20. **Meters:**

01. All voltmeters and indicating lamps shall be through MCB's.
02. Meters and indicating instruments shall be plug type.
03. All CT's connections for meters shall be through test terminal block (TTB).
04. CT ratio and burdens shall be as specified on the single line diagram.

21. **Current Transformers:**

Current transformers shall be provided for control panels carrying in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps. Secondary for operation of associated metering.

The CT's shall confirm to relevant Indian standards. The design and construction shall be dry type. Epoxy resin cast robust to withstand thermal and dynamic stresses during short circuit. Secondary terminals of CT’s shall be brought out side suitable to a terminals block, which shall be easily accessible for testing and terminals connections.

The protection CT’s shall be of accuracy class 5P 10 and measurements CT’s shall be of accuracy class I.

22. **Selector Switch:**

Where called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

23. **Starters:**

Each motor shall be provided with a starter with a starter of suitable rating. Starters shall be in accordance with relevant IS codes. All-star delta and ATS starters shall be fully automatic.

24. **Contactor:**

Contactor shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. This magnet system shall consist of laminated to ensure clean operation without hum or chatter.

Starter contactors shall have 3 main and 2Nos. NO/NC auxiliary contacts and shall be air break type suitable for making contacts at minimum power factor of 0.35 for design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direction-on-line starters and 3 times the full load current of the motor in case of star delta and reduced voltage starters. The insulation for contactor coils shall be of class “E”.

Coil shall be tape wound vacuum impregnated and shall be house in a thermostatic bobbin, suitable for tropical condition and shall withstand voltage fluctuation. Coil shall be suitable for 20/415 #10% volts AC, 50 cycles AC supply.

25. **Thermal Overload Relay:**

Thermal over load relay shall have built in phase failure sensitive tripping mechanism to prevent against single phasing as well as on overloading. The relay shall operate on the differential system of protection to safeguard against three-phase overload, single phasing and unbalanced voltage condition.
Auto-manual conversion facility shall be provided to convert from auto-reset to manual-reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from -5 °C to + 55°C.

All overload relays shall be of three elements, positive acting ambient temperature compensated time lagged thermal over load relays with adjustable.

Setting relays shall be directly connected for motor up to 35 HP capacities. C.T. operated relays shall be provided for motors above 35 HP capacities. Heater circuit contactors may not be provided with overload relays.

26. Time Delay Relays:

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connection.

27. Indicating Lamp And Metering:

All meters and indicating lamps shall be in accordance with BS 37 and 39. The meters shall be flush mounted type. The indicating lamp shall be of flow wattage. Each MCC and control panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three nos. CTs of suitable ratio with three ways and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 amps fuse. Other indicating lamps shall be backed up with fuses as called for in schedule of quantities.

28. Toggle Switch:

Toggle switches, where called for in Schedule of quantities, shall be in conformity with relevant IS codes and shall be of 5 amps rating.

29. Push Buttons Station:

Push buttons stations shall be provided for manual starting and stopping of motors/equipments. Green and red color push button shall be provided for ‘Starting’ and ‘Stopping’ operation. ‘Start’ or ‘Stop’ indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting and accessible from front without opening door. Lock lever shall be provided for ‘Stop’ push buttons. The push button contacts shall be suitable for 6 amps current capacity.

30. Conduits:

Conduits and Accessories shall conform to relevant Indian Standards. Wall thickness shall be 16-gauge up to 32mm dia and 14" above 32-mm dia conduit. Screwed GI conduits shall be used. Joints between conduits and accessories shall be securely made. To ensure earth continuity. All conduit accessories shall be threaded type only. All raw metal shall be painted with bit mastic paint only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduits shall bear the label of the manufacturer.
Maximum permissible numbers of 650/1100-volt grade PVC insulated wires that may be drawn into rigid non-metallic or GL conduits are given below.

<table>
<thead>
<tr>
<th>Size of wires nominal cross section area (sq)</th>
<th>Maximum number of wires within conduit size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>1.5</td>
<td>05</td>
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<td>2.5</td>
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<td>16</td>
<td>-</td>
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<tr>
<td>25</td>
<td>-</td>
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<tr>
<td>35</td>
<td>-</td>
</tr>
</tbody>
</table>

31. **Cables:**

MV Cables shall be PVC insulated aluminum Conductor and armored cables conforming to IS codes. Cables shall be armored and suitable for lying in trenches, ducts, and on cable trays required. MV cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel cables shall be multi cores PVC insulated copper conductor and armored cables.

