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| **Tender Document**  **For**  **HVAC Work – Coomaraswamy Auditorium**  at  Chhatrapati Shivaji Maharaj Vastu Sangrahalaya,  (formerly Prince of Wales Museum of Western India)  159-161, M G Road, Fort, Mumbai.  Last date for submission : 11th June, 2019 upto 4 PM.  Air Conditioning Consultant : Client  M/s Design Bureau CSMVS, The Museum  Consultants Pvt. Ltd. M G Road, Fort  122-123, Sai Commercial Mumbai.  Govandi Station Road,  Deonar, Mumbai. |

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# **1101 TENDER DETAILS**

**1.0 SCOPE**

1.1 The scope under this section covers the general details and conditions applicable on this contract and listed below :

**2.0 PROJECT DETAILS**

2.1 Project : CSMVS Airconditioning work

Coomaraswamy Hall

2.2 Client : Chhatrapati Shivaji Maharaj

Vastu Sangrahalaya

2.3 Site address : M.G.Road, Fort, Mumbai

2.3 Scope of work : Refurbishing of existing

airconditioning system

**3.0 Contract Details**

3.1 Type : Works Contract

3.2 Rate : Fixed Item Rate

3.3 Quantity : Measurable as per BOQ

3.4 Quantity Variation : +/- 10 % of Total Contract Value

3.5 Rate Validity : 6 months

3.6 Offer Validity : 30 days

3.7 Offer Value : Based on tender quantity and

rate offered

3.8 Contract Value : Based on tender quantity and

rate agreed up on

3.9 Final Contract Value : Based on quantity executed

and rates agreed upon

**4.0 Securities**

4.1 Earnest Money : Nil

4.2 Security : Bank Guarantee for 2.0% of

Contract Value till

commissioning and handing over

**5.0 Programme Schedule**

5.2 Submission of tender : 11th June 2019

**6.0 Taxes & Duties**

6.1 GST : Inclusive

**7.0 Material Delivery**

7.1 Location : Site

7.2 Freight & Insurance : Inclusive

7.3 Loading and Unloading : Inclusive

**8.0 Insurance**

8.1 Material : Inclusive

8.2 Workmen : Inclusive

**9.0 Guarantee**

9.1 Validity : 12 months after handing over

9.2 Maintenance : Free of cost including spare

parts during guarantee

9.3 Downtime Period : 24 Hrs

9.4 Penalty for delay : Rs.5,000 per day delay

**10.0 Terms of Payment**

10.1 Advance against BG : 10%

10.2 Delivery Pro-rata : 60%

10.3 Erection : 15%

10.5 Commissioning : 15%

**11.0 Site Facilities**

11.1 Power Supply : Free at one point,

any extension by contractor

11.2 Water Supply : Free at one point, any

extension by contractor

11.3 Storage : Covered Space by Client,

Partition, doors & security

by contractor

11.4 Security : By contractor till the

installation is taken over by

clients.

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# **2201 VRF AIRCONDITIONING SYSTEM**

1.0 SCOPE

1.1 Scope under this section consisting of :

1. VRF air conditioners
2. CODES AND REGULATIONS

2.1 All assembled equipments, components and the entire system installation shall conform to the codes, regulations and standard specification furnished separately.

2.1.1 General requirements

* 1. The refrigeration equipments shall meet the requirements shown in the equipment data / bill of materials. The equipments shall be complete with refrigeration compressors, motors and drive assembly, condenser, evaporators, refrigeration piping, controls and safety instrumentation, interconnected piping and wiring all accessories and first charge of refrigerant and lub oil.
  2. The equipment and the entire installation shall meet the codes, regulations and the standard specification prevalent at the origin of the equipments as well as local codes and regulations.
  3. The equipment shall meet the EER specified and the refrigerant used shall be environment friendly non CFC.
  4. The compressors shall be scroll or screw type and shall have precision control for VRF and precision air conditioning application.
  5. The compressors for VRF and precision air conditioning shall be inverter / digital type capable of modulating the refrigerant flow based on varying.
  6. All equipments shall be factory assembled and tested and shall be skid mounted.
  7. The equipment enclosure shall be suitable for the ambient temperature and humidity. Also the same shall be treated for anti corrosion based on the environment, surrounding the equipment.
  8. All equipments shall have automatic control system and display panels. The control system shall be built in, with chorded remote or cordless remote as indicated in bill of materials.
  9. The equipments and control system supplied shall be suitable for the power supply shown below :

1. 3 phase – 4 wire 415 V, 50 Hz.
2. 1 phase – 2 wire, 240 V, 50 Hz.

