

TECHNICAL SPECIFICATIONS - HVAC

1.0 Equipment :

1.1 Air-cooled Variable Refrigerant Flow System :

1.1.1 Scope

The scope of this section comprises of supply, installation, testing and commissioning of self-contained air cooled split type variable refrigerant flow packages each comprising of an outdoor and multiple indoor ductable / non ductable units conforming to these specifications and in accordance with the requirement of drawings and schedule of quantities.

1.1.2 Outdoor Unit :

Outdoor unit shall be factory assembled, good for outdoor installation, constructed out of heavy gauge MS panels with weather proof painting. The units shall be factory wired with necessary controls duly tested prior to dispatch conforming to the following specifications.

- (a) All outdoor units shall consist of minimum two scroll compressors, preferably one with inverter drive, capable to operate even when one compressor is unserviceable.
- (b) Outdoor units above 18 HP shall consist of minimum two separate inverter driven compressors.
- (c) The units shall be provided with duty cycling arrangement for multiple inverter scroll compressors.
- (d) The outdoor unit shall be modular in design to facilitate installation one after another close to each other. Preference would be given to compact units having smaller footprint.
- (e) Outdoor units should be rugged of anti-corrosion design.
- (f) The outdoor unit shall comprise of sub cooling feature to effectively use the entire coil surface through proper circuit/bridge in order to prevent flushing of refrigerant owing to large length of piping.
- (g) The condensing unit shall be provided with state-of-the-art microprocessor based control panel.

The outdoor unit shall be provided with Aero spiral design fan exhibiting low noise level characteristics complete with aero fitting grille to facilitate spiral discharge of airflow to effect reduction in pressure losses. The fan should be capable to respond to external static pressure of 5mm. The condensing unit shall be designed to facilitate fail safe operation when connected to multiple indoor units. Following safety devices shall be integral part of the outdoor unit:

- High pressure switch
- Fan drive overload protection switch
- Fusible plug
- Overload relay including overload protection for inverter driven scroll compressor.

1.1.2.1 Scroll Compressor :

The scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction & discharge service valves. The compressor shall be complete with straight suction tube, centrifugal oil pump, oil charging valve, oil level sight glass, crank case heater and check valve on the scroll discharge port. The compressor shall be complete with the provision of two-point lubrication for each motor bearing. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM. The compressor shall be capable of

functioning with inverter control. The inverter driven compressor shall preferably be with reluctance DC inverter for higher efficiency and reliability.

1.1.2.2 Condenser :

Condenser shall be air-cooled type, suitable for outdoor installation and shall be suitable for operating at 47 deg C db and 24 deg C wb temperatures. Condenser shall be in copper tube & aluminium fin construction. Condenser coil shall be of minimum 3 rows and the FPI shall be minimum 18. The maximum face velocity across the coil shall not exceed 215 MPM. The condenser frame shall be constructed from heavy duty galvanized steel.

The condenser fan/s shall be of propeller type with 900 RPM variable voltage electric motor complete with IP-55 protection. Motor shall be speed controlled to ensure a stable operation for varying ambient, by a factory fitted direct acting head pressure activated variable speed drive. The condenser shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessories necessary with the equipment supplied.

1.1.3 Anti-Corrosion Protective Treatment Associated with Condensing Units, Piping, Joints and U bends & Refrigerant Piping between Outdoor and Indoor Units.

All interconnecting piping, joints and U bends within the condensing unit shall be painted with two coats of clear transparent polymer coating for protection against corrosion from ambient air pollution. Two coats of protective coating shall be applied. Each coat shall have dry film thickness of 35 micron or more.

The coating shall be strong, flexible and durable. It shall have good adhesive and abrasion resistance. It shall be resistant to moisture, UV, acid, alkali and other chemicals and capable of functioning between -250 C and 1500 C.

The polymer shall be obtained by the mixing of base / monomer with a hardener/polymerizer. It may brush applied or with the use of a suitable gun.

1.2 Refrigerant Piping (VRF) :

The copper refrigerant piping shall be carried out neatly to connect outdoor and group of indoor units and shall run along with wires/cables. The refrigerant piping shall be carried out using hard drawn copper pipes & readymade copper fittings for pipe diameter exceeding 19mm. Piping less than 19mm shall be carried out using soft seamless copper pipes. Joints shall be affected by soldering/brazing process using silver rods. Suitable sleeves shall be provided at all wall crossings as required. The refrigerant circuit shall include liquid line and gas shut-off valves besides solenoid valve at the end of condenser.

The refrigerant piping shall be carefully sized with necessary headers and should consist of accessories including Y-joints. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure holding of 150 PSI for 3 minutes, followed by an increase in pressure to 325 PSI for holding for 5 minutes, and finally an increase in pressure to 600 PSIG and holding for 24 hours. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum equivalent to 700mm Hg and held for another 24 hours prior to commencement of gas charging.

All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building element by means of inserts or expansion shields of adequate size and number to support the load imposed thereon. The liquid and suction refrigerant lines including all fittings, valves, strainer etc. shall be insulated with 13 mm thick closed cell elastomeric insulation material preferably in tubing form as specified in Schedule of Quantities.

