contractor may excuse himself for not doing so only, if the required range as per BOQ is not being manufactured by that manufacturer. A letter from the respective manufacturer shall support the proof in such cases. Samples of all fittings and other accessories should have Consultant / Engineer-in-Charge’s approval.

18. Necessary formalities to obtain the energy meters from the Electricity Board etc. is the responsibility of the contractor.

19. The tenderer if any regarding this tender this tender should be clarified the clarification before submitting the offer. No claims for items will be entertained later on during the execution of the work arising out of interpretation of various tender/schedule items.

20. For any civil work connected with the owners can issue this tender cement on chargeable basis.

21. Obtaining of temporary construction power supply for this work is the responsibility of the contractor to his own cost.
22. No built up store shall be provided by the owners, only a space shall be provided for contractor to build his own store.

23. Dismantling of store and cleaning of the area will be the responsibility of the contractor.

24. The client will not take any responsibility for any theft, damage or loss etc. before the entire installation is tested, commissioned and handed over.

25. The client reserves the right to split up the work and award the job to different parties.

26. No price variation or escalation clause will be accepted or entertained at any time later on.

27. The work shall be done as per PWD/CPWD norms or as specified and as per the Engineer-in-charge.

28. The Vendor will indemnify the Owners against any sub-contractor or labour disputes.

29. All the incoming and outgoing cable to various panels to be from top/bottom side inlets and outlets as per requirement.
## LIST OF APPROVED MAKES/AGENCIES

<table>
<thead>
<tr>
<th>1- UPS BRAND NAME –</th>
<th>AS APPROVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2- SMF 12 V BATTERIES –</td>
<td>i- AMARAJA</td>
</tr>
<tr>
<td></td>
<td>ii- AMCO</td>
</tr>
<tr>
<td></td>
<td>iii- HBL</td>
</tr>
<tr>
<td></td>
<td>iv- GLOBAL</td>
</tr>
</tbody>
</table>

| 3- COPPER CABLE –   | i)- POLYCB |
|                    | ii- RR KABIL |
|                    | iii- SAFI   |

Signature of Contractor
Application for Extension of Time
(to be completed by the Contractor)

PART I

1. Name of Contractor
2. Name of the work as given in the Agreement
3. Agreement No
4. Estimated amount put to tender
5. Date of commencement work as per agreement
6. Period allowed for completion of work as per agreement
7. Date of completion stipulated as per agreement
8. Period of which extension of time has been given previously

Estimated granted

a) First extension vide Engineer-in-charge letter No ………. date Months Days
b) 2nd extension vide Engineer-in-charge letter No ………. date Months Days
c) 3rd extension vide Engineer-in-charge letter No ………. date Months Days
d) 4th extension vide Engineer-in-charge letter No ………. date Months Days

Total extension previously given

9. Reasons for which extension have been previously given (copies of the previous application should be attached)
10. Period for which extension is applied for:
11. Hindrance on account of which extension is applied for which dates on which hindrances occurred and the period for which these are likely to last

(a) Sr No
(b) Nature of hindrance
(c) Date of occurrence
(d) Period for which it is likely to last
(e) Period for which extension required for this particular hindrance
(f) Overlapping period, if any, with reference to item
(g) Net extension applied for
(h) Remarks, if any

Total period for which extension is now applied for on account of hindrances mentioned above ................. months / days

12. Extension of time required for extra work
13. Details of extra work and on the amount involved

(a) Total value of extra work
(b) Proportionate period of extension of time based on estimated amount put to tender on account of extra work
14. Total extension of time required for 11 & 12
   Submitted to the Engineer-in-Charges office
   Date :

   **Application for Extension of Time**

   **PART – II**

1. Date of receipt of application from Contractor for the work in the Engineer-in-charge office

2. Acknowledgement issued by Engineer-in-Charge vide his letter No .......... dated

3. Engineer-in-Charge remarks regarding hindrances mentioned by the Contractor
   
   i) Serial No
   ii) Nature of hindrance
   iii) Date of occurrence of hindrance
   iv) Period for which hindrance, is likely to last
   v) Extension of time period applied for by the contractor
   vi) Over lapping period, if any, giving reference to items which over lap
   vii) Net period for which extension is recommended
   viii) Remarks as to why the hindrance occurred and justification for extension recommended

4. Engineer-in-charge recommendations
   
   (The present progress of the works should be stated and whether the work is likely to be completed by the date upto which extension has been applied for. If extension of time is not recommended, what compensation is proposed to be levied under the agreement)

   **Signature of Consultant**
Proforma for Extension of Time

PART – III

To,
Name

Address of the Contractor

Subject:

Dear Sir(s)

Reference your letter No ................ dated ................. in connection with the grant of extension of time for completion of the work

The date of completion for the above mentioned work, is ............ as stipulated in the agreement, dated ............

Extension of time for completion of the above mentioned work is granted upto ................. without prejudice of the right of the GTSM to recover compensation for delay in accordance with the provision made in the relevant Clause(s) of the said agreement dated the ............ / ............ / ............ It is also clearly understood that the GTSM shall not consider any revision in contract price or any other compensation whatsoever due to grant of this extension

Provided that notwithstanding the extension hereby granted, time is and shall still continue to be the essence of the said agreement.

Yours faithfully,

For GTSM
FOR THE GTS MEDIQUEST Pvt. Ltd. AT SAHIBABAD, GZB., (U.P.)

Performa of Bank Guarantee (Performance)
(Judicial stamp per Stamp Act – paper of appropriate value as respective state)

GTS MEDIQUEST Pvt. Ltd.
SAHIBABAD, GZB.,
(U.P.)

Whereas the GTS MEDIQUEST PVT.LTD AT SAHIBABAD, GZB., (U.P.) (hereinafter called “GTSM” which expression shall include its successors and assigns) having awarded a work order / contract / supply order No ……….. dated (hereinafter called the contract) to M/s ………………………………………………………… (hereinafter called the contractor / supplier) at a total price of Rs …………………. Subject to the terms and conditions contained in the contract

WHEREAS, the terms and conditions of the contract require the contractor to furnish a bank guarantee for Rs …………………………….. (Rupees…………………………. ) being ……………. % of the total value of the contract for proper execution and due fulfillment of the terms and conditions contained in the contract

We, the Bank (hereinafter called the “Bank”) do hereby unconditionally and irrevocably undertake to pay to GTSM immediately on demand in writing and without protest / or demur all moneys payable to the contractor / supplier to GTSM in connection with the execution / supply of and performance of the works / equipment, inclusive of any loss, damages, charges, expenses and costs caused to or suffered by or which would be cause to or suffered by GTSM by reason of any breach by the contractor/ supplier of any of the term and conditions contained in the contract as specified in the notice of demand made by GTSM to the bank. Any such demands made by GTSM on the bank shall be conclusive evidence of the amount due and payable by the bank under this guarantee. However the Bank’s liability under this guarantee, shall be limited to Rs …………………. Ion the aggregate and the bank hereby agrees to the following terms and conditions:-

(i) This guarantee shall be continuing guarantee and irrevocable for all claims of GTSM as specified above and shall be valid during the period specified for the performance of the contract including the period of maintenance / warranty ie., upto …………..

(j) We, the said bank further agree with GTSM that GTSM shall have the fullest liberty without our concern and without affecting in any manner our obligations and liabilities hereunder to vary any of the terms and conditions of the said contract or to extend time for performance of contract by the contractor from time to time or to postpone for any time or from time to time any of the powers excisable by GTSM against the contractor / supplier under the contract and forbear or enforce any of the terms and conditions
relating to the said contract and we shall not be relieved from our liability by reason of any such variations of extension being granted to the contractor or for any forbearance, act or omission on the part of GTSM or any indulgence by GTSM to the contractor or by any such matter or thing whatsoever, which under the law relating to the sureties would, but for this provision, have effect of so relieving us.

(k) This guarantee / undertaking shall be in addition to any other guarantee or security whatsoever GTSM may now or at any time have in relation to the performance of the works / equipment and the company shall have full recourse to or enforce this security in performance to any other security or guarantee which the GTSM may have or obtained and there shall be no forbearance on the part of the company in enforcing or requiring enforcement of any other security which shall have the effect of releasing the Bank from its full liability. It shall not be necessary for GTSM to proceed against the said contractor / supplier before proceedings against the Bank.

(l) This guarantee / undertaking shall not be determined or affected by the liquidation or winding up, dissolution or change of constitution or insolvency of the supplier / contractor, but shall in all respects and for all purposes be binding and operative until payment of all moneys payable to GTSM in terms thereof are paid by the Bank.

(m) The Bank hereby waives all rights at any time inconsistent with the terms of this Guarantee and the obligations of the bank in terms hereof, shall not be otherwise effected or suspended by reasons of any dispute or disputes having been raised by the supplier / contractor (whether or not pending before any Arbitrator, Tribunal or Court) or any detail of liability by the supplier / contractor or stopping or preventing or purporting to stop or prevent any payment by the Bank to GTSM in terms hereof.

We, the said Bank, lastly undertake not to revoke this guarantee during its currency except with the previous consent of GTSM in writing. Unless a claim is made in writing within three months from the date of expiry of this guarantee ie. ................. (three months after the date of expiry) we shall be relieved from all liabilities under this guarantee thereafter.

Signed this .................. day of .................. at ............

For and on behalf of Bank

Witness:-

1

36
TECHNICAL SPECIFICATION

(A) This section of the specification includes the supply, installation, testing, commissioning and handing over of an Analog addressable fire alarm system which is required to form a complete, operative, coordinated system for the ...................... Site Address Details ...................... It shall include, but not be limited to, Alarm initiating devices, Alarm notification appliances, Control panels, Auxiliary control devices, Annunciation, Power supplies and wiring as specified herein.

(B) The fire alarm system shall generally comply with the requirements of NFPA Standard No. 72 for protected premises signaling systems except as modified and supplemented by this specification. The system shall be supervised either electrically or by software-directed polling of field. The panel, detectors and modules shall preferably be UL listed.

GENERAL FIRE ALARM SYSTEM DESCRIPTION

The main FACP shall contain a Microprocessor based Central Processing Unit (CPU). The Panel Shall communicate with and control various field devices used to make up the system, such as smoke, Thermal (heat) and Multi Sensor detectors, Addressable modules, including initiating circuits and notification appliance circuits, local and remote operator terminals, printers, annunciation, and other system controlled devices.

The FACP shall be capable of disabling an individual detector, Facility shall be provided on the FACP for simulating the fire condition to enable testing of the various alarm circuits.

The FACP shall have the facility to silence/ acknowledge/ reset the alarm. Apart from the FACP, Repeater panel present in the control room shall have the facility to silence/ acknowledge the alarm of all FACP’s in the Network.

In case of a Fire alarm initiation by an alarm initiating device, the audio–visual alarm shall be generated at the respective fire alarm control and the Annunciation/Repeater Panel located in the Control Room, various locations and also initiate signal to operate Sounders located in the various locations.

The FACP shall be programmed for the events to happen in case of fire like closing of fire dampers, shutting down supply fans for HVAC, deactivating the access control system and activating the sounder through a module

The FACP shall have the facility to silence/ acknowledge/ reset the alarm. Apart from the FACP, Repeater panel present in the control room shall have the facility to silence/ acknowledge the alarm of all FACP’s in the Network.

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The FACP shall be programmed for the events to happen in case of fire like closing of fire dampers, shutting down supply fans for HVAC, deactivating the access control system and activating the sounder through a module

The FACP shall have in built buzzer to alert the personnel in case of maintenance requirement.

The electronic circuit shall be of solid state and of fail-safe design Vermin proof, protected from humidity, corrosion and dust to ensure uninterrupted operation.

The circuit shall be protected against usual electrical transients, electromagnetic and electrostatic interference present in that vicinity.

Spares and shall be made available for a minimum period of 5 years from the date of commissioning of the system.

SLC cable should be placed at-least minimum of one meter away from any High Voltage cable
And the routing shall not permit multiple T joints.
The FACP shall have facility to alter access or reset the stored program through a password to avoid unauthorized use.

The system shall have reverse polarity protection, sensitivity adjustment, alert for drift compensation and shall be capable of networking minimum of 8 panels in a system

1) The system shall be capable of diagnosing the cabling for open and short circuits, unauthorized removal of detector head and AC failure.

2) In case of multiple alarms, the indication shall display in chronological order.

FIRE ALARM CONTROL PANEL (FACP):
The FACPs used in the Building shall confirm with the UL - 9th Editions.

The fire alarm control panel (FACP) shall be suitable for Class-A Style 5, 6 or 7 wiring and Class-B Style 4 type of wiring as per NFPA-72. It shall have provision to accept the range of 110V - 230V ± 10% single phase, 50 Hz SMPS supply. The processor shall be of M3 32 bit, capability for Day & Night mode. The panel shall maintain 2000 events, each with a time and date stamp. The control panels shall exclusively maintain 1000 alarm event and 1000 other events (troubles supervisory pre alarm etc). The system shall support three password levels, (i.e. Advance / Admin/ user). It shall have inbuilt USB 2.0 Interface for easy configuration facility via PC/Laptop. The FACP shall have Minimum 160 Characters LCD in which the LCD clearly indicates the location of fire, Fault & Supervisory. The FACP should have capacitive Touch Keypad, instead of mechanical snap dome switches for trouble free operation. The panel shall have degraded operating mode. In case of main CPU failure the panel still gives audio and visual notification.

The FACPs shall have maximum capacity of four loops and can be configurable as one, two, three and four loop. It shall have inbuilt RS485 facility for networking. Peer to peer networking of at least eight panels should be possible in a system, comprising of not less than 8128 devices in any combination. The panel shall have two circuits for remote monitoring with at least one for Initiating device circuit. The FACP should have minimum two inbuilt Notification Appliances circuits. The FACP shall have provision to interface Ethernet, GSM module and any BMS. The FACP shall have the facility to connect the Printer by using Interface module directly to the panels. The panel shall have minimum three programmable form C, potential free Relays, loop wise Auto-learn facility for easy installation and commissioning, capability to add or delete the devices without affecting the existing configurations, facility to program 192 groups with label, built in visual alarm indication for minimum 36 zones, programmable time delay facility. The Panel should be capable of alerting duplication of address, mismatch on the device type. The panel shall have provision to restore factory default setting. The FACP should give audio and visual indication for main and/or standby power supply failure. The panel shall indicate degraded power supply in case both the mains and standby power supplies are below the rated level with inbuilt battery charging circuit to charge up to 40Ah SMF batteries. The FACP shall be capable to integrate the voice evacuation system, shall have Programmable Trouble Reminder facility, AC loss Delay facility and also on site and off site programming.

The FACP shall have the following functions activated through the touch key pad:

- Acknowledge
- Silence
Loop card should have built in intelligence with 32 bit controller with auto addressing facility in respect to the slot it is inserted, shall be swappable without any configuration changes and should have LED for loop status indication. Each loop shall accommodate minimum 254 devices (detectors and modules) in any combination. All the alarm initiating devices shall be addressed through 8 way DIP switch without any configuration utility/ programming kit. (Binary – addressing). All types of detectors offered will be restorable type i.e. suitable for operating afresh after each actuation on alarm without replacement or adjustment. The sensitivity of smoke sensor shall be individually adjusted from the FACP to suit the conditions of each location. Each detector shall have self-test facility, which is monitored in the FACP. The FACP should be able to monitor each detector and raise maintenance alert once the drift compensation level is reached.

CONSTRUCTION DETAILS:

The FACP shall be of 1.6 mm CRCA cabinet and shall have an ingress protection of at least IP – 50. It shall be capable of being wall Mounted or flush mounted. The cabinet and front shall be corrosion protected, given a rust-resistant powder coat, and manufacturer's standard finish. It shall be of Red, White or Black finish as per requirement. The FACPs shall be provided with earthing terminals with cable entry from the top. The panel shall be completely factory wired, absolutely ready-in all respects for installation at site. The internal wiring of the panel shall be carried out with 650V grade, stranded copper wires of size rated for the current in the corresponding circuit. The minimum size of the wire shall be not less than 0.8 sq.mm for electronic-circuits and 1.5sq.mm for electrical circuits & 14AWG for grounding. The door shall be provided with a key lock and shall have the ability to be hinged.

POWER SUPPLY:

The System shall operate in the range of 110-240V AC, 50/60 Hz main supply (SMPS). The power supply shall have auto resettable fuses. The panel shall have protection against transient and surges. The Power Supply shall be provided with an earth detect circuit, capable of detecting earth faults. The power supply shall have Battery charging facility with thermal fuses to avoid reverse polarity damages. The SMPS power supply shall have LED indication to show the healthiness of the power supply in green color and in low voltage condition it shall have RED indication.

CENTRAL PROCESS UNIT (CPU):

The FACP shall have a processor which shall be 32 bit ARM cortex M3 controller. The sophisticated software shall facilitate extensive memory for storing the logs of alarms, times and action taken report. The memory shall store data in a non-volatile format and retrievable for at least seven years.
REPEATER PANEL (UL LISTED):

The Repeater Panel shall have minimum 160 characters LCD display in which the LCD clearly indicates the location of fire, fault & supervisory status. The repeater panel should have capacitive touch keypad, instead of mechanical snap dome switches, for trouble free operation. Repeater panels shall be suitable for wall mounting or mounting on table which shall display all the parameters occurring on the fire alarm control panel. It shall connect to any of the fire panels in the network. It shall be provided with an external power supply. The repeater panel shall replicate the main panel indications and shall be accessed only by authorized users through password. The repeater panels shall be connected to the main panel and other repeater panels in such a way that failure in any of the panels shall not affect the performance of the other panels.

ADDRESSABLE DETECTORS

Addressable Multi Sensor (Optical & Thermal) Detector:

The Optical & Thermal (combined) detector shall confirm to the relevant standards having the following features:

1. The detector shall be UL approved.
2. It shall have smoke sensitivity of 1.9 +/- 0.6 %/ft
3. The detector should have fixed temperature rating of 59 deg C and rate of rise of 11.1°C/min
4. The multi detector shall be loop powered and addressed by DIP switches.
5. All the detectors shall have a visible dual blinking LED to indicate the healthiness/trouble/ alarm condition of the detector. The LED shall be located in such a way that it shall be visible 360º.
6. It shall possess false alarm immunity and a superior signal to noise ratio.
7. It shall be capable of supporting style 7 wiring.
8. It shall have inbuilt drift compensation facility.
9. In case of a failure, panel shall allow to replace the detector with the same type without the need of additional programming.
10. The detector shall change sensitivity settings based on day/night mode or with schedules based on the programming.
11. The detector shall have at least 3 levels of sensitivity settings.
12. The detector wiring shall be polarity free.
13. The detector shall have the connection details on the bottom.

Addressable Optical Smoke Sensor Detector:

The Optical Detector shall confirm to the relevant standards having the following features-

1. Detector shall be UL approved.
2. It shall have smoke sensitivity of 1.9 +/- 0.6 %/ft
3. The Detector shall be loop powered and addressed by DIP switches.
4. All the detectors shall have a visible dual blinking LED to indicate the healthiness/trouble/alarm condition of the detector. The LED shall be located in such a way that it shall be visible from the 360º.
5. It shall possess False alarm immunity and a superior signal to noise ratio.
6. It shall be capable of supporting style 7 wiring.
7. It shall have inbuilt drift compensation facility.
8. In case of a failure, panel shall allow to replace the detector with the same type without the need of additional programming.
9. The detector shall change sensitivity settings based on day/night mode or with schedules based on the programming.
10. The detector shall have at least 3 levels of sensitivity settings.
11. The detector wiring shall be polarity free.
12. The detector shall have the connection details on the bottom.

**Addressable Heat Detector:**

The Heat Detector shall confirm to the relevant standards having the following features:

1. Detector shall be UL approved.
2. The detector should have fixed temperature rating of 59ºC and rate of rise of 11.1ºC/min
3. The Detector shall be loop powered and addressed by DIP switches.
4. All the detectors shall have a visible dual blinking LED to indicate the healthiness/trouble/alarm condition of the detector. The LED shall be located in such a way that it shall be visible from the 360º.
5. It shall possess False alarm immunity and a superior signal to noise ratio.
6. It shall be capable of supporting style 7 wiring.
7. In case of a failure, panel shall allow to replace the detector with the same type without the need of additional programming.
8. The detector wiring shall be polarity free.
9. The detector shall have the connection details on the bottom.

**Standard base:**

1. The base shall be UL Listed
2. The base shall be common for PHOTO, THERMAL AND MULTI SENSOR.
3. Terminals of base shall be rust resistant.
   The base shall have separated in and out terminals.
4. The base shall have terminals to connect remote indicator.
ADDRESSABLE MODULES

Control Module (CM):

1. The Control Module shall be UL listed.
2. The CM shall have LED indication to show the status.
3. The CM shall activating notification devices and 24V DC operated devices.
4. It shall have a capability of handling at least 1A @ 30VDC to integrate with third party system.
5. The CM shall be capable of powering through the auxiliary source and shall supervise the auxiliary power. The CM shall communicate faults and troubles related to the NACs, power supply to the panel.
6. The CM shall be addressed by means of dip switches.
7. The CM shall be loop powered.

Monitor Module (MM):

1. Monitor Module shall be UL Listed.
2. The MM shall have LED indication to show the status.
3. The MM shall have supervised monitoring circuit.
4. The MM shall monitor any number of potential free NO contact.
5. The MM shall be addressed by means of dip switches.
6. The MM shall be loop powered.

Relay Module (RM):

1. The Relay Module shall be UL Listed.
2. The RM shall provide two dry potential free contacts for activating a variety of auxiliary devices and other firefighting / ventilation equipment.
3. The RM shall have contact rating of 2A @30V DC, 0.5 @125 VAC
4. The RM shall be addressed by means of dip switches.
5. The RM shall have LED for status indication.
6. The RM shall be loop powered.

Isolator Module/ Base:

Isolator module/ base shall be part of the loop. These modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Style 6 (Class A) or Style 4 (Class B branch). The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is rectified, the isolator module shall automatically reconnect the isolated section. The isolator module shall not require any address setting, and its operations
shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

**Addressable Zone Interface Module (ZIM):**

1. The zone Interface module (ZIM) will facilitate connection of conventional detectors in the same circuit /loop consisting of addressable detectors.
2. The ZIM shall be capable of powering the detectors through the auxiliary source and shall supervise the IDC power supply.
3. The ZIM shall communicate alarm and troubles related to detector and power supply to the Panel.
4. The ZIM shall allow resetting conventional detectors from the panel.
5. The ZIM shall have LED status indication.
6. The ZIM shall be capable to connect at least 16 Initiating Devices.

**Manual Pull Stations:**

The Manual Pull Stations (MPS) shall conform to the relevant standards having the following features.
1. Easily replaceable break glass rod.
2. Shall be of single gang mounting.
3. Shall be connected thru the Monitor module for addressing facility.
4. Shall have 10 amp@120VAC rating SPDT contact.
5. Shall Made of High quality non toxic die casting.
6. Shall be UL listed.

**Sounder:**

The Sounder shall confirm to the relevant standards having the following features.

1. The Sounder shall be a Conventional sounder. (Bidder shall consider external power supply, cable, conduits, modules required for activating externally powered sounders and include the costing as part of the item – Sounders)
2. The sounder shall have audibility level of 100dB.
3. The sounder shall have the capability of being tested from the FACP.

**Sounder Cum Strobe:**

The Sounder Cum Strobe shall confirm to the relevant standards having the following features.

1. The Sounder Cum Strobe Shall have audibility level of 90db.
2. The Sounder Cum Strobe shall have 15cd flashing capacity at 1HZ for Visual indications.
3. The Sounder Cum Strobe shall be integrated with Control Modules with necessary auxiliary voltages.
4. The Sounder Cum strobe shall be working on 24VDC auxiliary power supplies.
 Beam Detector:  
The Beam Detector Shall confirm to the relevant standards having the following features.  

1. Shall have a Infrared transmitter and receiver in a single housing.  
2. Shall have an interoperating Prism Reflector.  
3. Shall supports from 5 metre to 100 metre in range.  
4. Shall have an inbuilt LASER light for easy alignment with the reflector.  
5. Shall have a adjust screws for precise alignment.  
6. Shall have inbuilt Drift level compensation.  
7. Shall have three levels of sensitivity threshold settings (i.e) 18%, 30%, 50%  
8. Shall operates on the temperature of -25deg C to 55 Deg C  
9. Shall operate on 24VDC power supply.  
10. Shall have a provision to connect the Response Indicator.  

A. Batteries:  
(i) Battery shall have sufficient capacity to power the fire alarm system for not less half an hour in alarm condition and at least 24 hours in normal condition.  
(ii) The batteries are to be completely maintenance free.  
(iii) The batteries shall be of Lead acid type.  

B. Cables/conduits:  
All cables/conduits to be laid on wall, ceiling and on the hangers wherever necessary and as directed by the authority with required hardware. The cables shall be armored PVC twisted 1.5 sq mm multi strand insulated, copper conductor, conforming to IS: 1554 and shall be of specified make. The cables shall be properly terminated and labeled.  

C. Approvals:  
All the equipment shall have proper listing and/or approvals and shall comply with the requirements of Underwriters Laboratories Inc. 9th edition.  

 CMS Software:  
- CMS software shall monitor and control maximum of 64 panels thru Local area network and Wide area network.  
- All the panels in the network shall have a static IP address on Local Area Network.  
- All the panels in the network shall have single public static IP address on Wide Area Network.  
- The Bandwidth of the LAN or the WAN shall be of minimum 1Gbps.  
- CMS shall be GUI based User Friendly Software  
- CMS shall be able to identify the fire with location name as shown in the fire alarm
control panels.

- CMS shall be able to identify the faults in the FACP.
- CMS shall have facility to program the location of the devices.
- CMS shall have the Event storage facility and printing facility of the events.
- CMS shall have configurable Visual and Sound Alerts for the fire and fault conditions
- CMS shall have Instant Pop-up alerts for any fire and Fault Events to override the existing application on the screen.
- CMS shall have the acknowledgement facility.
- CMS shall get stored all the events in the networked panel.
- CMS shall have two Level of access Admin and User levels

**Digital Alarm and Voice Evacuation System:**

- This DSP based voice alarm and Public Address System. The System comprising router, Digital Amplifier and Power supply. This unit provides audio routing, full system control and fault Reporting functions. The Ekonics, router provides digital storage (4X30 second) or (2X60 second) DVA messages, four audio outputs and four MIC / line inputs. The router has a front panel display control interface for commissioning the system, fault monitoring an diagnostics.
- 4 or multiple of 4 audio inputs to any combination of 4 or multiple of 4 outputs.
- Full system control and fault reporting functions.
- 19" Rack mountable.
- All-call or zone paging facility.
- Built-in 6 Programmable DVA messages.
- 40x4 LCD Display.
- USB 2.0 Interface for PC connectivity.
- 3 Levels of Password protection.
- ‘All call’ failsafe emergency evacuate alarm in the event of DSP failure.
- RS485 communication facility.
- Event log with RTC.
- User selectable digital filter, noise suppresser, attenuation for audio inputs.
- Zone wise volume control.
- Zone wise input priority level, permanent input, scheduled digital voice announcer.
- All field circuits are supervised.
- Rotary encoder for speed and user friendly operations.
- Analogue input interfaces : 8 Contacts
- Input Voltage : 24 VDC
**Digital Amplifier:**
- Input Voltage: 24 VDC
- Maximum DC Current: 10Amps
- Maximum Watts: 250Watt
- Operates on 220V, A.C supply.
- Battery backup with built in charging.
- Low battery visual warning with audible tone.
- DC Output indication.

**PA Ceiling Speaker:**
- Flush mount 15cm dynamic cone speaker.
- Three field selectable power taps.
- ABS plastic grill with metal punched net.
- Easy to install with spring catch mount.
- Connectors with screw for hooking up the wires tightly.
- Protective dust cover at rear.
- The white color of the grill has been selected to be obtrusive in virtually all interiors.
- Power: 10W
- Toppings 100V line: 1.5W / 3W / 6W
- Sound Pressure Level: 92dB (1W, 1M), Frequency: 60-15000Hz
- Material: ABS Plastic
- Dimensions: ø 210 mm, H 90 mm.
**PA Wall Speaker:**

- Wall mounted with 12.5 cm cone speaker for announcement and paging.
- Attractive, stylish ABS white plastic box.
- The specially designed slim speaker is obtrusive in all interiors.
- Equipped with the transformer to provide 100v line.
- Ideal for office cabin, work stations, classrooms, shops, malls etc.
- Optional Volume control.
- Music Power : 10W
- Impedance : 100V line
- Tapping’s : 1.5, 3W, 6W
- Dynamic Cone Speaker : 1 X 12.5 CM
- Frequency : 60 - 15000Hz
- SPL@/(1W/1M) : 90 Db
- Dimensions : (180 H X 140 W X 70D) mm

**PA Horn Speaker:**

- PA Horn has been provided with 100V line Matching Transformer with multiple taps easily selectable by changing the rotary switch at the rear of the sealed assembly. This is indoor/outdoor applications.
- Input Power :15W (RMS) 24W(Max)
- Taps : 2.5W, 5W, 7.5W, 10W, 12.5W, 15W
- Impedance : 100V Line
- Frequency Response : 275 - 7000 Hz
- Type : ABS Plastic
- Size : 205 ø (271 L)
- SPL @1Khz : 106dB
Firemen Telephone System:

- Firemen Telephone System provides a reliable user friendly Fireman’s Emergency communication. It consists of master Control panel with 8 zone location alarm indications,
- Phone jack and Handset.
- The Phone jack senses the insertion of the Fireman’s handset into jack and Immediately signals the status to the Control panel. The Control Panel in turn will indicate the location of the call and provide an audio visual indication to alert the operator’s attention.
- Group or all call can also be selected. Once connected a clear full duplex audio Conversation can take place. The call is ended by, replacing the master handset.
- Master to remote and remote to master calling facility
- Fully monitored for open and short circuit cable failures.
- Remotes connected via 2 cores radial.
- Primary power 220VAC and Secondary power 24VDC with built in charger.
- Recommended batteries 2 X 12V, 7AH

Telephone Hand set:

- Fire Fighters Telephone handset is constructed with MS Box. It comes with coiled cord with RJ 11. Single handset is housed in a single cabinet.
- Coiled Cord set and Wall mounting and Telephone handset is compatible with RJ-11 Telephone plug.

Telephone Jack:

- Telephone Jack is used to communicate with the central Fire Fighter Telephone Console by using the portable handsets.
- Any number telephone jack can be daisy chain. However only one can be Operated at a time per zone.
- Stainless Steel Enclosure and any number telephone jack can be daisy chain. However only one can be operated at a time per zone.
- Flush / Wall mountable.
TECHNICAL SPECIFICATION – CSSD EQUIPMENT

HORIZONTAL RECTANGULAR HIGH PRESSURE HIGH VACUUM RADIAL DOUBLE DOOR STEAM STERILIZER, FULLY AUTOMATIC CYCLE OPERATION WITH ACCESSORIES– QTY – 1 NO.

- Steam sterilizer, horizontal shape, with hinge type radial double doors, inner chamber volume of around 400 to 450 liters; Minimum Inner chamber dimensions-600mm width x 600mm height x 1200mm depth
- Vacuum pump - Should have inbuilt water-ring type vacuum pump of 3HP/5HP to provide pre-vacuum and post-vacuum pulses, to withstand negative pressure and create high vacuum of 26”hg; The sound level of vacuum pump shall be <80DP and no vibration. Vacuum pump brand shall be New Genre OR Vindi vak. This should also be fitted with suitable stainless steel condenser and pipings.
- Material : Inner chamber - Stainless steel SS 316 quality with a minimum thickness of 6mm; Both the doors – Stainless steel SS 316 quality with a minimum thickness of 12 mm; Radial locking arm for door – Stainless steel SS 304 quality, Inbuilt steam generator – made of stainless steel SS 304 quality; All connecting pipes shall be made of good quality stainless steel; Jacket-boiler quality steel; stand-mild steel with anticorrosion paint.
- Electrical immersion type heaters of 18KW, equipment should be operated on 400-440 V, 3 phase with neutral, AC supply.
- Should provide heat resistant SILICON door gasket withstand upto 140°C.
- The sterilizer shall have to draw the water, automatically through a feed water pump, when needed in the inbuilt boiler.; preferably Crompton make water pump
- Insulation of Glass wool thickness shall be 75-100mm. Insulation cover shall be made of good quality stainless steel 304 quality
- Should provide analog gauges for chamber pressure and Jacket pressure; Necessary calibration certificates to be submitted during supply
- The sterilizer shall be fitted with Pressure switch, Contactor, solenoid valves, pressure transmitter, steam trap, water reading glass, safety valve, plug screen, vacuum drier etc..as needed
- Working temperature of sterilizer is 121°C to 134°C and the corresponding pressure is 1.2 to 2.1 kg/cm²
- Validation Port shall be provided
- Should have microprocessor based controls, with touch screen display; Minimum of six programmable cycles, Bowie Dick test cycle, Leak test cycle should be provided; Preferred make of HMI and PLC: Siemens / Allen Bradley / Mitsubishi
- Shall have digital displays of Chamber Pressure, Chamber temperature, Cycle no., Batch no., Time & Date, Alarm indicator, Error code, Low water indicator etc.,
- Shall have provision for RS 232 port for data communication, In-built Real Time Clock with date and time function and F0 value
- Should be supplied with a suitable printer that will automatically and continuously monitor and record dates, time of day, load, identification no. and operating parameters i.e. temperature, pressure and residence time, through out the length of the autoclave cycles.
- Shall have necessary safety features that both doors should not open at time; Door should not open when the process is ON; Process should not start either in auto or manual if either side is open; Sterile door will open finally after completion of cycle and non sterile door will not open unless sterile door is opened etc.,
- Should have suitable alarm / indications
- The machine shall be IS: 3829 part 1 certification and ISO 9001:2008 company

Accessories
a) Qty – 1 No Stainless Steel loading / unloading carriage made of SS 316
b) Qty – 2 Nos. Stainless steel transfer trolley made of SS 304

Documents
User manual in English, Hydraulic test certificate, Material test certificate, IQ, OQ, DQ & PQ documents, Leak Test certificate, Gauge calibration certificate, Master Gauge calibration certificate and Warranty certificate
HORIZONTAL CYLINDRICAL HIGH PRESSURE HIGH VACUUM DOUBLE DOOR STEAM STERILIZER, FULLY AUTOMATIC CYCLE OPERATION – QTY – 1 NO.

