

**PARO INTERNATIONAL AIRPORT  
(OLD TERMINAL)**

**PARO - BHUTAN**

**HVAC SYSTEM**

**CONSULTANT**

**GLOBTECH**

**KOLKATA - INDIA**

## **SPECIFICATION OF EQUIPMENT / MATERIAL AND INSTALLATION STANDARDS**

### **1.1 Variable Refrigerant Volume System.**

The system selected is a modular system, with number of indoors connected to centrally located outdoor units, as per detail designing given in the tender. The outdoor units for all the system shall be air cooled type FULLY INVERTER BASED and mounted on Chajja / ground level of the building. Indoor units in various areas shall be as per enclosed drawings/ Bill of Quantities.

All the VRV air conditioners shall be fully factory assembled, wired, internally piped & tested. The outdoor unit shall be precharged with first charge of R 410A refrigerant. Additional charge shall be added as per refrigerant piping at site. All the units shall be suitable for operation with 415 V + 10%, 50 Hz + 3%, 3 Phase supply for outdoor units & 220 V + 10%, 50 Hz + 3%, 1 Phase supply for in door units.

The VRV system shall provide stable, trouble free & safe operation, with flexibility of operating desired indoor units. The outdoor units must be capable of delivering exact capacity proportional to the number of indoor units switched on & the heat load in the air conditioned area. The proportional operation shall be achieved by varying speed of the compressor in the outdoor units.

The operation of the VRV system shall be through independent wired/ wireless remote controllers as specified. The entire system shall be integrated with intelligent building management system of leading vendors like Honeywell/ Johnson Controls/ Staefa etc, through BAC Net Gateway. The detailing of operation required through BMS system are detailed under specifications of BMS system.

#### **1.1.1 Outdoor units.**

Outdoors units of the VRV system shall be compact air cooled type.

All the compressors of the outdoor units must be hermetically sealed scroll type. Each module of outdoor unit must have separate 1# inverter compressor, suitable to operate at heat load proportional to indoor requirement.

"Coated PE Fins (with special acryl pretreatment) "for Al fins of Condenser Coils is mandatory for increased durability to salt corrosion.

The outdoor units must be suitable for up to 165 m( straight length ) refrigerant piping between outdoor unit & the farthest indoor units, total piping of 1000 m for all the indoor units. Allowable level difference between outdoor unit & indoor units shall be 90 m in case of outdoor unit on top & 50 m in case of outdoor unit at bottom. Allowable level difference between various indoor units connected to one out door unit shall be up to 15 m.

Back up operation, in case of failure of one of the compressors of outdoor unit, for single module outdoor units or failure of one of the modules in case of multiple module outdoor units shall be possible. The VRV outdoor unit shall always be supplying at least 33% of back up operation, of the full load capacity.

The outdoor unit shall employ system of equal run time for all the compressors, fully inverter type, within each out door unit – Single Module or Multi Module.

The outdoor units shall be suitable to operate within an ambient temperature range of – 5 Deg C to 48 Deg C, in cooling mode & -20 Deg C to 15 Deg C in heating mode.

Air cooled condenser shall have Axial Flow, upward throw fan, directly coupled to fan motors with minimum IP 55 protection. The outdoor unit condenser fan shall be able to develop external static pressure up to 6 mm of H<sub>2</sub>O.

The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required.

Starter for the Outdoor Unit compressor shall "Direct on Line" type. Fully inverter compressor of the unit shall start first & at the minimum frequency, to reduce the inrush current during starting.

Refrigerant control in the outdoor unit shall be through Electronic Expansion Valve. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested.

Noise level of outdoor units shall not exceed 63 dB (A) at a distance of 1.5 m from the unit.

The outdoor units shall conform to Technological Guideline for Harmonic Suppression – JAEG 9702-1995. High Harmonic Environmental Target Level for Power Distribution system shall be 5%.