To protect nitrile rubber insulation associated with exposed copper piping from degrading

due to ultra violet rays & atmospheric conditions, it shall be covered with poly shield coating. Fiberglass tape shall be helically wrapped & applied with two coats of resin with hardener to give smooth finish.

1.3 Centralized Remote Controller, Touch Screen Type :

A multifunctional compact centralized controller shall be provided with the system. The Graphic Controller must act as an advanced air conditioning management system to facilitate complete control of VRF air conditioning equipment, it should be user friendly through its touch screen, icon display and colour LCD display. It shall be able to control up to several groups of indoor units with the following functions:

Starting/stopping of Airconditioners as a zone or group or individual unit.

Temperature setting for each indoor unit or zone.

Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.

Monitoring of operation status such as operation mode & temperature setting of individuals indoor unit, maintenance information and troubleshooting information.

Display of air conditioner operation history.

Daily management automation through yearly schedule function with possibility of various schedules.

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

1.4 Unified On/Off Controller :

Unified ON/OFF controller shall be supplied as optional accessory.

The controller shall be able to control minimum 15 groups, each group containing maximum 16 indoor units or 128 indoor units with the following functions:

On/Off as a zone or individual unit. Indication of operation condition of each group.

Select one of 4 operation modes.

1.5 Schedule Timer :

A schedule timer shall be supplied as an optional accessory.

The timer shall be able to set operation schedule for all indoor units.

The timer shall be able to set 8 patterns of schedule combined with centralized controller.

1.6 Propeller Fans :

Propeller type, Ring/Diaphragm mounted fans shall be equipped with a TEFC phase motor with the impeller mounted directly on the shaft. The blades shall be die formed steel. The fan shall be fitted with gravity type louvers.

a. The Contractor shall supply all foundation bolts, base frame wherever required, vibration eliminators etc. and shall ensure that all the above accessories are placed securely in proper position while the foundation is cast.

b. Vibration eliminators shall be provided with an efficiency of not less than 80% wherever necessary.

c. Fan inlet and outlet connections shall be with flexible canvas connections wherever necessary.

Testing :

All the fans shall be tested for performance and the following test results shall be furnished:

a. Air flow rate in CFM.

b. Static pressure at the fan supply end.

Painting

On completion of the erection and testing, the outside of the fans shall be painted with two coats of Synthetic Enamel paint of approved colour over and under coat of primer.

1.7 Inline Fans :

Inline fan shall incorporate approved make SISW direct driven Centrifugal Fan with TEFC motor with IP-44 protection. The fan assembly shall be encased in a sheet metal housing of 22 gauge GSS and with necessary inspection cover with proper gasket assembly. The fan material shall be galvanized sheet steel. Flanges shall be provided on both sides of the Inline fan to facilitate easy connection. Flexible anti-vibration joints shall be provided to arrest vibration being communicated to other equipment connected to the Inline fan. Motor shall be single phase/three phase as per required duty conditions.

All single phase fans shall be provided with speed regulator while all three phase fans shall be provided with opposed blade damper in GSS construction at fan outlet for air balancing. All inline fans shall be internally lined with 15mm thick open cell nitrile rubber insulation to achieve noise level of 40 db.

1.8 Centrifugal Fans :

Centrifugal fans shall be of high efficiency forward/backward curved approved make DIDW/SISW of specified Class and arrangement complete with access door, squirrel-cage induction motor, direct drive and vibration isolators. Type, direction of discharge / rotation, and motor position shall be as per the Approved for Construction shop drawings. The fan shall be complete with the following –

Housing : Housing shall be constructed out of heavy gauge galvanized sheet steel welded/bolted construction. Housing for mounting of blower should be strong enough to hold the bearings preferably with twin rib spider arrangement. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however, neoprene packing should be provided throughout split joints to make it air tight. 18 gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout and door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

Fan Wheel :

Fan Wheel shall be backward-curved non-overloading type OR forward curved type. Fan wheel and housing shall be statically and dynamically balanced, conforming to standard G 2.5 . Fan outlet velocity shall not exceed 2000 FPM (610 MPM) and maximum fan speed shall be 1000 RPM.

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

Bearings :

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

Motors :

Fan motor shall be high efficiency IE-3 suitable for operation on 415 + 10% volts, 50 cycle, 3 phase AC power supply. The motor shall be TEFC, squirrel cage induction type having two speed and IP-55 protection, provided with class 'F' insulation, centrifugal fans, whenever used for smoke venting duty, motor shall be with class H insulation. Motor name plate horse power shall exceed brake horse power by a minimum of 20%. Motor shall be designed especially for quiet operation and motor speed shall not exceed 1450 rpm. The fan and motor combination selected for the particular required performance shall be energy efficient ensuring lowest noise level. The motor shall be of approved make. Drive : Direct drive to fan shall be provided.

Vibration Isolation : MS base shall be provided for both fan as well as motor, built as an integral part, and shall be mounted on a concrete foundation through vibration isolators of approved

make or cushy foot mountings. The concrete foundation shall be at least 15 cm above the finished floor level or as shown in approved for construction shop drawings.

1.9 Extract Fan Section :

Fan section casing shall be of at least 16 gauge galvanized sheet complete with provisions of separate GI sheet enclosure to locate the motor in hot air stream free area (applicable for kitchens). The fan section shall be re-inforced with access panel as required. Factory Fabricated Plenums shall be provided as shown in design drawings.