The equipment shall be capable of withstanding the fluctuation in the power supply as shown below:

1. Voltage : ± 15%
2. Frequency : ± 5%
3. BASIC SYSTEM & COMPONENTS
   1. General

The basic system and components for the VRF units are as under. The detailed requirements are indicated separately.

* 1. Variable Refrigerant Flow System

1. Scope :

The scope of this section comprises the supply, erection, testing and commissioning of Variable Refrigerant Volume System conforming to these specifications and in accordance with the requirements of Drawings and Schedule of quantities.

1. Type :

Unit shall be air cooled, variable refrigerant volume air conditioner consisting of one outdoor unit and multiple indoor units. Each indoor unit having capability to cool independently for the requirement of the rooms. All indoor units shall be provided with isolation valves so that a particular unit can be isolated and removed for servicing, while system keeps functioning in normal way. It shall be possible to connect multiple indoor unit on one refrigerant circuit as shown in the drawings or as indicated in schedule of quantities. The indoor units on any circuit can be of different type and also controlled individually. Following type of indoor units shall be connected to the system :

* + - * 1. Ceiling mounted cassette type.
        2. Ceiling mounted ductable type.
        3. Wall mounted Hi-Wall type.
        4. Floor mounted type.

Compressor installed in outdoor unit shall be equipped with capacity control mechanism, and capable of changing the rotating speed / mass flow rate of refrigerant by scroll engaging / disengaging mechanism to follow variations in cooling. Outdoor unit shall be suitable for mix match connection of all type of indoor units. The refrigerant piping between indoor units and outdoor units shall be extended up to 100m with maximum 50 m level difference without any oil traps. Oil recovery system shall be managed without disturbance to normal operation cycle of the system / compressor. Both indoor unit and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivery at site.

1. Out Door Unit :

The outdoor unit shall be factory assembled, weather proof casing constructed from heavy gauge mild steel panels with powder coated finish. All outdoor units above 5 HP rating shall have minimum two number scroll compressors. In case of outdoor units with multiple compressor, the operation shall not be disrupted with failure of any compressor. The noise level shall not be more than 60 dB (A) at normal operation measured horizontally 1m away and 1.5 m above ground level. The outdoor unit shall be modular in design with possible future expansions. The unit shall be provided with microprocessor control panel.

1. Compressor :

The compressor shall be high efficiency scroll type and capable for capacity controlling. It shall change the speed / refrigerant mass flow rate in accordance to the variation in cooling load requirement. Refrigerant mass flow rate can be changed by speed modulation of compressor / mechanical control system. System shall incorporate liquid sub-cooling mechanism with liquid injection at intermediate pressure. The inverter if used, shall be IGBT (insulated gate bipolar transistor) type for efficient and quiet operation. All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated. Forced lubrication may also be employed.

Oil heater shall be provided in the compressor casing.

1. Heat Exchanger :

The Heat Exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fan coil and larger surface area. The fins shall have anticorrosion treatment for Heat Exchanger Coil. The treatmentshall be suitable for areas of high pollution, moisture and salt laden air. The casings, fans, motors etc. shall also be with anticorrosion treatment as a standard features. The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical / horizontal discharge. Each fan shall have a safety guard.

1. Refrigerant Circuit :

The Refrigerant Circuit shall include an liquid receiver /accumulator, liquid & gas shut off valves and a solenoid valve. All necessary safety devices shall be provided to ensure the safety operation of the system.

1. Safety Devices :

All necessary safety devices shall be provided to ensure safe operation of the system. Following safety devices shall be part of the outdoor unit : high pressure switch, low pressure switch, fuse, crankcase heater, fusible plug, over current protection for inverter, and short recycling guard timer.

1. Piping :

All connections of Refrigerant piping shall be in high grade Copper of Refrigeration quality with Eddy Current Testing and material test Certificates. All connections, tees, reducers etc. shall be standard make fittings. Insulation of cold lines shall be carried out with Armaflex / K-Flex insulation sheets and tubes of appropriate thickness so that condensation does not occur. For individual Piping 50 / 100 mm wide Aluminium Tape shall be used at joints of Piping with Bands for identification. For outdoor piping, the finish shall be woven GRP Mat finished with coloured Epoxy paints to

withstand outside ambient conditions and UV Radiation.