Outdoor units shall be complete with following safety devices:

- High pressure switch
- Fan driver overload protector
- Over current relay
- Inverter Overload Protector
- Fusible Plug

Unit shall be supplied with

- Installation manual
- Operation Manual
- Connection Pipes
- Clamps

### **1.1.2 Indoor Units**

#### **1.1.2 Ceiling Mounted duct type units.**

These units shall be ceiling suspended with suitable supports to take care of operating weight of the unit, without causing any excessive vibration & noise. The cold air supplied by these units will be supplied to the area to be air conditioned, through duct system specified in the tender.

Each indoor unit must have electronic expansion valve operated by microprocessor thermostat based temperature control to deliver cooling/ heating as per the heat load of the room.

The unit casing shall be Galvanized Steel Plate.

Unit must be insulated with sound absorbing thermal insulation material, Glass Fiber. The noise level of unit at the highest operating level shall not exceed 49 dB(A), at a vertical distance of 1.5 m below the units with duct connected to the unit.

The unit must be able to develop external static pressure of 25 mm, at the specified air quantities.

Unit must have Thermal Fuse for fan motor protection, in case of motor heating.

The unit will be connected in series to a suitable out door unit & it must be possible to operate the unit independently, through corded/ cordless remote specified in the bill of quantities.

### **1.1.3 Cassette type indoor units.**

These units shall be installed between the bottom of finished slab & top of false ceiling. The maximum allowable height for the cassette type units shall be 288 mm.

The unit must have in built drain pump, suitable for vertical lift of 750 mm.

The unit casing shall be Galvanized Steel Plate.

Unit must be insulated with sound absorbing thermal insulation material, Polyurethane foam. The noise level of unit at the highest operating level shall not exceed 42 dB(A), at a vertical distance of 1.5 m from the grille of the unit.

Unit shall have provision of connecting fresh air without any special chamber & without increasing the total height of the unit (288 mm maximum).

The unit shall be supplied with suitable decorative panel.

The unit shall be supplied with Resin Net filter with Mold Resistance. The filter shall be easy to remove, clean & re install.

The unit will be connected in series to a suitable out door unit & it must be possible to operate the unit independently, through corded/ cordless remote specified in the "Bill of quantities". The unit will be further connected to Intelligent Building Management System (To be supplied by other vendors) & it shall be possible to operate the unit through this IBMS system.

### **1.1.4 One way Cassette type indoor units.**

These units shall be installed between the bottom of finished slab & top of false ceiling. The maximum allowable height for the cassette type units shall be 132 mm.

The unit must have in built drain pump, suitable for vertical lift of 750 mm.

The unit casing shall be Galvanized Steel Plate.

Unit must be insulated with sound absorbing thermal insulation material, Polyurethane foam. The noise level of unit at the highest operating level shall not exceed 42 dB(A), at a vertical distance of 1.5 m from the grille of the unit.

Unit shall have provision of connecting fresh air without any special chamber & without increasing the total height of the unit (132 mm maximum).

The unit shall be supplied with suitable decorative panel.

The unit shall be supplied with Resin Net filter with Mold Resistance. The filter shall be easy to remove, clean & re install.

The unit will be connected in series to a suitable out door unit & it must be possible to operate the unit independently, through corded/ cordless remote specified in the "Bill of quantities". The unit will be further connected to Intelligent Building Management System (To be supplied by other vendors) & it shall be possible to operate the unit through this IBMS system.

### 1.2.1 AIR HANDLING UNITS

#### CASING:

The units shall be made of extruded Aluminium hollow profile frames. The profile box size shall be of minimum 30 mm for such that it provides the required mechanical strength and rigidity. The unit should be devoid of any welded construction and should be of cabinet type. All the frames should be assembled using pressure die cast aluminium joints/corners to make a self-supporting frame.

The panels shall be of double skin construction with both inner and outer steel sheets being minimum 0.8mm thick pre coated & plasticized. 25 mm thick fire retardant insulation shall be sandwiched between the sheets.