The fan shall be forward curved, floor standing, double inlet double width type. The wheel and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame/spider and self lubricated sealed eccentric type ball bearings.

The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM (610 MPM). Fan housing with motor shall be mounted on a common steel base inside the air handling housing on anti-vibration springs mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass.

Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be at least 20% over limit load plus transmission losses.

Fan motors shall be suitable for operation on 415+10% volts, 50 cycles, 3 phase, AC power supply and shall be IE-3, TEFC squirrel cage induction type totally enclosed, fan cooled with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Direct drive to fan shall be provided.

1.10 Fan Filter Units (Fresh Air Fans) :

Fan section casing shall be of at least 16 gauge galvanized sheet complete with viscous metallic filters and Factory Fabricated Plenums as shown in design drawings. The fan section shall be reinforced with access panel as required. Factory Fabricated Plenums shall be provided as shown in design drawings. Where called for in 'Schedule of Quantities', unit shall be provided in double skin configuration similar to 'Air Handling Units'.

The fan shall be forward curved floor standing double inlet double width type. The wheel and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame/spider and self lubricated sealed eccentric type ball bearings.

The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM (610 MPM). Fan housing with motor shall be mounted on a common steel base inside the air handling housing on anti-vibration springs mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass.

Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be at least 20% over limit load plus transmission losses.

Fan motors shall be suitable for operation on 415+10% volts, 50 cycles, 3 phase, AC power supply and shall be IE-3, TEFC squirrel cage induction type totally enclosed, fan cooled with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement.

Belts shall be of the oil-resistant type. Fan Filter units should be provided with necessary viscous metallic filters as mentioned under subhead filters.

1.11 Filters :

1.11.1 Viscous Metallic Filters

Viscous metal filter shall be all metal, washable type. The filter media shall be composed of layers of crimped GI wire mesh. The velocity over face of filter shall not exceed 90 MPM. and pressure drop shall not exceed 5mm for 50mm thick filter. The filter shall be of GI and suitable for mounting as required at site.

1.11.2. Synthetic Fibre Filters (EU5) (As per Datasheet Annexure-21) :

Synthetic fibre filter shall be constructed out of 50mm deep non-woven synthetic fibre replaceable media secured with anodized ductile aluminium mesh on one side & 40 sieve HDPE mesh on the other side. All the layers to be dully stitched together & to be housed in 18G Aluminium anodized frame. The filter element shall have 11 folds/Rft. The filter shall have an efficiency of 90 to 99 % down to 5 microns when tested as per BS: 2831 standard.

It shall be suitable for operation under 100% Relative Humidity & 120 degree C temperature conditions. The velocity over the face of filter shall not exceed 105 MPM and the pressure drop across the filter shall not exceed 3 mm WG for 50mm thick filter. The filter frame shall be suitable for mounting in air handling unit as required at site.

1.12 Air Curtains

Air curtains shall be vertical down throw type and shall comprise of twin centrifugal blowers, statically and dynamically balanced, designed for noiseless and continuous operation, motor etc. The enclosure shall be factory fabricated out of 18 gauge aluminium/CRCA sheet duly powder coated. The outlet shall be carefully designed to create laminar draft providing an invisible air curtain at critical junction isolating clean and semi clean areas or as required.

1.13 DX-Split Packages :

Scope :

The scope of this section comprises supply, installation, testing and commissioning of self-contained air cooled split type air conditioning units each comprising of an outdoor and single/twin indoor units conforming to these specifications and in accordance with the requirement of drawings and schedule of quantities.

1.13.1 Outdoor Unit

Outdoor unit shall be an air cooled condensing unit suitable for outdoor installation conforming to the following specifications.

1.13.1.1 Unit Base & Casing

Base panel shall be constructed out of fabricated steel structure of adequate size. Casing panels shall be of 1.2 mm thick, welded construction, removable type to provide easy access to equipment and shall be bonderized and painted. Casing shall be complete with discharge outlets, grilles, space for refrigeration equipment, fans, condenser coil etc.

1.13.2 Compressor

1.13.2.1 Inverter Scroll Compressor : The inverter scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction & discharge service valves. The compressor shall be complete with straight suction tube, centrifugal oil pump, oil charging valve, oil level sight glass, crank case heater and check valve on the scroll discharge port. The compressor shall be complete with the provision of two-point lubrication for each motor bearing. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.

1.13.2.3 Condenser : Condenser shall be air cooled in copper tube & aluminium fins construction. Condensers shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessory necessary with the equipment supplied.

1.13.2.4 Condenser Fan

Fan shall be preferably propeller type suitable for fractional horse power drive with IP-55 protection.

1.13.3 Indoor Unit

The indoor unit shall be basically a fan coil unit suitable for wall, floor and under ceiling installation of various types conforming to the following specifications. Indoor units shall be either ceiling mounted cassette type, wall mounted type, floor mounted type or ceiling mounted ductable type in conformity with the design drawings and schedule of quantities.

