MUMBAI CRICKET ASSOCIATION

TENDER DOCUMENT

FOR

PROPOSED REFURBISHMENT OF HVAC SYSTEM IN CORPORATE BOXES, PRESIDENT BOX, PRESS BOX, COMMON TOILETS AND OTHER AREAS OF MUMBAI CRICKET ASSOCIATION

AT

WANKHEDE STADIUM, CHURCHGATE, MUMBAI

ISSUED TO:

_____

CLIENT	**ARCHITECT**
MUMBAI CRICKET ASSOCIATION Cricket Centre, Wankhede Stadium, D Road, Churchgate, Mumbai – 400 020	**SHASHI PRABHU AND ASSOCIATES** Wankhede Stadium, Block A2 and B1, North Stand, D Road, Churchgate, Mumbai – 400 020

VOLUME – II

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS FOR HVAC WORKS

1. VARIABLE REFRIGERANT VOLUME/FLOW SYSTEM

SCOPE

The scope of this section comprises the supply, erection testing and commissioning of 100 % **inverter based** Variable Refrigerant Flow System with hermetically sealed Scroll/ Rotary Compressor conforming to these specifications and in accordance with the requirements. COP should be minimum or more than 3.8 or as per achieving green building parameters.

TYPE

Outdoor units shall be air cooled, variable refrigerant flow air conditioner of R410A gas based consisting of one outdoor unit and multiple indoor units. Each indoor units having capability to cool independently for the requirement of the rooms.

It shall be possible to connect minimum 20 indoor units on one refrigerant circuit. 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:

Ceiling mounted four way flow cassette type

Ceiling mounted Ductable type

Wall mounted type

DX type air handling unit

Compressor installed in outdoor unit shall be equipped with 100 % inverter compressor. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load.

Outdoor unit shall be suitable for mix match connection of all type of indoor units.

The refrigerant piping between indoor units and outdoor unit shall be extendable up to 165m actual piping length for outdoor unit with maximum 50m level difference without any oil traps and total piping length with 1000m.

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivering at site.

OUTDOOR UNIT

The outdoor unit shall be factory assembled unit housed in sturdy weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The Unit should be completely factory wired tested with all necessary controls and switch gears:

In case of outdoor units above 14HP, the outdoor unit shall have at least 2 inverter compressors so that the operation is not disrupted with failure of any compressor. All outdoor units must be equipped with optimized heat exchanger.

All outdoor units must be equipped with night time quite operation function which results in less sound level in night time operations of the outdoors. The nighttime quiet operation shall be with three modes automatic, manual and combined modes.

It should also be provided with duty cycling for switching starting sequence of multiple outdoor units.

The noise level shall not be more than 68 dB (A) at normal operation, measured horizontally 1m away and 1.5m above ground level or as per green building parameter.

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

The unit shall be provided with its own microprocessor control panel.

The outdoor units shall be complete with safety devices namely –high/ low pressure switch, fan driver overload protector, over current relay, inverter overload protector.

The oil mechanism shall be capable of oil film control by high thrust mechanism.

The heat transfer circuit should perform super cooling before the expansion process in the indoor units.

The outdoor unit’s side panel and outer panel shall be alloyed hot-dip zinc coated steel plate with powder polyester resin coating on the inner and outer surfaces in the thickness of 32 microns.

The outdoor unit’s bottom frame shall be hot-dip aluminum; zinc and silicone coated steel plate.
The outdoor unit should be fitted with low noise, aero spiral and aero asymmetrical design fan with multiple speed DC motor. The fan shall be coated with styrene acrylo nitrile resin(glass fiber filled) The fan shall be covered with aero smooth grille which shall be three dimensional, integrated, soft woven steel covered with plastic coating. The fan protective net shall be coated with weather resistant polypropylene resin.

The contractor shall visit and witness the test and shall submit photographs/proof to ascertain his witnessing the testing. The Client /consultant representative may also witness the test. The cost of their visit shall be borne by the Contractor. However, necessary coordination shall be arranged by the Contractor for their visit.

1.1.1 INVERTER COMPRESSOR

The compressor shall be highly efficient reluctance DC scroll/ rotary type with neodymium magnets and capable of inverter control. It shall change the speed in accordance to the variation in cooling load requirement:

The inverter shall be IGBT type for efficient and quiet operation.

All outdoor units shall have step less 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.

1.1.2 HEAT EXCHANGER

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fin coil.

The aluminum fins shall be covered **by anti-corrosion resin** film of special acrylic resin. The coils shall be integrally coated with Blygold PoluAl/AC Guard & coil shild (Aluminium hydroxide, 25-30 microns' thickness) after fins stamping process or equivalent coating material as recommended by manufacturer. The Cu/Al metallic couple will wholly have isolated from the corrosive atmosphere by aluminium coating to raise the ability of anti-corrosion.

The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

1.1.3 REFRIGERANT CIRCUIT

The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valve at condenser end.

All necessary safety devices shall be provided to ensure the safe operation of the system.

1.1.4 SAFETY DEVICES

All necessary safety devices shall be provided to ensure safe operation of the system.