The entire casing shall be mounted on electro galvanized channel framework with level screws. Condensate drain pan shall be fabricated from 18 g GSS/SS construction.

#### SUPPLY AIR SECTION

The supply air section shall comprise of the following:

#### FAN SECTION

The fan shall be centrifugal forward curved or backward curved, double inlet double width type.

The impeller and the fan casing shall be made of hot galvanized sheet steel. The impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearing. The impeller shall be statically and dynamically balanced. The fan shall be selected such that unit noise level is less than 65 db. Fan housing and motor shall be mounted on a common galvanized steel or aluminium block base which can be drawn out from side for ease of maintenance. A quarter pin lock arrangement between the slide and guide pin lock arrangement between Fan and TFA outlet should be provided.

#### a) MOTOR AND DRIVE

Fan motor shall be energy efficient and suitable for  $220 \pm 10\%$  volts, 50 cycles, single phase TEFC with IP – 55 protections. Motor shall be designed for quiet operation. **Drive shall be provided through belt – drive arrangement for exhaust fan and direct driven for Supply air fans.** Belts will be of oil resistant type. Casing to be of flame proof.

## **FILTER SECTION**

The filter section shall be normally designed for deep folded disposable synthetic prefilters for Class EU3. The filter elements shall be mounted on rails and shall be easily pulled out for replacement. The rails shall be provided with efficient gaskets to minimize the risk of leakage.

The system shall operate with outdoor air temperature ranging from -5 Deg. To 15 Deg. Cel. for heating & 19 Deg. Cel. To 43 Deg. Cel. for cooling.

The fan shall stop while operating in defrosting, oil return and hot start operation.

The units shall have an electronic expansion valve and microprocessor based control system to monitor the refrigerant flow .

The “self-diagnosis function” shall be there to indicate the occurrences and nature of abnormalities in the system by displaying codes on the remote controller.

### **1.2.2. Floor Mounted Treated fresh air units**

#### **CASING**

The framework of the casing will be in extruded Aluminium construction having 15 to 18 micron thick anodized finish. Double skin panels will be fabricated out of best G. I. 0.63 mm (22G) Powder coated sheet on outer side and plain G. I. 0.63 mm (24G) Sheet on inner side. PUF of density not less than 36 Kg / cuM will be sandwiched between inner and outer sheet. The panels will be fixed on Al. Extruded section in such a manner that fixing screw head does not project on outer face on the panel. The screw hole on panel will be blocked with Nylon sleeve with cap. The insulation shall be 25 mm thick. The screw cavity on will be blocked with nylon sleeve with cap. Drain tray will be fabricated out of SS sheet thickness not less than 1.2mm (18 G). The tray will have sufficient depth and proper size drain connection. The tray will be insulated from with nitrile rubber foam sheet having not less than 20mm.

Filter section will have rigid construction filter fabricated out of GI sheet to house required filters. The filters will be in flange construction having GI casing. Suitable panel of section will be provided with hole for entry with required arrangement to cover sharp edge G. I. Sheet. If required, a proper box cover will be provided on cable entry. A provision for earthing will be on mainframe near the cable entry hole.

The unit will be compatible with the VRV/VRF System.

All nut bolts, sheet metal screws, fasteners will Zinc / Nickel-plated having resistance against corrosion.

## **COOLING COIL**

The cooling coils shall be fabricated out of copper tube having OD not less than 12.5 mm and Aluminium fins spaced @ 12 fins / inch. Aluminium fins & copper tubes will have foam bond provided by hydraulic expansion method at the high pressure above yield point. The capacity of the coils shall be as required under the schedule of equipment. Velocity of air across coil face shall not exceed 500 FPM for 4 Row coil and 600 FPM for 6 Row coil.

Coil rating shall be as per ARI-410/2006.