Each indoor unit shall consist of PID controller for maintaining design room conditions besides micro-processor based thermostat for cooling. The indoor unit shall also be provided with wired LCD type remote controller which shall memorize the latest malfunction code for ease in maintenance. The controller shall incorporate self diagnostic features. Such remote controllers associated with cassette type and hi-wall type indoor units shall incorporate inbuilt feature to be able to change fan speed and angle of swing flap individually as desired by the user.

The ceiling mounted cassette type indoor units shall comprise of an attractive moulded ABS plastic exterior enclosure provided with four way supply air grilles on the periphery and square return air grill at the centre with filter behind. Each cassette types indoor unit shall consist of high efficiency paddle type condensate water pump to facilitate forced disposal of condensate water and low gas detection system.

The hi-wall indoor units shall be suitable for installation on the wall preferably at lintel level. The specifications shall otherwise be similar to above. Ceiling mounted ductable indoor units shall comprise of high static centrifugal fan, direct driven or belt driven through TEFC squirrel cage induction motor suitable for moderate amount of duct work. The housing shall be of light weight construction fabricated out of powder coated galvanized sheet steel single skin panels, internally insulated with 9mm thick closed cell elastomeric insulation material.

1.13.3.1 Cooling coil

Cooling coil shall be of the fin and tube type, having aluminium fins, firmly bonded to seamless copper tubes. Face and surface areas shall be such as to assure rated capacity and the air velocity across the coil shall not exceed 170 MPM. The coil shall be factory tested under water at 21 Kg/Sq cm air pressure.

1.13.3.2 Fan Section

The fan associated with non ductable indoor units shall be dual suction, aero dynamically designed, multi blade type, statically-dynamically balanced to ensure smooth circulation of air exhibiting lower noise level. The fan shall be direct driven type mounted directly on motor shaft supported from the housing.

Fan associated with ductable indoor unit shall be centrifugal double inlet double width forward curved type, preferably with variable pitch pulleys. The fan housing shall be statically-dynamically balanced at works to ensure noise and vibration free operation.

1.13.3.3 Filters

Filters shall be cleanable, synthetic fibre media of approved make. Velocity through filters shall not exceed 105 MPM and pressure drop across filters shall not exceed 5 mm of WG.

1.13.3.4 Insulation

All indoor unit shall be factory insulated with minimum 13 mm thick closed cell elastomeric insulation material towards thermal/acoustic treatment. Drain pan shall be insulated with minimum 13 mm thick closed cell elastomeric insulation material. Fixing of coil section and drain pan shall be done in such a way to avoid direct metal contact with any other un-insulated metal part in order to avoid condensation.

Condensate drain piping around the indoor unit shall also be insulated with minimum 9mm thick closed cell elastomeric insulation preferably in tubing form.

1.13.4 Refrigerant Piping (For Split Units)

The copper refrigerant piping shall be carried out neatly to connect outdoor and indoor unit/s and shall run along with wires/cables. The refrigerant piping associated with ductable units shall be carried out using hard drawn copper pipes & readymade copper fittings for pipe diameter exceeding 19mm. Piping less than 19mm shall be carried out using soft seamless copper pipes. Joints shall be affected by soldering/brazing process using silver rods. Suitable sleeves shall be provided at all wall crossings as required. The refrigerant circuit shall include liquid line and gas shut-off valves at the end of condenser.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure holding of 150 PSI for 3 minutes, followed by an increase in pressure to 325 PSI for holding for 5 minutes, and finally an increase in pressure to 600 PSIG and holding for 24 hours. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum equivalent to 700mm Hg and held for another 24 hours prior to commencement of gas charging.

All refrigerant pipes shall be properly supported and anchored to the buildings structure using steel hangers, anchors, brackets and supports which shall be fixed to the building element by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

The liquid and suction refrigerant lines including all fittings, valves, strainer etc. shall be insulated with 13 mm thick closed cell elastomeric insulation material preferably in tubing form as specified in Schedule of Quantities. To protect nitrile rubber insulation associated with exposed copper piping from degrading due to ultra violet rays & atmospheric conditions, it shall be covered with polyshield coating. Fiberglass tape shall be helically wrapped & applied with two coats of resin with hardener to give smooth finish.

2. Air Distribution :

2.1 Scope

The scope of this section comprises of supply, fabrication, installation and testing of all sheet metal ducts and supply, installation, testing and balancing of grilles, registers and diffusers, in accordance with these specifications and the general arrangements shown on various drawings.

2.2 Duct Material

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.

All ducts shall be fabricated from galvanized steel sheets and all ductwork shall conform to SMACNA Standard. Galvanized sheet shall possess light coating of Zinc, generally 120gm/sum of surface area. GI sheets shall be of Lock Forming Quality prime material along with mill test certificates. 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.

2.3 Duct Fabrication

All ducts shall be fabricated and installed in a workman like manner, generally conforming to SMACNA Standards. Round exposed ducts shall be die formed for achieving perfect circle configuration. The plain end of the round duct shall be slipped into the mating round duct with machine pressed flared end and thereafter pop riveted to complete the joint. The sample of round duct shall be displayed at the site prior to procurement for the approval of Consultants and IUCAA Engineers.