- Steam sterilizer, Cylindrical shape, with hinge type radial double doors, inner chamber volume of around 200 to 250 liters; Minimum Inner chamber dimensions-500mm dia x 1100mm depth
- Vacuum pump - Should have inbuilt water-ring type vacuum pump of 2HP to provide pre-vacuum and post-vacuum pulses, to withstand negative pressure and create high vacuum of 26"hg; The sound level of vacuum pump shall be <80DP and no vibration. Vacuum pump brand shall be New Genre OR Vindi vak. This should also be fitted with suitable stainless steel condenser and pipings.
- Material : Inner chamber - Stainless steel SS 316 quality with a minimum thickness of 4mm; Both the doors – Stainless steel SS 316 quality with a minimum thickness of 12 mm; Radial locking arm for door – Stainless steel SS 304 quality, Inbuilt steam generator – made of stainless steel SS 304 quality; All connecting pipes shall be made of good quality stainless steel; Jacket-boiler quality steel; stand-mild steel with anticorrosion paint.
- Electrical immersion type heaters of 18KW, equipment should be operated on 400-440 V, 3 phase with neutral, AC supply.
- Should provide heat resistant SILICON door gasket withstand upto 140°C.
- The sterilizer shall have to draw the water, automatically through a feed water pump, when needed in the inbuilt boiler.; preferably Crompton make water pump
- Insulation of Glass wool thickness shall be 50-75mm. Insulation cover shall be made of good quality stainless steel 304 quality
- Should provide analog gauges for chamber pressure and Jacket pressure; Necessary calibration certificates to be submitted during supply
- The sterilizer shall be fitted with Pressure switch, Contactor, solenoid valves, pressure transmitter, steam trap, water reading glass, safety valve, plug screen, vacuum drier etc..as needed
- Working temperature of sterilizer is 121°C to 134°C and the corresponding pressure is 1.2 to 2.1 kg/cm²
- Validation Port shall be provided
- Should have microprocessor based controls, with touch screen display; Minimum of six programmable cycles, Bowie Dick test cycle, Leak test cycle should be provided; Preferred make of HMI and PLC: Siemens / Allen Bradley / Mitsubishi
- Shall have digital displays of Chamber Pressure, Chamber temperature, Cycle no., Batch no., Time & Date, Alarm indicator, Error code, Low water indicator etc.,
- Shall have provision for RS 232 port for data communication, In-built Real Time Clock with date and time function and F₀ value
- **Should be supplied with a suitable printer** that will automatically and continuously monitor and record dates, time of day, load, identification no. and operating parameters i.e. temperature, pressure and residence time, through out the length of the autoclave cycles.
- Shall have necessary safety features that both doors should not open at time; Door should not open when the process is ON; Process should not start either in auto or manual if either side is open; Sterile door will open finally after completion of cycle and non sterile door will not open unless sterile door is opened etc.,
- Should have suitable alarm / indications
- The machine shall be IS: 3829 part 1 certification and ISO 9001:2008 company
- **Documents**
  - User manual in English, Hydraulic test certificate, Material test certificate, IQ, OQ, DQ & PQ documents, Leak Test certificate, Gauge calibration certificate, Master Gauge calibration certificate and Warranty certificate
TECHNICAL SPECIFICATION: HORIZONTAL CYLINDRICAL HIGH SPEED INSTRUMENT STERILIZER (FLASH AUTOCLAVE) – QTY -1 NO

- Shall be floor mounted - The sterilizer shall be manufactured as per IS specifications Mark IS: 3829 (Part-2) and also shall bear the certification.
- Volume of inner chamber – 75 litres to 80 liters; Minimum inner chamber dimensions – 400mm dia x 600mm depth
- Shall have single door, radial, hinge type with pressure locking safety facility. The door unlocking shall be possible only when the chamber is exhausted.
- Single control through multiport valve to set and select the cycle manually
- Material: Inner chamber - Stainless steel SS 316 quality with a minimum thickness of 4mm; Radial hinge type door – Stainless steel SS 316 with a minimum thickness of 12 mm; Inbuilt steam generator – SS 304 quality; All connecting pipes shall be made of good quality stainless steel; Jacket-boiler quality steel; stand-mild steel with anticorrosion paint
- Electrical immersion type heaters of 18KW, equipment should be operated on 400-440 V, 3 phase with neutral, AC supply.
- Should have an auto-feed water pump with controller, that shall draw the water automatically whenever the level of water in the steam generator goes down during operation; preferably Crompton make
- Should provide heat resistant SILICON door gasket withstand upto 140°C.
- Insulation of Glass wool thickness shall be 50-75mm. Insulation cover shall be made of good quality stainless steel 304 quality
- Should provide analog gauges for chamber pressure and Jacket pressure; Necessary calibration certificates to be submitted during supply
- The sterilizer shall be fitted with Pressure switch, Contactor, Non return valve, steam trap, water reading glass, safety valve, dial thermometer, plug screen, vacuum drier etc..as needed
- Working temperature of sterilizer is 134°C and the corresponding pressure is 2.1kg/cm²
- **Documents**: user manual in English, Hydraulic test certificate, Material test certificate, IQ, OQ, DQ & PQ documents, Leak Test certificate, Gauge calibration certificate, Master Gauge calibration certificate and Warranty certificate
TECHNICAL SPECIFICATION : STAINLESS STEEL WORK TABLE WITH TWO SINKS-QTY-1NO

- Complete stainless steel SS 304 body construction, 16SWG thickness.
- Should have good quality water inlet, air inlet valve, drain and overflow connections with manual drain valve, for washing of instruments.
- Shall have provision for attaching spray gun rinser (air / water)
- Separate hot and cold water faucet above each sink
- Shall have Two Sinks made of stainless steel SS 304 quality, 16SWG thickness, are designed in a way to minimize splash, Minimum size of each sink shall be 700mm Length x 440mm Width x 240mm Depth
- Shall have an undershelf made of stainless steel SS304, 16SWG thickness., shelf size: 2355mm Length x 400mm width, fitted at 300mm above floor level
- Frame (square) shall be made of stainless steel SS 304 quality, 14SWG thickness.
- All the joints shall be welded and fine finished.

TECHNICAL SPECIFICATION : SPRAY GUN RINSER WITH EIGHT ATTACHMENTS-QTY-1NO

- Various sizes and shapes of minimum eight attachments made of good quality Stainless Steel to be used for cleaning syringes, catheters, endoscopes, cyst scopes, other instruments and articles used in sterile services.
- Shall be capable for minute jet of spray of water / compressed air
- 1/4”BSP connection with SS breaded Hose for water & air
- The water and air pressure should be released, regulated and fully controlled by the spray gun trigger.
- Should be suitable to be connected with the wash station with double tank.
TECHNICAL SPECIFICATION : MICROPROCESSOR CONTROLLED WASHER DISINFECTOR WITH INBUILT DRYER, DOUBLE DOOR - QTY-1 NO

- Should be made of good quality Stainless Steel and the unit shall have double door stainless steel SS 304 quality, 16SWG thickness. All connecting pipes shall be made of good quality stainless steel.
- Body and Frame shall be made of Stainless steel 304 quality, 14SWG thickness.
- The external panel shall be made of stainless steel 304 quality, 18SWG thickness.
- Inner chamber volume shall be 250 to 275 Litres approx. and can handle up to 1200 instruments per hour.
- Shall be designed to wash, rinse and drying all kinds of surgical instruments, anesthetic and respiratory tubing, suction devices, bottles and other glassware.
- Microprocessor control for all services, programming and statistic functions – three preset programs and process shall be automatically controlled in a time regulated sequence.
- Double wall with insulation to run with minimum sound and heat emission; Shall be provided with Silicon type gasket for door.
- Temperature: Washing at 50 to 65 deg.C; Thermo disinfection at 80-90deg.C
- Hot or cold water Spray through rotating arms, Automatic Disinfectant loading through dosing pump
- **Effective Drying:** The instruments and hoses are dried very thoroughly, inside out. An air particle filter ensures that the drying air is free from particles.
- Shall be fitted with Sensor to detect level in soap tank and easy refilling system, Sensor for water in chamber to avoid dry run, have powerful water circulation pump, four spray arms, dual dosing pump etc.
- Electrical load – 20KW, 415 V, AC, three phase & N, 50Hz

TECHNICAL SPECIFICATION : ULTRASONIC CLEANER - QTY-1 NO

- Shall be made of Stainless Steel SS 304 quality, 18SWG thickness of body, door and panelling.
- The Ultrasonic generator and the ultrasonic cleaning bath are built in one integral cabinet with castor wheels.
- Shall be designed for ultrasonic generation with PZT transducers for mechanical vibration in the cleaning liquid.
- Shall have a minimum volume of 30 liters, with ultrasonic frequency of 30 KHz (+/- 3 KHz), ultrasonic power of 500 Watts.
- Transducers: PZT – elements in sandwich form.
- Should be supplied with suitable SS Lid and baskets.
**TECHNICAL SPECIFICATION : CONTROL & PACKING TABLE -QTY-1 NO.**

- Shall be made of good quality Stainless Steel SS 304, thickness of 16 SWG
- Shall have minimum two shelves for separation, control and packing of various sets of sterilized goods forwards, clinics, operation theatre etc.,
- Shall have Stainless steel 304 quality drawers, 18SWG thickness, underneath the table and also with nylon adjustable leveling bullets for legs
- Shall have provision for electrical connections for sockets of 5 Amps & 15 Amps
- All the joints shall be welded and fine finished.
- Table overall size – 2000mm length x 1400mm Width x 1400mm H

**TECHNICAL SPECIFICATION: GAUZE CUTTING MACHINE WITH SS TABLE -QTY-1 NO**

- The unit should be fitted on the table formed out of SS304 quality material
- The low profile base plate drastically reduces the fabric distortion & drag.
- The close fitting of the wing of the base plate easily slips under the bottom ply without catching or snagging the cloth.
- The motor cooling fan dissipates heat build-up & directs the hot air-flow away from the operator.
- Operating handle and lever are positioned for maximum convenience.
- Blade can be sharpened by the automatic sharpening unit only when lever is pressed down, ensuring safety.
- Blade size – 200mm.
- Cutting capacity – 165mm
- Power – 230V Ac 50Hz, 0.75HP
- Table top made of stainless steel SS 304 quality, 16SWG thickness and frame made of stainless steel SS 304 quality, 14 swg
- Table Size:900mm Length x 600mm width x 900mm Height

**TECHNICAL SPECIFICATION : CONTINUOUS BAND SEALER ON SS TABLE WITH UNDERSHELF -QTY-1 NO**

- This sealer with conveyor is suitable for small bags packaging and adopts electronic constant temperature control system and speed adjusting transmission mechanism. It can seal plastic films of various materials.
- Temperature Range: 0 – 300°C
- Sealing speed: 0-12mtr/min
- Sealing film thickness: 0.02-0.80mm
- Sealing width: 6-15 mm
- Power supply: 220-240 / 50 Hz 1 Phase ,
- Power consumption 500 W
- Conveyor Loading: 5Kg
- Machine Size: 900mm x 420mm x 660mm
- Table shall be made of Stainless steel 304 quality, 16SWG thickness.
- It shall have under shelf, made of stainless steel 304 quality, 16SWG thickness.
- Table Size: 1200mm Length x 600mm width x 900mm height
TECHNICAL SPECIFICATION: STAINLESS STEEL PASS BOX, DOUBLE DOOR - QTY-1 NO.
- The Pass Box shall be fabricated from S.S. 304 stainless steel sheets with double wall construction.
- Should have full argon welding for superior hygiene.
- Shall have UV lights for safe storage of components.
- As an additional safety to the operator the UV light will be automatically switched off when any one door is opened.
- Magnetic locks for both doors must be there.
- Door interlocking to prevent simultaneous opening of both doors.
- Toughened glass paneling for easy visibility.
- Inside size: 600mm x 600 mm x 600 mm

TECHNICAL SPECIFICATION: TABLE TROLLEY WITH TWO SHELF - QTY-1 NO
- The trolley is for use in the sterile goods store when batching sterile goods for delivery and also for short internal transport.
- Frame and body made of stainless steel 304 quality, 14SWG thickness and under shelf made of stainless steel SS 304 quality, 16SWG thickness.
- The trolley frame is provided with handle bars for easy movement.
- The undershell is mounted at 300mm above floor level with spacers on the trolley frame.
- The shelf is fitted with buffer wheels.
- The frame is fixed on 4 Nos. heavy duty castors swiveling castors for easy movement in narrow passage.
- Size: 1080mm length x 550mm width x 800mm height

TECHNICAL SPECIFICATION: STAINLESS STEEL STORAGE RACK WITH FIVE SHELVES - QTY-4NOS.
- Shall be made of good quality Stainless Steel SS 304; Size: 1830mm L x 535mm W x 1830mm H.
- Floor mounted type, storage rack with five shelves to store the medical instruments / linen.
- Frame shall be fabricated of 40mm square Stainless steel pipes, legs shall be provided with adjustable nylon Bullet feet; Frame thickness , 14SWG.
- The shelves are fabricated of 16 SWG Stainless Steel sheets ground polished to smooth surface.
- Edges are welded together & polished at corners.

- Approved makes for entire CSSD System : Periclave / Steris-USA / Gettinge

Note:
The main Contractor should sub-Contract the specialised nature of work to only those Contractors in India for modular OT system who must be authorised distributor for all approved makes mentioned in tender for imported material, Since it is life saving project and it require proper maintenance by highly qualified & specialist engineers for after sales & services to maintain system so that the system should work round the clock without any interruption in medical procedures.
Sub-Contractor must produce its authorization letter for Indian contingent for the approved makes mentioned in tender for modular OT system at the time of execution.

All items mentioned under NS i.e. Non Schedule items are to be read in conjunction with the prevailing specifications of manufacturers and as per the relevant I.S code for the item/Material as mentioned in the tender. All the relevant material sample shall be got approved from the consultant before placing bulk order/usage. Any discrepancy in specifications of any item or any material shall be brought to the notice of consultant before implementation.

FOR All imported items country of origin should be EUROPE / USA only.
Providing, Fabricating and fixing of Hospital Cubical Track System comprising of the following components and specifications.

Makes : MPS / Tracks2 Curtains / Aristro Helthcare

**CUBICLE TRACK**
Made of Metal Aluminium Alloy of Box size 1.7 x 20 x 25mm with 50-60 microns thick powder coating in white color finish. Tracks are bendable to a radius of 300 mm at 90 degree to cover the whole bed.

**CURTAIN**
Made of hospital grade premium quality Stain Proof fabric with High quality Nylon Net of 18” and 24” on top.

**SUPPORTING SYSTEM CONSISTS OF THE FOLLOWING MATERIAL:**

i. **Wall Bracket**
Made of CRC steel with white powder coating finish.

ii. **Bridge Clamp**
Made of CRC steel with powder coating finish.

**Roof Suspension**
Made of aluminium pipe of 12.5 mm & 19.5 mm diameter. The Upper Circular Plate made of aluminium with 50.4 mm diameter thickness. These are with white powder Coating (outer surface) finish & are variable height fixed with the ceiling with anchors, bolts, screws etc.

**Curtain Removable Point**
Made of SS for simple loading & unloading of curtains (Also serves as an end hook retainer).

**Runner**
Comprises of wheel type runners made of Teflon for easy and smooth sliding of the curtain.
SPECIFICATION OF
I.V. TREE SYSTEM

Providing, Fabricating and fixing of I.V. Tree System should comprise of the following components and specifications:

Makes: MPS / Tracks2 Curtains / Aristro Helthcare

1) Heavy duty Aluminium track (20mmx35mm) with white powder coated finish.
2) Heavy duty self looking wheel trolley.
3) Telescopic carrier hanger with length variation option.
4) Five point hanger systems made of SS with 6mm thickness. Four hanger points with folding provision.
5) Fifth hanger point is fixed right below the carrier for usage convenience.
6) Roof suspension is made of aluminium pipe of 1.5 mm gauge & 25mm/18mm (Adjustable mechanism) with white powder coated finish.
SECTION I
GENERAL INSTRUCTIONS

1.0 GENERAL REQUIREMENTS

1.1 Scope of Work

1.1.1 The form of Contract shall be according to the “Conditions of Contract”. The following clauses shall be considered as an extension and not in limitation of the obligation of the Contractor.

1.1.2 Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified in the Schedule of Quantities and/or shown on the Plumbing Drawings.

1.1.3 Without restricting to the generally of the foregoing, the sanitary installations shall include the following:

A. Fire Fighting Works
   a. Hydrant System
   b. Sprinkler System
   c. Fire Extinguishers

1.1.4 Services rendered under this section shall be done without any extra charge.

1.2 Specifications

1.2.1 Work under this contract shall be carried out strictly in accordance with Specifications attached with the tender.

1.2.2 Items not covered under these Specifications due to any ambiguity or misprints, or additional works, the work shall be carried out as per Specifications of the latest Central Public Works Department with up to date amendments as applicable in the contract and or as per the requirement of the client or its representative.

1.2.3 Works not covered above in para 1.2.1 and 1.2.2 shall be carried out as per relevant Indian Standards and in case of its absence as per British Standard Code of Practice.

1.3 Execution of Work

1.3.1 The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work. No extra charge made in consequence of any misunderstanding, incorrect information on any of these points or on ground of insufficient description will be allowed.

1.3.2 The work shall be carried out in conformity with the fire drawings and within the requirements of Architectural, HVAC, Electrical, Structural and Other specialized services drawings.

1.3.3 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction schedule.

1.3.4 On award of the work, Contractor shall submit a schedule of construction in the form of a PERT Chart or BAR Chart for approval of the Project Manager/Architect/Consultant. All dates and time

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schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

1.4 **Drawings**

1.4.1 Fire drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings.

1.4.2 Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.

1.4.3 Contractor shall verify all dimensions at site and bring to the notice of the Project Manager all discrepancies or deviations noticed. Decision of the Project Manager shall be final.

1.4.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small scale drawings.

1.4.5 All drawings issued by the Architects/Consultant for the work are the property of the Architects/Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

1.5 **Inspection and Testing of Materials**

1.5.1 Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.

1.5.2 For examination and testing of materials and works at the site Contractor shall provide all Testing and Gauging Equipment necessary but not limited to the followings:-

   a) Theodolite, Steel tapes  
   b) Dumpy level  
   c) Weighing machine  
   d) Plumb bobs, Spirit levels, Hammers  
   e) Micrometers, Tachometers  
   f) Thermometers, Stoves  
   g) Hydraulic test machine  
   h) Smoke test machine

1.5.3 All such equipment shall be tested for calibration at any approved laboratory, if required by the Project Manager.

1.5.4 All Testing Equipment shall be preferably located in a special room meant for the purpose.

1.5.5 Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Architects or kept at site in a sample room as prepared by the owners. Any materials declared defective by Project Manager/Architect/Consultant shall be removed from the site within 48 hours.

1.6 **Metric Conversion**

1.6.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

1.6.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

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1.7 **Reference Points**

1.7.1 Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.

1.7.2 All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

1.8 **Reference Drawings**

1.8.1 The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.

1.8.2 All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by the Project Manager or Architects.

1.9 **Shop Drawings**

1.9.1 The Contractor shall submit to the Project Manager three copies of the shop drawings.

1.9.2 Shop drawings shall be submitted under following conditions:

   (a) Showing any changes in layout in the plumbing drawings.

   (b) Equipment layout, piping and wiring diagram.

   (c) Manufacturer’s or Contractor’s fabrication drawings for any materials or equipment supplied by him.

1.9.3 The Contractor shall submit two copies of catalogues, manufacturer’s drawings, equipment characteristics data or performance charts as required by the Project Manager.

1.10 **Completion Drawings**

1.10.1 On completion of work, Contractor shall submit one complete set of original tracings and two prints of “as built” drawings to the Project Manager. These drawings shall have the following information.

   a) Run of all piping, diameters on all floors, vertical stacks and location of external services.

   b) Ground and invert levels of all drainage pipes together with location of all manholes and connections upto outfall.

   c) Run of all water supply lines with diameters, locations of control valves, access panels.

   d) Location of all mechanical equipment with layout and piping connections.

No completion certificate shall be issued unless the above drawings are submitted.

1.10.2 Contractor shall provide two sets of catalogues, service manuals manufacturer’s drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

1.10.3 All “Warranty Cards” given by the manufacturers shall be handed over to the Project Manager.
1.11. **Contractors Rates**

1.11.1 Rates quoted in this tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

1.11.2 Rates quoted are for all heights and depths and in all positions as may be required for this work.

1.11.3 All rates quoted must be for complete items inclusive of all such accessories, Fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.

1.11.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete/water proofing of appropriate mix and strength as directed by Project Manager. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

1.11.5 The Contractor shall furnish the Architects with vouchers and test certificates, on request, to prove that the materials as specified and to indicate that the rates at which the materials are purchased in order to work out the rate analysis of non tendered items which he may be called upon to be carried out.

1.12 **PAYMENT TERMS**

The terms of payments shall be as below:

- 10% of Contract amount as mobilization advance against submission of Bank guarantee of equivalent amount valid till end of completion period.

- 60% of Contract amount prorata against supply of materials at site.

- 10% Contract amount prorata against erection & Testing.

- 10% on testing, commission & handover of entire system.

10% Contract amount after handing over of all approvals as built drawings designs maintenance manuals and submission of Bank Guarantee of 2.5% and cash deposit of 2.5% of final value of work done (including extra items) valid till successful completion of Defect Liability period.

1.13 **Testing**

1.13.1 Piping works shall be tested as specified under the relevant clause(s) of the specifications.

1.13.2 Tests shall be performed in the presence of the Project Manager/ Consultant.

1.13.3 All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

1.13.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other bye-laws in force.

1.13.5 Contractor shall provide all labour, equipment and materials for the performance of the tests.

1.14 **Site Clearance and Cleanup**

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Contractor’s Signature & Seal
1.14.1 The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

1.14.2 After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

1.14.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors' risk and cost.

1.15 **License Permits and Authorities**

1.15.1 Contractor must keep constant liaison with the Municipal/statutory authority and obtain all approval of all drainage, water supply and other works carried out by him.

1.15.2 Contractor shall obtain, from the Municipal and other authority’s necessary completion certificate(s) with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. Employer shall pay all fees/deposits as required to be paid to the authorities towards connection charges.

1.16 **Recovery of Cost for Materials issued to Contractors Free of Cost**

1.16.1 If any materials issued to the Contractor free of cost, are damaged or pilfered, the cost of the same shall be recovered from the Contractor on the basis of actual cost to owner which shall include all freight and transportation, excise duty, sales tax, octroi, import duty etc. plus 100%. The decision on the actual cost given by the Employer shall be final and binding on the Contractor.

1.17 **Cutting of Water Proofing Membrane**

No walls, terraces shall be cut for making and opening after water proofing has been done without written approval of Project Manager/Architects. Cutting of water proofing membrane shall be done very carefully to ensure that other portion(s) of water proofing is (are) not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Architects.

1.18 **Cutting of Structural Members**

No structural member shall be chased or cut without the written permission of the Project Manager.

1.19 **Materials Supplied by Owner**

1.19.1 The Contractor shall verify that all materials supplied by the Employer confirm to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Project Manager.

1.20 **Materials**

Unless otherwise specified and expressly approved in writing by the Project Manager, only materials of makes and specifications mentioned in the list of approved makes attached with the specifications shall be used.

If required, the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Project Manager and returned to the Contractor at the appropriate time.
SECTION – I

FIRE HYDRANT SYSTEM

1.0 Scope of work

1.1 The scope of work shall cover supply, fabrication, installation, testing and commissioning of the fire hydrant system covering the following but not limited to:

a) Fire Hydrant pumps, electric and diesel driven as shown in the equipment schedule, drawings and as required.

b) Jockey pump, electric driven as shown in the equipment schedule, drawings and as required.

c) Engine Control Panel.

d) Hydrant mains, external ring and yard hydrants.

e) Wet risers in the building as specified and shown on drawings.

f) Landing valves, hose reels, hose cabinets etc.

g) Fire brigade breaching, siamese connections and connections to pumps and appliances.

1.2 The contractor shall get the Fire Fighting System approved by the Chief Fire Officer of Local Fire Service.

2.0 Standards

2.1 The fire hydrant installation shall conform to and meet with the requirements set out by the following:

2.1.1 As relevant IS Code of practice for the safety of buildings (General) fire fighting equipment and its maintenance.

2.1.2 As relevant IS Code of practice for installation of internal fire hydrant in multi-storeyed building.

2.1.3 Compliance with the local fire brigade and the fire enforcing authorities as specifically laid down by them.

3.0 Fire pump

3.1 The fire pump shall be single stage / double stage suction centrifugal type with split casing type and direct driven by electric motor or diesel engine as specified. The pump rating and performance shall conform to the equipment schedule and meet the TAC duty requirements.

3.2 Pump casing shall be of close grained cast iron with bronze impeller. The shaft sleeve shall be brass or SS 304 and the trim shall be brass or bronze.

3.3 Pump shall be capable of delivering 150% of the rated capacity at 65% of the rated head and the no-delivery head shall be not more than 140% (150% in case of end suction type) of the rated delivery head. The pump casing shall withstand 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.

3.4 The pump shall be either electrically driven or diesel driven with direct flexible coupling.

3.5 The electric drive motor shall be squirrel cage induction conforming to IS 325 - 1978 and rated for continuous duty (S1). Motor shall have not less than class F insulation and minimum enclosure of IP22. The starter shall be air cooled fully automatic star delta or auto transformer type. Starters shall conform to IS 8544 and rated for AC-3 duty conditions.

3.6 Drive rating shall be based on the largest of the following:

a) Rated pump discharge at rated head

b) 150% of rated discharge @ 65% of rated head
c) Maximum power absorbed by the pump in its operating range i.e. no-delivery to free discharge.

The diesel engine shall be naturally aspirated (non-turbocharged) and electrically started. The engine shall be complete with starting batteries full-wave selenium rectifier charger, isolator, leads, mounting frame etc. Engine rating shall be same as for the electric motor. The detailed specifications of the engine are at Clause no 6.0.

4.0 Accessories
4.1 The Fire Pumps shall be complete with the following accessories:
   a) Suction and discharge eccentric reducers
   b) Pump coupling guard
   c) Common base frame, fabricated mild steel or cast iron.

4.2 Each pump shall have independent set of pressure switches. The pressure switch shall be snap action SP DT switch rated 10A @ 220 V operated through a stainless steel diaphragm. The switch shall have a pointer for manual adjustment of set point, and all electrical connections shall be terminated in a screwed terminal connector. The entire unit shall be encased in a cold drawn steel (heavy gauge) enclosure. The diaphragm shall be designed for a maximum operating pressure of the system. Each pressure switch shall be provided with a pressure gauge in parallel as shown on the drawings and all gauges and pressure switches shall be mounted in an instrument panel with necessary control piping and drainage facility.

5.0 System operation and control panels
5.1 The fire pump shall be started automatically on loss of pressure and the operation sequence of the booster and fire pumps shall be as follows:
   a) Jockey Pump shall start when the system pressure drops by 0.35 kg/cm² and stop when the system pressure is re-established.
   b) The Fire Pump shall start when the system pressure drops by 1.0 kg/cm² and shall continue to run till manually switched off.
   c) Jockey and fire pump starting shall be indicated on the panel with a red indication lamp.

5.2 The motor starters (direct on line or star-delta) shall consist of electrically actuated contactors. The starter shall be complete with ON-OFF push buttons, timers and auxiliary contacts and shall be fully automatic. There shall be an indicating lamp with each of the pumps and an ammeter and selector switch with the fire pumps. Fire pump starting shall be annunciated through an electric siren.

5.3 The starter along with isolator shall be housed in a 14 SWG MS box duly rust inhibited through a process of degreasing and phosphating.

5.4 All cabling to and from the pumps to starter and control switch shall be carried out through armoured PVC cables of approved makes. Cables shall be laid in accordance with section "M V CABLING". The pump motors and panels shall be double earthed in accordance with IS 3043-1966 or as shown on drawings and as approved.

6.0 Diesel Engine
6.1 The diesel engine shall be of multi cylinder type four stroke cycle with mechanical (airless) injection, cold starting type.

6.2 The engine shall be designed with regard to ease of maintenance, repair, cleaning and inspection. This will also provide interchangeability of parts.

6.3 All parts susceptible to temperature changes shall have tolerance for expansion and contraction without resulting in leakage, misalignment of parts or injury to parts.

6.4 The engine shall be capable of both automatic and manual start. Generally the engine shall start

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automatically, but in case of the auto-start system failure the engine shall be capable of manual start. Engine shall be able to start without any preliminary heating of combustion chamber; cranking mechanism shall also be provided. All controls/mechanisms which have to be operated in the starting process, shall be within easy reach of the operator. A day oil tank constructed from minimum 1.6 mm thick sheet MS sheet of 200 litres capacity shall be provided as per Engine manufacturer’s guide line.

6.5 A high torque D.C. motor charged by battery shall initiate automatic start of diesel engine. The battery shall hold adequate retainable charge to provide the starting of the diesel engine. Starting power will be supplied from storage batteries. The battery capacity shall be adequate for ten consecutive starts without recharging with a cold engine under full compression. Battery shall be lead acid type of 12 V, 180 Ah capacity.

6.6 The battery banks shall be used for no other purpose other than starting of the engine and shall be fully charged at all times with provision for trickle & boost chargers. After start of the engine the charger shall be disconnected, the battery being fed from the engine dynamo.

6.7 The engine shall have a speed control device (Governor) which will control the speed under all conditions of load. The governor shall be suitable for operation without external power supply.

6.8 The Engine shall an adjustable governor to regulate engine speed within a range of 10% between shut-off and maximum load conditions of the pumps. The governor shall be set to maintain rated pump speed at maximum pump load.

6.9 The Governor shall have an over speed shutdown device to shutdown the engine at a speed approximately 20% above rated engine speed with manual reset, so that the automatic engine controller will indicate an over speed signal until the device is manually reset to normal operating position.

6.10 The Diesel Engine shall cooled by a Heat Exchanger and the Contractor shall be make arrangement for continuous supply of such water.

6.11 The engine shall be mounts on a base plate of fabricated steel construction. Adequate access shall be provides to the big end and main bearings, camshaft and governor drives, water jackets etc.

6.12 The engine shall have a base plate made from M S sections. There shall be reasonable space at the big end, camshaft, water jackets, governor drives and main bearings.

6.13 The engine shall be provides with intake and discharge ductwork, inlet filter and silencer, outlet muffler, expansion joints, dampers etc. as necessary for efficient operation. Intake air shall be taken from inside the building in which the engine is located, but the exhaust shall be discharged into the air.

6.14 The diesel engine shall be provides with adequate instrumentation. The gauges etc. as required are provides for in the Engine Panel.

7.0 Diesel Pump Panel:

7.1 The Panel shall consist of the following:

7.1.1 Engine Starting System:
It shall be provided with a Lead Acid of minimum 180 Ah capacity to provide adequate throttle for starting.

7.1.2 Engine Instruments and Control Panel:
It shall be complete with required connections to set and comprising:
Inlet and outlet water temperature gauge (dial type)
Lubrication oil pressure gauge.
Lubrication oil Temperature gauge.
Automatic Start Stop Device.
The Engine shall be provided with Manual Start / Stop Switch by means of Push Buttons.
Start Stop and Failure Control Device.
Start key for manual starting.
Stop Push Button for manual stopping of engine.
Starting failure indication by lamp and Horn Unit.
Engine temperature control with failure indication by red lamp.
Engine temperature very high indication by audio alarm and automatic stopping of engine.
Engine set in operation indication by green lamp.
Mains supply available indicated by yellow lamp.
Push Button for Audio Alarm reset.
Push Button Failure Indication by lamps.
The Panel shall also have an Auto / Manual / Test / Off Selector Switch.

8.0 Fire hydrants and hose reels

8.1 Hydrants shall be provided internally and externally as shown on the drawings. Internal hydrants shall be provided at each landing of an escape staircase and additionally depending on the floor area as shown on drawings. Landing valve shall be single headed gunmetal valve with 63 mm dia outlets and 80mm inlet conforming to IS 5290-1969. Landing valve shall have flanged inlet and instantaneous type outlets and mounted at 1.0m above the floor level. Instantaneous outlets for the hydrants shall be of standard pattern approved and suitable for 63mm dia fire brigade hoses. Wherever necessary, pressure reducing orifices plate and shall be provided so as to limit the pressure to 3.5 kg/sqcm or any other rating as required by the Local Fire Authority.

8.2 Each landing valve shall have a hose reel cabinet as shown on drawings.
   a) Landing valve with single 63 mm dia outlet and 80 mm dia inlet.
   b) First-aid hose reel with 30 m long 25 mm dia high pressure double braided rubber hose (IS:444 marked) with 25 m dia Ball Valve.
   c) 2 Nos. 15.0 Meter long 63 mm dia Reinforced Rubber Lined (RRL) hoses with gun metal I.S. marked instantaneous couplings.
   d) One gun metal branch pipe.

8.3 The First Aid Hose shall conform to IS 884-1969 and be wound on a heavy duty circular hose reel with a bracket. The hose shall be permanently connected on one end to the Wet Riser through a 25m Ball Valve with necessary hose adapter and a gun metal nozzle at the other end.

8.4 Hoses shall be in two lengths of 15.0 m each, of RRL type with instantaneous couplings, neatly rolled into bundles and held in position with steel brackets. Hoses shall be tested and certified by the manufacturer, to withstand an internal water pressure of not less than 35 kg/sqcm without bursting. The hose shall also withstand a working pressure of 7 kg/sqcm without leakage.

8.5 The hose cabinet shall be fabricated from 2mm mild steel sheet duly rust inhibited through a process of degreasing and phosphating. The cabinet shall have double flap hinged doors with 4mm clear glass and shall have necessary openings for riser main and brackets for all internals. The cabinet shall receive two coats of red oxide primer both inside and outside before two after coats of final paint of approved colour shade.

8.6 External hydrants shall be as per IS : 5490 with hand wheel control and a 80 mm dia pipe stand post. Hydrants shall be located at least 2m away from and within 15m from the building wall.

8.7 Each hydrant shall be provided with a hose cabinet containing 2x15m 63 dia RRL hoses with couplings. The cabinet shall contain a branch pipe and nozzle. The cabinet shall be 900 x 600 x 400 fabricated out of 2 m mild steel sheet duly rust inhibited through a process of degreasing, phosphating etc. The cabinet shall receive two coats of red oxide primer, inside and outside,
before 2 coats of final painting of approved shade. The cabinet shall be wall-mounted or free standing with its own steel legs depending on the site conditions and as shown on drawings and as approved.

8.8 The fire brigade connection shall consist of two / three/four headed as specified in BOQ 63mm dia gun metal outlets with built-in check valve and drain plugs connected to a 150mm dia outlet connection to the water reservoir or to the hydrant main. The fire brigade collecting head shall conform to IS 904-1965.

9.0 Test & commissioning

9.1 The Jockey & fire pump starting and stopping shall be tested by opening the test valve and record the following and the valves should be as furnished below:

1) Jockey pump start/stop
   - System pressure at start-up : 5.0 kg/sqcm
   - System pressure at stop : 7.0 kg/sqcm
   - Time elapsed from start to stop : 2 Seconds

2) Hydrant Pump start
   - System pressure at start-up : 4.0 kg/sqcm

3) Diesel Engine Pump start
   - Pressure : 3.0 Kg/sqcm

9.2 Maintained system pressure while discharging the landing valve at the highest point.

   a) Pump end : 7.0 kg/sqcm
   b) Highest outlet : 3.5 kg/sqcm
   c) Intermediate points : 5.0 kg/sqcm

10.0 Mode of measurement

Hydrant pump with mounting frame, excluding concrete foundation shall be measured per unit. Jockey pumps same as hydrant pump.

Instrument panel with pressure gauges, pressure switches, control piping etc. shall be measured as one unit.

Control cabling from pressure gauge panel to the respective starters shall be measured in running meter and paid at unit rates.
SECTION II

PIPING FOR FIRE FIGHTING SYSTEM

1.0 Scope
1.1 The scope of work covers, supply, fabrication, laying, testing, painting and commissioning of the entire piping system for the fire fighting installation i.e. fire hydrant and sprinkler systems.

2.0 Piping

2.1 External
2.1.1 All External pipes shall be, unless otherwise specified, heavy quality mild steel tubes to IS 1239 using wrought GI steel heavy duty screwed fittings. Flanges shall be provided to mate with valves and other equipment and shall conform to IS 6392. Flanges shall be screwed type. Flanges shall be rated for 2.0 N/sqmm.

2.1.2 Black mild steel pipes, when laid underground, shall be protected against corrosion by two coats of hot bitumen and 2mm thick wrapping of pykpote. Fittings shall be weld able wrought iron, suitable for butt welding and 10% of the welded joints shall be radio graphically tested and found in order. The welded joints shall be random selected for testing in consultation with the Engineer in-charge. All flanges shall be slip-on welded type to IS 6392 with a 3mm fibre-reinforced teflon gasket and rated for 2.0 N/sq.m, mm.

2.1.3 Underground mains shall be laid not less than 750 mm below the ground level and shall be at least 2m away from the building face and supported on concrete pedestals at every 3.5m and held on with galvanised iron clamps. Concrete thrust anchors shall be provided at all bends and tees as shown on drawing and as directed. All excavation for pipe laying shall be carried out with sufficient width for making proper joints. Backfilling shall be done only after the piping is hydro-statically pressure tested. Piping shall be constantly kept clean till tested.