Following safety devices shall be part of outdoor unit; high pressure switch, low pressure switch, fuse, crankcase heater, fusible plugs, over load relay, protection for inverter, and short recycling guard timer.

1.1.5 OIL RECOVERY SYSTEM

Unit shall be equipped with an oil recovery system to ensure stable operation with long

refrigeration piping.

1.1.6 INDOOR UNIT

This section deals with supply, installation, testing, commissioning of various type of indoor units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be in

1.1.7 GENERAL

Indoor units shall be either ceiling mounted cassette type, or ceiling mounted ductable type or wall mounted type. These units shall have electronic control valve to control refrigerant flow rate in response to load variations of the room.

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. The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.
The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coil shall be factory tested at 21kg/sqm air pressure under water.

Noise level should not be more than 42 db at high speed for Hiwall unit.
Noise level should not be more than 40 db at high speed for cassette.
Noise level should not be more than 45 db at high speed for Ductable unit.

Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall be slide away type and neatly inserted.

Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling and heating.

Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self-diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flat individually as per requirement.

1.1.8 CEILING MOUNTED CASSETTE TYPE UNIT (FOUR WAY TYPE)

The unit shall be ceiling mounted type with four directional flow. The unit shall include prefilter, fan section and DX-coil section. The housing of the unit shall be powder coated Galvanized steel. The body shall be light in weight and shall be able to suspend from four corners.

Unit shall have an external attractive panel for supply and return air. Unit shall have four-way supply air grilles on sides and return air grille in center.

Each unit shall have high lift drain pump, fresh air intake provision (if necessary) Low gas detection system and very low operating sound.

All the indoor units regardless of their difference in capacity should have **same panel size** for harmonious aesthetic point of view. The sound absorbing thermal insulation material shall be polyurethane foam.

1.1.9 CONTROLS & ACCESSORIES

For connection with Dx-type AHU, necessary kit for connection to the VRV/VRF based refrigerant circuit, expansion valve & dries, thermostat etc. as required shall be provided.

2. VENTILATION FAN

GENERAL

The scope of work comprises of supply, erection, testing and commissioning of cabinet fan section, centrifugal fans, axial flow fans, Inline & propellers fans conforming to these specifications and in accordance with the requirements as per relevant IS Codes, as per approval of Consultant and/or Engineer-In-charge.

Fan performance rating data shall be tested accordance with AMCA Standard 210- 85(Air Moving and Conditioning Association), ANSI/ASHRAE Standard 51-1985 “Laboratory Methods of Testing Fans for Rating”. Sound ratings shall conform to AMCA Standard 300-85, “Reverberant Room Method for Sound Testing of Fans”.
All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly.

Fan motors shall comply in all respects with continuous rating in accordance with IEC34 or equivalent. Motor bearings shall be of ball or roller type, grease or lubricant sealed for life. Fan and drive shall be earthed to prevent accumulation of static charge.

For Smoke Extraction Fans where motor is in the air stream with electrical/electronic temperature limit switch for motor protecting shall not be used.

If fan is open to atmosphere, Fans shall be with pure polyester powder coating for minimum thickness of 60 microns.

CENTRIFUGAL FANS

The Fans, Aero foil, forward/ backward curved, SISW/ DIDW shall be licensed to bear the AMCA Air, Sound and FEG Certified Ratings Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 “Laboratory Meth- od of Testing Fans for Rating” and AMCA 300 “Reverberant Room Method for Sound Testing of fans”.
Fan should be of G.S.S., the Steel sheet should be JFE Galva zinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero Spangle, skin passed, chromated and dry.

Fans housing shall be of an appropriate thickness to prevent vibration and drumming. The fan scroll shall be attached to the side plate by means of continuous lock seam or intermittent spot welding. The wheel and inlet cone shall be aerodynamically designed and constructed to provide maximum performance and efficiency as published by the manufacturer.

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

Shafts sizes shall be carefully calculated and designed such that the maximum operating speed (RPM) shall not exceed 75% of the first critical speed. For any application that is not a standard product of the fan manufacturer, detailed calculation of critical speed characteristic shall be submitted for approval.

Shafts shall be made of carbon steel (C45) machined and polished to tolerance of standard ISO 286-2 - grade g5. Protective coat of anti-rusting shall be applied to all bare surfaces of the shafts at the factory.

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

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

Belts and pulleys shall be sized for a minimum 115% of the installed motor horsepower. The belt speed shall not exceed 30m/s. The pulley shall be of Taper Lock SPZ, SPA, SPB or SPC type. Conventional type of pulley is not acceptable. Both fan and motor pulley shall be balanced to the quality grade G.2.5.

If, the fan used for smoke extraction, must have separate arrangement of motor & belt arrangement to avoid the contact with hot-air stream. Cabinet should be manufactured in galvanized sheet steel incorporated with a belt driven, high efficiency, low noise level, double inlet forward (CPF-F) or backward (CPF-B) impeller or backward Aero foil (CPF-B) impeller. The fan shall have tested in accordance to standard 'BSEN12101-3:2002' complies with the performance criteria for 400ºC at 2 Hours and certified by "TUV SUD PSB".