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

b. All exposed ducts within conditioned spaces shall have only slip joints and no flanged joints. The internal ends of slip joints shall be made in the direction of air flow.

c. Change in dimensions and shape of ducts shall be gradual. Curved elbows, unless otherwise approved, shall have a centre line radius equal to one and half times the width of the duct. Air

turns shall be installed in all abrupt elbows and shall consist of curved metal blades or vanes, arranged to permit the air to make the turns without appreciable turbulence. GI splitter dampers complete with brass metal lever shall be installed at each bifurcation/trifurcation point of duct for proper flow of air quantity in each duct.

d. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees or angles of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

e. All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed out of 18 gauge galvanized steel sheet, thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary doors as required by the Consultants to give access to all parts of the apparatus. Doors shall not be less than 450mm x 450mm in size. All hardware fittings such as thunder bolts, hinges, handles etc shall be in extruded aluminium construction.

f. In case of grid type false ceiling, the entire diffuser assembly with plenum shall be independently hung from the ceiling through adjustable GI wires and the same shall be connected to the main duct through a flexible round duct.

Fabrication Standards & Equipment

All duct construction and installation shall be in accordance with SMACNA standard. In addition, the ducts shall be factory fabricated with the help of following machines to produce the requisite quality of duct work.

1. Coil (sheet metal in roll form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.

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

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

2.4 Duct Construction

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

a.) Ducts so identified on the Drawing shall be acoustically lined and insulated from outside as described in the section "Insulation" and as indicated in schedule of quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gapes.

b.) Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or Snap button as per SMACNA practice to ensure air tightness.

c.) All ducts up to 750 mm width within conditioned spaces have slip and drive (C & S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that S/SS Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories including insulation within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint unless and otherwise specified.

d.) All ducts over 750 mm duct size for pressure class 1" / 250 Pa (W.G.), and over 550 mm duct size for pressure class 2" / 500 Pa (W.G.) shall have transverse joints.

e.) Changes in dimensions and shapes of ducts shall be gradual (between 1:4 and 1:7), Air – turns (vanes) shall be installed in all bands and duct collars designed to permit the air to make the turn without appreciated turbulence.

- f.) Ducts shall be fabricated as per details on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seam, tees, or angels of ample size to keep the ducts true to shape and to prevent buckling, vibration or breaking.
- g.) All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans shall be constructed of 18 gauge GSS/ 16 gauge aluminium thoroughly stiffened with 25mm x 25mmx3mm galvanized steel angle braces and fitted with all necessary inspection doors as required to give access to all parts of the apparatus access doors shall be not less than 45cm x 45 cm in size.
- h.) Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
- i.) Self-adhesive Neoprene rubber/ UV resistant PVC lining of 5mm thickness instead of felt shall be used between mating flanges and duct supports for all ducting installation.
- j.) Towards fire protection, all kitchen extract ductwork shall be fabricated out of 18 gauge GSS and coated with approved fire retardant paint preferably sprayed at factory prior to dispatch in order to capture the flanges, corners and internal joints.

2.5 Duct Installation

All ducts shall be installed generally as per the drawings and in strict accordance with approved for construction shop drawings prepared by the contractor.

- a. The contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these specifications and drawings. This work shall meet with the approval of the Architect/ Consultants in all its parts and details.
- b. All necessary allowances and provisions shall be made by the contractor for beams, pipes or other obstructions in the buildings, whether or not the same are shown on the drawings. Where it becomes necessary to avoid beams or other structural work, plumbing or other pipes, and or conduits, the ducts shall be transformed, divided or curved to one side, the required area being maintained as approved or directed by the IUCAA Engineers/Consultants.
- c. If a duct cannot be run as shown on the drawing, the contractor shall install the duct between the required points by any path available, subject to the approval of the IUCAA Engineers/ Consultants.
- d. All duct work shall be independently supported from building elements or as required by the Architect/Consultants. All horizontal ducts shall be rigidly and securely supported, in an approved manner, within hangers formed of wire rope suspension arrangement with hot dipped galvanized (HDG) perforated channel under the ducts. The distance between two successive supports shall not be greater than 1.5 meter centre to centre. All vertical duct work shall be supported by structural members at each floor.
- e. Ducting on top of the ceiling shall be supported from the slab above, or from beams with the help of adequate strength dash fasteners, after obtaining approval of the IUCAA Engineers / Consultant. In no case shall a duct be supported from the ceiling hangers or be permitted to rest on a hung ceiling.
- f. All metal work in dead or closed down spaces shall be erected in time to occasion no delay to other contractors in the building.
- g. All ducts shall be totally free from vibration under all conditions of operations. Whenever duct work is connected to fans, that may cause vibrations in the duct, ducts shall be provided with two flexible connections located close to the unit in mutually perpendicular directions. Flexible connection shall be constructed of fire resistant flexible double canvas sleeves at least 100mm deep, secured properly and bolted at both ends. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation.
- h. The two mating flanges of the ducts being joined with each other shall be made air tight by providing 2mm thick foam rubber insertion fixed on both mating flanges by means of good

quality adhesive. Rubber strip shall also be provided between bottom surface of duct and angle iron at each duct support to avoid metal to metal contact.

2.6 Volume Control Dampers

a. All dampers shall be multiblade type of robust construction of galvanized steel and tightly fitted. The design, method of handling, and control shall be suitable for the location and service required.

