SABARMTI RIVERFRONT DEVELOPMENT

Sabarmati River Front Development Corporation Limited

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B/h H.K Arts College,
Between Gandhi Bridge and Nehru Bridge,
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BID DOCUMENT

CONSTRUCTION OF RIVERSIDE SAVORIES I.E. BUILDING WITH UNDERGROUND ROAD BETWEEN NEHRU BRIDGE AND ELLISBRIDGE AND CONSTRUCTION OF PUBLIC PLAZA AND UNDERGROUND PARKING FACILITY AT SANSKAR KENDRA - TAGORE HALL CAMPUS CONNECTING RIVERFRONT ON WESTBANK FOR SRFDCL.

Contract Package : SRFDCL

VOLUME-02

IV) Technical Specification-HVAC

SECTION IV

TECHNICAL SPECIFICATIONS

Part A: - Riverside Savories

1.0 DX AIR COOLED HIWALL SPLIT AC UNITS – Minimum 4 Star Rating

Hi-Wall Mount Split Units shall be remote control operated and shall be with single or multi splits design as per the ratings and quantities provided in the schedule of quantities.

The units shall be ready-to-operate type and shall comprise of a Indoor type Fan-Coil unit (installed within the room) and Outdoor Air Cooled Condensing unit connected through insulated refrigerant piping. The system shall be charged with first charge of refrigerant after proper pre-commissioning process.

Single phase connection shall be provided by user at one point near each Hi Wall split unit. Rest of the electrical work including cabling from the power point up to the Unit's electrical panel including voltage stabilizer shall be supplied, laid and installed by vendor only.

The units shall be of one among the Approved Makes mentioned elsewhere in this Tender.

1.1 Brief Features Desired In Indoor (Fan-Coil) Unit

Hi Gloss finish all fiber body.

Highly efficient 3 layered air purification system to remove dust/bacteria and odors from the Return air.

Four bend heat exchanger design for efficient heat transfer

Noise level of Indoor Unit at operating speed shall not be exceeding 48 dB measured at a distance of 3 M from source.

Operated through remote control having a large LCD display, temperature set-point, sleep mode operation, On/Off timer, Real time clock, Auto-restart, filter status warning, dry mode operation (reduces the humidity without the temperature when required)

1.2 Brief Features desired in Outdoor Condensing Unit

Operating on single phase 230±10% V supply

Preferred Rotary Scroll compressor design for low power consumption per ton generated – not exceeding above 1.28 kW per TR

Electrolytic zinc steel sheet with antirust coated components to ensure rust free outdoor unit even in humid condition.

Hydrophilic fins to improve the heating efficiency by accelerating the defrosting process.

2.0 REFRIGERANT PIPING

a. All refrigerant pipes and fittings shall be hard drawn copper tubes and wrought copper / brass fittings suitable for connection with silver solder / phos-copper.

b. All joints in copper piping shall be sweat joints using low temperature brazing and / or silver solder. Before joining any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using carbon dioxide / nitrogen.

c. Refrigerant lines shall be sized to limit pressure drop between the evaporator and condensing unit to less than 0.2 kg per sq.cm.

d. Sight glass with moisture indicator and removable type combination dryer cum filter with MS housing and brass wire mesh / punched brass sheet shall be installed in liquid line of the refrigeration system incorporating a three valve by pass. After ninety days of operation, liquid line drier cartridges shall be replaced.

e. Horizontal suction line shall be pitched towards the compressor and no reducers shall be provided for proper oil return.

f. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using Freon mixed with nitrogen / carbon dioxide at a pressure of 20 kg per sq. cm (high side) and 10 kg per sq. cm (low side). Pressure shall be maintained in the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm of mercury and held for 24 hours. Vacuum shall be checked with a vacuum gage.

g. All refrigeration piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturer.

3.0 DRAIN PIPING:

3.1 All pipes to be used for cold water (makeup) drain, condensate drain and fittings shall be MS class 'C' (medium class) conforming to relevant BIS Codes.

3.2 All jointing in the pipe system shall be by screwed / welded joints & / or by screwed flanges using rubber insertion gaskets. Pipe threads and flanges shall be as per relevant BIS Codes.

3.3 All pipes supports and nuts and bolts shall be mild steel, hot dip galvanized / painted with synthetic animal paint.

3.4 Fittings shall be galvanized steel 'medium class' malleable casting of pressure rating suitable for the piping system. Flanges shall be of approved make. Supply of flanges shall include bolts, nuts, and gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connection shall be through equal or reducing tees. All equipment and valve connections or connections to any other mating pipes shall be through flanges required for the mating connections.

3.5 All condensate drain piping shall be insulated and painted as per the section "Insulation" if indicated in Bill of Quantities.

3.6 After the piping has been installed, tested and run for at least three days of eight hours each, all exposed & uninsulated piping shall be given two finish coats, of approved colour, conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows. For painting of insulated and clad pipes refer to insulation section.

4.0 SHEET METAL WORK:

4.1 Codes And Standards

Ducts shall be made of Aluminum sheet & confirm to IS: 655.
Aluminum sheet shall confirm to IS: 737. The duct construction shall be as follows:

4.2 Rectangular G I duct construction:

MAX. SIDE	THICKNESS-G AL	TYPE OF JOINT	BRACING

Up to 750	22	25 mm QSS flanges	None
751 to 1500 MS angle	20	25 mm x 3 mm MS angle flange.	25 mm x 3 mm
1501 to 2250 MS angle	18	40 mm x 3 mm MS angle flange.	40 mm x 3 mm at 1.25 m centers.
2251 & above MS angle	16	40 mm x 3 mm MS angle flange.	40 mm x 3 mm at 1.25 m centers.

4.3 Hangers for G I Duct:

Supporting Details for Ducts are given below			
Larger Side of Duct mm	**Support Channel mm**	**Vertical Rod Dia mm**	**Maximum Spacing between supports mm**
0-400	27x18x1.2	M8	2400
401 – 1000	38x24x2	M8	2400
1001 – 1250	38x24x2	M10	2400
1251 – 1600	38x40x2	M10	2400
1601 – 1800	38x40x2	M10	2400
1801 – 2000	40x60x3	M12	2400
2001 – 2500	40x60x3	M12	2400
2501 mm and above	40x80x3	M16	2400

4.4 Aluminum Duct Installation:

All ducts shall be fabricated and installed in workman like manner, generally confirming to IS: 655: 1963 updated. Round duct shall be die- formed for achieving perfect circle configuration.

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

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

Changes in the 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.

Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and adequately supported where required standing seams, teas, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed of 16 G Aluminum, 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 45 cm x 45 cm in size.

Plenums shall be panel type and assembled at the site. Fixing of MS angle, iron flanges on duct pieces shall be with rivets heads from inside and riveting shall be done from outside.

Rubber lining 6 mm thick shall be used between duct flanges instead of felt, in all clean room ducting installations.

The contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of this specifications and drawings. The work shall meet with the approval of the engineer In-charge at site in all it parts and details.

The contractor shall make all necessary provisions and allowances to avoid beams or other structural work, plumbing or other pipes, and / or conduits, the ducts shall be transformed, divided or curved to on a side, (the required area being maintained) all as per the site requirements.

If a duct cannot be run as shown on the drawings, the contractor shall install the ducts between the required points by any path available, in accordance with other services and as per approval of site engineer.

All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported by providing support channels made up of aluminum. The threaded rods should be made up of partially annealed medium carbon steel of grade 4.8 strength class or greater.
The Duct supports should be designed by a qualified engineer/manufacturer and valid Load calculations should be submitted for approval.

Ducting over ceiling shall be supported from beams using beam clamps for ducts running perpendicular to the beams and girder cleats for ducts running parallel to the beams, A relevant approval of site engineer is required for the same. All connections to the beam for supports should be FM Approved or UL Listed of VDS Approved. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling.

Where metal ducts or sleeves terminate in woodwork, tight joints shall be made by means of closely fitting heavy flanged collars. Where ducts pass through brick or masonry openings, wooden frame work shall be provided within the opening and crossing of ducts provided with heavy flanged collars on each side of the wooden frame work, so that duct crossing is made leak - proof.

All ducts shall be totally free from vibration under all conditions of operation. Wherever duct work is connected to fans / air handling units or blower coil units that may cause vibrations in the ducts, ducts shall be provided with two flexible connections, located close to the unit, in mutually perpendicular directions, flexible heavy canvas sleeve at least 10 cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation and shall be of approved make.

4.5 Dampers:

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 the service required.

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 ducts. Every damper shall have an indicating device clearly showing the damper position at all the times.

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.

4.6 Fire dampers:

All supply and return air ducts at AHU room crossing and at all floor crossings shall be provided with approved make Motorized fire dampers of at least 2.0 hour fire rating.

Fire damper blades shall be single / multi piece folded high strength galvanized steel construction. In normal position, these blades shall be gathered and stacked at the frame head, providing maximum air passage and preventing passing air currents from creating noise or chatter. The blades shall be held in position by solenoid valve. All fire dampers shall be smoke sensor actuated and solenoid valve operated. Ionization type smoke sensors shall be provided in the return air paths.

In case of fire, the intrinsic energy of the folded blades shall be utilized to close the openings. The thrust from closing of the damper shall operate a limit switch mounted in the bottom frame of fire damper

within the duct. Closing of this limit switch shall cut off the power supply to the AHU fan. Stopping all air flow instantaneously. No hinges or blade linkages shall be permitted which may give way under heat or air pressure. The thrust of suddenly released tension shall instantly drive the blade down and keep it down without the use of springs, weights or other devices subject to failure.

Fire damper sleeves and access doors shall be provided within the ducts in accordance with the manufacturers recommendations.

The contractor shall also furnish to the owner, the necessary additional spare solenoid valve, as recommended by manufacturer, at the time of commissioning of the installation.

4.7 Supply and Return Air Registers:

Supply and return air resisters shall be of anodized Aluminum section construction with individual adjustable bars as shown on drawings and indicated in Bill of quantities. Supply air register shall be generally double deflection type, with removable key operated volume control dampers. Return air resisters shall be generally similar to supply air resister but without dampers. All supply and return resisters behind wooden grilles shall be single deflection type with one-way bars only, the supply air resisters being provided with removable key operated volume control dampers.

All resisters shall be selected in consultation with site engineer. Different spaces shall require horizontal or vertical face bars and different width of margin frames.

All resisters shall have a soft, continuous rubber gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers shall not be less than 75 % of gross face area.

Resister shall be adjustable pattern as each grille bar shall be pivot able to provide pattern with 0 to ± 50° horizontal arcs and up to 30° deflections downwards. Bars shall hold deflection settings under all conditions of velocity and pressure. Excluded Aluminum registers shall have fixed bars.

Set-back vertical members of approved thickness shall reinforce bar longer than 45 cm.

4.8 Supply And Return Air Diffusers:

Supply and return air diffusers shall be of approved make as shown on the drawings and/or indicated in the Bill of quantities.

Round or Rectangular Diffuser: Shall be anodized Aluminum section construction, square, rectangular, or round diffusers with flush fixed pattern. Diffusers for different spaces shall be selected in consultation with site engineer. Supply air diffusers may be equipped with fixed air distribution grids, removable key operated volume control dampers, and anti-smudge rings as required in specific applications. all as per requirements of Bill of quantities.

Linear Diffuser: Shall be anodized Aluminum section construction, one or two-way blow linear diffusers. Supply air diffusers shall be provided with volume control / balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with site engineer and provided as per requirement of Bill of quantities. All linear / square / round diffusers shall have volume control dampers of MS construction.

4.9 Method of Measurements for Air Distribution System

Sheet Metal work:

Duct Length shall be measured along the center line from flange face to face unless otherwise stated. Ductwork shall be measured on the basis of external surface area (length as measured above, multiply by duct perimeter) of ducts including the joints for each duct section. Duct measurement shall be taken before application of the insulation. For taper section average perimeter shall be used for measurement. For special pieces like bends, reducers, branches, and collars, mode of measurement shall be identical to as described above using the length along the center line. The quoted unit rate for external surface of

ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles, and angles/flats with double nuts for supports, felt strip between duct and support, vibration isolation, 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. These accessories shall not be separately measured nor paid for.

Duct Accessories: Shall be measured by the cross section area perpendicular to air flow.

Grilles and diffusers:

Width multiplied by height, excluding flanges. volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

Diffusers: Cross-section area for airflow at discharge/capture area, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

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.

Fire Damper: Shall be measured by their 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, solenoid valves etc. No special allowances shall be payable for extension of cross section outside the air stream.

Flexible connection: Shall be measured by their cross sectional area perpendicular to the direction of airflow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.

4.10 Testing & balancing:

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

The entire air distribution system shall be balanced using 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 balance report shall be submitted along with the completion documents.

5.0 FLEXIBLE DUCT:

5.1 General:

The scope of this section comprise supply, installation, testing and commissioning of flexible ducting conforming to these specifications and in accordance with requirements of drawings and schedule of quantities

5.2 Duct Materials:

Un Insulated Flexible duct

Wherever specified, uninsulated flexible duct shall be made of double lamination of metalized polyester film permanently bonded to a coated spring steel wire helix. Duct shall be in tear and puncture resistant construction.

Insulated Flexible Duct

Wherever insulated flexible duct are specified inner core for the same should be made of double lamination of polyester film permanently bonded to a coated spring steel wire helix. Blanket of fiber glass insulation of R 3.6(RSI - 0.64 m2K/W) having density of 16 kg/Cu.meter and thickness of 25 mm shall be wrapped over the inner core & covered with tear and abuse resistant outer jacket cum vapor barrier made of fiber glass reinforced double layer of metalized polyester film laminate.

5.3 Installation:

Care must be taken to install all the flexible duct in fully extruded position and bends made with adequate radius as per manufacturer recommended practices.

Hangers and Supports

The flexible duct must be installed fully extended to produce optimum results.
The maximum allowable sag, between any two adjacent suspension points, should not exceed 50 mm per meter.

The distance between any two adjacent suspension points may vary from 1.50 to 3.00 meter, depending upon the type of flexible duct in use.

Flexible ducts mounted above suspended ceiling should always be independently supported. Ducts mounted in these locations are susceptible to damage whenever ceiling panels need to be periodically interchanged, unless they are separately supported

Bending Radius

All bends should be made as large as possible and should have a radius of not less than the diameter of the duct in use. This reduces un-favorable pressure losses and is particularly important for metal-based products which are more susceptible to stress rupturing. Double bends should be avoided, however if un-avoidable, ensure that each radius is not less than R = 2 x D.

Straps

Ideally the hanging straps should support the flexible duct with a minimum of half the circumference surface in contact, and without reducing the effective inside diameter of the duct. It is also recommended that the minimum width of material to be used for the hanging straps should be at least 25 mm.

Flexible Duct to Conventional Duct Connection

Extra care should be taken when making connection to fixed conventional ducts, etc., and ensure that they do not become too stressed. An additional support is recommended to obviate this potential problem.

Metal based flexible duct products are particularly prone to fracturing due to stress caused as a result of sharp connection.

Connections to ceiling illumination "troffer boxes" should be served in the most direct manner similar to that described for conventional ducts.

Too many bends, when connecting to "troffer boxes" and / or any other type of air supplying component, may result in excessive pressure loss and the generation of noise.

Longer Length Installation

In the event where extreme length of flexible duct is to be installed, round duct connectors made of galvanized sheets of at least 30 cm long should be used to connect the duct at every distance of 10 meters. Use metal or galvanized hangers as recommended (point 3) to support the point where connections are made. Light railing is a good alternative hanging support when using long length of flexible duct.

Direct Contact

It should be emphasized that the flexible duct must not be in direct physical contact with un-insulated heating or hot process pipes. If in the event where such situation can not be avoided, additional 1" thick insulation should be wrapped around pipes that are in contact with the duct

6.0 INSULATION:

6.1 Scope:

The scope of this section comprises the supply and fixing of insulation conforming to these specifications and in accordance with requirement of Bill of quantities.

Material:

Insulation material shall be Nitrile Rubber – Class O

Closed Cell Elastomeric Nitrile Rubber Insulation material shall have anti-microbial product, which is EPA approved, as an integral part of insulation that cannot be washed off or worn off, which does not allow the microbes to function, grow and reproduce. Microbiological growth on insulation surface should confirm to following standards: Mould Growth – UL 181; Fungi Resistance – ASTM G21/C1 338 and Bacterial resistance – ASTM G 22. Density of Material shall be between 40 to 60 Kg/m3.

Thermal conductivity of Elastomeric Nitrile rubber shall not exceed 0.033 W/m°K at an average temperature of 0°C. 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. Water vapour permeability shall not exceed 1.74 x 10-14 Kg/m.s.Pa, i.e. Moisture Diffusion Resistance Factor or "μ' value should be minimum 10,000.

Thickness of insulation shall be as specified for particular application or as specified in Bill of quantities. Samples of insulation material shall be submitted for approval and shall be tested for thermal conductivity values. Adhesive used for setting insulation shall be cold setting compound non-flammable, vapor proof adhesive, shalimar CPRX compound or equivalent approved make.

6.2 Duct Insulation:

a. Duct acoustic Lining

Internal Acoustic lining for ducting is proposed (discharge duct) with 19 mm thick Arma sound material.

Acoustic duct lining shall be applied inside the duct for a minimum distance of 3 meter or as shown in the drawing from the outlet of air handling units or as specified in drawings or as indicated in Bill of quantities. Acoustical duct lining shall be applied as follows:

i) The inside surface of the duct shall be cleaned and covered with cold setting adhesive compound.

ii) Depending on size of duct fit min. 2 or more rows of insulation fixing pins to each face of duct at every 300 mm center distance. Pins shall be self-adhesive, bond on type.

Carefully position insulation over the pins, pressing firmly so that pins penetrate through the insulation. Fit spring clip or lock washer over pins pushing them down until they are tight against insulation. Snip off any excess shank from pin. Seal all joints and openings with self-adhesive tape.

iii) Depending on size of duct fit min. 2 or more rows of Mechanical fasteners (G.I Bolts) of sufficient length to each face of duct at every 300 mm center distance. Pins can be self-adhesive type, bond on type.

Carefully position insulation over the bolts, pressing firmly so that bolts penetrate through the insulation. Fit G.I nut over the bolts pushing them down until they are tight against insulation. Snip off any excess shank from bolt. Seal all joints and openings with self-adhesive tape.

iv) The inside surface shall be covered with fiberglass tissue paper and 26 gauge perforated aluminum sheets having at least 15 percent perforation.

v) The aluminum sheet shall be screwed using cup washers. And neatly finished to give smooth inside surfaces. Use of nails shall not be permitted.

vi) The aluminum perforated sheet shall be screwed along with G.I nut to give smooth inside surfaces.

vii) All Meeting Rooms, Training Rooms, Conference Rooms, Well area & Executive Dining area return air duct will be acoustically insulated.

b. Duct thermal insulation:

Thermal insulation shall be applied over external surface of duct as per following procedure:

With Nitrile Rubber of thickness & density as per BOQ.

Duct surfaces shall be thoroughly cleaned and joints shall be made air tight.

Apply a thin layer of tar paints of Rubber Adhesive, Adhesive shall be applied on all side of duct.

Fix the insulation of specified thickness over the surface of the duct tightly before adhesive dries out.

All transverse and longitudinal joints shall be sealed with 40 mm wide Adhesive tape.

6.3 Drain Pan Insulation:

If insulated drain pan is not part of the AHU, then drain pan shall be insulated as under:
25 mm thick Nitrile Rubber shall be applied over the surface with help of cold setting adhesive.

6.4 Acoustic Insulation of AHU Room:

Walls and ceilings of AHU rooms shall be provided with acoustic insulation; further the return air volume within the truss areas for each AHU return path shall be isolated with Acoustic insulation. The procedure shall be as under:

Fix 25mm x 25mm (if specify in BOQ 50mm x 50mm) wooden battens, treated with solegnum and fire resistant paint, at 600 mm centers to the wall and ceiling by means of row plug and brass screws.

Fix one layer of 25mm (if specify in BOQ 50mm) thick resin bonded fiber glass between battens with cold setting adhesive compound.

Entire insulation shall be covered with fiber glass tissue paper.

Fix 3 mm thick perforated hard board sheets with round headed brass screws over the entire insulation surface taking care to fix the sheet on solegnum treated wooden battens. If specified in Bill of quantities, 26 G perforated aluminum sheets, having 15 % perforation shall be fixed over insulation surface with round headed brass screws taking care to fix the sheet on wooden battens. Overlapping of aluminum sheets shall be covered with aluminum strips.

Acoustical lining of walls shall be terminated approximately 150 mm above the finished floor to prevent damage to insulation due to accidental water logging in plant/AHU rooms.

Protective Coating shall be a flexible, fire resistive fungicidal resistant compound suitable for vapor sealing insulated ducts and pipes.

Protective Coating shall be suitable for indoor / outdoor use and sustain in high humidity environments.

Water vapor presence shall not exceed 0.932 metric perms at 1.3 mm dry film thickness when tested in compliance with ASTM E 96.

When tested for surface burning characteristics in compliance with ASTM E-84, flame spread shall be 5 and smoke developed 10 and complies with ASTM 4804 for flammability resistance.

Protective Coating shall be UL classified and should conform to UL 723 for surface burning characteristics.

The Protective Coating should conform to ASTM D 5590 standard for fungal resistance.

Protective Coating shall be available in color matching the design or façade requirement and UV resistant.

The Protective Coating should be easy to apply with brush.

Third Party Test Certification must be furnished by the Manufacturer to substantiate the claims.

6.5 Under Deck Insulation:

Under deck Insulation of the exposed roof shall be carried out with xx mm Extruded Poly Styrene Board having following Thermal insulation characteristics:

Insulation material technical specifications: Light weight self-extinguishing Expanded polystyrene boards

Material: Expanded Polystyrene (EPS) boards
Thickness: 50 mm
Density: 32 kg/m^3

- Insulation material should have density 32 kg/m^3.
- Insulation material shall have maximum thermal conductivity (k-value) 0.034 W/m K at 10°C mean temperature in accordance with testing standard ASTM C-518.
- It shall have minimum thermal resistance (R-value) 8.35 hr ft^2 °F/BTU at 10°C mean temperature.
- It shall have water absorption less than 0.5 %.
- Material shall have minimum compressive strength 1.4 kg/cm^2 as per IS 4671.
- Material shall have minimum cross breaking strength 2.2 kg/cm^2 as per IS 4671.

Application:
- Clean the surface to be insulated.
- Apply 50 mm thick Expanded Polystyrene boards under the slab with the help of G.I wire, screw washer & necessary mechanical accessories.

6.6 Method of Measurement for Insulation:

Measurement of duct, piping, equipment, plant room and false ceiling insulation shall be taken as per following basis.

All duct thermal insulation and acoustic duct lining shall be measured on the basis of prime surface area (bare duct surface area), excluding all openings for grilles and diffusers and including all flanges, dampers etc. Thus the surface area for thermally insulated duct as well as acoustically lined duct shall be equal to perimeter (comprising outer width and depth of bare duct to be insulated) multiplied by centerline length of duct including all tapered pieces, tees, bends, branches etc. Support structure required for the ducting support will not be considered as an extra. Acoustic insulation of AHU and A.C. plant room shall be measured on the basis of finished surface area.

Insulation covering above insulation:

a. Self-bonded olefin sheet – Outdoor area (Service Area/Mezz. Area/Shaft)

Material	:	Self-Bonded olefin sheet
Color	:	Silver White
Reflectivity :	0.92	

- It shall have backing of moisture protective metalized foil.
- Insulation material shall have a total Unit Weight 67.58 g/m2.
- Insulation material shall have Thickness 150 µm.
- Insulation material shall have Melting Point/Range of 135 °C.

b. Glass Cloth – Inside area

Material	:	Acrylic based woven fiberglass fabric made from E glass (self-adhesive)
Color	:	Black / Blue / Red / Gray
Thickness	:	0.19 mm ± 0.02

- Insulation material shall have a total mass 280 GSM ± 5%.
- Insulation material shall have PSA mass 50 GSM ± 5%.
- Insulation material shall have base fabric mass 225 GSM ± 5%.
- Insulation material shall have resistance to Thermal / Fire / Chemical / Electrical.
- Insulation material shall be dimensionally stable.

7.0 CENTRIFUGAL FAN :

7.1 Scope:

The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specification and in accordance with the requirement of bill of quantities.

7.2 Centrifugal exhaust air fan:

A. Type :

Centrifugal fan shall be SWSI class I construction arrangement 3 (i.e. bearings on both sides) or as specified in BOQ complete with access door, squirrel cage induction motor, v-belt drive, belt guard and vibration isolators. Type, direction of discharge/rotation and motor position shall be as shown in the drawing and/or in the bill of quantities.

Centrifugal shall be Double inlet Double width (DIDW) / SISW as the case may be class-I centrifugal and vibration isolators Discharge arrangements. The fans shall be a self-contained unit comprising of motor, belt drive/direct drive arrangement in suitable factory fabricated acoustically treated housing. The efficiency of fans at operating conditions should be more than 75%.

B. Housing:

Housing shall be constructed of 14 gauge sheet steel welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene/asbestos packing shall be provided throughout split joints to make it air tight. 18 gauge wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard clean out door with handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

C. Fan wheel:

Fan wheel shall be backward – curved non-overloading type utilizing hollow sectioned aerodynamically shaped aerofoil blades. Fan wheel and housing shall be statically and dynamically balanced. For Fans up to 450 mm dia., fan outlet velocity not exceed 1450 rpm. For Fans above 450 mm dia., the outlet velocity shall be within 700 meter/minute and maximum fan speed shall not exceed 1000 RPM. High static pressure fan speed shall be as per manufacturer.

D. Shaft:

Shaft shall be constructed of steel, turned, ground and polished.

E. Bearings:
Bearings shall be of the sleeve/ ball bearing type mounted directly on the fan housing. Bearings shall be especially designed for quiet operation and shall be of the self-aligning, oil/grease pack pillow block type.