## **FAN**

Fans shall be centrifugal, forward curved / backward curved / aerofoil so as to give maximum efficiency for given duty condition. Fans shall be selected for minimum efficiency of 65% Fan casing shall be made of galvanised steel sheet. Fan wheels shall be made of galvanised steel. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fan motor assembly shall be statically and dynamically balanced to G6.3 grade as per relevant ISO/AMCA standard. Computerized fan selection print outs shall be submitted along with the offer.

Motors shall be mounted inside the AHU casing on slide rails for easy belt tensioning, and be totally enclosed, fan cooled, to be class 'F' insulation. Motors shall drive heavy duty V-belt.

Both fan and motor assemblies shall be mounted on a deep section of aluminium base frame.

Combination spring and rubber anti vibration mounts shall be provided for isolating the unit casing. Frame retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan discharge.

## **MOTOR AND DRIVE**

Fan motors shall be energy efficient (EFF-1) and shall be  $415 \pm 10\%$  volts, 50 cycles, three phase, totally enclosed fan-cooled class F, 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. For three stage filtration AHUs, belt drive shall not be used and direct driven plug fans shall be used.

## **FILTER**

The activated carbon filter must comprise a multilayer structure of activated charcoal mats, covering nonwoven fabric and a grille on the clean air side. The frame material must be fibreboard, with a surrounding flat profile seal. The activated charcoal used must be of high-quality, fine, granular charcoal characterized by a high level of spontaneity in adsorption,

permanently fixed to a porous substrate system made of foamed material. It must have high specific adsorption capacity, low pressure loss and low weight, and are shock-resistant.

Pre-filters shall be HDPE washable types with 2" thickness provided with a factory assembled filter section containing washable synthetic type air filters having anodised aluminium frame. The filter shall have minimum 90% efficiency down to 10 microns. The media shall be supported with HDP mesh on one side and aluminium mesh on other side. Filter banks shall be easily accessible and designed for easy withdrawal and renewal of filter cells. Filter framework shall be fully sealed and constructed from aluminium alloy.

## **DAMPER**

Dampers 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. Manual dampers shall be provided with a Bakelite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorised operation. Damper frames shall be sectionalised to minimise blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

### **1.1.8 REFRIGERANT PIPING**

The indoor and outdoor units shall be connected with refrigerant piping. All piping connections for the units should be performed inside the unit. The refrigerant piping should be insulated with nitrile foam of minimum 19 MM thick. Lastly, cover up the pipes sections with the help of 36 G Aluminium sheets on straight pipes and 28 G Al. sheet on bends, tees, valves etc. All refrigerant piping to be done with hard copper pipes only.

## **DESIGN REQUIREMENT**

The parent material used for air – conditioning system refrigerant tubing should be Copper tubes, tubes and fittings conforming to following specifications:

1. Material composition should be conforming to C-1220 (JIS-H-3300) or C-12200 (ASTM). It should have a minimum Copper content of 99.9 % and Phosphorus content between 0.015 % and 0.040 %. It should have low residue (below 0.038 gm. / sq. mtr). The material should also be as per the RoHS norms specified by EU; that is, Mercury, Chromium and Lead contents below 1000 ppm, and Cadmium content below 100 ppm.
2. Physical properties of the material should conform to JIS-H-3300 or ASTM-B-68 & B-75, should be tested for Tensile / elongation / hardness / grain size tests as per ASTM B – 280.
3. Dimensional tolerance should be as per JIS-H-3300 or ASTM-B-251. The tubes should be tested Using non-destructive Eddy current test before the final anneal, as per JIS-H-3300 or ASTM-E-243.