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

c. Dampers shall be placed in ducts and at each supply air collar, whether or not indicated on the drawings, for the proper volume control and balancing of the system.

2.7 Fire Cum Smoke Dampers

2.7.1 Bare Dampers

a. All supply and return air ducts/return air spaces at AHU room crossings and at all floor crossings shall be provided with approved make motorized fire and smoke dampers of at least 90 minutes fire rating as certified by CBRI Roorkee, India as per clause 10 of UL:555-1995. These dampers shall be multi-leaf type -Ruskin.

b. Fire damper blades and outer frame shall be formed out of 1.6mm (16G) galvanized steel sheet of length as mentioned in the approved for construction shop drawings titled as AHU Room Blow Up. The damper blade shall be pivoted on both ends using chrome plated spindles in self lubricated bronze bushes. Stop seals shall be provided on top and bottom of the damper housing made of 16 gauge galvanized sheet steel.

For preventing smoke leakage, metallic compression side seals shall be provided. Dual side linkage shall be provided for better structural stability. The construction of the fire damper shall allow maximum free area to reduce pressure drop and noise in the air passage. In normal position damper blade shall be held in open position with the help of a 220 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

c. For wall mounted fire dampers retaining MS angles duly painted with black enamel paint shall be supplied and installed by HVAC Contractor as per established installation procedure. Whereas the fire damper is also to be used for Smoke management (Smoke and fire damper) the same shall be as per UL-555 S-Class-II.

d. Every motorized fire damper/ Smoke and fire damper shall be tested for in the factory and will be certified by the manufacturer in form of the test certificate.

e. Fire damper shall also be supplied with spring lock fusible link rated for 720 C (UL stamped) to close fire damper in event of rise in duct temperature.

f. For fire dampers/ smoke fire dampers of size higher than one approved by certifying agency the damper shall be supplied in multiple units of size not exceeding the tested damper by CBRI. All the multiple units shall be housed in a common factory fitted sleeve.

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

h. The damper shall be installed in accordance with the installation method recommended by the manufacturer.

2.7.2 Actuators

The actuator shall be maintenance free direct coupled spring return type suitable to work on 24 V electric supply. The torque rating of the actuator shall exceed at least by 15% over torque required to open/ close the damper. The selection of actuator size shall be the responsibility of the manufacture of the fire damper. Spring return time shall be 20 seconds or less at ambient temperature. Other features of the damper actuator shall be as under:

a. Actuator shall have tamper proof housing with IP-54 protection rating.

- b. Actuator shall have mechanical integrity of at least one hour at 9000 C.
- c. Actuator shall have minimum 60000 safe position at rated torque. It shall be capable to withstand temperature of 750 C for 24 Hrs.
- d. Actuator shall have electronic over load or digital sensing circuit to prevent damage to actuator.
- e. Should be capable of changing direction of rotation by changing mounting orientation.
- f. Actuator shall have manual over ride facility.

Damper actuator shall be such that it should close the damper in the event of power failure automatically & open in the same manner in case of power being restored.

2.7.3 Control Panel

The Control panel shall be supplied by damper manufacturer fitted on damper compatible with damper actuators. The control panel shall have at least following features:

- a. Power on lamps with 230 V/ 24 V Transformer.
 - b. Damper close and open indication.
 - c. Reset push button.
 - d. Push button for manual running of actuator for periodic inspection.
 - e. Auxiliary contacts 24V & 230V.
 - f. Contact points to receive signal from smoke detector/fire alarm panel.
 - g. Additional terminal shall be provided to have signal (audio or visual) in central control room.
- The control panel shall receive 230 V A/C supply & interconnecting wiring between control panel and actuator shall be carried out using fire proof cables. The Contractor shall ensure that all electrical connections are suitably terminated. The HVAC Contractor shall also check continuity of electrical circuit as recommended by the manufacture. Fire damper inspection door will be provided in AC duct to facilitate access to the system.

2.8 Supply Air Registers

Supply air registers shall be of approved make and of mild steel construction with individually adjustable bars. Supply air registers shall be double deflection type, with removable key-operated volume control dampers. The outer frame should be made out of 20 gauge and louvers of 24 gauge MS sheet.

- a. All registers shall be selected in consultation with the Consultants. Different spaces shall require horizontal or vertical face bars and different width of margin frames.
- b. All registers shall have a soft, continuous rubber gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers shall not be less than 80 percent.
- c. Registers shall be adjustable pattern as such grille bar shall be pivot able to provide pattern with 0 to 100 degree horizontal arc and up to 30 degree deflection up or down. Bars shall hold deflection settings under all conditions of velocity and pressure.
- d. Bars longer than 450 mm shall be reinforced by a set back vertical member.
- e. Registers shall be given a rust inhibiting prime coat and factory applied enamel finish of approved colour.

2.9 Supply Air Diffusers

Diffusers shall be of approved make and of mild steel construction, square in shape with flush fixed pattern or adjustable flow pattern. Diffusers for different spaces shall be selected in consultation with the Consultant.

All supply air diffusers shall be equipped with removable key-operated volume control dampers. Anti-smudge ring may be required in specific applications. The outer shell and diffusing assembly shall be made out of 18 gauge and 24 gauge MS sheet respectively.