32. **Cable Lying:**

Cable shall be laid in accordance with IS code of practice. Cables shall be laid on 14 gage factory fabricated perforated galvanized sheet steel cable trays, and cable drops / risers shall be fixed to ladder type cable trays factory fabricated out of galvanized steel angle. Access to all cables shall be provided to allow cable withdrawal / replacement in the future. Where more than one cable is running on a cable tray, one dia. spacing shall be provided between cables to minimize the loss in current carrying. Cables shall be suitable supported with galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250mm thick layer of soft sifted sand & protected with bricks / tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable.

33. **Wire and Wire Sizes:**

1100 volts grade PVC insulated copper conductor wires in conduit shall be used. For all single phase /3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipments inside plant room and AHU room shall be connected to the control panel by means of insulated copper conductor-wires of adequate size in exposed conduits. Final connections to the equipments shall be through wiring enclosed in galvanized flexible conduits rigidly clamped at both ends and at regular intervals. An isolator shall be provided near each motor / equipments wherever the motor / equipments is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panels for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic bends shall be provided at both the ends for easy identification of control wiring.

The minimize size of control wiring shall be 1.5 sq. mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipments and control panels.
34. Power wiring cabling shall be of the following sizes:

Up to 5 HP motor / 5kw heaters
3x4 sq. mm-copper conductor wires.

From 6 HP to 10 HP motor.
From 12.5 HP to 15 HP motor.
From 20 HP to 25 HP motor.
From 30 HP to 35 HP motor.
From 40 HP to 50 HP motor.
From 60 HP to 75 HP motor.
100 HP motor.
150 HP motor.
250 HP motor.
400 HP motor.
600 HP motor.

3x6 sq. mm-copper conductor wires. 6kw to 7.5 kw heaters.
2 Nos.3x6 sq. mm-copper conductor wires.
2 Nos.3x10 sq. mm-copper conductor wires.
2 Nos.3x16 sq. mm aluminum conductor armored cable.
2 Nos.3x25 sq. mm aluminum conductor armored cable.
1 No.3x70 sq. mm aluminum conductor armored cable.
1 No.3x150 sq. mm aluminum conductor armored cable.
1 No.3x240 sq. mm aluminum conductor armored cable.
2 Nos.3x240 sq. mm aluminum conductor armored cable.
3 Nos.3x240 sq. mm aluminum conductor armored cable.
3 Nos.3x400 sq. mm aluminum conductor armored cable.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors recommendation.

35. Motor Starter Recommendation Chart:

<table>
<thead>
<tr>
<th>Motor Feeder – DOL Starting – Type 2 coordination as per IS 13947</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>KW</strong></td>
</tr>
<tr>
<td>0.37</td>
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Motor Feeders – Star Delta Starting – Type 2 coordination as per IS 13947

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<tr>
<th>Motor</th>
<th>Motor Current</th>
<th>Switch Fuse Rating Amps</th>
<th>HBC Fuse Rating Amps</th>
<th>Contactor L/D Rating Amps</th>
<th>Contactor Star Rating Amps</th>
<th>O/L Relay Rating Amps</th>
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Contractor: [Signature]

Registrar: 263
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<tr>
<th>Motor</th>
<th>Motor Current</th>
<th>Switch Fuse</th>
<th>HBC Fuse</th>
<th>Contactor L/D</th>
<th>Contactor Star</th>
<th>O/L Relay</th>
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<td>756</td>
<td>438</td>
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<td>550</td>
</tr>
</tbody>
</table>

Two speed motors when specified shall be provided with DOL starter irrespective of it rating.

36. Earthling:

Earthling shall be provided in accordance with relevant BIS Codes and shall be copper strips / wires. The main panel shall be connected to main earthling system of the power supply. All single-phase metal clad switches and control panels motor and equipments shall be earthling with 2 number distinct and independent copper wires / tapes as follows:

- Motor up to and including 10 HP rating.
- Motor 12.5 HP to 40 HP capacities.
- Motor 50 to 75 HP capacities.
- Motor above 75 HP.

2 Nos. 3mm dia copper wires.
2 Nos. 4mm dia copper wires.
2 Nos. 6mm dia copper wires.
2 Nos. 3mm x25 mm copper wires.

All switches shall be earthed with two number distinct and independent copper wires tapes as follows:

- 3 phase switches and control panel up to 60 amps rating.
- 3 phase switches and control panel 63 amps to 100 amps rating.
- 3 phase switches and control panel 1 25 amps to 200 amps rating.

2 Nos. 3mm dia copper wires.
2 Nos. 4mm dia copper wires.
2 Nos. 6mm dia copper wires.
3 phase switches and control panels, bus ducts, above 200 amps rating.

