SECTION: 2.6

AIR HANDLING SYSTEMS

1.0 Scope

1.1 The scope of work covers supply, installation and testing of the Air Handling Systems. The units shall meet the requirements of the data sheets and specifications.

1.2 Equipment document shall be submitted comprising but not limiting to the following:

i) Manufacture, Model No.

ii) Catalogues showing unit selected, physical data & weights

iii) Performance data covering

a) Air side
b) Coil side

Equipment data shall be submitted as required under Annexure 2.1-5

2.0 Air Handling Units (Double - Skinned)

2.1 Casing

2.1.1 Air Handling Units shall be of sectionalised constructions with an underframe of extruded heavy aluminum profiles anodized for extra protection against corrosion. The aluminum profiles shall be connected through die-cast connectors which shall render the unit capable of being easily dismantled. Based on the capacity and data sheets, AH units could be horizontal floor mounted, horizontal ceiling suspended, vertical floor mounted or as mentioned in the data sheet.

2.1.2 The underframe shall be mechanically strong and shall take double skinned insulated panels. The panels shall consist of 0.6mm galvanised outer skin and 0.6mm galvanised inner skin with 40 mm polyurethane foamed in place for indoor units and 50 mm for outdoor units. The thermal conductance of the panel shall be not more than 1.2 $W/m^2.C$ and the noise reduction of 20 dB @ 250 Hz mid frequency. Thermal break profiles shall be used wherever specified.

2.1.3 Air tight access panels shall be provided in the fan section and coil sections. Entire unit shall be mounted on a 100mm galvanised steel subbase.

2.1.4 Units meant for outdoor exposed locations shall be specially designed to meet the arduous and corrosive atmosphere and **thermal profiles**. All hardware shall be hot dip galvanised.

2.2 Fan Section

2.2.1 The fans shall be backward curved centrifugal double-inlet double – width or plug type with optimized selection for low noise and high efficiency. Fans shall be statically and dynamically balanced for vibration free operation.

2.2.2 Fans shall be enclosed in galvanised steel scroll cases with variable inlet vane section wherever specified. Fans shall be driven by an induction motor. Fan and motor assembly shall be mounted on specified vibration isolators eliminating the need for external vibration isolators. Provision shall be made for belt tensioning.

2.2.3 Motors shall be rated 10% over the maximum possible power absorbed by the fan operating at a maximum face velocity of 3.25 mps (650 fpm). The natural frequency of the fan assembly shall not fall within 30% of the operating speed. There shall be an extended shaft with two drive systems and two motors for 24 hours operation. All motors shall have 'high' efficiency as per IS 12615-2004 unless otherwise specified.

2.2.4 The fan outlet and inlets shall be as shown on drgs. and shall be isolated from the casing by means of factory made flexible connectors as specified in section "Sheet Metal Ducting".

2.3 Coil Section

2.3.1 Coils shall be made of 10mm or larger copper tube with finned extended surface. Fins shall be of aluminum spaced with integral collars as specified and mechanically expanded for proper bonding. Coils shall be tested after assembly with compressed air at 30 bar under warm water. Finned coils meant for outdoor use (air cooled condenser) shall be suitably protected against corrosion.

2.3.2 Air velocity across the coil shall not exceed 2.75mps. Inlet and outlet coil nipples shall be sealed against unit casing by means of neoprene gaskets. Each coil shall have a double skin drain pan of SS 304 with 20mm polyurethane foamed in. PVC U-Trap for AHU drain shall have a minimum water seal which is half of fan static.

2.4 Filter Section

2.4.1 The filter frame shall accommodate the filters in a manner that no air bypass takes place. Filters shall be easily inserted in slide-in guides.

2.4.2 Filters shall be cleanable dry type "Pre filters" as specified under section "Air Filters" and shall be 50mm in thickness. Filter area shall be selected for 1.5m/s velocity with an initial pressure drop of 50Pa and with full dust load pressure of 150Pa.

2.5 Selection & Installation

2.5.1 All air handling units shall be selected to meet the performance criteria set out in the appropriate data sheets. Wherever the ceiling heights are low, unit selection shall be such that the unit could be accommodated in the space assigned.

2.5.2 Where it is not possible to take-in an assembled unit, it shall be dismantled and reassembled. All air handling units shall be installed with appropriate vibration isolation systems.