1. Oil Recovery System :

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping. System shall be designed for proper oil return to compressor along with the distribution of oil to individual compressor. The refrigerant piping shall be extended upped 100 M with 50-M level difference without oil Traps

1. Indoor Units :

Units shall be factory assembled, wired, piped and tested. Units shall have DX coils with copper tubes and bonded aluminium fins for highly efficient heat transfer. Units shall have Centrifugal fans for adequate amount of Air circulation and low Noise. Units shall have inlet filters, which are easily cleanable and replaceable. All components of Units are easily accessible for connection, repairs and maintenance. Units shall have very low noise. All units with Factory manufactured Units, Grills shall have auto swing feature for proper Air distribution. All unit shall be controlled by electronic Expansion Valves only. All units mounted inside the ceiling shall have fans capable of sustaining duct connections, and special filters if necessary. Visible indoor units shall have wireless remotes. Price of the same shall be included in cost of unit by default. Concealed indoor units shall have sensor mounted on supply air grilles / diffusers which can be controlled with wireless remotes. Anticorrosion treatment for avoiding corrosion of coils. All units shall have adequate insulation or Lining to avoid condensation. Cooling coil and refrigeration parameters shall be designed in such a way that supply air temperature shall not be less than 140C or 10C above room dew point temp, whichever is more. Contractor shall guarantee inside conditions with selected supply air temperature.

1. Ceiling Mounted Ductable Type Unit :

Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanised steel. The unit shall have high static fan for ductable arrangement.

1. Central Remote Controller (Option if Specified in BOQ) :

A multi-functional microprocessor based centralized controller (central remote controller) shall be supplied as an optional accessory. The controller shall be able to control upto min. 64 zones of 64 group (each group consisting of max. 16 units) or 128 nos. of indoor units with the following functions.

- Temperature setting for each zone, or group, or indoor unit.

1. - On/Off as a zone or individual unit.
2. - Indication of operating condition.
3. - Select ON of all operation modes for each zone..
4. - The controller shall have wide screen liquid crystal display and shall be wired by a on polar 2 wire transmission cable to a distance of 1000m away from the indoor unit.
5. - The controller shall be integrated to BAS system thru software for monitoring & controlling of all above parameters including start/ stop of each indoor / out door unit. All necessary interface cards / units should be supplied as a part of the system to integrate to the BAS Software.
6. Condensate :

25mm dia UPVC pipes, 40mm dia uPVC headers & fittings shall be used for condensate, from Evaporator Unit to drain point. The joints shall be properly sealed so that there is no water leakage. U-trap shall be provided at the end. Additional insulation drain tray shall be provided below the Evaporator Unit, if required.

1. Mounting

All indoor units shall be mounted with Brackets, Hangers etc. with proper size anchor

Fasteners.

1. Electrical installation :

For Variable Refrigerant flow systems, power will be provided near outdoor unit location. HVAC Contractor to provide suitable distribution panel along with 3-phase power to outdoor units and single phase power to all indoor units fed by these outdoor units. Power / control armoured cabling along with supports shall be included.

* 1. Refrigerant Piping

1. The refrigerant piping shall be refrigeration quality high grade copper seamless tubes with eddy current testing and material quality test certificate. The pipe shall be in coil formation or strait sections depending upon the size and availability.
2. The pipes and fittings shall be made of phosphorous dioxidised copper alloy C-106 or C-12200 with minimum copper purity of 99.9% and phosphorous purity of 0.015 to 0.040%. The dimensional tolerance shall be as per ASTM B251.
3. The pipe assembly shall be of soldered or brazed joints. The fitting shall be self soldered.
4. The pipe assembly to be tested for leakage at test pressure of twice the system pressure. The pipe assembly to be flushed before vacuuming and charging of the refrigerant.
5. The refrigerant piping shall be adequately insulated to avoid heat losses and condensation. The insulation shall be carried out with polyethylene or nitrile rubber tubes of adequate thickness. The joints at the fittings shall be sealed with 50/100 mm aluminum tapes.

Piping exposed to the atmosphere shall be coated for mechanical protection and against UV radiation using woven GRP coated with epoxy paint.