Fans for smoke extraction purpose, the motor and fan assembly should be capable of withstanding for 250C for 120 minutes.

Computer printout on fan performance rating corresponding to the AMCA li- censed data, with corrected rating for altitude and temperature, fan operating speed, bearing life, etc. shall be submitted for approval.

Fans should have coat of pure polyester powder coating.

Accessories

All necessary accessories shall be provided for proper operation and shall also include (As part of Unit).
Dunlop cushy foot vibration isolators for the blowers.
Nuts, bolts, shims etc. as required for the grouting of the equipment.
Slide rails for mounting the motor and belt adjustments.

CABINET FAN SECTION

The ventilation unit shall be of single/double skin construction housing (as per requirements) comprising of various sections such as fan, filter section etc.

Double skinned panels to be fabricated with anodized extruded aluminum section framework bolted together with sandwich panel having 24 gauge pre-plasticized outer skins and 24 gauge plain GI inner skins injected with 25 mm/43mm thick CFC-free PU foam insulation having density not less than 40 + 2 kg/ m3.
Single skin fan section shall be made of appropriate thickness but not less than 18G thicknesses pre-coated or powder coated galvanized steel sheet to prevent vibration and drumming.
Cabinet should be assembled together by means of fasteners for easy of dismantling for service and maintenance. Welded cabinets are not acceptable. All corner supporting frames shall be of extruded aluminum section.
Fan shall be of DIDW Forward /backward curved with belt drive or direct drive arrangement (as per requirements) assembled within a cabinet. The motor shall be mounted on the common base of Aluminum, inside the housing including anti-vibration.

Motor shall be with minimum IE3 rating, 415 + 10% volts/220 + 10%, 50 Hz, 3 phase/1 Phase, squirrel – cage, totally enclosed fan cooled with IP – 55, protections. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM.

Casing shall be of G.S.S with Oven-baked pure polyester powder coating & the fan shall be provided with zinc coatings of minimum coating weight @ 275 g/m2 on both sides. The fan outlet shall be connected to the casing with the help of fire retardant flexible canvass.

The fans used for fresh air supply, shall be provided with a factory assembled filter section with 50 mm thick washable synthetic type air filters having efficiency 90% down to 10 microns with extruded aluminum frame.

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

Fan and cabinet (complete unit) shall be licensed to bear the AMCA Air rating. Cabinet should also be AMCA certified.

Fan located at open atmosphere shall be provided with weather proof canopy. These fans shall be provided with special anti-corrosion/ epoxy coatings like pure epoxy zinc rich primer or equivalent coatings as recommended by manufacturers.

Accessories

All necessary accessories shall be provided for proper operation and shall also include (As part of Unit Price).

Dunlop cushy foot vibration isolators for the blowers.
Double canvass connections at the outlet of each fan.
Nuts, bolts, shims etc. as required for the grouting of the equipment.
Slide rails for mounting the motor and belt adjustments

INLINE FANS

Fans shall be single inlet single width (SISW) type / Double Inlet Double Width (DIDW). Fan shall have directly driven forward curved centrifugal impeller, running in a metal scroll balanced to give quiet and vibration free operation. Fan motor assembly shall be statically and dynamically balanced.

The fan shall be assembled in such a manner that the motor and impeller can be easily removed and reinstalled after servicing. The noise level of the fan should not exceed 40 DB in the factory area.

The air handling capacities, maximum motor H.P., Static pressure shall be as per requirements.

Fans casing shall be manufactured from galvanized steel sheets 2.0 mm thick and painted with two coats of rust proof primer and two coats of synthetic enamel paint. All other metal parts shall be hot dip galvanized.

Motors shall be with class 'F' insulation wired to an externally mounted weather proofed terminal box. Motor name plate horsepower shall exceed brake horsepower by minimum of 10%. Motor shall be designed especially for quiet operation and motor speed shall not exceed 1450 RPM.

Motor should be painted with two coats of rust proof primer and two coats of synthetic enamel paint.

Fan shall have rigid supports and fitted to both ends of the casing.
Wherever the fans are to be suspended from ceiling or mounted on the wall, the contractor shall include supply and fixing of all the material that may be required to complete the installation in all respect.

All the fans which shall be placed at open to atmosphere shall be provided with weatherproof canopy.

The fans shall be provided with special anti-corrosion/ epoxy coatings like pure epoxy zinc rich primer or equivalent coatings as recommended by manufacturers. Casing shall be of Galvanized steel with Oven-baked pure polyester powder coating.

Fan inlet and outlet connections shall be by means of flexible canvas connections having flexibility and slackness as per relevant IS Codes.

Fan after installation shall be tested for capacities, power consumption, noise level and vibration and results shall confirm to the approved data furnished by the contractor.

3. AIR DISTRIBUTION WORKS

1.1.10 General

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.

1.1.11 Duct Design Parameters: (Air Conditioning & Ventilation)

Maximum Velocity	Maximum Friction Rate
1250 to 1800 FPM	0.1 inch WG/100 Ft.