3.0 **Ventilation AH Units with Heat Recovery Systems**

3.1 The ventilation AH units are essentially same as double skinned AH units specified above but characterised by the following:

i) Outdoor weather resistant construction and installation including thermal profile.

ii) Units incorporate
- a) Intake section with filters & dampers
- b) Coil section
- c) Supply fan section
- d) Heat pipe with connections
- e) Heat recovery wheel or Z-duct
- f) Return fan section
- g) Exhaust intake & damper

3.2 The unit shall have demountable sections, if necessary, for easy handling and shall be installed in the places shown. Unit shall be complete with drive motors, single control panel with necessary incomer & outgoing breakers, starters for each drive motor, temp. & humidity sensors, power and control cabling

3.3 Heat Recovery Wheel

3.3.1 Type

The Thermal Heat Recovery Wheel shall be cabinet type construction, comprising of various sections such as supply air, exhaust air and fresh air connections as shown on drawings and included in schedule of quantities.

3.3.2 Accessories

a. **Wheel :** The wheel shall be made of alternate layer of corrugated and intervening flat composite material of aluminium foil of uniform width to ensure smooth surface. The wheel medium should be bonded together to form rigid transfer medium forming a multitude of narrow channels ensuring laminar flow. The wheels shall be of proven design.

The wheel can be fully wound or on larger units, sectorised, i.e. assembled in segments. In latter case the segments are assembled between rigid spokes thus ensuring structural longevity and allowing replacement of one or specific segments only.

The wheel shall be cleanable by spraying its face surface with compressed air, low temperature steam or hot water or by vacuum cleaning without affecting its latent properties.

The face velocity across the wheel should not exceed 700 fpm (3.5 m/s).

The wheels shall be tested in accordance with ASHRAE S4-78 method of testing air to air heat exchangers. Development an manufacturers shall meet all quality assurance criteria specified in BSEN ISO 9001.

The minimum sensible and latent efficiencies should be 75%. A computerized selection should be enclosed along with offer.

b. **Casing:** The casing shall be constructed as a single skin, self-supporting, galvanized sheet steel structure and include rotary wheel support beams and purging sector. The casing shall be supplied with access panels to facilitate inspection and service. Size 2150 mm and larger shall be in two sections to facilitate shipping and handling.

c. **Seals:** The casing shall be equipped with adjustable brush seals, which minimize the carryover to max 0.05 – 0.2%.

d. **Hub and Spokes:** Hub and Spokes on one piece rotor shall be Aluminium and on sectorrized rotor Hub shall be made of steel, painted with ani corosion paint and galvanized sheet steel spokes.

e. **Drive :** The wheel shall be belt driven along its perimeter. A constant speed fractional horsepower motor shall be used. The motor shall be mounted on a self-adjusting base to provide correct belt tension.

3.4 Heat Pipe

3.4.1 General

Heat pipes for enhanced dehumidification shall be of the 'wrap-around' type included in the AHU around the main cooling coil. The heat pipes shall consist of a precool fin block upstream of the cooling coil linked to a reheat fin block downstream of the cooling coil by means of 'wrap-around' pipes. Heat pipes will be delivered to the AHU manufacturer fully factory charged and sealed. Where necessary, dehumidifier heat pipes may be incorporated in the ductwork to and from the AHU.

3.4.2 Fins

The external fins shall be of aluminium with a minimum thickness of 0.14mm. Fins shall be of the continuous plate type to maximize the external surface area rather than individually finned tube pattern. The fins shall be of the rippled or louvered type to suit the application and spaced at such a distance as required by the conditions specified. If necessary, fin spacing may differ between the two sections of the heat pipe. In corrosive atmospheres copper fins, vinyl precoated aluminium, or Blygold/Heresite post coated aluminium may be used.

3.4.3 Tubes

Tubes shall be of refrigeration standard seamless copper C106 for heat exchanger use. Tube diameter shall be a minimum of 12mm with a grooved inner surface to enhance the internal surface area and prevent pooling of liquid. The minimum root thickness of the tube shall be 0.35mm. The number of rows of tubes shall be selected to suit the application. Multiple row heat pipes shall have tubes in a staggered, equilateral pattern to optimize the airside heat transfer.

3.4.4 Casing

Casings shall be from galvanized sheet steel with a minimum thickness of 1.2mm. The casing shall incorporate tube plates, sideplates and intermediate stiffening plates as required.

3.4.5 Working Fluid

The working fluid shall be water. The heat pipe circuits shall be factory charged with the calculated weight of water and hermetically sealed. Individual heat pipes shall be manufactured in such a way as to ensure that all non-condensable gases are removed from the tubes.