* 1. Power Panels

1. The power panel shall include :
2. Incoming and outgoing ELCB.
3. Starters and relays for compressor & condenser fan motors.
4. Safety and control instruments and indicators.
5. Single phase preventers for 3 phase motors.
6. Interconnection and wiring
7. Power panels for outdoor installation shall have IP55 protection.
   1. Control panel
8. The control panel shall be microprocessor based user friendly and self explanatory and shall include.
9. LCD display unit.
10. Automatic capacity control
11. Automatic system protection
12. Remote monitoring and controlling capability wherever specified.
13. Control panels for outdoor installation shall have IP 55 protection.

# **2202 AIR HANDLING EQUIPMENTS**

1.0 SCOPE

1.1 The scope under this section shall cover supply installation, testing and commissioning of Air Handling Equipment consisting of :

a) Air Handling units

b) Fan coil units

c) Centrifugal fans

d) Propeller fans

e) Vane axial fans

2.0 STANDARDS

2.1 The following standards shall be applicable

a) IS : 4283 Hot air fans

b) IS : 8272 Industrial cooling fans (man collers)

c) IS : 4894 Centrifugal fans

d) IS : 10470 Air cooled heat exchangers

e) IS : 2997 Air circulator type electrical fan and regulator

f) IS : 1169 Electrical pedestal type fans and regulators

g) IS : 374 Electrical ceiling type fan and regulator

3.0 GENERAL REQUIREMENTS

3.1 The air handling equipments shall meet the requirements indicated in the Equipment Data and shall be complete with fan, casing, motor mounting frame, vibration isolators.

3.2 The ventilation units, AHU's and FCU's shall be provided with air filters. Equipments used for heating/cooling system shall be provided with air cooled heat exchangers.

3.3 The equipment data indicated is a guide line for selection of the equipment based on various parameters which may vary from manufacturer to manufacturer. Hence the contractors should verify the adequacy of the equipment offered considering the basic requirement and parameters indicated in the equipment data.

3.4 All fans shall be double ball or roller bearings and selected for low noise level.

3.5 All air handling equipment shall be connected to the fire alarm system and shall be automatically switched off in case of fire in the zone served by that equipment. The supply and return air intakes shall be provided with fire dampers.

4.0 AIR HANDLING UNITS

4.1 The air handling units shall be of draw through sectionalised construction comprising of:

a) Filter section

b) Fan section

c) Heat Exchanger section

4.2 Each section shall be constructed out of 16 SWG GI sheet steel with spray galvanised MS frame work and re-enforcement members. The sections shall be bolted together and shall be easily detachable for easy maintenance and repairs.

4.3 The filter section, fan section and the heat exchanger section shall be as specified in the respective heading in this section.

4.4 The air handling units shall be provided with thermal and acoustic insulation as specified in the respective sections.

5.0 FAN SECTION

5.1 The fan sections shall be sectionalised construction and consisting of casing, fan, filters, dampers etc. The casing shall be fabricated out of GI sheets of minimum 1.2 mm thick welded construction with 2mm thick MS angle frame work and cross brazing.

5.2 The fans shall be forward curved centrifugal double inlet mounted on a common shaft. The fans shall be of GI, house in streamlined scroll cases and statically and dynamically balanced. The fans sections shall be provided with detachable filter section and damper section.

5.3 The drive assembly shall consist of motor, multi vee grooved adjustable pitch pulleys and multiple vee belts. The motor mounted on adjustable base frame shall be erected over the fan section through mounting shoes or structural members. The belts shall rotate in self aligning ball bearings.

The fan section having 2 motors (one working and one standby) shall

have the shaft extended on both sides with drive pulleys.

6.0 CENTRIFUGAL FANS

6.1 The centrifugal fans shall be heavy duty single or double suction conforming to IS: 4894. The casing shall be of heavy gauge steel sheet/plate seam welded with necessary stiffened with angle or channel side bracings and with fixed suction and discharge flanges, manually operated suction vanes, access doors etc.

6.2 The impellers shall be backward curved hollow heavy section aero foil construction with internal re-inforcement with non-overloading characteristic. The wheels hubs shall be machine cast or fabricated.

6.3 The shafts shall be of hot rolled steel or alloy steel liberally sized to achieve the critical speed at least 30% above the normal speed. The bearing shall be heavy duty self-aligning repressible ball or roller type capable of absorbing radial and thrust loads.

7.0 FILTERS

7.1 The filters shall be metallic, PVC or fabric as specified in equipment data. Air handling units for special application shall be provided with Microvee or HEPA.