2.1.4 All valves shall be housed in brick masonry chambers over 150mm cement concrete (1:3:6) foundation. The brick walls of the chamber shall be plastered inside and outside with 20mm cement sand plaster 1:4 with a floating coat of neat cement. Chambers shall be 650 x 650 mm clear for depths upto 1200 mm and 1000 x 1000 mm for depths beyond. Each chamber shall have a cast iron surface box approved by the Engineer in-charge.

2.1.5 Piping laid above ground shall be supported on cement concrete (1:2:4) pedestals raising the bottom of the pipe at least 150mm over the ground level and held to the pedestals with galvanised steel brackets. Pedestals shall be made at 3.0m centre to centre and as shown on drawings. Cement concrete 1:2:4 thrust anchors shall be provided at all tee-off points and change of direction as shown on drawings and as required. Pipes laid on walls and ceiling shall have galvanised steel brackets.

2.2 Internal
2.2.1 All internal pipes shall be, unless otherwise specified, heavy quality mild steel tubes to IS 1239 using wrought steel heavy duty screwed fittings. Flanges shall be provided to mate with valves and other equipment and shall conform to IS 6392. Flanges shall be screwed type. Flanges shall be rated for 2.0 N/sqmm.

2.2.2 Valves shall be suitable for external piping.

2.2.3 All pipes shall be of approved make and best quality without rust marks. Pipes and fittings shall be fixed in a manner as to provide easy accessibility for repair, maintenance and shall not cause obstruction in shafts, passages etc. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanship manner. Pipes shall be securely fixed to walls and ceilings by suitable supports at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceiling and walls.

2.2.4 All pipes shall be adequately supported from ceiling or walls through structural supports fabricated from mild steel structural e.g. rods, channels, angels and flats generally as shown on drawings. Fasteners shall be shear type anchor fasteners in concrete walls and ceilings and wrought steel spikes of at least 75mm long in brick walls. All pipes supports shall be painted with 1 coats of red oxide primer and two coats of black enamel paint.

2.2.5 All low point loops in the piping shall be provided with 25mm Ball Valves with rising spindle for draining the system. All valves shall have screwed brass caps. Likewise 25mm gun metal air vents shall be provided at all high point loops to prevent air-locking.

2.2.6 All piping shall have flanged joints at about 25m intervals to facilitate easy maintenance.

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3.0 Pipe Jointing
3.1 All pipes shall be provided with threaded joints up to 50mm diameter and welded joints for pipe above 50mm diameters. Hold tite shall be used for sealing.
3.2 All welded joints shall be tested by radiography test.
3.3 Joints between CI and GI pipes shall be made by providing a suitable flanged tail or socket piece and MS flange on the GI pipe. Flanges shall have appropriate number of holes and shall be fastened with nuts, bolts and 1.5mm thick compressed asbestos gasket.

4.0 Valves and other accessories
4.1 Gate Valves
4.1.1 Sluice / Gate valves shall be used for isolation of flow in pipe lines For sizes upto 65 mm, gate valves shall be outside screw rising spindle type and shall be as per IS: 778 Class-I and Class-II, as applicable. For sizes 80 mm to 300 mm, gate valve shall be as per IS: 780, PN=1.0 and shall be of inside screw and non rising type and cast iron double flanged.
4.1.2 Gate valves shall be provided with a hand wheel, draining arrangement of seat valve and locking facility (as required). Gate valves shall have back setting bush to facilitate gland renewal during full open condition.
4.1.3 The Body, bonnet, Stuffing Box, cap and hand wheel shall be of cast iron to IS:210/70, grade FG 200 / 260. The non rising spindle shall be of solid forged high tensile brass or carbon steel to AISI 304 construction. The Body seating and wedge ring shall be of solid leaded gun metal. The Bonnet gasket shall be of high quality rubber.
4.1.4 The Valve shall be PN 1.0 rated but shall withstand tests of upto 20 kg / cm^2. The ends shall be flanged. The batch number of the valve shall be punched on the top of the flange. The spindle shall be removable type, and shall be easily rotated.
4.2 Pressure Switch
4.2.1 The Pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm type. It shall be suitable for line pressures upto 15 kg / cm2. The scale range for cut in and cut out shall be from 0 to 10 kg / cm2.
4.2.2 The Switch shall be suitable for consistent and repeated operations without change in values. It shall be provided with IP:66 water and environment protection.
4.2.3 The enclosure shall be of aluminium and pressure element and wetted parts shall be of stainless steel. The switch shall be snap acting type with 1 number N O / N C contact.
4.3 Air Vessel
4.3.1 Air vessel shall be fabricated from 6 mm thick, 300mm x 1000mm MS plate suitable for 7kg/cm^2 working pressure complete with air release valve, safety valve, pressure gauge etc. as required. The air vessel shall be continuous welded construction and painted with two coats of Postal red enamel outside over a coat of primer and epoxy paint inside.
4.4 Pressure Vessel
4.4.1 The Pressure Vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter acting pressure surges whenever the pumping set comes into operation. It shall be normally partly full of water, the remaining being filled with air which will be under compression when the system is in normal operation.
4.4.2 Pressure vessel shall be fabricated from 8-10 mm thick MS plate with dished ends and suitable supporting legs. It shall be provided with a 50 mm dia flanged connections from pump, one 25 mm drain with ball valve, one water level gauge and 25 mm sockets for pressure switches. The pressure vessel shall be hydraulically tested as required.
4.4.3 The Pressure Vessel shall be for Hydrant Systems. The Pressure Switches shall be mounted on the drain end of each Vessel. The Vessel shall also be provided with an air release valve mounted at the top.
4.5 Pressure Gauge
4.5.1 The Pressure Gauge shall be constructed of die cast aluminium and stove enameled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type Pressure Gauge with a scale range from 0 to 16 Kg / CM2 and shall be constructed as per IS: 3624. Each Pressure Gauge shall have a siphon tube connection. The Shut off arrangement shall be by Ball Valve.
4.6 Ball Valve

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4.6.1 The Ball Valve shall be made from die cast brass and tested to 14 Kg/cm² pressure.
4.6.2 The valve shall be internally threaded to receive pipe connections.
4.6.3 The Ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body- bonnet gasket and gland packing shall be of Teflon.
4.6.4 The handle shall be of chrome plated steel with PVC jacket. The handle shall also indicate the direction of ‘open’ and ‘closed’ situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping upto 14 Kg / cm² pressure.
4.6.5 The handle shall also be provided with a lug to keep the movement of the ball valve within 90 degree. The lever shall be operated smoothly and without application of any unnecessary force.

4.7 Non Return Valve
4.7.1 Non-return valves shall be cast iron spring action swing check type. An arrow mark in the direction of flow shall be marked on the body of the valve. The valve shall bear IS:531 certification.
4.7.2 The Valve shall be of cast iron body and cover. The internal flap in the direction of water shall be of cast iron and hinged by a hinge pin of high tensile brass or stainless steel. Cast iron parts shall be conform to IS:210 / 70, grade 200 / 260 type.
4.7.3 The gasket shall be of high quality rubber and flap seat ring of leaded gun metal to BS 1400 LG 2C. At high pressure of water flow the flapper shall seat tightly to the seat. The Valve shall be capable of handling pressure upto 15 kg / cm².

4.8 Butterfly Valve
4.8.1 The Butterfly Valve shall be suitable for waterworks and tested to minimum of 16 kg / sq cm pressure. The Valves shall fulfil the requirements of AWWA (American Water Works Association) C 504, API 609 and MSS-SP-67.
4.8.2 The body shall be of cast iron to IS:210 in circular shape and of high strength to take the minimum water pressure of 10 kg / cm². The disc shall be heavy duty cast iron with anti corrosive epoxy or nickel coating.
4.8.3 The valve seat shall be of high grade elastomer or nitrile rubber. The Valve in closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be of EN 8 grade carbon steel.
4.8.4 The Valve shall be fitted between two flanges on either side of pipe flanges. The Valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakage.
4.8.5 The Valves shall be supplied with manual gear operated opening / closing system by lever.

5.0 Pipe supports
All pipes whether horizontal or vertical shall be suitably supported using galvanized mild steel clamps/clevis hanger manufactured by M/s Hitech Support (India) Pvt Ltd or equivalent product of good quality as approved by engineer in-charge.

5.1 Vertical Pipes
5.1.1 The pipes running vertical shaft shall be supported by galvanized mild steel rigid clamps fixed to wall with anchor bolts and studs.
5.1.2 When the horizontal distance between the centre line of two adjacent pipes is less than 300 mm a powder coated HITECH/or equivalent rail shall be fixed to wall the pipes independently clamped to the rail with ‘U’ bolt clamps.

5.2 Horizontal Pipes
5.2.1 Pipes running horizontal shall be supported from structural beam/slab by using appropriate galvanised m.s. pipe clevis hangers.
5.2.2 The spacing of supports shall be as follows:

<table>
<thead>
<tr>
<th>GI Pipes/MSP Pipes</th>
<th>CI Spun Pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal Dia (mm)</strong></td>
<td><strong>Spacing (mm)</strong></td>
</tr>
<tr>
<td>15</td>
<td>1800</td>
</tr>
<tr>
<td>20,25</td>
<td>2400</td>
</tr>
<tr>
<td>32</td>
<td>2700</td>
</tr>
<tr>
<td>40-50</td>
<td>3000</td>
</tr>
<tr>
<td>65-80</td>
<td>3600</td>
</tr>
<tr>
<td>100</td>
<td>4000</td>
</tr>
</tbody>
</table>

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5.2.3 Supports for horizontal piping longer than 15m in a stretch shall be provided with swivel clamps. Otherwise, the clamps shall be universal clamps or rigid clamps as required by the project engineer.

5.3 Fixing of clamps/rails etc.
All clamps, rails and accessories shall be fixed to the structure (beam, slab, walls etc.) by using approved good quality anchor fasteners of appropriate size.

6.0 Painting

6.1 All exposed piping for fire fighting shall be distinctly painted 'Fire red' shade 536 to IS:5-1978. Pipes shall first receive two coats of red oxide primer uniformly applied and two coats of oil paint applied thereafter. All pipes supports shall be painted black as specified for support & clamps.

6.2 Painting Schedule

6.2.1 All equipment and piping shall be painted in accordance with the following colour code:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Colour</th>
<th>Distinguishing Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Pump motors</td>
<td>Fire Red Shade</td>
<td>No.536 to IS: 5-1978</td>
</tr>
<tr>
<td>b) Internal piping</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>c) Landing valves &amp;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>Hose reel cabinets</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>d) External Hydrants</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>e) Fire brigade connection</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>f) Priming tank</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>g) Air vessel</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>h) Electric panels</td>
<td>Black &amp; Red</td>
<td></td>
</tr>
<tr>
<td>i) Fire Alarm Panel</td>
<td>Black &amp; Red</td>
<td></td>
</tr>
<tr>
<td>j) Repeater panel</td>
<td>Black &amp; Red</td>
<td></td>
</tr>
<tr>
<td>k) Break Glass Unit</td>
<td>Fire Red</td>
<td></td>
</tr>
<tr>
<td>l) Hooters/Speakers</td>
<td>Fire Red</td>
<td></td>
</tr>
<tr>
<td>m) Sprinkler pipes</td>
<td>Fire Red</td>
<td></td>
</tr>
</tbody>
</table>

6.2.2 All surfaces to be painted shall be thoroughly cleaned with wire brush to remove completely rust and other extraneous substances. Over the cleaned surfaces one coat of red oxide primer shall be applied completely covering the exposed surfaces. Finishing coat of enamel paint shall be applied one day after the prime coat, after ensuring that the paint is dry. The second coat shall be done before the installation is handed over and after approval to do so from the Engineer-in-charge.

7.0 Testing & Commissioning

All piping after installation shall be tested for a hydrostatic test pressure of 10.5 kg/sqcm or 1.5 times the working pressure (whichever is less) maintained for 24 hours. All joints and valves shall be checked for leaks and rectified and retested. During testing all valves except drain & air valves shall be kept fully open.

8.0 Makes of Materials

For makes of materials refer to list of approved makes of material.

9.0 Mode of Measurement

9.1 All external piping shall be measured along the centre line of the pipe and paid per unit length and shall include:

9.1.1 All pipes & fittings

9.1.2 Bituminous coating

9.2 All internal piping shall be measured similarly but shall include for the pipe supports and clamps.

9.3 All valves, air valves, drain valves together with flanges or tail pieces shall be measured per unit.

9.4 All excavation and concrete supports and thrust blocks shall be measured as per drawing and paid for per cum.

9.5 The cost of pipe supports described above form part of the rate quoted for piping and no extra shall be payable on the account.

All painting shall form part of the cost of equipment piping etc. No separate payment shall be admissible.
SECTION - III
SPRINKLER SYSTEM

1.0 Pendant type Sprinkler Head
1.1 Sprinkler heads shall be of quartzoid bulb type with bulb, valve assembly, yoke and the deflector. The sprinkler shall be of approved make and type with 15 mm nominal dia outlets.
1.2 The bulb shall be made of corrosion free material strong enough to withstand any water pressure likely to occur in the system. The bulb shall shatter when the temperature of the surrounding air reaches at 68°C / 79°C.
1.3 The nominal bore shall be 15 mm dia and colour of liquid shall be Red / Yellow.
1.4 The Sprinkler head shall be approved by UL / FM.

2.0 Upright type Sprinkler Head
2.1 Upright sprinkler heads shall be similar to Pendent type in material construction and performance but designed to throw water Droplets upwards in umbrella fashion, to cool the underside of ceiling and extinguish any fire involving combustibles on the floor below.
2.2 The Sprinkler head shall be approved by UL / FM. The nominal bore shall be 15 mm dia and the colour of liquid shall be red.
2.3 Upright Sprinkler heads shall be use in lower and upper basement parking areas and above the false ceiling.

3.0 Side Wall type Sprinkler Head
3.1 Side wall sprinkler heads shall be similar to Pendent type in material construction and performance but designed to throw water Droplets horizontally.
3.2 The Sprinkler head shall be approved by UL / FM. The nominal bore shall be 15 mm diameter and the colour of liquid shall be red.
3.3 Side wall sprinkler heads shall be use in staircase landing and along the ramp.

4.0 Powder coated Sprinkler with Powder coated Twin plate Rosette.
4.1 Most areas below false ceiling shall be provided with powder coated pendant sprinkler with twin plate sliding rosette. The sprinkler head shall be same as Pendent type above but powder coated white. The sprinkler head shall be provided with a double plate powder coated rosette that shall seal the gap between the false ceiling and he sprinkler head.
4.2 The adjustment allowable shall be 12 mm. The lower part shall have flared ends that shall fit tightly into the upper piece.
4.3 The Sprinkler head shall be approved by UL / FM. The nominal bore shall be 15 mm diameter and the colour of liquid shall be red.

5.0 Installation Control Valve for Sprinkler
4.1 The Installation Control Valve shall be double seated clapper type check valve. The Body and cover shall be made from Cast Iron to IS:210 Grade FG 200. The seat and seat clamp shall be made from bronze to IS: 318, LTB II grade. The sealing to the seat shall be neoprene gasket. The hinges pin and ball shall be from stainless steel.
4.2 It shall be vertically mounted and the direction of water travel shall be indicated on the surface. It shall be rated to 12 Kg / cm² and tested to 25 Kg / cm² pressure.
4.3 A By-pass check valve shall be fitted to adjust minor and slow variations in water pressure for balancing so as to avoid any false alarm.
4.4 The valve shall also be provided with a Test Control Box. The Box shall house a lever to test and operate the ICV. A brass strainer shall also be provided at the point of water supply to the Alarm gong. A Retarding Chamber shall also be provided.
4.5 The Chamber shall be able to balance the water pressure in case of water line surges.
4.6 Each Installation Control Valve shall have two sets of Pressure Gauges with brass ball valve type shut off.
4.7 A Water Motor Alarm. shall also be provided. This shall be mechanically operated by discharge of water through an impeller. The drive bearing shall be weather resistant. A strainer shall be provided on line before the nozzle. The Gong piece shall be constructed from bronze to IS 318, 2 TB II Grade, and base of cast iron. The Motor Housing, Rotor and Housing Cover shall be pressure die cast aluminium.
6.0 Flow Switch
6.1 Flow switch shall have a paddle made of flexible material of the width to fit within the pipe bore. The terminal box shall be mounted over the paddle / pipe through a connecting socket. The Switch shall be potential free in either N O or N C position as required. The switch shall be able to trip and make / break contact on the operation of a single sprinkler head. The terminal box shall have connections for wiring to the Annunciation Panel. The seat shall be of stainless steel. The Flow Switch shall have IP:55 protection.
6.2 The Flow Switch shall work at a minimum flow rate of 100 LPM. Further, it shall have a 'Retard' to compensate for line leakage or intermittent flows.

7.0 Makes of materials
For makes of materials refer to list of approved makes of material.

8.0 Mode of measurement
8.1 Sprinkler head including supports and clamps for fixing shall be measured as unit.
8.2 All alarm control valves including drain valves, butterfly valve and all other accessories together with flanges or tail pieces shall be measured per unit.
8.3 All floor control valves including drain valves, butterfly valve, sight glass and all other accessories together with flanges or tail pieces shall be measured per unit.
SECTION - IV
PORTABLE FIRE EXTINGUISHERS & EXIT SIGNAGES

1.0 Scope
1.1 The scope of work covers the supply and installation of portable fire extinguishers. The following
types are envisaged in these specifications and provided as shown in the schedule of portable fire
extinguishers.
1.0.1 Dry powder extinguisher
1.0.2 Carbon-dioxide extinguisher
1.0.3 Mono ammonia phosphate extinguisher
1.0.4 Water expelling type.

2.0 Standards
2.1 The following standards and rules and regulations shall be applicable:
2.1.1 Fire protection manual of the tariff advisory committee, Fire Insurance Association of India
2.1.2 IS:2176 :Portable fire extinguisher Dry power type
2.1.3 IS:2878 :Portable fire extinguisher carbon-dioxide type
2.1.4 Local Fire Brigade/Authority
2.2 All standards mean the latest.

3.0 Extinguishers
3.1 Dry powder type
3.1.1 The extinguishers shall be 2, 5, 10 kg capacity and cartridge type unless specified otherwise.
3.1.2 The body shall be of cold rolled carbon steel grade D and 1.5mm thick upto 5 kg and 2mm for 10 kg.
The construction shall be similar to `Soda Acid type' but of the following dimensions.

<table>
<thead>
<tr>
<th>Capacity (kg)</th>
<th>Outside dia (mm)</th>
<th>Filler opening (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00</td>
<td>100</td>
<td>45</td>
</tr>
<tr>
<td>5.00</td>
<td>150</td>
<td>45</td>
</tr>
<tr>
<td>10.00</td>
<td>175</td>
<td>45</td>
</tr>
</tbody>
</table>

3.1.3 The discharge fitting shall be with 500mm 10mm dia hose upto 5 kg and 750 mm 12.5 mm dia for 10 kg with a trigger controlled nozzle capable of discharging 85% of the contents as follows:

<table>
<thead>
<tr>
<th>Capacity (kg)</th>
<th>Time (Sec.)</th>
<th>Throw (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00</td>
<td>8 - 10</td>
<td>2</td>
</tr>
<tr>
<td>5.00</td>
<td>15 - 20</td>
<td>4</td>
</tr>
<tr>
<td>10.00</td>
<td>23 - 30</td>
<td>6</td>
</tr>
</tbody>
</table>

3.1.4 A carbon dioxide cartridge conforming to IS:4947 shall be fitted in a cartridge holder with an inner
shell. A spring loaded piercing device shall be provided in the cap for piercing the seal of the gas
cartridge. A syphon tube of copper or PVC shall be provided for upright operation. The cap and neck
ring shall be similar to Soda Acid type extinguisher.
3.1.5 All internal and external components and surfaces shall receive anti-corrosive coating of not less than
12 microns shall be applied uniformly as indicated below:

a) Body Mild steel Tin alloy
b) Cage for acid Brass sheets Lead or tin alloy

3.2 Carbon dioxide type
3.2.1 The extinguishers shall be rated for 2.0 and 4.5 kg by weight or carbon dioxide, unless stated
otherwise. The contents shall be with a filling ratio not exceeding 0.667.
3.2.2 The body shall be steel cylinder made according to IS:2872 and approved by the chief controller of
explosives.
3.2.3 The discharge head shall be simple and safe to operate conforming to IS:3224 with a safety release to
IS:5903 set to 18.0 to 20.0 N/sqmm. A syphon tube of copper or PVC shall be fitted. A non-conducting
discharge horn and a high pressure hose (27.5 N/sqmm pressure) shall be fitted with each extinguisher.
3.2.4 The discharge system shall be designed to expel 95% of the contents in continuous discharge as follows:

<table>
<thead>
<tr>
<th>Capacity (kg)</th>
<th>Time (Sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>8 - 18</td>
</tr>
<tr>
<td>3.0</td>
<td>10 - 20</td>
</tr>
</tbody>
</table>

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3.3 Mono ammonium phosphate type
3.3.1 The capacities envisaged are 2 kg & 5 kg. The filling pressure shall be 0.95 +/- 0.055 N/sqmm.
3.3.2 The body shall be cylindrical in shape and made of cold rolled carbon steel grade D/DD or hot rolled steel plate with radiographically tested welded construction. Plate thickness shall conform to IS:11108.
3.3.3 Discharge valve mechanism shall be a simple and safe squeeze grip valve. 4.5 kg and above capacity shall have a high pressure (0.5 N/sqmm) hose and non-conducting horn and shall also be provided with a pressure gauge. 95% of the contents shall be discharged as follows:

<table>
<thead>
<tr>
<th>Capacity (kg)</th>
<th>Time (sec)</th>
<th>Throw (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.00</td>
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3.3.4 The internal and external components and surface shall be treated for anti-corrosion as for dry powder type extinguishers.

3.4 Water CO₂ Fire Extinguisher
3.4.1 The extinguishing medium shall be primarily water stored under normal pressure, the discharge being effected by release of carbon dioxide gas from a 60 gms cylinder.
3.4.2 The capacity of the cylinder when filled shall be 9 litres +/- 5 %.
3.4.3 The cylinder shall be fabricated from MS sheet, welded at seams, with dish and dome, being of same thickness and of size not exceeding the diameter of the body. The neck shall be externally threaded with leaded tin bronze.
3.4.4 The cap shall be of leaded tin bronze. The siphon tube shall be of brass or GI. The cartridge holder, knob, discharge fittings and plunger shall be of leaded tin bronze and plunger of stainless steel with spring also of stainless steel. The discharge tube shall be of braided nylon, of 10 mm dia and 600 mm length with a brass nozzle.
3.4.5 The extinguisher shall be treated for anti corrosion internally and externally and painted fire red externally. The cartridge shall be IS marked. The Extinguisher body shall be tested to 25 bar pressure for 2 minutes. The Extinguisher shall be IS:940 marked.

3.5 General requirements
3.5.1 All extinguishers shall be standard products approved by the Tariff Advisory Committee and Local Fire Authority and manufactured and tested strictly in accordance with the relevant Indian Standard. All markings and test results shall be stamped in the appropriate colour markings accordingly to the Indian Standards.
3.5.2 All extinguishers shall have a structurally designed galvanised steel handle and also a suitable wall mounting bracket.

4.0 Illumination signs/EXIT signage
The illuminated signs shall have the letters 'FIRE EXIT' or "NO FIRE EXIT" painted in red on a 6mm thick white perspex sheet as the front face of a sheet steel enclosure constructed with minimum 1.5mm thick sheet. The MS box shall be powder coated finished in white colour. The perspex sheet shall be back lit with a rechargeable maintenance free sealed battery integral with a battery charging circuit. The battery backup facility shall operate independent of the mains supply in the event of a mains failure. The batteries shall be of adequate rating so as to support the illumination of the signage for a minimum period of 1 hour without mains power. The preferred dimensions of the illuminated signs shall be 450 mm length and 225mm height with 100 mm high lettering. They shall be suitable for surface or recessed mounting or ceiling hung type as required including all arrangements for suspension, cutting/chasing and making good the defects etc. complete as approved.

5.0 Mode of measurement
5.1 Each extinguisher with its mounting bracket shall be measured per unit and paid for.
5.2 Exit signages with mounting plate shall be measured per sq.inch and paid for.

6.0 Makes of Equipment and materials
Refer to list of approved makes.
SECTION - V

ELECTRICAL WORK

1.0 Scope

1.1 The scope of this section comprises of fabrication, supply, erection, testing and commissioning of electric panels, wiring and earthing of all equipment components and accessories, including supply, installation and wiring of remote mounted push button stations.

1.2 All the electrical cables, termination, wires and accessories are also including in the Scope of Work. The main cable from the main distribution board will be supplied and erected by other Agency.

2.0 General

2.1 Work shall be carried out in accordance with the specifications of CPWD specifications, Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended up to date.

3.0 Construction Features

3.1 The control panel shall be metal enclosed sheet steel cubical, indoor type, floor mounting/wall mounting type as per BS 5486 Part 1, 190 & IEC 439-1. The control panel shall be totally enclosed, completely dust and vermin proof, Gaskets between all adjacent units and beneath, covers shall be provided to render the joints dust proof. Control panels shall be arranged in multitier formations. All doors and covers shall also have sealing & pad locking arrangement. All mild steel sheets used in the construction of control panels shall be minimum 2mm. thick or as specified and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all slag grounded off and welding pits wiped smooth with plumber metal.

3.2 All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal provided with hank nuts. Self threading screws shall not be used in the construction of control panels. Base channel shall be of 75mm x 40mm x 5mm thick shall be provided at the bottom. Minimum clear space of 250 mm between top of channel of control panel and bottom most unit shall be provided.

3.3 The control panels shall be of adequate size with a provision of 10% spare space to accommodate possible future additional switchgear. Knockout holes of appropriate size and number of cables shall be provided in the control panels in conformity with the location of incoming and outgoing conduits/cables. All equipment such as meters and indicating lamps, etc shall be located adjacent to the unit with which it is associated and care shall be taken to achieve a neat and symmetrical arrangement. Facility shall be provided for termination of cables from both above and below the control panel. Where cables enter below, cables boxes shall be fitted at the rear and arranged in tiers to facilitate making connections to the upper and lower units. Clamps shall be provided to support the weight of the cables. All incoming and outgoing feeders shall be brought out to a terminal block of adequate size at suitable location inside the control panel. All wiring inside the control panel shall be color coded and labeled with approved plastic beads for identification. Circuit diagrams showing the arrangement of circuits shall be pasted on the inside of the panel door and covered with transparent plastic sheet and all labeling shall be provided on the front face of the panel board.

4.0 Circuit Compartments

4.1 Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the ‘ON’ position. Safety interlocks shall be provided to prevent the breaker or Contactor from
being drawn out when the breaker is in the draw out position of the panel. Instruments and indicating lamps shall not be mounted on the panel compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

5.0 Instrument Accommodation

5.1 Separate and adequate compartments shall be provided to accommodate instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accident contact with live parts of the circuit breaker and bus bar.

6.0 Bus Bars and Bus bar Connection

6.1 The bus bar and interconnections shall be of aluminum and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bars and shall be extensible on either side. The bars and interconnections shall be insulated with PVC heat shrinkable sleeve and color coded. All bus bars shall be supported on unbreakable, non-hygroscopic insulated SMC/DMC type supports at regular intervals not more than 400 mm, to withstand the forces arising in case of short circuit in the system. Bus bars shall be provided in separate chamber of main control panels shall be connected by clamping, no holes shall be drilled in bus bars. If holes have to be drilled for making connections, extra cross section of bus bars shall be provided.

6.2 All bus bar connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts. Additional cross section of bus bars shall be provided in small control panels to cover up the holes drilled in the bus bars.

6.3 All connections between the bus bar and breaker and between breaker and contactor shall be through copper strips of proper size to carry full rated current and shall be insulated with coloured PVC heat shrinkable sleeve.

7.0 Terminals

7.1 The outgoing terminals and neutral links shall be brought out to a terminal block suitably located in the control panels. The current transformer for instruments, metering and for protection shall be mounted on the terminal blocks. Separate cable compartment shall be provided for incoming and outgoing cables.

8.0 Wire ways

8.1 A horizontal wire way screwed covers shall be provided at the top to take in the connecting control wiring of different vertical sections.

9.0 Cable Compartments

9.1 Cable compartments/alley of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top using detachable gland plates with proper knockouts. Adequate and proper DMC supports shall be provided in cable compartments to support cables. All incoming and outgoing terminals shall be brought out on terminal blocks in the cable compartment.

10.0 Materials

a) Rotary Switches

Switches up to 60 amps shall be rotary type with compact and robust construction, built up from one or more stacks with contacts and a positioning mechanism, with stop as required. The
terminals shall be shrouded with insulation to prevent accidental contact with live parts. Rotary switches shall be backed up with moulded type HRC fuse fittings of appropriate rating.

b) Selector Switch

When called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

c) Molded Case Circuit Breakers (MCCB)

MCCBs shall be quick make, quick break, and preferably double break contact system, arc extinguishing device, independent manual type with trip free feature with mechanical ON, OFF, and TRIP indications as called for in BOQ. A trip button shall be provided for tripping the breaker.

MCCB shall be a compact high strength, heat resistant, flame retardant; insulating molded case with high withstands capability against thermal and mechanical stresses. All MCCBs shall be capable of defined variable overload adjustment.

d) Switches

Switches beyond 60 amps shall be panel mounted double break type and suitable for load break duty, quick make and break action. Switch contacts shall be silver plated and shall be back-up with HRC fuses of appropriate rating. The switch handles shall be located at the front.

e) HRC Fuses

Fuses shall be high Rupturing capacity of not less than 20 MVA at 415 volts. The backup fuse rating of each motor/heater/equipment shall be so chosen that the fuse does not operate on starting of motor/heater/equipment. Fuses shall be of the same make as the switches.

f) Starters

Each motor shall be provided with a starter of suitable rating. Direct on line starters shall be provided for motors up to 10 HP.

Operating coils of contactors shall be suitable for 220/415 +/- 10% volts AC, 50 cycles supply system. The contactor shall drip out when voltage drops to 90% of the rated voltage.

g) Over Load Relays

Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset type thermal over load relay with adjustable setting.

h) Current Transformers

Current Transformer shall be of accuracy class - I and suitable VA burden for operation for the connected meters and relays.

i) Single Phase Preventor

Single phase preventor shall be provided for all the starters. Single phase preventor shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

j) Indicating Lamp and Metering
The meters shall be flush mounted and draw-out type. The indicating lamp shall be neon type and of low burden. Each phase indicating lamp shall be backed up with 2 amps fuse.

**k) Push Button Stations**

Push button station shall be for manual starting and stopping of motors/equipment as called for. Red and Green colour push buttons shall be provided for starting and stopping operations. Push buttons shall be suitable for panel mounting and accessible from front without opening door.

**m) Cables**

M.V. cables shall be PVC insulated aluminium conductor armoured cables suitable for laying in trenches, duct, and on cable trays as required.

**n) Wires**

650/1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

### 11.0 Cable Laying

11.1 Easy access to all cables shall be provided to allow cable withdrawal/replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimize the loss in current carrying capacity with necessary saddling/clamps.

### 12.0 Earthing

12.1 The earthing of MCC and equipment shall be as per BIS Specification and considered in the main electrical panel. The loop earthing shall be carried out with G.I/Copper Strips/wires.

### 13.0 Painting for Panel

13.1 All sheet steel work shall undergo a process of seven tank treatment and painting with powder coating paint of approved shade.

### 14.0 CABLE WORK

This section covers detailed requirements for supply, laying, testing and commissioning of cables.

#### 14.1 GENERAL

MV cable 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 drum.

#### 14.2 MATERIAL

14.2.1 The MV power cable of 660/1100 V. grade shall be PVC insulated Aluminium conductor armoured cable conforming to IS : 1554 ( part - I ). MV cable shall be 3.5/4 core of size and type as specified.

14.2.2 The MV control cables shall be PVC insulated copper conductor armoured cable.

#### 14.3 STORAGE AND HANDLING

14.3.1 All cables shall be inspected upon receipt at site and checked for any damage during transit.
14.3.2 Cable drums shall be stored on a well drained, hard surface, preferably of concrete, so that the drums do not sink in the ground causing rot and damage to the cable drums.

14.3.3 During storage periodical rolling of drums once in 3 months through 90° shall be done. Rolling shall be done in the direction of the arrow marked on the drum.

14.3.4 It should be ensured that both ends of the cable are properly sealed to prevent ingress/absorption of moisture by the insulation.

14.3.5 Protection from rain and sun shall be ensured. Sufficient ventilation between cable drums, should be ensured during storage.

14.3.6 The drums shall always be rested on the flanges and not on the flat sides.

14.3.7 Damaged battens of drums etc. should be replaced, if necessary.

14.3.8 When cable drums have to be moved over short distances, they should be rolled in the direction of the arrow, marked on the drum.

14.3.9 For transportation over long distances, the drum should be mounted on cable drum wheels strong enough to carry the weight of the drum and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.

14.3.10 When unloading cable drums from vehicles, a crane shall preferably be used. Otherwise the drum shall be rolled down carefully on a suitable ramp or rails, where necessary.

14.3.11 While transferring cable from one drum to another, the barrel of the new drum shall have a diameter not less than that of the original drum.

14.3.12 The cables shall not be bent sharp to a small radius. The minimum safe bending radius for all types of PVC cables shall be taken as 12 times the overall diameter of the cable. Wherever practicable, larger radius should be adopted. At joints and terminations, the bending radius of individual cores of a multi core cable shall not be less than 15 times its overall diameter.

14.3.13 Cable with kinks and straightened kinks or with similar apparent defects like defective armouring etc. shall be rejected.

14.3.14 Cables from the stores shall be supplied by the contractor as per the site requirement in pieces cut in the stores.

14.4 INSTALLATION

14.4.1 GENERAL

The cable installation including necessary joints shall be carried out in accordance with the specifications given herein. For details not covered in these specifications, I.S.:1255 shall be followed. No straight through joint shall be permitted in the system. The cables shall be supplied as per cable schedule submitted by the contractor & approved by Engineer-in-Charge.

14.4.2 ROUTE

14.4.2.1 Before the cable laying work is undertaken, the route of the cable shall be decided by the Architect in consultation with Owner representative.

14.4.2.2 While shortest practicable route shall be preferred, cable runs shall generally follow fixed developments such as roads, foot-paths etc. with proper offsets so that future maintenance, identification etc. are rendered easy. Cross country run to shorten the route length is not desirable.
as it would lead to route identification and maintenance problems, besides posing difficulties during later development of open areas etc.

14.4.2.3 While selecting cable routes, corrosive soils, ground surrounding sewage and effluent etc. shall be avoided. Where this is not feasible, special precautions as approved by the Architect shall be taken.

14.4.2.4 As far as possible, the alignment of the cable route shall be decided taking into consideration the present and future requirements of other agencies and utility services affected by it, the existence of any cable in the vicinity as may be indicated by cable markers or cable schedules or drawing maintained for that area, possibilities of widening of roads/lanes, storm water drains etc. Cable routes shall be planned away from the drains and should be within the property.

14.4.2.5 Whenever cables are laid along well demarcated or established roads, the MV cables shall be laid further from the kerb line than HV cables.

14.4.2.6 Cables of different voltages and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted, MV cables shall be laid above HV cables.

14.4.2.7 Where cables cross one another the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

14.5 WAY LEAVE

14.5.1 It may be necessary to obtain way leave for the cable route from the appropriate authorities some of whom are listed below:

a) Drainage, Public Health and Water Works.
b) Telephones and Telegraphs.
c) Gas works.
d) Other Undertakings.
e) Owners of properties.

14.5.2 Where necessary, joint inspection with representatives of other authorities may be arranged so that mutual interests are safeguarded. In case of private property, Section 12/51 of the Indian Electricity Act shall be complied with.