1.1.12 Duct Design Parameters: (For Fire mode application)

Maximum Velocity	
2500 FPM	

1.1.13 Rectangular Duct Work

FLEXIBLE ALUMINIUM DUCTING-

The ducting shall be fully flexible, compressible and extendable made of 2 ply multi layered aluminium polyester foil bonded together by quality adhesive and reinforced with high carbon corrosion proof spring wire. The distance between spring wires shall not exceed 1". The ducting shall be strong, durable and should not go out of shape even fully extended. The ducting should be also available with insulation of desired thickness.

SMACNA STANDARDS

Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards – Metal and Flexible – Second Edition – 1995"-SMACNA)

All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. raw material furnished with accompanying Mill Test Certificates.

Galvanizing shall be of 120gms/sq.m. (total coating on both sides). In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS

Duct Construction shall be in compliance with 1" (250 Pa) w.g. static norms as per SMACNA. All transverse connectors shall be the 4-bolt slip-on flange system standard makes of similar 4-bolt systems with built-in sealant.

The specific class of transverse connector and duct gauge for a given duct dimensions will be as per Table given below for the 1" (250 Pa) pressure class.

Non-toxic, AC-applications grade P.E. or PVC Gasketing is required between all mating flanged joints. Gasket sizes should conform to flange manufacturer's specification.

MACNA STANDARDS

FOR SELECTION OF FLANGE CLASS AND DUCT GAUGES **AT 1200 MM SPACING**

Duct Dimension (in mm)	**Duct Pressure in Inches / (Pascal)**					
	1"(250) *[5]	**2" (500)**	**3" (750)**	**4" (1000)**	**6" (1500)* [4]**	**10" (2500)**
	Reinforcement Class Duct Gauge					
upto 250	***[3]E-26**	**E-26**	**E-26**	**E-26**	**E-26**	**E-24**
251-300	**E-26**	**E-26**	**E-26**	**E-26**	**E-24**	**E-24**
301-350	**E-26**	**E-26**	**E-26**	**E-26**	**E-24**	**E-22**
351-400	**E-26**	**E-26**	**E-26**	**E-26**	**E-24**	**E-22**
401-450	**1.1.14-26**	**EE-26**	**E-26**	**E-26**	**E-24**	**H-20**
451-500	**E-26**	**E-26**	**E-24**	**E-24**	**E-24**	**H-20**
501-550	**E-26**	**E-26**	**E-24**	**E-24**	**H-24**	**H-20**
551-600	**E-26**	**E-26**	**E-24**	**E-24**	**H-22**	**H-20**
601-650	**E-26**	**E-26**	**E-24**	**E-24**	**H-22**	**H-20**
651-700*[2]	**E-26**	**E-26**	**E-24**	**H-24**	**H-22**	**H-18**
701-750	**E-26**	**E-26**	**E-24**	**H-24**	**H-22**	**J-18**
751-900	**E-26**	**E-24**	**H-22**	**H-22**	**H-20**	**J-18**
901-1000	**E-26**	**H-24**	**H-22**	**H-20**	**J-18**	**J-16**
10 01-1200	**E-24**	**H-22**	**H-20**	**J-18**	**J-18**	

12 01-1300	***[3]H-24**	**H-20**	**J-18**	**J-18**	**J-16**	
13 01-1500	**H-24**	**1.1.15 -18**	**J-18**	**J-16**		NOT
15 01-1800	**H-22**	**J-18**	**J-16**		DESIGNED	
18 01-2100	***[3]J-20**	***J-20**				
2101-2400	**1.1.16 -18**	**J J-18**				
2401-2700	**J-18**					

Notes:

SMACNA – Sheet Metal & Air conditioning Contractors' National Association Inc – "HVAC Duct Construction Standards. Metal and Flexible"-1995, U.S.A.

Reading GuideFor duct sizes between, say, 651 mm and 700 mm, when the pressure class is 1" w.g. static, we require a standard 'E' class flange and duct gauge of 26. For the same size range but with static pressure at 4" w.g. a standard 'H' class flange with duct gauge of 24 should be used.

The standard flange classes available are designated E, H and J. For E & H class of standard make use gasket size 10 mm wide and 4.5 mm thick. For standard J-class use 15 mm wide and 6 mm thick gasket.

DUCT CONSTRUCTION

The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

Dimensional Tolerances: All fabricated dimensions will be within +/1.0mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be +/1.0 mm per meter.

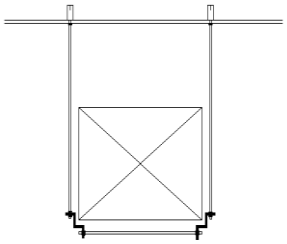
Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge. Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness

Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

Plenums shall be shop/ Reinforcement of ducts shall be achieved by either cross breaking or straight beading depending on length of ducts

As per SMACNA page no. 1.74, fig. 1-8 “Duct Sizes 19” (483 mm) wide and larger which have more than 10 ft^2 of unbraced panel shall be beaded or cross broken unless ducts will have insulation covering or acoustical liner. This requirement is applicable to 20 G (1.00 mm) or less and 3” W.G. (750 Pa) pressure or less. Ducts for 4” W.G. (1000 Pa) or more do not require beads or cross-breaks.” factory fabricated panel type and assembled at site.