4. Heat treatment should be carried out in non-oxidizing atmosphere to ensure oxygen-free and Cuprous oxide-free surface.
5. Proper certificates describing composition and results of all tests carried out must be supplied with each consignment. These certificates, along with check results for dimensional and thickness accuracy are recommended to be carried out for every delivered lot, should be maintained till handing over of the project.
6. Tubes should have 360 degree concentric wall thickness along their entire length.
7. Wall thickness for soft tubes ( bright annealed mirror finish ) should be 0.8 mm for ¼", 3/8" & ½" tubes, 1.0 mm for 5/8" tubes, 1.2 mm for ¾" tubes. Wall thickness for hard tubes should be 1 mm for 7/8", 1" and 1.1/8" tubes, 1.1 mm for 1.1/4", 1.2 mm for 1.3/8" and 1.3 mm for 1.5/8" tubes.
8. Wall thickness for elbows and fittings should be minimum 0.2 mm more than corresponding tube / tube size.
9. For sizes up to ¾", pulley type benders should be used and brazed joints should be avoided as far as possible. Similarly, for tubes of size 7/8" or more, one side expanded tubes must be used and use of couplings should be avoided as far as possible.

#### **Packaging, Storage and Traceability of Copper tubes:**

1. Cleaned tubes end are sealed with plastic end caps for identification, traceability and authenticity of genuine product.
2. The inside bore of straight tubes and coils can be kept clean by covering their ends with plastic end caps, so that no dust gets into it.
3. The tubes are then sealed in polythene bags to prevent any tarnish on the finish due to its exposure to atmosphere.
4. For better storage use of vacuumed polythene shrink wrapping of coil tubes is also done.
5. As per packing list and customer order of product matrix, these packed copper tubes are further put in transport-worthy corrugated boxes with appropriate packing material stuffing to prevent any damage during transit.
6. For specific needs especially for soft annealed tubes, final packing is done in wooden boxes to prevent any damage to the tubes during transit.

#### **1.1.11 PVC DRAIN PIPING**

Condensate from the evaporator unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan. Drain piping of specified sizes and suitable of 6 Kg/Sq cm. pressure rating with water tight threaded connections, leading from the room unit to a suitable drain point. Complete drain piping shall be made leak proof and water tight by means of precise installation and the use of leak proof sealant/adhesives. Drain piping shall be insulated with 13 mm plain nitrile rubber.

### **1.1.5 Controls System**

#### **1.1.5. A Wired Remote Controller.**

Wired remote controller shall be supplied as specified in the "Bill of Quantities".

The controller must have large crystal display screen, which displays complete operating status.

The digital display must allow setting of temperature with 1 Deg C interval.

Remote shall be able to individually program by timer the respective times for operation start and stop within a maximum of 72 hours

Remote must be equipped with thermostat sensor in the remote controller that will make possible more comfortable room temperature control

The remote shall be able to monitor room temperature & preset temperature by microcomputer & can select cool/ heat operation mode automatically.

The remote must constantly monitor malfunctions in the system & must be equipped with a "self diagnosis function" that let know by a message immediately when a malfunction occurs.

It shall be possible to wire the remote up to 500 RMT.

#### **1.1.5. B Wireless Remote Controller.**

Wireless remote controller shall be supplied as specified in the "Bill of Quantities".

The same operation modes & settings as with wired remote controllers must be possible.

Compact light receiving unit to be mounted into wall or ceiling shall be included.

## 1.3 AIR DISTRIBUTION SYSTEM

### 1.3.1 SHEET METAL WORK

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/factory fabricated panel type and assembled at site.

The deflection of transverse joints should be within specified limit for rectangular duct deflection as per SMACNA Standards.

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

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)

Ducts shall be made of either galvanized steel sheet as specified in the BOQ and confirm to IS-655. The galvanized steel sheet shall confirm to IS-277 grade 140 or better. The duct construction shall be as follows.

### RECTANGULAR DUCT CONSTRUCTION

For low pressure System (Upto static pressure of +/- 75mm wc) Max.Size	Min.thick	Trans joints	Reinforcement	Hanger
Up to 750	24 G	25x3 eq.angle	Cross Breaking	10mm
751 to 1500	22 G	25x3 eq.angle	25x3 girth angle at 1250mm centre	10mm
1501 to 2250	20G	37x3 eq.angle	37x3 girth angle at 750	12mm
Above 2250	18g	40x6 eq.angle	40x6 girth angle at 600	12mm

### SUPPORT SYSTEM

A completely galvanized system consisting of fully threaded rods, slotted angles or double-L bottom brackets (made out of 3.0 mm M.S. sheet) nuts, washers and anchor bolts as supplied by supplier or generally conforming to SMACNA standards should be used.