14.6 PROXIMITY TO COMMUNICATION CABLES

Power and communication cables shall as far possible cross at right angles. Where power cables are laid in proximity communication cables the horizontal and vertical clearances shall not normally be less than 60 cms.

14.6.1 LAYING METHODS

14.6.1.1 Cables shall be laid direct in ground or in pipes/closed ducts, in open ducts or on cable trays suspended from slab depending on site conditions.

14.6.2 Laying in Pipes/Closed ducts :

14.6.2.1 In location such as road crossing, entry to building, on poles, in paved areas etc. cables shall be laid in pipes or closed ducts.

14.6.2.2 GI or Hume Pipes (spun reinforced concrete pipes) shall be used for such purposes. In the case of new construction, pipes as required shall be laid along with the Civil works and jointed according to the instructions of the Engineer-in-Charge as the case may be. The size of pipe shall be as indicated
in the electrical drawings. GI pipe shall be laid directly in ground without any special bed. Hume pipe (Spun reinforced concrete pipe) shall be laid over 10 cm. thick cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate of 40mm nominal size) bed, after which it shall be completely embedded in concrete. No sand cushioning or tiles need be used in such situations. Unless otherwise specified, the top surface of pipes shall be at a minimum depth of 1mtr. from the ground level when laid under roads, pavement etc.

14.6.2.3 Where steel pipes are employed for protection of single core cables feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of polyphase system.

14.6.2.4 The pipes on road crossing shall preferably be on the skew to reduce the angle of bends as the cable enters and leaves the crossings. This is particularly important for high voltage cables.

14.6.2.5 Manholes of adequate size as decided by the Engineer-in-Charge shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design. The construction of manholes and providing the cover is not in the scope of this Contract and shall be got executed and paid for by the Engineer-in-Charge through another agency.

14.6.2.6 Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing.

14.6.2.7 Pipes for cable entries to the building shall slope downwards from the building and suitably sealed to prevent entry of water inside the building. Further the mouth of the pipes at the building end shall be suitably sealed to avoid entry of water. This seal in addition to being waterproof shall also be fireproof.

14.6.2.8 All chases and passages necessary for lying of service cable connections to buildings shall be cut as required and made good to the original finish and to the satisfaction of the Engineer-in-Charge.

14.6.2.9 Cable grips/draw wires and winches etc. may be employed for drawing cables through pipes/closed ducts etc.

14.6.3 Laying on Cable Trays

14.6.3.1 Cables, where indicated in approved shop drawings, shall be laid on overhead cable trays which are suspended from ceiling or supported from wall, by anchor fasteners as required.

14.6.3.2 The Contractor shall provided for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, trifoil clamps and structural steel members (comprising of channels, angles, flats, rods) to be fabricated at site for structural supports for cable trays racks etc.

14.6.4 Termination

Brass single compression glands shall be provided for MV cables termination

14.6.5 Testing

14.6.5.1 All 650/1100 Volt grade cables before laying shall be tested with a 500 V megger or with a 2,500/5,000 V megger for cables of higher voltages. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armour and insulation resistance between conductors.

14.6.5.2 All cables shall be subject to above mentioned tests during laying, before covering the cables by protective covers and back filling and also before the jointing operations.

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15.0 **CABLE TRAYS**

15.1 Prefabricated Cable trays of ladder type and associated accessories, tees, bends, elbows & reducers shall be fabricated from 12 gauge (2.6 mm thick) mild steel. Perforated cable trays and associated accessories tees, elbows, and reducers shall be fabricated from 14 gauge (2 mm thick) MS steel.

15.2 Cable trays and accessories and covers shall be painted with one shop coat of red oxide zinc chromate primer and two coats of Aluminium alkyd paint.

15.3 The Contractor shall provide for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, trifoil clamps and structural steel members (comprising of channels, angles, flats, rods) to be fabricated at site for structural supports for cable trays racks etc.

16.0 **EARTHING**

This section covers detailed requirements for earthing.

16.1 **GENERAL**

16.1.1 The non-current carrying metal parts of electrical installation shall be earthed properly. All metallic structure, enclosures, junction boxes, outlet boxes, cabinets, machine frame, portable equipments, metal conduits, trunking, cable armour, switchgear, distribution boards, lighting fittings and all other parts made of metal in close proximity with electrical circuits shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing will be in conformity with the relevant Indian Electricity Rules 1956 and Indian Standard Specification IS : 3043. Every item of equipment served by the electrical system shall be bonded to earthing system.

16.1.2 Every switch, lighting fixture and 5 Amp outlets shall be provided with insulated copper conductor of 1.5 sq. mm for earthing. The computer workstations shall be earthed with 2.5 sq.mm. insulated copper conductor wire.

16.1.3 Separate copper earth pits shall be provided for UPS, EPABX & Networking equipment.

16.1.4 The raceways shall not be used as a grounding conductor.

16.2 **CONNECTION OF EARTHING CONDUCTORS**

16.2.1 Main earthing conductor shall be taken from the earth connections at the PDB to the earthing pit. Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution boards or to an earth leakage circuit breaker. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to switchboards at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of equipment shall be earthed with 2 no. G.I. strips/wires and non-current carrying metallic parts with, 1 no. G.I. strips/wires.

16.2.2 Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures cables and conductors, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in earthing system. The Electrical resistance of metallic enclosures for cables and conductors measured between earth connections at the main switch boards and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate circuit breakers and shall not exceed 1 OHM.

16.3 **EARTH CONNECTIONS**
All metal clad switches and other equipment carrying single phase circuit, shall be connected to earth by a single connection. All metal clad switches carrying 3 phase shall be connected with earth by two separate and distinct connections. The earthing conductor inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The earthing conductor shall be painted to protect it against corrosion. Earthing conductor outside the building shall be laid 600 mm below finished ground level. The overlap lapping in G.I. strips in joints shall be welded. Lugs of adequate capacity and size shall be used for all termination of conductor wires. Lugs shall be bolted to the equipment body to be earthed after the metal is cleaned of paint and other oily substance and properly tinned.

16.4 PROTECTION FROM CORROSION

Connection between copper and galvanized equipment shall be made on vertical face and protected with paint and grease. Galvanized fixing clamps shall not be used for fixing earth conductors. Only copper fixing clamp shall be used for fixing earth conductors. When there is evidence that the soil is aggressive to copper, buried earthing conductors shall be protected by suitable serving and sheathing.

16.5 EARTHING STATION

16.5.1 PLATE ELECTRODE EARTHING

16.5.1.1 Earthing electrode shall consist of a Copper plate of 600 mm X 600 mm X 3 mm or G.I. plate of 600mm x 600mm x 6.3 mm as called for in the Schedule of Quantity. The plate electrode shall be buried as far as practicable below permanent moisture level but in any case not less than 3 meters below ground level. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrode shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer surface of the wall.

16.5.1.2 The earth plate shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 20 mm dia GI pipe shall run from the top edge of the plate to the ground level. The top of the pipe shall be provided with a funnel and a mesh for watering the earth through the pipe. The funnel over the GI pipe shall be housed in a masonry chamber approximately 300 mm x 300 mm x 300 mm deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame. Test facility shall be provided with test links for the earthing station.

16.5.2 PIPE ELECTRODE EARTHING

Earthing Electrode shall consist of G.I. medium class. 40 mm dia 4.5 m long pipe (without any joint) 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 2 M of length from the bottom. Pipe electrode shall be buried in the ground vertically with its top at not less than 200 mm below the ground level. When more than one pipe is to be installed a separation of not less than 2 M shall be maintained between two adjacent electrodes as called for in the drawings. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrode shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer surface of the walls. The pipe electrode shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 40 mm x 20 mm reducer shall be used for fixing of funnel with mesh. The funnel and mesh have been provided for watering the earth through the pipe. The funnel over the G.I. Pipe shall be housed in a masonry chamber 300mm x 300mm x 300mm deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame. The breaked earth pit will be provided with test links in suitable enclosures.

16.5.3 ARTIFICIAL TREATMENT OF SOIL

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, as specified in Clause no. 7 then the soil resistivity immediately surrounding the earth electrodes shall be reduced by adding sodium chloride, Calcium chloride, sodium carbonate, copper sulphate, salt and soft coke or charcoal in suitable proportions.

16.5.4 RESISTANCE TO EARTH

The resistance to each earthing system shall not exceed 1.0 ohm.

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1. SCOPE OF WORK

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rotameters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

2. PRECOMMISSIONING

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

2.1 Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

a) All strainers shall be inspected and cleaned out or replaced.

b) Check all clamps, supports and hangers provided for the pipes.

c) Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.
d) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

3 FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

4 REJECTION OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority’s requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Architect/Employer.

5 WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

6 HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner’s site representative and all testing and commissioning documents shall be hand over to the Owner’s site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner’s site representative.
## List of Standard Codes

<table>
<thead>
<tr>
<th>S.No.</th>
<th>IS Code No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>IS:780:1984</td>
<td>Specification for sluice valve for water works purposes (6th rev.) (50 to 300 mm size) (amendment 3)</td>
</tr>
<tr>
<td>2.</td>
<td>IS:13095:1991</td>
<td>Butterfly valves for general purposes</td>
</tr>
<tr>
<td>3.</td>
<td>IS:5312 (part 1):1984</td>
<td>Swing heck type reflux valves (non-return valve): part 1 single door pattern (1st rev.) (amendment 1)</td>
</tr>
<tr>
<td>4.</td>
<td>IS:884:1985</td>
<td>Fire aid hose reel for fire fighting</td>
</tr>
<tr>
<td>5.</td>
<td>IS:901:1988</td>
<td>Coupling double male and female instantaneous pattern for fire fighting</td>
</tr>
<tr>
<td>6.</td>
<td>IS:903:1984</td>
<td>Fire hose delivery coupling, branch pipe, nozzles and nozzles spanner</td>
</tr>
<tr>
<td>7.</td>
<td>NBC-SP-7-1983 Part IV</td>
<td>National building code of India 1983, amendment No. 3</td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td>Central public works division (CPWD) Part-V, wet riser system for fire fighting 1985, Govt. of India</td>
</tr>
<tr>
<td>9.</td>
<td>IS:3844-1989</td>
<td>Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises</td>
</tr>
<tr>
<td>11.</td>
<td>IS:6382:1984</td>
<td>Code of practice for design and installation of fixed system carbon dioxide fire extinguishing system</td>
</tr>
<tr>
<td>12.</td>
<td>SP:35 (s&amp;t)-1987</td>
<td>Hand book on water supply &amp; drainage by bureau of Indian standards</td>
</tr>
<tr>
<td>13.</td>
<td></td>
<td>National Building code (sec-ix)</td>
</tr>
<tr>
<td>14.</td>
<td>IS:933-1989</td>
<td>Specifications for portable chemical from fire extinguisher</td>
</tr>
<tr>
<td>15.</td>
<td>IS:2171-1985</td>
<td>Specifications for portable fire extinguishers, dry power</td>
</tr>
</tbody>
</table>
SPECIFICATION  FIRE INSTALLATION WORKS

PROJECT NAME : PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.
## GENERAL SPECIFICATIONS OF KITCHEN EQUIPMENT

<table>
<thead>
<tr>
<th><strong>Structure Framework</strong></th>
<th>Wherever required of 40 x 40 x 3 mm Approx. M/Steel Welded, grinded &amp; coated with rust proof coating.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Work Tops</strong></td>
<td>All Work tops, wherever required shall be of 16 swg thick Stainless Steel Sheet of 304 grade.</td>
</tr>
<tr>
<td><strong>Sound Deadners</strong></td>
<td>Under all type of work tops a coating for sound deadning Compound shall be applied.</td>
</tr>
<tr>
<td><strong>Uprights</strong></td>
<td>All uprights wherever required shall be of 38 mm x 16 swg Thick S.Steel tube welded to Main Frame 202 grade</td>
</tr>
<tr>
<td><strong>Adjustable Feet</strong></td>
<td>Wherever required shall be drawn from solid S.S.Rod.</td>
</tr>
<tr>
<td><strong>Undershelvings</strong></td>
<td>Wherever required shall be of 18/20 SWG thick S.S.Sheet 202 grade</td>
</tr>
<tr>
<td><strong>Overshelvings</strong></td>
<td>Wherever required shall be of 20/18 SWG thick S.S.Sheet with 25 mm dia S.S.Uprights 202 grade.</td>
</tr>
<tr>
<td><strong>Side Covering</strong></td>
<td>Wherever required shall be of 20 SWG S.S.Sheet.</td>
</tr>
<tr>
<td><strong>Compressors</strong></td>
<td>Of Kirloskar Make.</td>
</tr>
<tr>
<td><strong>Electrical Motor</strong></td>
<td>Of Crompton or Equivalent Quality.</td>
</tr>
<tr>
<td><strong>Electrical Fittings</strong></td>
<td>Of I.S.I. mark or Equivalent Quality</td>
</tr>
<tr>
<td><strong>Heating Elements</strong></td>
<td>Of our Own Make.</td>
</tr>
<tr>
<td><strong>Burners/Needle Valves</strong></td>
<td>Of United or Equivalent Make</td>
</tr>
<tr>
<td><strong>Exhaust hoods</strong></td>
<td>Constructed of S.S. Sheet of 202 grade with baffle filters</td>
</tr>
<tr>
<td><strong>Finishing</strong></td>
<td>No. 04 finish.</td>
</tr>
</tbody>
</table>

RELIEF INDIA/COLD FOOD/ PERICLAVE
TECHNICAL SPECIFICATION – LAUNDRY EQUIPMENT


- Capacity: 25 Kg dry weight filling per charge, electrically operated
- **Type:** Side Loading; **Compartment:** one
- The inner basket and outer basket shall be made of good quality stainless steel.
- Inside basket door shall be provided with double locking arrangements of latches. First lock by spring action and second by turning ‘T’ bolt in clockwise direction.
- A motor drives the inner basket through set of multiple pulleys and ‘V’ belts.
- The machine shall be provided with an integrally mounted electrical control panel.
- **Outer Dimension:** 1800mm length x 1050mm width x 1400mm Height.
- **Inner Basket Dimension (Minimum):** 762 mm Dia x 915 mm length.
- **Inner Drum Volume:** Minimum 417 Litres;
- Complete Stainless Steel ball valve for Water inlet.
- Large drain valve ensures faster drain of water.
- **Wash Motor:** 2HP on 415v, 3Phase, 50c/s, A.C.
  - **Note:** The machine shall be fitted with suitable electrical heater load 24KW (6 KW x 4 Nos.), to produce hot water for washing, if needed.

**Safety Features**

- The outside basket door is interlocked electrically to ensure that the electrical drive system do not function until the door is firmly closed.
- The machine shall not START if any of the door is left open
- The inside basket doors are designed to ensure that unless these are locked in position with the provided spring locks, the outside basket doors cannot be closed
- An overflow arrangement prevents the machine from flooding with water.
- Digital temperature controller cuts of heaters at the preset temperature automatically, thus ensuring the correct/economical use of heat energy.
- A foot brake with inching device helps the operator to align inside and outside doors in position simultaneously cutting off supply to the drive system. The brake locks the inner basket during loading and unloading
- The foot brake is interlocked electrically to ensure that the electrical drive system do not function until the brake is released.
- Thermal overload relays cuts off the supply to motor during overloading.
ITEM NAME: HYDRO EXTRACTOR, 15KG CAPACITY – QTY – 1No.

- Type: Three point suspension, electrically operated.
- Capacity: 15 Kg dry weight filling per charge
- **Outer Dimension**: 930mm width x 1135mm depth x 850mm height.
- **Inner basket Dimension**: 510mm dia x 280mm depth.
- **Volume**: 57 Litres.
- **Extractor Motor**: 3 HP (2.2 KW)
- Power Supply: 415v, 3Phase, 50c/s, A.C. Supply.
- The Inner and outer basket made of stainless steel.
- The inner basket shall be designed for free rotation.
- All contact parts with wash load made of stainless steel.
- The unit shall be equipped with microprocessor based control system along with the electrical starter arrangement for drive motor to ensure highly accurate process control and safety of equipment as well as operator.
- Microprocessor based process controller with LED indications & following features –
  1) Single phasing, 2) Phase reversal, 3) MCB tripped, 4) OLR tripped, 5) Door Open & 6) ON/OFF switch.
- Process control – the system is equipped with 3nos. one touch preset process timer buttons
- The controller unit consists of main MCB and starter arrangement for the drive motor along with suitable Siemens make switchgears and other components.

**Safety Features**

- Door interlocked to drive mechanism
- Air lock to prevent door opening when machine in operation
- Thermal overload protection for motor
- Outside basket shall be suspended on tough springs of machine frame so as to avoid any vibration due to uneven load on high speed.
- The large size drain designed for fast draining of water and avoids flooding of machine
- The entire machine shall be suspended to minimize vibration.
- The set of angular contact ball bearing ensures free rotation of inner basket and designed to accept varying axial and thrust loads at high speed.
ITEM NAME: DRYING TUMBLER, 25KG CAPACITY – QTY – 1No

- Type: End loading, electrically operated
- Capacity: 25 Kg dry weight filling charge.
- **Outer Dimensions:** 1100mm width x 1575mm depth x 1815mm Height
- **Inner Basket:** 908mm dia x 850mm depth.
- **Volume:** 558 liters.
- Power Supply: 415v, 3Phase, 50c/s, A.C. Supply.
- **Electrical Heater Load:** 24 KW
- Motor for drive and exhaust: 3.5 HP
- The inner basket made of stainless steel. The outer basket shall be mild steel with paint
- The outer basket carries an operating control panel with digital temperature controller, timer, push buttons etc. for main supply.
- The suitable electrical fin heater shall be provided at the top of outer basket and is designed for maximum utilisation of heat.

**Safety Features**

- Inner basket supported on heavy duty sealed bearings.
- Self cleaning lint screen of ample size.
- Electrical interlocking of door for drive.
- Dynamically balanced aluminium impeller fan directly mounted on motor shaft.
- The machine will be stop automatically at the end of preset time thus ensuring correct use of dryer.
- A timer for automatic forward-reverse rotation of drive motor is provided in the control panel.
- Auto timed by digital timer with illuminated display of lapse time.
- Auto-reverse prevents entanglement of linen also ensures faster drying.
ITEM NAME: SINGLE ROLL FLAT WORK IRONER (CALENDERING MACHINE) – QTY – 1 No

- For pressing of bed sheet, pillow cover, etc.
- Electrically heated Calendering Machine (Flat Work Ironer),
- Single roll of size 375mm dia x 1830mm long, feeding & delivery on opposite sides, Pneumatic lifting.
- **Air Consumption:** 3 CFM; **Recommended air pressure:** 8 Kg/cm²
- Drive Motor: 2.5 HP; Exhaust Motor: 1.5 HP
- **Speed of rolls:** 3 – 6 mtrs/minute.;
- Overall Size: 3250mm L x 1550mm W x 1200mm H
- Two fixed speed / variable speed drive shall be provided
- Roll/s padded with multi layers of Stainless steel Wool & covered with two rounds of Polyester cloth. Stainless steel wool padding ensures longer life of padding & reduces the down-time. Also, it maintains porosity for efficient removal of moisture ensuring wrinkle free ironing.
- Each roll is provided with separate Exhaust Blower Dynamically balanced aluminium impeller mounted directly on motor shaft.
- Metal powder coated Feeding tray & Delivery Table of ample sizes shall be provided.
- Full length Finger Guard is electrically interlocked with drive & pneumatic system.
- The Frame is well protected against corrosion. The Chest is rigidly fixed on the frame with fasteners. The Steam Chamber of the chest has a multi-pass arrangement, which ensures fast and uniform heating of the ironing surface of the chest.
- The padding is designed to provide elasticity and hardness to the rolls and thus ensuring even pressing of flat linen.
- The pneumatic control system consists of air filter, regulator, lubricator, pressure gauge, solenoid valves and quick exhaust valves.

**Safety Feature:**
1) Finger guard shall protects the operator`s fingers from getting crushed between the roller and the chest. The slightest disturbance of the finger guard stops the drive to the rollers and lifts both the rollers away from the chest.
2) During operation if power supply fails the rollers lift away from the chest automatically thus protecting the cloths and the roller covers from getting scorched.
3) The machine can not iron without compressed air supply ensuring that the safety system is in operation whenever the machine is used for ironing.
4) Separate safety pawls are provided for each roller which locks the rollers in the lifted position whenever the power fails and both rollers remain in locked/lifted position even without air after that.
5) Digital Temperature Controllers (DTC) cut off the heaters automatically when preset temperature has been reached, individually to each chest.
ITEM NAME: FLAT BED PRESS – QTY – 1 No

- For pressing of trousers, pants, flat linen etc.
- Electrically heated Flat Bed Press, Pneumatic and auto head opening
- Size of buck 1500mm x 750mm (60”x30”).
- Electric Connected load: 10.8 KW;
- Air Consumption: 3 CFM ;
- Air Pressure: 6 Kg/cm²
- Over all dimension: 1710mm length x 1550mm width x 1265mm height
- The Frame is fitted with head, buck and levers.
- The buck is padded with one layer of asbestos clothes, one layer of cotton knitted padding/two layers of blanket and covered with cotton cloth
- Heating on both HEAD (Top plate) & BUCK (Bottom plate).
- Head plate of Stainless Steel --Polished / buffed.
- Both Head & Buck are insulated & covered with powder coated panels.
- Head will remain in UP/OPEN position even without AIR
- Metal powder coated work table of ample size.
- All panels are powder coated.
- Air Filter, Air Pressure regulator with gauge, Lubricator & air inlet valve shall be provided.
- **Operation**: The closure of the machine can be done by pressing of the two hand levers are provided in the front. The releasing of any of the levers will make the head to open thus ensuring the safety of the operator.
- It will have Pressure Adjusting Device, to suit the requirements of different kinds of fabrics or garments of varying thickness. The unit will have self aligning system, to give even pressing to uneven thickness of garments

**Features:**

a) All operations pneumatic & Head closing by **simultaneous** pressing of two push buttons for operator’s safety
b) Auto timed through **Digital Timer** --preset time on counter & lapse time by **Illuminated display for automatic opening of Head as per preset time.**
ITEM NAME: ELECTRIC HAND IRON WITH TABLE – QTY – 1No
- Heavy Duty electric hand Iron: 1KW
- The electric hand iron is manufactured out of gun metal and cast iron.
- Wooden top Table on structural steel frame work.
- Table Size: 1500mm length x 750mm width x 900mm Height

ITEM NAME: DRY LINEN TROLLEY – QTY – 2 Nos.
**Purpose**: To carry the dry linen
**Description**: Complete stainless steel construction for long rust free life. Trolley sides have pressed ribs for extra strength. Corners would be rounded for easy movement and fitted with rubber bumpers to avoid any damage. These trolleys would be mounted with 4 Nos. swiveling type rubber wheels on ball bearings.
The trolley is designed for light weight, rugged and easy manoeuver. Four castors are provided in the frame.
**Wheels**: 4” dia Thread free castors
**Overall Size**: 1000mm Length x 600mm width x 810mm height

ITEM NAME: WET LINEN TROLLEY – QTY – 2Nos.
**Purpose**: To transport / carry the wet linen
**Description**: Complete stainless steel construction for long rust free life. Trolley sides have pressed ribs for extra strength. Corners would be rounded for easy movement and fitted with rubber bumpers to avoid any damage. These trolleys would be mounted with 4 Nos. swiveling type rubber wheels on ball bearings.
These trolleys have a perforated S.S. mesh at the bottom are fitted with a drain valve. The front two castors are fixed type and the rear two are of swivelling type.
**Wheels**: 4” dia Thread free castors
**Overall Size**: 800mm Length x 600mm width x 710mm height

ITEM NAME: AIR COMPRESSOR, 1.5 HP – QTY – 1No.
**Approved makes for entire Laundry System**: Periclave / Steris-USA / Gettinge
The main Contractor should sub-contract the specialised nature of work to only those Contractors in India for modular OT system who must be authorised distributor for all approved makes mentioned in tender for imported material. Since it is life saving project and it require proper maintenance by highly qualified & specialist engineers for after sales & services to maintain system so that the system should work round the clock without any interruption in medical procedures.

Sub-Contractor must produce its authorization letter for Indian contingent for the approved makes mentioned in tender for modular OT system at the time of execution.

All items mentioned under NS i.e. Non Schedule items are to be read in conjunction with the prevailing specifications of manufacturers and as per the relevant I.S code for the item/Material as mentioned in the tender. All the relevant material sample shall be got approved from the consultant before placing bulk order/ usage. Any discrepancy in specifications of any item or any material shall be brought to the notice of consultant before implementation

FOR All imported items country of origin should be EUROPE / USA only.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>OXYGEN SYSTEM</td>
<td>MPS / Advantech Health Care / Supreme</td>
</tr>
</tbody>
</table>

1.1 Oxygen Manifold: CE marked with four digit notified body no.

Oxygen manifold should be extendable type, of size 10+10 for Indian type bulk cylinders and it should be suitable to withstand a working pressure of 145 kg/cm² and should be tested at 380 kg/cm².

The Manifold shall have the following characteristics:

- Manifold should have high pressure copper annealed tail pipes with one end having brass bull nose suitable for oxygen cylinders and other end suitable for manifold non-return Valves.
- It should have middle frame of manifold of 10+10 size along with chain for individual bulk oxygen cylinder.
- Manifold should have Non-return valves.

1.2 Fully Automatic Control Panel for Oxygen: CE marked / UL Listed

Allied Healthcare USA / Pneumatik Berlin / Modular USA / Powerex-USA

Fully automatic in operation and requiring no action, Automatic Control Panel is pneumatically operated by the service gas and needs no electrical supply to operate. It will continue to function therefore, should there be a failure in the electricity supply. It takes over automatically from the empty cylinder bank to filled cylinder bank.

A visual indication of the state of the manifold is provided by 3 gauges within the control panel, clearly visible through the transparent cover, these gauges indicate the pressure of the right and left hand banks, and the supply pressure from the control panel to the distribution system.

The panel is supplied with sensing facilities to provide visual signals and other ancillary services such as heaters. A heater block is fitted to the inlet pipes for Nitrous Oxide.

In addition the panel is fitted with audio alarm indication for changeover of empty cylinder bank to filled cylinder bank.

The entire manifold will be hydraulically tested at 250 Kg/Cm² pressure, duly degreased for Nitrous Oxide service, and supplied in sealed cover, ready for assembly at site.

**NOTE:** The above referred system does not comprise the supply of cylinders, which are to be separately arranged by the Hospital.

1.3 Emergency Oxygen Manifold: CE marked with four digit notified body no.

It comprises of Double cylinders bank of 3(three) number of cylinders each bank which shall be connected to the main line through Automatic Control Panel isolating the main control panel to ensure uninterrupted supply of medical oxygen in case main manifold/control panel is inoperative (supplied without cylinders).

2 NITROUS OXIDE SYSTEM

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nitrous Oxide Manifold</td>
<td>MPS / Advantech Health Care / Supreme</td>
</tr>
</tbody>
</table>

TECHNICAL DATA SHEET FOR MEDICAL GAS PIPELINE SYSTEM for ESIC Hospital
The Nitrous Oxide cylinder manifold shall comprise of two cylinder banks which should be extendable type, of size 3+3 for Indian type bulk cylinders.

The Manifold shall have the following characteristics:

- Manifold should have high pressure copper annealed tail pipes with one end having brass bull nose suitable for Nitrous Oxide cylinders and other end suitable for Manifold non-return Valves.
- Nut nipple fitting of R.H. internal threading suitable for cylinder valves conforming to IS:3224 (Nitrous oxide Service), and cylinder support system.
- It should have middle frame of manifold of 3+3 size along with chain for individual bulk oxygen cylinder.

The copper tail pipes are fitted with individual non-return valves to the cylinder manifold for easy removal of cylinders, without any disturbance to system operation.

Each manifold will have one terminal header and a NPT connection for the Automatic Control Panel.

NOTE: The above referred system does not comprise the supply of cylinders,

Fully automatic in operation and requiring no action, Automatic Control Panel is pneumatically operated by the service gas and needs no electrical supply to operate. It will continue to function therefore, should there be a failure in the electricity supply. It takes on automatically from the empty cylinder bank to filled cylinder bank.

A visual indication of the state of the manifold is provided by 3 gauges within the control panel, clearly visible through the transparent cover, these gauges indicate the pressure of the right and left hand banks, and the supply pressure from the control panel to the distribution system.

The panel is supplied with sensing facilities to provide visual signals and other ancillary services such as heaters. A heater block is fitted to the inlet pipes for Nitrous Oxide.

In addition the panel is fitted with audio alarm indication for changeover of empty cylinder bank to filled cylinder bank.

The entire manifold will be hydraulically tested at 250 Kg/Cm² pressure, duly degreased for Nitrous Oxide service, and supplied in sealed cover, ready for assembly at site.

The emergency stand by manifold should provide a stand by nitrous oxide gas supply from Double cylinders bank of 2 (two) number of cylinders which shall be connected with copper tail pipes, safety valves, NRV’s. Each bank shall be connected with main line, through Automatic Control Panel isolating the main control panel to ensure uninterrupted supply of medical Nitrous Oxide in case main manifold/control panel is inoperative (supplied without cylinders).
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Oil free Scroll COMPRESSED AIR SYSTEM -as per NFPA-99 std / HTM -2022/02-01 of UK (Imported)</td>
</tr>
</tbody>
</table>

a) The total plant capacity running and stand by should be 80 scfm capacity @ 100psi oil-less air compressors and associated equipment, one vertical ASME Tank and one control panel. The entire system including the receiver should be mounted on a common structural steel stack base. The only field connections required would be system intake, exhaust and power connection at the control panel. All components should be completely prepped and pre-wired to single-point service connections. All interconnecting piping and wiring should be completed and operationally tested at the site of manufacturer.

b) The medical air compressors should be of the totally oil-less reciprocating air-cooled design. Connecting rod and bearings should be packed with lifetime lubrication and sealed.

c) Each compressor should be belt driven by a suitable HP, 3 phase, 50 cycle, 415 volt, ODP NEMA construction motor. Slide bases for convenient belt tension adjustment and totally enclosed OSHA approved belt guards should be provided.

d) Each air compressor should have a capacity of 40 scfm at 100 PSIG.

e) The system should include individual compressor inline intake filters, discharge check valves of bronze construction, safety relief valves, bronze intake and discharge flexible connectors, solenoid unloaders, isolation valves, air cooled after coolers for each compressor, high discharge temperature shut down switches on each cylinder, pressure control switches, as well as copper tubing with shut-off cock for gauge and switches. The system should include a 120 gallon, pressure storage tank of ASME construction rated for 200-PSI MWP service. The tank should be equipped with a pressure gauge, safety relief valve, 3-way by-pass; gauge glass and automatic electronic tank drain with manual override. The inside of the tank should be coated for rust protection with a two component coating which provides a hard, durable lining. Provide spring vibration isolators for each compressor.

f) The system should include a UL listed control panel in a NEMA 12 enclosure with the following accessories for each pump:

g) Externally operable fusible disconnect with door interlock, control circuit transformer with fused primary and secondary coils, H-O-A switch, magnetic starter with 3 leg overload protection, hour meter, motor running light. Provide the panel with a multiple position selector switch for selection of normal operation (automatic alternation) or manual selection of lead and lag pumps if one of the pumps is taken out of service due to scheduled maintenance. Provide audible and visual local alarm...
Provide manual reset for thermal malfunction shutdown. All control and alarm functions should remain energized while any compressor in the system remains electrically on-line. The lag compressor should be able to start automatically if the lead compressor fails to operate.

STANDARD BILL OF MATERIAL FOR DUPLEX

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUPLEX</td>
<td></td>
</tr>
<tr>
<td>Oil-Less Compressor-2</td>
<td>2</td>
</tr>
<tr>
<td>Belt Guard -2</td>
<td>2</td>
</tr>
<tr>
<td>Electric Motor-2</td>
<td>2</td>
</tr>
<tr>
<td>High Air Temperature Switch-2</td>
<td>2</td>
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<tr>
<td>Air Receiver ( ASME Rated)-1</td>
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</tr>
<tr>
<td>Control Pressure Switch-2</td>
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<tr>
<td>Three-Valve By pass -1</td>
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<tr>
<td>Sight-Gauge Glass -1</td>
<td>1</td>
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<tr>
<td>Pressure Gauge -1</td>
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<tr>
<td>Pressure Relief Valve -1</td>
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<tr>
<td>Automatic Tank Drain -1</td>
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</tr>
<tr>
<td>Electrical Control Panel -1</td>
<td>1</td>
</tr>
<tr>
<td>NEMA 12 Enclosure-1</td>
<td>1</td>
</tr>
<tr>
<td>Power Distribution Block -1</td>
<td>1</td>
</tr>
<tr>
<td>Combination Motor Starters with Circuit Breaker Disconnects</td>
<td>1</td>
</tr>
<tr>
<td>Automatic Alternation-1</td>
<td>1</td>
</tr>
<tr>
<td>Running Lights -2</td>
<td>2</td>
</tr>
<tr>
<td>Hour Meters-2</td>
<td>2</td>
</tr>
<tr>
<td>Control Transformer -2</td>
<td>2</td>
</tr>
<tr>
<td>Hand-Off Automatic switch-2</td>
<td>2</td>
</tr>
<tr>
<td>High-Air Temperature Light with contacts-2</td>
<td></td>
</tr>
</tbody>
</table>

Medical Vacuum should be provided by vacuum plant reference and capable of providing a flow rate of 2100 LPM with one Pump running and one pump standby, pumps running simultaneously at a vacuum level of 19” Hg. The total plant capacity should be 75 SCFM.

The Oil Lubricated Rotary Vane Medical vacuum System should provided superior performance with minimal maintenance. The packaged system should contains all necessary controls and components to meet or exceed NFPA99 recommended guidelines. Systems should be available in simplex and all multiplex arrangements.

The factory packaged vacuum system consists of rotary vane vacuum pumps, pre-wired control panel, receiver, and interconnecting wiring and piping, requiring only two plumbing connection. The Medical Vacuum systems should be available as base mounted with vertical receiver size. The vacuum pumps should be continuous duty, rotary vane, oil-sealed, air cooled, direct driven units capable of continuous operation over a working range of 18” to 29” Hg. Each pump should have single shaft seals and should be equipped with an automatic gas ballast valve to prevent condensation of water vapor, extending the life of the oil and the system.
The pump should include an integral, multi-stage oil-removal system featuring a built-in exhaust demister that should remove and reclaim 99.9% of the exhausted oil. Additionally each pump should include exhaust back pressure gauge to indicate the need for filter maintenance and an oil sight glass for monitoring oil level. Lubrication should be provided by the integral, fully re-circulating oil supply. The pump inlet should be protected by means of a wire mesh screen. An internal anti suck back valve should be included to prevent oil from entering the vacuum piping network. Pump vanes, because of their construction, should provide superior heat transfer and long life. The pumps should be dynamically balanced and virtually vibration free.

Each pump should be driven by a direct flanged three-phase, standard TEFC motor via a pin and bush coupling. All models should operate between 58-83 dBA. Pumps require standard automotive grade SAE-30 non-detergent oil for lubrication.

The UL listed / CE marked electrical control panel should be mounted in a control cabinet. The standard control panel includes the following components:

- Integral circuit breaker disconnected with door interlock, across-the-line motor starters with three-phase overload protection
- A programmable logic controller to cycle lead pump with each use
- Hand off Automatic selector switch for each pump
- Lag pump in use indicator light with horn and connection for remote annunciation
- Hour meters to monitor factory recommended service intervals
- Pump running lights to indicate pump in operation

Each system should include an ASME coded receiver rated for full vacuum service. The system receiver includes a 4-1/2” vacuum gauge, manual drain, and three valve bypass. Additionally, each system should include properly sized inlet and exhaust flex connectors and vibration isolation pads for field installation. The pump has the facility that in case one pump stop the standby pump should automatically start. If any pump fails the system should automatically revert to the stand by pump. All the status monitoring of the pump can be connected to the Master Alarm. The system should also include factory installed 5 micron pump inlet filters to promote longer life.