7.2 Metallic filter shall consist of V fold galvanised wire mesh inter speed with a flat layer of galvanised wire mesh. The density of the filter medium shall increase in the direction of air flow. Wire mesh edges shall be suitable hemmed to eliminate the danger of abrassion during handling. Filter medium shall be supported on either side by galvanised expanded metal casing. Filter frame shall be constructed of galvanised sheet of thickness not less than 18 gauge. Filter shall be either dry or oil melted type. Oil shall be suitable mineral oil of approved type.

Alternatively the filter frames shall be fabricated for aluminium alloy conforming to IS : 737 and medium shall be aluminium alloy.

All filters must be capable of being completely cleaned of their accumulated dust by flushing with tap water.

7.3 Fabric filters shall be flat filter fabric or suitable material recommended by the manufacturer stitched by inforce wire gauge support and crimped to form deep folts. Suitable aluminium spacers shall be provided to ensure uniform distribution of air flow through the filter. Filter casing shall be provided with neoprene sponge rubber sealing, the filter shall be either dry type or oil wetted type, with element of three ply or five ply construction a specified in data sheet.

7.4 Nylon filters shall be made of repellanting nylon fabric with continuous water spraying on it from a header for keeping it clean. Efficiency of this filter should be 85% down to 10 microns.

7.5 Microvee filters shall be constructed by plating acculinuous sheet of filter medium into closely spaced plates separated by heavy corrugated aluminium spacers. The microvee filter shall have an efficiency of 99.9% down to five micron. The clean filter static pressure drop shall not be greater than 25mm WG when operating at the rated capacity. A neoprene sponge rubber sealing shall be provided on either face of the filter frame.

7.6 The HEPA filters shall consist of aluminium frame with media of 100% submicronic glass fibers. The glass fibers shall be suitably for the condition of use and shall have high resistance to corrosion vapours. The filter shall have filtration efficiency of 99.97% down to 0.3 microns. When tested with hot DDP test, the filter capacity specified shall be taken as rated capacity at 25mm WG pressure drop and offer shall be made accordingly. It should be possible to use HEPA filter upto 75mm WG pressure drop.

# **2203 AIR DISTRIBUTION**

1.0 SCOPE

1.1. The scope under this section covers air distribution system consisting of :

a) Sheet metal ducting

b) Grilles and diffusers

2.0 STANDARDS

* 1. The following standards shall be applicable.

a) IS : 277 Galvanised steel sheet

b) IS : 513 Cold rolled low carbon steel sheets and strips

c) IS : 655 Metal air ducts

d) IS : 659 Safety code for airconditioning

e) IS : 737 COP for wrought aluminium and aluminium alloy sheets and

strips for general engineering purposes.

f) IS : 1079 Hot rolled carbon steel sheets and strips

g) IS : 2629 Recommended practic for hot-dip galvanising of iron & steel

h) CP : 352 Mechanical ventilation and air-conditioning in buildings

i) SMACNA Low pressure duct construction standard

3.0 GENERAL REQUIREMENT

3.1 The material and fabrication shall meet the requirement of the relevant standard specifications and codes. The materials and fabrication shall be suitable for the system pressure. All upstream ducting for VAC units shall be of minimum 500 Pa pressure clause.

3.2 The duct shall be preferably factory fabricated to SMACNA standards.

3.3 The contractor shall prepare detailed shop/working drawings and get it approved by the Consultants before taking up the fabrication work. The drawing shall indicate the size and thickness of duct, air flow rate, air discharge at each outlet, size of discharge, grilled diffuser, location and size of guide vanes, dampers, access door etc.

3.4 Ducts shall be straight, smooth, air tight and neatly finished. The system leakage shall not exceed 5%.

* 1. The sheet metal ducting shall be done for the proper distribution of air in air-conditioned/ventilated space. The ducting shall be designed on the basis of equal pressure drop and shall incorporate necessary accessories like reducers, bends, splitters, dampers and guide vanes for proper control and smooth air flow.

3.6 The selection of air diffusing attachments and their location shall be done to achieve uniform air distribution. The grilles and diffusers shall be pained M.S or aluminium as specified and shown on the drawing.

3.7 The ducting shall be supported by means of hangers from the ceiling slab using anchor bolts and shall not rest on the false ceiling. Chipping of concrete slab and exposing reinforcement is prohibited.

