

TENDER DOCUMENT **FOR** **VRF SYSTEM**

C-2 STAFF FLAT AT
ST . STEPHEN'S COLLEGE, DELHI

Architects

Ranjit John Architects
126, Hill Top Farm
Andheria Modh Mehrauli,
New Delhi 110030.
Phone NO-91-9810048703,
9868155711.

ISSUED TO:

Principal, St. Stephen's College, Delhi invites sealed competitive unit rate tenders in the prescribed format from the short-listed tenderers for the Supply and Installation of VRF Systems at **C-2, Staff Flat, St. Stephen's College, Delhi**, through Architect to be submitted on or before 18 January 2021 for the following work:

- | | | |
|----|--------------------|--|
| a) | Name of the work | Supply and Installation of VRF Systems at C-2 Staff Flat |
| b) | Time of completion | 40 days. |
| c) | Earnest Money | Rs.25000/- (Rupees Twenty Five Thousand only) |

The tender document and schedule of Quantities can be downloaded from the College Website starting from 11 January 2021 to 18 January 2021.

The Tender Fee amounting Rs.2500/- (in cash) in required to be submitted at the Estate Office at the time of submission of the sealed packet containing the Bid

Earnest Money Deposit is Rs.25000/- (Rupees Twenty Five Thousand Only) in the form of crossed demand draft in favor of "Principal, St. Stephen's College" payable at Delhi.

Tenders in sealed covers, with the name of the work written on envelopes shall be submitted to the Estate Office, St. Stephen's College, Delhi – 110007 on or before 18 January 2021 by 5 pm. Tenders received late shall not be considered.

Section 1

System Design Data

1. **General**

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

2. **Location**

2.1 The proposed "C-2, St Stephens's College" is located at Delhi.

3. **Scope of work**

3.1 The work proposed under this tender includes providing and fixing Air Cooled Variable Refrigerant Volume air conditioning system, Toilet Exhaust System, Refrigerant piping, drain piping, insulation, electrical wiring etc. for the above project.

3.2 The work shall also include chasing of walls for piping, rough plaster to seal the chases, embedding of drain piping under floor, wiring from electrical point upto unit, making holes in bricks wall and damaging good etc.

4. **System Design**

4.1 It is proposed to provide variable refrigerant volume system of capacity 20 HP for entire block with 10 HP and 10 HP unit. VRV system will be of heat pump type.

4.2 There shall be ceiling mounted ductable type Indoor cooling, Heating units for each area of the Guest house.

4.3 The Outdoor condensing units shall be located at the roof.

4.4 The Outdoor & Indoor units shall be interconnected with copper refrigerant piping duly insulated.

4.5 The system shall be provided with a central controller which shall control and monitor all the units from one location.

4.6 The Exhaust air to the conditioned areas would be supplied through Inline, propeller fan unit and ducting.

5. **Basis of Design**

5.1	Outside Conditions	Summer &	:	43.3°C DB, 23.9°C WB
		Monsoon	:	35.0°C DB, 28.3°C WB
		Winter	:	07.2°C DB, 07.2°C WB

7. **Items to be provided by other Agencies**

The following items of works shall be provided by other agencies. The HVAC contractor shall be responsible for the adequacy and accuracy of these works and shall ensure that these are completed as per the required time schedule.

- 7.1 Provision of 220v/ 1 PH / 50 Hz electric supply upto each indoor unit.
- 7.2 Provision of 415 V/3 Ph/50 Hz electric supply with ELCB/RCCB upto outdoor units.
- 7.3 Finishing of wall chases.
- 7.4 Sleeves in masonry walls and sealing of same.

8. **Drawings**

Tender drawings are diagrammatic only and indicate arrangement of system and the extent of work covered in the contract. These drawings indicate point of supply and point of termination and suggest the route to be followed. The architectural drawings and details shall be examined for exact location of equipment, cutouts etc. Contractor shall follow the tender drawings in preparation of shop drawings and for subsequent installation work and will coordinate with other services also.

9. **Test data**

The whole system shall be tested as per specifications given elsewhere and complete test data shall be furnished on prescribed data sheet.

10. **Deviation from specifications**

Deviation from specifications may be accepted, provided such deviations are found necessary and appropriate, in order to conform to the design of established foreign collaborators/manufacturers.

11. **Completeness of Items**

The prices of each equipment shall include the cost of all accessories or miscellaneous items listed in the respective section, except for the items where "Price Separately" is indicated. The item shall be complete regardless of whether or not it is listed in the BOQ.

12. **Technical data**

Each tenderer must submit along with the tender the technical data for all items listed herein in the indicated format. Failure to furnish technical data with tenders may result in summary rejection of the tender.

13. **Performance Guarantee**

- 13.1 The contractor shall guarantee that the air conditioning system shall maintain the design inside temperature within $\pm 1.0^{\circ}\text{C}$ tolerance and the relative humidity shall not exceed the specified limit.
- 13.2 The contractor shall guarantee that the capacity of various components as well as the whole system shall not be less than specified.
- 13.3 The contractor shall ensure, that the system shall be free of all objectionable vibrations and disturbing sounds under all conditions of operation.

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Section 2**Split System
(VRV Type)****1. General**

Unit shall be air cooled, variable refrigerant volume air conditioner consisting of outdoor units and multiple indoor units, each suitable to cool in summer and heat in winter as per the requirements.