Standard Bill of Material
Oil-Lubricated Rotary Vane Vacuum System

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>DUPLEX</td>
<td></td>
</tr>
<tr>
<td>Rotary Vane Pump</td>
<td>2</td>
</tr>
<tr>
<td>TEFC Motors</td>
<td>2</td>
</tr>
<tr>
<td>Back Pressure Indicator Gauge</td>
<td>2</td>
</tr>
<tr>
<td>Oil Reservoir</td>
<td>2</td>
</tr>
<tr>
<td>Oil Sight-Gauge Glass</td>
<td>2</td>
</tr>
<tr>
<td>Air Receiver (ASME Rated)</td>
<td>1</td>
</tr>
<tr>
<td>Three Valve Bypass</td>
<td>1</td>
</tr>
<tr>
<td>Control Vacuum Switch</td>
<td>2</td>
</tr>
<tr>
<td>Vacuum Gauge</td>
<td>1</td>
</tr>
<tr>
<td>Manual Drain</td>
<td>1</td>
</tr>
<tr>
<td>S. No.</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>1</td>
<td>Electrical Control Panel 1</td>
</tr>
<tr>
<td></td>
<td>NEMA 12 Enclosure 1</td>
</tr>
<tr>
<td></td>
<td>Integral Motor Starter with Circuit Breaker Disconnect 2</td>
</tr>
<tr>
<td></td>
<td>Automatic Alternation 1</td>
</tr>
<tr>
<td></td>
<td>Running Light 2</td>
</tr>
<tr>
<td></td>
<td>Hour Meter 2</td>
</tr>
<tr>
<td></td>
<td>Minimum Run Timer (7.5 hp and larger) 2</td>
</tr>
<tr>
<td></td>
<td>Control Transformer 2</td>
</tr>
<tr>
<td></td>
<td>Hand-Off-Automatic Switch 2</td>
</tr>
<tr>
<td></td>
<td>Lag On Alarm with Horn, Light &amp; contacts 1</td>
</tr>
<tr>
<td></td>
<td>Interconnecting piping 1 lot</td>
</tr>
<tr>
<td></td>
<td>Pump Isolation Valve 2</td>
</tr>
<tr>
<td></td>
<td>Check Valve 2</td>
</tr>
<tr>
<td></td>
<td>5 Micron Pump Inlet Filter 2</td>
</tr>
<tr>
<td></td>
<td>Pump Inlet Flex Connector (installed) 2</td>
</tr>
<tr>
<td></td>
<td>Pump Discharge Flex Connector (Shipped loose) 2</td>
</tr>
<tr>
<td></td>
<td>Receiver Flex Connector (Shipped loose) 1</td>
</tr>
<tr>
<td></td>
<td>Vibration Dampeners (Shipped Loose) 1 set</td>
</tr>
</tbody>
</table>

5 **COPPER PIPE WITH REQUIRED COPPER FITTINGS**

5.1 All pipes shall be drawn half hard temp., solid drawn, seamless, phosphorous deoxidised, non-arsenic and degreased copper pipe conforming to BS EN 13348 Kite certified. The supplies of copper pipe would be accompanied with manufacturers test certificate for the physical properties of copper pipes and their Chemical composition. The supply of pipes be further substantiated with inspection certificate from the third party like KITE.

The Pipeline will be laid as per HTM-2022 or NFPA 99. Supply to the following sizes of pipe:
- 54 mm Outer Dia, 1.2mm thick
- 42 mm Outer Dia, 1.2mm thick
- 28 mm Outer Dia, 0.9mm thick.
- 22 mm Outer Dia, 0.9mm thick.
- 15 mm Outer Dia, 0.9mm thick.
- 12 mm Outer Dia, 0.7mm thick.

5.2 Fittings: All copper fittings shall be manufacture to the highest standards complying with EN1254-1. The fittings should be manufactured in accordance with EN 1254-1 and 4 (formerly BS 864: part 2). Copper pipes would be secured to wall with LDPE saddles or to ceiling fixed MS bracket wherever necessary.

5.3 Brazing: For copper joints, brazing material to be used will be silver-copper phosphorous alloy which shall be used without flux. For copper to brass joints 43% silver brazing rods with flux would be used. Flow of nitrogen gas would be provided to avoid oxidization inside the pipeline during brazing.

5.4 Cleaning: Before putting for erection all pipes, valves and fittings are cleaned and degreased.
For copper fittings in the copper pipeline, the brazing for copper joints shall be done without using flux and the material for jointing used will be silver-copper-phosphorous alloy. For brass joints for jointing outlet points and area/zonal valves material used is 43% silver brazing rod with specified flux. For installation of equipments threaded connections equipped with nut, nipple & adaptors are used.

**Bends**

All bends are made of copper pipe of higher dia than the pipe requiring change of direction and these bends will be made out of thicker size pipe to avoid thinning and flattening at any point.

**Erection:**

The erection of the copper pipe shall be done only after cutting the pipes to size as per site requirements. It does not leave any scope for springing.

**Supports:**

To avoid weight of the pipe on the joints supports (saddles made of LDPE material) are provided at a distance of every 4-6 feet as prescribed by HTM-2022 and NFPA 99.

**Testing**

**Blowing:**

After erection all the pipes are blown with nitrogen or compressed air. This blowing of the pipeline with nitrogen or compressed air under pressure clean the pipeline thoroughly.

**Joints tests:**

The entire pipeline after erection is put to test for checking leakage of brazing joints at a pressure one and a half times of the working pressure for 24 hours. In case of drop in pressure the joints are examined with soap solution.

**Final test:**

After repairing the joints in case leakages are found, the pipeline shall again be put to test with compressed air at a pressure of one and a half times the working pressure for 24 hours and then thereafter entire pipeline will be tested with specific gas for ant-confusion tests.

**Painting**

All pipes after laying shall be painted as per colour specification "IS CODE" 2379:1963 amended 1990.

**Valves with Valve Box and Pressure Gauge**

CE marked with four digit notified body no MPS / Advantech Health Care / Maxon Healthcare

Area service unit module should consist of 1 to 5 AVSU (Area Valve Service Units). It should incorporate a valve with NIST connection at either side. The valve boxes would be made of Zinc coated Mild Steel and shall be powder coated for housing area/zonal valves. The valve box would be lockable having glass cover, the valve will be complete with stub pipes that extend to the outside of the box to enable easy connection to the MGPS. The valve box should be equipped with gauge for the gases.
### Anaesthetic Gas Scavenging System (AGSS) Plants

AGSS plants are designed to provide a safer working environment for medical personnel by removing waste gases produced during anaesthesia and from the surrounding environment.

AGSS plants are available as simplex or duplex units, comprising die cast aluminium side channel blowers complete with electrical controls, pressure sensors, relief valve and drain flask, all pre-piped, pre-wired and factory tested.

The duplex plant control panel incorporates a duty pump selector, vacuum gauge and indicators to identify the plant status. The standby pump is activated automatically on high demand or failure of the duty pump. Duplex units incorporate non-return valves to enable the maintenance of one pump while the other is in service.

Pumps are available to suit single phase or three phase electrical supplies. Remote switches are available to enable control of the AGSS plant from within the department served and to indicate the status of the plant.

Designed to meet the requirements of:
- **HTM 2022/ NFPA99** Medical Gas Pipeline Systems
- **BS 6834** Active anaesthetic gas scavenging systems
- **BS EN 737-2** Anaesthetic gas scavenging disposal systems - basic requirements

### Bed Head Panel

The bed head panel is made of high strength extruded aluminum. It is powder coated to make it aesthetically appealing and long lasting. The panel is divided into different sections to segregate low voltage, high voltage and medical gas chamber. The panel consists of special railings to hang various items like humidifier bottles, vaccine basket, examination lamp, suction jar, IV pole, etc. which facilitates patient treatment.

The bed panel should have provision for Medical Gas outlet points (2 Gas, 3 Gas, 5 Gas, 6 gas outlet as per requirement) and Nurse call system. It should be equipped with Electrical Switch Socket of 5/15 Amp., data socket and Telephone socket.

### Medical Gas Alarm

The Medical Gas alarm should be capable of monitoring up to 6 medical gas services by means of pressure sensors which detect deviation from the normal operating limits of either pressure or medical vacuum. The area alarms should have a digital display of pressure and should be displayed by standardized coloured LED’s. It should have audible Alarm for high – caution – normal – caution – Low). It should have programming facility from front panel. Facility to connect to remote alarm box by potential free contacts provided in the alarm box. Operated by 230V ac power supply.

The alarm limits: High, caution, Normal, Caution, Low limits are set as below at factory testing:

<table>
<thead>
<tr>
<th><strong>S. No.</strong></th>
<th>Description</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td><strong>AGSS/WAGD System as per NFPA-99 std / HTM -2022/02-01 of UK(Imported)</strong></td>
<td>Allied Healthcare USA/ Pneumatik Berlin/ Phoenix Pipeline-UK/ Powerex-USA</td>
</tr>
<tr>
<td>8</td>
<td><strong>BED HEAD PANEL</strong></td>
<td>MPS /Supreme / Maxon Healthcare</td>
</tr>
<tr>
<td>9</td>
<td><strong>MEDICAL GAS ALARM</strong></td>
<td>MPS /Advantech HealthCare / Maxon Healthcare</td>
</tr>
<tr>
<td>S.No.</td>
<td>Description</td>
<td>Details</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>FOR 1,2,3 Channels: (PSI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIGH</td>
<td>:75</td>
<td>RED</td>
</tr>
<tr>
<td>CAUTION (nH)</td>
<td>:70</td>
<td>Yellow</td>
</tr>
<tr>
<td>NORMAL (n)</td>
<td>:60</td>
<td>Green</td>
</tr>
<tr>
<td>CAUTION (nL)</td>
<td>:50</td>
<td>Yellow</td>
</tr>
<tr>
<td>LOW (L)</td>
<td>:45</td>
<td>Red</td>
</tr>
<tr>
<td>For Vacuum Channel: (mmHg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NORMAL (n)</td>
<td>:450</td>
<td>Green</td>
</tr>
<tr>
<td>CAUTION (nL)</td>
<td>:300</td>
<td>Yellow</td>
</tr>
<tr>
<td>LOW (L)</td>
<td>:250</td>
<td>Red</td>
</tr>
<tr>
<td>ALARMS ACKNOWLEDGE RESETTING TIME:</td>
<td></td>
<td>Factory setting 10 minute.</td>
</tr>
<tr>
<td>Pneumatic Service Selection:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factory setting all 4 Pneumatic are activated (unless specification mentioned in the order).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure switches as sensing devices in audio visual alarms for Oxygen, Nitrous Oxide &amp; Compressed Air System. Pressure switches are equipped with NO/NC contacts. These are properly cleaned &amp; fit for use with medical gases. These would be used with 220V Ac electric supply &amp; have a rating up to 15 Amps, tested with 100 &amp; 200 PSIG pressures.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The pressure switch constructed of a rugged, weather proof housing with mounting bracket, and a ¼&quot; BSP gas service line connection at the bottom of the assembly.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacuum Switches:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacuum switches used to make cut in or out connections on either increasing or decreasing vacuum. These would be cleaned for use with medical gases &amp; have an adjustable range up to 29&quot; of mercury vacuum. It has both NO &amp; NC contacts &amp; is fit for use with 230V electric supply.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The vacuum switch constructed of a rugged, weather proof housing with mounting bracket, and a 3/8&quot; BSP gas service line connection at the bottom of the assembly.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>FLOOR ISOLATION VALVE</td>
<td>RB-Italy</td>
</tr>
<tr>
<td>It should having ball type valves with PTFE seat Brass body with Nickel plating valves having quarter turn handle opening. Size suitable for 12mm OD copper pipe to 54mm OD copper pipe should have brass adapter suitable for copper pipe. The valve are designed for a working pressure of 27&quot; Hg vacuum to 300 psi.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>MEDICAL AS OUTLET POINTS TERMINAL UNIT FOR OXYGEN, N2O, COMPRESSED AIR SYSTEM, ASS AND VACUUM IMPORTED CE</td>
<td>Allied Healthcare USA/ Pneumatik Berlin/ Modular USA / Powerex-USA</td>
</tr>
</tbody>
</table>
Design of outlet will be such that it will have the feature to accept two types of probes & push button mechanism for quick release of adaptor. The secondary check valve automatically will form a positive seal to prevent a gas flow when the finishing assembly is removed. The secondary check valve to include 7” (17.78cm) of 1/2” Type K copper tubing with a label affixed which identifies the specific gas by name and colour. A plastic cap inserted at the end of the inlet tube. Rotation of the inlet tube will allow gas connection from the top or bottom. the finishing assembly will consists of a die cast chrome plated cover plate, a machined brass housing for the primary check valve, and a positive—pin keying device to prevent accidental installation into a roughing in assembly of a dismal gas. The finishing assembly incorporates a double seal arrangement which automatically engages when a hose adapter or patient treatment device is removed from the outlet.

The finishing assembly will have a colour coded (specific gas) keying disc to prevent connection of hose adapters or patient treatment device to the wrong gas service. The primary check allows absolutely no gas flow to take place until the keying devices are engaged. It will be manufactured in accordance with all applicable NFPA and CGA standards. The locking device will be in the probe instead of gas outlet. Matching probe for outlets – Imported as per NFPA -99 UL Listed Matching probes to the gas outlet mentioned above. That is adapter for Oxygen N2o, Air & vacuum / WAGD. Each adapter will have suitable barb or threads so that it can be connected to tube or flow meter /suction regulator. Adapter will have clear gas service embossed on it.

Matching probes: one end of matching probes shall be suitable for Medical Gas Outlet point & other end shall be suitable for hose. Suitable for Oxygen, Nitrous Oxide, Compressed air 4 bar, compressed air 7 bar, DiSS connection, vaccum & WAGD.

12 OTHER MEDICAL PIPELINE ACCESSORIES

12.1 Oxygen Flow Meter with humidifier bottle CE marked with four digit notified body no MPS /Advantech Health Care / Maxon Healthcare

The flow meter must be constructed with chromium plated brass body, extremely robust, to take care of the day to day usage demand. Flow meter cartridge type knob : easy to maintain, offers optimum adjustment quality and superior designing and engineering to provide high level of accuracy, with no significant affect from restrictions caused by down-stream equipments. The flow meters should be 0-15 LPM range for oxygen. Humidifier bottle should be unbreakable, reusable to disinfectants and complements. It should be autoclavable at 134 degree centigrade and made of polycarbonate material. The capacity of the bottle should be approximately 200ml.

12.2 High pressure tube for O2, N2O, Compressed Air & Vacuum MPS /Advantech Health Care / Maxon Healthcare

The high pressure tube should be made of antistatic rubber as per ISO standards and colour coded white for Oxygen, Blue for N2O, Yellow for Vacuum and Black for Compressed Air.

12.3 Ward Vacuum Unit with Regulator CE marked with four digit notified body no MPS /Advantech Health Care / Maxon Healthcare

Consisting of one no. Suction Regulator connected with 1000/600 CC pot of collection. The jar and the lid are made of polycarbonate which are autoclavable and unbreakable. The jar is fitted with an overflow safety trap & the regulator fitted with an ON/OFF valve and a knob to regulate the online suction.
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.4</td>
<td>Theater suction Trolley with Regulator for Operation theaters CE marked with four notified body digit no MPS / Advantech Health Care / Maxon Healthcare</td>
</tr>
</tbody>
</table>

It is equipped with two polycarbonate jars of 2000 CC each having lid and float assembly. Mounted on a dormodule type trolley fitted with free running castors. It would be fitted with a vacuum regulator, gauge and overflow safety trap and a three way valve to control the suction either in left jar/right jar/both the jars.

<table>
<thead>
<tr>
<th>Note</th>
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<tbody>
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<td>1</td>
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<td>3</td>
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<tr>
<td>4</td>
</tr>
</tbody>
</table>
1. **BASIS OF DESIGN**

The Plumbing, External Drainage and water supply System for the project is designed keeping in view the following:

1.1 Requirement of adequate and equal pressure availability of hot and cold water lines in Public Toilets, Kitchen and other identified areas.

1.2 Adequate storage of water in underground raw + overhead treated domestic water tanks.

1.3 Levels of roads / pavements and other services in the area.

1.4 Landscape layout.

The execution of works and materials used shall be as per the latest relevant I.S. specifications. Wherever reference has been made to Indian Standard or any other specifications, the same shall mean to refer to the latest specification irrespective of any particular edition of such specification being mentioned in the specifications below or Schedule of Quantities.

2. **CONCEPT OF THE SYSTEM**

The following services are envisaged for the complex:

2.1 Water Treatment System for meeting the domestic water quality requirement with chemical parameters in acceptable limits as per SP: 35 (S&T) 1987 which is considered safe for human consumption.

2.2 Domestic/Flushing water supply through Hydropneumatic system.

2.3 Sewage and Sullage collection system based on IS:1742 and applicable standards for domestic drainage and connected to Sewage Treatment Plant and /or as otherwise specified with outfall into municipal system.

2.4 Storm / Rain water drainage system from various levels of the building and disposal to Rain Water Harvesting System / storm water drain.

3. **WATER STORAGE & DISTRIBUTION SYSTEM**

3.1 **Water Requirement**

The water requirement for this project is proposed to be as per the provisions in IS : 1172 and prevalent practices.

3.2 **Source of Water**

It is expected that part of the daily domestic water requirement shall be through municipal mains supply. The rest will be obtained from bore wells/tankers.

3.4 **Appurtenant**

Following components shall be included in the water supply system for efficient functioning:

i. Automatic air vent

ii. Pressure Gauge.

iii. Water Hammer arrestors.
4. WORKMANSHIP

The workmanship shall be best of its kind and shall confirm to the specifications, as below or Indian Standard Specifications in every respect or latest trade practices and shall be subject to approval of the Owner’s Site Representative. All materials and/or workmanship which in the opinion of the Owner’s Site Representative / Architect / Consultant are defective or unsuitable shall be removed immediately from the site and shall be substituted with proper materials and/or workmanship forthwith.

5. MATERIALS

All materials shall be best of their kind and shall confirm to the latest Indian Standards.

All materials shall be of approved quality as per samples and origins approved by the Owner’s Site Representative / Architect / Consultants.

As and when required by the Owner’s Site Representative / Consultant, the contractor shall arrange to test the materials and/or portions of works at his own cost to prove their soundness and efficiency. If after tests any materials, work or portions or work are found defective or unsound by the Owner’s Site Representative / Consultant, the contractor shall remove the defective material from the site, pull down and re-execute the works at his own cost to the satisfaction of the Owner’s Site Representative / Consultant. To prove that the materials used are as specified the contractor shall furnish the Owner’s Site Representative with original vouchers on demand.
SECTION I
GENERAL INSTRUCTIONS

1.0  GENERAL REQUIREMENTS

1.1  Scope of Work

1.1.1  The form of Contract shall be according to the “Conditions of Contract”. The following clauses shall
       be considered as an extension and not in limitation of the obligation of the Contractor.

1.1.2  Work under this contract shall consist of furnishing all labour, materials, equipment and appliances
       necessary and required. The Contractor is required to completely furnish all the Plumbing and
       other specialized services as described hereinafter and as specified in the Schedule of Quantities
       and/or shown on the Plumbing Drawings.

1.1.3  Without restricting to the generally of the foregoing, the sanitary installations shall include the
       following:–

       A.  Plumbing Works
           a.  Sanitary ware Installation
           b.  Water Supply System (Hot & Cold).
           c.  Under ground water tanks with all sleeves.
           d.  Sewerage & Storm water drainage system.
           e.  Garden Irrigation System.
           f.  High side works.

1.1.4  Services rendered under this section shall be done without any extra charge.

1.2  Specifications

1.2.1  Work under this contract shall be carried out strictly in accordance with Specifications attached
       with the tender.

1.2.2  Items not covered under these Specifications due to any ambiguity or misprints, or additional
       works, the work shall be carried out as per Specifications of the latest Central Public Works
       Department with upto date amendments as applicable in the contract and or as per the
       requirement of the client or its representative.

1.2.3  Works not covered above in para 1.2.1 and 1.2.2 shall be carried out as per relevant Indian
       Standards and in case of its absence as per British Standard Code of Practice.

1.3  Execution of Work

1.3.1  The Contractor should visit and examine the site of work and satisfy himself as to the nature of the
       existing roads and other means of communication and other details pertaining to the work and
       local conditions and facilities for obtaining his own information on all matters affecting the
       execution of work. No extra charge made in consequence of any misunderstanding, incorrect
       information on any of these points or on ground of insufficient description will be allowed.

1.3.2  The work shall be carried out in conformity with the Plumbing drawings and within the
       requirements of Architectural, HVAC, Electrical, Structural and Other specialized services drawings.

1.3.3  The Contractor shall cooperate with all trades and agencies working on the site. He shall make
       provision for hangers, sleeves, structural openings and other requirements well in advance to
       prevent hold up of progress of the construction schedule.
1.3.4 On award of the work, Contractor shall submit a schedule of construction in the form of a PERT Chart or BAR Chart for approval of the Project Manager/Architect/Consultant. All dates and time schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

1.4 **Drawings**

1.4.1 Plumbing drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings.

1.4.2 Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.

1.4.3 Contractor shall verify all dimensions at site and bring to the notice of the Project Manager all discrepancies or deviations noticed. Decision of the Project Manager shall be final.

1.4.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small scale drawings.

1.4.5 All drawings issued by the Architects/Consultant for the work are the property of the Architects/Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

1.5 **Inspection and Testing of Materials**

1.5.1 Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.

1.5.2 For examination and testing of materials and works at the site Contractor shall provide all Testing and Gauging Equipment necessary but not limited to the followings:

   a) Theodolite, Steel tapes
   b) Dumpy level
   c) Weighing machine
   d) Plumb bobs, Spirit levels, Hammers
   e) Micrometers, Tachometers
   f) Thermometers, Stoves
   g) Hydraulic test machine
   h) Smoke test machine

1.5.3 All such equipment shall be tested for calibration at any approved laboratory, if required by the Project Manager.

1.5.4 All Testing Equipment shall be preferably located in a special room meant for the purpose.

1.5.5 Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Architects or kept at site in a sample room as prepared by the owners. Any materials declared defective by Project Manager/Architect/Consultant shall be removed from the site within 48 hours.

1.6 **Metric Conversion**

1.6.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.
1.6.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

1.7 **Reference Points**

1.7.1 Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.

1.7.2 All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

1.8 **Reference Drawings**

1.8.1 The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.

1.8.2 All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings. All changes to be made shall be initialed by the Project Manager or Architects.

1.9 **Shop Drawings**

1.9.1 The Contractor shall submit to the Project Manager three copies of the shop drawings.

1.9.2 Shop drawings shall be submitted under following conditions:

(a) Showing any changes in layout in the plumbing drawings.

(b) Equipment layout, piping and wiring diagram.

(c) Manufacturer’s or Contractor’s fabrication drawings for any materials or equipment supplied by him.

1.9.3 The Contractor shall submit two copies of catalogues, manufacturer’s drawings, equipment characteristics data or performance charts as required by the Project Manager.

1.10 **Completion Drawings**

1.10.1 On completion of work, Contractor shall submit one complete set of original tracings and two prints of “as built” drawings to the Project Manager. These drawings shall have the following information.

a) Run of all piping, diameters on all floors, vertical stacks and location of external services.

b) Ground and invert levels of all drainage pipes together with location of all manholes and connections upto outfall.

c) Run of all water supply lines with diameters, locations of control valves, access panels.

d) Location of all mechanical equipment with layout and piping connections.

No completion certificate shall be issued unless the above drawings are submitted.

1.10.2 Contractor shall provide two sets of catalogues, service manuals manufacturer’s drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.
1.10.3 All “Warranty Cards” given by the manufacturers shall be handed over to the Project Manager.

1.11. **Contractors Rates**

1.11.1 Rates quoted in this tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

1.11.2 Rates quoted are for all heights and depths and in all positions as may be required for this work.

1.11.3 All rates quoted must be for complete items inclusive of all such accessories, Fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.

1.11.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete/water proofing of appropriate mix and strength as directed by Project Manager. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

1.11.5 The Contractor shall furnish the Architects with vouchers and test certificates, on request, to prove that the materials as specified and to indicate that the rates at which the materials are purchased in order to work out the rate analysis of non tendered items which he may be called upon to be carried out.

1.12 **PAYMENT TERMS**

The terms of payments shall be as below:

10% of Contract amount as mobilization advance against submission of Bank guarantee of equivalent amount valid till end of completion period.

60% of Contract amount prorata against supply of materials at site.

10% Contract amount prorata against erection & Testing.

10% on testing, commission & handover of entire system.

10% Contract amount after handing over of all approvals as built drawings designs maintenance manuals and submission of Bank Guarantee of 2.5% and cash deposit of 2.5% of final value of work done (including extra items) valid till successful completion of Defect Liability period.

1.13 **Testing**

1.13.1 Piping and drainage works shall be tested as specified under the relevant clause(s) of the specifications.

1.13.2 Tests shall be performed in the presence of the Project Manager/ Consultant.

1.13.3 All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

1.13.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other bye-laws in force.

1.13.5 Contractor shall provide all labour, equipment and materials for the performance of the tests.

1.14 **Site Clearance and Cleanup**
1.14.1 The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

1.14.2 After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

1.14.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

1.15 License Permits and Authorities

1.15.1 Contractor must keep constant liaison with the Municipal/statutory authority and obtain all approval of all drainage, water supply and other works carried out by him.

1.15.2 Contractor shall obtain, from the Municipal and other authority’s necessary completion certificate(s) with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. Employer shall pay all fees/deposits as required to be paid to the authorities towards connection charges.

1.16 Recovery of Cost for Materials issued to Contractors Free of Cost

1.16.1 If any materials issued to the Contractor free of cost, are damaged or pilfered, the cost of the same shall be recovered from the Contractor on the basis of actual cost to owner which shall include all freight and transportation, excise duty, sales tax, octroi, import duty etc. plus 100%. The decision on the actual cost given by the Employer shall be final and binding on the Contractor.

1.17 Cutting of Water Proofing Membrane

No walls, terraces shall be cut for making and opening after water proofing has been done without written approval of Project Manager/Architects. Cutting of water proofing membrane shall be done very carefully to ensure that other portion(s) of water proofing is (are) not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Architects.

1.18 Cutting of Structural Members

No structural member shall be chased or cut without the written permission of the Project Manager.

1.19 Materials Supplied by Owner

1.19.1 The Contractor shall verify that all materials supplied by the Employer confirm to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Project Manager.

1.20 Materials

Unless otherwise specified and expressly approved in writing by the Project Manager, only materials of makes and specifications mentioned in the list of approved makes attached with the specifications shall be used.

If required, the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Project Manager and returned to the Contractor at the appropriate time.
SECTION-II

SANITARY FIXTURES

2.1 SCOPE OF WORK

2.1.1 Work under this section shall consist of furnishing all material and labour as necessary and required to completely install all sanitary fixtures, brass and chromium plated fittings and accessories as required by the drawings and specified hereinafter or given in the schedule of quantities.

2.1.2 Without restricting to the generally of the foregoing the sanitary fixtures shall include all sanitary fixtures, C.P. fittings and accessories etc. necessary and required for the building.

2.1.3 Whether specifically mentioned or not all fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

2.2 GENERAL REQUIREMENTS

2.2.1 All fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the schedule of quantities, specifications, drawings or not.

2.2.2 All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per architectural/interior designers requirements. Wherever necessary the fittings shall centered to dimensions and pattern desired.
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME: PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

2.2.3 Fixing screws shall be half round head chromium plated brass with C.P. washers wherever required as per directions of Architect.

2.2.4 All fittings and fixtures shall be fixed in a neat workmanlike manner true to levels and heights shown on the drawings and in accordance with the manufacturer’s recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at contractors cost.

2.2.5 When directed, contractor shall install fixtures and accessories in a mock-up room for the approval of the Architect. Sample room fixtures may be reused on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.

2.3. INDIAN W.C.

2.3.1 Indian W.C. pan shall be Orissa pattern of size as specified in the schedule of quantities. Each W.C. shall be provided with a 100mm dia cast iron or porcelain P or S trap with or without vent horn.

2.3.2 W.C. shall be flushed by means of a C.I. high level flushing cistern or low level cistern of polyethylene body complete with accessories on an exposed or concealed type flush valve or as specified in bill of quantities.

2.3.3 The W.C. shall be fixed in level in a neat workmanlike manner. The W.C. and trap shall be set in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). Joints between W.C. and flush pipe shall be made with a putty or white lead and linseed oil and caulked well or with an approved rubber joint.
2.4 ANGLO INDIAN W.C.

2.4.1 Anglo Indian W.C. shall be wash down type 'P' or 'S' Trap set.

2.4.2 Each Anglo Indian W.C. set shall be provided with a solid plastic seat with cover of colour given in the schedule of quantities, rubber buffers and chromium plated hinges.

2.4.3 Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.

2.4.4 Each Anglo Indian W.C. shall be flushed with a porcelain flushing cistern or an exposed or concealed type flush valve. Flush pipe/bend shall be connected to the W.C. by means of a suitable rubber adapter.

2.5. EUROPEAN W.C.

2.5.1 European W.C. shall be wash down, single or double siphonic type, floor or wall mounted set, flushed by means of porcelain low level flushing cistern, or an exposed or concealed type flush valve, as specified in schedule of quantities. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adapter. Wall hung w.c. shall be supported by C.I. floor mounted chair.

2.5.2 Each W.C. seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.

2.6 URINALS

2.6.1 Urinals shall be lipid type half shall white glazed vitreous China of approx. size 630x420x380mm size or as specified in bill of quantities.

2.6.2 Half stall Urinals shall be provided with 15mm dia C.P. spreader, 32mm dia C.P domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by one C.I. bracket and two C.I. wall clips as recommended by manufacturers complete as directed by Architect.

2.6.3 Half stall urinals shall be fixed with C.P. brass screws and shall be provided with 32mm dia domical waste leading to urinals trap.

2.6.4 Urinals shall be flushed by means of automatic porcelain flushing cistern or exposed or concealed type urinal flush valve, as specified in schedule of quantities.

2.6.5 Flushing cistern for urinals shall be automatic type cast iron or vitreous china as given in the schedule of quantities. Each flushing cistern shall have a copper siphon and inlet noose cock to control the flow. Flushing cistern shall be fixed to wall with R.S. or C.I. brackets. Cast iron cistern and brackets shall be painted with two coats of white enamel paint. Cistern may be concealed in pipe shafts or false ceilings where required as directed by Architect.

2.6.6 Flush pipes of flushing cistern with sizes of main and branch flush pipes shall be as follows:

<table>
<thead>
<tr>
<th>No. of Urinals in range</th>
<th>Capacity of cistern litres</th>
<th>Size of main flush pipe</th>
<th>Size of branch flush pipe</th>
<th>Size of Connection to urinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>5</td>
<td>--</td>
<td>--</td>
<td>15</td>
</tr>
<tr>
<td>Two</td>
<td>10</td>
<td>20</td>
<td>--</td>
<td>15</td>
</tr>
<tr>
<td>Three</td>
<td>10</td>
<td>25</td>
<td>--</td>
<td>15</td>
</tr>
</tbody>
</table>

2.6.7 Alternatively, urinals may be flush with flush valves, exposed or concealed type.
2.6.8 Waste pipes for urinals shall be any one of the following:

a). G.I. pipes
b). Rigid P.V.C.
c). Lead pipes.

Waste pipes may be exposed on wall or concealed in chase as directed by the Architect. Specifications for waste pipes shall be same as given in sub-section 8.0 to 10.0 section-II of Volume-II.

2.7 LAVATORY BASIN

2.7.1 Lavatory basins shall be white glazed vitreous chine or polymarble of size, shape and type specified in the bill of quantities.

2.7.2 Each basin shall be provided with R.S. or C.I. brackets and clips and the basin securely fixed to wall. Placing of basins over the brackets without secure fixing shall not be accepted.

2.7.3 Each basin shall be provided with 32mm dia C.P. waste with overflow, pop-up waste or rubber plug and chain as given in the bill of quantities, 32mm dia C.P.Brass bottle trap with C.P. pipe to wall and flange.

2.7.4 Each basin shall be provided with fittings or mixing fitting as specified in the bill of quantities.

2.7.5 Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cms above the floor or as directed by Architect.

2.8 SINKS

2.8.1 Sinks shall be of precast Terrazzo marble, or white glazed fireclay or vitreous china or stainless steel or any other material as specified in the schedule of quantities.

2.8.2 Each sink shall be provided with R.S. or C.I. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Each sink shall be provided with 40mm dia C.P. waste with chain and plug or P.V.C. waste. Fixing shall be done as directed by Architect.

2.8.3 Supply fittings for sinks shall be mixing fittings or C.P. taps as specified in the bill of quantities.

2.9 MIRRORS

2.9.1 Mirrors shall be electro coated copper 5.5mm thick of guaranteed reputed make. The size shall be as specified in the bill of quantities or shown on the drawings. The image shall be clear and without waviness at all angles of vision.

2.9.2 Mirrors shall be provided with backing of 12mm thick marine plywood sheet fixed with C.P. brass semi-round headed screws and cup washers or C.P. brass clamps as specified or instructed by Architect.

2.10 SHOWER SET

2.10.1 Shower set shall comprise of one/two C.P.Brass concealed stop cocks with two long body brass/C.P. brass bib cock, or bath spout or as given in the bill of quantities.
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME: PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

2.10.2 Each shower set shall also be provided with C.P. Shower arm with wall flange and shower head of approved quality as specified in the bill of quantities.

2.10.3 Concealed stop cocks shall be so fixed as to keep the wall flange clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

2.11 ACCESSORIES

2.11.1 Contractor shall install all chromium plated and porcelain accessories as shown on the drawings or directed by Architect, and given in the bill of quantities.

2.11.2 All C.P. accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Architect.

2.11.3 Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.

2.12 URINAL PARTITIONS

2.12.1 Urinal partitions shall be white glazed vitreous china or 25mm thick marble of size specified in the schedule of quantities.

2.12.2 Porcelain partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners and M.S. clips as recommended by the manufacturer and directed by Architect.

2.13 MEASUREMENT

2.13.1 Rate for providing and fixing of sanitary fixtures accessories, urinal partitions shall include all items and operations stated in the respective specifications and bill of quantities and nothing extra is payable.

2.13.2 Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, C.P. screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning.
3. **SOIL, WASTE, VENT & RAINWATER PIPES & FITTINGS**

3.1 **Scope of Work**

3.1.1 Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the Schedule of Quantities.

3.1.2 Without restricting to the generally of the foregoing, the soil, waste, vent pipes system shall include the followings:-

1. Vertical and horizontal soil, waste and vent Pipes, and fittings, joints, clamps, connections to fixtures.
2. Connection of pipes to sewer lines as shown on the drawings at ground floor levels.
3. Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads /Khurras.
4. Testing of all pipe lines.

3.2 **General Requirements**

3.2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager.

3.2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

3.2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

3.2.4 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

3.2.5 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the Civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawings so that other agencies are instructed to provide the same.

3.3 **Piping System**

3.3.1 **Soil, Waste and Vent Pipes**

a) The soil and waste pipe system above ground has been planned as a “Two pipe system” having separate pipes for waste for kitchen sinks, wash basins, AHU’s, condensate drains and floor drains and soil from the WCs and Urinals.

b) All waste water from AHU’s plant and pump rooms, floor channels in basements (if any) will be provided with a deep seal trap before connecting to the main drain or vertical stack.

c) Vertical soil and waste stacks shall be connected to a separate horizontal drain / single horizontal drain at basement ceiling generally as shown on the drawings.

d) Toilet layouts have been so arranged that the W.C outlets shall be with “P” trap above ground level.
e) All soil/waste from areas in basement areas will be collected in sumps and pumped into sewer lines or as specifically designed.

f) Head (Starting point) of drains and sewage/waste water sumps (as and where applicable) having a length of greater than 4m upto connection to the main drain or manhole shall be provided with a 80/100mm vent pipe terminating above roof / a Maxi-Filtra with an ACF cartridge shall be provided close to the MH as directed by the Project Manager.