3.8 Duct crossing walls and slabs shall be treated for anticorrosion and the openings shall be closed properly unless indicated on the drawing for the purpose of return air. There shall be no traverse joint in the section of duct concealed in brick wall. All longitudinal seams shall be sealed with mastic sealants.

3.9 Volume control dampers of splitter or louvered type shall be provided as shown on the drawings. Additional dampers if required shall be provided for proper balancing of the air distribution system.

3.10 Fire dampers shall be provided at the AHU outlet and return air inlet to the Air Handling Equipment/room Additional fire dampers shall be provided as per the codes of local fire authorities.

3.11 Access door shall be provided adjacent to the fire, splitter and louvred dampers.

3.12 Air outlets shall be selected based on the air quantity, throw and aerodynamic noise power not exceeding NC 30.The location size and shape of the air outlets shall be co-ordinated with interior and false ceiling scheme.

3.13 The ducting material and fabrication shall meet the requirements of local authorities, especially the fire authorities and shall incorporate necessary fire dampers to stop/curtail the propagation of fire through the duct.

4.0 MATERIAL

4.1 The ducting material shall be of aluminium or GI as specified. The GI shall be of lock forming quality sheets or coils conforming to standards ASTM A 653 and A 924 or conforming to grade D of IS : 1079 or IS : 513 as specified in IS : 272 coils are preferred to reduce the number of longitudinal joints.

4.2 The zinc coating of the sheets shall be hot dip G60 grade having minimum 180 gms/sq.m.

4.3 The yield strength of sheet and reinforcement shall be 200 Mpa.

4.4 The gaskets shall be self adhesive 3mm formed rubber or expanded polyethylene. The filters shall be heavy mastic sealants having excellant adhesion and elasticity.

4.5 The duct flanges and supporting materials shall be mild structural steel sections. The duct hangers shall be MS rod with threaded end and adjustable nuts.

4.6 All galvanised plain sheets shall be reasonably flat and free from twist. The zinc coating shall be clean, even and free from ungalvanised spots. Sheets shall not crack or peel during bending or fabrication. All sheets shall be procured from approved manufacturers.

5.0 DUCT FABRICATION

5.1 The duct shall be rectangular or circular as indicated on the drawings. The minimum thickness of the sheets shall be as per the pressure class and specified in SMACNA standards reproduced below.

5.2 The longitudinal joints shall preferrably be restricted to two diagonally opposite edges and shall be machine formed Pittsburgh lock type or button punch snap lock type.

5.3 The joints and seams should be able to withstand 1.5 times maximum operating pressure without deformation or failure. The traverse joints and reinforcement shall be as per SMACNA standards furnished above. The maximum deflection on traverse reinforcement joint shall be 6mm for ducts upto 1200 mm width and W/200 for greater width.

5.4 Cross breaking or beading shall be provided to tackle natural sag.

5.5 The companion flanges and girth angles shall be metered and welded at corners and riveted to the duct at 75mm centers. The longitudinal seams shall be inside groove or pits-burg type. The flanged joints shall be made air tight with 3mm rubber or 6mm felt gasket and secured with 10mm GI bolts at 150mm centers. Ducts shall not be cross broken, if insulated. The seams and joints shall be rendered air tight with mastic sealant.

5.6 The elbows shall have a minimum R/D ratio of 1:3. The elbows of R/D rate of less than 1:3 and square elbows wherever provided due to site condition, shall be with equally spaced guide vanes for smooth flow. Splitter dampers shall be provided for all branch splits. All branches, feeding more than two outlets, shall be provided with control dampers.

5.7 Capped air flow connections shall be provided, wherever shown, for testing and balancing of air distribution.

5.8 The joints shall be sealed as indicated below.

|  |  |  |  |
| --- | --- | --- | --- |
| Sl.no. | Pressure Class | Sealing Class | Sealing details |
| 1. | 500 Pa | C | All travers joints only |
| 2 | 750 Pa | B | All travers joints and longitudinal  seams only |
| 3 | 1000 Pa and above | A | All travers joints, longitudinal seams  and duct walls penetration |

The upstream ducting for the VAV shall be considered as 1000 Pa class.

6.0 DAMPERS & GUIDE VANES

6.1 The GUIDE VANES shall be provided as shown below:

a) At every non-split branch take off

b) At every bend/elbow of less than 1.3 R/D ratio

c) At first 4 collars after the fans and first two collar after every bends.