SUPPORT FOR HORIZOTAL RECTANGULAR DUCT



Sr. No.	Maximum Duct Size(mm)	Hanger Rod Diameter	Interval (mm)
1	Upto 700	6 mm	2400
2	701 1200	8 mm	2400
3	1201 2000	10 mm	2400
4	Above 2000	12 mm	2400

As an alternative, slotted galvanized brackets attached to the top two bolts of the Rolamate system may also be used as appropriate for the sitecondition. To provide the required thermal brake effect, Neoprene or equivalent material of suitable thickness shall be used between duct supports and duct profiles in all supply air ducts not enclosed by return air plenums.

INSTALLATION PRACTICE

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

All necessary allowances and provisions shall be made by the Contractororbeams, pipes, or other obstructions in the building whether or not the same are shown on the drawings. Where there is interference/fouling with other beams, structural work, plumbing and conduits, the ducts shall be suitably modified as per actual site conditions.

Ducting over false ceilings shall be supported from the slab above, or from beams. In no case shall any duct be supported from false ceilings 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.

Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick appropriate insulation around the duct and totally covered with fire barrier mortar for complete sealing.

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.

TESTING

After duct installation, a part of duct section (approximately 5 % of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA"HVAC Air Duct Leakage Test Manual" (First Edition)

LOW LEAK DAMPER-

Damper shall be opposed blade type, blades shall be made of double skinned aerofoil Aluminium sections with integral gasket and assembled within a rigid extruded Aluminium alloy frame.

All linkages and supporting spindles shall be made of Aluminium or nylon, turning in Teflon bushes and linkages shall be extended for motorized operation wherever specified. Manual dampers shall be provided with a Bakelite knob for locking the damper blades in position. Damper frames shall be sectionalized to minimize blade warping.

Air leakage through dampers when in the closed position shall not exceed 1.5 % of the maximum design volume flow rate at the maximum design pressure.

1.1.17 A fire damper shall be provided at crossing of fire rated walls. The fire dampers shall be confirming to UL-655 and other applicable fire codes. The dampers shall be operated through either fusible link or solenoid valve.

The ducts shall be fabricated from galvanized steel sheets class VIII conforming to ISS: 277-2003 (revised).

The steel sheets shall be hot dip galvanized with coating of minimum 180 GSM of Zinc

(Total coating on both sides)

All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements as described SMACNA standard for factory fabricated duct. The minimum thickness of fabricated GSS duct shall be 24 G & for Al 22 G.

1.1.18 Raw Material

All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. raw material furnished with accompanying Mill test Certificates.

In addition, if deemed necessary, samples of raw material, selected at random by client's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.

1.1.19 Duct Connectors and Accessories

All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support system shall be zinc-coated (galvanized).

1.1.20 MISCELLANEOUS

All ducts above 450mm are to be cross broken to provide rigidity to the ducts.

All duct work joints are to be true right angle or approaching with all sharp edges removed.

Sponge rubber gaskets also to be provided behind the flange of all grilles.

Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grills through the shoot.

Inspection doors measuring at least 450mm x 450mm are to be provided in each system at an appropriate location, as directed by Consultants.

Diverting vanes must be provided at the bends exceeding 600mm and at branches connected into the main duct without a neck.

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 Consultants.

The ducts should be routed directly with a minimum of directional change.

The duct work shall be provided with additional supports/hangers, wherever required or as directed by the Engineer in Charge, at no extra cost.

All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost.

All angle iron flanges to be welded electrically and holes to be drilled.

All the angle iron flanges to be connected to the G.S.S. ducts by rivets at 100mm centers.

All the flanged joints, to have a 4mm thick felt packing stack to the flanges with shellac varnish. The holes in the felt packing are to be burnt through.

The G.S.S. ducts should be lapped 6mm across the flanges.

Sheet metal connection pieces, partitions and plenums required, shall be constructed of 1.25 (18 gauge) sheet thoroughly stiffened with 40mm x 40mm x 6mm angle iron braces and fitted with access doors.

1.1.21 TRANSFORMATION

Duct transformation shall be made with a side slope of 10mm to 70mm. However, if the duct Cross section area need to be reduced, a maximum reduction of 20% of the original area shall be allowable.

1.1.22 VOLUME CONTROL DAMPERS

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 gauge of the large duct, and shall be rigid in construction to the passage of air.

The volume dampers shall be of an approved type, lever operated and complete with locking devices which will permit the dampers to be adjusted and locked in any positions.

The dampers shall be of splitter, butterfly or louver type. The damper blade shall not be less than 1.25mm (18 gauge); reinforced with 25mm angles 3mm thick along any unsupported side longer than 250mm. Angles shall not interfere with the operation of dampers, nor cause any turbulence.

Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings, dampers frames shall be constructed of 1.5mm steel and blades shall not be over 225mm wide.

The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8mm thickness with fine mesh spacing.

Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and thumb screw lock. Provide damper rod and damper block with upset screws.

After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.

1.1.23 FIRE DAMPERS

Fusible Link Fire Damper. 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 2 hours or higher depending upon the fire rating of the wall.

1.1.24 GRILLES

The supply and return air grilles shall be fabricated from aluminum extruded sections. The supply air grilles shall have single louvers (which shall be used for air conditioning) & ventilation grille shall be of double louvers. The front horizontal louvers shall be of extruded section, fixed type. The rear vertical louvers shall of aluminum sheet and adjustable type. The return air grille shall have single horizontal extended section fixed louvers. The grilles may or may not be with an outer frame.

The aluminum grilles shall have opposed blade dampers of black anodized extruded aluminum sections, which shall be key operated from the grille face wherever required.

The adjustable grille louvers shall be fabricated from extruded aluminum sections. The damper blades shall be of black anodized extruded aluminum sections and shaped to form air tight joints. Grills longer than 450mm shall have intermediate supports for the horizontal louvers.

1.1.25 DIFFUSERS

The ceiling type round or square diffusers shall be of extruded aluminum sections with anti-smudge ring to prevent dust collection on ceiling around the diffusers.

The diffusers shall be die formed for proper air diffusion & shall have removable inner core.

All supply diffusers shall be provided with extruded aluminum dampers, with knobs for adjustment from the bottom.

1.1.26 DRAIN PIPING

The drain piping shall be medium class Hot-dipped galvanized steel as per IS 1239/1979 with up to date amendments.

Rigid PVC pipes may be used for drain pipe. (Optiononly for single story building)

The fittings shall be of `R' brand forged with screwed connections.

The gate valves shall be of gun metal as described earlier.

Pipe crosses shall be provided at bends, to permit easy cleaning of drain line.

The drain line shall be provided up to the nearest drain trap and pitched towards the trap.

Drain lines shall be provided at all the lowest points in the system, as well as at equipment, where leakage of water is likely to occur or to remove condensate and water from pump glands.

The pipes shall be laid in proper slope for efficient drainage of condensate water. A downward gradient of atleast 1/100 will be provided for the drain piping.

For proper drainage of condensate, U Trap shall be provided in the drain piping(wherever required). All pipe supports shall be of pre-fabricated & pre painted

slotted angle supports, properly installed with clamps etc.

The main drain pipe should be connected to the vertical drain pipe through a Y-joint or T-joint. A vent pipe should be installed at the top of the vertical to improve the drain water flow. Vent pipe should be provided with insect screen. Cost for these accessories is deemed to be included in the rates quoted by the renderer.

4. INSULATION WORKS

1. INSULATION

FOR G.I. DUCTING
SPECIFICATION FOR THERMAL & ACOUSTIC INSULATION

SCOPE

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

DUCT THERMAL INSULATION

MATERIAL

Insulation material shall be Closed Cell Elastomeric Nitrile Rubber.
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 mean temperature of 0°C.
Insulation material shall have anti-microbial product, which is EPA (Environmental Protection Agency), USA approved, as an integral part of insulation that cannot be washed off or worn off.
It shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi and should confirm to following standards: Fungi Resistance – ASTM G21 and Bacterial resistance – ASTM G 22 / ASTM 2180.
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.
Material should be FM (Factory Mutual), USA approved.
Water vapor 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 10000.

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

THICKNESS SELECTION CHART FOR NITRILE RUBBER INSULATION Design Basis: Condensation Control				
DUCT INSULATION				
	Required Thickness (mm)			
Supply Air Duct (Line Temperature 14 Deg. C)	25			
Return Air Duct (Line Temperature 22 Deg. C)	25			

External thermal insulation shall be provided as follow:

The thickness of the nitrile rubber shall be as shown on drawing or identified in the schedule of quantity. Following installation procedure should be adopted:

Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.
Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubbers sheets to size with sufficient allowance in dimension.
Material shall be fitted under compression and no stretching of material should be allowed.
A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface.
When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.
All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.
The adhesive shall be strictly as recommended by the manufacturer.
The detailed Application specifications are as per the manufacturer's recommendation.

INSTALLATION OF DUCTS EXPOSED DIRECTLY TO SUNLIGHT:

For installations exposed to sunlight, after giving 36 hours curing time for the adhesive apply manufacturer's recommended UV/Mechanical Protection. Please refer the separate detailed guidelines on UV/Mechanical Protection.

ACOUSTIC INSULATION

Acoustic insulation 15 mm thick class 1 rating open cell nitrile rubber elastomeric insulation with density of 140-180 kg /m³. The insulation manufactured as per BS 476 part 7 & which should also meet UL 94 test supplementary materials for air distribution system which should not absorbs less 0.2% water by volume (ASTM c 209) should not support microbial growth (ASTM 2180, G21, G22) and should not emit objectionable odors (ASTM C 665) and should have thermal conductivity of 0.04w/m k @ 20 deg. C as per DIN EN 12667. and water vapor permeance of 0.10. Adhesive shall be used additionally with VOC level not exceeding 50 grams / liter 10 mm thick.