3.4 Rainwater Pipes

a) All open terraces shall be drained by rain water down takes.

b) Rainwater down takes are separate and independent of the soil and waste system and will discharge into the underground storm water drainage system of the complex.

c) Rainwater in open courtyards shall be collected in catch basins and connected to the storm water drains.

d) Any dry weather flow from waste appliances e.g. AHU’s, Parking and Drainage Sumps shall connected to the Storm Water Network and Sewerage Sumps will be connected to the Sewerage System.

3.5 Balcony/Planter Drainage

Wherever required, all balconies, terraces, planters and other formal landscape areas will be drained by vertical down takes or other type of drainage system shown on the drawings and directed by the Project Manager.

3.6 Soil Waste and Vent Pipes and Fittings above Ground

3.6.1 Soil, waste, vent, anti-syphonage and rain water pipes shall be cast iron pipes.

3.6.2 All pipes shall be straight and smooth and inside free from irregular bore, blow holes cracks and other manufacturing defects. Pipes shall be centrifugally spun iron so pipes conforming to IS 3989-1979 and fittings shall be conforming to IS 3989-1979.

3.6.3 Fittings

3.6.3.1 Fitting shall conform to the Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specifications.

3.6.3.2 Fittings shall be of the required degree of curvature with without access door.

3.6.3.3 Access door shall be up with 3MM thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal. The fixing shall be air and water tight.

3.6.4 Floor Traps & Urinal Traps

Floor traps shall be cast iron, deep seal with an effective seal of 50 mm. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 Cement: 2 Coarse sand: 4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor levels. Contractor shall provide all necessary shuttering and centering for the block. Size of the block shall be 30 x 30 cms of the required depth.

3.6.5 CLEANOUT PLUGS
Contractor shall provide cast brass cleanout plugs as required. Cleanout plugs shall be thread and provided with key holes for openings. Cleanout plugs shall be fixed the pipes by a G.I. socket drip seal caulked. (Detail with sketch).

3.6.6 Jointing (CI Soil Pipes & Fittings)

Joints for cast iron soil, waste vent, anti syphonage and rainwater pipes shall be made with drip seal / pipe seal compound and sufficient skein of jute rope dipped in coal tar shall be caulked to leave a minimum space for the sealant compound.

3.6.7 Cleanout Plugs

Floor Clean Out Plug
Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, “Yes” and on straight runs at such intervals as required as per site conditions. Clean out plugs shall terminate flush with the floor levels. They shall be cast brass suitable for the pipe dia. With screwed to a G.I socket. The socket shall be joined to the pipe with drip seal/pipeline seal.

3.7 Waste Pipe from Appliances

3.7.1 Waste pipe from appliances e.g. washbasins, sinks, urinals shall be of galvanized steel in toilets, kitchens, pantries and service areas where so required, and as given in the Schedule of Quantities or as shown on the drawings.

3.7.2 All pipes shall be fixed in gradient towards the connection to stack or drains. Pipes inside all toilets room shall be in chase unless otherwise shown on drawings. Where so required and shown on drawings or directed by the Project Manager.

3.7.3 (a) Galvanized Pipes (Where specified or required at site for sump drainage only)

Pipes shall be galvanized steel tubes conforming to IS: 1239 (medium class) and quality certificates shall be furnished. Pipes shall be provided with all required fittings e.g. Tees, Couplings, Bends, Elbows, Unions, Reducers, Nipples, Plugs. All G.I. waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes in chase shall be painted with two coats of black bitumen paint and exposed pipes with one coat of red oxide primer and two or more coats of synthetic enamel paint or as given in the Schedule of Quantities. G.I. waste pipes buried in ground or sunken slab shall be protected with multi layer bitumen membrane tape 3mm thick with a final coat of hot or cold applied bitumen. "Pypkote" or equivalent.

3.7.3 (b) uPVC Pipes (Where specified or required at site for waste/rain only)

Pipes shall be uPVC confirming to IS: 4985-2000 (quick fit type) and quality certificates shall be furnished as required. Pipes shall be provided with all required fittings e.g. Tees, Couplings, Bends, Elbows, Unions, Reducers, Nipples, and Plugs. All waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter.

3.8 Drainage under floor/above floor (service floors, basement ceiling etc.)

3.8.1 All drainage lines passing under building, in exposed position above ground e.g. service floors, basement ceiling etc. shall be Multilayered as per details given in sub-clause 3.10 above or shall be as per details given below. Position of such pipes shall generally be shown on the drawings.

3.8.1 (a) SOCKET PIPES

3-layered reinforced polypropylene (PP) sewage pipes, halogen and lead free, with integral push-fit socket and factory-fitted lip ring, tested and monitored according to the Product Standard EN 1852
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME: PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

– 1, having internal layer of PP in light grey color, intermediate layer of PP in grey/titanium-grey color, external layer of PP in copper brown color.

3.8.2 **Fittings**

3-layered reinforced polypropylene (PP) sewage pipes, halogen and lead free, with integral push-fit socket and factory-fitted lip ring, tested and monitored according to the Product Standard EN 1852 – 1. Fittings upto dimension DN/OD 200 are manufactured by injection molding (1-layer), above DN/OD 200 (250 and above)

The fittings are butt or extrusion welded by the manufacturer. Fabrication of fittings at site shall not be permitted.

3.8.4 **Cleanout on Drainage Pipes (CO Plugs)**

a) Cleanout plugs shall be provided on head of each drain and in between at locations indicated on plans or directed by. Cleanout plugs shall be of size matching the full bore of the pipe but not exceeding 150mm dia. CO plugs on drains of greater diameters shall be 150mm dia. Fixed with a suitable reducing adapter.

b) Floor cleanout plugs shall be cast brass as given in para 3.10.6 above.

c) PP plugs of material as in item 3.12 above provided at ceiling level pipe shall be fixed to a socketed end piece.

3.8.5 **Pipe Joints**

Field-proven push-fit connection with improved and modified lip ring of high ageing-resistant shall be provided with the pipes and fittings for easy push-fit installation, installation procedure as given in clause 3.10 above shall be followed.

3.9 **Encasing in Cement Concrete**

3.9.1 Encasing of pipes is required to provide stability to the line and prevent its damage during construction.

3.9.2 **Soil and waste pipes under floor**

Pipes laid in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 12mm size) 75mm in bed and all round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of 1.8m. All drainage pipes except when fixed above ground or in exposed locations shall be encased in cement concrete as specified above for soil and waste pipes. The bed and encasing thickness shall however be 150mm in bed and all round as shown on the drawing/specified in the BOQ.

3.10 **Painting**

3.10.1 Paints used shall be of approved quality and shade. Where directed pipes shall be painted in accordance with approved pipe color code.

3.10.3 G.I waste pipes buried in ground or fixed in chase shall be protected with 2mm thick bitumen membrane tape with a final coat of hot or cold applied bitumen. Exposed waste pipes shall be painted with two or more coats of synthetic enamel paint.

3.11 **Cutting and Making Good**
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME: PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

3.11.1 Contractor shall provide all holes cut outs and chases in structural members necessary and required for the pipe work as building work proceeds. Wherever cut outs, holes are left in the original construction, they shall be made good with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20mm nominal size) or cement mortar 1:2 (1 cement : 2 coarse sand) and the surface restored as in original condition.

3.12 **Sleeves/Cutouts**

3.12.1 Contractor shall utilize all cutout and sleeves provided during construction to prevent breaking. The annular space between the pipe and the sleeve shall be filled up with approved type of fire hydrant sealant. When sleeves are misplaced or inaccurately located contractor shall make the holes in the wall or structural members at his own cost but only with the prior permission of the Project Manager.

3.13 **Testing**

3.13.1 Testing procedure specified below apply to all soil, waste and vent pipes above ground including Multilayered PP pipes laid in basement ceiling.

3.13.2 Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests.

3.13.3 All materials obtained and used on site must have manufacturers hydraulic test certificate for each batch of materials used on the site.

3.14 **Measurements**

3.14.1 **General**

   a) Rates quoted for all items quoted shall be inclusive of all work and items given in the specifications and Schedule of Quantities

   b) Rates are applicable for the work in basements, under the ground, floors, in shafts at ceiling level area for all depths and building upto 45m in height.

3.14.2 Rates are inclusive of cutting holes and chases in masonry work and making good the same.

3.14.3 Rates are inclusive of pre testing and on site testing of the installations, materials and commissioning of the works.

3.14.4 Pipes (unit of measurement. Linear meter to the nearest centimeter)

3.14.5 Soil, waste, vent, anti syphonage, rain water pipes, and drainage pipes shall be measured net when fixed correct to a centimeter including all fittings along its finished length.

3.14.6 G.I. pipes/uPVC shall be measured per running meter correct to a centimeter for the finished work, which shall include fittings e.g. Bends, Tees, Elbows,Reducers, Crosses, Sockets, Nipples and Nuts. The length shall be taken along center line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality and finish. The diameter shall be diameter of internal bore.

3.14.7 Cement concrete around pipes shall be measured along the center of the pipe line measured per linear meter and include any Masonry Supports, Shuttering and Centering Cutting complete as described in the relevant specifications.
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME : PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

3.14.8 Slotted angles/channels shall be measured per linear meter of finished length and shall include support bolts and nuts embedded in masonry walls with cement concrete blocks and nothing extra will be paid for making good the same.

3.14.9 Fittings (excluding pipe fittings) (Unit of measurement by numbers)

Urinal traps, trap gratings, hoppers, cleanout plugs shall be measured by number per piece and shall include all items described in the relevant specifications and Schedule of Quantities.

3.14.10 Painting

Painting of pipes and fittings shall be measured per running meter.

3.14.11 Excavation for soil pipes:

No extra payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for pipes laid below ground, in sunken slabs or over basement rafts.
SECTION IV
WATER SUPPLY SYSTEM

4. WATER SUPPLY SYSTEM

4.1 Scope of Work

4.1.1 Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities.

4.1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following:

a) Distribution system from main supply headers to all fixtures and appliances for cold/hot water.
b) Cold water supply lines from tube-wells and city water connections to fire and underground water tanks.
c) Municipal water and Bore-well connections to U.G. water tanks.
d) Garden Irrigation system
e) Excavation and refilling of pipes trenches.
f) Pipe protection and painting.
g) Control valves, masonry chambers and other appurtenances.
h) Connections to all plumbing fixtures, tanks, appliances and Municipal mains
i) Inserts for RCC tank.

4.2 General Requirements

4.2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.

4.2.2 Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

4.2.3 Short or Long bends shall be used on all main pipe lines as far as possible. Use of Elbows shall be restricted for short connections.

4.2.4 Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

4.2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

4.2.6 Clamps, hangers and supports on RCC walls, columns and slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.

4.2.7 All pipe clamps, supports, nuts, bolts, washers shall be galvanized MS steel throughout the building. Painted MS clamps & MS nuts, bolts and washers shall not be accepted.

4.2.8 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

4.3 Water Supply System

4.3.1 Contractor should study the site plan and water supply system diagram for an overview of the system.
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME: PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

4.3.2 Source

Water supply will be acquired from Municipal Corporation water mains to a service connection and captive tube-wells within the site and collected in water storage tanks located in basement.

4.4 G.I. Pipes, Fittings & Valves (In Plant rooms and for Equipments)

4.4.1 All pipes inside the buildings and where specified, outside the building shall be galvanized steel tubes conforming to I.S. 1239 of medium/heavy class as specified in the BOQ.

4.4.2 Fittings shall be malleable iron with a reinforcing ring over the threaded ends upto 50mm dia and without reinforcing rings for sizes 65mm dia and above. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall include Couplings, Bends, Tees, Reducers, Nipples, Unions, and Bushes. Fittings shall conform to I.S:1879 (Part I to X).

4.4.3 Pipes and fittings shall be jointed with screwed joints. Care shall be taken to remove burr from the end of the pipe after reaming with a proper time.

4.4.4 Pipe threaded joints will be made by applying suitable grade of TEFLON tape used for drinking water supply.

4.4.5 All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other as shown on drawings.

4.5 Pipe Supports

4.5.1 All pipes clamps, supports, hangers, rods, pipe supports, nuts and washers shall be factory made galvanized MS steel or alternatively galvanized after fabrication to suit site requirements.

4.5.2 G.I. pipes in shafts and other locations shall be supported by galvanized M.S clamps of design approved by pipes in wall chases shall be anchored by G.I hooks, pipes at ceiling level shall be supported on structural clamps fabricated from M.S structural steel. Pipes in typical shafts shall be supported on Galvanised slotted angles/channels as specified elsewhere.

4.6 Clamps

G.I. pipes in shafts and other locations shall be supported by M.S. clamps of design approved by Project Manager. Pipes in wall chases shall be anchored by iron hooks, Pipes at ceiling level shall be supported on structural clamps fabricated from M.S structural steel as described above. Pipes in typical shafts shall be supported on slotted angles/channels as specified.

4.7 Anchor Fasteners

4.7.1 All pipe supports, hangers and clamps to be fixed on RCC walls, beams, columns, slabs and masonry walls 230mm thick and above by means of galvanised expandable anchor fasteners in drilled holes of correct size and model to carry the weight of pipes. Drilling shall be made only by approved type of power drill as recommend and approved by manufacturer of the anchor fasteners. Failure of any fastening devices shall be the entire responsibility and contractor shall redo or provide additional supports at his own cost. He shall also compensate the owner for any damage that may be caused by such failures.

4.8 Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME: PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

4.9 Flanges

Flanged connections shall be provided on pipes as required or where shown on the drawings, all equipment connections as necessary and required or as directed by connections shall be made by the correct number and size of Gi nuts, bolts & washers with 3 mm thick gasket. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Bolt hole dia for flanges shall conform to match the specification for C.I. sluice valve to I.S.780. and C.I. butterfly valve to IS: 3095.

4.10 CPVC and UPVC Pipes and Fittings:

_Chlorinated Poly Vinyl Chloride (CPVC)_ compound shall meet cell class 23447 B as defined by ASTM D 1784 and have a design stress of 2000 psi and a maximum service temperature upto 93 degree Celsius. Pipes shall be as per SD 11, material as per ASTM 1784, specifications as per ASTM D2846 and cpvc jointing solvent shall be as per ASTM F493. SCHEDULE PIPES 40 and 80 shall be as per ASTM F441. (for Hot water and Cold water applications)

Clamping for cpvc pipe shall be as per manufacturer’s recommendations only.

4.10.1 INSTALLATION GUIDELINES

1. Handling of pipes and fittings
   In order to prevent dirt from penetrating inside the pipes, these are delivered conveniently plugged. Should a length be cut, it is advisable to re-plug what will be later used. fittings are stored in sealed disposable plastic bags.

2. Pipe Cutting
   Pipes are to be cut at right angle to the required length using the proper cutter tools. Oil cooled saws, abrasive wheels or cutting torches are not to be used.
   After cutting, pipe ends must be properly deburred internally and externally using suitable tools.
   The detail is paramount as sharp edged ends of pipes might damage the o-ring when they are inserted into the socket, and this will cause a leak in the joint that cannot be tightened.

3. Pipe Bending
   The range of components of the Jindal press fitting system offers various types of bends for each pipe size. Nevertheless pipes in austenitic stainless steel (AISI 316 and 304) having outside diameter up to 18 mm can be cold bended, to a minimum radius of about 3.5 times the outside diameter, using a commercial bending tool.
   Bending by means of heat is not allowed under any circumstances.

4. Coupling of pipes to fittings
   To make the connection, the pipe is to be inserted into the fitting until it reaches its stop. The end of the fitting (which contains the o-ring) is then pressed onto the pipe by means of a pressing tool.
   The pressing tool is operated electro-hydraulically and should be fitted with the right jaw, according to size of pipe to crimp, in a few seconds. The automatic regulation of the stroke of the pressing halfjaws ensures the correct compression of parts to be joined.
   The controlled deformation of the fitting and pipe, generated by the jaw, provides the mechanical strength of the connection and prevents the slip off and turning of coupled parts. The watertightness is produced by the compression of the fitting and of the o-ring located in its groove, onto the pipe.
   To obtain the required mechanical properties and water-tightness of the joint following instructions must be carefully applied.
   > Check that no bur is present on the cut-to-length pipe and that the o-ring seal is correctly inserted in the fitting.
   > Push the pipe into the fitting axially, slightly rotating at the same time, until it reaches the stop. Never insert the pipe obliquely to avoid damaging the o-ring.
   In order to grant the requested mechanical strength to the connection the pipe must be introduced into
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME : PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

the socket until the stops. It is recommended to mark the depth of penetration on the pipe.

> If the pipe can only be inserted into the fitting with difficulty, due to tight tolerance, lubricants such as water and soap solution can be used. Never use oil or grease for this purpose.

> Before pressing the fitting onto the pipe verify that the joint are not under stress. To this purpose pipes must be aligned before the fittings are pressed.

5. Pipe positioning
Before installing a pipeline it is necessary to verify that all around the joint there is room enough for inserting the pressing tool.

In the table below, the minimum clearance required for pressing is given for each pipe size and for different position of press fitting.

<table>
<thead>
<tr>
<th>Pipe outside diameter</th>
<th>15</th>
<th>22</th>
<th>28</th>
<th>35</th>
<th>42</th>
<th>54</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (mm)</td>
<td>25</td>
<td>35</td>
<td></td>
<td>45</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>B (mm)</td>
<td>75</td>
<td>81</td>
<td>81</td>
<td>85</td>
<td>130</td>
<td>150</td>
</tr>
<tr>
<td>C (mm)</td>
<td>56</td>
<td>70</td>
<td>76</td>
<td>76</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>L (mm)</td>
<td>24</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>85</td>
<td>90</td>
</tr>
</tbody>
</table>

Installation

6.1 Making a press connection
> Prepare the pipe and fitting for the pressing operation.
> Push pipe into fitting to correct insertion depth.
> Press the fitting.

6.2 Prepare the pipe and fitting for the pressing operation
> Check that the pipe and fitting are clean, undamaged and free from scoring or dents.
> Determine the pipe length.
> Cut the pipe to the correct length.

> Deburr the pipe ends, internally and externally.
> Clean chips from the pipe ends.
> Mark the insertion distance. Insufficient mechanical strength if correct insertion depth is not observed.
> On fittings with a plain end, mark the insertion distance on the end.
> Check the seal ring.

Push the fitting onto the pipe up to the marked insertion distance.
> Align the pipe and fix it in position.
> Ensure that the diameter of the press fitting matches the diameter of the pressing jaw.
> Press the fitting.

4.11 Trenches

All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches shall be as follows

<table>
<thead>
<tr>
<th>Dia of pipe</th>
<th>15mm to 50mm</th>
<th>65mm to 100mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of Trench</td>
<td>30 cms</td>
<td>45 cms</td>
</tr>
<tr>
<td>Depth of Trench</td>
<td>75 cms</td>
<td>100 cms</td>
</tr>
</tbody>
</table>

4.12 Sand filling

Pipes in trenches shall be protected with fine sand 15 cms all round before filling in the trenches.
4.13 Painting

All pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard color code given in this document or specified by Project Manager.

4.14 Pipe protection

4.14.1 All GI pipes in wall chase and below floor in toilets (where so fixed) shall be protected against corrosion by the application of two coats of bitumen paint covered with polythene tape and a final coat of bitumen paint.

4.14.1 G.I. water supply pipes, if buried in ground or sunken slab, shall be protected with multi layer bitumen membrane tape 3mm thick with a final coat of hot or cold applied bitumen. "Pypkote" or equivalent.

4.15 Valves

4.15.1 Ball Valves

Valves up to 50 mm dia. shall be screwed type Ball Valves with stainless steel balls spindle teflon seating and gland packing tested to a hydraulic pressure of 20 kg/sq.cm., and accompanying couplings and steel handles.( to BIS 5351 )

4.16 Butterfly Valves – Slim Seal Type

4.16.1 Valves 65 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle.

4.16.2 Butterfly valve shall be of best quality conforming to IS: 13095.

4.17 Non Return Valve (Dual Slim Type)

Where specified, non return valve shall be provided through which flow shall occur in one direction only.

Each Butterfly and Slim Type Swing Check (NRV) Valve shall be provided with a pair of flanges screwed or welded to the main line and having the required number of nuts, bolts and washers of correct length.

4.18 Storage tanks Underground & Overhead Tank. (Accessories & Connections)

4.18.1 Storage tanks for water supply shall be in reinforced cement concrete built by the building contractor.

4.18.2 Each tank shall be provided with a 560mm Dia Heavy Duty Cast Iron manhole frame and cover.

4.19 Storage Tanks

4.19.1 Underground

Underground storage tanks for water supply shall be reinforced cement concrete built by the building contractor. Each tank shall be provided with a 560mm Dia Heavy Duty Cast Iron manhole frame and cover or as approved by local municipal authority.

4.20 Outlets and overflow

All nozzles for puddle flanges in RCC tank for inlet, outlet, overflow and scour etc. shall be provided by civil contractor or as given in the Schedule of Quantities, further connections and accessories shall be provided under this contract.

4.21 Testing
All pipes, fittings and valves, after fixing at site, shall be tested by hydrostatic pressure of 1.5 times the working pressure or 7 kg / sq.cm whichever is higher. Pressure shall be maintained for a period of at least thirty minutes without any drop. A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Project Manager.

In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes’ or failure of fittings, to the building, furniture and fixtures shall be made good by the Contractor during the defects liability period without any cost.

After commissioning of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves, which do not effectively operate, shall be replaced by new ones at no extra cost and the same shall be tested as above.

Hot water pipes chased into the walls shall be provided with a 6mm thick insulation with elastic flexible material having hermetic closed cell structure of expanded synthetic material rated for 60ºC hot water supply.

4.22 Measurement

a) Pipes above ground shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, flanges and U clamps with nuts, bolts & washers fixed to wall or other standard supports.

b) Jointing with teflon tape, white lead, solvent, crimping and insertion gasket of appropriate temperature grade.

c) Cutting holes, and chases in walls, floors, any pipe support required for pipes below ground & making good the same.

d) Excavation, backfilling, disposal of surplus earth and restoring the ground & floor in original condition.

4.23 Pipe Supports

Fabricated and/or galvanised supports shall be measured by weight. Weight for each type of clamp shall be calculated on basis of the quantity of structural and MS used from the theoretical weight calculated on basis of the components theoretical weight of the sections.

4.24 Rate quoted for supports & hangers shall be inclusive of:

a) Expandable anchor fastens.
b) Galvanising of all supports & hangers.
c) Cutting holes in walls, ceilings on floors and making good where permitted.
d) Nuts, bolts and washers for fixing and assembling.
e) Wooden / PVC pipe saddles for vertical or horizontal runs.

4.25 Valves

Gunmetal, cast iron, butterfly and non return valves and puddle flanges shall measured by numbers and shall include wheels I caps, GI nuts, bolts, washers, insertion gasket.

4.26 Painting/pipe protection/insulation

Painting/pipe protection/insulation for pipes shall be measured per linear meter over finished surface and shall include all valves and fittings for which no deduction shall be made. No extra payment shall be made for fittings, valves or flanges.
SECTION V
DRAINAGE

5. DRAINAGE (Sewers & Storm Water Drains)

5.1 Scope of work

5.1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install all the drainage system as required by the drawings and specified hereinafter or given in the Schedule of Quantities.

5.1.2 Without restricting to the generality of the foregoing, the drainage system shall include:-

5.1.2.1 Sewer lines including excavations, pipelines, manholes, drop connections and connections to the existing sewer.

5.1.2.2 Storm water drainage, excavation, pipelines, manholes, catch basins, drain channels and connections to the existing storm water drain.

5.2 General requirements

5.2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of the Project Manager.

5.2.2 Drainage lines and open drains shall be laid to the required gradients and profiles.

5.2.3 All drainage work shall be done in accordance with the local municipal bye-laws.

5.2.4 Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority.

5.2.5 Location of all manholes, etc. shall be got confirmed by the Contractor from the Architect / Landscape Architect. As far as possible, no drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Project Manager.

5.3 Excavation

5.3.1 Alignment and grade

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Project Manager. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Project Manager.

5.3.2 Excavation in tunnels

The excavation for sewer works shall be open cutting only, unless the permission of the Project Manager is obtained for laying pipes in tunnel where sewers have to be constructed along narrow passages or difficult ground.

5.3.3 Opening out trenches

In excavating the trenches, etc. the solid road metalling, pavement, kerbing, etc. and turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully sifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Project Manager.
The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Project Manager.

5.3.4 Obstruction of roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Project Manager.

5.3.5 Removal of filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer or cess pool, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and remove to a suitable place to be provided by the Contractor.

5.3.6 Excavation to be taken to proper depths

The trenches shall be excavated to such a depth that the sewer shall rest on concrete as described in the several clauses relating thereto and so that the inverts may be at the levels given in the sections.

5.3.7 Refilling

After the sewer or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and upto 75cms above the crown of the sewer shall consist of the finest selected materials placed carefully in 15cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15cms layers with materials taken from the excavation, each layer is being watered to assist in the consolidation unless the Project Manager.

5.3.8 Contractor to restore settlement and damages

The contractor shall, at his own costs and charges make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, berms, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be reliable for any accidents caused thereby. He shall also at his own cost and expenses and charges, repair any make of any damage done to the buildings and other property.

5.3.9 Disposal of Surplus Earth

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

5.3.10 Timbering of sewer and trenches

a) The contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, pilling and sheeting and they shall be closed, timbered in loose of sandy strata and below the surface of the sub soil water level.

b) All timbering, sheeting and piling with their walling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse of subsidence of the walls of the trench shall be take place.
c) The contractor shall be held responsible and will be accountable for the sufficiency of all timbering, bracings, sheeting and piling used as also for, all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of the same.

5.3.11 Shoring of Buildings

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

5.3.12 Removal of water from sewer, trench etc

a) The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed of by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.

b) If any excavation is carried out at any point or points to a greater width than the specified cross section of the sewer with its envelope, the full width of the trench shall be filled with concrete by the Contractor at his own expenses.

5.3.13 Width of trench

5.3.14 Recommended width of trenches at the bottom shall be as follows:

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Recommended Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 mm dia</td>
<td>55 cms</td>
</tr>
<tr>
<td>150 mm dia</td>
<td>55 cms</td>
</tr>
<tr>
<td>225-250 mm</td>
<td>60 cms</td>
</tr>
<tr>
<td>300 mm dia</td>
<td>75 cms</td>
</tr>
</tbody>
</table>

Maximum width of the bed concrete shall also be as above. No additional payment is admissible for widths greater than specified.

5.4 Salt glazed stoneware pipes (Where applicable)

5.4.1 Stoneware pipes shall be of first class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall have the manufacturers name marked on it and shall comply to I.S. 65.1

5.4.2 Laying and jointing of stoneware salt glazed pipes

- Pipes are liable to be damaged in transit and notwithstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at the site. Each pipe shall be rung with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes should be segregated, marked in a conspicuous manner and their use in the works prevented.

- The pipes shall be laid with sockets leading uphill and rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.

- Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried too low it shall be made up with cement concrete at the Contractor’s cost and charges.
• If the bottom of the trench consists of rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed to ensure even bearing.

5.4.3 Jointing of pipes

• Tarred gaskin shall first be wrapped round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid, the pipe shall then be adjusted and fixed in its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

• The remainder of the socket shall be filled with stiff mix of cement mortar (1 cement: 1 clear sharp washed sand). When the socket is filled, a fillet should be formed round the joint with a trowel forming an angle of 45 degrees with the barrel of the pipe. The mortar shall be mixed as needed for immediate use and no mortar shall be beaten up and used after it has begun to set.

• After the joint has been made any extraneous materials shall be removed from inside of the joint with a suitable scraper of "badger". The newly made joints shall be protected until set from the sun, drying winds, rain or dust. Sacking or other materials, which can be kept damp, shall be used. The joints shall be exposed and space left all round the pipes for inspection by the inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

5.5 uPVC Pipes & Fittings.

a) Upvc pipes shall be straight and smooth conforming to IS 4985-1983 of class as specified in Schedule of Quantities.

b) Joints shall be done as per the manufacturer’s recommendations. The pipes and fittings must have matching dimension for perfect joints in the system shall be with solvent cement as per manufacturers requirements.

5.6 Testing

• All lengths of the sewer and drain shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 1.5 meter head of water. The test pressure shall, however, not exceed 6 meter head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.

• Sewer lines shall be tested for straightness by: (i) inserting a smooth ball 12 mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball should roll down the invert of the pipe and emerge at the lower end. (ii) means of a mirror at one and a lamp at the other end. If the pipeline is straight the full circle of light will be seen otherwise obstruction of deviation will be apparent.

• The Contractor shall give a smoke test to the drains and sewer at his own expense and charges, if directed by the Project Manager.

A test register shall be maintained which shall be signed and dated by Contractor.

5.7 Gully traps

Gully traps shall be of the same quality as described for stoneware pipes in clause 5.4.1 above and used where shown on drawings.
Gully traps shall be fixed in cement concrete 1:5:10 mix (1 cement: 5 coarse sand: 10 stone aggregate 40 mm nominal size) and a brick masonry chamber 30x30 cms inside plastered with cement mortar i:5 with 15x 15 cms grating inside and 30x30 cms C.I. sealed cover and frame weighing not less than 7.3 kg to be constructed as per standard drawing. Where necessary, sealed cover shall be replaced with C.I. grating of the same size.

5.8 Reinforced cement concrete pipes

- All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun S & S RCC pipes of specified class. Pipes shall be true and straight with uniform bore, throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer.

- Laying
  R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings. The cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12 mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and bonding rods etc. Cradles or concrete bed may be omitted, if directed by the Project Manager.

- Jointing
  After setting out the pipes the socket shall be centered over the spigot and filled in with tarred gasket, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 Cement: 2 fine sand) and caulked by means of proper tools. All joints shall be finished at an angle of 45 degrees to the longitudinal axis of the pipe on both sides of the collar neatly.

- Testing
  All pipes shall be tested to a hydraulic test of 1.5 m head for at least 30 minutes at the highest point in the section under test. Test shall also be carried out similar to those for stoneware pipes given above. The smoke test shall be carried out by the contractor, if directed by the Project Manager and a test register shall be maintained which shall be signed and dated by the Contractor/Project Manager.

5.9 Cement Concrete and masonry works (For Manholes and Chambers)

5.9.1 Materials

a) Water
  Water used for all the construction purposes shall be clear and free from Oil, Acid, Alkali, Organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered good enough for construction purpose.

b) Aggregate for Concrete
  The aggregate for concrete shall be in accordance with I.S. 383 and I.S. 515 in general, these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Project Manager. The size of the coarse aggregate shall be done as per I.S.383.

c) Sand
  Sand for various constructional purposes shall comply in all respects with I.S 650 and I.S. 2116. It shall be clean, coarse hard and strong, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali,
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME: PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

organic matters, salt, loam and other impurities which may be considered by the Project Manager.

d) Cement

The cement used for all the constructional purposes shall be ordinary Portland cement or rapid hardening Portland cement conforming to I.S. 269.

e) Mild Steel Reinforcement

The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of I.S. 432 (Grade I).

f) Bricks

Bricks shall have uniform color, thoroughly burnt but not over burnt, shall have plan rectangular faces with parallel sides and sharp right angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Project Manager.

g) Other Materials

Other materials not fully specified in these specifications and which may be required in the work shall conform to the latest I.S. All such materials shall be approved by the Project Manager before use.

5.9.2 Cement concrete (plain or reinforced)

a) Cement concrete pipes bedding, cradles, foundations and R.C.C. slabs for all works shall be mixed by a mechanical mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.

b) Concrete work shall be of such thickness and mix as given in the Schedule of Quantities.

c) All concrete work shall be cured for a period or at least 7 days. Such work shall be kept moist by means of gunny bags at all times. All pipes trenches and foundations shall be kept dry during the curing period.

5.9.3 Masonry

Masonry work for manholes, chambers, septic tanks, and such other works as required shall be constructed from 1st class bricks or 2nd class as specified in the Schedule of Quantities in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

5.9.4 Cement concrete for pipe support

Wherever specified or shown on the drawing, all pipes shall be supported in bed all round or haunches. The thickness and mix of the concrete shall be given in the Schedule of Quantities. Width of the bedding shall be as per para 5.3.1.4.

Unless otherwise directed by the Project Engineer, cement concrete for bed, all-round or in haunches shall be laid as follows:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Upto 1.5m</th>
<th>Upto 3m</th>
<th>Beyond 3m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Contractor’s Signature & Seal

Page - 30
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME: PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

<table>
<thead>
<tr>
<th>Material</th>
<th>Condition</th>
<th>Size</th>
<th>Haunches</th>
<th>Size</th>
<th>Haunches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stoneware pipes</td>
<td>All round</td>
<td>1:4:8</td>
<td></td>
<td>All round</td>
<td>1:4:8</td>
</tr>
<tr>
<td></td>
<td>In open ground (no sub soil water)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.C.C or SW</td>
<td>All round</td>
<td>1:3:6</td>
<td></td>
<td>Haunches</td>
<td>1:3:6</td>
</tr>
<tr>
<td>(In sub soil water)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.I Pipes</td>
<td>All round</td>
<td>1:3:6</td>
<td></td>
<td>Haunches</td>
<td>1:3:6</td>
</tr>
<tr>
<td>(In all conditions)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R.C.C Pipes</td>
<td>All round</td>
<td>1:3:6</td>
<td></td>
<td>All round</td>
<td>1:3:6</td>
</tr>
<tr>
<td>Or C.I Pipes</td>
<td>(1:3:6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Under or building
(Ratio refer to cement: coarse sand: stone aggregate 40 mm nominal size)

R.C.C pipes or C.I. pipes may be supported on brick masonry or precast R.C.C or in situ cradles. Cradles shall be shown on the drawings. Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

5.10 Manholes and chambers

5.10.1 All manholes, chambers and other such works as specified shall be constructed on brick masonry in cement mortar 1:5 (1 cement: 5 coarse sand) as specified in the Schedule of Quantities.

5.10.2 All manholes and chambers, etc. shall be supported on base of cement concrete of such thickness and mix as given in the Schedule or Quantities or shown in the drawings.

Where not specified, manholes shall be constructed as follows:- (all dimensions internal clear in cms)

<table>
<thead>
<tr>
<th>Size of manhole type</th>
<th>90x80 Rect.</th>
<th>120x90 Rect.</th>
<th>91 dia Conical</th>
<th>122 dia Conical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum depth</td>
<td>120</td>
<td>240</td>
<td>167</td>
<td>168</td>
</tr>
<tr>
<td>Average thickness</td>
<td>15</td>
<td>15</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Of R.C.C slab</td>
<td>150</td>
<td>50 dia</td>
<td>50 dia</td>
<td>50 dia</td>
</tr>
<tr>
<td>Size of cover and frame cms</td>
<td>60x45</td>
<td>50 dia</td>
<td>50 dia</td>
<td>50 dia</td>
</tr>
<tr>
<td>Weight of Cover and frame</td>
<td>38 kg</td>
<td>116 or</td>
<td>116 or</td>
<td>116 or</td>
</tr>
</tbody>
</table>

5.10.3 All manholes shall be provided with cement concrete benching in 1:2:4 mix. The benching shall have a slope of 10 cms towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement. (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nom. Size) as per standard details.

5.10.4 All manholes shall be plastered with 12mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster mixed with water proofing compound.

5.10.5 All manholes with depths greater than 1 m. shall be provided with 20 mm square or 25 mm round rods plastic coated catch rings set in cement concrete blocks 25x10x10 cms in 1:2:4 mix 30 cms vertically and staggered. Foot rests shall be coated with coal tar before embedding.