The vanes shall be double walled and properly curved for smooth air flow and change in direction of flow and shall be fabricated out of 0.8 mm GI sheets. The vanes shall be fixed to the side runners at equidistant and riveted/bolted to the ducts.

6.2 The SPLITTER DAMPERS shall be double walled aero foil blade fabricated out 1.6mm (16 SWG) GI sheet. The damper shall be complete with flanged sheet metal enclosure to suit the upstream and downstream duct connections, hinge at the downstream and operating road at the upstream end. The GI enclosure shall be one size thicker than the upstream duct.

6.3 The LOUVRED DAMPERS shall be multi blade aero foil construction with opposed/parallel blades of maximum 250 x 1200 mm size . The blades shall be mounted on 50mm channel with suitable gang operated linkage and operating rod. The operation rod shall be terminated in a locking quadrant with position indicator.

6.4 The FIRE DAMPERS shall be rated for 2 hrs. fire resistance conforming to BS : 476-1 and CP-413 and shall be housed in a GI sheet enclosure flanged at both ends and shall include the damper blades, fusible link, holding spring, manual adjustable handle etc.

The material for fabrication of fire dampers shall be as shown below:

a) Damper blades - 3mm (GI SWG) Galvanised sheet steel

b) Casing - 2mm (GI SWG)

c) Bearing - Sintered

d) Spring - SS 304

e) Fusible link - Set for 7 deg C fusing temperature

6.5 All dampers larger than 1200 mm width shall be fabricated in multiple sections. The damper rods shall be MS epoxy coated with bronze bushes at one end and locking quadrant with damper position indicator at the other end. The damper rods shall extend beyond the enclosure frame and insulation.

6.6 The access doors for dampers shall be 400 x 400mm steel bolted with rubber gasket.

7.0 AIR OUTLETS

7.1 The air outlets shall be grille or diffuser type as indicated on the drawing. The grilles and diffusers shall be MS painted, aluminum or aluminum powder coated as shown on the drawing and schedule of material.

7.2 Supply air grilles shall be double deflection type with horizontal face bars and vertical rear bars placed in a rigid marginal frame. Bars shall be shaped and spaced at 18mm centers with swaged pivot pins positively holding the defections setting under all conditions of velocity and pressure. All grilles shall be provided with integral opposed blade, grille face kept-operated dampers.

7.3 Return grilles shall have fixed face bars shaped and set at 18mm centers. Bars shall be set at 5 degree deflection for vision proof installation. The grilles shall be complete with rigid marginal frames and shall be matching with the supply grilles.

7.4 Ceiling diffusers shall be round/square/rectangular face flush type horizontal air diffusion pattern. Diffusers shall have ample margins to minimise ceiling smudge. Half diffusers shall be provided with face operated volume control dampers. Half diffusers shall be similar to full diffusers.

7.5 All MS grilles and diffusers shall be fabricated out of 1.0mm mild steel and painted with two coats of red oxide. All duct collars terminating on to a grille or diffuser shall be given two coats of black paint for a length of 300mm.

7.6 Aluminium grilles and diffusers wherever specified shall be of extruded aluminium with margins & GSS butterfly dampers. Grilles shall have horizontal face bars only.

7.7 Linear diffusers/grilles shall be die formed, flush mounted type with single or double directional air flow. The diffuser/grille shall be in a frame with minimum 20mm margin. All linear air diffusing equipment shall be fitted with a distribution sheet metal plenum as shown on the drawings.

8.0 AIR INTAKES & EXHAUST OUTLETS

8.1 The outside air intakes and exhaust air outlets shall consists of louvers, bird screen and enclosure, the total assembly fitted into wall with clear opening and the edges sealed with mastic sealant.

8.2 The sheet metal enclosure shall be made out of 1.25mm GI sheets flanged at both ends and with minimum 4 hold fast. The enclosure shall be minimum 250mm long or 100mm more than the width of the wall.

8.3 The louvers shall be 100mm wide mounted at 45 deg. and spaced at 100mm centers and shall be fabricated out of 1.25mm GI sheets.

8.4 The bird screen shall be made out of 15 x 15mm 1.0 mm GI wire mesh inset with 0.8mm GI frame and bolted to the enclosure flange at 150mm centres using 12mm MS brass bolts and nuts.