### **Support for Horizontal duct-Rectangular/Square**

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

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.

### **DAMPERS**

All dampers shall be of 18 S.W.G. G.I sheets louver dampers of robust construction and tight fitting. The design, method of handling and control, shall be suitable for the location and service required. Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation, control or setting in any desired position. Dampers and their operating devices shall be made robust, easily operable and accessible through suitable access door. Every damper shall have indication device clearly showing the damper position at all times. All the bushing will be of brass only.

### **FIRE DAMPERS**

The fire dampers shall be provided between each air handling unit room and the rest area and 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 motorized actuator.

Fire dampers blades and outer frames shall be made of 16G GSS construction. Fire dampers shall be provided with factory fitted sleeves incase of being fitted in fire walls.

### **INSTALLATION-**

a. 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. All the joints shall be made tight and all interior surfaces shall be smooth. Bends shall be made with radius not less than one half the width of the duct or with properly designed interior curved vanes where metal ducts or sleeves

terminate in woodwork, brick or masonry openings, tight-flanged collars. Ducting over false ceiling shall be supported from the slab above or from beams. In no case a duct shall be supported from the false ceiling hangers or to be permitted to rest on a hung ceiling.

b. All holes in concrete, masonry etc. made by contractor for fixing supports etc. shall be made good and restored to original finish by him.

#### **TESTING-**

a. After completion all such system shall be tested for leakage.

b. The entire air distribution system shall be balanced to supply the air quantities as required in various zones and rooms to maintain the specified room conditions. The final shall be recorded and submitted to the Consultant for approval before acceptance and taking over of the entire system by the Employer.

### **1.3.2 INSULATION FOR G.I. DUCTING-**

#### **THERMAL INSULATION-WITH NITRILE RUBBER**

Nitrile Rubber of approved make of 60 kg / m<sup>3</sup> density

Method of applying insulation-

- a) Clean the duct surface to be insulated.
- b) Apply a thin layer of tar paints.
- c) Apply a thin coat of rubber solution to stick the insulation.
- d) Fix the insulation of specified thickness over the surface of the duct tightly and seal all the joints using BOPP tape.

#### **ACOUSTIC INSULATION-**

First 3 meter length of supply air duct shall be acoustically insulated with 15 mm thick class 'O' nitrile rubber of Armasound / eqvt. Make of 140-180 kg / m<sup>3</sup> & 240 kg / m<sup>3</sup> density as specified in BOQ.

- a) Clean the duct surface to be insulated.
- b) Apply a thin layer of tar paints.
- c) Apply a thin coat of rubber solution to stick the insulation.
- d) Fix the insulation of specified thickness over the surface of the duct tightly and seal all the joints.

## **UNDERDECK INSULATION**

Insulation material shall be Closed Cell Elastomeric Nitrile Rubber

Density of Material shall be between 60 Kg/m<sup>3</sup>.

The insulation shall be 25 mm thick.

Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m<sup>2</sup>K at an average temperature of 0°C

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 and the Building Standards

Water vapour permeability shall not exceed 0.017 Perm inch ( $2.48 \times 10^{-14}$  Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor ' $\mu$ ' value should be minimum 7000.

## **5.0 GRILLES**

The grilles & slot diffusers shall be rated in accordance with ASHRAE standard 3672.

All grilles & slot diffuser shall have concealed fixing system and shall have quick release frame to facilitate cleaning.