F. Motor:

Fan motor shall be TEFC, Squirrel cage, induction motor, with IP-55 protection and class 'F' OR equivalent insulation as per particular application. Motor shall be suitable for 415± 10% volts, 3 phase, 50 cycles, and A.C. supply. Motor shall be of continuous duty and specially designed for quiet operation and motor speed shall not exceed 1450 rpm. Motor nameplate horsepower shall exceed brake horsepower by a minimum of 10%. The fan and motor combination selected for the particular required performance shall be of the most efficient (smallest horse power), so that the sound level is lowest.

G. Drive:

Flexible coupling with guard shall be provided if fan- motor arrangement is direct drive type if specified in bill of quantities. 'V' belts and pulleys shall be provided if fan-motor arrangement is variable drive type. Belt guard with vent shall be provided for belt protection and heat dissipation.

H. Vibration Isolation:

M.S. base shall be provided for both fan and motor, built as an integral part, and shall be mounted on a concrete foundation through spring isolators. The concrete foundation shall be at least 150 mm above the finished floor level.

8.0 CENTRIFUGAL CABINET EXHAUST AIR FAN:

8.1 Scope:

The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specification and in accordance with the requirement of bill of quantities.

8.2 Centrifugal Cabinet Exhaust Air Fan

Application/ Location as per Layouts and Selection as per Tender annexure

Specifications same as FFU above but shall be without Filters

- Kitchen Exhaust Fan:

The fan for kitchen exhaust shall be backward inclined curved impeller type with self cleaning properties. It shall have limit load characteristics. The motor drive train shall be kept outside the air stream. Casing for Fan shall be made of Al extruded PUF insulated panels.

9.0 DRY SCRUBBER:

Equipment Description

The Industrial Electronic Air Cleaning System shall be supplied as a one-piece factory joined assembly of individual section(s) selected to treat oil mist, smoke, fume, grease & dust/ powder problem.

9.1 Unit Housing:

Housing shall be 1.2mm thick cold steel construction & powder coated to protect against rust and corrosion. It shall have a single hinged door for cell access, located one side of the unit. The door shall be gasketed to prevent air leakage. There shall be a safety interlock switch to cut off primary supply when the access door is opened.

9.2 Finish:

The external finish shall be a durable industrial grade semi gloss epoxy coating.

9.3 Ionizing – Collecting Cells:

Ionizing-Collecting cell(s) shall be of one-piece construction 13.38" (340mm) deep in direction of airflow. The dimension of the collection cell shall be 18.89" (480mm) H x 21.65" (550mm) W Max. All support framing, end plates and ionizer ground electrodes shall be 0.090 inch (2.2mm) thick aluminum. Both repelling and collector plates shall be 0.032 inch (0.8mm) thick aluminum alloy material rigidly retained in place with tubular spacers and tie rods. Each plate shall be corrugated, perpendicular to airflow direction. Spacing between plates shall be no less than 0.318 inch (8mm). Each cell shall weigh at least 14 kg with at least 8 ionizing wires.

UNIT SHALL BE SELECTED SUCH THAT THE FACE VELOCITY ACROSS THE ESP CELLS DOES NOT EXCEED 3.2 M/S & MINIMUM COLLECTION AREA SHALL BE 2.1 SQM/1000 CMH.

9.4 Ionizer:

Ionizing electrodes / wires shall be of tungsten material, rigidly supported both vertically and laterally. Ionizing electrode to ground electrode spacing shall be 1.0" (25mm). High voltage support insulators shall be of Teflon material, glazed to enhance dielectric strength and retard tracking.

9.5 Air handling Capacity:

Each Ionizing / Collecting Cell shall be capable of handling up to 2500cmh of air. There shall be one or two such Ionizing / Collecting Cells per module. handling up to 2500 cmh & 5000cmh per module respectively.

The rated efficiency shall be up to 95% based on the **NIOSH 5026 OIL MIST TEST-4.0**

9.6 Power Supply:

Power supplies shall be 100% solid state, operate on 240 VAC, 50 HZ, 1 Phase input and provide a dual high voltage output of 12 to 13 KVDC for the ionizer and 6.0 to 6.5 KVDC for the collector in normal operation conditions. Current output at the high tension shall be 12mA. A

maximum power output for the solid state power supply shall be 120 watts to maintain the specified collection efficiency. Integrally mounted Electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power. The power supply shall operate over a temperature range of -32 degrees F to 140 degrees F, be overloaded self-protecting and accommodate an LED lights indicating the performance status of the ionizing/collecting cell. High voltage output components in the power supply shall be sealed with epoxy for moisture resistance.

9.7 Outstanding Features:

The power pack shall incorporate a short circuit arc protection with automatic power restoration system to prevent overload.

9.8 Performance Indicator:

There shall be 2 LED lights (Green & Red) installed on the access door of the unit to indicate the status of the air cleaning system.

9.9 BMS (Building Management System) interface:

The power supply (pack) shall have a 3 wire dry contacts (NO/NC) for remote link to Building Management System. This is for performance indication of the air cleaning system.

9.10 Electrical:

Factory wiring will be in accordance with the National Electrical Code. Required field wiring shall conform to the National Electrical Code and any local code requirements. The manufacturer shall be informed of any local variances to the National Electrical Code.

10.0 AIR WASHER UNIT:

10.1 General:

Direct cooling system includes components of evaporative media, re-circulating pump, sump drain, overflow, automatic fill and level control and internal piping. House all components in a common casing.

Exterior panels shall be removable to permit access to any interior component.

The unit will be sectionalized double skin construction made out of 0.63mm white pre-coated GI outer skin, 0.63mm GI inner skin, 23+/-1 mm CFC free PUF Insulation to density of 38-42Kg/m3. The structural construction shall be extruded aluminum profile.

The skid will have necessary cross members to take care of the load of fan blower assembly. All the components of the unit will be of proper design and quality to ensure vibration free and noiseless operation.

- **Filters**

The filters shall comprise of HDPE filters of cell/box type construction with 85% efficiency down to 20 or 10 microns. The filters should be slidable and washable.

Pre-coated Louvers should be provided for outdoor installation units.

- **Re-Circulation pumps**

The recirculation pump should be of SS 304 submersible type and of approved Ebara make. The pump should be designed such that it can handle the designed amount of water flow and maintain required head. The pumps should be designed such that pump shaft horsepower (BHP) shall not exceed motor rated horsepower throughout the entire operating range of the pump performance curve. Pump shall be built to operate.

The pump shall be furnished with a non-mechanical double oil seal.

The pump motor shall be minimum 1/3HP, 0.3 Kw, 230 Volts, 50 Hz single phase motor. The motor shall be supplied with built-in thermal protection with automatic reset and shall be rated for continuous duty.

- **Piping**

All internal piping shall be of UPVC.

- **Direct Evaporative Media**

The media shall be celdek with Thickness of 200 mm in case of 7mm flute. The water tank shall be made up of 18SWG (1.2mm) thick SS 304 plain sheet to house adiabatic heat exchangers.

The water tank shall be designed as chassis to hold the heat exchangers support system. The water distribution system shall be designed properly to get proper efficiency across the heat exchangers. The piping shall be used of rigid UPVC material. Piping connections should be made so as to ensure uniform distribution of water. The sump shall be fitted with float valve.

- **U-V Filter**

Provide UV filter for re-circulation line.UV filtration controls the bacterial disinfections in the supply water line thereby restricting the growth of algae and fungus. The capacity shall be based on the flow rates of individual machines.

10.2Blower Section:

The blower section shall include AMCA certified centrifugal Backward curved DIDW fans. The unit shall be of GI construction. It shall have individual motor and drive and shall be mounted on C channel frame and cushy foot mounts. The fan shall be constructed and rated based on the delivery against the rated static pressure with the media and filters in place. The fan shall be of riveted construction and made with GI sheet of required thickness. The fan wheels shall be of multiblade type and mounted on two self alignining pillow block bearings of required size. The fan shall be run with the help of 'V' groove drives as per the recommendation of the drive supplier. The blower housing shall be made of machine made roll formed Pittsburgh joint construction and the drive shall be provided by a motor of required capacity.

10.3Motor:

Motors shall be IE2 (EEF-1) type of ABB/Siemens/BB approved make.

10.4Control Panel:

Panel shall be Non - Compartmentalized panel and should have RYB indication -Indication lamps, Incomer-SFU/MCCB Blower/Pump controls- Thru' -MPCB. Contactor with OLR. Digital display-VAF meter, ATE-PLC - for logic control.

It should have both Auto and Manual mode. It should have light indicator with push buttons for each component i.e. Primary fan and Pump that shows On – Off – Trip status.

11.0 TUBE AXIAL FLOW FAN

11.1 SCOPE:

The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specifications and in accordance with the requirement of bill of quantities.
Tube Axial Fans are suggested for Ductless Car Park Ventilation. Axial Fan shall be adjustable pitch blade type having non-overloading feature. Fan shall comprise of following components.

Capacities: Fan capacities shall be as per the schedule shown in Tender BOQ

Fan: Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

Casing: shall be constructed of heavy gage sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 20mm thick and machined to receive motor flange.

An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.

Rotor: hub and blades shall be cast aluminium or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual airflow values, as specified and quoted.

Motor: shall be energy efficient, squirrel cage, thermally enclosed, fan cooled, standard frame, continuous duty, single winding/ Dahlander winding (for dual speed applications) type suitable for 400V/3 Ph/ 50Hz , AC power supply provided with class F insulation for normal operations and H class for smoke exhaust application , IP55 in accordance with EN 60034-5/IEC 85. Motor Kw must be higher than Bkw by minimum 10-15%.

The speed of the fans shall not exceed 1440 RPM for fans with impeller diameter above 450 mm, and 2880 RPM for fans with impeller diameter 450 mm and less. For lowest sound level, fan shall be selected, for maximum efficiency or minimum horsepower. Motor shall be specially designed for low noise operation. Fan sound level shall not exceed 75 dBA at 1 m distance from the unit. Fan attenuators shall be provided after acoustic assessment to achieve the specified noise level within occupied areas. The motor bearings should be life lubricated and completely maintenance free and can be used at any installation position at indicated maximum temperature of transported air. The life expectancy of the bearing should be at least 40000 hours (L10)

Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

Where axial flow fans of bifurcated type are indicated, the motors shall be out of the air stream.

Minimum fan efficiency shall be 65%.

FAN shall be direct driven to have less losses in transmission mounted on extended motor shaft of carbon steel material.

Drive: To fan shall be provided through direct or belt drive; belt drive shall be with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of oil-resistant type.

Vibration Isolation: The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of rubber-in-shear type OR Mounted flush with the wall with proper isolation to avoid transmission of vibrations to the wall and structure.

12.0 PROPELLER FAN UNIT:

12.1 Scope:

The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specification and in accordance with the requirement of bill of quantities.

12.2 Propeller Fan Unit :

Application/ Location as per Layouts and BOQ

These fans shall be of single phase type and installed for
Propeller fans shall be of approved make in tender, direct-drive, three or four-blade type mounted on a steel mounted plate with orifice ring to deliver as per duty points.

Please refer tender bill of quantities for duty point and quantities as applicable.

Mounting Plate
The mounting plate shall be constructed of 12/16 gauge sheet steel, depending upon the fan size and finished with baked enamel paint of approved shade. The mounting plate construction shall be of streamlined venturi inlet type (reversed for supply application). Orifice ring shall be correctly formed by spinning or a stamping to provide easy passage of air without turbulence & to direct the air stream.

Fan Blades

Fan blades shall be constructed of aluminum or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades shall be quiet in operation and shall be statically and dynamically balanced at the factory.

Shaft
Shall be of steel (EN 8), accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed through the full range of specified fan speeds.

Motor
Shall be standard energy efficient (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 750 RPM and. will be suitable for 415 +/- 10% volts, 50 cycles, 3 phase supply and shall be suitable for either horizontal or vertical service, as indicated on drawings and BOQ.

Accessories
The following accessories may be required and provide with propeller fans as indicated in the BOQ:

Wire guard on inlet side and bird screen at the outlet.
Fixed or Gravity operated steel louver shutters built into a steel frame.

Regulators for controlling fan speed for single phase fan motors.
Single phase preventers for 3 phase fans

13.0 ROAD TUNNEL VENTILATION:

13.1 System Description and Function and Responsibilities

The contractor shall provide a turn key Road Tunnel ventilation system that is consistent with the scheme as indicated on the drawings. The proposed scheme utilizes Jet fans and CO sensors. The system shall serve both CO evacuation and smoke extract function.

The contractor shall provide a full engineering proposal that includes the following information for review by the Engineer, Architect & EIC.

CFD models for Tunnel allowing 3 numbers runs each for CO and Smoke Extract mode.

Specification, manufacturer's data and performance data for all devices and equipment to be utilized in the system.

Control schematic for operation of the system.

All ancillary devices such as motorized dampers, silencers, smoke detectors, CO detectors, etc. those are required to ensure proper system operation in both the CO and smoke modes.

All necessary devices that are required to interface with the base building systems such as fire alarm detection and BMS etc.

The system principles are as follows: Fully automatic smoke control. Lower the air temperatures during fires. Improved firefighting access. High air movement preventing fire spread. Efficient cross ventilation.

13.2 CO-Detection

The car park ventilation systems shall be controlled by an individual CO-Monitoring system for entire car park located on each level to optimize efficiency. The contactors within the motor control panel shall be controlled by a Carbon Monoxide monitoring panel which shall contain D.D.Cs (Direct Digital Controllers) where the pre-determined switching strategy and logic will be loaded. The CO monitoring panel shall receive signals from CO sensors located throughout the levels at a spacing of no. more than 1 per 350 m2. The 24V AC power supply for the CO sensors shall be mounted in the same panel. The power supply shall be looped across the CO sensors. The proposed CO sensor shall provide a 0-10 VDC signal for measuring the CO level in the car park area.

CO monitoring devices shall be mounted remotely throughout the basement. The devices shall be mounted in accordance with the manufacturer's guidelines but no greater than 1.5 m above FFL.

The contractor should refer to the specific requirements of the sensor supplier for quantities of CO-detectors. The minimum design requirement shall ensure a simple CO-detector covers a maximum area of 350 sqm.

13.3 CO Sensor

The sensor shall be suitable for wall mount & capable of following features:

Digital display of the CO level : 0 to 200 ppm Analog output : 4 to 20 mA Low Voltage operation : 24 VAC / VDC Wall Mount Configurations

Test Switch : Provides mode for system self-test. Automatic Calibration (Field Calibration Kit) Overrange indication.

Start-up mode : steps display and output through test ranges. Operating range : within OSHA range for CO exposure.

Solid – Stat sensor : Life expectancy of 7 to 10 years. Multiple sensors with one power supply.

Carbon monoxide sensor shall comprise of a carbon monoxide meter and a 0-10 VDC transmitter an all-electronic system that utilizes a microprocessor to measure carbon monoxide (CO), calculate various calibration factors and analog output. The sensor shall average samples over a time period and update the output every 2 ½ minutes. The sensor is intended to be used in enclosed basement, where it provides CO data to building automation computers or controllers. A box shall house the sensor and provide an easy-to-mount, study housing for the system.

Sensors shall be mounted on walls or columns about 1500 mm above the floor. Sensors shall be evenly spaced and not put in corners, or directly in front of air inlets. Each sensor must have a cable directly to the control panel.

In addition to above CO-sensor shall comply with following :

Power	24 VAC / VDC @ 150 mA
Measurement range	0 to 200 ppm of CO (4-20 mA)
Electrical class	General Purpose, non-hazardous.

Operating temperature range 0 deg. To 125 deg.F (-18 deg. To 52 deg.C)

13.4 Fire / Smoke Detection

The Road Tunnel Ventilation system shall interface with the fire alarm control panel to receive signals from the detectors.

The Contractor shall be responsible for the full integration of the fire alarm and ventilation control systems.

13.5 Control Panels:

The manufacturers engineered solution shall allow for a stand-alone intelligent PLC control system for both CO monitoring and smoke control. Tunnel shall have individual PLC Control Panel. The PLC control system shall control all exhaust & supply air fans. The broad logic shall be as follows:

PLC based Logic panel shall be provided to receive signals from the Carbon Monoxide Detector panel and the Fire Control Panel which will contain DDC (Direct Digital Controller) to give command to Exhaust and Supply air fans for their operation on the basis of the logic provided to the PLC panel as shown below:-

Condition 1 : Under normal ventilation condition, air shall be drawn through all parts of the basement by the axial fans (operating at low speed) at a rate equivalent to 3 air changer per hours.

Condition 2: When the CO level rise beyond 25ppm the fan shall operate at higher speed to achieve the CO ppm level below 25 ppm.

Condition 3: If the CO level continues to rise to the high limit set value to 50ppm, the extract fans shall operate at high speed to provide a rate equivalent to 6 air changes per hour.

Condition 4: In the event that Smoke is detected in the Tunnel a priority Signal shall be provided by the fire detection panel .

13.6 Performance Data

All fans shall be selected for the lowest operating noise level. Capacity ratings, power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

13.7 Testing

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

A. Performance Data

All fans shall be selected for the lowest operating noise level. Capacity ratings, power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

B. 10.2 Testing

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

13.8 INSTALLATION

i) The Contactor shall supply all required bolts, base frame(wherever required), vibration isolators any other accessories and shall assure that the components are placed securely in proper position.
ii) Vibration isolators shall be provided with an efficiency of not less than 80%.

13.9 TESTING

All the fans shall be tested for performance at the factory and the following test results shall be furnished.

i)CFM
ii)Static pressure at the specified flow rate
iii)KW input to motor

13.10 **Jet Ventilation Fan**

Jet Fans, a part of ductless car park ventilation system, should be supplied as completely assembled before dispatched to the job site having characteristics as of high-performance ventilation with small air volume. Each unit shall consist of fan having inlet cones, protective screen, two silencers, terminal box & mounting arms or brackets.

Fan: Fan shall be axial flow type balanced dynamically and statically. The fans shall have adjustable aluminum impeller or shall be fully welded. The complete fan assembly with its Casing, impeller & motor (not only the motor or one of the items) shall be imported from manufacturer and certified as tested for 300 Deg C for 2 hours operation.

Casing: The Casing of Jet Fans shall be made of Hot Dipped Galvanized Steel with flanges at both ends.

Motor: The Motor shall run on the electrical power suitable for 50Hz. The Type of motor shall be suitable for 2 speed or single speed as specified in the BOQ.

Protective Guards: The fans shall have protection guards at inlet side.

Silencers: Noise level from Jet fan shall not exceed 52 dB(A) at 1 mtr distance. Silencers Casing should be rolled, pre-galvanized sheet steel with spun end rings incorporating tapped inserts for fixing.

Absorbent material used should be of acoustic grade mineral fiber with a layer of erosion resistant facing and must be further protected by a sheet of pre-galvanized perforated steel.

Minimum length of silencers should be 900mm.

13.11 VENTILATION SYSTEM SPECIFICATIONS:

The intent of this document is to specify the systems and equipment's for Ventilation system for basement service areas / car park areas.

The equipment schedule for the same is already provided above; the system shall be designed in accordance with the details provided under various schedules there in.

13.12 CODES AND STANDARDS

- All relevant codes as per BS for underground ventilation design shall be complied by the bidder.
- Duct Construction Standard as per IS :655 and applicable SMACNA Codes for ducting design, fabrication and installation
- NFPA compliance for fire safe HVAC design
- BMC Instruction

The scope of this tender covers design, supply, installation, testing, commissioning and handing over of ventilation system for
a. Basement Car park areas
b. Utility Equipment Rooms

The area, air quantity requirement and the equipment's for the above compliance are mentioned under Schedule 1 and 2 above.

14.0 AIR CURTAINS

14.1 Scope:

The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specification and in accordance with the requirement of bill of quantities.

14.2 Air Curtains

Proposed to trap the Air Conditioned air near entrances opening into AC areas. the Air Curtains shall be installed on the Non AC portion of the entrance/exit doors; the length of the curtain assembly shall exceed the actual width of the OPEN Door Portion for effective entrapment of conditioned air.

Curtains shall be CRCA Powder Coated with suitable color shade, Polymer Suction Grille.

Impellers shall be Aluminum material, statically/dynamically balanced, low noise operation, forward curved driven by Motor of reputed make, 240 V, Single phase and double ended shaft.

Housing
The self-supporting compact unit construction to be made of galvanized sheet steel. The housing and galvanized sheet metal should be of Zink plated (Z275) with a thickness of 35 um. Visible surfaces with high-quality plastic powder coated (polyester powder coating, 60 um) in a subtle gray and white combination of both RAL9016 and RAL7042. A dominant and timeless design, hinged front and front access panel, high-grade aluminum allows integrating technical detail for each input. With M8 nuts, the air curtain is simple and easy to mount on the wall or ceiling. Matching design panels for cable connections are available as accessories for every type of installation. For vertical installations of either single or several air curtains, vertical installation accessories are available for each specific needs and requirement.

Fans

Vibration-free individually driven, double inlet five -stage variable high performance centrifugal fans with external rotor motor for extremely quiet operation, IP 44, with accessible motor protection and thermal contacts with class B insulation and ensure low noise operation. The newly developed sound-absorbing lined air outlet pressure chamber provides the internal air flow for reduced emissions of the engine noise and the formation of a highly effective flow profile.

Inlet grille Integrated and located on top of the unit, not visible from below for hiding dust; guarantees a quiet slipstream.

Outlet grille
The streamlined grey powder coated outlet nozzle rod profiles, are lockable between 0 ° and 30 ° (in and out) and creates and provides a guided, aerodynamic air flow and high shielding effectiveness: Thermo zone Technology.

Electrical connection
The main control connection is mounted and located on the top of the device and easily accessible to its integrated control system and designed are according to ISO 9001:2000.

Control system
The provided control system should be an intelligent and adaptive control system, allowing and operating the installed air curtain with five different fan speed for being energy efficient as possible yet providing the best and most efficient air curtain effect. Including the control system, a calendar program can easily be set and adjusted according to each specific needs for the air curtain of operating without any manual handling. The air curtain can together with included and installed control system be also connected to either 0-10V or Modbus BMS system.

Certification
The air curtain must comply to EN and ISO standards valid for air curtains and tested and approved according ISO standards (ISO 27327-1), EN standards (EN 308; EN 12238; EN 60335) and AMCA standards (AMCA 210; AMCA 220-5; AMCA 300).

15.0 PAINTING - COLOUR CODE.

All **Equipments** shall be supplied with approved finish. Shop coat of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with two coat of synthetic enamel paint. Pump base-plate / piping supports subject to water exposure to be painted with rubber paint using zinc base primer. Water treatment Units to be painted with anticorrosive paint / CGC, as exposed to acid and caustic solutions.

All **sheet steel work** shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be baked in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

All exposed condenser water piping shall be applied with cold galvanizing spray / paint.

15.1 Standard colour code:

The tentative colour code given below shall be followed. However changes if any will be indicated well in advance. All painting colour code shall be approved before execution. No separate payment shall be made for painting work.

Item :	Colour:
▪ Condenser, Pumps, Belt guards	▪ Battleship Grey
▪ Motors	▪ Siemens Grey
▪ Chiller	▪ Dark Blue
▪ AHU	▪ Mulshell Grey
▪ POT Strainers	▪ Grey
▪ B.M Valve / Copper Line	▪ Golden
▪ Gauge Panel / MP panel	▪ Siemens Grey
▪ Chilled water Line –	

In let / Return / & storage tank	▪ Light Blue
Out let / Supply	▪ Dark Blue
▪ All supports / Stands / drain	▪ Black
▪ Condenser water piping	
In let / Return / & storage tank	▪ Light Green
Out let / Supply	▪ Dark Green
▪ Cooling Towers	▪ Light Green
▪ Ducting / Grilles / Diffusers	▪ Approved by DTA

All "Approved shade" shall be duly approved by DTA.

16.0 INSPECTION AND TESTING:

16.1 Inspection (pre-dispatch & site), testing & acceptance

Pre-dispatch inspection shall be carried out for certain items. All the system equipment, parts shall be checked for physical damage, before commencing the installation work. Complete fabrication, installation and commissioning work shall be jointly supervised and shall be carried out as per the specifications and instructions of site Engineer In-charge. All the rotating equipment shall be checked for static and dynamic balancing, minimum operating vibration and noise.

All the system / equipment shall be checked before / after satisfactory commissioning, at manufacturer's works / site as may be required for the approved technical specifications, performance data provided by supplier / manufacturer. Actual capacity of each equipment shall be calculated based on the test readings, recorded jointly, for design conditions / operating conditions. Performance acceptance is subject to comparison of test results with supplier / manufacturer's performance data and contract specification. Acceptance is subject to satisfactory installation, commissioning and performance testing with respect to technical specifications. Rejected items must be replaced or rectified for the defects. In case of system modification / rectification complete performance tests are to be repeated. Site test readings shall be jointly recorded.

In general following Inspection / tests are involved. Type of test, duration of test, testing procedure / parameters, will be as per the applicable BIS codes. However the detail Inspection and test procedure shall be worked out jointly by the purchaser and the contractor along with the approval of drawings, within 30 days from the date of contact agreement.

a. Pre-dispatch Inspection.
b. Pre-dispatch testing at manufacturers shop / factory. (Material, performance, pressure, joints, etc.)
c. Physical Inspection – Pre-installation at site.
d. Performance testing at site (capacity, power consumption, pressure drop, vibration, etc.)
e. Calibration at site.

16.2 Test certificates:

Contractor shall furnish following Test certificates:

- Material testing of various components of the equipment/ system parts.
- Fabrication inspection / test certificates– Radiography and others
- Welder's qualification certificate.
- Performance test certificates carried out by manufacturer before Pre- dispatch inspection & testing.
- Performance test certificates carried out by manufacturer.
- Performance guarantees certificate / calibration certificate
- All equipment operation and maintenance manual.

16.3 Testing The Equipment's at Site:

The following aspects shall be considered for performance testing.

- Prevailing conditions shall be as close as to design conditions.
- Type, quantity, location, frequency, duration of test parameters shall be decided and recorded accordingly during the test.

- Rated capacity, power consumption, and other operating parameters shall be checked.
- Functional test for all Instruments, controls (safety and capacity) shall be carried out to check for the expected operation / action / accuracy / response time / repeatability parameters.