- 1.2 The refrigerant piping shall be extendable up to 100m with 50m level difference **without any oil traps.**

2. Outdoor Unit

- 2.1 The outdoor unit shall be a factory assembled unit housed in a sturdy weather proof casing constructed from rust-proofed mild steel panels coated with a baked enamel finish.

- 2.1.1 The outdoor unit shall have multiple scroll compressors and be able to operate even in case of breakdown of one of compressors.

- 2.1.2 The connectable range of indoor units shall be from 0.8 HP to 10HP with all outdoor units.

- 2.1.3 The noise level shall not be more than 62 dB(A) at normal operation measured horizontally 1m away and 1.5m above ground.

- 2.2 The outdoor unit shall be modular in design and shall be allowed for side by side installation.

3. Compressor

- 3.1 The compressor shall be of highly efficient hermetic scroll type and equipped with inverter control capable of changing the speed in accordance to the cooling load requirement.

- 3.2 The inverter shall be IGBT (Insulated Gate Bipolar Transistor) type to be efficient and quiet.

- 3.3 The 30HP outdoor unit shall have the multi-step of capacity control to meet cooling load fluctuation.

4. Heat Exchanger

- 4.1 The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fin coil. The aluminium fins shall be covered by anti-corrosion resin film.

5. **Refrigerant Circuit**

- 5.1 The refrigerant circuit shall include an accumulator, liquid and gas shut off valves and a solenoid valves.
- 5.2 All necessary safety devices shall be provided to ensure the safety operation of the system.

6. **Safety Devices**

- 6.1 The following safety devices shall be part of the outdoor unit; High Pressure Switch, Low Pressure Switch, Fan Motor Safety Thermostat, Inverter Overload Protector, Over Current Relay, Fusible Plugs, Fuses.

7. **Oil Recovery System**

- 7.1 Each unit shall be equipped, with an oil recovery system to ensure stable operation with long refrigerant piping.

8. **Indoor Unit**

- 8.1 Each Indoor unit shall be ceiling mounted built-in type or floor standing, concealed type or wall mounted type, as specified in scope of work. It shall have electronic control valve to control refrigerant flow rate in response to load variations of the room. The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation.

- 8.2 The address of the indoor unit shall be set automatically in case of individual and group control. In case of centralized control, it shall be set by liquid crystal remote controller.

8.3 **Ceiling mounted cassette /High wall mounted type:**

- 8.3.1 Units shall be suitable for floor standing arrangement. The unit shall be with pre-filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel. The unit shall be perfectly concealed in overhead boxing. Noise level should not be more then 35 dB at low speed.
- 8.3.2 The cooling coil shall be of seamless copper tubes, and shall have continuous aluminium fins. The tubes shall be staggered in the direction of airflow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The coils shall be tested against leaks.
- 8.3.3 Unit shall have cleanable type filter of resin net (with mold resistant) fixed to an integrally moulded plastic frame. The filter should be slide away type but neatly inserted.
- 8.3.4 Each unit shall have high lift drain pump, fresh air intake provision, low gas level detection system etc.

- 8.3.5 The above indoor unit shall have an electronic expansion valve to control refrigerant flow rate in response to load variations of room. Each unit shall also have a pressure sensor.
- 8.3.6 The computerized PID control shall be used to maintain a correct room temperature. Each unit to be provided with microprocessor thermostat for cooling & heating.
- 8.3.7 Each unit shall be with wired remote controller LCD type. The LCD remote controller shall memorize the latest malfunction code for easy maintenance.

9. **Control Unit**

- 9.1 Computerized PID control shall be used to maintain room temperature
- 9.2 Unit shall be equipped with a self-diagnosis for easy and quick maintenance and service.
- 9.3 The LCD (Liquid Crystal Display) remote controller shall memorize the latest malfunction code for easy maintenance.
- 9.4 It shall be able to control up to 16 indoor units and change fan speed individually in the group.

10. **Centralized intelligent Touch Remote Controller**

- 10.1 A multifunctional compact centralized controller shall be provided with the system.
- 10.2 The Graphic Controller shall act as an advanced air conditioning management system to give complete control of VRV air conditioning equipment. It shall have ease of use for the user through its touch screen, icon display and colour LCD display.
- 10.3 It shall be able to control up to 64 groups of indoor units with the following functions:-
 - 10.3.1 Starting/stopping of Air conditioners as a zone or group or individual unit.
 - 10.3.2 Temperature setting for each indoor unit or zone.
 - 10.3.3 Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.
 - 10.3.4 Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.
 - 10.3.5 Display of airconditioner operation history.
 - 10.3.6 Daily management automation through yearly schedule function with possibility of various schedules.

10.4 The controller shall have wide screen user friendly colour LCD display and can be wired by a non polar 2 wire transmission cable to a distance of 1 km. away from indoor unit.