5.10.6 All manholes shall be provided with cast iron/steel fiber reinforced plastic (SFRC) covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be as specified in the Schedule of Quantities or given above.
5.10.7 Road gullies, ramp drains, gratings in basement shall be cast iron with M.S. frame or Steel Fiber Reinforced Concrete (SFRC) with frame as specified in the Schedule of Quantities.

5.11 Making connections

5.11.1 Contractor shall connect the sewer line of the building to the main manhole by providing making holes and channels etc.

5.12 Measurement

5.12.1 Excavation

5.12.1.1 Measurement for excavation of pipe trenches shall be made per linear meter under the respective category of soil classification encountered at site and specified in the tender.

A) Ordinary soil
B) Hard soil (hard moorum & soft rock)
C) Hard rock requiring chiseling
D) Hard rock requiring blasting

5.12.1.2 Trenches shall be measured between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth up to 1.5 m or as given in the Schedule of Quantities.

5.12.1.3 Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the schedule of quantities and above the rate for depth up to 1.5 m.

5.12.1.4 Timbering and Shoring Timbering and shoring as described above shall be measured per sq m and paid for as per the type of timbering of shoring done at site and as per the relevant item in the Schedule of Quantities. Rate for timbering and shoring shall be for all depths and types of soil classifications including saturated soil.

5.12.1.5 Saturated Soil

No extra payment for pumping and bailing out water shall be made for excavation with an average depth of 1.5 m in saturated soil, surface water from rain falls or broken pipes lines, or sieves and other similar sources. An extra rate as quoted in the schedule of quantities shall be paid for excavation in saturated soil for pipe trenches above average depth of 1.5 m. No payment is admissible for water collected from surface sources and broken pipelines or sewers.

5.12.1.6 Refilling, Consolidation and Disposal of Surplus Earth

Rate quoted for excavation of trenches shall be inclusive of refilling, consolidation and disposal of surplus earth within a lead of 200 m.

5.12.2 Stoneware Pipes/RCC/C.I. pipes

Stoneware/R.C.C./C.I. pipes shall be measured for the finished length of the pipeline per linear meter i.e.

(a) Lengths between manholes shall be recorded from inside of one manhole to inside of other manhole
(b) Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole. Rate shall include all items given in the schedule of quantities and specifications.

5.12.3 Gully Traps
Gully traps shall be measured by the number and rate shall include all excavation, foundation, concrete brick masonry, cement plaster inside and outside, C.I. grating and sealed cover and frame.

5.12.4 Cement Concrete for Pipes

Cement concrete in bed and all-round or in haunches shall be paid per running meter between the outside walls of manholes at bottom of the trench. No additional payment is admissible in respect of concreting done for widths greater than specified, for shuttering or centering and concreting in sub soil water conditions.

5.12.5 Manholes, Catch basins & Ramp drains

a) All manholes and catch basins shall be measured by numbers and shall include all items specified above and necessary excavation, refilling & disposal of surplus earth.

b) Manholes with depths greater than specified under the main item shall be paid for under "extra depth" and shall include all items as given for manholes. Measurement shall be done to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of chancel.

a) Ramp drains shall be measured per meter length.

5.12.6 Making Connections

Item for making connection to municipal sewer shall be paid for by number and shall include all items given in the Schedule of Quantities and specifications.
SECTION VI
GARDEN IRRIGATION

6.0 Garden Irrigation System

6.1 Scope of Work

Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to install garden hydrants and sprinklers and drip irrigation water supplies system as required by the drawings, specified hereinafter and as given in the Schedule of Quantities (BOQ).

6.1.1 Without restricting to the generality of the foregoing, the water supply system shall include the following:-

a) Connections from the water supply system to all hydrants, sprinklers and drip irrigation points.

b) Garden hydrants, surface sprinklers & pipe emitters.

c) Excavation and refilling of pipes trenches.

d) Control valves, masonry chambers and other appurtenances.

e) Connections to all pumps & appliances.

6.2 The System

6.2.1 The garden hydrant and sprinkler irrigation system will be new and fully working system in the complex.

6.4.1 System components shall be pipes, valves, controllers, various types of sprinklers and drip irrigation lines with emitters as approved by the Project Manager.

6.5 General requirements

6.3.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.

6.5.1 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

6.5.2 Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted fur short connections.

6.5.3 Pipes shall be laid in a manner as to provide as far as possible easy accessibility for repair and maintenance. Pipes under roads shall be laid in RCC pipe sleeves.

6.5.4 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

6.6 HDPE Pipes and Fittings.

6.6.1 Garden hydrant mains shall be HDPE pipes conforming to IS: 4984 of class specified. If class is not mentioned in the schedule of quantities the same shall be Material Grade PF100, unless other materials like uPVC schedule 40 or uPVC as per IS 4985 in accordance to specifications given above are specified in the BOQ.
6.6.2 Fittings for HDPE pipes shall be injection molded fitting suitable for thermal weld joints. Fittings must have suitable provision for expansion and shall be rated for the same working pressure as the pipeline, unless other materials like uPVC schedule 40 or uPVC as per IS 4985 in accordance to specifications given above are specified in the BOQ.

6.6.3 Thermal Joints shall be made in an approved manner as recommended by the manufacturer.

6.6.4 Provide flanges at intervals of 20-25 m. for all pipes 65 mm dia and above.

6.6.5 Provide suitable adapters for connection between pipes & valves.

6.6.6 Provide cement concrete supports and anchor blocks at all bends, tees and other locations as directed by the Project Manager. Connections at garden hydrant outlet, near valves must also be anchored.

6.6.7 **Drip Irrigation Pipes**

Pipes shall be LLDPE pipes of UC 7510 resin conforming to ASAE S-435 standard.

6.6.8 **G.I. Pipes & Fittings**

Vertical connection for garden hydrant points shall be galvanised steel tubes to IS12:1239 (medium class) with matching malleable iron fitting of approved make.

6.7 **Sprinklers**

Pop-up Sprinklers Pop-up sprinklers shall be underground with rugged plastic high impact case with precision jet spray guide arm control with brass head, Sprinklers shall be suitable for pressure and coverage given in the schedule of quantities.
PUMPING AND WATER TREATMENT PLANT SYSTEM

7.0 SCOPE OF WORK

a) Work under this section shall consist of furnishing all labour, materials equipment and appliances necessary and required to completely install all works described hereinafter and shown on the drawings.

b) Without restricting to the generality of the foregoing the system shall include the following:
   a. Raw water, Treated water, Soft water and drainage pumps.
   b. Water filtration plant with pressure filter and chlorination plant.
   c. Water Softening plant.

7.1 GENERAL REQUIREMENT

7.1.1 All materials shall be new as per approved makes complying with the appropriate Indian Standards.

7.1.2 All equipment other than specified in approved makes shall be of the best available make manufactured by reputed firms to the entire satisfaction of Resident Engineer.

7.1.3 The sample of the items shall be provided on the request of engineer-in-charge.

7.1.4 All equipment shall be so installed on suitable existing foundations, true to level and in a neat work-man like manner.

7.1.5 Equipment shall be installed so as to provide sufficient clearance between the end walls & between equipment to equipment.

7.1.6 Shop drawings for equipment layout with associated piping, control panels and wiring of equipment showing the route of conduit / cable from equipment to control panel shall be submitted by the Contractor for approval to engineer-in-charge before starting the fabrication of panel and starting the work. On completion of the works, four sets of "As-installed" drawings incorporating all details like equipment layout, piping routes, location of panels etc. shall be furnished by the contractor.

7.2 WATER SUPPLY PUMPS

7.2.1 HYDROPNEUMATIC SYSTEM – Fresh Water Supply

7.2.1.1 Hydro pneumatic system pumps shall be multistage stage, vertical stainless steel pumps, having stainless steel casing, stainless steel pump foot and diffusers, stainless impeller, stainless steel shaft, ceramic bearings, tungsten carbide shaft protection bushes and hydro pneumatic pump make to mechanical seal driven by 2900 RPM, 220 Volts, 50 Cycles, AC 3–phase TEFC vertical flange motor. Each pump shall be capable of operating within a performance pressure characteristics range sufficient below and above the required working pressure.

7.1.1.2 200 lits diaphragm tank fabricated from prime quality steel for long life the tanks are long lasting epoxy paint treatment for greater protection against atmospheric elements.

7.1.1.3 Pumps and motors shall be mounts on a common MS structural base plate.

7.1.1.4 Each pump shall be provides with a totally enclosed fan cooled induction motor of H.P and R.P.M specified in schedule of quantities.
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME: PROPOSED 100 BED ESIC HOSPITAL AT BHILA, CHHATTISGARH.

7.1.1.5 Each pumping set shall be provided with a Gun Metal “Bourden” type pressure gauge with gunmetal isolation cock and connecting piping and also with pressure switch for its operation controlling.

7.1.1.6 Appropriate vibration eliminating pads shall be provided with each pump.

7.1.1.7 The pump set shall be provided with gun metal gate valve of appropriate sizes on delivery. A non-return valve of appropriate size and a pressure gauge with cock shall be provided on the delivery line.

7.1.1.8 Suction and delivery lines of the pumps shall be provided with double flanged reinforced Neoprene flexible pipe connectors. Connectors shall be suitable for a working pressure of each pump as specified in Schedule of Quantities.

7.1.1.9 Mega Control Device with one number variable frequency drive.

7.3 WATER TREATMENT PLANT FEED PUMPS

7.3.1 Treatment plant feed pumps shall be single stage, vertical stainless steel pumps, having stainless steel casing, stainless steel pump foot and diffusers, stainless impeller, stainless steel shaft, ceramic bearings, tungsten carbide shaft protection bushes and mechanical seal driven 2900 RPM, 220 Volts, 50 Cycles, AC 3-phase TEFC vertical flange motor. Each pump shall be capable of operating within a performance pressure characteristics range sufficient below and above the required working pressure.

7.3.2 Pumps and motors shall be mounts on a common MS structural base plate.

7.3.3 Each pump shall be provided with a totally enclosed fan cooled induction motor of H.P and R.P.M specified in schedule of quantities.

7.3.4 Each pump shall be provided with a Gun Metal “Bourden” type pressure gauge with gunmetal isolation cock and connecting piping.

7.3.5 Appropriate vibration eliminating pads shall be provided with each pump.

7.3.6 The pump set shall be provided with gun metal gate valve of appropriate sizes on delivery. A non-return valve of appropriate size and a pressure gauge with cock shall be provided on the delivery line along with suitable size of Y-strainer at suction side.

7.3.7 Suction and delivery lines of the pumps shall be provided with double flanged reinforced Neoprene flexible pipe connectors. Connectors shall be suitable for a working pressure of each pump as specified in Schedule of Quantities.

7.4 SUMP PUMPS

7.4.1 Pumps shall be submersible type as indicated in data sheet.

7.4.2 Pump shall be integral with submersible motor on a common shaft. The pumps shall have 2900 rpm synchronous speed unless stated otherwise in the data sheets.

7.4.3 The pump set shall be installed in vertical position in sumps with level controller cum operated float switches.

7.4.4 Pump casings shall be aluminum and impellers of SS. All pumps shall have combination ball and roller bearings and shaft seals should be mechanical. Motor shall be submersible and shall be rated for minimum hp specified or the BHP absorbed in the operating range of the pump.
7.5 DOSING PUMP

Dosing Pump shall be provided for the working pressure of System where the solution is to be dosed.

Metering Pump shall be provided for operation on 220 V, 50 Hz., AC Power Supply.

Piping from the Main Water Supply Line to the doser shall be PVC flexible pipe branded.

All parts of the metering/dosing pump coming in contact with solution shall be of stainless steel of grade SS-304.

7.6 LEVEL CONTROLLER

Contractor shall provide and install low voltage transistorised level controllers as specified in Schedule of Quantities. Each level controller shall be provided with required number of PVC sheathed stainless steel probes with necessary wiring and conducting.

7.6.1 FOR FILTER FEED PUMPS

To cut off water treatment plant feed pumps on low water level in raw water tanks and high water level in ground floor treated water tank. To start pumps on low water level in treated water tanks.

7.6.2 FOR SOFTENER FEED PUMPS

To cut off water treatment plant feed pumps on low water level in Treated water tanks and high water level in ground floor Soft water tank. To start pumps on low water level in soft water tanks.

7.6.3 TREATED WATER TRANSFER PUMPS

To cut off treated water transfer pumps on low water level in treated water tank and high water level in overhead treated water tank and start sump on low water level in overhead treated water tank.

7.6.4 IRRIGATION WATER TRANSFER PUMPS

To cut off soft water transfer pumps on low water level in soft water tank and high water level in overhead soft water tank and start sump on low water level in overhead soft water tank.

7.6.5 FOR HYDROPNEUMATIC SYSTEM

To cut off hydro-pneumatic system pumps on low water level in ground level treated water tanks. To start pumps on opening of any taps.

7.7 WATER FILTERATION & SOFTENING PLANT

The water treatment equipment shall be based on the raw water criteria as mentioned.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameters</th>
<th>Raw Water (Inlet) Properties of water</th>
<th>Unit</th>
<th>Desirable Limits Drinking Water as per IS 10500</th>
<th>Extended Limits Drinking Water as per IS 10500</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Colour</td>
<td>&lt; 1</td>
<td>Max</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Turbidity</td>
<td>0.2</td>
<td>NTU</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>PH Valve</td>
<td>7.6</td>
<td>Range</td>
<td>6.5 – 8.5</td>
<td></td>
</tr>
</tbody>
</table>
7.7.1 WATER FILTERS

Water filters shall be sand / gravel pressure filters downward or upward flow type suitable for a rate of filtration given in schedule of quantities.

Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure given in schedule of quantities. The minimum thickness of shell will be 8 mm and dished ends shall be 10 mm. The filter shall have at least one pressure tight manhole cover. Each filter shall be provide with screwed or flanged connections for inlet, outlet, individual drain connections and all other connections necessary and required. Filter shall be painted inside with two or more coats of non-toxic corrosion resistant paint and one coat of red oxide primer outside.

UNDER DRAIN SYSTEM: Each filter shall be provides with an efficient under drain system comprising of collecting pipes, gunmetal / poly propylene nozzles of manufacturer’s design. The entire under drain system shall be provides on M.S. plate cement concrete supports.

FACE PIPING: Each filter shall be provides with interconnecting face piping comprising of inlet, outlet, and backwash complete with valves. Piping shall be cast iron double flanged to I.S.1536-1967 and C.I. Double flanged fittings to I.S. 1537-1967. Sluice valves 65 mm dia. and above shall be cast iron Double flanged sluice valves to I.S. 780. Valves 50 mm and below shall be screwed type gunmetal full way gate valves. Water softener must be of multiport valve.

ACCESSORIES: Each filter shall be provided with following accessories:

Air release valve with connecting piping.

100 mm diameter dial Bourden type gunmetal pressure gauges with gunmetal isolation cock and connecting pipes.

Sampling cocks on raw water inlet and filtered water outlet.

Individual drain connection with gunmetal full way valve.

Connection with valve for air scouring.

Flow meter or water meter (if required).

FILTER MEDIA

Each filter shall be provided with clean and washed filter media. Following is recommended:

<table>
<thead>
<tr>
<th>Media</th>
<th>Size</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pebbles</td>
<td>13.6mm</td>
<td>100mm deep</td>
</tr>
<tr>
<td>Gravel</td>
<td>6-2.5mm</td>
<td>100mm deep</td>
</tr>
<tr>
<td>Coarse sand</td>
<td>2.5-.25mm</td>
<td>100mm deep</td>
</tr>
</tbody>
</table>
7.7.2 CHEMICAL DOSER (Alum Doser, chlorinator)

Chemical doser shall be displacement type complete with rubber bag in vessel duly painted of 50 liters capacity or as mentioned in the schedule of quantities.

Doser shall be suitable for working pressure mentioned in the schedule quantities.

Each doser shall be provided with orifice plate assembly injection and corrosion proof piping. Piping from the main water supply line to the doser shall be G.I. pipes to IS : 1239 (heavy class).

7.7.3 WATER SOFTNER

Softener vessel shall be designed in accordance with the code of unfired pressure vessel conforming to BIS.

Softeners shall be designed to give ‘Soft Water’ of quality of Commercial Zero i.e. hardness less than 5 ppm for soft water tanks and less than 150 ppm for treated water tank. Softener shall provide with suitable grade of CATION exchange resin in quantity to be considered by the Contractor at the time of quoting.

Softener shall be fabricated out of mild steel and suitable for self-supporting arrangement.

Softener shall have a set of face piping for inlet, outlet brine injection with all valves. Suitable drain shall be provided (with multiport valve preferably).

One set of hydraulic injector with control valve and brine delivery pipes.

One cylindrical PVC/HDPE brine saturator and mixing tank, provided with brine delivery piping with adjustable level indicating clamp and control valves complete. The tank shall be of capacity as given in the schedule of quantities.

The first charge of resin, chemicals, media & consumables shall be included in the cost of water softening plant.

7.8 INSTALLATION AND TESTING

All pumps, water treatment equipments, R.O. plants and solar heater shall be laid out generally in accordance with the shop drawings (submitted by contractor and approved by engineer-in-charge / consultant / architect) achieving economy of space and piping.

All pumps, water treatment equipments, R.O. plants and solar heater shall be tested for the rated performance in the presence of the employer’s representative and got approved.

7.9 Mode of measurement

Pumps for water supply with valves on suction & delivery side, non-return valve on delivery, pressure gauge on delivery, set of high/low control including wiring, foundation bolts, nuts etc. shall be measured as one unit and paid.

Sump pumps with motor, water proof cable, gun metal valve, and non return valve in delivery all
installed in position will be measured as one unit and paid.

Level controllers shall be measured by numbers.

Water filter, Softener, Chemical dosers shall be measured by number and shall include all items given in schedule of quantities.

7.10 CATALOGUES & MANUAL

The Contractor shall furnish the operation & maintenance manual/ technical literatures in duplicate to engineer-in-charge.
SECTION - VIII
ELECTRICAL WORK

1.0 Scope

1.1 The scope of this section comprises of fabrication, supply, erection, testing and commissioning of electric panels, wiring and earthing of all equipment components and accessories, including supply, installation and wiring of remote mounted push button stations.

1.2 All the electrical cables, termination, wires and accessories are also including in the Scope of Work. The main cable from the main distribution board will be supplied and erected by other Agency.

2.0 General

2.1 Work shall be carried out in accordance with the specifications of CPWD specifications, Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended up to date.

3.0 Construction Features

3.1 The control panel shall be metal enclosed sheet steel cubical, indoor type, floor mounting/wall mounting type as per BS 5486 Part 1, 190 & IEC 439-1. The control panel shall be totally enclosed, completely dust and vermin proof, Gaskets between all adjacent units and beneath, covers shall be provided to render the joints dust proof. Control panels shall be arranged in multitier formations. All doors and covers shall also have sealing & pad locking arrangement. All mild steel sheets used in the construction of control panels shall be minimum 2mm. thick or as specified and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all slag grounded off and welding pits wiped smooth with plumber metal.

3.2 All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal provided with hank nuts. Self threading screws shall not be used in the construction of control panels. Base channel shall be of 75mm x 40mm x 5mm thick shall be provided at the bottom. Minimum clear space of 250 mm between top of channel of control panel and bottom most unit shall be provided.

3.3 The control panels shall be of adequate size with a provision of 10% spare space to accommodate possible future additional switchgear. Knockout holes of appropriate size and number of cables shall be provided in the control panels in conformity with the location of incoming and outgoing conduits/cables. All equipment such as meters and indicating lamps, etc shall be located adjacent to the unit with which it is associated and care shall be taken to achieve a neat and symmetrical arrangement. Facility shall be provided for termination of cables from both above and below the control panel. Where cables enter below, cables boxes shall be fitted at the rear and arranged in tiers to facilitate making connections to the upper and lower units. Clamps shall be provided to support the weight of the cables. All incoming and outgoing feeders shall be brought out to a terminal block of adequate size at suitable location inside the control panel. All wiring inside the control panel shall be color coded and labeled with approved plastic beads for identification. Circuit diagrams showing the arrangement of circuits shall be pasted on the inside of the panel door and covered with transparent plastic sheet and all labeling shall be provided on the front face of the panel board.

4.0 Circuit Compartments

4.1 Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the ‘ON’ position. Safety interlocks shall be provided to prevent the breaker or Contactor from
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME: PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

being drawn out when the breaker is in the draw out position of the panel. Instruments and indicating lamps shall not be mounted on the panel compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

5.0 Instrument Accommodation

5.1 Separate and adequate compartments shall be provided to accommodate instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accident contact with live parts of the circuit breaker and bus bar.

6.0 Bus Bars and Bus bar Connection

6.1 The bus bar and interconnections shall be of aluminum and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bars and shall be extensible on either side. The bars and interconnections shall be insulated with PVC heat shrinkable sleeve and color coded. All bus bars shall be supported on unbreakable, non-hygroscopic insulated SMC/DMC type supports at regular intervals not more than 400 mm, to withstand the forces arising in case of short circuit in the system. Bus bars shall be provided in separate chamber of main control panels shall be connected by clamping, no holes shall be drilled in bus bars. If holes have to be drilled for making connections, extra cross section of bus bars shall be provided.

6.2 All bus bar connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts. Additional cross section of bus bars shall be provided in small control panels to cover up the holes drilled in the bus bars.

6.3 All connections between the bus bar and breaker and between breaker and contactor shall be through copper strips of proper size to carry full rated current and shall be insulated with coloured PVC heat shrinkable sleeve.

7.0 Terminals

7.1 The outgoing terminals and neutral links shall be brought out to a terminal block suitably located in the control panels. The current transformer for instruments, metering and for protection shall be mounted on the terminal blocks. Separate cable compartment shall be provided for incoming and outgoing cables.

8.0 Wire ways

8.1 A horizontal wire way screwed covers shall be provided at the top to take in the connecting control wiring of different vertical sections.

9.0 Cable Compartments

9.1 Cable compartments/alley of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top using detachable gland plates with proper knockouts. Adequate and proper DMC supports shall be provided in cable compartments to support cables. All incoming and outgoing terminals shall be brought out on terminal blocks in the cable compartment.

10.0 Materials

a) Rotary Switches

Switches up to 60 amps shall be rotary type with compact and robust construction, built up from one or more stacks with contacts and a positioning mechanism, with stop as required. The terminals shall be shrouded with insulation to prevent accidental contact with live parts. Rotary switches shall be backed up with moulded type HRC fuse fittings of appropriate rating.
b) **Selector Switch**

When called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

c) **Molded Case Circuit Breakers (MCCB)**

MCCBs shall be quick make, quick break, and preferably double break contact system, arc extinguishing device, independent manual type with trip free feature with mechanical ON, OFF, and TRIP indications as called for in BOQ. A trip button shall be provided for tripping the breaker.

MCCB shall be a compact high strength, heat resistant, flame retardant; insulating molded case with high withstands capability against thermal and mechanical stresses. All MCCBs shall be capable of defined variable overload adjustment.

d) **Switches**

Switches beyond 60 amps shall be panel mounted double break type and suitable for load break duty, quick make and break action. Switch contacts shall be silver plated and shall be back-up with HRC fuses of appropriate rating. The switch handles shall be located at the front.

e) **HRC Fuses**

Fuses shall be high Rupturing capacity of not less than 20 MVA at 415 volts. The backup fuse rating of each motor/heater/equipment shall be so chosen that the fuse does not operate on starting of motor/heater/equipment. Fuses shall be of the same make as the switches.

f) **Starters**

Each motor shall be provided with a starter of suitable rating. Direct on line starters shall be provided for motors up to 10 HP.

Operating coils of contactors shall be suit able for 220/415 +/- 10% volts AC, 50 cycles supply system. The contactor shall drip out when voltage drops to 90% of the rated voltage.

g) **Over Load Relays**

Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset type thermal over load relay with adjustable setting.

h) **Current Transformers**

Current Transformer shall be of accuracy class - I and suitable VA burden for operation for the connected meters and relays.

i) **Single Phase Preventor**

Single phase preventor shall be provided for all the starters. Single phase preventor shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

j) **Indicating Lamp and Metering**

The meters shall be flush mounted and draw-out type. The indicating lamp shall be neon type and of low burden. Each phase indicating lamp shall be backed up with 2 amps fuse.

k) **Push Button Stations**
Push button station shall be for manual starting and stopping of motors/equipment as called for. Red and Green colour push buttons shall be provided for starting and stopping operations. Push buttons shall be suitable for panel mounting and accessible from front without opening door.

m) Cables

M.V. cables shall be PVC insulated aluminium conductor armoured cables suitable for laying in trenches, duct, and on cable trays as required.

n) Wires

650/1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

11.0 Cable Laying

11.1 Easy access to all cables shall be provided to allow cable withdrawal/replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimize the loss in current carrying capacity with necessary saddling/clamps.

12.0 Earthing

12.1 The earthing of MCC and equipment shall be as per BIS Specification and considered in the main electrical panel. The loop earthing shall be carried out with G.I/Copper Strips/wires.

13.0 Painting for Panel

13.1 All sheet steel work shall undergo a process of seven tank treatment and painting with powder coating paint of approved shade.

14.0 CABLE WORK

This section covers detailed requirements for supply, laying, testing and commissioning of cables.

14.1 GENERAL

MV cable 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 drum.

14.2 MATERIAL

14.2.1 The MV power cable of 660/1100 V. grade shall be PVC insulated Aluminium conductor armoured cable conforming to IS : 1554 ( part - I ). MV cable shall be 3.5/4 core of size and type as specified.

14.2.2 The MV control cables shall be PVC insulated copper conductor armoured cable.

14.3 STORAGE AND HANDLING

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

14.3.2 Cable drums shall be stored on a well drained, hard surface, preferably of concrete, so that the drums do not sink in the ground causing rot and damage to the cable drums.

14.3.3 During storage periodical rolling of drums once in 3 months through 90\degree shall be done. Rolling shall be done in the direction of the arrow marked on the drum.
SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME : PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.

14.3.4 It should be ensured that both ends of the cable are properly sealed to prevent ingress/absorption of moisture by the insulation.

14.3.5 Protection from rain and sun shall be ensured. Sufficient ventilation between cable drums, should be ensured during storage.

14.3.6 The drums shall always be rested on the flanges and not on the flat sides.

14.3.7 Damaged battens of drums etc. should be replaced, if necessary.

14.3.8 When cable drums have to be moved over short distances, they should be rolled in the direction of the arrow, marked on the drum.

14.3.9 For transportation over long distances, the drum should be mounted on cable drum wheels strong enough to carry the weight of the drum and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.

14.3.10 When unloading cable drums from vehicles, a crane shall preferably be used. Otherwise the drum shall be rolled down carefully on a suitable ramp or rails, where necessary.

14.3.11 While transferring cable from one drum to another, the barrel of the new drum shall have a diameter not less than that of the original drum.

14.3.12 The cables shall not be bent sharp to a small radius. The minimum safe bending radius for all types of PVC cables shall be taken as 12 times the overall diameter of the cable. Wherever practicable, larger radius should be adopted. At joints and terminations, the bending radius of individual cores of a multi core cable shall not be less than 15 times its overall diameter.

14.3.13 Cable with kinks and straightened kinks or with similar apparent defects like defective armouring etc. shall be rejected.

14.3.14 Cables from the stores shall be supplied by the contractor as per the site requirement in pieces cut in the stores.

14.4 INSTALLATION

14.4.1 GENERAL

The cable installation including necessary joints shall be carried out in accordance with the specifications given herein. For details not covered in these specifications, I.S.:1255 shall be followed. No straight through joint shall be permitted in the system. The cables shall be supplied as per cable schedule submitted by the contractor & approved by Engineer-in-Charge.

14.4.2 ROUTE

14.4.2.1 Before the cable laying work is undertaken, the route of the cable shall be decided by the Architect in consultation with Owner representative.

14.4.2.2 While shortest practicable route shall be preferred, cable runs shall generally follow fixed developments such as roads, foot-paths etc. with proper offsets so that future maintenance, identification etc. are rendered easy. Cross country run to shorten the route length is not desirable as it would lead to route identification and maintenance problems, besides posing difficulties during later development of open areas etc.

14.4.2.3 While selecting cable routes, corrosive soils, ground surrounding sewage and effluent etc. shall be avoided. Where this is not feasible, special precautions as approved by the Architect shall be taken.
14.4.2.4 As far as possible, the alignment of the cable route shall be decided taking into consideration the present and future requirements of other agencies and utility services affected by it, the existence of any cable in the vicinity as may be indicated by cable markers or cable schedules or drawing maintained for that area, possibilities of widening of roads/lanes, storm water drains etc. Cable routes shall be planned away from the drains and should be within the property.

14.4.2.5 Whenever cables are laid along well demarcated or established roads, the MV cables shall be laid further from the kerb line than HV cables.

14.4.2.6 Cables of different voltages and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted, MV cables shall be laid above HV cables.

14.4.2.7 Where cables cross one another the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

14.5 WAY LEAVE

14.5.1 It may be necessary to obtain way leave for the cable route from the appropriate authorities some of whom are listed below:

a) Drainage, Public Health and Water Works.
b) Telephones and Telegraphs.
c) Gas works.
d) Other Undertakings.
e) Owners of properties.

14.5.2 Where necessary, joint inspection with representatives of other authorities may be arranged so that mutual interests are safeguarded. In case of private property, Section 12/51 of the Indian Electricity Act shall be complied with.

14.6 PROXIMITY TO COMMUNICATION CABLES

Power and communication cables shall as far possible cross at right angles. Where power cables are laid in proximity communication cables the horizontal and vertical clearances shall not normally be less than 60 cms.

14.6.1 LAYING METHODS

14.6.1.1 Cables shall be laid direct in ground or in pipes/closed ducts, in open ducts or on cable trays suspended from slab depending on site conditions.

14.6.2 Laying in Pipes/Closed ducts:

14.6.2.1 In location such as road crossing, entry to building, on poles, in paved areas etc. cables shall be laid in pipes or closed ducts.

14.6.2.2 GI or Hume Pipes (spun reinforced concrete pipes) shall be used for such purposes. In the case of new construction, pipes as required shall be laid along with the Civil works and jointed according to the instructions of the Engineer-in-Charge as the case may be. The size of pipe shall be as indicated in the electrical drawings. GI pipe shall be laid directly in ground without any special bed. Hume pipe (Spun reinforced concrete pipe) shall be laid over 10 cm. thick cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate of 40mm nominal size) bed, after which it shall be completely embedded in concrete. No sand cushioning or tiles need be used in such situations. Unless otherwise specified, the top surface of pipes shall be at a minimum depth of 1mtr. from the ground level when laid under roads, pavement etc.
14.6.2.3 Where steel pipes are employed for protection of single core cables feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of polyphase system.

14.6.2.4 The pipes on road crossing shall preferably be on the skew to reduce the angle of bends as the cable enters and leaves the crossings. This is particularly important for high voltage cables.

14.6.2.5 Manholes of adequate size as decided by the Engineer-in-Charge shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design. The construction of manholes and providing the cover is not in the scope of this Contract and shall be got executed and paid for by the Engineer-in-Charge through another agency.

14.6.2.6 Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothened to prevent injury to cable insulation or sheathing.

14.6.2.7 Pipes for cable entries to the building shall slope downwards from the building and suitably sealed to prevent entry of water inside the building. Further the mouth of the pipes at the building end shall be suitably sealed to avoid entry of water. This seal in addition to being waterproof shall also be fireproof.

14.6.2.8 All chases and passages necessary for lying of service cable connections to buildings shall be cut as required and made good to the original finish and to the satisfaction of the Engineer-in-Charge.

14.6.2.9 Cable grips/draw wires and winches etc. may be employed for drawing cables through pipes/closed ducts etc.

14.6.3 Laying on Cable Trays

14.6.3.1 Cables, where indicated in approved shop drawings, shall be laid on overhead cable trays which are suspended from ceiling or supported from wall, by anchor fasteners as required.

14.6.3.2 The Contractor shall provided for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, trifoil clamps and structural steel members (comprising of channels, angles, flats, rods) to be fabricated at site for structural supports for cable trays racks etc.

14.6.4 Termination

Brass single compression glands shall be provided for MV cables termination

14.6.5 Testing

14.6.5.1 All 650/1100 Volt grade cables before laying shall be tested with a 500 V megger or with a 2,500/5,000 V megger for cables of higher voltages. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/armour and insulation resistance between conductors.

14.6.5.2 All cables shall be subject to above mentioned tests during laying, before covering the cables by protective covers and back filling and also before the jointing operations.

15.0 CABLE TRAYS

15.1 Prefabricated Cable trays of ladder type and associated accessories, tees, bends, elbows & reducers shall be fabricated from 12 gauge (2.6 mm thick) mild steel. Perforated cable trays and associated accessories tees, elbows, and reducers shall be fabricated from 14 guage (2 mm thick) MS steel.

15.2 Cable trays and accessories and covers shall be painted with one shop coat of red oxide zinc chromate primer and two coats of Aluminium alkyd paint.
15.3 The Contractor shall provide for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, trifoil clamps and structural steel members (comprising of channels, angles, flats, rods) to be fabricated at site for structural supports for cable trays racks etc.

16.0 EARTHING

This section covers detailed requirements for earthing.

16.1 GENERAL

16.1.1 The non-current carrying metal parts of electrical installation shall be earthed properly. All metallic structure, enclosures, junction boxes, outlet boxes, cabinets, machine frame, portable equipments, metal conduits, trunking, cable armour, switchgear, distribution boards, lighting fittings and all other parts made of metal in close proximity with electrical circuits shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All earthing will be in conformity with the relevant Indian Electricity Rules 1956 and Indian Standard Specification IS : 3043. Every item of equipment served by the electrical system shall be bonded to earthing system.

16.1.2 Every switch, lighting fixture and 5 Amp outlets shall be provided with insulated copper conductor of 1.5 sq. mm for earthing. The computer workstations shall be earthed with 2.5 sq.mm. insulated copper conductor wire.

16.1.3 Separate copper earth pits shall be provided for UPS, EPABX & Networking equipment.

16.1.4 The raceways shall not be used as a grounding conductor.

16.2 CONNECTION OF EARTHING CONDUCTORS

16.2.1 Main earthing conductor shall be taken from the earth connections at the PDB to the earthing pit. Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution boards or to an earth leakage circuit breaker. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to switch boards at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of equipment shall be earthed with 2 no. G.I. strips/wires and non-current carrying metallic parts with, 1 no. G.I. strips/wires.

16.2.2 Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures cables and conductors, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in earthing system. The Electrical resistance of metallic enclosures for cables and conductors measured between earth connections at the main switch boards and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate circuit breakers and shall not exceed 1 OHM.

16.3 EARTH CONNECTIONS

All metal clad switches and other equipment carrying single phase circuit, shall be connected to earth by a single connection. All metal clad switches carrying 3 phase shall be connected with earth by two separate and distinct connections. The earthing conductor inside the building wherever exposed shall be properly protected from mechanical injury by running the same in GI pipe of adequate size. The earthing conductor shall be painted to protect it against corrosion. Earthing conductor outside the building shall be laid 600 mm below finished ground level. The overlapping in G.I. strips in joints shall be welded. Lugs of adequate capacity and size shall be used for all termination of conductor wires. Lugs shall be bolted to the equipment body to be earthed after the metal is cleaned of paint and other oily substance and properly tinned.
16.4 PROTECTION FROM CORROSION

Connection between copper and galvanized equipment shall be made on vertical face and protected with paint and grease. Galvanized fixing clamps shall not be used for fixing earth conductors. Only copper fixing clamp shall be used for fixing earth conductors. When there is evidence that the soil is aggressive to copper, buried earthing conductors shall be protected by suitable serving and sheathing.