A. Units:
   - Main volts / Amps.

B. Compressor:
   - Refrigerant suction pressure (LP, Bar) / Temp. °C.
   - Refrigerant Discharge pressure (HP, Bar) / Temp. °C
   - Discharge cutout pressure (Bar)
   - Discharge cutin pressure (Bar)
   - Suction cutout pressure (Bar)
   - Suction cutin pressure (Bar)
   - Compressor motor Amp.

C. Cooling Coil:
   - Surface(Face) area - Sq.m
   - Return (entering coil) air Temp. DBT / WBT °C
   - Supply (leaving coil) air Temp. DBT / WBT °C
   - Air velocity across the cooling coil - m/min.
   - Air volume -CMH capacity

D. Air cooled Condenser:
   - Surface (Face) area - Sq.m
   - Air Temp. In - DBT °C
   - Air velocity across the coil - m/min.
   - Air Temp. at Fan outlet - DBT °C
   - Air Temp. at Grilles, Supply Duct outlets - DBT °C
   - Air volume -CMH at Supply Duct outlets
   - Air volume – CMH at fresh air intake

E. Room Conditions:
- Average reading of DBT / WBT °C, at 12-00 PM, 14-00 PM, and 16-00 PM on a test (summer / monsoon) day, shall be recorded to check the inside / room design condition.

17.0 SUPPORT STRUCTURE:

17.1 Support from RCC slab

17.1.1 DUCT SUPPORTS

Description

The Duct should be simply supported by Support Channel made up of cold rolled steel of quality **DX51 or greater and as per EC3 (Eurocode 3) or DIN EN 1993-1-1.**

The Support channel should be **pre galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail.**

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C.**

The Threaded Rods used for the suspension of the Duct should be made up of **partially annealed** medium carbon steel of **grade 4.8 strength class and as per DIN 976 standard.**
The Drop-in anchors used for the suspension of the rods should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

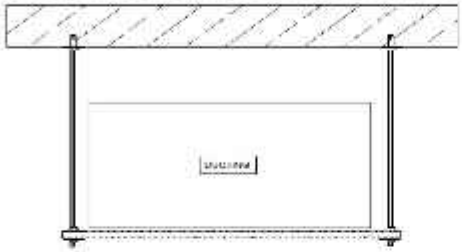
It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load calculations should be as per Finite Element Method for the selection of the channels for suitable size of the duct and should be provided by the contractor to the consultant for verification.

Supporting DETA (European Technical Approval) ils for low pressure systems are given below

Larger Side of Duct mm	Support Channel mm	Vertical Rod Dia mm	Maximum Spacing between supports mm
0-600	27x18x1.2	M8	2400
601-1250	38x24x2	M8	2400
1250-2100	38x40x2	M10	2400
2100 and above	40x60x2.5	M12	2400

Fig.A. Typical Arrangement for Duct Supports from RCC slab



17.1.2 **CHW pipe / ref. pipe support:**

Description

The CHW Pipes should be simply supported by **Split Clamps with rubber support insert.**

Split Clamps should be as per **DIN 3567** pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

Rubber support insert should be made from **EPDM or NR/SBR Rubber**
The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp and rubber support insert should have the temperature capacity of -50 degree Celsius to +150 degree Celsius.

In the case of multiple pipes, the supporting arrangement should be made using support channel made up of cold rolled steel of quality **DX51 or greater and as per EC3(Eurocode 3) or DIN EN 1993-1-1.**

The Support channel should be **pre galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail**.

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C**.

The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of grade **4.8 strength class and as per DIN 976 standard**.

The Drop-in anchors used for the suspension of the rods should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

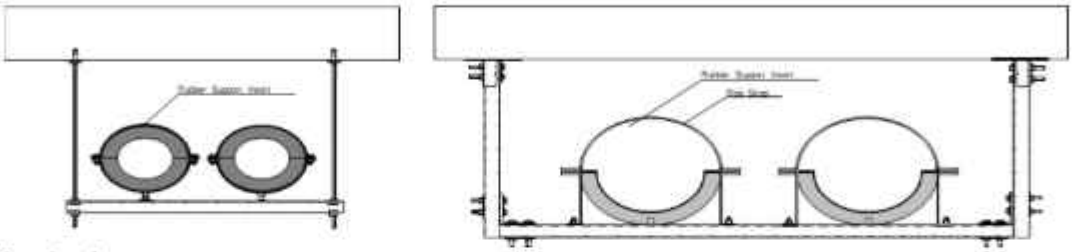
It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load bearing capacity for the selection of the split clamp for suitable size of the pipe should be provided by the contractor to the consultant for verification.

Maximum Support Spacing (m)

Nominal Pipe Dia (mm)	Support Distance (M)	Nominal Pipe Dia (mm)	Support Distance (M)	Nominal Pipe Dia (mm)	Support Distance (M)
Upto 15	1.8	65	3.7	250	5.0
20	2.4	80	3.7	300	6.1
25	2.4	100	3.7	350	10.0
32	2.7	125	3.7	400	10.5
40	3.0	150	4.5	450	11.0
50	3.0	200	5.6	500	12.0

Fig B. Typical Arrangement for Pipe Supports from slab



17.1.3 **Drain pipe support**

Description

The Drain Pipes should be simply supported by **Split Clamps**.

Split Clamps should be pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp should have the temperature capacity of -50 degree Celsius to +150 degrees Celsius.

The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of grade 4.8 strength class and as per DIN 976 standard.

The Drop-in anchors used for the suspension of the rods should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

Maximum Support Spacing (m)					
Pipe Dia (mm)	Support Distance (M)	Nominal Pipe Dia (mm)	Support Distance (M)	Nominal Pipe Dia (mm)	Support Distance (M)
Upto 15	1.0	32	1.0	65	1.2
20	1.0	40	1.0	90	1.4
25	1.0	50	1.1	80	1.5

Fig C. Typical Arrangement for Drain Pipe Supports from slab

17.2 **Support from building shaft**

17.2.1 **DUCT SUPPORTS**

Description

The Duct should be simply supported by Support Channel made up of cold rolled steel of quality **DX51 or greater and as per EC3(Eurocode 3) or DIN EN 1993-1-1**

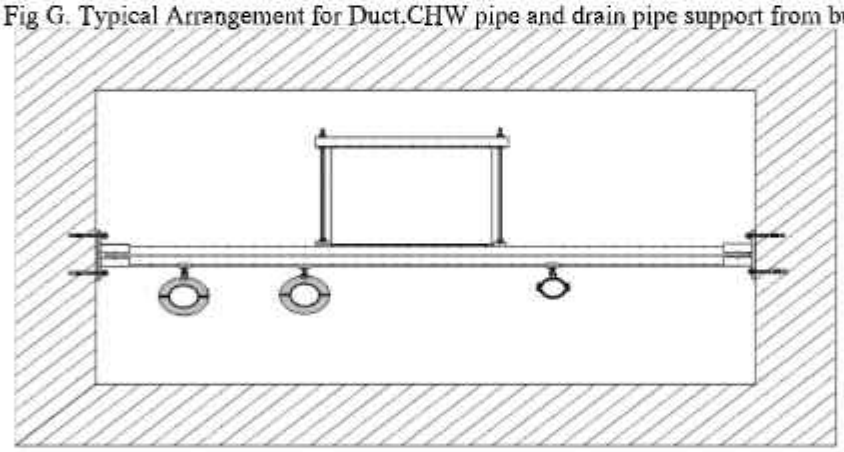
The Support channel should be **pre galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail**.

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C**.
The Threaded Rods used for the suspension of the Duct should be made up of **partially annealed** medium carbon steel of **grade 4.8 strength class and as per DIN 976 standard.**

The Drop-in anchors or stud anchor used for the suspension of the rods should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete. It should be divided into four expansion segments for uniform pressing force distribution in the borehole.
The load calculations should be as per Finite Element Method for the selection of the channels for suitable size of the duct and should be provided by the contractor to the consultant for verification.
Supporting DETA (European Technical Approval) is for low pressure systems are given below

Larger Side of Duct mm	Support Channel mm	Vertical Rod Dia mm	Maximum Spacing between supports mm
0-600	27x18x1.2	M8	2400
601-1250	38x24x2	M8	2400
1250-2100	38x40x2	M10	2400
2100 and above	40x60x2.5	M12	2400

Fig G. Typical Arrangement for Duct.CHW pipe and drain pipe support from building shaft



17.2.2 **CHW PIPE / REF. PIPE SUPPORT:**

Description

The CHW Pipes should be simply supported by **Split Clamps with rubber support insert.**

Split Clamps should be as per **DIN 3567** pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

Rubber support insert should be made from **EPDM or NR/SBR Rubber**
The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp and rubber support insert should have the temperature capacity of -50 degree Celsius to +150 degree Celsius.

In the case of multiple pipes, the supporting arrangement should be made using support channel made up of cold rolled steel of quality **DX51 or greater and as per EC3 (Eurocode 3) or DIN EN 1993-1-1.**

The Support channel should be **pre-galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail**.

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C**.
The Threaded Rods used for the fixing Pipe clamp with channel that should be made up of partially annealed medium carbon steel of grade 4.8 strength class and as per DIN 976 standard.

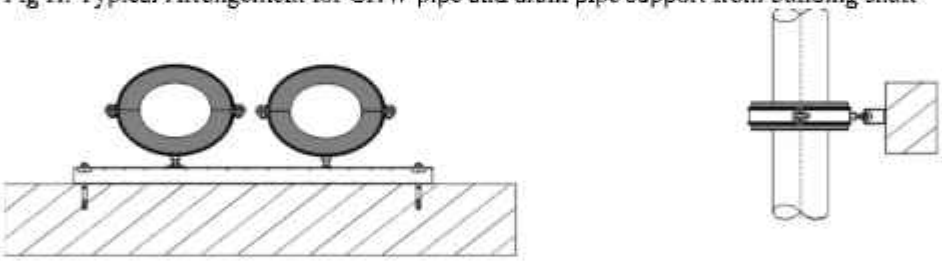
The Drop-in anchors or stud anchor used for the channel fixing with shaft that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load bearing capacity for the selection of the split clamp for suitable size of the pipe should be provided by the contractor to the consultant for verification.

Maximum Support Spacing (m)					
Nominal Pipe Dia (mm)	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**
Upto 15	1.8	65	3.7	250	5.0
20	2.4	80	3.7	300	6.1
25	2.4	100	3.7	350	10.0
32	2.7	125	3.7	400	10.5
40	3.0	150	4.5	450	11.0
50	3.0	200	5.6	500	12.0

Fig H. Typical Arrangement for CHW pipe and drain pipe support from building shaft



17.2.3 **Drain pipe support**

Description
The Drainpipes should be simply supported by **Split Clamps**.

Split Clamps should be pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp should have the temperature capacity of -50 degree Celsius to +150 degrees Celsius.
The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of **grade 4.8 strength class and as per DIN 976 standard.**

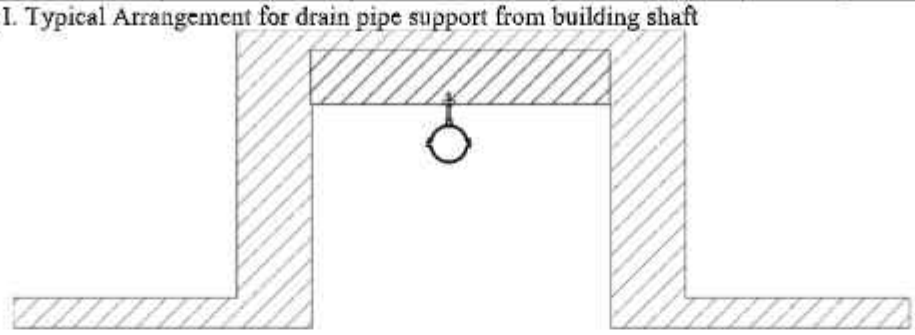
The Drop-in anchors or stud anchor used for the suspension of the rods should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

Maximum Support Spacing (m)

Pipe Dia (mm)	Support Distance (M)	Nominal Pipe Dia (mm)	Support Distance (M)	Nominal Pipe Dia (mm)	Support Distance (M)
Upto 15	1.0	32	1.0	65	1.2
20	1.0	40	1.0	90	1.4
25	1.0	50	1,1	80	1.5

Fig I. Typical Arrangement for drain pipe support from building shaft



17.3 **Support on terrace**

17.3.1 **DUCT SUPPORTS**

Description

The Duct should be simply supported by Support Channel made up of cold rolled steel of quality **DX51 or greater and as per EC3(Eurocode 3) or DIN EN 1993-1-1**

The Support channel should be **pre galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail**.

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C**.
The Threaded Rods used for the assembly of channel structure that should be made up of **partially annealed** medium carbon steel of **grade 4.8 strength class and as per DIN 976 standard.**

The Drop-in anchors used for the fixing channel with terrace that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

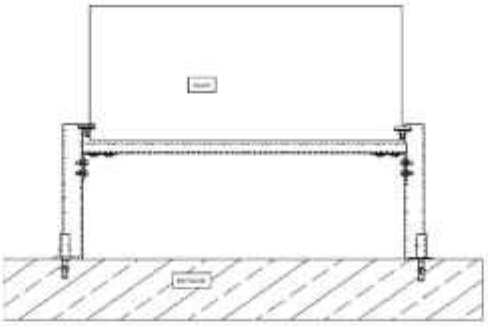
It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load calculations should be as per Finite Element Method for the selection of the channels for suitable size of the duct and should be provided by the contractor to the consultant for verification.

Supporting DETA (European Technical Approval)ils for low pressure systems are given below

Larger Side of Duct mm	Support Channel mm	Vertical Rod Dia mm	Maximum Spacing between supports mm
0-600	27x18x1.2	M8	2400
601-1250	38x24x2	M8	2400
1250-2100	38x40x2	M10	2400
2100 and above	40x60x2.5	M12	2400

Fig J. Typical Arrangement for drain pipe support on terrace



17.3.2 **CHW pipe / ref. pipe support:**
Description

The CHW Pipes should be simply supported by **Split Clamps with rubber support insert.**

Split Clamps should be as per **DIN 3567** pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

Rubber support insert should be made from **EPDM or NR/SBR Rubber**

The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp and rubber support insert should have the temperature capacity of -50 degree Celsius to +150 degree Celsius.

In the case of multiple pipes, the supporting arrangement should be made using support channel made up of cold rolled steel of quality **DX51 or greater and as per EC3 (Eurocode 3) or DIN EN 1993-1-1.**

The Support channel should be **pre-galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail**.

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C**.
The Threaded Rods used for the connecting clamp and channel that should be made up of partially annealed medium carbon steel of **grade 4.8 strength class and as per DIN 976 standard**.

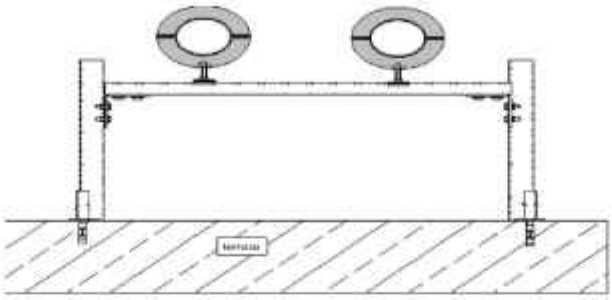
The Drop-in anchors used for the fixing channel with terrace that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load bearing capacity for the selection of the split clamp for suitable size of the pipe should be provided by the contractor to the consultant for verification.

Maximum Support Spacing (m)					
Nominal Pipe Dia (mm)	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**
Upto 15	1.8	65	3.7	250	5.0
20	2.4	80	3.7	300	6.1
25	2.4	100	3.7	350	10.0
32	2.7	125	3.7	400	10.5
40	3.0	150	4.5	450	11.0
50	3.0	200	5.6	500	12.0

Fig K. Typical Arrangement for CHW pipe support from on terrace



17.4 **Drain pipe support**
Description

The Drain Pipes should be simply supported by **Split Clamps**.

Split Clamps should be pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

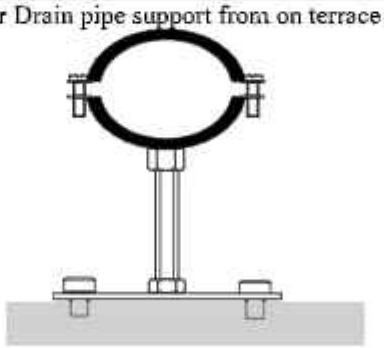
The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp should have the temperature capacity of -50 degree Celsius to +150 degrees Celsius.
The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of **grade 4.8 strength class and as per DIN 976 standard**.
The Drop-in anchors used for the Fixing base plate, should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

Maximum Support Spacing (m)					
Pipe Dia (mm)	**Support Distance M)**	**Nominal Pipe Dia (mm)**	**Support Distance M)**	**Nominal Pipe Dia (mm)**	**Support Distance M)**
Upto 15	1.0	32	1.0	65	1.2
20	1.0	40	1.0	90	1.4
25	1.0	50	1,1	80	1.5

Fig L. Typical Arrangement for Drain pipe support from on terrace



17.5 **Support from WALL**

17.5.1 **DUCT SUPPORTS**

Description
The Duct should be simply supported by Support Channel made up of cold rolled steel of quality **DX51 or greater and as per EC3(Eurocode 3) or DIN EN 1993-1-1**

The Support channel should be **pre galvanised with minimum GSM of 120** and should have universal mounting

slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail**.
The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C**.
The Threaded Rods used for the suspension of the Duct should be made up of **partially annealed** medium carbon steel of **grade 4.8 strength class and as per DIN 976 standard.**

The Drop-in anchors or stud anchor used for fixing with wall that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

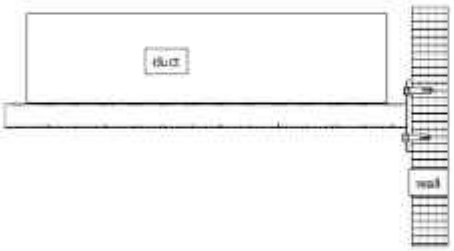
It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load calculations should be as per Finite Element Method for the selection of the channels for suitable size of the duct and should be provided by the contractor to the consultant for verification.

Supporting DETA (European Technical Approval) ils for low pressure systems are given below

Larger Side of Duct mm	Support Channel mm	Vertical Rod Dia mm	Maximum Spacing between supports mm
0-600	27x18x1.2	M8	2400
601-1250	38x24x2	M8	2400
1250-2100	38x40x2	M10	2400
2100 and above	40x60x2.5	M12	2400

Fig M. Typical Arrangement for Duct support from wall



17.5.2 **CHW pipe / ref. pipe support:**

Description

The CHW Pipes should be simply supported by **Split Clamps with rubber support insert.**
Split Clamps should be as per **DIN 3567** pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

Rubber support insert should be made from **EPDM or NR/SBR Rubber**

The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp and rubber support insert should have the temperature capacity of -50 degree Celsius to +150 degree Celsius.

In the case of multiple pipes, the supporting arrangement should be made using support channel made up of cold rolled steel of quality **DX51 or greater and as per EC3 (Eurocode 3) or DIN EN 1993-1-1.**

The Support channel should be **pre-galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail**.

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C**.

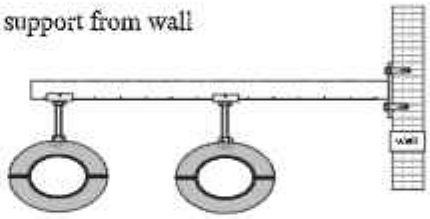
The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of **grade 4.8 strength class and as per DIN 976 standard**.
The Drop-in anchors or stud anchor used for Fixing with wall that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load bearing capacity for the selection of the split clamp for suitable size of the pipe should be provided by the contractor to the consultant for verification.

Maximum Support Spacing (m)					
Nominal Pipe Dia (mm)	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**
Upto 15	1.8	65	3.7	250	5.0
20	2.4	80	3.7	300	6.1
25	2.4	100	3.7	350	10.0
32	2.7	125	3.7	400	10.5
40	3.0	150	4.5	450	11.0
50	3.0	200	5.6	500	12.0

Fig N. Typical Arrangement for CHW pipe support from wall



17.5.3 **Drain pipe support**

Description

The Drain Pipes should be simply supported by **Split Clamps**.

Split Clamps should be pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp should have the temperature capacity of -50 degree Celsius to +150 degrees Celsius.

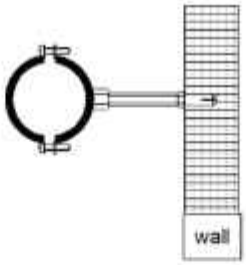
The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of **grade 4.8 strength class and as per DIN 976 standard**.

The Drop-in anchors or stud anchor used for fixing with wall that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

Maximum Support Spacing (m)					
Pipe Dia (mm)	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**
Upto 15	1.0	32	1.0	65	1.2
20	1.0	40	1.0	90	1.4
25	1.0	50	1,1	80	1.5

Fig O. Typical Arrangement for Drain pipe support from Wall



18.0 PVC CONDUIT

All non-metallic PVC conduits shall conform to IS: 9537(Part - 3) and of FRLS type. The conduit shall be planed and of type as specified in IS: 9537 and shall be used with the corresponding accessories (Refer IS: 3419 specification for fittings for rigid nonmetallic conduits). Refer below table for detail specification of PVC conduit.

S. NO.	Characteristics	Reference 'IS'	Specified Requirement	Bidder to Fill
1	Construction	IS:9537 Part-3(1983)	Both the surfaces should be clean and free from burrs	
2	Durability of Marking	IS:9537 Part-3(1983)	It should be legible & durable & should not come out after rubbing with piece of cloth soaked in petrol.	
	Dimension	IS:9537 Part-3(1983)	Maximum OD: - need to be specified	
			Minimum OD: - need to be specified	
			Minimum ID: - need to be specified	
3	Compression Test	IS:9537 Part-3(1983)	% of Comp. Under load less than 25%	
			% of Comp. Without load less than 10%	
4	Impact Test	IS:9537 Part-3(1983)	There should be no crack and no sign of disintegration.	
5	Resistance to Heat	IS:9537 Part-3(1983)	Resistance of heat (Diameter of Ball Impression in MM at 60°C for 2 hours) less than 2.0mm	
6	Resistance to Burning	IS:9537 Part-3(1983)	Resistance to burning (Period of burning after removal of flame 30 sec) Flame dies out in time less than 30 sec.	
7	Electrical Strength	IS:9537 Part-3(1983)	Shall withstand 2000V AC for 15 minutes	
8	Insulation Resistance	IS:9537 Part-3(1983)	Applied Voltage: 500V DC for 60 sec and IR Min 100 Mega ohms.	
9	Temperature Index	Not applicable	Should be minimum 250° C	
10	Oxygen Index	Not applicable	Should be more than 21%	
11	Smoke Density	Not applicable	Should be less than 55%	

19.0 Make List

Sr.	Details Of Material / Equipment	Approved Manufacturers Name
1	Dx Ductable Split Ac / Wall Mount Split Ac	O-General / Daikin / Mitsubishi Electric/ Toshiba / Samsung /Blue Star
1	Air Curtain	Euronics / Eureka / VTS / Dolphy India
2	GI Ducting	SAIL / Tata / Jindal / Essar
3	MS Ducting	Tata / Jindal / Surya / SAIL / ALP Apollo
4	Insulation Material	
a	Nitrile Rubber	Aramacell / K Flex / ALP Aeroflex
b	Closed cell Nitrile rubber/EPDM	ALP Aeroflex/Armaflex/Aerocell/INNER flex
c	Open Cell Nitrile Rubbre Insulation	Aramacell / K-Flex / ALP Aeroflex
d	Expanded Polysterene / Extruded Polysterene	Owens Croning / Supreme Insuboard / Inner
5	Grilles / Diffusers / Dampers	Carryaire / Systemaire / Cosmos / Greehheck / Air Flow
6	Vibration Isolation.	Dunlop / Cori / Resistoflex / Easyflex / Vibrosolve
7	Refrigerant Pipe	Mandev / Mexflow / Totaline / Rajco
8	Drain Pipe / Pvc Pipe	Finolex / Ashirwad/ Supreme / Astral
9	Inline Fans / Centrifugal Fans	Kruger / System Air / Greenhec / Air Flow
10	Propeller Fans	Systemair/Kruger/Greenheck / Flaktswood / Air Flow
11	Tube Axial Flow Fan	Systemair/Kruger/Greenheck/Flaktswood / AirFlow
12	Dry Scrubber For Kitchen Exhaust Unit	Rydair / Trion / Halton
13	Air Washer Units	DRI / HMX / Ambiator
14	Flexible Canvass Connection	Airflow / Easyflex / Hira
15	Adhesive	Pidilite / ALP Aerostick / Inbond/Inner
16	Engineered Support	Mupro / Gripple / Valraven / Easy Flex / Inner
17	Anchor Fastner	Hilti / Fischer / Eq. Approved
18	PLC / DDC Controllers And Co Sensors	Siemens / Tac / Honeywell / Mitshubishi / Allen Bradly / Johnson Control
19	Jet Fans	Systemair/Kruger/Greenheck/Flaktswood / AirFlow
IMPORTANT NOTE		
1	1. THE SUCCESSFUL CONTRACTOR HAS TO OBTAIN APPROVAL FOR ALL THE SAMPLES / MAKES FROM THE CLIENT/CONSULTANT BEFORE USE. WITHOUT APPROVAL CLIENT HAS THE RIGHT TO ASK TO REMOVE THAT MATERIAL FROM THE SITE.	
2	2. THE APPROVED MAKES GIVEN ABOVE ARE APPLICABLE IN GENERAL. **HOWEVER FINAL APPROVAL HAS TO BE TAKEN FROM THE AMC & Consultants BEFORE EXECUTION OF ANY ITEM.**	
3	3. CLIENT HAS THE RIGHT TO CHOOSE ANY OF THE ABOVE MAKE OR ANY EQUIVELLENT MAKE OTHER THEN THIS AT THE TIME OF EXECUTION.	
4	4. THE SUCCESSFUL CONTRACTOR HAS TO PRIOR INFORM TO AMC IN ANY TENDER ITEM EXCESS FROM BOQ.	