All supply grilles & slot diffuser shall be mounted on substantial frame and shall be provided with soft rubber or felt joining ring inserted under the frame to prevent air leakage and the formation of condensate on the fitting,

All grilles & slot diffuser shall not be less than the size indicated; where no size is given they shall be capable of handling the air flows and distribution indicated without producing unacceptable air flow noise. The Contractor shall select the supply air grilles & slot diffuser and diffusers to achieve good air distribution and adequate air movement in the conditioned space.

In order for the ceiling grilles & slot diffuser and diffusers to match with the false ceiling layout pattern, the actual size of the grilles & slot diffuser shall be confirmed by the Architect/consultant before ordering.

For all grilles & slot diffuser which are smaller than the ceiling tile on which they are installed, they shall be located in the centre of the ceiling tile. The exact location of the ceiling grilles & slot diffuser and diffusers shall be co-ordinate with other services. The Contractor shall confirm the exact location with the Architect/consultant before works commence.

Where grilles & slot diffuser are to be incorporated into false ceilings before any grilles & slot diffuser or diffusers are installed into ductwork or fan coils, the Contractor shall ensure that the Building Contractor marks out the ceiling line on the adjacent plastered walls or

columns and also indicates where ceiling tee bars line up or the ceiling joints occur in order that such datum can be worked to.

The finishing colour of the grilles & slot diffuser shall be approved *by* the Architect as different colours may be specified in different areas. The Contractor shall co-ordinate with the Building Contractor and other specialist Contractors especially the ceiling and electrical Contractor for the integration of the air diffuser into the ceiling and luminaire (for light troffer diffuser).

Grilles shall be of steel, aluminium, PVC or as otherwise indicated. Steel grilles & slot diffuser shall be protected against rusting and supplied in fully finished stove-enamelled or otherwise specified condition.

Each supply air grille shall have two sets of separately adjustable louvres, one set horizontal and one set vertical, and shall be complete with an opposed blade multi-leaf damper. Alternatively in lieu of the opposed blade multi-leaf damper a rhomboidal air controller may be provided; this air controller shall control both the volume of air passing and the distribution of air across the grille face. The louvers and the damper or air controller shall be adjustable from the front of the grille.

Return air grilles & slot diffuser shall have either a single set of louver or bars (either vertical or horizontal) or a lattice, egg crate or expanded metal form.

Each return air grille shall be complete with/without an opposed blade multi-leaf damper or a rhomboidal air controller operable from the front as specified.

Where return air grilles & slot diffuser are fitted for fan coil units, they shall be arranged such that the central core of the grille hinged and demountable for access to the filter for cleaning.

Mounting frames for these grilles & slot diffuser shall include provision for fixing the filter in position.

#### 1.4.1 VENTILATION FANS:

##### SINGLE SKIN CABINET TYPE FANS (FRESH AIR & EXHAUST FANS)

###### Construction

Floor mounted exhaust unit will consist of blower section with return air cut out and ventilation units will consist of filter section and fan section with S. A. cut-out. Units will have the construction as described below-

###### Casing

Units will be in single skin construction with all the **features similar to double skin construction units**. Units will be fabricated out of Aluminium Extruded section and GI panels.

Extruded aluminium profiles will be duly anodized as per industrial standards (15 to 18 Micron anodizing). The panels will be in 1.8 mm thick GI construction duly coated with pure epoxy powder / liquid polyurethane paint for the highest production against humid or polluted weather. The panels will be secured properly on the frame structure providing proper gasket between panel and frame.

Filter section (for ventilation units) will have rigid construction filter frame fabricated out of GI sheet to house required size filters. The filters will be in flange type construction having GI casing. Threaded inserts / nuts duly nickel-plated will be pre-fixed on filter frame for securing the filters.

Blower section will consists of fan base frame made out of extruded sections of proper size to facilitate the mounting of fan and motor. Vibration isolators will be provided to eliminate direct contact of fan base frame and AHU casing. Also flexible connection will be provided at the fan outlet. Suitable panel of blower section will be provided with hole for cable entry with required fitting. If required, a proper size box cover will be provided on cable entry location. A provision for earthing will be provided on mainframe near the cable entry hole.