11. Refrigerant Piping

11.1 All refrigerant piping for the air conditioning system shall be constructed from hard drawn seamless copper refrigerant pipes with copper fittings and silver-soldered joints. The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include expansion valves, charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

11.2 The suction line pipe size and the liquid line pipe size shall be selected according to the manufacturer's specified outside diameter. All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, slotted angle tray, anchors, brackets and supports which shall be fixed to the building structure by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

11.3 The OD & wall thickness of copper refrigerant piping shall be as follows:

<u>Outside Dia (mm)</u>	<u>Wall Thickness (mm)</u>
a) 41.3, 34.0	1.3
b) 31.8, 28.6, 25.4, 22.2	1.2
c) 19.1, 15.9	1.0
d) 12.7, 9.5, 6.4	0.8

12. Drain Piping

12.1 The indoor units shall be connected to drain pipe made of medium duty PVC with minimum wall thickness of 2mm dia.

12.2 The pipes shall be laid in proper slope for efficient drainage of condensate water.

12.2 Drain Pipe Insulation

12.2.1 Drain pipes carrying condensate water shall be insulated with 6 mm Nitrile rubber having a 'K' value of 0.037 W/mk at a mean temperature of 20°C and a minimum density of 55 Kg/Sqm.

12.2.2 The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

13. **Pipe Insulation**

13.1 **Refrigerant Pipe Insulation**

13.1.1 The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19mm /13 mm thick Nitrile close cell rubber.

13.1.2 The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

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Section 3**Treated Fresh Air Units**
(DX Type Ceiling Suspended Double skin)**1. General**

The treated fresh air units shall be complete in all respects and shall generally comply with the specifications as given in the following paragraphs.

2. Treated Fresh Air Units

2.1 The treated fresh air units shall be double skin ceiling suspended, draw through type and shall include pre filter, fan and coil.

2.2 Fan and Accessories

The fan shall be forward curved, double inlet double width type. The housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported on an area mount with taper block bearing. The fan shall be selected for a speed not exceeding 1400 RPM. The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not exceed 1800 FPM. Fan housing with motor shall be mounted on a common extruded aluminum base mounted inside the fan section on anti-vibration springs mounts or cushy foot mount. The fan outlet shall be connected to casing with the fire retardant double canvass. The fan shall be complete with multi 'V' belt drive and adjustable motor mounting base. The opening for the access of the fan section shall be provided with micro-switch and galvanized iron mesh.

2.3 Cooling coil

The cooling coil shall be of seamless copper tubes, not less than 0.5 mm thick and 12 mm O.D.. The bends shall be ready made with solder rings on both ends. The coil shall have continuous aluminum dual sine wave fins. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of air flow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The coils shall be tested against leaks at a hydraulic pressure of 225-280PSI with Nitrogen. This pressure shall be maintained for a period of 2 hours. No drop should be observed indicating any leaks.

2.4 Filtration

Each TFA shall have one or two types of filters and conforming to the specifications given under:

2.4.1 Pre-filters of 80% efficiency by weight with aluminium frame and synthetic media.

2.4.2 High Efficiency filters of 90% efficiency down to 10 micron particle size (wherever specified in "Schedule of Prices").

2.5 **Drain Pan:**

The drain pan shall be construction of 18 Gauge stainless steel sheets, externally insulated with 12 MM thick closed cell polyethylene foam insulation with necessary slope to facilitate fast removal of condensate.

2.6 **Coil and Filter Housing**

The cooling coils, special and standard filters, etc., shall all be housed in a separate enclosure of suitable size and length. The inspection doors shall have neoprene rubber T-section, rubber seals, hinges and locking arrangements. The gaps between filter frames and housing shall have synthetic rubber packing, to eliminate any air leakage. All filter frame shall be epoxy painted. The flat filter section shall be suitable for mounting filters vertically.

2.7 **TFA Enclosure/Housing**

2.7.1 The TFA enclosure shall be double skin design with the main frame work made of extruded aluminium structural section.

2.7.2 The panels shall be double sandwich type with 0.60 MM precoated galvanised sheet on the outside and 0.60 MM galvanised sheet on the inside. The insulation shall be 25 MM thick foam injected polyurethane foam.

2.7.3 Each section shall be provided with separate access panel of suitable size. The access panel shall be hinged type with heavy duty hinges and handles made of nylon. The handles shall be self tightening type to ensure leak proof closing.

2.7.4 The opening for access doors and gaps between sections shall be provided with the neoprene rubber T-gaskets fixed in grooves in the extruded sections.

2.7.5 The sandwich panels shall be fixed to the frame work with self and tapping stainless screws and both ends of the screw shall be provided with rubber caps.

2.8 **Fan Motor & Starter**

2.8.1 The fan shall be provided with a totally enclosed fan cooled squirrel cage motor which shall have a minimum rating as given under "Schedule of Equipment". The starter rating shall match the motor rating and will conform to specifications under "motor and switch gears.

2.9 **Fresh air controls**

An adjustable damper of G.I. Sheet along with bird screen, air inlet louvers and pre-filter shall be provided in the TFA.

3. **Accessories**

3.1 Each air handling unit shall be complete with the following accessories:

3.1.1 Drain line from the unit upto floor trap. (Priced Separately)

3.1.2 Fire retardant Flexible connection between the fan outlet and duct.

4. **Testing**

The treated fresh air unit shall be tested to measure air quantity and coil performance by measuring temperature difference, water pressure drop across coil and then calculating the capacity.

5. **Limitations**

5.1 The air velocity across the cooling coil shall be as specified in schedule of equipment but in any case shall not exceed 550 FPM (2.75 m per sec.).