20.0 Air Conditioning & Ventilation Annexures:-

Annexure I_ AC Annexure

Sr no.	Floor	Area Name	Sq Mtr.	Sq Ft.	Height Ft.	Occupancy	Fresh Air CFM	Cooling Load		HVAC System Proposed	Unit Type(Provision Only)	Capacity		Qty	Total CFM	Total TR	Ele. Load KW	VRF ODU SELECTION				
								CFM	TR			CFM	TR					VRV ODU Calculated (HP)	Qty	Selected total HP	VRF ODU System Tag	Ele. Load KW
1	Ground	Restaurant 1 (left)	109.52	1178	19.0	24	189	6101	11.9	VRV	Ceiling Suspended Unit	2800	8	2	5600	16	3.2	20	1	20		23.10
2	Ground	Restaurant 2 (left)	199.14	2143	19.0	43	343	5545	12.0	VRV	Ceiling Suspended Unit	2800	8	2	5600	16	3.2	20	1	20		23.00
3	Ground	Mercantile 1 (Left)	98.3	1058	19.0	21	169	2839	6.1	VRV	Ceiling Suspended Unit	2800	8	1	2800	8	1.6	10	1	10		11.50
4	Ground	Mercantile 2 (Left)	148	1592	19.0	32	255	3811	8.3	VRV	Ceiling Suspended Unit	2100	6	1	2100	6	1.2	8	1	14		9.20
												1400	4	1	1400	4	0.8	6				
5	First	Restaurant 3 (left)	121.07	1303	19.0	26	208	6456	12.6	VRV	Ceiling Suspended Unit	2100	6	3	6300	18	3.6	12	2	24		27.60
6	First	Mercantile 4 (Left)	181.69	1955	19.0	39	313	7563	15.3	VRV	Ceiling Suspended Unit	2800	8	1	2800	8	1.6	10	1	26		11.50
												2100	6	2	4200	12	2.4	16				
7	First	Mercantile 5 (Left)	111.42	1199	19.0	24	192	3429	7.3	VRV		2100	6	1	2100	6	1.2	8	1	14		9.20

Sr no.	Floor	Area Name	Sq Mtr.	Sq Ft.	Height Ft.	Occupancy	Fresh Air CFM	Cooling Load		HVAC System Proposed	Unit Type(Provision Only)	Capacity		Qty	Total CFM	Total TR	Ele. Load KW	VRF ODU SELECTION				
								CFM	TR			CFM	TR					VRV ODU Calculated (HP)	Qty	Selected total HP	VRF ODU System Tag	Ele. Load KW
											Ceiling Suspended Unit	1400	4	1	1400	4	0.8	6				
8	First	Mercantile 6 (Left)	135	1453	19.0	29	232	4647	9.6	VRV	Ceiling Suspended Unit	2100	6	2	4200	12	2.4	16	1	16		18.40
9	Second	Mercantile 7 (Left)	98.3	1058	19.0	21	169	3283	6.8	VRV	Ceiling Suspended Unit	2800	8	1	2800	8	1.6	10	1	10		11.50
10	Second	Mercantile 8 (Left)	148	1592	19.0	32	255	4381	9.3	VRV	Ceiling Suspended Unit	2100	6	2	4200	12	2.4	16	1	16		18.40
		TOTAL	**1350.4**	**14530.7**		**291**	**2325**	**48054**	**99.2**					**20**	**45500**	**130**	**26.3**		**11**	**170**		**163.4**
1	Ground	Restaurant 1 (Right)	109.52	1178	19.0	24	189	3320	7.0	VRV	Ceiling Suspended Unit	2800	8	1	2800	8	1.6	10	1	10		11.50
2	Ground	Restaurant 2 (Right)	199.14	2143	19.0	43	343	9537	18.9	VRV	Ceiling Suspended Unit	2800	8	3	8400	24	4.9	16	2	32		36.80
3	Ground	Mercantile 1 (Right)	98.3	1058	19.0	21	169	2839	6.1	VRV	Ceiling Suspended Unit	2800	8	1	2800	8	1.6	10	1	10		11.50
4	Ground	Mercantile 2 (Right)	148	1592	19.0	32	255	3811	8.3	VRV	Ceiling Suspended Unit	2100	6	2	4200	12	2.4	16	1	16		18.40

Sr no.	Floor	Area Name	Sq Mtr.	Sq Ft.	Height Ft.	Occupancy	Fresh Air CFM	Cooling Load		HVAC System Proposed	Unit Type(Provision Only)	Capacity		Qty	Total CFM	Total TR	Ele. Load KW	VRF ODU SELECTION				
								CFM	TR			CFM	TR					VRV ODU Calculated (HP)	Qty	Selected total HP	VRF ODU System Tag	Ele. Load KW
5	First	Restaurant 3 (Right)	121.07	1303	19.0	26	208	6456	12.6	VRV	Ceiling Suspended Unit	2800	8	2	5600	16	3.2	20	1	20		23.00
6	First	Mercantile (Right)	181.69	1955	19.0	39	313	7563	15.3	VRV	Ceiling Suspended Unit	2800	8	1	2800	8	1.6	10	1	26		11.50
												2100	6	2	4200	12	2.4	16				
7	First	Mercantile 1 (Right)	111.42	1199	19.0	24	192	3429	7.3	VRV	Ceiling Suspended Unit	2100	6	1	2100	6	1.2	8	1	14		9.20
												1400	4	1	1400	4	0.8	6				
8	First	Mercantile 2 (Right)	135	1453	19.0	29	232	4647	9.6	VRV	Ceiling Suspended Unit	2100	6	2	4200	12	2.4	16	1	16		18.40
9	Second	Mercantile 1 (Right)	98.3	1058	19.0	21	169	3283	6.8	VRV	Ceiling Suspended Unit	2800	8	1	2800	8	1.6	10	1	10		11.50
10	Second	Mercantile 2 (Right)	148	1592	19.0	32	255	4381	9.3	VRV	Ceiling Suspended Unit	2100	6	2	4200	12	2.4	16	1	16		18.40
		TOTAL	**1350.4**	**14530.7**		**291**	**2325**	**49265**	**101.3**					**19**	**45500**	**130**	**26.3**		**11**	**170**		**170.2**
		One Cluseter	**2700.9**	**29061.5**		**581**	**4650**	**97319**	**200.5**					**39**	**91000**	**260**	**52.7**		**22**	**340**		**333.6**

Sr no.	Floor	Area Name	Sq Mtr.	Sq Ft.	Height Ft.	Occupancy	Fresh Air CFM	Cooling Load		HVAC System Proposed	Unit Type(Provision Only)	Capacity		Qty	Total CFM	Total TR	Ele. Load KW	VRF ODU SELECTION				
								CFM	TR			CFM	TR					VRV ODU Calculated (HP)	Qty	Selected total HP	VRF ODU System Tag	Ele. Load KW
		Total for Three cluster	8102.6	87184.4		1744	13950	29195	61.6					117	273000	780	158.1		66	1020		1000.8

Annexure II_ Ventilation Annexure

Sr no.	Floor	Area Name	Ac / Non Ac	Sq Mtr.	Sq Ft.	Ht. Ft.	ACPH	Vent CFM	FA CFM	Total Numbers of Merchantile	Fan Selection	CFM	QTY.	Ele. Load KW	Total Ele. Load KW	Phase
1	Ground	Kitchen 1 (Left)	Vent	31	334	19.02	50	5288		3	Exhaust Fan with Dry Scrubber	5500	3	2.6	7.9	3P
									4230	3	Air Washer	4500	3	2.1	6.4	3P
2	Ground	Kitchen 2 (Left)	Vent	40.96	441	19.02	50	6987		3	Exhaust Fan with Dry Scrubber	7000	3	3.3	10.0	3P
									5590	3	Air Washer	5500	3	2.6	7.9	3P
3	First	Kitchen 3 (Left)	Vent	23.6	254	19.02	50	4026		3	Exhaust Fan with Dry Scrubber	4200	3	2.0	6.0	3P
									3221	3	Air Washer	3200	3	1.5	4.6	3P

Sr no.	Floor	Area Name	Ac / Non Ac	Sq Mtr.	Sq Ft.	Ht. Ft.	ACPH	Vent CFM	FA CFM	Total Numbers of Merchantile	Fan Selection	CFM	QTY.	Ele. Load KW	Total Ele. Load KW	Phase
4	Ground	Female TOI (Left)	Vent	19.5	210	19.02	10	665		3	Cabinet Type Exhaust Fan	6000	3	2.9	8.6	3P
5	Ground	Male TOI (Left)	Vent	27.1	292	19.02	10	925								
6	Ground	PH TOI (Left)	Vent	4.1	44	19.02	10	140								
7	First	Female TOI (Left)	Vent	19.5	210	19.02	10	665								
8	First	Male TOI (Left)	Vent	27.1	292	19.02	10	925								
9	First	PH TOI (Left)	Vent	4.1	44	19.02	10	140								
10	Second	Female TOI (Left)	Vent	19.5	210	19.02	10	665								
11	Second	Male TOI (Left)	Vent	27.1	292	19.02	10	925								
12	Second	PH TOI (Left)	Vent	4.1	44	19.02	10	140								
13	Ground	Electrical (left) - Upper	Vent	23.9	257	19.02	10	815		3	Propeller Type Fan	300	9	1.3	11.6	1P
14	Ground	Electrical (left) - Lower	Vent	14	151	19.02	10	478		3	Propeller Type Fan	300	6	0.9	5.1	1P
15	Ground	Kitchen 1 (Right)	Vent	31	334	19.02	50	5288		3	Exhaust Fan with	5500	3	2.6	7.9	3P

Sr no.	Floor	Area Name	Ac / Non Ac	Sq Mtr.	Sq Ft.	Ht. Ft.	ACPH	Vent CFM	FA CFM	Total Numbers of Merchantile	Fan Selection	CFM	QTY.	Ele. Load KW	Total Ele. Load KW	Phase
											Dry Scrubber					
									4230	3	Air Washer	4500	3	2.1	6.4	3P
16	Ground	Kitchen 2 (Right)	Vent	40.96	441	19.02	50	6987		3	Exhaust Fan with Dry Scrubber	7000	3	3.3	10.0	3P
									5590	3	Air Washer	5500	3	2.6	7.9	3P
17	First	Kitchen 3 (Right)	Vent	23.6	254	19.02	50	4026		3	Exhaust Fan with Dry Scrubber	4200	3	2.0	6.0	3P
									3221	3	Air Washer	3200	3	1.5	4.6	3P
18	Ground	Female TOI (Right)	Vent	19.5	210	19.02	10	665		3	Cabinet Type Exhaust Fan	6000	3	2.9	8.6	3P
19	Ground	Male TOI (Right)	Vent	27.1	292	19.02	10	925								
20	Ground	PH TOI (Right)	Vent	4.1	44	19.02	10	140								

Sr no.	Floor	Area Name	Ac / Non Ac	Sq Mtr.	Sq Ft.	Ht. Ft.	ACPH	Vent CFM	FA CFM	Total Numbers of Merchantile	Fan Selection	CFM	QTY.	Ele. Load KW	Total Ele. Load KW	Phase
21	First	Female TOI (Right)	Vent	19.5	210	19.02	10	665								
22	First	Male TOI (Right)	Vent	27.1	292	19.02	10	925								
23	First	PH TOI (Right)	Vent	4.1	44	19.02	10	140								
24	Second	Female TOI (Right)	Vent	19.5	210	19.02	10	665								
25	Second	Male TOI (Right)	Vent	27.1	292	19.02	10	925								
26	Second	PH TOI (Right)	Vent	4.1	44	19.02	10	140								
27	Ground	Electrical (Right)-Upper	Vent	23.9	257	19.02	10	815		3	Propeller Type Fan	300	9	1.3	11.6	1P
28	Ground	Electrical (Right) - Lower	Vent	14	151	19.02	10	478		3	Propeller Type Fan	300	6	0.9	5.1	1P
29	Ground	HT Panel Room	Vent	30	323	13.12	15	1059		1	Propeller Type Fan	300	3	0.4	1.3	1P
30	Ground	LT Panel Room	Vent	20	215	13.12	15	706		1	Propeller Type Fan	300	2	0.3	0.6	1P

Sr no.	Floor	Area Name	Ac / Non Ac	Sq Mtr.	Sq Ft.	Ht. Ft.	ACPH	Vent CFM	FA CFM	Total Numbers of Mercantile	Fan Selection	CFM	QTY.	Elec. Load KW	Total Ele. Load KW	Phase
31	Basement	PHE Pump Room Ventilation	Vent	189.6	2040	16.40	15	8364		1	Cabinet Type Exhaust Fan	8500	1	4.0	4.0	3P
									6692	1	Fresh air fan with Filter	7000	1	3.3	3.3	3P
		TOTAL		**811**	**8723**								**79**	**47**	**145**	

Annexure III_ Road Tunnel Ventilation Annexure

Sr.	Floor	Area Name	Area (Sq.Ft)	Height (Ft)	Ventilation CFM		Fresh Air Selection	Jet Fans	CO Sensors (Qty)	Exhause Fan Selection	Normal kW	Fire Mode KW
					Normal Mode	Fire Mode	Normal/Fire Mode			Normal/Fire Mode		
					6 ACPH	12 ACPH						
1	Tunnel	Tunnel Area	64560	18.040	116466	232932	FA Through Ramp	30 Nos. 450mm Dia Jet Fans (1.7 KW during fire mode & 0.34 KW during normal mode)	15 Nos.	Exhaust Through Ramp	10.2	25.5
		Total	**64560**								**10**	**26**

Make of Material

Sr.	Details Of Material / Equipment	Approved Manufacturers Name
1	Dx Ductable Split Ac / Wall Mount Split Ac	O-General / Daikin / Mitsubishi Electric/ Toshiba / Samsung /Blue Star
1	Air Curtain	Euronics / Eureka / VTS / Dolphy India
2	GI Ducting	SAIL / Tata / Jindal / Essar
3	MS Ducting	Tata / Jindal / Surya / SAIL / ALP Apollo
4	Insulation Material	
a	Nitrile Rubber	Aramacell / K Flex / ALP Aeroflex
b	Closed cell Nitrile rubber/EPDM	ALP Aeroflex/Armaflex/Aerocell/INNER flex
c	Open Cell Nitrile Rubbre Insulation	Aramacell / K-Flex / ALP Aeroflex
d	Expanded Polysterene / Extruded Polysterene	Owens Croning / Supreme Insuboard / Inner
5	Grilles / Diffusers / Dampers	Carryaire / Systemaire / Cosmos / Greehheck / Air Flow
6	Vibration Isolation.	Dunlop / Cori / Resistoflex / Easyflex / Vibrosolve
7	Refrigerant Pipe	Mandev / Mexflow / Totaline / Rajco
8	Drain Pipe / Pvc Pipe	Finolex / Ashirwad/ Supreme / Astral
9	Inline Fans / Centrifugal Fans	Kruger / System Air / Greenhec / Air Flow
10	Propeller Fans	Systemair/Kruger/Greenheck / Flaktswood / Air Flow
11	Tube Axial Flow Fan	Systemair/Kruger/Greenheck/Flaktswood / AirFlow
12	Dry Scrubber For Kitchen Exhaust Unit	Rydair / Trion / Halton
13	Air Washer Units	DRI / HMX / Ambiator
14	Flexible Canvass Connection	Airflow / Easyflex / Hira
15	Adhesive	Pidilite / ALP Aerostick / Inbond/Inner
16	Engineered Support	Mupro / Gripple / Valraven / Easy Flex / Inner
17	Anchor Fastner	Hilti / Fischer / Eq. Approved
18	PLC / DDC Controllers And Co Sensors	Siemens / Tac / Honeywell / Mitshubishi / Allen Bradly / Johnson Control
19	Jet Fans	Systemair/Kruger/Greenheck/Flaktswood / AirFlow

IMPORTANT NOTE

1	1. THE SUCCESSFUL CONTRACTOR HAS TO OBTAIN APPROVAL FOR ALL THE SAMPLES / MAKES FROM THE CLIENT/CONSULTANT BEFORE USE. WITHOUT APPROVAL CLIENT HAS THE RIGHT TO ASK TO REMOVE THAT MATERIAL FROM THE SITE.
2	2. THE APPROVED MAKES GIVEN ABOVE ARE APPLICABLE IN GENERAL. **HOWEVER FINAL APPROVAL HAS TO BE TAKEN FROM THE AMC & Consultants BEFORE EXECUTION OF ANY ITEM**.
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4	4. THE SUCCESSFUL CONTRACTOR HAS TO PRIOR INFORM TO AMC IN ANY TENDER ITEM EXCESS FROM BOQ.

Signature of Bidder

SABARMTI RIVERFRONT DEVELOPMENT

Sabarmati River Front Development Corporation Limited

2nd Floor, Riverfront House,
B/h H.K Arts College,
Between Gandhi Bridge and Nehru Bridge,
Pujya Pramukh swami Marg
(River Front Road-West)
Ahmedabad-380009

BID DOCUMENT

CONSTRUCTION OF RIVERSIDE SAVORIES I.E. BUILDING WITH UNDERGROUND ROAD BETWEEN NEHRU BRIDGE AND ELLISBRIDGE AND CONSTRUCTION OF PUBLIC PLAZA AND UNDERGROUND PARKING FACILITY AT SANSKAR KENDRA - TAGORE HALL CAMPUS CONNECTING RIVERFRONT ON WESTBANK FOR SRFDCL.

Contract Package : SRFDCL

VOLUME-02

IV) Technical Specification-HVAC

HVAC TECHNICAL SPECIFICATIONS
Part B: -Sanskar Kendra plaza

INDEX

1.0 SHEET METAL WORK:

1.1 Factory fabricated Ducts:

A. Scope

The scope of this section comprises supply fabrication, installation and testing of all sheet metal. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

B. Raw Materials

Galvanizing shall be Class VIII – light coating of zinc, nominal 120gm/sq. m. surface area and Lock Forming Quality prime material along with mill test certificates.

C. Gauges, Bracing By Size Of Ducts

All ducts shall be fabricated from galvanized steel of the following thickness, as indicated as below:

For Ducts with external SP up to 250 Pa (25mmWg)

Rectangular	**Pressure 250 Pa** **Duct Section Length 1.2mtr (4 ft)**	
Maximum Duct Size	**Gauge**	**Joint Type**
1–750 mm	26	C & S
751 – 1000 mm	26	4 Bolt TDC/TDF
1001 – 1200 mm	24	4 Bolt TDC/TDF
1201 – 1500 mm	24	4 Bolt TDC/TDF
1501 – 1800 mm	22	4 Bolt TDC/TDF
1801 – 2100 mm	20	4 Bolt TDC/TDF
2101 – 2700 mm	18	4 Bolt TDC/TDF

'C'-cleat; 'S'- cleat;

D. Fabrication Standards & Equipment

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

1) 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.

2) All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.

3) All edges to be machine treated using lock formers, flangers and rollers for turning up edges.

E. Duct Construction

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

a) Ducts so identified on the Drawings shall be acoustically lined and insulated from outside 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. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.

b) Ducts shall be straight and 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 airtightness.

c) All ducts up to 75cms width within conditioned spaces shall have C & S joints. The internal ends of joints shall be in the direction of airflow. Care should be taken to ensure that S Cleats are mounted on the longer side of the duct and Cleats on the shorter side.

d) 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.

e) 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 angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

f) 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 thoroughly stiffened with 25mm x 25mm x 3mm 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 45cm x 45cm in size.

g) 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.

h) Self-adhesive PE foam lining having 4mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

F. Installation Practice

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

a) The Contractor shall provide and neatly 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

b) 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 other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.

c) 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 representative.

d) All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze

hangers formed of galvanized steel rods and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners.

e) 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 no delay to other contractor's work in the building.

f) Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick

TF quality expanded polystyrene around the duct and totally covered with fire barrier mortar for complete sealing.

g) All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

h) Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

1.2 Dampers:

Supply and installation of volume control damper within ducts complete with suitable links, levers. G.S.S construction, 18 gauge frame and 20 gauge " V " groove single skin blade or 18 gauge frame and 24 gauge aerofoil double skin blade mounted on nylon bushes, opposed blade multi leaf type volume control damper . Manual quadrant control with position indicator is provided to adjust volume of air as required.

a. Dampers: All duct dampers shall be opposed blade louver dampers of robust GSS (min.120GSM) construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.

b. Damper Frame shall be a roll formed structural hat channel with min. 30mm flange, reinforced at corners, formed from a single piece of min. 1.0mm galvanized steel with blades shall be double skin aerofoil design (min 0.6 mm) or single skin 3V design (min 1.0mm).

c. Damper blades shall be airfoil shaped (equivalent to 2mm thickness strength) roll formed using 0.6 thick single piece of galvanized sheet or roll formed 3-v groove (min.1.0mm thick) as per specification mentioned in B.O.Q. . The width of the blades, measured in the direction of airflow shall not be less than 100 mm and shall not be greater than 200 mm.

d. Blades are mounted in nylon bushes operated by an exterior linkage which allow the dam per to be opened and closed with a minimum of air disturbance.

e. Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.

f. 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 air distribution system.

g. For Motorized operation
The dampers shall be operated by electric actuators and shall be readily assembled on Site from modular panels. Each motor operated damper panel shall be of the multiple-parallel/opposed- blade type, with an independent channel frame; and shall be factory-assembled complete with frames, blades, shafts, bearings, seals, linkage, and all accessories required to erect the panels into composite dampers. Motor operated dampers shall be provided with all structural support members and hardware required for installation with additional framing or trims as required to complete the installation.

h. Motor operated damper actuator shall be mounted outside of the damper frame.

i. For the motorized operation , Actuator shall develop sufficient torque for easy operation of VCD with 24 V or 230 V power supply & operation can me modulating or on off as per requirement. Spring-return type damper actuator shall be provided either to open or close damper if required in the event of power failure.

j. The motor operated damper blade and shaft assemblies shall be supported at each end by means of heavy duty, double nylon bushing for rattle free operation.

k. All VCDs, and MVCDs shall also comply with above specifications to the extent applicable. VCDs shall have provision to set & lock the damper at any desired position, whereas, MDs shall have a two-position set and lock facility only.

1.3 Supply And Return Air Diffusers:

- Supply and return air diffusers shall be of approved make as shown on the drawings and/or indicated in the Bill of quantities.

- Round or Rectangular Diffuser: Shall be anodized Aluminum section construction, square, rectangular, or round diffusers with flush fixed pattern. Diffusers for different spaces shall be selected in consultation with site engineer. Supply air diffusers may be equipped with fixed air distribution grids, removable key operated volume control dampers, and anti-smudge rings as required in specific applications, all as per requirements of Bill of quantities.

- Linear Diffuser: Shall be anodized Aluminum section construction, one or two-way blow linear diffusers. Supply air diffusers shall be provided with volume control / balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with site engineer and provided as per requirement of Bill of quantities. All linear / square / round diffusers shall have volume control dampers of MS construction.

1.4 Method Of Measurements For Air Distribution System

Sheet Metal work:

Duct Length shall be measured along the centre line from flange face to face unless otherwise stated. Ductwork shall be measured on the basis of external surface area (length as measured above, multiply by duct perimeter) of ducts including the joints for each duct section. Duct measurement shall be taken before application of the insulation. For taper section average perimeter shall be used for measurement. For special pieces like bends, reducers, branches, and collars, mode of measurement shall be identical to as described above using the length

along the centre line. The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles, and angles/flats with double nuts for supports, felt strip between duct and support, vibration isolation, 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. These accessories shall not be separately measured nor paid for.

Duct Accessories: Shall be measured by the cross section area perpendicular to air flow.

Grilles and diffusers:

Width multiplied by height, excluding flanges, volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

- Diffusers: Cross-section area for airflow at discharge/capture area, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

- 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.

- Fire Damper: Shall be measured by their 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, solenoid valves etc. No special allowances shall be payable for extension of cross section outside the air stream.

- Flexible connection: Shall be measured by their cross-sectional area perpendicular to the direction of airflow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.

1.5 Testing & balancing:

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

The entire air distribution system shall be balanced using 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 balance report shall be submitted along with the completion documents.

2.0 FLEXIBLE DUCT:

2.1 General:

The scope of this section comprise supply, installation, testing and commissioning of flexible ducting conforming to these specifications and in accordance with requirements of drawings and schedule of quantities

2.2 Duct Materials:

2.2.1 Un Insulated Flexible duct

Wherever specified, uninsulated flexible duct shall be made of double lamination of metalized polyester film permanently bonded to a coated spring steel wire helix. Duct shall be in tear and puncture resistant construction.

2.2.2 Insulated Flexible Duct

Wherever insulated flexible duct are specified inner core for the same should be made of double lamination of polyester film permanently bonded to a coated spring steel wire helix. Blanket of fiber glass insulation of R 3.6(RSI - 0.64 m2K/W) having density of 16 kg/Cu.meter and thickness of 25 mm shall be wrapped over the inner core & covered with tear and abuse resistant outer jacket cum vapor barrier made of fiber glass reinforced double layer of metalized polyester film laminate.

2.3 Installation:

Care must be taken to install all the flexible duct in fully extruded position and bends made with adequate radius as per manufacturer recommended practices.

2.3.1 Hangers and Supports

The flexible duct must be installed fully extended to produce optimum results.
The maximum allowable sag, between any two adjacent suspension points, should not exceed 50 mm per meter.

The distance between any two adjacent suspension points may vary from 1.50 to 3.00 meter, depending upon the type of flexible duct in use.

Flexible ducts mounted above suspended ceiling should always be independently supported. Ducts mounted in these locations are susceptible to damage whenever ceiling panels need to be periodically interchanged, unless they are separately supported.

2.3.2 Bending Radius

All bends should be made as large as possible and should have a radius of not less than the diameter of the duct in use. This reduces un-favorable pressure losses and is particularly important for metal-based products which are more susceptible to stress rupturing. Double bends should be avoided, however if un-avoidable, ensure that each radius is not less than R = 2 x D.

2.3.3 Straps

Ideally the hanging straps should support the flexible duct with a minimum of half the circumference surface in contact, and without reducing the effective inside diameter of the duct. It is also recommended that the minimum width of material to be used for the hanging straps should be at least 25 mm.