2.10 Extruded Aluminium Grilles & Diffusers

2.10.1 Rectangular/ Square Ceiling Diffusers

Rectangular /square ceiling diffusers shall be fabricated out of extruded aluminium sections powder coated in colour approved by IUCAA Engineers/Consultants. The four directional air

flow diffuser shall consist of outer ring fixed to duct collar with concealed screws. Foam gasket shall be provided between outer ring and suspended ceiling. The central core shall be clip fixed to the outer ring. Opposed blade volume control damper in extruded aluminium construction shall be fixed to the neck of diffuser. The damper shall be adjusted after removing the central core. The diffuser shall be equipped with anti-smudge ring.

In case of grid type false ceiling, the entire diffuser assembly with plenum shall be independently hung from the ceiling through adjustable GI wires and the same shall be connected to the main duct through a flexible round duct.

2.10.2 Plaque Diffuser

The Plaque diffusers shall be constructed out of Extruded Aluminium powder coated sections are designed to integrate with suspended ceiling arrangement preferably grid type. The diffuser shall consist of a rear pan and a removable heavy gauge front flat panel attached to the rear pan through spring loaded locking posts. The flat panel may be removed whenever need arises to facilitate adjustment of the damper for air balancing.

The front panel shall be aerodynamic in appearance, rigid and preferably in single piece construction and free from any welding or forming blemishes. The horizontal air discharge pattern shall be 360° type. Blank off baffles shall be provided to obtain one, two or three way blow pattern if specifically asked for in the "Schedule of Quantities". Diffusers shall be provided with following accessories:

I. Opposed blade damper

II. Spigot to facilitate round duct connection at neck.

The performance criteria shall be in conformity with relevant ANSI/ASHRAE standards.

2.10.3 Swirl Diffuser

The diffuser face shall consist of fixed radially arranged air control blades. The supply air pattern shall permit specifically arranged internal air guidance elements or guide vanes. Such elements are not required for return/extract versions. Due to the rotary swirling motion of the air discharge, induction of room air occurs very quickly, resulting in decay of supply air velocity and temperature differential.

In order to stabilize horizontal discharge, all sizes must be mounted flushed with the suspended ceiling. The minimum height between floor & the diffuser face should be 2.6 M or less. The face plate shall be square. The supply air versions shall be supplied with top/side entry spigot with lip seals and Volume Control Damper.

The diffuser face shall be fabricated out of 1.2 mm thick galvanized steel sheet, pre-treated and powder coated white. The spigot shall also be of 1.2 mm thick galvanized steel sheet & lip seal of soft rubber.

The performance criteria shall be in conformity with relevant ANSI/ASHRAE standards.

2.10.4 Multislot Linear Diffuser

Linear ceiling diffuser shall be multislot type. The diffuser shall be fabricated out of extruded aluminium sections. Each slot shall be 19mm wide. Each slot shall be equipped with air flow direction control louver mechanically fixed. Integral sliding type hit & miss type volume control damper in extruded aluminium construction shall be provided for each slot for fine control of air flow in supply air portion only. The damper shall be fabricated out of anodized extruded aluminium sections. Other sections of ceiling diffuser shall be powder coated in colour & shade approved by the Consultants/IUCAA Engineers. The linear diffuser shall be fixed in to a plenum chamber with concealed screws. Side end pieces or corner pieces shall be provided if required.

2.10.5 Multi Louvered Grilles : For supply air double louvered grilles in extruded aluminium construction shall be provided with individually adjusted louvers along with volume control damper in extruded aluminium construction. The louvers shall be pivoted in Nylon bushes for smooth operation for return air grilles similar to supply air as described above will be provided

but without volume control dampers. These grilles shall be painted as per approved powder coated shade.

2.10.6 Linear Grilles

Linear Grilles shall be fabricated out of extruded aluminium sections. Flanges shall be of 1.3mm thick extruded aluminium. Louvers shall be of extruded aluminium sections 3.7mm thick at the front and 2.2 mm at the rear with 15 degree deflection strong enough to withstand site abuse during installation. The sample of grille shall have to be got approved by the consultants before delivery. The linear grilles shall be provided with removable/fixed internal core.

All sections of linear grille shall be powder coated in colour/shade approved by the IUCAA Engineers/Consultants.

The linear grilles shall be fixed into a plenum chamber having GI spacers with concealed screws. End pieces or corner pieces shall be provided as required.

2.11 Fresh Air Arrangements

Extruded aluminium construction duly anodized (20 microns and above) fresh air louvers with bird screen and extruded construction dampers shall be provided in the clear openings in the masonry walls of the air handling rooms having at least one external wall.

Louvers, damper, pre-filters, ducts and fresh air fan, if required with speed regulator shall be provided as shown on drawings and in schedule of quantities. Fresh air dampers shall be of the interlocking, opposed-blade louver type. Blades shall be made of extruded aluminium construction and shall be rattle-free. Dampers shall be similar to those specified in "Air Distribution". Fresh air fans and fresh air intake shall be as per the schedule of quantities.

2.12 Air Transfer Door Grille

Air transfer grilles in extruded aluminium construction shall be provided at the door of pantry and toilets wherever required. The air transfer grille shall be complete with matching rear flange. The grilles shall be anodized or powder coated in colour and shade as approved by the IUCAA Engineers/Consultants.