3.4.6 Circuitry

Wrap-around heat pipes shall be formed from an array of complete loops such that the working fluid flows around the loop in only one direction i.e. liquid and vapour flow in the same direction to ensure that returning liquid is not entrained by the vapour. There will be a multitude of loops in the height of the heat pipe and each loop shall be individually charged. Heat pipes with header assemblies containing a single circuit are not suitable as a single leak will render the entire heat pipe inoperative. When multiple row heat pipes are used the rows shall be connected together in a counter flow orientation to optimize the heat pipe performance. Rows shall not be manifolded together. Heat pipe loops shall be arranged to slope down to the precool side to allow gravity assisted liquid return to maximize the internal heat transfer.

3.4.7 Performance

Heat pipes shall be designed to comply with the specified conditions when subject to the air volumes given in the specification. Heat pipe performance shall be independently type tested and certified in line with the requirements of British Standards BS 5141 pt1 / European Standards EN 305 & 306 for testing and rating of heat exchangers. Alternative acceptable and equivalent standards are AHRI 410 and AHRI 1060 respectively. All software used to predict the performance of heat pipes shall be based upon the results of these independent tests.

3.4.8 Installation

Wrap-around heat pipes shall be designed to fit around the main cooling coil within the AHU and its dimensions will be selected so as to allow this. Both the heat pipe and cooling coil shall be blanked-off to ensure that there is no air bypass around the fin blocks of either the heat pipe or cooling coil. The base of the air treatment section of the AHU shall form a drain pan.

4.0 **Fan Coil Units**

4.1 Fan coil units shall be horizontal/vertical type as shown on data sheets with return air plenum and filter as shown on drawings. Unit capacities shall be as required in the data sheets.

4.2 Unit shall consist of coil section, fan deck, motor and blower assembly, insulated drain pan. Entire unit shall be capable of being supported from four points. All sheets used for casing panels shall be hot dip galvanised before assembly and phosphate coated before being painted. Sheet metal shall not be less than 1.6mm.

4.3 Coils shall be made of 10mm or larger copper tube with plain aluminum fins expanded on to the tube. Number of fins shall not be less than 320 nor more than 400 per meter. Coils shall be tested to 20 bar working pressure. Supply and return connections shall be 16mm O.D copper arranged either right or left handed as required. Automatic air vents shall be provided on the return headers with a flexible pipe discharging into the drain pan. End connections shall have supply, return and control solenoid valves (on the return side). Coil design shall be such that the coil (alone) could be disconnected and removed from the unit for cleaning and maintenance.

4.4 Fans shall be slow-speed direct driven centrifugal forward curve type, statically and dynamically balanced. Fans shall have three speeds (100%, 70% & 50%) and quiet in operation. The maximum sound power level of the unit shall not exceed NC 35. A length of acoustically treated duct shall be provided as shown on drawings and as specified under section `NOISE & VIBRATION'.

4.5 Ductable fan coil units shall be capable of rated air discharge against specified external static resistance which shall be 200Pa by default.

4.6 Fan motors shall be single phase 220V 50Hz or 3 phase 400V with built in thermal overload protection and shall be capable of reliable starting and vibration free operation upto 90% of the rated voltage. Motor shall be mounted on a 3mm thick motor board and capable of being removed easily.

4.7 A full size double skin drain pan shall be fabricated of 1.25mm galvanised sheet. 25mm polystyrene or polyurethane shall be sandwiched or foamed-in. The two skins shall not be interconnected at no point. Pan shall be large enough to contain the unit and the coil connection shut-off valves, control valves etc. Units shall be mounted on the pan with rubber bushes. Inside of pan shall be finished smooth and pitched towards a 25mm drain connection located on the same side as the coil connections. Drain shall be connected to the drain pipe with flexible connection and a PVC trap of 40mm water seal and with inbuilt cleaning plug.

4.8 Unit control package shall consist of two way or three way solenoid or motorised water valve and two shut-off valves. A wall mounted control panel shall consist of:

a) ON-OFF room thermostat with adjustable set point.
b) Control switch with ON-OFF and High, Medium & Low Fan speeds. (upto 1000cfm)
c) On-line starter with a 3PN mcb/ mccb.

A sample of the entire unit and control panel shall be got approved by the project manager.