5.2 The fan outlet velocity shall not exceed 1800 FPM. (9.15 M per sec.).

5.3 The air velocity across the filters shall not exceed 500 FPM. (2.54 m per sec.)

6. **Air Cooled Condenser**

6.1 Remote air cooled condensing unit shall have efficient condenser coils made out of copper tubing with extended aluminium fins.

6.2 Tubes shall be arranged in a staggered design for better efficiency.

6.3 Condenser fans shall be selected to operate quietly for required CFM to keep condensing temperature low.

6.4 The compressor shall be capable of operating continuously even at high ambient of 45 deg.C (113 deg.F).

6.5 The condensing unit shall be installed with MS base frame with neoprene rubber pads.

6.6 The compressor units shall be hermetically sealed scroll type.

7. **Miscellaneous**

7.1 Interconnected refrigerant piping between outdoor unit and indoor unit shall be of heavy gauge copper complete with insulation.

7.2 The units shall be tested in accordance with IS 1392.

7.3 The power supply shall be provided at outdoor/indoor unit as per manufacturer's requirement.

Section 4

Duct work and outlets

1. General

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

2. Duct Materials

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

The thickness of the sheet shall be as follows:-

	Size of Duct	Sheet Thickness	Type of Joints	Bracing if any
2.2.1	Upto 750 mm	0.63 mm	G.I. Flange	
2.2.2	751 mm to 1000 mm	0.80 mm	25x25x3 mm Angle iron frame with 8 mm dia nuts & bolts	25x25x3 mm at the rate of 1.2 M from joints
2.2.3	1001 mm to 1500 mm	0.80 mm	40x40x5 mm Angle iron frame with 8 mm dia nuts & bolts	40x40x5 mm at the rate of 1.2 M from joints
2.2.4	1501 mm to 2250 mm	1.00 mm	50x50x5 mm Angle iron frame with 10 mm dia nuts & bolts at 125 mm centre.	40x40x3 mm at the rate of 1.2 M to be Braced Diagonally
2.2.5	2251 mm and above	1.25 mm	50x50x6 mm Angle iron frame	40x40x3 mm at the rate of 1.6

M
with 10 mm dia nuts & bolts at 125 mm centre. from joints

- 2.3 The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.
- 2.4 Ducts larger than 600 MM shall be cross broken, duct sections upto 1200 MM length may be used with bracing angles omitted.
- 2.5 Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-Charge.
- 2.6 All ducts shall be supported from the ceiling/slab or on wall by means of M.S. Rods / MS channel of 9 MM (3/8") DIA with M.S. Angle at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

3. **Installations**

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

The ducts shall be re-inforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

- 3.4 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.
- 3.5 The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.
- 3.6 Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member

- anchored to the building structure with anchor bolts and with the sheet screwed to them.
- 3.7 Flanges bracings and supports are to be black, mild steel and are to be painted with rust proof primer on all surfaces before erection. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
- 3.8 Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.
- 3.9 Joints requiring bolting or rivetting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.
- 3.10 Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.
- 3.11 The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.
- 3.12 The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.
- 3.13 Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

4. **Dampers**

- 4.1 At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided. Dampers shall be two gauges heavier than the gauge of the large duct and shall be rigid in construction.
- 4.2 The volume dampers shall be of an approved type, lever operated and completed with locking devices which will permit the dampers to be adjusted and locked in any positions and clearly indicating the damper position.
- 4.3 The dampers shall be of splitter, butterfly or louver type. The damper blade shall not be less than 1.25 MM (18) Gauge, reinforced with 25 MM angles 3 MM thick along any unsupported side longer than 250 MM. Angles shall not interfere with the operation of dampers, nor cause any turbulence.

- 4.4 Automatic and manual volume opposed blade dampers shall be completed with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.6 MM steel sheets and blades shall not be over 225 MM wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 MM thickness with fine mesh.
- 4.5 Wherever require for system balancing, a volume balancing opposed blade damper with quadrant and thumb screw lock shall be provided.
- 4.6 After completion of the duct work, dampers are to be adjusted and set to deliver air flow as specified on the drawings.
- 4.7 Fire dampers shall be provided wherever shown on the drawings. The damper shall be multi blade louvre type. The blades should remain in the air stream in open position and shall be constructed with minimum 1.8 MM thick galvanised sheets. The frame shall be of 1.6 MM thickness. Other materials shall include locking device, solenoid assembly type actuator etc.

The fire dampers shall be capable of operating automatically on receiving signal from a fire alarm panel. All control wiring shall be provided between fire damper and electric panel.

5. **Access Panel**

- 5.1 A hinged and gasketed access panel measuring at least 450 MM x 450 MM shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct work.

6. **Miscellaneous**

- 6.1 All duct work joints are to be true right angle and with all sharp edges removed.
- 6.2 Sponge rubber gaskets also to be provided behind the flange of all grilles.
- 6.3 Each chute from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.
- 6.4 Diverting vanes must be provided at the bends exceeding 600 MM and at branches connected into the main duct without a neck.
- 6.5 Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-In-Charge.
- 6.6 The ducts should be routed directly with a minimum of directional change.
- 6.7 The duct work shall be provided with additional supports/hangers, wherever required or as directed by the Engineer-In-Charge, at no extra cost.
- 6.8 All angle iron flanges to be welded electrically and holes to be drilled.