2 Nos. 3mm x 25mm copper tapes.

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75mm. These starlight joints shall be riveted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipments body to be earthed after the metal body is cleaned of paint and other oily substance, and properly tinned.

37. Drawing:

Shop drawings for control panels and for wiring of equipments showing the route of conduit & the contractor for approval of Architect / Consultant before starting the fabrication of panel and starting the work shall submit cable. On completion, four sets of complete “As-installed” drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction / pull boxes and cables route etc... shall be furnished by the contractor.

38. Testing:

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report furnished by a qualified and authorized person. Electrical inspector shall be approved the entire electrical installation and a carried out in the presence of Owner’s site representative. Testing of the panels shall be as per relevant BIS codes.

39. Measurement Of Electrical Control Panels:

Panels shall be counted as number of units. Quoted rates shall include as lump sum (NOT measurable lengths) for all internal wiring, power wiring and earthing connections from the control panel to the starter and to the motor, control wiring for interlocking, power and control wiring for automatic and safety control, and control wiring for remote start / stop as well as indication as per the specifications. The quoted rate of panel shall also include all accessories switchgear, contractors, indicating meters and lights as per the specifications and schedule of quantities.

40. Rubber Mat:

Rubber mat shall be provided in front to cover the full length of all panels. Where backspace is provided for working from the rear of the panels, rubber mat shall also be provided to cover the full length of panel.

D. AIR DISTRIBUTION SYSTEM:

01. Scope:

The section comprises the general requirements for the following:

a. Sheet metal ducting.
b. Supply air / return air fresh air outlets.
c. Material of construction for the above.
d. Methods of installation and finishing requirement.
e. Air balancing.
f. Grilles, Diffusers, Splitters & Volume control dampers etc.

The above will be in accordance with these specifications and the general arrangement as shown in the drawing.
02. Material for Ducting:

All ducts shall be fabricated from cold annealed flat, class VIII galvanized steel sheet (galvanized to specifications of IS 277, 1962 (revised) and with a galvanizing thickness of 125 gm per sqm surface area) or Aluminum sheets conforms to IS specifications i.e. IS 737. Sheets should be clean, smooth, and straight. The joints shall be finished straight and neat. Flanges for mating duct sections and stiffening angles shall be as per IS: 655, 1963 with Amendment – I (1971 edition). The ductwork shall be supported / secured from roof. Slab / MS boxes and roof slab or any other building members using angle / rods as may be required.

03. Construction and Installation:

Duct construction shall generally follow IS: 655 specifications for sheet metal air duct. Thickness of sheets for rectangular ductwork shall however be as follows:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Maximum Size of duct (mm)</th>
<th>Thickness of Sheets (mm)</th>
<th>Type of joints</th>
<th>Bracing</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Up to 750</td>
<td>0.63 (24 gauge)</td>
<td>GI flanges</td>
<td></td>
<td>GI rods 8 mm thick and GI angle/ channel 50 mm x 50 mm x 5 mm at 2 mt distance</td>
</tr>
<tr>
<td>b.</td>
<td>751 to 1000</td>
<td>0.80 (22 gauge)</td>
<td>25x25x3 mm angle iron frame with 8 mm dia nuts &amp; bolts</td>
<td>25x25x3 at rate of 1.2 m.</td>
<td>GI rods 8 mm thick and GI angle/ channel 50 mm x 50 mm x 5 mm at 2 mt distance</td>
</tr>
<tr>
<td>c.</td>
<td>1001 to 1500</td>
<td>0.80 (22 gauge)</td>
<td>40x40x3 mm angle iron frame with 8 mm dia nuts &amp; bolts</td>
<td>40x40x3 at rate of 1.2 m.</td>
<td>GI rods 10 mm thick and GI angle/ channel 50 mm x 50 mm x 5 mm at 2 mt distance</td>
</tr>
<tr>
<td>d.</td>
<td>1501 to 2250</td>
<td>1.00 (20 gauge)</td>
<td>40x40x5 mm angle iron frame with 10 mm dia nuts &amp; bolts at 125 mm center.</td>
<td>40x40x3 at rate of 1.2 m</td>
<td>GI rods 10 mm thick and GI angle/ channel 50 mm x 50 mm x 5 mm at 2 mt distance</td>
</tr>
<tr>
<td>e.</td>
<td>above 2250</td>
<td>1.25 (20 gauge)</td>
<td>40x40x5 mm angle iron frame with 10 mm dia nuts &amp; bolts at 125 mm center.</td>
<td>40x40x3 at rate of 1.2 m</td>
<td>GI rods 10 mm thick and GI angle/ channel 50 mm x 50 mm x 5 mm at 2 mt distance</td>
</tr>
</tbody>
</table>