2.3.4 Flexible Duct to Conventional Duct Connection

Extra care should be taken when making connection to fixed conventional ducts, etc., and ensure that they do not become too stressed. An additional support is recommended to obviate this potential problem.

Metal based flexible duct products are particularly prone to fracturing due to stress caused as a result of sharp connection.

Connections to ceiling illumination "troffer boxes" should be served in the most direct manner similar to that described for conventional ducts.

Too many bends, when connecting to "troffer boxes" and / or any other type of air supplying component, may result in excessive pressure loss and the generation of noise.

2.3.5 Longer Length Installation

In the event where extreme length of flexible duct is to be installed, round duct connectors made of galvanized sheets of at least 30 cm long should be used to connect the duct at

every distance of 10 meters. Use metal or galvanized hangers as recommended (point 3) to support the point where connections are made. Light railing is a good alternative hanging support when using long length of flexible duct.

2.3.6 Direct Contact

It should be emphasized that the flexible duct must not be in direct physical contact with un-insulated heating or hot process pipes. If in the event where such situation can not be avoided, additional 1" thick insulation should be wrapped around pipes that are in contact with the duct.

3.0 INSULATION:

3.1 Scope:

The scope of this section comprises the supply and fixing of insulation conforming to these specifications and in accordance with requirement of Bill of quantities.

MATERIAL:

Insulation material shall be Nitrile Rubber – Class O

Closed Cell Elastomeric Nitrile Rubber Insulation material shall have anti-microbial product, which is EPA approved, as an integral part of insulation that cannot be washed off or worn off, which does not allow the microbes to function, grow and reproduce. Microbiological growth on insulation surface should confirm to following standards: Mould Growth – UL 181; Fungi Resistance – ASTM G21/C1 338 and Bacterial resistance – ASTM G 22. Density of Material shall be between 40 to 60 Kg/m3.

Thermal conductivity of Elastomeric Nitrile rubber shall not exceed 0.033 W/m°K at an average temperature of 0°C. 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. Water vapour permeability shall not exceed 1.74 x 10^{-14} Kg/m.s.Pa, i.e. Moisture Diffusion Resistance Factor or 'μ' value should be minimum 10,000.

Thickness of insulation shall be as specified for particular application or as specified in Bill of quantities. Samples of insulation material shall be submitted for approval and shall be tested for thermal conductivity values. Adhesive used for setting insulation shall be cold setting compound non-flammable, vapor proof adhesive, shalimar CPRX compound or equivalent approved make.

3.2 DUCT THERMAL INSULATION

Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035W/ (m°K) at an average mean temperature of 0o C (Tested acc. To EN 12667 & EN ISO 8497)

The insulation material shall be closed cell Elastomeric Nitrile rubber – Class O

The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame, also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class '0' Fire category requirement as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990
Insulation material should be approved by Local State's Fire Department

Density of laminated insulation material shall be between 50 to 70 Kg/m³
Density of foam insulation shall be between 40 to 55 Kg/m³

The material shall be Duct and Fibre Free

Unlike other generic materials it should be self-extinguishing, does not drip fireballs and does not spread flames

Moisture Diffusion Resistance Factor or 'μ' value shall be minimum 60,000 for an insulation material with lamination or Vapor barrier of tough aluminum foil as per EN 12086 and Min 7000 for base foam without any lamination or vapor barrier to prevent water vapor ingress
The material shall have ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) of Zero

The Insulation material shall withstand maximum Surface Temperature of +85 deg C and minimum surface temperature of 0 deg C as per EN 14706

- **Summary of Duct Insulation Thickness**

Ducting position	Thk. for non-coastal places	Thk. for coastal places
SA duct in RA path	13mm	19mm
Ducted return air system	SA duct: 19mm RA duct: 13mm	SA duct: 25mm RA duct: 19mm
Both SA& RA exposed	Both 25mm	Both 25mm

3.3 Under deck insulation:

Underdeck Insulation of the exposed roof shall be carried out with xx mm Extruded Poly Styrene Board having following Thermal insulation characteristics:

Insulating material: Extruded Poly Styrene board

Thermal conductivity: (ASTM C518) 90 days at 24 Deg C : 0.028 W/mK or better.

(The above is very essential that the above properties should be tested for 90 Days)

Density: 30 – 32 Kg/Cu. Mt.
Thickness: As per BOQ
Water absorption: As per ASTM C272: % (V / V) : Less than 0.1
Compressive Strenth : 250 Kpa

APPLICATION

- Clean the roof surface which is to be insulated
- Secure the panel in position with the help of GI screw washer & GI diagonal wires.
  The insulation shall also be carried out to the exposed beams and columns within the air – conditioned space.

3.4 Duct Acoustic Insulation:

Open Cell Nitrile Rubber Material with Microban for Antifungal and Antimicrobial Properties

- Acoustic Insulation material Properties
- Sound Absorption Coefficient; tested as per **IS: 8225/ISO: 354/ASTM 423C**, shall be minimum as per enclosed chart
- Recommended Thickness for Ducts
- Application Procedure

- **Acoustic Material Properties**

  Material: Open cell nitrile rubber sheet

Density: 180 - 220 Kg/m³

- Insulation material should be sustaining to the temperature in the range of -20˚C to 85˚C.
- Insulation material should be dust and fiber free.
- **Noise Reduction Coefficient (NRC)** value of insulation material should not be less than **0.55** as per testing standards in accordance to **IS: 8225/ISO: 354/ASTM 423C.**
- **Thermal conductivity** of insulation material should **not be more than 0.045 W/mK** at 35˚C mean temperature as per testing standards in accordance to ASTM C 518/EN 12667/ISO:8301.
- **Thermal resistance (R-value)** of insulation material should not be less than **1.89 ˚F ft2 hr/BTU** at 35˚C mean temperature.
- Thickness of the material shall be as specified for the individual application.
- The insulation shall be installed as per manufacturer's recommendation

- **Sound Absorption Coefficient of the material at 1/3 Octave Frequency in accordance with IS: 8225/ISO: 354/ASTM 423C is given below.**

Freq(Hz)	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**
Absorption coefficient	0.49	0.68	0.63	0.71	0.76	0.75	0.64	0.61	0.63

Freq(Hz)	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**
Absorption coefficient	0.71	0.79	0.87	0.86	0.89	0.87	0.87	0.91	0.94

3.5 Acoustic Insulation of AHU Room:

Schedule Number	**Density & Thickness**	**Material to be used**	**Material Specifications**
4	Density – 180 - 220 kg/m³ Thickness – 20 mm	**EPA approved** Open Cell Nitrile Rubber Material with Anti-fungal and Anti-bacterial Properties	• Insulation material should be sustaining to the temperature in the range of -40˚C to 105˚C. • Insulation material should be dust and fiber free. • **Noise Reduction Coefficient (NRC)** value of insulation material should not be less than **0.55** as per testing standards in accordance to **ISO: 354/ASTM 423C.** • Material shall have **fire class 1 in accordance with BS 476 part 7.** • **Material shall be EPA approved and shall be Anti-Fungal & Anti-bacterial in accordance with ASTM G21 & ASTM E 2180.** • Thickness of the material shall be as specified for the individual application. • The insulation shall be installed as per manufacturer's

Schedule Number	Density & Thickness	Material to be used	Material Specifications
			recommendation.

- **Sound Absorption Coefficient of the material at 1/3 Octave Frequency in accordance with IS: ISO: 354/ASTM 423C is given below.**

Freq(Hz)	500	1000	1600	4000	5000
Absorption Coefficient	0.32	0.82	0.95	0.82	0.83

3.6 Kitchen Exhaust Duct Insulation :

Insulation Material

Effective Heat Resistant – Ceramic Wool Blankets having High Temperature Stability

The Insulation material should offer such characteristics as High Temperature Stability, Low Thermal conductivity, low heat storage, excellent thermal shock resistance, light weight and superior corrosion resistance.
Density of material shall be 96 Kg/m3
Thermal conductivity value shall not exceed 0.058 W/m.K at an average mean temperature of 200 deg C
The Insulation material should have withstand temperature up to 1430 deg C
The insulation material shall be completely inorganic
The Insulation material shall confirms to 90A, 90B and Life Safety Code NFPA 101
It shall confirms to ASTM E84 for surface burning characteristics of building materials
The material shall also confirms to 120 Minutes fire rating as per building insulation requirements
The Insulation material shall be Non-Combustible
Confirming Standards: IS-15402, ASTM C 518
It shall have Zero Fire spread index

3.7 Method of Measurement for Insulation:

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centre line measurements described herewith

a. Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are not separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

b. Duct Insulation and Acoustic Lining shall be measured on the basis of surface area along the centre line of insulation thickness. Thus the surface area of externally thermally insulated or acoustically lined be based on the perimeter comprising centre line (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centre-line length including tapered pieces, bends, tees, branches, etc. as measured for bare ducting.

4.0 FLEXIBLE CANVASS CONNECTIONS:

4.1 Scope:

The scope of this section comprises the supply, erection, testing and commissioning of flexible canvass connections conforming to these specifications and in accordance with the

requirement of bill of quantities.

4.2 Specifications:

Supply , installation, testing commissioning of of Flexible canvass connections to isolate vibrations produced by Air handling units, Axial Flow fans and other air moving equipment's when these are to be connected to air ducts where ever specified. Canvass connections shall be of the same cross-sectional area as the mating fan inlet/outlet or duct section.

Flexible canvass connection shall be provided with 45 mm galvanized metal strip of minimum 0.40 mm thickness both side with minimum 0.80 mm this fabric for easy connection to duct or equipment's. The fabric shall be fire resistant, fiberglass weave with silicone rubber coating on both side. Flexible connector fabric shall withstand severe effects of strong sunlight, weathering and ageing. Flexible duct connector fabric shall be air tight, waterproof, virtually chemically inert and shall not emit toxic fumes when exposed to open flame. The flexible canvass connection shall be suitable to withstand the positive and negative fan pressures at point of installation to which they will be subjected to and shall not allow perceptible leakage and shall be completely free from stress and shall not be required to accept any weight.

Duct work connections to the fan inlets / outlets shall be concentricity aligned so that the flexible connections are not subjected to any strain

Flexible Duct connector shall be tested and certified in accordance with BS 476 part 7 for class 1 and NFPA -701 from NABL accredited lab

5.0 TUBE AXIAL FLOW FAN:

5.1 SCOPE:

- The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specifications and in accordance with the requirement of bill of quantities.
- TUBE AXIAL FLOW FAN (Tag: TA)
- Tube Axial Fans are suggested for Ductless Car Park Ventilation. Axial Fan shall be adjustable pitch blade type having non-overloading feature. Fan shall comprise of following components.
- Capacities: Fan capacities shall be as per the schedule shown in Tender BOQ
- Fan: Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.
- Casing: shall be constructed of heavy gage sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 20mm thick and machined to receive motor flange.
- An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.
- Rotor: hub and blades shall be cast aluminium or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external

lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual airflow values, as specified and quoted.

- Motor: shall be energy efficient, squirrel cage, thermally enclosed, fan cooled, standard frame, continuous duty, single winding/ Dahlander winding (for dual speed applications) type suitable for 400V/3 Ph/ 50Hz , AC power supply provided with class F insulation for normal operations and H class for smoke exhaust application , IP55 in accordance with EN 60034-5/IEC 85. Motor Kw must be higher than Bkw by minimum 10-15%.

- The speed of the fans shall not exceed 1440 RPM for fans with impeller diameter above 450 mm, and 2880 RPM for fans with impeller diameter 450 mm and less. For lowest sound level, fan shall be selected. for maximum efficiency or minimum horsepower. Motor shall be specially designed for low noise operation. Fan sound level shall not exceed 75 dBA at 1 m distance from the unit. Fan attenuators shall be provided after acoustic assessment to achieve the specified noise level within occupied areas. The motor bearings should be life lubricated and completely maintenance free and can be used at any installation position at indicated maximum temperature of transported air. The life expectancy of the bearing should be at least 40000 hours (L10)

- Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

  Where axial flow fans of bifurcated type are indicated, the motors shall be out of the air stream.

6.0 PROPELLER FAN:

6.1 Scope:

The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specifications and in accordance with the requirement of bill of quantities.

6.2 Specifications:

Propeller fan casing, protection guard and impeller shall be made with galvanized steel. Entire assembly shall be enamel painted to avoid the rust. The fan should have sickle blade impellers.

The maximum noise level shall not be more than 60 dB(A) at 3 meter in hemispherical reverberant room condition.

The fan motor should be external rotor type with IP 54 protection to comply 40 ° ambient temperature and isolation against high humidity (max 80 %).

Motor shall be suitable for 410 ± 10% volts, Single phase, 50 cycles electric supply- I. The motor (Eff1 Class-Motor must be VFD Compatible)

The Fan should be available in different diameters ranging from 300 mm to 630 mm.
Statically and dynamically balanced to ISO 1940 standard.

Accessories such as speed controller and mounting accessories shall be supplied with Fan.

7.0 INLINE FAN UNIT:

7.1 Scope:

The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specifications and in accordance with the requirement of bill of

quantities.

7.2 Inline Fan Unit:

Application/ Location as per Layouts and BOQ

The INLINE ventilation fans shall be designed for space saving / low noise generation. Inline fans shall preferably be single skin with swing out motors; these fans shall be complete with casing and impeller. Direction of discharge and rotation position shall be as per the job requirement and shall be marked on the fan assembly.

The duty points shall be mentioned in the schedule of quantities. Brief specifications for the fans are as under.

The proposed fan shall be complete with casing, motor and impeller. Direction of discharge and rotation position shall be in line with the layout shown.

Housing Shall be of GSS powder coated design. The duct connections at the inlet and discharge side of the fan shall be in accordance with the manufacturer standards to avoid transmission of vibrations if any to the ducting.

Impeller Fan shall have Aluminium impeller with backward curved blades suitable for lowest sound power level. Impeller shall be statically and dynamically balanced. Necessary acoustic insulation required to bring down the noise to the value specified in the SOQ shall be carried out if required; the product shall be supplied with factory insulated design in this case.

Ball Bearings Shall be completely maintenance free and can be used in any mounting position at maximum indicated temperature.

Fan motor Fans shall be energy efficient type have external rotor motor or IEC standard motor supplied with built-in thermal contacts. At the critical high temperature point the thermal contact shall open and break the power supply of the Fan. Fan motor shall be insulation class F and protection class IP55.

Drive Drive of the fans shall be direct driven.

Performance Data All fans shall be selected for the lowest operating noise power levels. Capacity ratings, power consumption with operating points indicated shall be submitted and verified at the time of testing and commissioning of the installation. All technical data of fans should be as per AMCA accredited. High temp fans should have valid European certification in accordance with EN12101-3.

Testing Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall confirm to specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

8.0 CENTRIFUGAL FAN:

8.1 Scope:

The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specifications and in accordance with the requirement of bill of quantities.

8.2 Centrifugal Exhaust Air Fan:

Type:
Centrifugal fan shall be SWSI class I construction arrangement 3 (i.e. bearings on both sides) or as specified in BOQ complete with access door, squirrel cage induction motor, v-belt drive, belt guard and vibration isolators. Type, direction of discharge/rotation and motor position

shall be as shown in the drawing and/or in the bill of quantities.

Centrifugal shall be Double inlet Double width (DIDW) / SISW as the case may be class-I centrifugal and vibration isolators Discharge arrangements. The fans shall be a self-contained unit comprising of motor, belt drive/direct drive arrangement in suitable factory fabricated acoustically treated housing. The efficiency of fans at operating conditions should be more than 75%.

Housing:
Housing shall be constructed of 14-gauge sheet steel welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene/asbestos packing shall be provided throughout split joints to make it airtight. 18-gauge wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard clean outdoor with handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

Fan wheel:
Fan wheel shall be backward – curved non-overloading type utilizing hollow sectioned aerodynamically shaped aerofoil blades. Fan wheel and housing shall be statically and dynamically balanced. For Fans up to 450 mm dia, fan outlet velocity not exceed 1450 rpm. For Fans above 450 mm dia, the outlet velocity shall be within 700 meter/minute and maximum fan speed shall not exceed 1000 RPM. High static pressure fan speed shall be as per manufacturer.

Shaft:
Shaft shall be constructed of steel, turned, ground and polished.

Bearings:
Bearings shall be of the sleeve/ ball bearing type mounted directly on the fan housing. Bearings shall be especially designed for quiet operation and shall be of the self aligning, oil/grease pack pillow block type.

Motor:
Fan motor shall be TEFC, Squirrel cage, induction motor, with IP-55 protection and class 'F' OR equivalent insulation & EFF 1 as per particular application. Motor shall be suitable for 415± 10% volts,3 phase, 50 cycles, A.C. supply. Motor shall be of continuous duty and specially designed for quiet operation and motor speed shall not exceed 1450 rpm. Motor nameplate horsepower shall exceed brake horsepower by a minimum of 10%. The fan and motor combination selected for the particular required performance shall be of the most efficient (smallest horsepower), so that the sound level is lowest.

Drive:
Flexible coupling with guard shall be provided if fan- motor arrangement is direct drive type if specified in bill of quantities. `V' belts and pulleys shall be provided if fan-motor arrangement is variable drive type. Belt guard with vent shall be provided for belt protection and heat dissipation.

Vibration Isolation:
M.S. base shall be provided for both fan and motor, built as an integral part, and shall be mounted on a concrete foundation through spring isolators. The concrete foundation shall be at least 150 mm above the finished floor level.

9.0 CENTRIFUGAL CABINET EXHAUST AIR FAN:

9.1 Scope:

The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specification and in accordance with the requirement of bill of quantities.

9.2 Centrifugal Cabinet Exhaust Air Fan

Application/ Location as per Layouts and Selection as per Tender annexure

Specifications same as FFU above but shall be without Filters

- Kitchen Exhaust Fan:

The fan for kitchen exhaust shall be backward inclined curved impeller type with self cleaning properties. It shall have limit load characteristics. The motor drive train shall be kept outside the air stream. Casing for Fan shall be made of Al extruded PUF insulated panels.

10.0 DRY SCRUBBER:

Equipment Description

The Industrial Electronic Air Cleaning System shall be supplied as a one-piece factory joined assembly of individual section(s) selected to treat oil mist, smoke, fume, grease & dust/ powder problem.

10.1 Unit Housing:

Housing shall be 1.2mm thick cold steel construction & powder coated to protect against rust and corrosion. It shall have a single hinged door for cell access, located one side of the unit. The door shall be gasketed to prevent air leakage. There shall be a safety interlock switch to cut off primary supply when the access door is opened.

10.2 Finish:

The external finish shall be a durable industrial grade semi gloss epoxy coating.

10.3 Ionizing – Collecting Cells:

Ionizing-Collecting cell(s) shall be of one-piece construction 13.38" (340mm) deep in direction of airflow. The dimension of the collection cell shall be 18.89" (480mm) H x 21.65" (550mm) W Max. All support framing, end plates and ionizer ground electrodes shall be 0.090 inch (2.2mm) thick aluminum. Both repelling and collector plates shall be 0.032 inch (0.8mm) thick aluminum alloy material rigidly retained in place with tubular spacers and tie rods. Each plate shall be corrugated, perpendicular to airflow direction. Spacing between plates shall be no less than 0.318 inch (8mm). Each cell shall weigh at least 14 kg with at least 8 ionizing wires.

UNIT SHALL BE SELECTED SUCH THAT THE FACE VELOCITY ACROSS THE ESP CELLS DOES NOT EXCEED 3.2 M/S & MINIMUM COLLECTION AREA SHALL BE 2.1 SQM/1000 CMH.

10.4 Ionizer:

Ionizing electrodes / wires shall be of tungsten material, rigidly supported both vertically and laterally. Ionizing electrode to ground electrode spacing shall be 1.0" (25mm). High voltage support insulators shall be of Teflon material, glazed to enhance dielectric strength and retard tracking.

10.5 Air handling Capacity:

Each Ionizing / Collecting Cell shall be capable of handling up to 2500cmh of air. There shall be one or two such Ionizing / Collecting Cells per module, handling up to 2500 cmh & 5000cmh per module respectively.

The rated efficiency shall be up to 95% based on the **NIOSH 5026 OIL MIST TEST.4.0**

10.6 Power Supply:

Power supplies shall be 100% solid state, operate on 240 VAC, 50 HZ, 1 Phase input and provide a dual high voltage output of 12 to 13 KVDC for the ionizer and 6.0 to 6.5 KVDC for the collector in normal operation conditions. Current output at the high tension shall be 12mA. A maximum power output for the solid state power supply shall be 120 watts to maintain the specified collection efficiency. Integrally mounted Electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power. The power supply shall operate over a temperature range of -32 degrees F to 140 degrees F, be overloaded self-protecting and accommodate an LED lights indicating the performance status of the ionizing/collecting cell. High voltage output components in the power supply shall be sealed with epoxy for moisture resistance.

10.7 Outstanding Features:

The power pack shall incorporate a short circuit arc protection with automatic power restoration system to prevent overload.

10.8 Performance Indicator:

There shall be 2 LED lights (Green & Red) installed on the access door of the unit to indicate the status of the air cleaning system.

10.9 BMS (Building Management System) interface:

The power supply (pack) shall have a 3 wire dry contacts (NO/NC) for remote link to Building Management System. This is for performance indication of the air cleaning system.

10.10 Electrical:

Factory wiring will be in accordance with the National Electrical Code. Required field wiring shall conform to the National Electrical Code and any local code requirements. The manufacturer shall be informed of any local variances to the National Electrical Code.

11.0 AIR WASHER UNIT:

11.1 General:

Direct cooling system includes components of evaporative media, re-circulating pump, sump drain, overflow, automatic fill and level control and internal piping. House all components in a common casing.

Exterior panels shall be removable to permit access to any interior component.

The unit will be sectionalized double skin construction made out of 0.63mm white pre-coated GI outer skin, 0.63mm GI inner skin, 23+/-1 mm CFC free PUF Insulation to density of 38-42Kg/m3. The structural construction shall be extruded aluminum profile.

The skid will have necessary cross members to take care of the load of fan blower assembly. All the components of the unit will be of proper design and quality to ensure vibration free and noiseless operation.

- **Filters**
  The filters shall comprise of HDPE filters of cell/box type construction with 85% efficiency down to 20 or 10 microns. The filters should be slidable and washable.
  Pre-coated Louvers should be provided for outdoor installation units.

- **Re-Circulation pumps**
  The recirculation pump should be of SS 304 submersible type and of approved Ebara make. The pump should be designed such that it can handle the designed amount of water flow and maintain required head. The pumps should be designed such that pump

shaft horsepower (BHP) shall not exceed motor rated horsepower throughout the entire operating range of the pump performance curve. Pump shall be built to operate.

The pump shall be furnished with a non-mechanical double oil seal.
The pump motor shall be minimum 1/3HP, 0.3 Kw, 230 Volts, 50 Hz single phase motor. The motor shall be supplied with built-in thermal protection with automatic reset and shall be rated for continuous duty.

- **Piping**
  All internal piping shall be of UPVC.

- **Direct Evaporative Media**
  The media shall be celdek with Thickness of 200 mm in case of 7mm flute. The water tank shall be made up of 18SWG (1.2mm) thick SS 304 plain sheet to house adiabatic heat exchangers.

  The water tank shall be designed as chassis to hold the heat exchangers support system. The water distribution system shall be designed properly to get proper efficiency across the heat exchangers. The piping shall be used of rigid UPVC material. Piping connections should be made so as to ensure uniform distribution of water. The sump shall be fitted with float valve.

- **U-V Filter**
  Provide UV filter for re-circulation line.UV filtration controls the bacterial disinfections in the supply water line thereby restricting the growth of algae and fungus. The capacity shall be based on the flow rates of individual machines.

11.2 Blower Section:

The blower section shall include AMCA certified centrifugal Backward curved DIDW fans. The unit shall be of GI construction. It shall have individual motor and drive and shall be mounted on C channel frame and cushy foot mounts. The fan shall be constructed and rated based on the delivery against the rated static pressure with the media and filters in place. The fan shall be of riveted construction and made with GI sheet of required thickness. The fan wheels shall be of multiblade type and mounted on two self alignining pillow block bearings of required size. The fan shall be run with the help of 'V' groove drives as per the recommendation of the drive supplier. The blower housing shall be made of machine made roll formed Pittsburgh joint construction and the drive shall be provided by a motor of required capacity.

11.3 Motor:

Motors shall be IE2 (EEF-1) type of ABB/Siemens/BB approved make.

11.4 Control Panel:

Panel shall be Non - Compartmentalized panel and should have RYB indication -Indication lamps, Incomer-SFU/MCCB Blower/Pump controls- Thru' -MPCB, Contactor with OLR, Digital display- VAF meter, ATE-PLC - for logic control.

It should have both Auto and Manual mode. It should have light indicator with push buttons for each component i.e. Primary fan and Pump that shows On – Off – Trip status.

12.0 CAR PARK BASEMENT VENTILATION SYSTEM:

12.1 Design Brief and Equipment:

A. Introduction:

The scope of this tender is to design, supply, install, test and commission
Basement Ventilation Systems

Lift Well Pressurization System
The Basement area comprises of following major areas:
Basement: Car Park
Car Park Area is proposed with ducted ventilation system and other areas of Basement are proposed with dedicated ventilation for each area.

B. Design Philosophy for Ventilation Systems:

The basis of ventilation system design is based on NBC ; The rates concluded on basis of the same are as under:

Total 15 air changes per hour for all rooms under normal conditions
Total 30 air changes per hour for all rooms for Smoke extraction mode at the time of fire.

System option Recommended for CAR PARK Area

Tube axial fans with jet fan network ductless ventilation System is proposed for Car Park Ventilation exhaust main fans for CAR PARK. The **Fire Mode** operation shall be catered by additional Tube Axials . During normal mode, hence, under this option, the offered additional Fire Mode TAF shall remain non-operational.

ANNEXURE - shows the area and volume calculations for Basement Car Park Area

Design Notes:
Dual speed fans avoided to eliminate higher power consumption during fire modes on account of increase in design static at 30 ACPH as well as to avoid installing higher rating motors at this stage.