- 6.9 All the angle iron flanges to be connected to the GSS ducts by rivets at 100 MM centres.
- 6.10 All the flanged joints, to have a sponge rubber packing stuck to the flanges with suitable adhesive.
- 6.11 The G.S.S. ducts should be lapped 6 MM across the flanges.
- 6.12 The ducts should be supported by approved type supports at a distance not exceeding 2.0 Metres.

7. **Standard Grilles**

- 7.1 The supply and return air grilles shall be fabricated from extruded aluminium sections. The supply air grilles shall have single/double louvers. The front horizontal louvers shall be of extruded section, fixed/adjustable type. The rear vertical louvers where required shall of aluminium extruded sections and adjustable type. The return air grille shall have single horizontal extruded section fixed louvers. The grilles may or may not be with an outer frame.
- 7.2 The damper blades shall also be of extruded aluminium sections. The grill flange shall be fabricated out of aluminium extruded section. Grilles longer than 450 MM shall have intermediate supports for the horizontal louvers.

8. **Linear Diffusers/Grilles**

- 8.1 The linear diffusers/grilles shall be fabricated from Aluminium extruded sections.
- 8.2 The diffusion blades shall be extruded, flush mounted type with single or double direction air flow.
- 8.3 The frame shall be of aluminium extruded section and shall hold the louvers tightly in fixed position.
- 8.4 The dampers as described under grilles shall be provided wherever specified.

9. **Exhaust Grilles**

- 9.1 The exhaust grilles shall be fabricated from aluminium extruded sections.
- 9.2 The exhaust grilles shall be horizontal fixed bar grilles with 15° blade inclination.

10. **Exhaust Fresh Air Louvres**

- 10.1 The louvres shall be fabricated from aluminium extruded sections.
- 10.2 The blades shall be extruded flush mounted type with single horizontal throw.
- 10.3 The frame shall be of aluminium extruded section and shall hold the louvers tightly in fixed position.

11. Painting and Vision Barrier

- 11.1 All grilles, and diffusers shall be powder coated, before installation, in approved colour.
- 11.2 All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matt finish.
- 11.3 The return air and dummy portion of all linear grilles shall be provided with a vision barrier made of 24 gauge galvanised sheets. The vision barrier shall be fixed to the false ceiling frame with self tapping screws and shall be given two coats of black paint in matt finish. Care shall be taken to ensure that the return air path is not obstructed.

12. Testing

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

Section 5**Electric Wiring****1. General :**

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

2. Wiring for Motors :

2.1 The wiring for above equipment shall be carried out in conduits or using PVC armoured cables.

2.2 The PVC armoured power cable for use on 415 volts system shall be 3 or 3.5 core with aluminium conductors and be of 650/1100 volts grade, as per IS 1554 part I-1964. The across section of the cable shall be to suit the load or rating of the equipment. The cable shall be aluminium conductor PVC insulated single wire/strip armoured with overall PVC sheathing.

2.2.1 The cables shall be laid as per IS-1255/1967, Indian Standard Code of Practice.

2.2.2 The cables shall be laid, as per drawings or along a short and convenient route between switch board and the equipment, either in trenches, on wall or on hangers, supported from the slab. Cable routing shall be checked on the site to avoid interference with structure, equipment etc. Where more than one cables are running close to each other, proper spacing should be provided between them.

2.2.3 The radius of bends of the cable should not be less than 12 times the radius of cable to prevent undue stress and damage at the bends, the cables should be supported with wooden cleats fixed on M.S. Supports, when running in trenches, wall or ceiling suspended hangers. When laid under ground the cables should be covered with fine soft earth and protected with cement concrete covering. Suitable G.I. Pipe shall be used wherever the cable comes out of the connected surface and clamped properly.

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

2.2.5 All cables shall be terminated using suitable size cable glands and packing.

2.3 The wiring in conduits shall be 1100 volts grade.

2.3.1 The conduits used shall be of high quality, all joints shall be made with sockets. The bends and elbows shall have inspection covers fixed with grease free screws. The joints shall be water tight. Approved metal saddles shall be used to secure the exposed conduits at a space of 1meter or less. The connection of the conduit to switches etc., shall be secured by a check nut and ebonite bushes provided at the ends of conduits.

2.3.2 Flush inspection covers shall be provided in case of concealed, recessed conduits. The staples for the conduits shall not be spaced more than 0.60 metres apart. Before filling up the chase with concrete the conduits should be given a coat of rust proof paint.

2.3.3 The wires shall be drawn only after all the conduits have been properly fixed in position.

3. **Control Wiring :**

3.1 Control cables shall be 660 volts grade as per IS 1554 made from copper conductor of 1.5/2.5SQ. MM PVC insulated single/multi core unarmoured with an overall PVC sheathing.

3.2 The cables and conduits wiring shall be carried out as per details given under 2.2 and 2.3 above.

4. **Earthing :**

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

Size of phase wire sq.MM Aluminium	Size of copper conductor tape/wire (SWG)
185	20 MM x 3 MM (strip)
150	20 MM x 3 MM (strip)
120	12 MM x 3 MM (strip)
95	4 SWG
70	6 SWG
50	8 SWG
35	8 SWG
25-6	8 SWG
4	10 SWG

Note :- GSS earthing conductors of equivalent size may be used in lieu of copper earth mentioned above.