Sheet shall be determined by longest side of the duct from the above table. All ducts shall be fabricated and installed in a workmanship like manner generally conforming to relevant IS codes. Transverse joints, bracings, etc. shall be as recommended in the relevant IS codes.
Thickess of sheet for round ducts

<table>
<thead>
<tr>
<th>Diameter of duct (mm)</th>
<th>Thickness (mm)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 to 500</td>
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<td>24 Gauge</td>
</tr>
<tr>
<td>501 to 750</td>
<td>0.80</td>
<td>22 Gauge</td>
</tr>
<tr>
<td>751 to 1000</td>
<td>0.80</td>
<td>22 Gauge</td>
</tr>
<tr>
<td>1001 to 1250</td>
<td>1.00</td>
<td>20 Gauge</td>
</tr>
</tbody>
</table>

04. Duct Construction:

The intent of the above specifications is to obtain duct pieces that are robust and rigid enough to preclude flutter. Ducting shall be supported from independent hangers fixed to the building structure. The contractor shall prepare detailed drawing of hangers and support and submit for the approval of the consultants / architects. Dimensions of duct section shown are inside dimension of bare ducts. Where duct cannot be supported from the ceiling, wall brackets or other suitable arrangement, approved by the Engineer-in-charge as shown on the drawings may be adopted. 3mm-neoprene isolation packing shall be provided between the duct and the angle iron support bracket.

Simple elbows, transformation section shall be formed with double corner seam. Complicated fittings, shall be constructed with double corner elbows, bends and offset pieces shall have a centerline radius of 1.25 to 15 times the radial of duct width. Turning vanes should be provided at required spacing such that the aspect ratio rate of each individual elbows formed by the vanes shall not be more than 5 changes in dimension. Main duct branch off shall be provided with splitter dampers of length equal to 1/3 of duct width followed by volume control damper in both branches as detailed in schedule of quantities. Cutting vanes shall be gradual.

Adequate bracing shall be provided where vanes are of large size. Duct joints shall be sealed, where required, with Silicon sealant.

All sheet metal connections, partitions, and plenum shall be fabricated out of 18 gauge GSS thoroughly stiffened with 25mm x 25mm 3mm angle iron braces and fitted with all necessary access doors not less than 450mm x 450mm in size.

05. Dampers:

Volume control dampers shall be provided at junction of each branch duct with main duct split of main duct.

The damper blade shall be 18 gauge GSS, lever operated and complete with locking devices which will permit the damper to be adjusted and locked in any position.

06. Supply and return Registers:

Supply & Return air registers shall be extruded aluminum section as specified in schedule of quantities. Extruded aluminum registers shall be either anodized or powder coated as given in schedule of quantities.

Supply air registers shall be provided with key operated opposed blade all extruded aluminum construction volume control damper in black anodized finish.

The registers shall be suitable for fixing arrangement concealed or visible screw as approved by owner / architect.

07. Supply and return Air Diffusers:

Supply & Return air diffusers shall be as shown on the drawings and indicated in schedule of quantities. Diffuser's dampers shall be factory coated with rust resistant primer. Aluminum diffusers shall be powder coated and made from extruded aluminum section as given in schedules.

Square / Rectangular diffusers shall be extruded aluminum construction, square & rectangular diffusers with flush fixed pattern for different spaces shall be selected in consultation with the Architect / Consultant.

Supply air diffusers may be equipped with fixed air distribution grid, removable key-operated volume control
08. Supply and return Air Grilles:

All supply grilles shall be double deflection type with both horizontal and vertical vanes being independently adjustable. Grilles shall be provided with multi-louver damper for volume control, which shall be key operated from the front of the grilles. All return air and exhaust grilles shall have only horizontal louver and similar to Tuttle and bailey Aero vane T-70 or equipment. Grilles shall be provided as shown in the drawing and indicated in the schedule of quantities.

Grilles shall be provided with sponge rubber gasket between flanges and wall or ceiling sample of grilles / diffuser shall be approved by the architect / consultant before installation. All registers, grilles and diffusers shall have an effective area of not less than 75% across face area.

09. Volume Control Dampers for Grilles / Diffusers:

Suitable volume control dampers shall be provided as required for proper control and balancing of air distribution. Opposed blade volume control damper shall be provided as shown in the drawing and indicated in the schedule of quantities.

Dampers shall be of all extruded aluminum construction in opposed blade construction and shall be of black anodized finish. Opposed blade louver shall be pivoted to the Extruded Aluminum frame with Nylon bushes so as to provide smooth and accurate operation.