16.5 EARTHING STATION

16.5.1 PLATE ELECTRODE EARTHING

16.5.1.1 Earthing electrode shall consist of a Copper plate of 600 mm X 600 mm X 3 mm or G.I. plate of 600mm x 600mm x 6.3 mm as called for in the Schedule of Quantity. The plate electrode shall be buried as far as practicable below permanent moisture level but in any case not less than 3 meters below ground level. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrode shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer surface of the wall.

16.5.1.2 The earth plate shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 20 mm dia GI pipe shall run from the top edge of the plate to the ground level. The top of the pipe shall be provided with a funnel and a mesh for watering the earth through the pipe. The funnel over the GI pipe shall be housed in a masonry chamber approximately 300 mm x 300 mm x 300 mm deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame. Test facility shall be provided with test links for the earthing station.

16.5.2 PIPE ELECTRODE EARTHING

Earthing Electrode shall consist of G.I. medium class. 40 mm dia 4.5 m long pipe (without any joint) 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 2 M of length from the bottom. Pipe electrode shall be buried in the ground vertically with its top at not less than 200 mm below the ground level. When more than one pipe is to be installed a separation of not less than 2 M shall be maintained between two adjacent electrodes as called for in the drawings. Wherever possible, earth electrode shall be located as near the water tap, water drain or a down take pipe as possible. Earth electrode shall be kept clear of the building foundations and in no case shall it be nearer than 2 meters from the outer surface of the walls. The pipe electrode shall be set vertically and surrounded with 150 mm thick layer of charcoal dust and salt mixture. A 40 mm x 20 mm reducer shall be used for fixing of funnel with mesh. The funnel and mesh have been provided for watering the earth through the pipe. The funnel over the G.I. Pipe shall be housed in a masonry chamber 300mm x 300mm x 300mm. deep. The masonry chamber shall be provided with a cast iron cover resting over a CI frame. The breaked earth pit will be provided with test links in suitable enclosures.

16.5.3 ARTIFICIAL TREATMENT OF SOIL

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, as specified in Clause no. 7 then the soil resistivity immediately surrounding the earth electrodes shall be reduced by adding sodium chloride, Calcium chloride, sodium carbonate, copper sulphate, salt and soft coke or charcoal in suitable proportions.

16.5.4 RESISTANCE TO EARTH

The resistance to each earthing system shall not exceed 1.0 ohm.
1. **SCOPE OF WORK**

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rotameters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

2. **PRECOMMISSIONING**

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

2.1 Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

   a) All strainers shall be inspected and cleaned out or replaced.

   b) Check all clamps, supports and hangers provided for the pipes.

   c) Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.

   d) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

3. **FINAL ACCEPTANCE TESTS**

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.
4. REJECTION OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority’s requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.

After works have been accepted, the Contractor may be required to carry out additional performance tests as reasonably required by the Architect/Employer.

5. WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

6. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner’s site representative and all testing and commissioning documents shall be handed over to the Owner’s site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner’s site representative.

8. PIPE COLOUR CODE:

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<tr>
<th>S.No.</th>
<th>Pipe Lines</th>
<th>Ground / Base Color</th>
<th>First Color Band</th>
<th>Second Color Band</th>
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<tbody>
<tr>
<td>1</td>
<td>Drinking Water (All cold water lines after filter)</td>
<td>Sea Green</td>
<td>French Blue</td>
<td>Single Red</td>
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<tr>
<td>2</td>
<td>Treated Water (Soft Water)</td>
<td>Sea Green</td>
<td>Light Orange</td>
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</tr>
<tr>
<td>3</td>
<td>Domestic Hot Water</td>
<td>Sea Green</td>
<td>Light Grey</td>
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<tr>
<td>4</td>
<td>Drainage</td>
<td>Black</td>
<td></td>
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</tr>
</tbody>
</table>

Color code to confirm to IS: 2379:1990
### LIST OF STANDARD CODES

<table>
<thead>
<tr>
<th>S.No.</th>
<th>IS Code No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>IS:1729:1979</td>
<td>Specification for sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories (1st rev.) (Amendment 4)</td>
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<tr>
<td>2.</td>
<td>IS:651:1992</td>
<td>Specification for salt glazed stoneware pipes and fittings (5th rev.) (Amendment 1)</td>
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<td>8.</td>
<td>IS:780:1984</td>
<td>Specification for sluice valve for water works purposes (6th rev.) (50 to 300 mm size) (amendment 3)</td>
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<tr>
<td>9.</td>
<td>IS:1172:1993</td>
<td>Code of basic requirements for water supply, drainage &amp; sanitation (4th rev.)</td>
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<td>14.</td>
<td>IS:5312 (part 1) :1984</td>
<td>Swing heck type reflux valves (non-return valve): part 1 single door pattern (1st rev.) (amendment 1)</td>
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<tr>
<td>15.</td>
<td>IS:1726:1991</td>
<td>CI manhole covers &amp; frames (3rd rev.)</td>
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<td>16.</td>
<td>NBC-SP-7-1983 Part IV</td>
<td>National building code of India 1983, amendment No. 3</td>
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SPECIFICATION PLUMBING INSTALLATION WORKS

PROJECT NAME : PROPOSED 100 BED ESIC HOSPITAL AT BHILAI, CHHATTISGARH.
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<thead>
<tr>
<th>Make: TATA / JINDAL / BHUSHAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>The inner walls will be constructed with 1.50mm thick EGP sheet panel with as per IS 277, backed by 12-mm gypsum board panel. The Panel will be flame resistance to BS 1142 part 3. The EGP sheet panel will be indigenous of reputed make and will be provided with test certificate. The inner surface walls will be fixed to the brick wall with essential supports.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Make: SSK/LiquiPlast</th>
</tr>
</thead>
<tbody>
<tr>
<td>The individual wall panels will be welded together. All joints will be filled with metal filler and will be sanded flush on site till ready to receive the plastic finish. Wall panel joints will not be visible after the final wall coating is applied.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Make: PHILPS/BAJAJ/Kalinga / MPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>The gap between the inside and outside surfaces of the theatre will be variable to suit the architects’ layout, but will be sufficient for the flush mounting of equipments. The gap between the inner and outer walls will be left to accommodate the equipment at a later date and to enable services, pipes, conduits etc, to be run within the gap. All wall-mounted equipment will be flush mounted and sealed into theatre. All the sharp edges and corners will be in radius to avoid bacteria contamination. The wall panel design will be such that is allow to installation and support of all equipment and the provision of openings required for the installations, without affecting rigidity and strength. Access boxes will be fitted to the rear of all wall-mounted equipment to enable maintenance to be carried out from outside the operating theatre. There will be 4 return air ducts with grills provided to meet the HVAC requirements.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Make: MPS / Advantech Healthcare / Maxon Healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td>The prima will be applied prior to coating of Anti – bacterial &amp; Anti- Fungus sterile paint an EGP walls &amp; ceiling. 3 to 4 coates will be applied to achieve a thickness of 200micrones.</td>
</tr>
</tbody>
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</thead>
<tbody>
<tr>
<td>Sterile coating and primer will be applied on the surface by air-less spray gun. Sterile coating will be to withstand with commonly used cleaners in the operation rooms and even withstanding with regular steam cleaning.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Make: MPS / Advantech Healthcare / Maxon Healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td>The plenum box (2400mm x 2400mm) will be made of high quality Aluminium 1.5mm thick &amp; Air diffuser will be made of Woven polyester cloth that will introduce the highest air quality into the Operation Theatre. There will be 8 HEPA filters (as per plenum size) with 99.97% efficiency to ensure high quality clean air &amp; tight control of bacteria infection system. Air will be diffused into the theatre uniformly over the total area through perforated aluminium sheet. The air distribution system serving to the Operation Theatre will be tested as per DIN 4799 standards.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Make: MPS / Advantech Healthcare / Maxon Healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td>The laminar flow installation &amp; lighting system will be design to provide the Operation Theatre as key to preventing patients being infected during operation lies on the design of sterilized air conditioning system and the flow pattern of draught as well as the quality of engineering.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Make: MPS / Advantech Healthcare / Maxon Healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ceiling will incorporate supports to secure it to the main structural frame of the modular operating theatre.</td>
</tr>
</tbody>
</table>

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<tr>
<th>Make: PHILPS/BAJAJ/Kalinga / MPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Six sets of double peripheral OT lights each set having two lights will be provided with stepped finish aluminium reflector and will be of A class for use in clean room application. The peripheral light diffusers will be constructed from opal prismatic diffuser material in aluminium frames.</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Make: MPS / Advantech Healthcare / Maxon Healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light will be generated from high frequency electronic ballast’s complete with colour corrected fluorescent tubes. The ceiling will incorporate supports to secure it to the main structural frame of the modular operating theatre. The laminar flow ceiling will be able to provide integrated lamp support system, ease of maintenance and long life system. Control equipment for the peripheral lighting will be provided in the theatre control panel to allow independent control of the lighting levels by the surgical team.</td>
</tr>
</tbody>
</table>

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>The operation procedures can never be affected by shadows, shimmering lights and dazzling eyes. This has been achieved by the lighting system with sufficient illumination level at the wound site and to provide flicker less design lighting control system.</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Make: MPS / Advantech Healthcare / Maxon Healthcare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls for the peripheral lighting will be provided in the theatre control panel to allow independent control of the lighting levels by the surgical team.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Make: Medepha / Triumph / Pnuematic-Berlin</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Control panel can be configured to incorporate all the services that Operation Theatre staff required. The connection between the surgeon control panel and the distribution board will be by a multiplexed system, providing a PWM signal on a two-core cable.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Make: Medepha / Triumph / Pnuematic-Berlin</th>
</tr>
</thead>
<tbody>
<tr>
<td>The panel will contain 7 services as follows:</td>
</tr>
<tr>
<td>a). Time day clock</td>
</tr>
<tr>
<td>b). Time Elapsed Clock</td>
</tr>
<tr>
<td>c). Temperature &amp; Humidity Indicator</td>
</tr>
<tr>
<td>d). General/peripheral Lighting control</td>
</tr>
<tr>
<td>e). Medical Gas Alarm Panel – upto 6 gases</td>
</tr>
<tr>
<td>f). Hand Free telephone with memory card.</td>
</tr>
<tr>
<td>g). Hea Filter status</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Make: Medepha / Triumph / Pnuematic-Berlin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Day Clock will be digital type and clocks have high brightness characters, not less than 30mm in height. Time Elapsed Day Clock will be digital type and clocks have high brightness characters, not less than 30mm in height. Temperature Indicator will indicate the theatre temperature will be connected to the local pressure switches of Air-Conditioning system. Indicator will be digital type have high brightness characters, not less than 30mm in height.</td>
</tr>
</tbody>
</table>
The medical gas alarm will indicate High and Low gas pressure for each gas service present in the operating theatre and will have an audible buzzer with mute facility. The medical gas alarms will be connected to local pressure switches located downstream of the last isolation valves. A Hand Free Set Telephone system incorporated in the panel with memory type card.

The size of the each tile will not be more than 300mm x 200mm. Colour will be RAL 9002 for the frame and membrane fascia. The Control Panel will be designed for front – access only.

A floor screed will be provided, flat to within a tolerance of +/- 3mm over any 3-metre area. Onto this sub floor, a self-levelling compound will be laid prior to laying of the floor finish.

The self-levelling compound will be of the type that does not promote bacteriological growth. Copper grounding strips (0.05mm thick, 50mm width) will be laid flat on the floor in the conductive adhesive and connect to copper wire of grounding.

The doors will be constructed with high-density particle board cores, and high pressure laminate faced on both sides.

All sliding doors will be electrically operated. The doors will be constructed with high-density particle board cores, and high pressure laminate faced on both sides. The cores will be set firmly in an aluminium frame, suitably sealed with a non-porous non-shedding gasket. The aluminum frames will contain the door seal. The door will seal on all four edges in the closed position. The door track will be constructed from an aluminum extrusion, fixed firmly to the walls.

All high voltage equipment is installed in a separate enclosure. The remote cabinet will house the operating lamp transformers, mains failure relays, electrical distribution equipment and circuit protection equipment for all circuits within the operating theatre. All internal wiring will terminate in connectors with screw and clamp spring connections of the Clip-on type mounted, on a DIN rail and labelled with indelible proprietary labels. Individual fuses or miniature circuit breakers will protect all internal circuits. All internal wires will be marked with plastic ferrule type cable markers, for ease of identification.

The controller will have the facility to individually set opening speeds, partials opening, closing speeds, time delays and a variety of locking and interlocking options, within factory preset limits. The controller will also have the ability to sense additional loads on the door caused by any obstruction in its path and to automatically stop or reverse the direction of travel.

A floor screed will be provided, flat to within a tolerance of +/- 3mm over any 3-metre area. Onto this sub floor, a self-levelling compound will be laid prior to laying of the floor finish.

The self-levelling compound will be of the type that does not promote bacteriological growth. Copper grounding strips (0.05mm thick, 50mm width) will be laid flat on the floor in the conductive adhesive and connect to copper wire of grounding.

The door frames will be edged with an aluminium extrusion and with concealed fixings that are adjustable during installation to ensure a 100% hermetic seal.

Flooring will fulfill EN 649 of US requirements. It will have chemical resistance as per EN 423. It will have electrical resistance conforming to EN 1081/IEC 61340.

All joints will be welded and the plastic wall finish will overlap the floor coving by 25mm, to provide a continuous sealed surface.

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The doors will seal on all four edges in the closed position. The door track will be constructed from an aluminum extrusion, fixed firmly to the walls. The door track and wheel design will be such that during the last 50 mm at travel on the closing cycle, the door moves in 3 directions to form a seal against the floor, at the bottom and against the frame on both sides and at the top.

Nylon runner guides will be fixed to the floor in such a way that they do not obstruct trolley movement through the door. They will provide stability during the opening and closing cycles and assist in creating the necessary pressure at the bottom of the door to maintain the seal.

To ensure efficient sealing of the doors, the door manufacturer will provide the door frames. They will consist of reinforced plasterboard panels faced with the same laminate as the doors. The door frames will be edged with an aluminium extrusion and with concealed fixings that are adjustable during installation to ensure a 100% hermetic seal is achieved.

Vision panels will be fitted to all doors. Automatic units will be of the single phase electronic type mounted directly to the door track. The units will consist of a computerized electronic controller and motor. The drive mechanism will be by heavy-duty steel reinforced toothed fabric belt.

The controller will have the facility to individually set opening speeds, partials opening, closing speeds, time delays and a variety of locking and interlocking options, within factory preset limits. The controller will also have the ability to sense additional loads on the door caused by any obstruction in its path and to automatically stop or reverse the direction of travel.

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The controller will have the facility to individually set opening speeds, partials opening, closing speeds, time delays and a variety of locking and interlocking options, within factory preset limits. The controller will also have the ability to sense additional loads on the door caused by any obstruction in its path and to automatically stop or reverse the direction of travel.

All doors will be able to be operated easily manually in the event of failure of the power supply or the automation units.
PRESSURE RELIEF DAMPER
Make: MPS / Supreme / Maxon Healthcare

Pressure Relief Dampers should be provided in each room to prevent cross contamination of air from clean and dirty areas. Suitably sized air pressure relief damper should be strategically placed, enabling differential room pressure to be maintained and ensure that when doors are opened between clean and dirty area. Counter-weight balancing system should be provided in the PRD to maintain positive pressure inside the operation room. Air pressure stabilizers should have unique capability of controlling differential pressure to close tolerance. The PRD should remain closed at pressure below the set pressure and should open fully at pressure only fractionally above the threshold pressure.

The body should be epoxy powder coated as per standard BS colors. First class electrolyzed steel plate should be used for body and with high grade SS304 Stainless Steel for bladders.

MEDICAL AS PIPELINE INSIDE OPERATION THEATRE
Make: MEXFLOW / Lawlow / Mahata tubes

All pipes shall be drawn half hard temp., solid drawn, seamless, phosphorous deoxidised, non-arsenic and degreased copper pipe conforming to BS EN 13348 Kite Marked medical grade.

The supplies of copper pipe (MEXFLOW) would be accompanied with manufacturers test certificate for the physical properties of copper pipes and their Chemical composition. The supply of pipes be further substantiated with inspection certificate from the third party like Kite Register.

The Pipeline will be laid as per HTM-2022 or NFPA 99.

A Hatch of 600mm x 600mm size from MPS / MAXON HEALTHCARE / MANJOT ENGINEERING should be provided in the Operation Theatre as specified in the scope of the work to remove waste materials from the Operation Theatre to Dirty linen Area just adjacent to Operation Theatre. Each Hatch should be equipped with two doors and the door should be operated electronically. The Hatch should be designed in such a way that only one door should be opened at one time. The UV light should be so installed that it is kept on white both the doors are closed, this UV light has to be automatically turned off in case of opening of either of the doors. There should be indicators on both sides of the OT so that the door open/close status can be monitored from both ends. Hatch Box should be manufactured from Stainless Steel (Grade 304).

Multimovement Pendant is a new design motorized (1000+800) arm with up & down movement of 515 mm and load carrying capacity of 80 kg. The arm can be rotated upto 330º - 340º with adjustable stopper. An extremely quite electric motor reduces noise to a minimum, dampened stoppers and very low hand forces for horizontal movements contribute to an ergonomically optimised workplace. The newly developed pneumatic brake system can be adapted to various safety requirements and construction facilities. Modern and very quite, high performance motors as well special spindles are used to realise precise & steady movement. As a safety feature the motor is equipped with an over load protection. The large interior cross section for supply lines offers completely new applications with 120 mm diameter. The stoppers are infinitely variable from 0-330º -340º

service head is provided with the modular design octagonal in shape to achieve maximum supply with minimum required space. Service head is designed to hosts, Base, Gas Module, Electric Module and shelves. Upto 8 Gas outlets & 10 Electrical switches. Racks & shelves are provided to mount the equipments like monitor etc. The total length of the manager is 1000mm. Surgeon pendent will have 2 arms with shelves as per following details:

a. Horizontal arm system - 2
b. Weight carrying capacity - 80kg
c. 5/15 Amp. Electrical sockets without switches - 8Nos.
d. Shelves with side rails - 2 Nos.
e. Provision to fix Gas outlets (i.e.) Oxygen-2, Vacuum-2, Air 4 bar-1, Air 7 bar-1 & WAGD-1 no.
f. Gas interface set for interface plate - 1
g. Ceiling mounting system for interim ceiling upto 1000 - 1
h. Interface plate with electrical fittings - 1
i. Ceiling cover for interim ceiling - 1

Multimovement Pendant should be new design motorized Single arm(900mm) with up & down movement of 515 mm and load carrying capacity of 80 kg. The arm should be rotated upto 330º - 340º with adjustable stopper. An extremely quiet electric motor reduces noise to a minimum, dampened stoppers and very low hand forces for horizontal movements contribute to an ergonomically optimised workplace. The pneumatic brake system should be adapted to various safety requirements and construction facilities. Modern and very quite, high performance motors should have well special spindles should be used to realise precise & steady movement. As a safety feature the motor should be equipped with an over load protection. The large interior cross section for supply lines offers completely new applications with 120 mm diameter. The stoppers should be infinitely variable from 0-330º -340º

service head should be provided with the modular design to achieve maximum supply with minimum required space. Service head should be designed to host, Base, Gas Module, Electric Module and shelves. Upto 8 Gas outlets & 10 Electrical switches. Racks & shelves should be provided to mount the equipments like monitor etc. The total length of the manager should be 800mm. Surgeon pendent should have 1 arms with shelves as per following details:

a. Horizontal arm system - 1
b. Weight carrying capacity - 80kg
c. 5/15 Amp. Electrical sockets without switches - 8 to 10 Nos.
d. Shelves with side rails - 2 Nos.
e. Provision to fix Gas outlets (i.e.) Oxygen-2, Vacuum-2, Air 4 bar-1, N2O -1
f. Gas interface set for interface plate - 1
g. Ceiling mounting system for interim ceiling upto 1000 - 1
h. Interface plate with electrical fittings - 1
i. Ceiling cover for interim ceiling - 1

Make: Medepha / SIMEION / Pnuematic-Berlin
should have the following Features:

**Central illumination Ec (1mt)** 160,000 Lux

**Intensity Range (Lux)** 40,000- 140,000

**Light Field Diameter (mm)** 200-320

**Depth of Field L1+L2 (mm) >= 1200**

**CRT (Ra) Color range index >=96**

**R9 (deep saturated red color index) >=96**

**Color Temp(K) >=4500**

**Rated Power Output less or equal approx 60W**

**Light Head Power Consumption 200 VA +/- 10%**

**Radiant Energy around 3.4mW/m2lx**

**Temp increase < 1 deg**

**Certification UL/CE**

**Power Supply-Primary Voltage(V AC) 90-240**

**Rotation 360 deg**

**Operating Range >= 1700 mm**

**Adjustment of the spring arm >= 1175 mm**

**Approx wt of each LH <= 15kg**

**Measurement of light head 695/611 mm**

Any discrepancy in specifications of any item or any material shall be brought to the notice of consultant before implementation.

FOR All imported items country of origin should be EUROPE / USA only.

The bidder should submit agencies whole credentials for approval of agency from USER as per CVC guidelines for eligibility.

The contractor should prepare and submit layout plan as well as As-Built drawing for MOT to USER / Consultant for approval before beginning of supply and installation and As-Built drawing after installation.

The contractor should provide test certificate for all materials and equipments used for MOT.

Single agency will do all work for MOT.

Training of personnel of the Institute should be 30 days at least.

Agency for this specialized job should not be blacklisted or debarred in past by any Govt. Department or Hospital.
**TECHNICAL SPECIFICATION – TSSU EQUIPMENT**

**ITEM SI.No. 1: HORIZONTAL CYLINDRICAL HIGH PRESSURE HIGH VACUUM DOUBLE DOOR STEAM STERILIZER WITH AUTOMATIC CYCLE OPERATION AND PRINTER**

**PERICLAVE**, Horizontal Cylindrical High pressure High vacuum Sterilizer, electrically operated

<table>
<thead>
<tr>
<th>Chamber Size:</th>
<th><strong>500mm diameter x 1100mm depth</strong>, in inches will be 20” x 44”.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber capacity:</td>
<td><strong>227 litres</strong> approximately</td>
</tr>
<tr>
<td>Door:</td>
<td>DOUBLE DOOR, Hinge type with radial locking</td>
</tr>
</tbody>
</table>

**Inbuilt Vacuum Pump (Pre vacuum and post vacuum):** A suitable 2 HP water ring vacuum pump to withstand negative pressure and create high vacuum of 26”Hg for efficient drying and sterilization of loads. It will be fitted with the required Stainless Steel condenser, pipings and fittings to enable efficient drying with the use of the vacuum pump.

**Auto feed water pump:** To draw the water, automatically, when needed in the inbuilt boiler.

**Material of Construction:**

| Chamber: | Stainless steel 316 quality |
| Door: | Stainless steel 316 quality |
| Radial locking arm for Door: | Stainless steel 304 quality |
| Outer cover: | Stainless steel 304 quality |
| Inbuilt boiler / Steam generator: | Stainless steel 304 quality |
| Connecting pipes: | Stainless steel 304 quality |
| Jacket: | Boiler quality steel plate |
| Stand: | Mild Steel with anticorrosion paint |
| Door Gasket: | Silicon rubber gasket, withstand upto 140°C |
| Flush Mounting Panel: | Stainless steel SS 304 quality, fitted on sterile side |

**Working Temperature & Pressure:** 121 deg C corresponding to 1.2kg/cm² and 134 deg C corresponding to 2.1kg/cm²

**Electrical Heater Load:** 18 KW + Vacuum pump load

**Power Supply:** 3 phase, 440V, AC 50Hz supply

**Cycle operation mode**

<table>
<thead>
<tr>
<th>Automatic operated through Microprocessor (PLC, Siemens make), instead of manual operating valve:-</th>
</tr>
</thead>
<tbody>
<tr>
<td>• PLC based microprocessor with the facility of HMI which is incorporated with the sterilizer.</td>
</tr>
<tr>
<td>• Touch Screen HMI will be provided, German Technology, Siemens make</td>
</tr>
<tr>
<td>• It will have eight programmed cycle:</td>
</tr>
<tr>
<td>1. High Pressure High vacuum @ 121°C,</td>
</tr>
<tr>
<td>2. High Pressure High Vacuum @ 134°C,</td>
</tr>
<tr>
<td>3. Gravity @ 121°C,</td>
</tr>
<tr>
<td>4. Gravity @ 134°C,</td>
</tr>
<tr>
<td>5. Liquid @ 121°C,</td>
</tr>
<tr>
<td>6. User defined,</td>
</tr>
<tr>
<td>7. bowie dick test,</td>
</tr>
<tr>
<td>8. vacuum leak test</td>
</tr>
</tbody>
</table>
**Digital displays of**: Chamber Pressure, temperature, Cycle no., Batch no., Time & Date, Alarm indicator, Error code, Low water indicator

**Features of HMI**: Provision of ‘error code analysis’ inbuilt, Password protection for security, In-built Real Time Clock with date and time function

**Test**: Leak Test and Standard Process test, Bowie & Dick test and vacuum holding

**Printer (Dot matrix)**, **EPSON make**: Printer that will automatically and continuously monitor and record dates, time of day, load, identification no. and operating parameters

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**Other Fittings**

The sterilizer will be fitted with pressure gauge, compound gauge, plug screen, vacuum breaker, steam trap, safety valve and water reading glass and valves etc.

**Safety features**

Door locking facility, Low water protection system, Pressure cut off facility and all other necessary safety features etc.

**Documentation**

User manual in English, Warranty certificate and Hydraulic test certificate, IQ, OQ, DQ, PQ, Gauge calibration certificate, material test certificate

**MODEL**

P227C/DD/V/A

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**ITEM Sl.No. 2: HORIZONTAL CYLINDRICAL HIGH SPEED INSTRUMENT STERILIZER (FLASH AUTOCLAVE, FLOOR MOUNTED) WITH MANUAL CYCLE OPERATION-DOUBLE DOOR**

**PERICLAVE**, Horizontal Cylindrical High speed Instrument Sterilizer (Flash Autoclave, Floor Mounted), electrically operated

- **Chamber Size**: 400mm diameter x 600mm depth, in inches will be 16” x 24”; Chamber capacity: 79 litres approximately
- **Door**: DOUBLE DOOR, Hinge type with radial locking.

**Material of Construction**:

- **Chamber**: Stainless steel 316 quality; **Door**: Stainless steel 316 quality
- **Radial locking arm for Door**: Stainless steel 304 quality
- **Outer cover**: Stainless steel 304 quality
- **Inbuilt boiler / Steam generator**: Stainless steel 304 quality
- **Connecting pipes**: Stainless steel 304 quality
- **Jacket**: Boiler quality steel; **Stand**: Mild Steel with anticorrosion paint
- **Door Gasket**: Silicon rubber gasket, withstand upto 140°C

- **Working Temperature & Pressure**: 134 deg C corresponding to 2.1kg/cm²
- **Electrical Heater Load**: 18KW on 3 phase, 440 V, AC, 50Hz supply

**Safety features**: Door locking facility, Low water protection system, Pressure cut off facility and all other necessary safety features etc.

**Cycle operation mode**: Manual operated through multiport valve to set & select

**Auto feed water pump**: To draw the water, automatically, when needed in the inbuilt boiler

**Other Fittings**: The sterilizer will be fitted with pressure gauge, compound gauge, plug screen, vacuum breaker, steam trap, safety valve and water reading glass and valve etc.

**Documents**: User manual in English, Warranty certificate, Gauge calibration & Hydraulic test certificate.

**MODEL**: P79CF/DD
### ITEM Sl.No.3:- WASHER DISINFECTOR WITH INBUILT DRIER, DOUBLE DOOR

<table>
<thead>
<tr>
<th>SPECIFICATION</th>
<th>PHOTO IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Stainless steel Washer Disinfector is a straight through model designed to wash, rinse and drying all kinds of surgical instruments, anaesthetic and respiratory tubing, suction devices, bottles and other glassware. The process is automatically controlled in a time regulated sequence.</td>
<td><img src="image1.jpg" alt="Washer Disinfector" /></td>
</tr>
<tr>
<td>• It can handle up to 1280 instruments per hour;</td>
<td></td>
</tr>
<tr>
<td>• It will have DOUBLE DOOR</td>
<td></td>
</tr>
<tr>
<td>• Microprocessor control for all services, programming and statistic functions – three preset programs</td>
<td></td>
</tr>
<tr>
<td>• Chamber Size: 600mm x 700mm x 700mm; Volume: 250 – 275 Ltrs approx.</td>
<td></td>
</tr>
<tr>
<td>• Electric supply requirement: 415 V, AC, three phase &amp; N, 50Hz</td>
<td></td>
</tr>
<tr>
<td>• Electrical load – 20KW on 400-440V AC 50Hz supply</td>
<td></td>
</tr>
<tr>
<td>• Will have powerful water circulation pump</td>
<td></td>
</tr>
<tr>
<td>• Equipped with four spray arms for good penetration</td>
<td></td>
</tr>
<tr>
<td>• Dosage of detergent can be preset with dosing pump</td>
<td></td>
</tr>
<tr>
<td>• Sensor to detect level in soap tank and easy refilling system</td>
<td></td>
</tr>
<tr>
<td>• Sensor for water in chamber to avoid dry run</td>
<td></td>
</tr>
<tr>
<td>• Double wall with insulation to run with minimum sound and heat emission</td>
<td></td>
</tr>
<tr>
<td>• <strong>Effective Drying</strong>: The instruments and hoses are dried very thoroughly, inside out. An air particle filter ensures that the drying air is free from particles.</td>
<td></td>
</tr>
<tr>
<td><strong>Model</strong>: PWDD/DD</td>
<td></td>
</tr>
</tbody>
</table>

### ITEM Sl.No.4:- STAINLESS STEEL ULTRASONIC CLEANER, 30 LITRES

<table>
<thead>
<tr>
<th>SPECIFICATION</th>
<th>PHOTO IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Material</strong>: Made of Stainless steel.;</td>
<td><img src="image2.jpg" alt="Ultrasonic Cleaner" /></td>
</tr>
<tr>
<td>• <strong>Heater</strong>: 1.5KW on 230 V AC single phase.;</td>
<td></td>
</tr>
<tr>
<td>• Ultrasonic frequency: 30Khz (+/-3Khz);</td>
<td></td>
</tr>
<tr>
<td>• Ultrasonic Power: 500 watts</td>
<td></td>
</tr>
<tr>
<td>• Size (Tank): 505mm length x 300mm width x 250mm Depth. Volume: 30 Litres</td>
<td></td>
</tr>
<tr>
<td>• <strong>Overall Dimension</strong>: 530mm x 330mm x 380mm height</td>
<td></td>
</tr>
<tr>
<td>• <strong>Transducers</strong>: PZT – elements in sandwich form.;</td>
<td></td>
</tr>
<tr>
<td>• <strong>Accessories</strong>: Lid and baskets.</td>
<td></td>
</tr>
<tr>
<td><strong>Model</strong>: PUC</td>
<td></td>
</tr>
</tbody>
</table>
### ITEM Sl.No.5:- STAINLESS STEEL WORK TABLE WITH DOUBLE SINK

**SPECIFICATION**

- Stainless Steel Work table with double sink unit with hot water, cold water and air spray connections – for washing of instruments:
- Complete stainless steel 304 body construction, with four leg supports made of stainless steel
- Will have a drain outlet connection
- Sinks are designed in a way to minimize splash
- Will have an under shelf made of stainless steel 304
- Bench top dimension: 1500mm L x 650mm W x 900mm Ht
- All smooth ground corners
- All the joints will be welded with TIG Argon arc, fine finished

**PHOTO IMAGE**

Model: PWT/2S

### ITEM Sl.No.6:- SPRAY GUN RINSER WITH EIGHT ATTACHMENTS

**SPECIFICATION**

- Spray Gun Rinser with attachments is used for cleaning syringes, catheters, endoscopes, cystoscopes and variety of other instruments and articles used in sterile services.
- The instrument shall be cleaned through water and compressed air
- Various regular dimensions are included in the scope of supply.

**PHOTO IMAGE**

### ITEM Sl.No.7:- STAINLESS STEEL CONTROL & PACKING TABLE

**SPECIFICATION**

- The control and packing table with two shelves is used for separation, control and packing of various sets of sterilized goods for wards, clinics, operation theatre etc.,
- It will have drawer and with nylon adjustable levelling bullets for legs.
- The complete table will be made of SS 304, 16SWG.
- It will have provision for electrical connections sockets 5 Amps & 15 amps
- Overall size – 2000mm length x 1400mm Width x 1400mm H
- The corners will be smooth rounded to avoid any sharp edges.
- All the joints will be welded with TIG Argon arc, fine finished and mirror polished.

**PHOTO IMAGE**

Model: PCP/T

*Shown photo image – the width of table is 1400mm*
### ITEM Sl.No.8:- CONTINUOUS BAND SEALER ON STAINLESS STEEL TABLE WITH UNDER SHELF

<table>
<thead>
<tr>
<th>SPECIFICATION</th>
<th>PHOTO IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• This sealer with conveyor is suitable for small bags packaging and adopts electronic constant temperature control system and speed adjusting transmission mechanism. It can seal plastic films of various materials.</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>• Temperature Range: 0 – 300°C</td>
<td></td>
</tr>
<tr>
<td>• Sealing speed: 0-12mtr/min</td>
<td></td>
</tr>
<tr>
<td>• Sealing film thickness: 0.02-0.80mm</td>
<td></td>
</tr>
<tr>
<td>• Sealing width: 6-15 mm</td>
<td></td>
</tr>
<tr>
<td>• Power supply: 220-240 / 50 Hz 1 Phase</td>
<td></td>
</tr>
<tr>
<td>• Power consumption 500 W</td>
<td></td>
</tr>
<tr>
<td>• Conveyor Loading: 5Kg</td>
<td></td>
</tr>
<tr>
<td>• Machine Size: 900mm x 420mm x 660mm</td>
<td></td>
</tr>
<tr>
<td>• Table made of Stainless steel good quality</td>
<td></td>
</tr>
<tr>
<td>• It will have under shelf, made of stainless steel good quality</td>
<td></td>
</tr>
<tr>
<td>• Table Size: 1200mm Length x 600mm width x 900mm height</td>
<td></td>
</tr>
</tbody>
</table>

### ITEM Sl.No.9:- STAINLESS STEEL STORAGE RACK WITH THREE SHELVES

<table>
<thead>
<tr>
<th>SPECIFICATION</th>
<th>PHOTO IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Floor mounted, storage rack with Three nos. shelves are used to store the medical instruments / linen</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>• Frame is fabricated of 40mm square Stainless steel pipes. The legs are provided with adjustable nylon. Bullet feet.</td>
<td></td>
</tr>
<tr>
<td>• The shelves are fabricated of 16 SWG Stainless Steel sheets ground polished to smooth surface. Edges are welded together &amp; polished at corners.</td>
<td></td>
</tr>
<tr>
<td>• Overall Size: 900mm L x 425mm W x 900mm H</td>
<td></td>
</tr>
<tr>
<td>MODEL: PSR/3S</td>
<td></td>
</tr>
</tbody>
</table>

- Approved makes for entire TSSU System : Periclave / Steris-USA / Getinge

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The main Contractor should sub-Contract the specialised nature of work to only those Contractors in India for modular OT system who must be authorised distributor for all approved makes mentioned in tender for imported material. Since it is life saving project and it require proper maintenance by highly qualified & specialist engineers for after sales & services to maintain system so that the system should work round the clock without any interruption in medical procedures.
Sub-Contractor must produce its authorization letter for Indian contingent for the approved makes mentioned in tender for modular OT system at the time of execution.

All items mentioned under NS i.e. Non Schedule items are to be read in conjunction with the prevailing specifications of manufacturers and as per the relevant I.S code for the item/Material as mentioned in the tender. All the relevant material sample shall be got approved from the consultant before placing bulk order/usage. Any discrepancy in specifications of any item or any material shall be brought to the notice of consultant before implementation.

FOR All imported items country of origin should be EUROPE / USA only.