5. **Miscellaneous :**

5.1 The final connections to the equipment shall be through flexible connections in case of conduit wiring and also where the equipment is likely to be moved back and forth, such as on slide rails.

5.2 An isolator switch shall be provided at any motor which is separated from the main switch panel by a wall or partition or other barrier or is more than 15 metres away from the main panel.

5.3 Two separate and distinct earthing conduits shall be connected from the equipment upto the main switch board panel.

- 5.4 The branch lines from the main panel to each equipment shall be separated and should not criss cross other lines.
- 5.5 The entire installation shall be tested as per electricity rules and I.S.S 732-1973 with amendments 1,2&3 prior to the commissioning of the plant and a suitable test report furnished by a competent and authorised person. The test report will be obtain by contractor himself at his own expenses.

Section 6**Insulation****1. General**

The Insulation of refrigerant piping, drain piping, etc. shall be carried out as per specifications given below :

2. Materials

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere. The detailed specifications of the materials are listed under respective sub heads.

- 2.1 Refrigerant Pipe Insulation : Closed Cell Elastomeric Insulation
- 2.2 Drain Pipe Insulation : Closed Cell Elastomeric Insulation

3. Refrigerant Pipe Insulation

3.1 The insulation for refrigerant piping shall be carried out from closed cell elastomeric insulation having a 'K' value of 0.037 W/mK. at mean temperature of 20°C and a density of 55 kgs/cubm.

3.1.1 The thickness of the insulation for refrigerant pipes shall be 19 MM/13 MM thick closed cell nitrile rubber.

3.2 Drain Pipe Insulation

3.2.1 The material for insulation of drain pipes shall be pipe sections of flexible closed cell elastomeric insulation having a 'K' value of 0.037 W/mk at a mean temperature of 20°C and a minimum density of 55 Kg./cubm.

3.2.2 The thickness of insulation shall be 6 mm thickness.

4. Duct Insulation(With Closed Cell Elastomeric)**4.1 Materials**

4.1.1 The materials for duct insulation shall be sheets of closed cell elastomeric insulation. The density of insulation shall not be less than 40-55 kg/cubm and material shall be in the form of sheets of uniform thickness. The 'K' value at 20° C. shall not be less than 0.037 W/mK.

4.1.2 The thickness of duct insulation shall be as follows :

- a. Duct in conditioned space - 13 mm thick
- b. Duct in unconditioned space - 25 mm thick

4.2 **Cold Adhesive Compound**

4.2.1 The Cold adhesive compound for closed cell elastomeric insulation shall be synthetic glue with glue thinner as per insulation supplier recommendations.

4.2 **Tar Felt**

The Tar felt used for water proofing shall conform to IS: 1322 Type 3 Grade I.

5. **Installation**

5.1 **Refrigerant Piping**

5.1.1 The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.

5.1.2 The pipes shall be given a coat of red oxide primer.

5.1.3 Two coats of synthetic glue shall be applied on the cleaned pipe surface.

5.1.4 The preformed sections of insulation shall be fixed tightly to the surface to take care to seal all joints.

5.1.5 All longitudinal joints and circumferential joints shall be sealed with synthetic glue.

5.2 **Drain Piping**

5.2.1 The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.

5.2.2 Then preformed sleeves of 6 mm thick insulation shall be slipped on the pipe.

5.2.3 All joints shall be insulated with sleeves cut in two sections and fixed to the pipes with cold adhesive compound.

5.2.4 All joints shall be covered with 3 mm x 50 mm PVC self adhesive.

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Section 7**Testing and Commissioning****1. General**

- 1.1 The contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the architect, in accordance with the provisions of the applicable ASHRAE standards or approved equal in addition to furnish necessary test certificates from manufacturers.
- 1.2 The system shall then be commissioned, tested and balanced to fulfill the intent and purpose for which it is designed.
- 1.3 In addition continuous Run Tests shall be carried out during peak weather condition.

2. Compressors Condensers/Out Door Units/Evaporators/

- 2.1 Hydraulic test for various components and assembled equipments at 1.5 times design pressure or double the operating pressure, whichever is higher.
- 2.2 Pneumatic leak test after assemblies at design pressure
- 2.3 Static and dynamic balancing on electronic precision machine for rotating parts, links, impeller/ crank shaft assemblies etc.
- 2.4 Testing of oil passages in compressor at 1.5 times pump discharge pressure.
- 2.5 Pressure drop test for condenser, chiller and evaporator.
- 2.6 For compressor assembly, electronic leak, air running test, pneumatic test with dry nitrogen and leak test in water.

3. Indoor Units

- 3.1.2 Performance test as per applicable codes.

3.2 Coils

- 3.2.1 Pneumatic test.

3.3 Filters

- 3.3.1 Test of filter elements as per B.S. 2831 B.S. 1701 as applicable. This is to ascertain filtration efficiency by weight at inlet and outlet.
- 3.3.2 Manufacturer's test certificates also to be produced for the assembled unit. Final dimensional check will be done. Inspection may be done during assembly of components for quality of workmanship, painting etc.

3.3 **Piping**

Materials check for specifications and size.