4.9 Fan coil units shall be installed with necessary galvanised steel frame to support the fan coil units.

5.0 Variable Air Volume Terminals

5.1 The VAV unit assembly shall be pressure independent and shall reset to any air flow between zero and the maximum catalogued air volume. At an inlet velocity of 10mps, the differential static pressure for any unit shall not exceed 2.5mm WG. Sound rating of air distribution assemblies shall not exceed NC 35 at 50mm WG pressure.

5.2 The air flow sensor shall be of cross configuration located at the inlet of assembly and shall have multiple pick up points, designed to average the flow across the inlet of assembly. The air flow sensor shall amplify the sensed air flow signal.

5.3 The assembly shall be constructed of 0.8mm thick zinc coated steel, internally lined with 20mm thick, fibre glass insulation. Any cut edges of fibre glass exposed to the air stream shall be coated with sealant. The primary air valve damper shall be heavy gun metal with peripheral gasket, pivoted in self lubricating bearings. In the full closed position air leakage past the closed damper shall not exceed 2% of the nominal catalogue rating at 80mm static pressure.

5.4 The terminal unit controller shall be a dedicated, microprocessor based, pressure independent VAV controller complete with electronic flow transducer. The controller shall be capable of stand alone operation and have the capability to network with a building automation system, personal computer or portable operator interface device.

5.5 The actuator shall be bi-directional and direct coupled to the damper shaft. The actuator must be capable of operating in the stalled position without overheating or mechanical damage.

5.6 Terminal controller, flow transducers and electric actuator shall be factory wired, calibrated and pretested to ensure full functional unit. The zone sensor shall be furnished by the terminal unit manufacturer and shall include temperature set point adjustment and access for connection of a hand held operator terminal. The DDC control package shall be calibrated and factory set for maximum and minimum flow rates as shown on the drawings.

5.7 The air terminal unit shall be installed and field adjusted to maintain controlled pressure independent airflow. The units shall be provided with a minimum of four duct diameters of straight inlet duct, same size as the inlet, between the inlet and any takeoff, transition or fitting. To facilitate field measurements terminal unit manufacturer shall furnish a portable hand held operator interface. The operator interface shall have capability of changing all inputs, set points and operating parameters of the VAV controllers by connection to the zone sensor.

All control components should be mounted inside a protective metal shroud. All VAV terminals shall be connected to the grille or diffuser through an insulated flexible duct and grille/diffuser.

6.0 **Testing**

6.1 The air handling and fan coil and VAV units shall be tested for establishing:

i) Air side
- Fresh air quantity (cmh)
- Dehumidified air quantity (cmh)
- Total static pressure (WG) & external static pressure (WG)
- Leaving & entering conditions (DB & WB)
- Coil capacity
  - Sensible heat (Kcal/hr)
  - Total heat (Kcal/hr)
- Fan speed (rpm)
- Power consumption of fan (watts)

ii) Water Side : Water flow (lpm)
Temp. IN & OUT (deg C)
Pressure IN & OUT (mWG)

iii) Noise level : NC level @ 1m from the unit and at the four corners of the room.

iv) Ventilation AH Units for supplying treated fresh air shall be tested for all the parameters of the Air Handling Units above but also register the performance of the heat recovery wheel / heat pipe for the actual flow conditions.

7.0 **Air Distribution**

7.1 Air distribution shall be by means of sheet metal ducting grilles and diffusers as described under `SHEET METAL DUCTING'.

8.0 **Mode of measurement**

8.1 i) The air handling unit complete with fan, filters, cooling coil, dampers, flexible connections and vibration mounts, motor and drive and starter power and control cabling as shown on data sheets etc. shall form one unit (two motors, drives & starters on all 24 hour units).

8.2 i) The fan coil unit complete with filter, cooling coil, poleflex insulated pipe connections, shut off valves, full drain pan, motorised valve, room thermostat with fan speed control, wiring from unit to thermostat and fan speed controller or starter, duct with acoustic insulation and supply & return grills, support etc. shall form one unit of measurement.

8.3 Automatic controls for AH units complete with damper actuator, transformer, RA thermostat, damper linkage, control wiring, relays etc. shall form part of the BMS as shown in the schedule of work.

8.4 VAV units shall be treated as one unit complete with:

i) Temp. sensor.
ii) Control wiring from unit to temp. sensor.
iii) 200 dia flexible ducting not more than 1.2m
iv) Plenum of approximately 1.2 x 0.15 x 0.3m

8.5 Ventilation AH Unit complete with supply and return fan sections, cooling coil, heat recovery wheel, heat pipe etc. and control panel & all internal power and control cabling shall be regarded as one unit of measurement.