Fresh air fans to be normal design and Exhaust Air fans to be Treated Fire type with 300 deg C for 3 hrs.

Due to its lower BHP consumption, Vendor to provide option of Centrifugal Fan for Normal Mode Fresh Air and Normal Mode Exhaust fan; in this option, the fire mode operation shall be augmented by the above referred Tube Axial Fan only.

Section 1.01

Tube Axial Fan TAF shall be adjustable pitch blade type having non-overloading feature. Fan shall comprise of following components.

Capacities: Fan capacities shall be as per the schedules shown in Schedule 1 and 2 for various areas.

Fan: Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

Casing: shall be constructed of heavy gage sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 20mm thick and machined to receive motor flange.

An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.

Rotor: hub and blades shall be cast aluminum or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual airflow values, as specified and quoted.

Motor: shall be energy efficient squirrel-cage, totally-enclosed, fan cooled standard round frame, constant speed, continuous duty, single winding, suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, provided with class 'F' insulation. Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1440 / 2990 RPM for fans with impeller diameter 450 mm and less. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

Drive: To fan shall be provided through direct or belt drive; belt drive shall be with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of oil-resistant type.

Vibration Isolation: The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of rubber-in-shear type OR Mounted flush with the wall with proper isolation to avoid transmission of vibrations to the wall and structure.

Jet Ventilation Fan

Jet Fans, a part of ductless car park ventilation system, should be supplied as completely assembled before dispatched to the job site having characteristics as of high performance ventilation with small air volume. Each unit shall consist of fan having inlet cones, protective screen, two silencers, terminal box & mounting arms or brackets.

Fan: Fan shall be axial flow type balanced dynamically and statically. The fans shall have adjustable aluminium impeller or shall be fully welded. The complete fan assembly with its Casing, impeller & motor (not only the motor or one of the item) shall be imported from manufacturer and certified as tested for 300 Deg C for 2 hours operation.

Casing: The Casing of Jet Fans shall be made of Hot Dipped Galvanized Steel with flanges at both ends.

Motor: The Motor shall run on the electrical power suitable for 50Hz. The Type of motor shall be suitable for 2 speed or single speed as specified in the BOQ.

Protective Guards: The fans shall have protection guards at inlet side.

Silencers: The Jet Fans shall have silencers manufactured from Galvanized steel length should not be less than 900 mm.

Inlet Cone: Jet fans shall have Inlet cone made of Galvanized steel
Terminal Box: The pre-wired Terminal box shall be mounted at the outer fan Casing.
Mounting Arms / Brackets: The unit shall be with mounting brackets for ceiling suspension.

12.2 Ventilation System Specifications:

The intent of this document is to specify the systems and equipment's for Ventilation system for basement service areas / car park areas.

The equipment schedule for the same is already provided above; the system shall be designed in accordance with the details provided under various schedules therein.

A. Codes and Standards:

- All relevant codes as per BS for underground ventilation design shall be complied by the bidder.
- Duct Construction Standard as per IS:655 and applicable SMACNA Codes for ducting design, fabrication and installation
- NFPA compliance for fire-safe HVAC design
- BMC Instruction

The scope of this tender covers the design, supply, installation, testing, commissioning and handing over of ventilation system for

a. Basement Car park areas
b. Utility Equipment Rooms

The area, air quantity requirement and the equipment's for the above compliance are mentioned under Schedules 1 and 2 above.

13.0 JET FANS :

13.1 Jet Fan Axial Type:

The location of the jet fans should be such that to ensure best distribution of the inlet airflow as far as possible to maintain pollution level within statutory limits.

- Minimum velocity in the car park at low speed to be at least 0.1 m/sec
- Noise at low speed to be less than 58 dBA @ 1M.
- Quantity & location of the jet fan shall be fine-tuned after CFD analysis.
- For the acceptance of the CFD report, following are the vital criteria

a. CFD analysis shall be carried out for both normal pollution mode and as well as during fire mode. During normal pollution mode analysis would be done for Air-Velocity & CO concentration in the domain when the Jet fans are operated at half speed and smoke spill fresh air fans (if any),

b. During fire mode CFD analysis will be carried out for Air-Velocity, CO concentration, Temperature of smoke laden air in the domain and sight length i.e. visibility during smoke clearance. In fire mode the Jet fan are operated at high speed and all smoke spill fans at full speed.

➢ The Jet Fan section should consist of axial flow type with statically and dynamically balanced. Smoke and heat exhaust fans are required to be CE Labeled or UL Listed in accordance with "Power Ventilators for Smoke Control Systems" or should be EN-12101-3. The fan should have aluminium impeller. The complete fan assembly with casing, impeller and motor shall be used only imported also tested at 300°C for 2 hours operation.

A. Casing: -

The casing of Jet fans shall be made of Aluminum / Galvanized steel with flanges from both ends. To achieve the minimum and equal clearance between the blade tips and casing, tube casing shall maintain its roundness by means of using one piece of sheet metal with 90 edge flanging up.

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.

B. Motor: -

Fan motor shall be shall be suitable for 300 Deg.C @ 2 hrs. The fan motor shall be suitable for 415 ± 10% volts, 50 Hz, 3 phase power supply.

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.

C. Silencers: -

Silencers of Jet Fan shall be provided in Galvanized construction with all fans with appropriate length.

Silencer should have rounded nose to smooth airflow and a tapered tail to reduce the air turbulence and pressure drop.

Silencer should be with Glass fiber as absorption filler material to achieve excellent acoustic performance.

The complete assembly shall provide with inlet & outlet painted protection net for protection against foreign particle.

D. PERFORMANCE DATA:

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated, shall be submitted, and verified at the time of testing and commissioning of the installation.

E. TESTING:

Capacity of all fans shall be measured by Velometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

- **CO SENSORS**

CO sensors are a vital tool used for energy saving and hence specification and type used is very important.

CO sensors should be designed for high accuracy at low concentrations, for detecting CO levels in the parking lot. Range Should be 0 to 250 PPM, accuracy should be ± 10% FS for 100 to 250ppm, ±5% FS for 0 to 100ppm & warming up time Within 30 Seconds to 90% of final value. It is used or the purpose to conserve energy when the CO level is low.

The CO Sensors shall be placed at mid height within the space at column positions.

Upon detection, a signal is sent to the master control panel, which then determines which fans, on which level and at what speed are to be activated.

- **CONTROL PANEL WITH PLC**

Control Panels for value engineered proposal as per our design has following feature:-

The jet fans, smoke spill fans & CO Sensor shall be operated through Fan Starter Panels. The distribution shall be for all these fans in form of three phase supply.

Incoming Power feeder to each Panel shall be supplied by client. PLC panel to zone the fans and varying of speed based on pollution norms and Fire Panel feedback is also a part of scope.

We shall also provide micro-processor based Remote Logic controller with all logics and built-in 4 line HMI (minimum) for monitoring the Panel individually.

The scope shall also include linking of all local PLC installed in the individual/in combination Power distribution Panel with a MASTER LOGIC CONTROLLER (MLC) where status of all Panels can be monitored.

This MLC is typically placed in BMS room for centralized monitoring. Communication between Local Logic Controller will be Ethernet / Profibus / Modbus. MLC will have at least 5.7inch HMI with touchscreen for Operator Interface.

MLC shall have provision for future expansion to link with client BMS.

LOGIC of Fans switching on during fire is also a part of SCOPE.

MASTER LOGIC CONTROLLER PRIMARILY CONSISTS OF

Programmable logic controller (PLC).

Touch screen based human machine interface (HMI) placed in an operator pendant.

Communication bus protocol like Ethernet / Modbus for interface with control panel.

MLC WITH TOUCH SCREEN DISPLAY ARE PROVIDED TO

- Control the Jet fan operation based on the CO level.
- Flexibility in modifying the logic of control at site.
- Single point monitoring window for all Jet fan and sensor status with respect to speed & Current of individual Jet fans and CO level of each sensor can be monitored.
- Displaying the energy (KW) consumed viz.a.viz the total installed KW
- Diagnostics of individual fan status

HUMAN MACHINE INTERFACE:

- Touch screen HMI is provided as easy interface for monitoring & diagnostics.
- Variables like ON / OFF time, sequence of operation etc. Can be viewed in the screen and
- modified as a variable
- Thus, HMI works like a localized SCADA system
- Details of screen developed is as follows:

Reduced hardwire in control panel, - reducing MTBF (mean time between failure)

Single cable communication between control panel to master logic controller

Single point operation of the control panel – ease of operator control

Fire operation control via external input (from fire panel/BMS) or selection at control panel.
Continuously monitor the fan status (speed / current) and sensor status (CO levels) at single point

Integration with building automation controls for seamless control of complete building systems

It is also possible to set a Time-stamp where the Operation of Car park ventilation can be started / switched off based on Pre-programmed time schedule which can be set based on actual Load on Car parking.

POLLUTION LEVEL	JET IMPULSE FANS	PARKING EXHAUST AXIAL FANS	SMOKE EXHAUST FANS
CO ≤ 30 PPM	OFF. However, all Jet Fans shall operate for 5 minutes every one hour irrespective of CO level when the car park is ON.	All fans shall operate at such a speed in each level to achieve 2 ACH	OFF.
CO > 30 ≤ 50 PPM	Low Speed for the respective fans connected to the CO sensors Group.	All fans shall operate at such speed in each level that is directly proportional to the CO level. (Generally within 2-4 ACH)	OFF.
CO > 50 PPM	Low Speed for the respective fans connected to the CO sensors Group.	All fans shall operate at such speed in each level.(Generally up to 6 ACH)	OFF.
In case of Fire in any of the Level	All jet fans are stopped at the alarm detection system, after a 2-3 minute delay, the jet fans resume at high speed. This delay is to prevent spread of smoke and assist in evacuation of people during fire.	All fans shall be operated at full speed in fire level to achieve 15 ACH.	All fans shall be operated at full speed in fire level to achieve 30 ACH.

14.0 STAIRCASE & LIFTWELL PRESSURIZATION:

Stairwells and elevator shafts can become smoke logged thereby blocking evacuation and inhibiting fire fighting. Once inside a protected route, people in a building should be able to make their way to a final exit and safety in the open air. As per BS - 5588 Part-4 1978 "It is the smoke and toxic gases, rather than the flame, that will in the first instance inhibit this movement and the exclusion of the smoke and gases from the protected routes is thus of great importance

To achieve the above, a two-stage compensated type stair well pressurization system is envisaged for all the stairwell shafts to ensure normal stairwell ventilation during normal conditions and attain higher pressure for prevention of smoke accumulation during fire or emergency. Automatic pressure compensation against door openings shall be achieved by a variable air flow rate by varying the fan speed. The control signal shall be obtained from a pressure sensor controller that senses the static differential pressure between the stair tower and the occupied zone and gives feed back for corrective action.

14.1 Design Guidelines

As per, BS- 558 part 4, ASHRAE manual, an optimum pressure level of 50 Pa during emergency operation shall be maintained across the stairwell door and ambient. Maximum pressure difference is expected to exist when all the doors are closed.

If the stairwell shaft and lobby is in the core of the building a positive pressure between 25 and 30 pa shall be maintained in the lobby and a positive pressure of 50 pa shall be maintained in the lift shaft. The mechanism for the pressurization shall act automatically with the fire alarm/sprinkler system and it shall be possible to operate this mechanically also.

If the staircase is in the core of the building and cannot be ventilated at each landing, a positive of 5-mm. w.g. by an electrically operated blower/blowers shall be maintained.

Table A: Pressurization Level BS 5588 Part-4		
	Pressurization Level (Pascal)	
	Emergency Operation	Reduced Operation
Upto12m	50Pa	8Pa
Above 12 m	50 Pa	15 Pa

14.2 The Existing Application Falls In "Above 12 M" Category

AIR INTAKE AND DISTRIBUTION

The supply air intake should be separated, from various exhaust shafts and roof smoke and heat vents. Open vents of elevator shafts or other building openings that may expel smoke during a fire should be located remotely from the intake air location. This separation should be maximum possible.

The air supply to the pressurized staircase should be evenly distributed throughout the whole height of the staircase. The air outlet grilles should be located not more than three storey apart preferably the air be injected at each floor to prevent loss of pressurization through a few open doors. The system shall be capable of automatic shut down in events of smoke feedback into the tower.

The proposed stairwell pressurization system shall basically comprise of but not limited to
SISW industrial type backward curved centrifugal fan for each stair well with discharge route duly ducted operated by suitable 4 pole TEFC induction motor as per the specifications provided later herein.

Fan Motors shall be operated by Variable frequency drive to compensate and maintain the desired pressure difference in the stairwell
Intake assembly with necessary louvers and filters.
Distribution GI ducting with grills. The grills shall suite to the interiors within the building. The specifications of the duct work and grills shall be as specified elsewhere.
Related electrical work comprising of power and control panel
Automation system comprising of

i. Field DP Transmitters to provide DP feedback and vary fan speeds to counter the leakage situations during normal and emergency operation
ii. Smoke sensors to check & give alarm and shut down the system during reverse smoke feedback.

15.0 VARIABLE FREQUENCY DRIVES

15.1 General Requirements

This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD.

The frequency converter shall not be a general-purpose product, but a dedicated HVAC engineered product.

The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.

The VFD shall be tested to UL 508C. The appropriate UL label shall be applied.

The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.

The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.

15.2 Technical Requirements

The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.

VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

IEEE519, 1992 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC). On request VFD manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuit impedance etc to allow this calculation to be made.

All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-3 : 2004, Category C1 with 50m motor cable (unrestricted distribution). The suppliers of VFDs shall include additional EMC filters if required to meet compliance to this requirement.
The VFD's full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

A programmable automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.

The VFD must be able to produce full torque at low speed to operate direct driven fans.

Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

The VFD shall allow up to at least 100 meters of SWA (Single Wire Armour) cable to be used between the FC and the motor and allow the use of MICS (Mineral Insulated Copper Sheath) cable in the motor circuit for fire locations.

15.3 Protective Features

A minimum of Class 20 I2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.

Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high. In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

The VFD shall have temperature-controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

Protect from output switching: The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor with VFD in ON mode.

The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

15.4 Interface Features

Hand, off and Auto keys shall be provided on the control panel to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

There shall be an "Info" key on the keypad. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.

The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

Display shall be programmable to communicate in multiple languages including English, Chinese, Korean, Japanese, Thai and Indonesian.

A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

A three-feedback PID controller to control the speed of the VFD shall be standard.

This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or minimum deviating signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

The VFD shall be able to apply individual scaling to each feedback signal.

For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.

The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.

Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

Five simultaneous meter displays shall be available. They shall be selectable from (at a minimum), frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, feedback signals in their own units, among others.

Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.

VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F). Examples can be room temperature in 0C, return air temperature in 0C, supply air temperature in 0C, CO2 concentration in ppm, pressure in bar, differential pressure in PSI etc.

VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

Standard Control and Monitoring Inputs and Outputs

- Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.
- Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.
- Each relay shall have an adjustable on delay / off delay time.
- Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.
- Each shall be independently selectable to be used with either an analog voltage or current signal.
- The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.
- A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
- The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,
- One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.
- It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.

- It shall be possible to command all digital and analog output through the serial communication bus.

Optional Control and Monitoring Inputs and Outputs

- It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.
- These modules shall use rigid connectors to plug into the VFD's control card.
- The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
- Modules may include such items as:
- Additional digital outputs, including relay outputs
- Additional digital inputs
- Additional analog outputs
- Additional analog inputs, including Ni or Pt temperature sensor inputs
- It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Firemode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

A real-time clock shall be an integral part of the VFD.

1. It shall be possible to use this to display the current date and time on the VFD's display.

2. Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

3. All VFD faults shall be time stamped to aid troubleshooting.
4. It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

5. The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

6. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

    - The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
    - Comparators for comparing VFD analog values to programmed trigger values
    - Logic operators to combine up to three logic expressions using Boolean algebra
    - Delay timers
    - A 20-step programmable structure

The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

15.5 Serial Communications

The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

- Metasys N2
- Modbus RTU

VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

15.6 Adjustments

The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.

Four independent setups shall be provided.

Four preset speeds per setup shall be provided for a total of 16.

Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.

The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

15.7 Optional Features

All optional features shall be built and mounted by VFD manufacturer as an inbuilt factory solution. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.

15.8 8 Service Conditions

Ambient temperature at full speed, full load operation with continuous drive rated output current:

- 10 to 45°C for ratings upto 90 kW without derating
- 10 to 40°C for ratings 110 kW and higher without derating

Relative Humidity: 0 to 95%, non-condensing.

Elevation: Up to 3,300 feet without derating.

AC line voltage variation: + 10% of nominal with full output.

VFD Enclosure protection: IP 55, integral, with no additional cabinets.

Side Clearances: No side clearance shall be required for cooling.

All power and control wiring shall be done from the bottom.

All VFDs shall be plenum rated.

15.9 Quality Assurance

To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

All optional features shall be functionally tested at the factory for proper operation.

16.0 INSTRUMENTATION SYSTEM

16.1 Fan Coil Thermostatic Controller

Fan coil controllers shall be digital type and designed for heating and cooling application. The controller shall have digital display of room temperature which shall be programmable through a set-point knob. The unit shall be provided with liquid filled sensing element.

Controller shall be located around 5 feet above floor in the location of avg. temperature without exposure to heat generating areas.

Range	:	40 to 90 F
Ambient Operating Temp	:	0 – 105 F
Switch	:	Snap Acting Type
Cover	:	Thermoplastic
Base	:	SS
Listing	:	UL/CSA

The proposed room thermostatic controller shall be BMS communicable.

16.2 Field Instruments – Sensors and Transmitters

Factory Calibration, Supply, Installation with all required fixtures and accessories, Testing, Site calibration and Commissioning of Field Sensors and Transmitters tabulated as per SOQ

Brief Specifications for the field devices are provided below; however, detailed installation and other specifications are provided in the material specifications which vendor shall comply to.

Temperature Sensors

Temperature sensors shall be of the resistance type and shall be either three-wire 100 ohm platinum RTD, or two-wire 1000 ohm platinum RTD. General specifications for these are as under

- Materials: Nickel or Platinum element.
- Mounting: Duct/Pipe, Room
- Range: -10°C to 60°C, 0°C to 70°C
- Accuracy: +/- 0.3°C
- Output: Resistive 1000ohms @ 21°C
- Approval: UL/CSA/FM/Eq

Special: Duct Element Holder, Brass Well Assembly, Room Mounting Bracket and Cover

Humidity Transmitters

The sensor shall be a solid state, resistance type relative humidity sensor of the Bulk Polymer Design.

The sensor element shall be washable and shall resist surface contaminations.

- Materials: Polymer
- Mounting: Duct or Wall
- Range: 0% to 100%
- Accuracy: +/-3%
- Protection: 0-100% non-condensing
- Output: 0-10vDC, 4-20mA
- Approval: UL/CSA/FM/Eq
- Special: Duct or Wall Mounting Kit

Note: A combined T+Rh (Temperature and Humidity sensing) can be offered by vendor complying with individual sensor specifications as above.

31.1 Combined T+RH Transmitter

Combined Temperature and Relative Humidity Sensors/Transmitter (Installed in AHU RA path for Humidity and Temp sensing)

1. The sensor shall be a solid state, resistance type relative humidity sensor of the Bulk Polymer Design. The sensor element shall be washable and shall resist surface contaminations.

- Materials: Polymer
- Mounting: Duct or Wall
- Range: 0% to 100%
- Accuracy: +/-3%
- Protection: 0-100% non-condensing
- Output: 0-10vDC, 4-20mA for Rh / RTD output for T sensor
- Special: Duct or Wall Mounting Kit
- Combined Temperature sensor: RTD Type

Pressure Transmitters

Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.

- Materials: SS body and Brass bellows
- Accuracy: ± 0.5 % FS
- Mounting: Pipe mounted at Pumps discharge points
- Op Pressure Range: To Suit Pump Discharge Pressures ranging from 1kg/cm2 to 6 kg/cm2
- Operating Temp Range: -30 °C to 80 °C

- Protection: IP65 Housing.
- Output: 0-10V (or as suitable for DDC input)
- Approval: UL/CSA/FM/Eq
- Special: Pipe taps and shut off valves provided by Mechanical Contractor

16.3 Differential Pressure Transmitters

The DP Transmitter shall be for air DP and supplied with all Accessories (for AHU Discharge Duct pressure measurement and for Shaft DP measurement for stairwell pressurizatroin system)

1. General Air Differential Pressure Transmitter Requirements:

   a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.

   b.
   - Materials: Brass bellows
   - Mounting: Pipe mounted
   - Range: 100mbar to 5bar, 60mbar fixed differential.
   - Operating Range: -30 °C to 80 °C
   - Protection: 10 bar Differential overpressure, IP65 Housing.
   - Output: Changeover contact, 1A @ 250Vac
   - Special: Pipe taps and shut off valves provided by Mechanical Contractor.

   c. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device and shall be supplied with shutoff and bleed valves in the high and low sensing pick-up lines (3 valve manifolds).

   d. Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible.

      Low air pressure, differential pressure transmitters used for room filter monitoring. Shall be equipped with a LED display indicating the transmitter output signal

Liquid Level Transmitters (water duty)

The proposed liquid level sensors shall be of non-contact ultrasonic type and balance specifications as below

- Mounting: Tank with all necessary fixtures to ensure plumb installation
- Range: 0.5m to 8m
- Accuracy: 0.25% measuring range
- Protection: -20-80 °C, IP68
- Output: 0-10vDC, 4-20mA (matching the DDC protocol)
- Approval: UL/CSA/FM/Eq
  - Special: Tank Mounting Kit to be supplied

Differential Pressure Switches (water duty)

- Mounting: Discharge and Suction Ports of Pumps for hydraulic status
- Operating Temp: -1 to 70 deg C
- Wetted parts: Polyeurethane dia / eq.
- Type: SPDT Precision snap acting type (10 million cycles)
- Approval: UL/CSA/FM/Eq.
- Operating Pressure: 0-150 psi
- Repeatability: ± 1 % span
  - Protection/Listing : NEMA 4/UL

Damper Actuators

- Mounting: Fresh Air Dampers for Public Area AHUs
- Action - spring return (0-90deg turn max.)
- Modulating Type operating on 0-10V/4-20mA to meet Controller Output
- Torque = 8-10 Nm (to suit damper demand)
- Run time = 150 s (app.)
- Shaft diameter = 8-26 mm adjustable
- Protection / Listing = IP 54 / UL-CE
  - Environmental = Minus 30 to Plus 50 C / 95% non-condensing

Clamp On type Flow Meter

- Location: Chilled Water Return header from chiller
- Type: Ultrasonic type – clamp on type.
- Accuracy: ± 2% of full scale
- For pipes size upto: 200 mm NB with required fixtures
- Listing: UL/CE
  - No insertion in the pipes is required.

CO2 Sensor

- To trigger: Fresh Air damper actuator through DDC Controller
- Location: At 8 feet in center to suit interiors for public areas
- Coverage: 100 sft area at 8 feet ht @ 120 degrees
- Response time: 1 sec
- Sensitivity adjustment: Required
- Listing: UL/CS
- Accuracy: As per mfr std.
  - Installed with all required fixtures

Insertion Flow Meter

- Location: Chilled Water Supply header from chiller
- Type: Turbine/Eq.
- Accuracy: ± 1% of full scale
- Sensor body: SS 316
- Shaft: Ni bound Tungsten Carbide eq.
- Bearings: Ruby eq.
- For pipes size upto: 200 mm NB
  - Listing: UL/CE

Control Valves

For FCU

- Type: 2way
- Location: FCU inlet (diverting) OR FCU outlet (mixing)
- Actuator Type: Two position / ON/Off type
- Actuator details: IP 40 protection/24 V AC/Direct Mount spring return
- Valve Body: Forged Brass with Cr plated stem
- Listing: UL/CE
- For AHU
- Type: 2 way Pressure Independent Balancing cum Control Valve
- Location: AHU inlet
- Body: Bronze with SS Stem
- Actuator Type: Modulating/Direct mount spring return
- Actuator details: 0-10V signal/IP 40 protection/230V AC
- For Chiller Isolation
- Type: 2 Way butterfly type/equal percentage
- Location: Chiller outlet
- MOC : Body Ductile Iron / EPDM Seat / Shaft & Disc 304 SS

- Actuator: Spring return ON/Off / 24V AC
  - Protection: NEMA 2

17.0 AIR CURTAINS:

17.1 SCOPE:

The scope of this section comprises the supply, erection, testing and commissioning of fans conforming to these specifications and in accordance with the requirement of bill of quantities.

17.2 Air Curtains

Proposed to trap the Air-Conditioned air near entrances opening into AC areas, the Air Curtains shall be installed on the NonAC portion of the entrance/exit doors; the length of the curtain assembly shall exceed the actual width of the OPEN-Door Portion for effective entrapment of conditioned air.

Curtains shall be CRCA Powder Coated with suitable color shade, Polymer Suction Grille.

Impellers shall be Aluminium material, statically/dynamically balanced, low noise operation, forward curved driven by Motor of reputed make, 240 V, Single phase and double ended shaft.

18.0 SENSORS AND TRANSMITTERS:

18.1 General Requirements

All Sensors should comply to following minimum general requirement

- It should be CE/UL Certified
- Should have individual serial numbers with calibration and traceability certificates
- Should have option of site calibration and validation
- Should be of the same make to ease installation, commissioning and post-handover services.
- Should have manufacturers' sales and service office in India mandatorily
- All Certificate copies to be submitted for approval

a. Provide sensors and transmitters required as outlined in the input/output summary and sequence of operation, and as required to achieve the specified accuracy as specified herein.

b. Temperature transmitters shall be equipped with individual zero and span adjustments. The zero and span adjustments shall be non-interactive to permit calibration without iterative operations. Provide a loop test signal to aid in sensor calibration.

c. Temperature transmitters shall be sized and constructed to be compatible with the medium to be monitored. Transmitters shall be equipped with a linearization circuit to compensate for non-linearities of the sensor and bridge and provide a true linear output signal.

d. Temperature sensors shall be of the resistance type and shall be either three-wire 100 ohm platinum RTD, or two-wire 1000 ohm platinum RTD.

e. Temperature Sensors (Resistance)

- Materials: Nickel or Platinum element.
- Mounting: Duct/Pipe, Room
- Range: -10°C to 60°C, 0°C to 70°C
- Accuracy: +/- 0.2°Cover full scale range

- Output: Resistive 1000ohms
- Special: Duct Element Holder, Brass Well Assembly, Room Mounting Bracket and Cover

f. CU operating software shall be equipped with a self-calibrating feature for temperature sensors.

g. The following accuracy's are required and include errors associated with the sensor, lead wire and A to D conversion.