2.13 Testing and Balancing

After completion of the installation of the complete air distribution system, all ducts shall be tested for air leaks.

Before painting the interiors, air distribution system shall be allowed to run continuously for 48 hours for driving away any dust or foreign material lodged within ducts during installation. The entire air distribution system shall be balanced using approved anemometer. Air quantities at the fan discharge and at various outlets shall be identical to, or less than 5 percent in excess of, those specified and quoted. Leakage in each air distribution system shall be within 3 percent so that supply air volume at each fan shall be identical to, or no greater than 3 percent in excess of, the total air quantity measured at all supply outlets served by the fan. Branch duct adjustments shall be made by volume or splitter dampers.

Dampers shall be permanently marked after air balancing is complete so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted to the Consultants for scrutiny and approval, and six copies of the approved report shall be provided with completion documents.

3. Insulation

3.1 All chilled water piping/refrigerant piping, chilled water equipment and Duct work shall be insulated in the manner specified hereunder:

Material

Chilled water pipes shall be insulated with closed cell elastomeric insulation of properties No insulation shall be applied on pipes until the pipes are satisfactorily tested, as specified in section "PIPING".

3.1.1 Application of Insulation

Cold insulation on pipes shall be applied as specified below:

a. Pipes shall be thoroughly cleaned with brush & linen and rendered free from all foreign matter and grease.

b. Apply SR –998 (or equivalent) adhesive on the bare surface of pipes.

c. Closed cell Elastomeric Thermal insulation preferably in tubing form shall be fixed tightly to the surface. All joints to be sealed properly with vapour barrier compound. Condensate drain piping and refrigerant piping shall be insulated in the manner specified above.

All valves, fittings, strainers, etc in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and applied generally in the manner specified above, valves bonnets, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced. Exposed CHW pipe insulation shall be provided with necessary treatment as under:

a. Apply two layers of surface coating as under:

I. Apply a coat of composition prepared out of synthetic resin, crystalline silica & ethyl alcohol.

II. Cover the insulated surface with lagging in the form of fire retardant glass fibre cloth, by wrapping it on wet coating.

III. Subsequently, apply a coat of special composition and allow drying.

IV. Apply second coating thereafter achieving sufficient mechanical strength.

3.2 AHU Room Acoustic/Thermal lining

3.2.1 Scope

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

3.2.2 Material

Insulation material shall be processed Elastomeric, nitrile rubber or other approved equal.

Samples of insulation material shall be submitted for approval to the Consultants prior to procurement.

3.3.3 Application of Insulation

Acoustic lining of ducts wherever specified shall be applied as under:

a. Clean the internal surface of the duct to make it free from dirt and dust.

b. Apply adhesive on the bare surface of duct.

c. Processed Nitrile rubber foam shall be fixed tightly to the surface, joints sealed properly with tape of same material.

3.4 Duct Insulation

External thermal insulation of ducts shall be carried out with closed cell elastomeric insulation having thermal properties mentioned on first page of insulation sub head and thickness mentioned in schedule of quantities. The contractor shall ensure availability of all accessories as mentioned under appendices for achieving perfect workmanship.

Insulation of ducts shall be applied strictly as per the recommendations of manufacturers amended from time to time. However, application procedure shall generally be as given hereunder:

a. Apply SR 998 / equivalent adhesive on the bare surface after vigorously cleaning the duct using fresh linen.

b. Closed cell elastomeric insulation material possessing class “O” properties in specified thickness to be fixed tightly to the surface with joints well butted.

c. Longitudinal as well as vertical joints shall be sealed with the adhesive forming proper bonding.

Circular ducts shall be insulated internally following procedure as mentioned above. In addition, insulated surface shall be secured with circular GI strips spaced at regular intervals. A sample of insulated duct shall be displayed at site and approval sought prior to application.

3.5 Thermal Insulation of ducts exposed to atmosphere:

Duct insulation shall be applied as follows:

- a. Apply SR 998 / equivalent adhesive on the bare surface after vigorously cleaning the duct using fresh linen.
- b. Closed cell elastomeric insulation material of class “O” properties in specified thickness to be fixed tightly to the surface with joints well butted.
- c. Longitudinal as well as vertical joints shall be sealed with the adhesive forming proper bonding and taped over with same material.
- d. Apply two layers of surface coating as under:
 - I. Apply a coat of composition prepared out of synthetic resin, crystalline silica & ethyl alcohol.
 - II. Cover the insulated surface with lagging in the form of fire retardant glass fibre cloth, by wrapping it on wet coating.
 - III. Subsequently, apply a coat of special composition and allow drying.

VRV/VRF Outdoor Units Combination :

- | | |
|-----------------|-----------------------|
| 1) Basement | - 1) 30 HP (16+14) |
| 2) Ground Floor | - 2) 32 HP (16+16) |
| | 3) 28 HP (18+10) |
| 3) First Floor | - 4) 40 HP (20+20) |
| | 5) 30 HP (20+10) |
| 4) Second Floor | - 6) 56 HP (20+20+16) |
| | 7) 38 HP (20+18) |
| | 8) 36 HP (20+16) |