3.6 **Instruments and Controls**

Visual examination.

3.7 **Special Note**

Vendor to note that above procedure is to be followed in addition to the specifications attached with the tender.

4. **Associated Works at Site.**

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

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

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

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

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

4.6 Checking of calibration of controls and instrumentation

4.7. Checking of assemblies or electrical control panel, instruments panels, local panels (dimensional and functional) annunciator panels etc.

4.8 Inspection of complete electrical installation at site.

4.9 Performance testing of complete VRV system as per specifications.

5. **Vendor Responsibility**

5.1 The above inspection procedure is given for general guidance and information of vendors. The inspection of purchaser/consultant is strictly not limited to these.

5.2 The inspection engineer of purchaser/consultant will have full right, to have detailed inspection at any stage right from placement of order to completion of project, as and when desired by inspection engineer.

- 5.3 Co-ordination of inspection agency of purchaser/consultant with his factory/sub-vendor's factory/erection site will be the sole responsibility of successful vendor, subsequent to placement of order for complete air conditioning plant, covered under these technical specifications.

6. **Piping System**

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

7. **Electrical Equipment**

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

7 The following tests shall be carried out :

- 7.2.1 Cables and Wires continuity tests.
- 7.2.2 Insulation resistance tests, phase to phase and phase to earth, on all circuits and equipment, using a 500 Volts meggar. The meggar reading shall be not less than one megaohm.
- 7.2.3 Earth resistance between conduit system and earth must not exceed half (1/2) CMH.
- 7.2.4 Phasing out and phase rotation tests.
- 7.2.5 Operating tests on all protective relays to prove their correct operation before energizing the main equipment.
- 7.2.6 Operating tests on all starters, circuit breakers etc.

8. **Commissioning of the System**

The system shall be commissioned by adopting the following procedure.

- 8.1 The installation as a whole shall be balanced and tested upon completion, and all relevant information, including the following shall be submitted to the architects.
- 8.1.1 Air volume passing through each unit, apertures.

- 8.1.2 Differential pressure readings across each filter, fan and coil, and through each pump.
- 8.1.3 Electrical current readings, in amperes of full and average load running and starting, together with name plate current of each electrical motor.
- 8.1.4 Continuous recording over a specified period, of ambient wet and dry bulb temperatures under varying degrees of internal heat loads and use and occupation, in each zone of each part of the building.
- 8.2 Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream "On-Coil" of each cooling coil. Also suction temperatures and pressures for each refrigerating unit. The current and voltage drawn by each machine.
- 8.3 Any other readings shall be taken which may subsequently be specified by the architect.
- 8.4 If these air quantities cannot be delivered without exceeding the speed range of the pulley or the available horse power, the architect shall be notified, before proceeding with the balancing of air distribution system.
- 8.5 A proper record shall be maintained as per Test Performa given else where.

9. **Miscellaneous**

- 9.1 The above tests and procedures are mentioned herein, for general guidance and information only, but not by way of limitation to the provisions of conditions of contract and specification.
- 9.2 The date of commencement of all tests listed above, shall be subject to the approval of the architect and In accordance with the requirements of this specification.
- 9.3 The contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system, if the architect requests such a test for determining specified or guaranteed data, as given in the specification or on the drawings.
- 9.4 Any damage resulting from the tests shall be repaired and/or damaged material replaced, to the satisfaction of the architect.
- 9.5 In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommenced after the adjustment or repairs have been completed.
- 9.6 The contractor must inform the architect when such tests are to be made, giving sufficient notice, in order that the architect or his nominated representative may be present.

- 9.7 Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the architect.
- 9.8 The contractor may be required to repeat the test as required, should the Ambient conditions at the time, do not give, in the opinion of the architect, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

S.No.	Unit	Unit	Condition of Services
2.	<u>Treated Fresh Air Unit (DX Type)</u>		
2.1	Type	--	-----Ductable ceiling suspended-----
2.2	Cooling Capacity	Tons (KW)	5.5 (19)
2.3	Heating Capacity	KW	--
2.4	Quantity	No.	1
2.5	Air quantity	Cum/hr.	3740
2.6	Coil Area (each)	Sqm	0.41
2.7	No. of rows	Nos.	3
2.8	No. of fins/cm	Nos.	5
2.9	Static pressure	MMWG	40
2.10	Motor rating	KW	2.2
2.11	Type of motor enclosed	--	TEFC
2.12	Refrigerant	--	R-22
2.13	Electric Supply	--	-- 220 V/1 Ph/50 Hz --

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Section 9**Technical Data**

Contractor should furnish technical data as mentioned below, of the equipment and accessories offered by him as per scheme given in schedule of equipment and bill of quantities.