10. Smoke / fire Dampers:

Fire dampers shall be installed in the supply / return air ducts connections of the units. Fire dampers, shall be provided with approved make, and shall have fire rating of at least 90 minutes.

The dampers frame and the blades shall be fabricated out of 16 gauge G.I sheets. The dampers, blades on both ends shall be provided using chrome-plated spindles in self-lubricating bronze bushes. Stop sealed shall be provided on top and bottom of the damper housing. To prevent smoke leakage, side seals shall be provided.

The normal position the damper shall be held in open position with the help of a stainless steel spring through a thermal link. The thermal link will be UL stamped. This link will be set to operate at 165 deg. F.

Smoke & fire damper shall have similar construction as above. However, these dampers will be motorized types having electric actuator, actuated by smoke sensor and electronic heat detector factory set at 165 deg. F. The dampers shall be provided with spring return system to ensure damper closing in case of power failure and open the same in case of power being restored.

Fire and smoke dampers shall be mounted in fire rated wall with a duct sleeve of 400mm / 500mm long depending upon the wall thickness. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of GI sheet shall be 18 gauges.

The fire smoke damper shall be complete with remote control panel incorporating status-indicating lamps (open, close & fire alarm). Push buttons for buttons for open, close and reset. Auxiliary connections will be available for hooter or central indications. The remote panel shall be connected to emergency power supply 220V.

Micro switch with Bakelite base will be provided with necessary electrical contacts. The micro switch during close position of damper will automatically switch off the blower / fan motor.

In the closed position there shall be no openings between the blades & frame of the damper to allow passage of air, heat, smoke or flame. Access doors shall be provided in the dust for access and resetting the fire dampers.
The fire damper and its frame shall be finished with two coats of fire retardant paint of nervier or approved equivalent paint.

11. Fresh Air Intake Louvers:

Fresh air intake louvers wherever required as per shop drawing will be made of extruded aluminum construction duly anodized or powder coated. Bird / insects screen will be provided with the intake louvers. The lowest louver of the assembly shall extend out slightly to facilities disposal of rainwater without falling on door / wall on which it is mounted.

Where specified, the intake louvers & frame shall be provided with factory fitted all aluminum construction volume control dampers in black anodized finish.

12. Air transfer door grills:

Extruded aluminum construction air transfer door grills will be provided as per approved shop drawing. The grill will be complete with dual grill frame to be mounted on door panel from both sides. The central core shall be NO-SEE-THRU type. The grill shall be anodized or powder coated as per requirement. The grill shall be provided with insect screen to prevent movement of insect from inside to out side or vice for vice versa for peripheral installation.

13. Apparatus and Equipment Connections:

Equipments such as indoor unit shall be connected to the duct by means of double canvas sleeve at least 150mm long.

14. Access Doors:

Hinged access doors shall be provided for all apparatus such as fire dampers, heaters, and etc. required frequent servicing, and inspection. Access doors shall be rigid and shall be provided with airtight gaskets. Insulated ducts shall be provided with insulated doors.

15. Flexible Connections:

All ducts work connections to plant are to be fitted with flexible connections to prevent the transmittance of vibration from the plant, through the ductwork system. Connections shall not exceed 200mm in length and shall be constructed from fire retardant double canvas or other approved material. Connections shall be secured to a make suitable airtight seal with the ductwork and plant.

16. Installation:

All ducts shall be installed generally as per Tender drawings, and strictly in accordance with approved drawings.

a) The contractor shall provide and neatly erect all sheet metal work a may be required to carry out the intent of specifications and drawings. The work shall meet with the approval of owner’s site representative in all parts and details.

b) All necessary allowances and provision 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 beam or other structural, divided or curved to one side, the required area being maintained, all as per the site requirements.

c) If a duct can't be run as shown in the drawings the contractor shall install the duct between the required points by any path available, in accordance with other service & as per approval of Owner’s site representative.
d) All ducts work shall be independently supported from building elements. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of MS rods and angle iron.

e) Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of owner’s suite 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 occur no delay to other contractor’s work in the building.

f) Rat proofing consisting of 16G galvanized weld mesh, with about 6mm centers sieve, shall be provided in supply air ducts at AHU / Fan outlets, in return air opening of AHU room wall, and above return air slits in conditioned spaces, as required by owner’s site representative.

g) Where metal ducts or sleeves terminate in woodwork, tight joints shall be made means of closely fittings heavy flanged collars. Where ducts pass through brick or masonry openings, wooden framework shall be provided within the opening and crossing is made leak proof.

h) All ducts shall be totally free from vibration under all conditions of operation whenever ducts work is connected to fans, air handling units, or blower oil units that may cause vibrations in the units, in mutually perpendicular directions. Flexible connections shall be constructed of fire resistant flexible duct able canvas sleeve at least 10 cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and supports on both ends. The flexible connections shall be suitable for pressure at the point of installation.