Point Type	Accuracy
Outside Air	0.2°C
Room Temperature	0.2°C
Duct Temperature	0.2°C
Calculations	0.1°C

a. Sensors used in BTU or process calculations shall be accurate to ±0.10°F. over the process temperature range. Submit a manufacturer's calibration report indicating that the calibration certification is traceable to the National Bureau of Standards (NBS) Calibration Report Nos. 209527/222173.

18.2 Design Installation & Specifications

a. Temperature sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.

b. Strap-on mountings shall not be permitted.

c. Outdoor installations shall be; of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. Protective shield shall be stainless steel.

d. Sensors shall be with enclosure where located in finished space.

e. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces or positions obstructed by ducts, equipment, and so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element. Ducts shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.

f. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be noncorrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to effect proper flow across the entire area of the well.

g. Thermowells

ii. When thermowells are required, the sensor and well shall be supplied as a complete assembly including well head and greenfield fitting.

iii. Thermowells shall be pressure rated and constructed in accordance with the system working pressure

iv. Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.

v. Thermowells shall be constructed of the following materials:

- Chilled and Hot Water; brass.
- Steam; 316 stainless steel.
- Brine (salt solutions): marine grade stainless steel.

h. Outside Air Sensors

i. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

ii. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.

iii. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

i. Duct Type Sensors

- Duct mount sensors shall mount in a hand box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. A neoprene grommet (sealtite fitting and mounting plate) shall be used on the sensor assembly to prevent air leaks.

- Duct sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. Duct sensors probe shall be constructed of 304 stainless steel.

- For outdoor air duct applications, use a weatherproof mounting box with weatherproof cover and gasket.

j. Averaging Duct Type Sensors

- For ductwork greater any dimension than 48 inches and/or where air temperature stratification exists, utilize an averaging sensor with multiple sensing points. The averaging sensor shall be a 304 stainless steel tube with holes extending across the duct or plenum to be sampled. A bleed hole outside the duct or plenum causes air to enter the sample tube and exit at the bleed hole, thus bathing the sensor in average air. The averaging sensor shall be installed complete with end cap, compression fittings, gaskets, mounting flange and required accessories.

- Provide capillary supports at the sides of the duct to support the sensing string.

k. Intelligent Room Sensors

- Room temperature sensors are to be provided with a cover to prevent accidental damage.

- Sensor shall be supplied with a vertical base for mounting on a standard single gang junction box supplied by the SI contractor.

- Provide an integrated thermistor, neuron chip and FTT Transceiver for communication with the PCU communication network.

- Room Temperature sensor shall be a digital type with a digital display and setpoint adjustment.

18.3 Relative Humidity Sensors/Transmitter

1. The sensor shall be a solid state, resistance type relative humidity sensor of the Bulk Polymer Design. The sensor element shall be washable and shall resist surface contaminations.

2. Humidity Sensors

- Materials: Polymer
- Mounting: Duct or Wall
- Range: 0% to 100%
- Accuracy: +/- 0.2 % Over 0 to 100% full scale range
- Protection:0-100%non-condensing
- Output: 0-10vDC, 4-20mA
- Special: Duct or Wall Mounting Kit

3. Provide a single point humidity calibrator, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

18.4 Pressure Transmitters

1. Water Pressure Transmitter Requirements:

a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input.

b. •Materials: Stainless Stell
•Accuracy: ± 0.25 % FS
• Mounting: Pipe mounted at Pumps discharge points
•Pressure Range: To Suit Pump Discharge Pressures ranging from 1kg/cm2 to 6 kg/cm2
•Operating Temp Range: -30 °C to 80 °C
•Protection: IP65 Housing.
•Output: 0-10V (or as suitable for DDC input)
•Special: Pipe taps and shut off valves provided by Mechanical Contractor.

c. Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible.

2. **Low Air Pressure Applications (0 to 0.5" WC)**

a. The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the room and reference static pressure input signals with the following minimum performance specifications.

1) Span: Not greater than two times the design space DP.
2) Accuracy: Plus or minus 0.25% of F.S.
3) Dead Band: Less than 0.3% of output.
4) Repeatability: Within 0.2% of output.
5) Linearity: Plus or minus 0.2% of span.
6) Response: Less than one second for full span input.
7) Temperature Stability: Less than 0.01% output shift per degree F. change.

b. The transmitter shall utilize variable capacitance sensor technology and be immune to shock and vibration.
c. Provide a two-year warranty for each transmitter. Replace all transmitters found to be defective at no cost to the Owner during the warranty period.

18.5 Liquid Level Sensors

- Operation: Submersible / Capacitance principal / Ultrasonic (as per BOQ)
- Mounting:Tank
- Range: Designed for 5m
- Accuracy: 0.25% measuring range
- Protection: -20-80 °C, IP68
- Output: 0-10vDC, 4-20mA (matching the DDC protocol)

- Special: Tank Mounting Kit with corrosion protected cables
- Accessories: Complete for fixing

18.6 Differential Pressure Switches

- Mounting: Discharge and Suction Ports of Pumps for hydraulic status
- Operating Temp: -20 to 85 deg C
- Wetted parts: Polye urethane dia / Copper Alloy eq.
- Type: SPDT Precision snap acting type (10 million cycles)
- Approval: UL/CSA/FM/CE
- Operating Pressure: 0-150 psi
- Repeatability: ± 1 % span
- Protection: NEMA 4
- Accessories: Complete for fixing

18.7 Pressure Independent Control Valve Assembly (if part of BOQ)

The Self balancing flow control valves that are pressure independent, two-way, modulating to accept Input signals from the control system.

Each Air Handling Unit / Fan Coil Unit shall be provided with 2Way Pressure Independent Balancing Cum Control Valve with Integrated in a single Body with Globe Type in Construction.

FCU Valves Should be Provided with Spring Return Function Actuators Only.

Regarding Control - Valve should be equipped with electronic modulating actuator which can accept either "4(0)-20 mA / 2(0)-10 V DC signals. Operating voltage for actuator shall be 24V AC. Delta p controller should ensure 100% valve authority at all loads (part load Actuator shall be able to work against maximum closing pressure of 6 Bar at full load). With feedback signal to Control system.

Regarding Balancing – Each Valve should have steeples adjustable maximum flow limitation as per the designed flow rate of coils. Balancing should be done only in Valve not in actuator so that at any given condition of failure balancing is not lost and easily accessible.

All Valve actuator are microprocessor based with self-calibrating feature.

Valve should be of linear control characteristics with stepless Characteristics.

- **Valve Body**

  i. Pressure Controller Device should maintain the Pressure irrespective of Fluctuation with the help of Diaphragm self-adjusting type and should not be in contact with each other.
  ii. Valve should be Globe Type in Construction and not with cylinder type cartridge. Globe construction valves are accepted as the most accurate characteristics valves. (i.e. they very closely follow the graphs made for valve opening and flow characteristics.)
  iii. Control valve shall accurately control the flow, with help of Modulating Actuator
  iv. All Valve Sizes should have a Testing Port Device for verifying accuracy of flow performance with respective of Differential Pressure.
  v. Flow regulation unit shall consist of stainless-steel Material 316.

- **Valve Actuator and Housing**

  i. The Valve + Actuator must have ability to undertake both Logarithmic Control Characteristics and Linear Control Characteristics. This ensures compatibility for both Water/Air and Water/Water Heat Exchange.

ii. Valve Actuator housing shall made of non-Corrosive (Aluminum) Material. Valve actuator housing shall be IP Protection (Weatherproof: Dust & Water Protected). Valve actuator housing shall be acceptable to IP 42 Till 40MM and above should be IP55.
iii. Control/Dip Switch Setting should be easy to Manual Access to avoid Manual Contact to directly with Integrated IC Circuit of the system.
iv. Actuator should not play a part in balancing process. This will ensure that even an operational issue in the actuator will not lead to loss of Balancing.
v. Only Liner characteristics should not be acceptable as with this valve + actuator characteristic, the resultant energy characteristic will not remain linear and this shall lead to improper control leading to overflow/underflow phenomenon.

- **Flow Balancing**

i. Balancing &Control: Balancing should be accomplished by the Diaphragm and Control should be taken care by Actuator receiving signals from Room Thermostats or BMS.
ii. Manual Override Flow Balancing should only be done in Valve, not in actuator and should not involve opening of actuator Body.
iii. Flow Setting Balancing (Commissioning) for the Valves should be simple and fool proof.
iv. Should not involve opening of the actuator.
v. Should not need compulsory involvement of high-end technicians.
vi. Should avoid direct Manual Contact with Integrated Circuit (IC) of the actuators.

18.8 Velocity Transmitters

- Mounting: Duct type for AFMS / Duct discharge / FA Duct as per BOQ
- Operating cond: 0-50 C / 0-90% RH non-condensing
- Type: Heat Loss Measuring signal(Thermal Principle)
- Approval: CE/Eq
- Accuracy: ± 3 % full scale
- Output: 4-20 mA / 0-10 V DC
  - Range: 0-1500 FPM
  - Protection: IP65
  - Accessories: Complete as required for fixing

18.9 CO2 sensors

- Mounting: Duct type for AFMS / Duct discharge / FA Duct as per BOQ
- Type: Non-dispersive Dual Beam IR sensing
- Measuring Range: 0-2000 ppm
- Duct air velocity range: 0-1500 FPM
- Stability: < 2% over FS
- Temp dependence: 0.2% FS per deg C or better
- NonLinearity: < 1% of FS
- Ambient Op Temp: 0-50 C
  - Approval: CE/Eq
- Accuracy: ± 3% reading over the entire range
- Housing: Flammability classification UL 94V-5 or eq.
- Sensor should have the option for altitude correction
- Accessories: With fixtures as required.

18.10 Damper Actuators

- Mounting: Duct Dampers on Shaft/pinion with universal clamp
- Type: ON/Off or Modulating as per BOQ (Spring Return unless stated otherwise in BOQ)
- Torque Nm rating: To match the damper being controlled/operated
- Auxiliary Switch: Required for On/Off Status to BAS
- Switching range: 0-95 deg with reversible direction facility
- Operating Cond: -30 to 50 C / 5 to 95% Rh noncondensing
- Housing: IP 54/NEMA 2

- Approval: Related UL standards
- Accessories: As required complete for fixing

18.11 Static Pressure Sensors

- Mounting: Duct discharge
- Type: Duct Static pressure sensing
- Range: 0-50 mm WC unless specified in BOQ with 0-10V or 4-20 mA output
- Operating Cond: 0 to 50 C / 5 to 95% Rh noncondensing
- Accuracy: ±0.25 % full scale
- Housing: IP 65
  - Approval: Related UL / CE standards
  - Accessories: As required complete for fixing

18.12 Digital Energy Meters

- Sensing: 3 Ph/3 wire/4 Wire field configurable
- Measurement: True RMS
- Voltage Input: 110-415 nominal
- Current Input: 5- or 1-Amp nominal
- Max Current: 120% of nominal
- Freq: 50 Hz+-5%
- Accuracy for all parameters: Class 1: +/- 0.2% of FS + 0.8% of reading + 1 digit
- Accuracy of Hz: 0.2% Reading
- Accuracy of Phase: +/- 1 deg of reading
- Display update: Every 1 sec. (configurable)
- Emission confirmation: CISPR 22
- Protection: Front IP 51 – Rear IP 40
- Protocol: MODBU RTU compliance

18.13 Water Level Switch

- Reversible Float or eq.
- Switching Volts 240
- Switch Current 0.5 A Max
- Capacity 16A, 230VAC
- Material SS-304 For Flameproof Applications / Fireproof ABS for water applications
- Operating Temp -10 to +120C

18.14 Insertion Flow Meter

- Principal Electromagnetic
- Measured Error: 0.5 %
- Output 4-20 mA/Matching DDC's AI protocol
- Approval FM/CSA/CE
- Protection IP66
- Process Temp -20 to 120 C
- Sensor Tip: Viton O Ring / Eq
- Sensor Sleeve: SS
- Housing: Die Cast Al / Eq

18.15 Fire Damper Actuator

- Application Fire and Smoke Protection dampers
- Movement 90deg
- Voltage 24 AC/DC
- Control Open/close
- Protection Class III
- Degree IP 54
- Std Temp -30 to + 50 deg C

18.16 Dew Point Sensor

- Application Dew Point Temp after Cooling Coil
- RH + Temperature Sensor with Calculations are not allowed. True Dewpoint only
- Range -20 to +55 TdC
- Accuracy +/-1 TdC
- Output Analog 4-20mA/Eq
- Metal Stem with minimum length of 200mm
- Housing Fireproof ABS/IP65 or higher
- Compliance EMC to EM61326-1

18.17 LPG sensor

- Application LPG leak in Kitchen
- Measurement 100-10000 ppm iso-butane propane
- Response time < 10 s
- Heater voltage 5V
- Protection Mfr. Specific
- Protocol – matching supplier's DDC AI protocol

18.18 Isolation Valve for Chiller/Condenser

- Valve Type: Butterfly
- Coating Epoxy
- Valve disc/moving parts SS
- Pressure: 1600 kPA
- Media: Water -20 to +120C
- Leakage Rate: EN compliance
- Actuator: Shall have valve matching torque rating
- Protocol: Matching supplier's DDC DO protocol
- Type: On-Off type Rotary with Spring return
- Protection: IP54/higher
- Feature: Auxiliary Switch for ON/Off status preferred

Devices whose Specifications are not appearing above shall be pre-approved from consultants before supply

19.0 FIRE DAMPERS:

19.1 Fire Dampers with UL 555 Certification

Each fire damper shall be equipped with a factory installed heat responsive device (fusible link) rated to close the damper when temperature at the damper reaches 165 Deg F. Static Fire Damper shall have Galvanized Steel in gauges required as per manufacturers UL listing. The Damper shall be supplied with factory fitted sleeves. The Blades as be Curtain Style Galavanized type. The Closure device shall be replaceable fusible type. The fire dampers shall be UL 555 Listed for 1 ½ hours fire rating.

19.2 Fire & Smoke Dampers: Dampers to Bear UL555s and AMCA Certification

Fire damper blades shall be one piece folded high strength galvanized steel construction. In normal position these blades shall be gathered and stacked at the Combination Fire Smoke Dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules. Dampers shall meet the requirements of the latest edition of NFPA 90A, 92A, and 92B.

Dampers shall be tested, rated and labeled in accordance with the latest edition of UL Standards 555 and 555S. Dampers shall have a UL555 fire rating of 1 1/2 hours. Each damper

shall be equipped with a heat responsive device which has been tested and approved for use with the damper assembly in accordance with UL555. The heat responsive device shall have a temperature rating of 74 C or 100 C. Dampers shall be UL labeled for use in dynamic systems. The damper shall have a dynamic closure airflow rating equal to or greater than the airflow at the damper's installed location and a dynamic closure pressure rating of 101.6 mm H2O.

Dampers shall have a UL555S Leakage rating of Class I and a Temperature rating of 177 C. Dampers shall have a UL555S operational airflow rating equal to or greater than the airflow at its installed location and an operational pressure rating of 101.6 mm H2O. Damper actuators shall be factory mounted and qualified for use with the damper in accordance with UL555S. Damper actuators shall be (specifier select one of the following) electric type for 120 (or 24) volt operation or pneumatic type for 137,895.14 Pa minimum operation. Manufacturer's submittal data shall indicate actuator space requirements around the damper.

All UL555 and 555S Dynamic Closure Ratings, Operational Ratings and Leakage Ratings shall be qualified for airflow and pressure in either direction through the damper. UL ratings shall allow for mounting damper vertically (with blades running horizontal) or horizontally.

The Damper Manufacturer's submittal data shall certify all air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3 and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D.

Damper blades shall be 1.6 mm galvanized steel 3 Vee type with three longitudinal grooves for reinforcement. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow and operation in either direction through the damper (blades that are non-symmetrical relative to their axle pivot point or utilize blade stops larger than 13 mm are unacceptable).

Damper frames shall be galvanized steel formed into a structural hat channel shape with reinforced corners. Bearings shall be sintered bronze sleeve type rotating in extruded holes in the damper frame. Jamb seals shall be stainless steel compression type.

20.0 PVC conduit

All non-metallic PVC conduits shall conform to IS: 9537(Part - 3) and of **FRLS** type. The conduit shall be planed and of type as specified in IS: 9537 and shall be used with the corresponding accessories (Refer IS: 3419 specification for fittings for rigid nonmetallic conduits). Refer below table for detail specification of PVC conduit.

S.NO.	Characteristics	Reference 'IS'	Specified Requirement	Bidder to Fill
1	Construction	IS:9537 Part-3(1983)	Both the surfaces should be clean and free from burrs	
2	Durability of Marking	IS:9537 Part-3(1983)	It should be legible & durable & should not come out after rubbing with piece of cloth soaked in petrol.	
	Dimension	IS:9537 Part-3(1983)	Maximum OD: - need to be specified	
			Minimum OD: - need to be specified	
			Minimum ID: - need to be specified	
3	Compression Test	IS:9537 Part-3(1983)	% of Comp. Under load less than 25%	
			% of Comp. Without load less than 10%	

S.NO.	Characteristics	Reference 'IS'	Specified Requirement	Bidder to Fill
4	Impact Test	IS:9537 Part-3(1983)	There should be no crack and no sign of disintegration.	
5	Resistance to Heat	IS:9537 Part-3(1983)	Resistance of heat (Diameter of Ball Impression in MM at 60°C for 2 hours) less than 2.0mm	
6	Resistance to Burning	IS:9537 Part-3(1983)	Resistance to burning (Period of burning after removal of flame 30 sec) Flame dies out in time less than 30 sec.	
7	Electrical Strength	IS:9537 Part-3(1983)	Shall withstand 2000V AC for 15 minutes	
8	Insulation Resistance	IS:9537 Part-3(1983)	Applied Voltage: 500V DC for 60 sec and IR Min 100 Mega ohms.	
9	Temperature Index	Not applicable	Should be minimum 250° C	
10	Oxygen Index	Not applicable	Should be more than 21%	
11	Smoke Density	Not applicable	Should be less than 55%	

21.0 PAINTING - COLOUR CODE.

All Equipments shall be supplied with approved finish. Shop coat of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with two coat of synthetic enamel paint. Pump base-plate / piping supports subject to water exposure to be painted with rubber paint using zinc base primer. Water treatment Units to be painted with anticorrosive paint / CGC, as exposed to acid and caustic solutions.

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be baked in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

All exposed condenser water piping shall be applied with cold galvanizing spray / paint.

21.1 Standard colour code:

The tentative colour code given below shall be followed. However changes if any will be indicated well in advance. All painting colour code shall be approved before execution. No separate payment shall be made for painting work.

Item :	**Colour:**
▪ Condenser, Pumps, Belt guards	▪ Battleship Grey
▪ Motors	▪ Siemens Grey
▪ Chiller	▪ Dark Blue
▪ AHU	▪ Mulshell Grey
▪ POT Strainers	▪ Grey
▪ B.M Valve / Copper Line	▪ Golden
▪ Gauge Panel / MP panel	▪ Siemens Grey
▪ Chilled water Line –	
In let / Return / & storage tank	▪ Light Blue
Out let / Supply	▪ Dark Blue
▪ All supports / Stands / drain	▪ Black
▪ Condenser water piping	
In let / Return / & storage tank	▪ Light Green
Out let / Supply	▪ Dark Green
▪ Cooling Towers	▪ Light Green
▪ Ducting / Grilles / Diffusers	▪ Approved by Architect

All "Approved shade" shall be duly approved by Engineer In-charge / Architect.

22.0 INSPECTION AND TESTING:

22.1 Inspection (pre-dispatch & site), testing & acceptance

Pre-dispatch inspection shall be carried out for certain items. All the system equipments, parts shall be checked for physical damage, before commencing the installation work. Complete fabrication, installation and commissioning work shall be jointly supervised and shall be carried out as per the specifications and instructions of site Engineer In-charge. All the rotating equipment shall be checked for static and dynamic balancing, minimum operating vibration and noise.

All the system / equipments shall be checked before / after satisfactory commissioning, at manufacturer's works / site as may be required for the approved technical specifications, performance data provided by supplier / manufacturer. Actual capacity of each equipment shall be calculated based on the test readings, recorded jointly, for design conditions / operating conditions. Performance acceptance is subject to comparison of test results with supplier / manufacturer's performance data and contract specification. Acceptance is subject to satisfactory installation, commissioning and performance testing with respect to technical specifications. Rejected items must be replaced or rectified for the defects. In case of system modification / rectification complete performance tests are to be repeated. Site test readings shall be jointly recorded.

In general following inspection / tests are involved. Type of test, duration of test, testing procedure / parameters, will be as per the applicable BIS codes. However the detail Inspection and test procedure shall be worked out jointly by the purchaser and the contractor along with the approval of drawings, within 30 days from the date of contact agreement.

a. Pre-dispatch Inspection.
b. Pre-dispatch testing at manufacturers shop / factory. (Material, performance, pressure, joints, etc.)
c. Physical Inspection – Pre-installation at site.
d. Welding joint inspection and testing at site.
e. Pressure testing at site.
f. Performance testing at site (capacity, power consumption, pressure drop, vibration, etc.)
g. Calibration at site.

SR.	ITEM/ EQUIPMENT	INSPECTION / TEST INVOLVED.
1.	Water chilling machines	a, b, c, e, f.
2.	Cooling Tower	a, b, c, e, f.
3.	Pumps	a, b, c, e, f.
4.	Air Handling Units	a, b, c, e, f.
5.	Electrical control panel boards	a, b, c, e, f.
6.	Piping - MS & GI	a, b, c, d, e, f.
7.	Piping and fittings -	a, b, c, d, e, f.
8.	Valves / Control valves and strainers	c, e, f.
9.	Instruments and controls	c, e, f, g.
10.	Insulation	a, b, c, e, f.

22.2 Test certificates:

Contractor shall furnish following Test certificates:

- Material testing of various components of the equipments/ system parts.
- Fabrication inspection / test certificates– Radiography and others
- Welder's qualification certificate.
- Performance test certificates carried out by manufacturer before Pre- dispatch inspection

& testing.
- Performance test certificates carried out by manufacturer.
- Performance guarantees certificate / calibration certificate
- All equipment operation and maintenance manual.

22.3 Testing The Equipment's At Site:

The following aspects shall be considered for performance testing.

- Prevailing conditions shall be as close as to design conditions.
- Type, quantity, location, frequency, duration of test parameters shall be decided and recorded accordingly during the test.
- Rated capacity, power consumption, and other operating parameters shall be checked.
- Functional test for all Instruments, controls (safety and capacity) shall be carried out to check for the expected operation / action / accuracy / response time / repeatability parameters.

A. Chiller Unit:

The unit shall be selected and installed for the lowest operating speed and noise level. Capacity ratings and power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation. Measurements of chilled water flow rate and temperature of chilled water in and out of the chilling unit shall ascertain capacity.

Power consumption shall be computed from measurements of incoming voltage & input current to the chilling machine.

B. Pumps:

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.
Pump performance shall be computed from the pump curves provided by manufacturer

C. Control & Instruments:

All Instruments shall be factory calibrated and provided with necessary instructions for site calibration and testing. Various items of the same type shall be completely interchangeable and the manufacturer shall guarantee their accuracy. All automatic controls and instruments shall be tested at site for accuracy and reliability before commissioning the installation.

D. AHUs:
All AHUs shall be tested for the designed air flow capacity and chilled water flow balancing. The air flow shall be measured and balanced for supply air , return air and fresh air.
All the AHUs chilled water flow balancing and controlling shall be monitored and controlled and checked for the modulation of flow control valve with respect to return air temperature at AHU.
All AHU shall be tested for designed Tonnage Capacity Delivery and record all the given perimeter in testing and commissioning document.

E. Piping:

- All piping shall be tested to hydrostatic test pressure of at least one and half times the Maximum operating pressure, but not less than 10 kg/cm2 gauge 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.

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

- System may be tested in sections and such sections shall be securely capped, then re-tested for entire system.

- The Contractor shall give sufficient notice to all other agencies at site of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Owner's site representative.

- The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due to air bound connection, the Contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and re- finishing of floors and walls as required.

- The Contractor shall provide all materials, tools, equipment, instruments, and services and labour required to perform the test and to remove water resulting from cleaning and after testing.

Performance Testing:

After testing and commissioning all the chiller plant room equipment, AHU, Pumps etc , all the air conditioning areas room temperature shall be measured at multiple point in presence of client / project manger representative and show the cooling performance T & RH as per design guideline.

23.0 SUPPORT STRUCTURE:

23.1 Support from RCC slab

23.1.1 DUCT SUPPORTS

Description

The Duct should be simply supported by Support Channel made up of cold rolled steel of quality **DX51 or greater and as per EC3 (Eurocode 3) or DIN EN 1993-1-1**.

The Support channel should be **pre galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail.**

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C**.

The Threaded Rods used for the suspension of the Duct should be made up of **partially annealed** medium carbon steel of **grade 5.8 strength class and as per DIN 976 standard.**
The Drop-in anchors used for the suspension of the rods should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

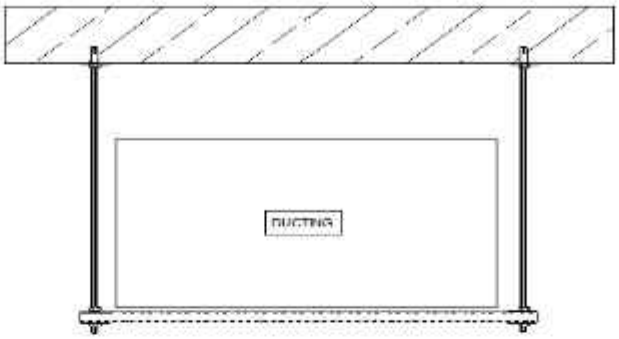
It should be divided into four expansion segments for uniform pressing force distribution in the borehole.
The load calculations should be as per Finite Element Method for the selection of the channels for suitable size of the duct and should be provided by the contractor to the consultant for verification.