FALSE CEILING INSULATION

The false ceiling shall be insulated with 50 mm thick fiberglass slab of 16 Kg. / Cu. M. density. The fiberglass slab shall be wrapped in polyethylene bags.

UNDERDECK INSUALTION

Insulation should be FM approved highly. flexible, closed-cell, 25 mm thick underdeck insulation of elastomeric foam based on synthetic rubber (NBR) tested for service temperature range -50-105'C as per EN 14706, EN 14707 & EN 14304, thermal conductivity A 3 0.037 WmK. at mean temperature 0, = 20'C as per EN 12667 & EN ISO 8497, water vapour diffusion resistance factor y > 7000 as per EN '12086 & EN 13469, water absorption by volume 0.2o/o as per ASTM C 1763 & ASTM C 209, Class 0 fire performance as per BS 475 Part 6: 1989, Class 1 surface spread of flame as per BS 476 7: '1997, flammability HB, V.0 as per UL- 94, having good resistance to mechanical impact, excellent resistance to ozone, oil and chemicals, zero ozone depletion potential along with adhesives and other necessary accessories complete all as specified and directed by engineer-in-charge.

1.1.27 VRF COPPER PIPING INSULATION

1.1.28

Thermal insulation material for Pipe insulation shall be Closed Cell Elastomeric Nitrile Rubber foam. The Thermal conductivity of the insulation material shall not exceed 0.0352 W/moK at an average temperature of 24˚C. Density of the Nitrile rubber shall be 40-60 Kg/m3. The product shall have temperature range of –57oC to 125oC. The insulation material shall be fire rated for Class V 0 as per UL 94.The flammability and smoke density shall be 15/50 as per ASTM E 84, Nonflammable as per JIS K 6911, Australian standard 1530 and class 5.3 as per EMPA. The minimum Water vapour diffusion resistance factor(μ) ≥ 7000.The water absorption (weight%)shall not exceed 5 as per ASTM D 1056. The insulation material should be free from Nitrosamine contents as per US FDA norms. It should be CFC free. It should not be corrosive to copper and stainless when tested as per DIN 1988.The material should not develop crack when tested for ozone resistance as per ASTM 1149. The % shrinkage (Heat Stability) should not exceed 6% when tested as per ASTM C 534 (93oC, 7 days). No cracks should develop when exposed to UV (accelerated

weathering resistance test cycle UVB-313 at 60oC/8h, CON at 50oC/4h) as per ASTM G 154-04. The resistance to microbiological growth should be in accordance to UL 181 – and meet the acceptance criteria of resistance to fungal contamination as per ASTM G21.It should meet the acceptance criteria of resistance to bacterial contamination as per ASTM 2180.

VRF piping insulation should be factory laminated black UV protection glass fabric. Factory cut self-adhesive tube shall be used to insulate smaller pipes and factory cut sheets shall be used for large pipe diameters& joint should be self-adhesive. All the longitudinal and butt joints should be sealed strictly by manufacturer recommended adhesive.
Thickness of the insulation material should be as follows:

Condensate Drain pipe	9 mm
Refrigerant Pipe	As per Manufacturer

5. MODE OF MEASUREMENTS

1.1.29 UNIT PRICES

The unit price shall be held to include everything necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.

The unit price of the various items shall include the following:

All equipment, machinery, apparatus and materials required as well as the cost of any tests which EIC may request in addition to the tests generally required to prove quality and performance of equipment.

All the labour required to supply and install the complete installation in accordance with the specifications/drawings.

Use of any tools, equipment, machinery, lifting tackle, scaffolding, ladders etc. required by the contractor to carry out his work.

All the necessary measures to prevent the transmission of vibration.

The necessary material to isolate equipment foundations from the building structure, wherever necessary.

Storage and insurance of all equipment apparatus and materials.

The contractor's unit price shall include all equipment, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

1.1.30 MEASUREMENTS METAL DUCTS, GRILLES/ DIFFUSERS ETC.

SHEET METAL DUCTS

All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars, vanes & other fittings. Gaskets, nuts, bolts, vibration reducing pads are included in the basic duct items of the SOQ./ or as per IS code.

The unit of measurements shall be the finished sheet metal surfaces area in meters squares. No extra shall be allowed for laps and wastage.

All the guide vanes, deflectors in duct elbows, branches, grille collars quadrant dampers etc. shall be measured for actual sheet metal surface and paid for at the same rate as duct of same thickness.

The unit duct price shall include all the duct hangers and supports, exposing of concrete reinforcement for supports and making good of the same as well as any materials and labour required to complete the duct frame.

GRILLES/DIFFUSERS

All grilles/diffusers as per tender requirements shall be measured as follows.

All measurements of grilles/diffusers shall be the actual outlet size excluding the outer flanges.

The square or rectangular grills/diffusers shall be measured in sq.m.