17. Measurements for Ducting:

Unless otherwise specified, measurements for ducting for the installation shall be on the basis of centerline measurements described herewith.

a) Duct work - Ductwork shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter covering overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section, and adding up areas of all duct sections.

For tapers rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the sections midway between large and small diameters shall be adopted, the length of tapered duct section shall be the centerline distance between the flanges of the duct sections.

For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline.

The quoted unit rates for external surface of ducts shall include all wastage, flanges and gaskets for joints, nuts and bolts, hangers, and angles and angle / flat with double nuts for supports, neoprene strips between duct and supports, vibration isolator suspension where specified or required, inspection chamber / access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the specifications.

b) Special items for air distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith:

i) Grilles and Registers – width multiplied by height, excluding flanges. Volume control dampers shall from part of the unit, rate for registers and shall not be separately accounted.

ii) Diffusers – cross section area for air flow at the neck. Neither the bell mouth area, discharge face area, nor the flanges will be measured.
iii) Linear Diffusers – shall be measured by linear measurements only, not by cross sectional areas, and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

iv) Fire/Smoke Dampers – shall be measured by cross – sectional area perpendicular to the direction of airflow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, fusible links etc. No special allowances shall be payable for extension of cross-section outside the air stream. In case of smoke dampers the smoke sensors and actuators shall be counted separately and paid for according to quoted rates. Limit switch and wiring shall from part of the damper.

v) Flexible Connection – shall be measured by their cross sectional area perpendicular to the direction of airflow, multiplying with the overall length from flanges face to flanges face. Quoted rates shall include the necessary mounting arrangement, flanges, nuts, and bolts and treatment-for-fire, requisite length of canvas clothe.

18. Testing and Balancing:

After the installation of the entire air distribution system is completed in all ducts shall be tested for air leaks by visual inspection.

The entire air distribution system shall be balanced using an approved anemometer. 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 completed 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 air balancing report shall be forwarded with completion documents.

19. Painting:

All exposed duct (inside and outside) shall be painted with two coats of enamel paint of approved shade in strict accordance with approved drawings provided by the contractor.

E INSULATION WORK

01. General:
The section of the tender deals with thermal insulation for piping, ducting and equipment.

02. Scope:
The scope of this section comprises of the supply and applications of thermal insulation that shall generally conform to the following specifications.

All chilled water piping and chilled water equipments shall be insulated in the manner specified hereunder:

03. Application of Thermal Insulation:

Chilled water pipes shall be insulated with rigid preformed sections of TF quality expanded polystyrene of density not less than 24 Kg/CuM or Polyurethane foam insulation density not less than 36 Kg/CuM of the following thickness and as indicated in schedule of quantities.

<table>
<thead>
<tr>
<th>Temperature Range (Degree C)</th>
<th>Pipe Diameter (NB in mm)</th>
<th>Thickness (PUF/EP) (mm)</th>
</tr>
</thead>
<tbody>
<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>12-100</td>
<td>30/50</td>
</tr>
<tr>
<td></td>
<td>Above 100</td>
<td>50/75</td>
</tr>
<tr>
<td>12.8 - 15.6</td>
<td>All sizes</td>
<td>25/40</td>
</tr>
</tbody>
</table>

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Cold insulation on pipes shall be applied as follows:

Pipes shall be thoroughly cleaned with wire brush and rendered free from scale, grease and foreign matter.

One coat of zinc chromate of primer and two coats of CPRX compound shall be applied on the cleaned pipe surface.

TF/P quality expanded polystyrene / polyurethane rigid pipe sections shall be fixed tightly to the surface. All joints to be sealed properly with CPRX compound.

Two layers of 500 G polythene sheet to be wrapped over the insulation to work as vapor barrier.

Insulation surface shall be clad with 26-gauge aluminum sheet in a neat and clean manner with joints over lapped properly.

For chilled water pipes buried in trench, 24 gauges x 19 mm square mesh GI wire netting shall be applied over polythene sheet butting all joints and shall be faced down with 20 gauge GI wire. Finally insulated surface shall be finished with two layers of sand cement plaster and there after painted with synthetic enamel paint after necessary curing.

Condensate drain piping and refrigerant piping shall be insulated in the manner specified above.

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, valves 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,

Chilled water pumps 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.