9.0 SUPPORTS & HANGERS

9.1 The ducts shall be supported at the traverse joints as indicated below :

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl.  No. | Duct Size  (mm) | Support  Spacing  (mm) | Supporting  Member  (Angle) | Cleat  (Angle) | Hanger  Rod  (mm) dia | Anchor Fastner  No. & dia |
| 1 | Upto 500 | 3000 | ISA 2525/3 | 50 mm ISA4040/6 | 6 | 2 x 10 |
| 2 | 501-1500 | 3000 | ISA 4040/6 | 50 mm ISA4040/6 | 10 | 2 x 10 |
| 3 | 1501-2000 | 2500 | ISA 5050/6 | 200 mm ISA5050/6 | 10 | 4 x 10 |
| 4 | 2000 & Above | 2000 | ISA 5050/6 | 200 mm ISA5050/6 | 10 | 4 x 10 |

9.2 Additional supports wherever considered necessary by the Engineer - in-charge shall be provided. Supports shall be taken from steel members grouted in the RCC work and fixing of steel members shall involve minimum damage. The entire supporting system shall be meet with the approval of the Engineer-in-charge.

9.3 All duct supports, flanges, hanger shall be given two coats of red-oxide before installation and one coat of aluminium paint after erection.

9.4 Where ducts are connected to the wall, such connections shall be made through mild steel frame fixed to the wall through suitable shear fasteners.

10.0 INSTALLATION

10.1 The ducts shall be routed as shown on the drawing or as instructed. Working drawing shall be got approved before taking up the fabrication and erection.

10.2 Ducts connecting to air moving apparatus shall be through 15 OZ mildew resistant double canvas securely bonded and bolted at both ends as directed by the Engineer. On all circular spigots the flexible material is to be screwed with adjustable screw 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. The flexible connection shall not be less than 75mm and not more than 200mm.

10.3 The ducting work and the air outlets shall be properly co-ordinated with other building services and necessary modifications, if required to be incorporated at site. Similarly modifications and re-routings are to be carried out at site in case of obstruction/non-availability of space for ducting due to structural members, other equipment and services.

10.4 Uninsulated ducting in incorrosion atmosphere shall be painted in black epoxy paint.

11.0 TESTING & BALANCING

11.0 The entire air distribution shall be adjusted and balanced for delivery of design air quantities or as required for achieving design space conditions. After all adjustments are made, the air readings shall be recorded on the drawings vis-a-vis the space conditions. All dampers after adjustment shall be set and locked in position. All air and static pressure measurements shall be done through proble type meters. Vane type meter readings are not considered reliable.

# **2204 RECOMMENDED MAKES OF MATERIAL**

1.0 SCOPE

1.1 The scope under this section shall cover the recommended makes of equipments, material components. The final choice of makes shall be indicated at the time of award of work.

1.2 The makes of material and model offered by the contractor shall be indicated at the space provided for proper evaluation of the offer . In the absence of such indication, the decision rests with the Consultants/Clients.

1.3 The client reserve the right to change the make and model of the materials even after awarding the work but before contractor plans order with

2.0 MAKES RECOMMENDED

2.1 The makes of material recommended are as shown below.

|  |  |  |  |
| --- | --- | --- | --- |
| SL. NO. | ITEM | MAKES RECOMMENDED | MAKES OFFERED |
| 1.0 | VRF units | Bluestar, Carrier, Daikin, ETA,General, GREE,Hitachi, LG, Midea, Mitsubishi Electric, Mitsubishi Heavy Ind., Panasonic, Sanyo,Samsung, Toshiba,Voltas,Zamil |  |
| 1.0 | Air Handling Units | Carryaire, Citizen, Edgetech, Nutech, Systemaire,Zeco |  |
| 2.0 | Drainage Pipe – CPVC | Astral, Supreme, Ashirvad |  |
| 3.0 | Copper pipes | Rajco, ABC, IBP, Champ,  Mehta |  |
| **4.0** | **AIR DISTRIBUTION** |  |  |
| 4.1 | GI ducts | Alpha, Ecoduct, Rolastar,  Sevenstar, Zeco, Nutech |  |
| 4.2 | Dampers | Caryaire, Cosmos, Dynacraft, Nutech,Citizen |  |
| 4.3 | Air outlets | Caryaire, Cosmos, Dynacraft, Nutech,Citizen |  |
| 4.4 | Insulation | Aeroflex, Armaflex,A-flex,  Polybond, Thermobreak |  |