All round diffusers shall be measured by their diameters in cm.

All linear diffusers shall be measured as per actual length in metres.

1.1.31 MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS

PIPE

All pipes shall be measured in linear meter (to the nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings e.g. tees, bends, reducers, elbows etc. Deduction shall be made for valves in the line.

The rate quoted shall be inclusive of cutting holes, exposing reinforcement in wall and ceiling and floors and making good the same and inclusive of all items as specified in specification.

Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by the Consultants.

Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.

The length of the pipe for the purpose of payment will be taken through the centerline of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also resumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings. For valves and flanges, section 3.2 below app lies.

1.1.32 STRUCTURAL SUPPORTS

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications or as required at site by Consultants.

1.1.33 INSULATION

The measurement for vessels, piping, and ducts shall be made over the bare uninsulated surface area of the metal.

1.1.34 PIPES, DUCTS & VESSELS

PIPES

The measurements for insulation of piping shall be made in linear metres through all valves, flanges, and fittings. Pipes/bends shall be measured along the centerline radius between tangent points. If the outer radius is R1 and the inner radius is R2. The center line radius shall be measure as (R1+R2)/2. Measurement of all valves, flanges and fittings shall be measure with the running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured as part of the larger size.

1.1.35 DUCTS

The measurements for insulation of ducts shall be made in actual square metres of bare uninsulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be for the surface dimension for the connecting duct, nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

1.1.36 VESSELS

The area of standard dished and flat ends of vessels shall be the square of the diameter of the uninsulated body of the shell. Areas for other shapes shall be the actual calculated area. There shall be no deduction or additions for nozzles, handles ribs, dampers, expansion joints etc. All projections on vessels or tanks shall be measured separately as pipe/duct.

1.1.37 ACCESSORIES INSULATION

The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be uninsulated area in square meters.

In case of curved or irregular surfaces, measurements shall be taken along the curves.

The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

LIST OF APPROVED MAKES

LIST OF APPROVED MAKE FOR MATERIALS (MEP WORKS)		
SR. NO.	**MATERIAL**	**APPROVED MAKE**
HVAC WORKS		
1	VARIABLE REFRIGERANT SYSTEM	DAIKIN
2	VENTILATION FAN	FANAIR / GREENHECK / NICOTRA / VTS
3	PROPPELER FAN	CARRIAIR / GEC / ACCO / FANAIR
4	MOTORS	CROMPTON / SEIMENS / BHARAT BIJLEE.
5	CLOSED CELL (XLPE)	THERMOBREAKE / THERMOFLEX / K-FLEX
6	CLOSED CELL & OPEN CELL NITRILE RUBBER	ARMAFLEX / ALP AEROFLEX / K-FLEX / HIRA-AEROFOAM / THERMOBREAKE
7	GRILLES / DIFFUSERS / DAMPER	CARYAIRE
8	PRE-FILTERS	KIRLOSKAR / DYNA / KLENZAIDS / AIRTECH
9	DUCTING SHEETS	JINDAL / SAIL
10	FACTORY FABRICATED DUCT	ASAWA / ZICO
11	POWER CABLES	FINOLEX / RR KABEL
12	CIRCUIT BREAKERS	L&T / HONEYWELL
13	VFD	L&T / HONEYWELL / FUJI / DANFOSS
14	MCCB/RCCB	L&T / HONEYWELL
15	SWITCHES	L&T / HONEYWELL
16	STARTERS	L&T / HONEYWELL
17	PUSH-BUTTONS/OVERLOAD RELAY	L&T / HONEYWELL
18	VOLTMETER / AMMETER	A/E - IMP
19	UPVC / CPVC PIPING	SUPREME / PRINCE / FINOLEX
20	COPPER PIPING	RAJCO / MANDEV / MEHTA
21	ALDES	AIRFLOW / AIR PRODUCT
22	MOTORIZED FIRE DAMPER	HONEYWELL / BELIMO / SIEMENS
23	ACTUATORS	HONEYWELL / BELIMO / SIEMENS

24	THERMOSTATE	HONEYWELL/DANFOSS/BELIMO
25	ANTI VIBRATION MOUNT	GETZER /INTERLASP / KINETIC NOISE CONTROL
26	FIRE SEALENT	ARMAPROTECT
27	DUCT SEALENT	XCHEM / FOSTER
28	WELDED ROD	ADVANI / ORLOKON / ESAB
29	ANCHOR FASTNERS	FISCHER / HILTI / POWER FASTNER
30	PIPE AND DUCT SUPPORT	ASAWA / GRIPPLE
	NOTES:-	
1	The contractor should one of the approved makes as approved by the engineer- in-charge. If a make for any item is not provided than the contractor shall provide technical data sheets for those makes along with rate analysis for that item and get it approved from architect / client / pmc prior to use without any extra claim.	
2	In case of different quality/ pattern of make, the pattern/ quality shall be approved engineer-in- charge	
3	If any major equipment is using a small component of make other than that given as a standard component with the equipment, the same shall be accepted subject to approval of Architect / Engineer-in-charge	