Expansion tank shall be insulated to the same thickness as for the pipes to which they are connected. The mode of the insulation shall be as above.

04. Duct Lining, AHU Room Lining, Duct Thermal Insulation:

The scope of this section comprises of supply and application of insulation conforming to these specifications.

05. Material (Duct Insulation Material):

This shall be closed cell polyethylene foam insulation having a thermal conductivity not exceeding 0.0329 kcal/hr-sq. m-deg c/meter. The density of material shall not be less than 32kg/cu.m, capable to operate in the range of 40-80 °C to + 110 °C. Insulation shall be provided with factory applied self-sticking adhesive on one side & aluminum foil lamination on other side and if used for out door applications PE moralized film lamination on other side. Material shall be self extinguishing & CFC free so as not to emit toxic gases and the smoke density shall not exceed 0.1 as per AS-1530.3 in case of fire. 19mm thickness of insulation shall be applied for exposed for exposed duct insulation and 10mm thickness of insulation shall be applied for internal duct insulation. Material should conform to IS 8183 – 1976.

06. Duct Insulation:

External thermal duct insulation on sheet metal ducts shall be insulated as shown in the drawings and as per the method specified for different applications as given below.

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07. Duct Insulation Within the Building:

The duct surface shall be cleaned and prior to applying the insulation. To avoid the contamination of adhesive insulation shall be provided with factory-applied adhesive. Insulation roll shall be directly applied on the ducts wrapped/stuck on the surface of the duct and the same shall be held in position with aluminum tape. The above insulation shall be given the necessary overlaps and all joints and ends shall be providing complete sealing with the aluminum taps. Finally 15mm wide PVC strap along with GI angle (made of 24G sheets) shall be provided every after 1200mm distance to tighten the insulation in position. Also precaution must be taken so as to avoid any bulging, or stretching of the material.

08. Duct Lining:

The ducts identified for acoustic treatment as shown in drawing and the schedule of quantities shall be installed / acoustically treated as per the methods described below.

Duct acoustic lining material shall be 12 mm thick fiber glass rigid board having density of 48 kg/sqmt. The insulation shall be applied to inner surface of duct using bitumen and screws at 600 mm centre distance. The rigid board shall be finished with RP tissue and 30 G aluminium perforated sheet.

09. Under-Deck Insulation with material:

Under - deck insulation shall be carried out under the RCC roof slab in the schedule of quantities. The under-deck insulation material shall be carried out with TF quality expanded polystyrene of 50mm thick having density of not more than 16kg/Cu.m. The insulation slabs shall be fixed under RCC ceiling with fevicol. All corners shall be supported with 150mm x 150mm (24 gauge) GI sheet fixed with rowel plugs and GI screw with GI washers. GI wire drawn tight against the material and wire drawn through the rowel plugs shall be used to re-enforce insulation material.

AHU Room Acoustic / Thermal Lining

It shall be applied as under:

Fix factory pressed GS Sheet channel frame work of 24 gauge 25 mm wide and depth equal to thickness of insulation at 600 mm center to center forming a grid work of 600 x 600, screwed to the walls and ceiling.

Supply and fix fibre glass TI-200 or other approved equivalent insulation material of 32 kg / CuM density in GS sheet channel framework with joints well butted together.

Cover insulation with RP tissue.

Finally cover the insulation with 24 SWG perforated aluminum sheet having at least 20% perforation with joints overlapped and screwed to the GS Sheet channel frame by means of brass metal screw to produce an even surface. All longitudinal joints shall be covered with 20 mm wide x 3 mm thick aluminum strips secured with cup washers and brass metal screws.

Measurement of Insulation

10. Duct Insulation:

Unless specified otherwise, measurements for insulation on ducts for the installation shall be on basis of center-line-measurements.

Insulation shall be measured on the basis of external surface area of insulation on ducts. The external surface area shall be calculated by measuring the perimeter overall width and depth, including the bends, multiplying with the overall length of insulated duct.

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11. Acoustic Lining in Duct:

Acoustic lining shall be measured on the basis of external surface area of ducts. The external surface area shall be calculated by measuring the perimeter covering overall width and depth, including the bends, multiplying with the overall length of duct provided with acoustic lining.

12. Under deck Insulation:

Under deck insulation shall be measured on the basis of internal surface area of ceiling and beams.

General Scope of Field Work

The Contractor is required to provide labor, all consumables like electrodes, gas, all tools and tackles, safety gadgets, test set up etc. for carrying out the job.

It is not the intent to specify herein all the details pertaining to the design, selection of material, equipments, procurement, manufacture, installation, testing and commissioning, however, the same shall comply to all current applicable standards and safety codes. All statutory requirements will be complied with under the Factories Act 1948.