S.No.	Description	Unit	Condition of Services
<u>Variable Refrigerant Volume System</u>			
1.	Outdoor Units		
1.1	Make	--	
1.2	Model	--	
1.3	Cooling Capacity	--	
1.3.1	Nominal	TR	
1.3.2	Actual	TR	
1.4	Heating Capacity	--	
1.4.1	Nominal	KW	
1.4.2	Actual	KW	
1.5	Compressor Motor	KW	
1.6	Sound level at distance of 3m	DB(A)	
1.7	No. of Compressor	--	
1.7.1	Fixed Speed Type	Nos.	
1.7.2	Variable Speed Type	Nos.	
1.7.3	Total No. of compressor	Nos.	
1.8	Power Supply requirement	3Ph/1Ph	
1.9	Power consumption at rated capacity	KW	
2.	Indoor Units		
2.1	Make	--	
2.2	Model	--	
2.3	Cooling Capacity	--	
2.3.1	Nominal	TR	
2.3.2	Actual	TR	
2.4	Heating Capacity	--	
2.4.1	Nominal	KW	
2.4.2	Actual	KW	
2.5	Air Quantity	CMH	
2.6	Sound level at a distance of 1m	DB(A)	
2.7	Power supply requirement	3Ph/1Ph	
2.8	Power consumption at rated capacity	KW	

S.No.	Description	Unit	Condition of Services
3.	<u>Treated Fresh Air Units (DX Type CSU Double Skin)</u>		
3.1	Manufacturer	Casing : Coil :	Name Name
3.2	Type		(Horizontal /Vertical)
3.3	Operating Weight		KGS
3.4	Overall Dimension		MxMxM
3.5	Dimension of Coils		MxM
3.6	Finned Area		Sqm
3.7	Material of coil Header		Steel/Copper
3.8	No. of Rows		Nos
3.9	Fins per cm		Nos.
3.10	Type of fins- Plate/vertical		--
3.11	No. of circuits		Nos.
3.12	Water velocity in tubes		M/s
3.13	Tube Material		--
3.14	Tube Dia.		MM
3.15	Thickness of tubes		MM4
3.16	Fin material		--
3.17	Water pressure drop		M
3.18	Air quantity		CUBM/HR
3.19	Make of Fan		--
3.20	Fan outlet velocity		M/s
3.21	No. of fans		Nos.
3.22	Dia of fans		MM
3.23	Fan speed		RPM
3.24	Total static pressure		MM WG
3.25	Whether both Balancing Carried out-static and dynamic		Yes/No
3.26	Motor Output		KW
3.27	Type of motor		--
3.28	Type of air filters & efficiency		--
3.29	Velocity across filters		M/s
3.30	Material and thickness of sheet		
3.30.1	Internal		--
3.30.2	External		--
3.31	Material and thickness of Insulation		MM
3.32	External finish		Type

S.No.	Description	Unit	Condition of Services
4.	<u>Material proposed for</u>		
4.1	Duct insulation	--	
4.2	Pipe insulation	--	
4.3	Acoustic treatment of ducts	--	
5.	<u>Insulation Details</u>		Ducts / Piping / Acoustic Lining
5.1	Manufacturer	--	
5.2	Materials	--	
5.3	Density	KG/Cum.	
5.4	Mean 'K' value at 10 ⁰ c	--	
6.	<u>Indoor Units</u>		
6.1	Make	--	
6.2	Model	--	
6.3	Cooling Capacity	--	
6.3.1	Nominal	TR	
6.3.2	Actual	TR	
6.4	Heating Capacity	--	
6.4.1	Nominal	KW	
6.4.2	Actual	KW	
6.5	Air Quantity	CMH	
6.6	Sound level at a distance of 1m	DB(A)	
6.7	Power supply requirement	3Ph/1Ph	
6.8	Power consumption at rated capacity	KW	

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Section 10

List of Approved Makes

Note : The tenderer must indicate the makes he has used to cost his tender. Ultimate International is at its liberty to insist on any make mentioned below.

S.No.	Items	Approved Makes	Make Proposed	
			In Tender	Alternate
1.	VRV System	Daikin/Mitsubishi/Toshiba		
2.	Treated Fresh Air Unit	Crystal/Caryaire/Zeco/		
3.	Condensing Unit	Bluestar/Voltas		
4.	Closed Cell Elastomeric Insulation	Armaflex/Aeroflex/ Supreme		
5.	UPVC Pipe	Polypack/Finolex/Supreme		
6.	Slotted Tray	KEPL/Flatco/SMC/ISI approved by Architect		
7.	Y-Joints	Daikin/Mitsubishi/Toshiba		
8.	Weather Proof Isolators	L&T/Siemens/Legrand		
9.	Control Cables	Polycab/Finolex/Delton/ National		
10.	Power Cables	Polycab/Havells/National		
11.	Ducting & Grilles			
11.1	Grilles/ Diffusers	Caryaire/ Cynor/ Mapro/ Tristar		
11.2	Fire Dampers	Caryaire/ Cynor/mapro		
11.3	Jet Nozzles diffuser	Caryaire/ Cynor/ Mapro/ Tristar		
11.4	Fire Dampers motors	Belimo/Seimens/ Honeywell		
11.5	G.I. Sheet Metal Duct	Jindal/National/ Tata/SAIL		
11.6	Factory fabricated duct	Dustech/Ductofab/ MK Duct		
11.7	Duct flange	Dustech/Ductofab/ MK Duct		
11.8	Self Adhesive Sealing Gasket for Ducts	Prima Seal/ Air Flow/ Paramount		
11.9	Hessian (Fire treated)	Navair/ Pyroguard		
11.10	Stick Pins	Prima Seal/ Air Flow		
11.11	VCD/ Gravity louvers/ Exhaust & fresh air louvers	Caryaire/ Cynor/ Mapro/ Tristar		