Supporting DETA (European Technical Approval) ils for low pressure systems are given below

Larger Side of Duct mm	Support Channel mm	Vertical Rod Dia mm	Maximum Spacing between supports mm
0-600	27x18x1.2	M8	2400

601-1250	38x24x2	M8	2400
1250-2100	38x40x2	M10	2400
2100 and above	40x60x2.5	M12	2400

Fig.A. Typical Arrangement for Duct Supports from RCC slab



23.1.2 CHW pipe / ref. pipe support:

Description

The CHW Pipes should be simply supported by **Split Clamps with rubber support insert.**

Split Clamps should be as per **DIN 3567** pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

Rubber support insert should be made from **EPDM or NR/SBR Rubber** The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp and rubber support insert should have the temperature capacity of -50 degree Celsius to +150 degree Celsius.

In the case of multiple pipes, the supporting arrangement should be made using support channel made up of cold rolled steel of quality **DX51 or greater and as per EC3(Eurocode 3) or DIN EN 1993-1-1.**

The Support channel should be **pre galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail.**

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C.**

The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of grade **5.8 strength class and as per DIN 976 standard.**

The Drop-in anchors used for the suspension of the rods should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

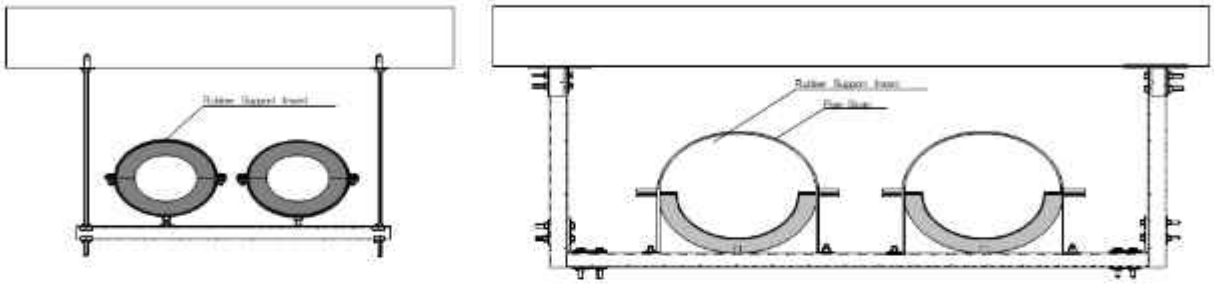
It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load bearing capacity for the selection of the split clamp for suitable size of the pipe should be provided by the contractor to the consultant for verification.

Maximum Support Spacing (m)

Nominal Pipe Dia (mm)	Support Distance (M)	Nominal Pipe Dia (mm)	Support Distance (M)	Nominal Pipe Dia (mm)	Support Distance (M)
Upto 15	1.8	65	3.7	250	5.0
20	2.4	80	3.7	300	6.1
25	2.4	100	3.7	350	10.0
32	2.7	125	3.7	400	10.5
40	3.0	150	5.5	450	11.0
50	3.0	200	5.6	500	12.0

Fig B. Typical Arrangement for Pipe Supports from slab



23.1.3 Drain pipe support

Description

The Drain Pipes should be simply supported by **Split Clamps.**

Split Clamps should be pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp should have the temperature capacity of -50 degree Celsius to +150 degrees Celsius.

The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of grade 5.8 strength class and as per DIN 976 standard.

The Drop-in anchors used for the suspension of the rods should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

Maximum Support Spacing (m)					
Pipe Dia (mm)	Support Distance (M)	Nominal Pipe Dia (mm)	Support Distance (M)	Nominal Pipe Dia (mm)	Support Distance (M)
Upto 15	1.0	32	1.0	65	1.2
20	1.0	40	1.0	90	1.4
25	1.0	50	1.1	80	1.5

Fig C. Typical Arrangement for Drain Pipe Supports from slab

23.2 Support from building shaft

39.2.1 DUCT SUPPORTS

Description

The Duct should be simply supported by Support Channel made up of cold rolled steel of quality **DX51 or greater and as per EC3(Eurocode 3) or DIN EN 1993-1-1**

The Support channel should be **pre galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail.**

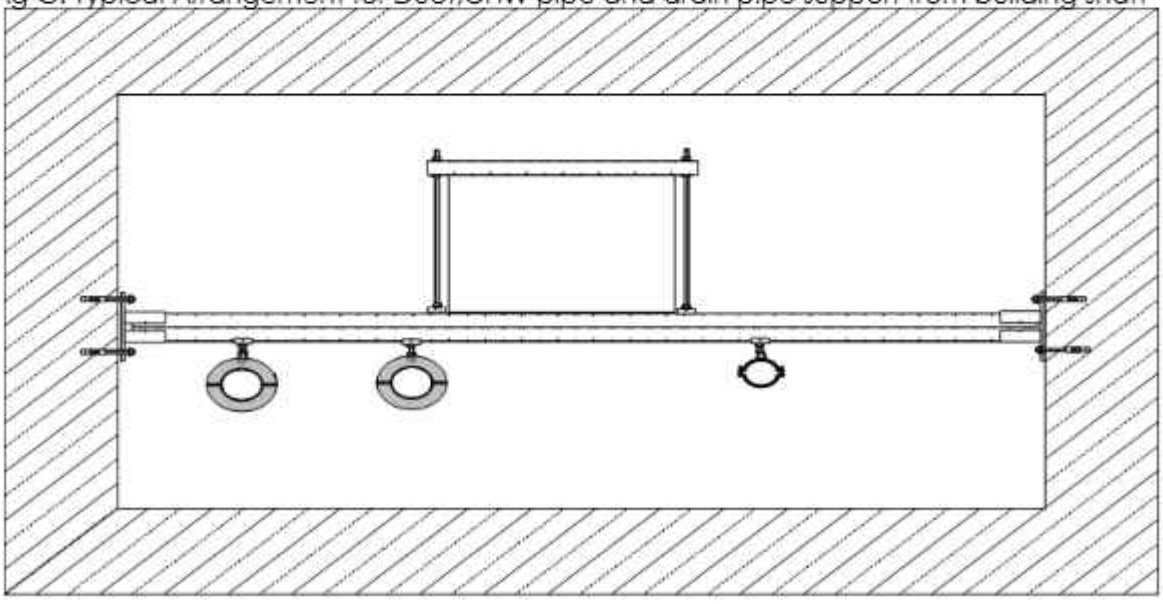
The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C.**
The Threaded Rods used for the suspension of the Duct should be made up of **partially annealed** medium carbon steel of **grade 5.8 strength class and as per DIN 976 standard.**

The Drop-in anchors or stud anchor used for the suspension of the rods should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete. It should be divided into four expansion segments for uniform pressing force distribution in the borehole.
The load calculations should be as per Finite Element Method for the selection of the channels for suitable size of the duct and should be provided by the contractor to the consultant for verification.

Supporting DETA (European Technical Approval) is for low pressure systems are given below

Larger Side of Duct mm	Support Channel mm	Vertical Rod Dia mm	Maximum Spacing between supports mm
0-600	27x18x1.2	M8	2400
601-1250	38x24x2	M8	2400
1250-2100	38x40x2	M10	2400
2100 and above	40x60x2.5	M12	2400

Fig G. Typical Arrangement for Duct,CHW pipe and drain pipe support from building shaft



39.2.2 CHW pipe / ref. pipe support:

Description
The CHW Pipes should be simply supported by **Split Clamps with rubber support insert.**

Split Clamps should be as per **DIN 3567** pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

Rubber support insert should be made from **EPDM or NR/SBR Rubber**
The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp and rubber support insert should have the temperature capacity of -50 degree Celsius to +150 degree Celsius.

In the case of multiple pipes, the supporting arrangement should be made using support channel made up of cold rolled steel of quality **DX51 or greater and as per EC3 (Eurocode 3) or DIN EN 1993-1-1.**

The Support channel should be **pre-galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail.**

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C.**
The Threaded Rods used for the fixing Pipe clamp with channel that should be made up of partially annealed medium carbon steel of grade 5.8 strength class and as per DIN 976 standard.

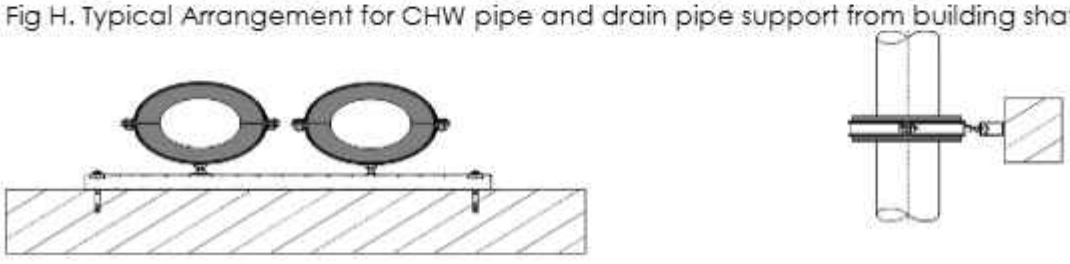
The Drop-in anchors or stud anchor used for the channel fixing with shaft that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load bearing capacity for the selection of the split clamp for suitable size of the pipe should be provided by the contractor to the consultant for verification.

Maximum Support Spacing (m)					
Nominal Pipe Dia (mm)	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**
Upto 15	1.8	65	3.7	250	5.0
20	2.4	80	3.7	300	6.1
25	2.4	100	3.7	350	10.0
32	2.7	125	3.7	400	10.5
40	3.0	150	5.5	450	11.0
50	3.0	200	5.6	500	12.0

Fig H. Typical Arrangement for CHW pipe and drain pipe support from building shaft



39.2.3 Drain pipe support

Description

The Drainpipes should be simply supported by **Split Clamps.**

Split Clamps should be pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

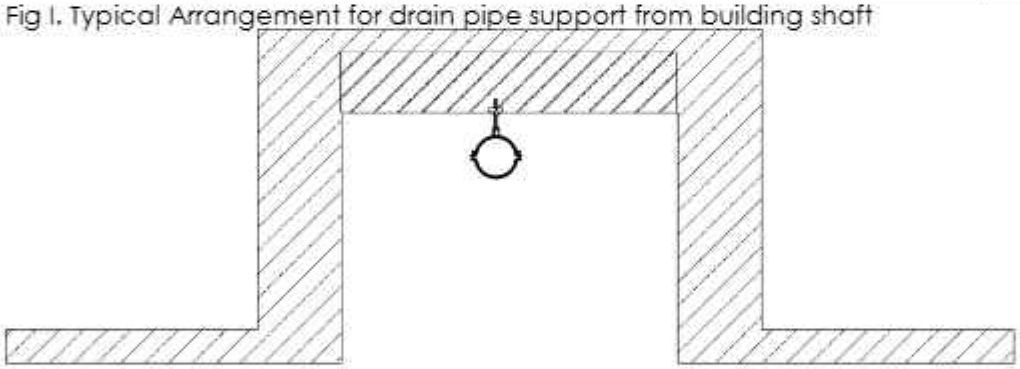
The Clamp should have the temperature capacity of -50 degree Celsius to +150 degrees Celsius.
The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of **grade 5.8 strength class and as per DIN 976 standard.**

The Drop-in anchors or stud anchor used for the suspension of the rods should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

Maximum Support Spacing (m)					
Pipe Dia (mm)	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**
Upto 15	1.0	32	1.0	65	1.2
20	1.0	40	1.0	90	1.4
25	1.0	50	1,1	80	1.5

Fig I. Typical Arrangement for drain pipe support from building shaft



23.3 Support on terrace

39.3.1 DUCT SUPPORTS

Description
The Duct should be simply supported by Support Channel made up of cold rolled steel of quality **DX51 or greater and as per EC3(Eurocode 3) or DIN EN 1993-1-1**

The Support channel should be **pre galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail.**

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C.**
The Threaded Rods used for the assembly of channel structure that should be made up of **partially annealed** medium carbon steel of **grade 5.8 strength class and as per DIN 976 standard.**

The Drop-in anchors used for the fixing channel with terrace that should be **ETA (EUROPEAN**

TECHNICAL APPROVAL) with CE mark for cracked and un-cracked concrete.

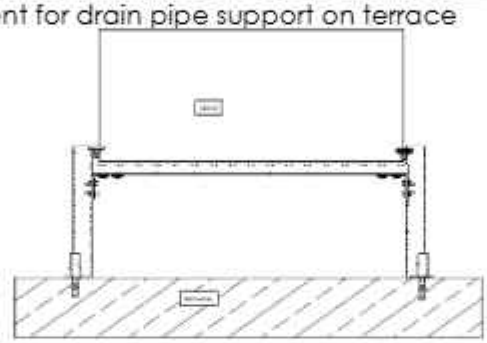
It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load calculations should be as per Finite Element Method for the selection of the channels for suitable size of the duct and should be provided by the contractor to the consultant for verification.

Supporting DETA (European Technical Approval)ils for low pressure systems are given below

Larger Side of Duct mm	Support Channel mm	Vertical Rod Dia mm	Maximum Spacing between supports mm
0-600	27x18x1.2	M8	2400
601-1250	38x24x2	M8	2400
1250-2100	38x40x2	M10	2400
2100 and above	40x60x2.5	M12	2400

Fig J. Typical Arrangement for drain pipe support on terrace



39.3.2 CHW pipe / ref. pipe support:

Description

The CHW Pipes should be simply supported by **Split Clamps with rubber support insert.**

Split Clamps should be as per **DIN 3567** pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

Rubber support insert should be made from **EPDM or NR/SBR Rubber**

The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp and rubber support insert should have the temperature capacity of -50 degree Celsius to +150 degree Celsius.
In the case of multiple pipes, the supporting arrangement should be made using support channel made up of cold rolled steel of quality **DX51 or greater and as per EC3 (Eurocode 3) or DIN EN 1993-1-1.**

The Support channel should be **pre-galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail.**

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C.**
The Threaded Rods used for the connecting clamp and channel that should be made up of partially annealed medium carbon steel of **grade 5.8 strength class and as per DIN 976**

standard.

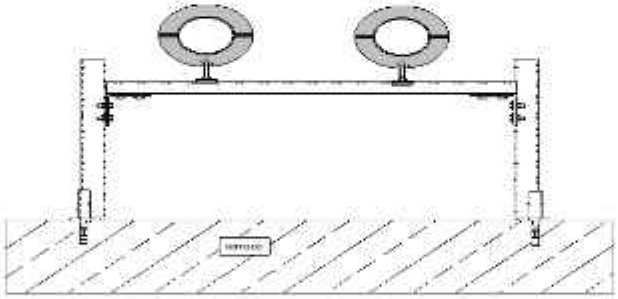
The Drop-in anchors used for the fixing channel with terrace that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load bearing capacity for the selection of the split clamp for suitable size of the pipe should be provided by the contractor to the consultant for verification.

Maximum Support Spacing (m)					
Nominal Pipe Dia (mm)	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**
Upto 15	1.8	65	3.7	250	5.0
20	2.4	80	3.7	300	6.1
25	2.4	100	3.7	350	10.0
32	2.7	125	3.7	400	10.5
40	3.0	150	5.5	450	11.0
50	3.0	200	5.6	500	12.0

Fig K. Typical Arrangement for CHW pipe support from on terrace



39.3.3 Drain pipe support

Description

The Drain Pipes should be simply supported by **Split Clamps.**

Split Clamps should be pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

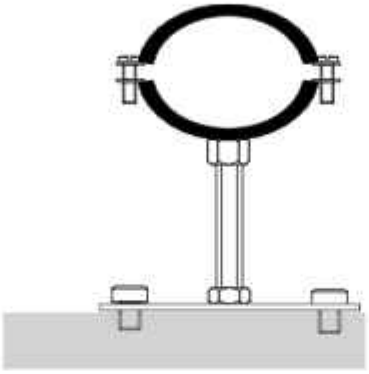
The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp should have the temperature capacity of -50 degree Celsius to +150 degrees Celsius.
The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of **grade 5.8 strength class and as per DIN 976 standard.**
The Drop-in anchors used for the Fixing base plate, should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

Maximum Support Spacing (m)					
Pipe Dia (mm)	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**
Upto 15	1.0	32	1.0	65	1.2
20	1.0	40	1.0	90	1.4
25	1.0	50	1.1	80	1.5

Fig L. Typical Arrangement for Drain pipe support from on terrace



23.4 Support from WALL

39.4.1 DUCT SUPPORTS

Description

The Duct should be simply supported by Support Channel made up of cold rolled steel of quality **DX51 or greater and as per EC3(Eurocode 3) or DIN EN 1993-1-1**

The Support channel should be **pre galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail.**
The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C.**
The Threaded Rods used for the suspension of the Duct should be made up of **partially annealed** medium carbon steel of **grade 5.8 strength class and as per DIN 976 standard.**

The Drop-in anchors or stud anchor used for fixing with wall that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

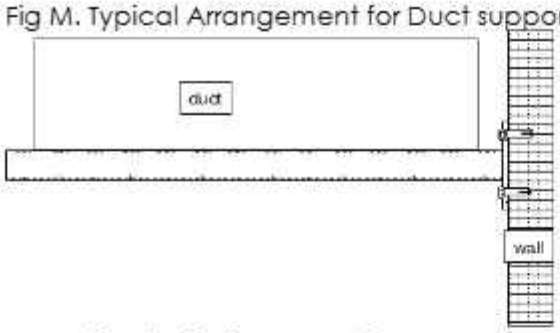
It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

The load calculations should be as per Finite Element Method for the selection of the channels for suitable size of the duct and should be provided by the contractor to the consultant for verification.

Supporting DETA (European Technical Approval) ils for low pressure systems are given below

Larger Side of Duct mm	**Support Channel mm**	**Vertical Rod Dia mm**	**Maximum Spacing between supports mm**
0-600	27x18x1.2	M8	2400
601-1250	38x24x2	M8	2400
1250-2100	38x40x2	M10	2400
2100 and above	40x60x2.5	M12	2400

Fig M. Typical Arrangement for Duct support from wall



39.4.2 CHW pipe / ref. pipe support:

Description

The CHW Pipes should be simply supported by **Split Clamps with rubber support insert.**
Split Clamps should be as per **DIN 3567** pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

Rubber support insert should be made from **EPDM or NR/SBR Rubber**

The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp and rubber support insert should have the temperature capacity of -50 degree Celsius to +150 degree Celsius.

In the case of multiple pipes, the supporting arrangement should be made using support channel made up of cold rolled steel of quality **DX51 or greater and as per EC3 (Eurocode 3) or DIN EN 1993-1-1.**

The Support channel should be **pre-galvanised with minimum GSM of 120** and should have universal mounting slot on the front of the rail for accurate positioning of fasteners and system compatible **round and long holes on back of the rail.**

The Mounting according to static requirements should undertake into account the manufacturer's documents and should be monitored according to **RAL - GZ 655-C.**

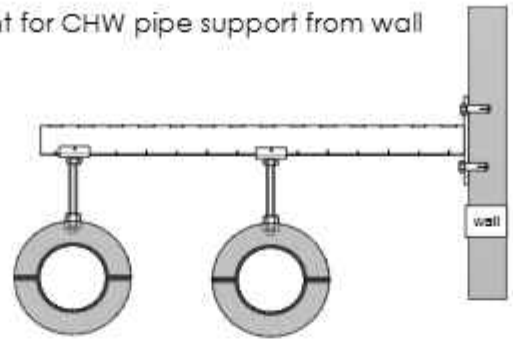
The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of **grade 5.8 strength class and as per DIN 976 standard.**
The Drop-in anchors or stud anchor used for Fixing with wall that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.
The load bearing capacity for the selection of the split clamp for suitable size of the pipe should be provided by the contractor to the consultant for verification.

Maximum Support Spacing (m)					
Nominal Pipe Dia (mm)	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**
Upto 15	1.8	65	3.7	250	5.0
20	2.4	80	3.7	300	6.1
25	2.4	100	3.7	350	10.0
32	2.7	125	3.7	400	10.5
40	3.0	150	5.5	450	11.0

50	3.0	200	5.6	500	12.0

Fig N. Typical Arrangement for CHW pipe support from wall



39.4.3 Drain pipe support

Description

The Drain Pipes should be simply supported by **Split Clamps**.

Split Clamps should be pre-galvanised and should have a two-piece arrangement with ribbing reinforced clamp body and two captive tightening bolts, secured with loss washers for non-slipping high load bearing capacity.

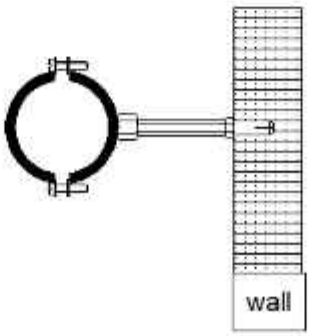
The Split clamp should have an **EPDM rubber lining** which will prevent the direct contact of Pipe with the steel. The rubber lining should have the capacity to reduce the structure borne noise vibration to up to 18 dB.

The Clamp should have the temperature capacity of -50 degree Celsius to +150 degrees Celsius.
The Threaded Rods used for the suspension of the Pipe should be made up of partially annealed medium carbon steel of **grade 5.8 strength class and as per DIN 976 standard.**
The Drop-in anchors or stud anchor used for fixing with wall that should be **ETA (EUROPEAN TECHNICAL APPROVAL) with CE mark** for cracked and un-cracked concrete.

It should be divided into four expansion segments for uniform pressing force distribution in the borehole.

Maximum Support Spacing (m)					
Pipe Dia (mm)	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**	**Nominal Pipe Dia (mm)**	**Support Distance (M)**
Upto 15	1.0	32	1.0	65	1.2
20	1.0	40	1.0	90	1.4
25	1.0	50	1,1	80	1.5

Fig O. Typical Arrangement for Drain pipe support from Wall



Project : - SRFDCL Sanskarkendra

Document : List Of Approved Makes

SR.	DETAILS OF MATERIAL / EQUIPMENT	APPROVED MANUFACTURERS NAME
1	Valve / Damper Actuators	Honeywell / Danfoss / Siemens / Johnson Controls / Belimo
2	GI Ducting	SAIL /Tata / Jindal / Essar
3	MS Ducting	Tata / Jindal / Surya / SAIL
4	Pre Fabricated Ducting	Zeco / Redical Duct / Asawa / Ductofab / Maruti
5	Fire Dampers and Fire Smoke Dampers	Carryaire / Systemaire / Cosmos / Greehheck / Fairflow / Air product
6	Grilles / Diffusers / Dampers	Carryaire / Systemaire / Cosmos / Greehheck / Fairflow / Air product / Edgetech
7	Flexible Canvass Connection	Airflow / Easyflex / Hira
8	Centrifugal Fans	Systemair/Kruger/Greenheck / AirFlow
9	Cabinet Fans	Systemair/Kruger/Greenheck / AirFlow
10	Tube Axial Flow Fans	Systemair/Kruger/Greenheck / AirFlow
11	Inline Fans	Systemair/Kruger/Greenheck / AirFlow
12	Propeller Fans	Systemair/Kruger/Greenheck / AirFlow
13	Dry Scrubber For Kitchen Exhaust Unit	Rydair / Trion / Halton
14	Air Washer Units	DRI / HMX / Ambiator
15	Jet Fans	Systemair/Kruger/Greenheck / Flaktswood / Air Flow
16	Insulation Material	
16.01	Extruded Polystyrene Board	Owens Croning / Supreme Insuboard
16.02	EPDM / Nitrile Rubber	Aramacell / ALP / Aeroflex / Hira / Armaflex
16.03	Open Cell Nitrile Rubbre Insulation	Aramacell / ALP / Aeroflex / Hira / Armaflex
16.04	Resin bonded encapsulated bag	INROCK/Lloyds
16.05	PUF Insulation	Beardshell / Lloyds
16.06	Glass Cloth	INFIX GC/Pidilite
16.07	PIR Boards	Beardsell/ bakelite hylam/INPANEL
16.08	EPS	Beardsell/ Lloyds/ Infoam EPS
17	Protective Coating & Adhesive	Foster / Childer / Miracle / Pidilite
18	Drain Pipe / PVC Pipe	Finolex / Ashirwad/ Supreme / Astral Prince
19	Duct/Pipe/ Engineered Support System	Mupro / Gripple / Valraven / Hilti
20	Adhesive	Pidilite / Miracle / Foster / Childer
21	PLC / DDC Controllers And Co Sensors	Siemens / Tac / Honeywell / Mitshubishi / Allen Bradly / Johnson Control

Project : - SRFDCL Sanskarkendra Document : List Of Approved Makes		
SR.	**DETAILS OF MATERIAL / EQUIPMENT**	**APPROVED MANUFACTURERS NAME**
IMPORTANT NOTE		
1	1. THE SUCCESSFUL CONTRACTOR HAS TO OBTAIN APPROVAL FOR ALL THE SAMPLES / MAKES FROM THE CLIENT/CONSULTANT BEFORE USE. WITHOUT APPROVAL CLIENT HAS THE RIGHT TO ASK TO REMOVE THAT MATERIAL FROM THE SITE.	
2	2. THE APPROVED MAKES GIVEN ABOVE ARE APPLICABLE IN GENERAL. **HOWEVER FINAL APPROVAL HAS TO BE TAKEN FROM THE AMC & Consultants BEFORE EXECUTION OF ANY ITEM**.	
3	3. CLIENT HAS THE RIGHT TO CHOOSE ANY OF THE ABOVE MAKE OR ANY EQUIVELLENT MAKE OTHER THEN THIS AT THE TIME OF EXECUTION.	
4	4. THE SUCCESSFUL CONTRACTOR HAS TO PRIOR INFORM TO AMC IN ANY TENDER ITEM EXCESS FROM BOQ.	