Inspection doors at required location will be provided with elegant design hinges made out die cast Aluminium alloy or glass filled nylon. Two or more number of hinges per door will be provided depending upon the size of the door to provide required rigidity to the door panel. One or more number of door handles will be provided with cam type tightening arrangement. The handle and cam will be made out of glass filled nylon having galvanized iron spindle.

The inspection door for blower section will be provided at such a location that the motor and drive package and fan bearing can be assessed for easily maintenance. An additional guard made out of GI wire mesh of required strength will be provided at inner side of



blower section inspection door. A limit switch / door switch with covered electrical terminal will be provided to facilitate the door inter locking with fan operation.

The entire unit will be mounted on a common skid fabricated out of Hot Deep Galvanized MS channel of required size. The skid will be secured with AHU frame structure through threaded fasteners. The skid will be duly painted with the best quality rust preventive primer followed by tow coats of enamel paint.

All nut bolts, sheet metal screws, fasteners will be Zinc / Nickel-plated having resistance against rusting.

### **Fan**

Fan wheels and scrolls shall be fabricated from best quality GI sheets. The fan wheels shall be of the forward curved type enclosed in housing and mounted on a solid shaft. The fan shaft will be coated with suitable rust preventives after the final assembly. Backward curved impellers (wherever required) will be in galvanized iron or epoxy painted construction. Fan scrolls shall be fitted with die formed streamlined inlet to ensure smooth airflow into the fan.

### **Filters**

Flanged type filters shall be HDPE washable types with required thickness and filtration level as per requirement.

### **Fan motors**

Fan motors shall be 3 phases, sq. cage, and T.E.F.C. induction type of efficiency 1, together with starters. The motors shall be capable of high initial starting torque requirement of fans.

### **PROPELLER TYPE EXHAUST FANS**

Wall Mounted Axial free flow type exhaust air fan with Gravity louvers - As per IS 2312 – 1967 with electrostatic powder coating for effective chemical and corrosion resistance. The fan shall be design to deliver maximum volume of air with minimum sound level for minimum power consumption dynamically balanced blades for smooth & vibration free running. The totally enclosed continually rated type motor specially designed meet the fan duty suitable for use on 220 / 240 Volts ( Single phase) 380 / 440 Volts ( Three phase ) 50 Hz AC supply. All motors are fitted with pre lubricated ball Barings & can be operated continuously complies with class B insulation.

#### **1.4.2. A. DUCT INLINE FANS**

Fan shall be of SISW / DIDW, forward or backward curved centrifugal, direct driven type. Casing shall be of Galvanized steel with Oven-baked pure polyester powder coating. Impeller material shall be either Galvanized Steel or Glass Reinforced Polypropylene. Motor

shall be external power supply 220~240V/50Hz/Single Phase. Fan should be of G.S.S., the Steel sheet should be JFE Galvazinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m<sup>2</sup>) zinc coating & Zero Spangle, skinpassed, chromated and dry.

## **1.5 CABLES**

The MV cables shall be cross linked polyethylene (XLPE) insulated PVC inner sheathed and HR PVC outer sheath of 1100 volts grade as asked for in the schedule of quantities. Cables up to 16 sq.mm shall be with aluminum conductor and suitable for laying in trenches, ducts, and on cable trays as required. M.V. Cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

### **1.5.1 CABLE LAYING**

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks.

### **1.5.2 Laying of Cables on Cable Trays**

The relative position of the cables, laid on the cable tray shall be preserved and the cables shall not cross each other. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturer's. All cables shall be laid with minimum one diameter gap and shall be clamped at every metre to the cable tray. Cables shall be tagged for identification with aluminum tag and clamped properly at every 20M. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

All cables passing through holes in floor or walls shall be sealed with fire retardant Sealant and shall be painted with fire retardant paint upto one meter on all joints, terminations and both sides of the wall crossings by "VIPER CABLE RETARD".