Contractor shall bear the cost of repair, modifications and replacement, if any becoming necessary due to non-compliance of codes, this specification and due to disregard to the instructions of Engineer.

This is an item rate tender. The estimated Bill of Quantities given in this tender document is for guidelines only. The Contractor shall prepare his own Bill of Quantities and shall be paid only for the material installed at site. Any material, if supplied extra by the Contractor, shall not be paid by Owner and will have to be taken back after final reconciliation.

The technical particulars of various major & important items works have been given. It is the responsibility of the contractor to confirm for himself the suitability of the technical particulars and in case of any discrepancy bring the same to the attention of Owner for incorporation.

General Project Information is given below.

<table>
<thead>
<tr>
<th>Location</th>
<th>Pashan Pune</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>Maharashtra</td>
</tr>
<tr>
<td>Maximum Temp</td>
<td>41°C</td>
</tr>
<tr>
<td>Minimum Temp</td>
<td>7°C</td>
</tr>
<tr>
<td>Ref. Ambient Temp</td>
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<tr>
<td>Rainfall annual average</td>
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<tr>
<td>Altitude</td>
<td>560 M</td>
</tr>
<tr>
<td>Humidity</td>
<td>30% to 93%</td>
</tr>
</tbody>
</table>

Brief Technical Specifications for field work

This includes the recommended practice of Erection, Testing and Commissioning of various components / equipments of FPS as per scope of work. Erection, Testing and Commissioning shall be done as per the relevant Indian Standards, Code of Practice, Statutory requirements etc.

Similarly the civil works such as for leveling, making foundation bolt holes, grouting base frames & bolts, structural support pad plates, hangers, installing the Sub DBs, MDFs, router / switch cases etc in the wall chases etc. are included.

The design, material of construction, manufacture, inspection, testing and performance of all equipments / items shall comply with all currently applicable standards regulations and safety codes in the locality, where the
equipment will be installed. Those equipments/items shall conform to the specifications and latest applicable standards as specified.

**Mechanical Works**

**Pipe Work Specifications**

Pipe work shall be carried out as per the routing generally as shown in tender drawing. This drawing shall be referred as guideline while carrying out piping work.

The job comprises of supply, fabrication, erection and commissioning of pipe lines at all elevations.

All the materials and equipments (like pipes, valves, flanges etc.) required to carry out this work shall be procured and supplied by the Contractor. Estimated Bill of Quantities of piping and fittings are given. However, Contractor shall cross check the BOQ with his final BOQ based on his execution drawings.

Instruments and valves shall be adequately supported to facilitate easy operation of manually operated valves. Adequate spacing and handling arrangements shall be provided.

**Erection Instructions**

All pipe work shall be erected in conformity with relevant and ASME B 31.1Codes for pressure piping or equivalent.

All supports, anchors, hangers, clamps, guides, sway bracings etc. required for aligning and controlling the pipe work shall be installed. Design, material and workmanship for structural steel work used for pipe supports shall also conform to relevant Indian Standards.

Support shall prevent under operating conditions, excessive stresses and excessive vibration of supporting elements from possible resonance with imposed vibrations.

As far as possible, the pipes shall be laid over the pipe racks.

Pipe Fabrication Instructions

**Pipe Joints**

All pipe lines shall be of welded construction (Butt Weld / Socket Weld). Flanges shall be provided at strategic locations, as required, for easy erection and maintenance. The HP tanks Valves and other fittings shall be connected by flanged joints. The location of flange joint shall be approved by Consultant/Purchaser.

**Welding**

All jointing by electric arc and gas welding processes shall be as per IS: 823 and 1323 respectively or equivalent.

All welding work shall be carried out by qualified welders. All filler materials, edge preparation, post weld treatment etc. shall be as per relevant standards. All welds shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond the root areas. The general procedure followed shall be as per AWS D 1.1.

All welding by the shielded electric arc process shall be done using electrodes in accordance with the relevant standards. Composition of consumable electrodes or filler rods in case of non-consumable electrodes shall be same as that of the parts being welded so that there is no dilution of the alloying components at the welded joints. The approved brands to be used are Advani Oerlikon / Esab / L & T.

Welded carbon steel piping need not be stress relieved. Bends, branches, reducers etc. may be fabricated from pipes, by cutting and welding as above, where permitted by the service conditions/Engineer.

Field welding of pipe supports to primary structural members of buildings and crane rails etc. and field burning or patching of structural members shall not be carried out without approval / guidance of the Engineer. Pipe shall be allowed to cool slowly in still air before the same is removed.

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