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TENDER DOCUMENT- HVAC WORKS

R0 - DATED : MAY , 03 , 2024

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TECHNICAL SPECIFICATIONS: VENTILATION & EXHAUST FANS

1.0 Scope

Scope of this section comprises the supply, erection commissioning and testing of the ventilation and exhaust fans of the capacities set forth in the schedule of equipment.

2.0 Axial Fans:

Fan shall be complete with motor, motor mount, direct driven (or belt driven) and vibration isolation type suspension arrangement as per approved for construction shop drawings.

Casing shall be constructed of heavy gage sheet steel.

Fan casing, motor mount and straightening vane shall be of welded steel construction.

Motor mounting plate shall be minimum 15 mm thick and machined to receive motor flange.

Casing shall have flanged connection on both end for ducted applications.

The Axial Fan Blades shall be of Cast Aluminum of aero foil design for high efficiency and high static pressure.

The blades shall be joined together on cast aluminum hub.

Hub and blades shall be cast aluminum alloy or cast steel construction.

Blades shall be die-formed aero foil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length.

Rotor shall be statically and dynamically balanced.

The fan pitch control may be manually readjusted at site upon installation, for obtaining actual air flow values, as specified and quoted.

Taper lock bushing shall be used to mount the propeller to the motor shaft. The impeller and fan casing shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence.

Casing shall be bowdlerized, primed (minimum 2 coats of rust-proof primer) and finish coated with enamel paint or powder coated after phosphating process.

The mounting ring shall be of CRCA/Sheet Steel with steel brackets to connect the frame with the Fan/Motor assembly. Rubber mounts shall be provided between the mounting frame and the mounting brackets.

The fan assembly shall be statically and dynamically balanced.

The fan motor shall be totally enclosed squirrel cage type. All Fan Motors shall be EFF-1 rating as per Leeds Green Building Requirement

The motor shall be energy efficient squirrel-cage, totally enclosed, fan cooled, standard frame, constant speed, continuous duty, single winding, suitable for $415 \pm 10\%$.

Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

The axial flow fans should be provided with wire guard and back draft dampers as part of unit price (factory fabricated).

The motor shall be selected for HP in 10% excess of BHP of Fan.

Vibration Isolation: The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of heavy-duty spring isolators.

3.0 Propeller Type Wall Exhaust Fans

Propeller type of fans shall be of good quality. Fan shall be of the broad type, ring or diaphragm mounted and the capacity shown in the schedule of equipment. Fans shall be provided with gravity type louvers unless otherwise stated.

Fan drive shall be single phase, or three phase motors as indicated in the schedule of equipment and shall be complete with starter.

The following accessories shall be provided with propeller fans:

- i. Wire guard on inlet side and bird-screen at the outlet.
- ii. Fixed or gravity louvers built into a steel frame at the outlet.
- iii. Regulator for controlling fan speed for single phase fan motor.
- iv. Single phase preventers for 3 phase fans.

4.0 Centrifugal Fans:

The imported backward curved centrifugal blowers shall be double / single inlet, double/single width, non-overloading type of suitable construction. The blower performance must be rated in accordance with approved test codes and procedures. The centrifugal fans should conform to and shall be AMCA certified.

The blower housing comprising of scroll/housing shall be fabricated out of 18 Gauge (min) G.I. sheet, sectional construction with the housing fixed to the side plates in "Pittsburg Lock" form system. Outlets shall be flanged to assure proper duct connections. Inlet cones shall be spun venture type, to ensure smooth air entry. The frame shall be of angle iron in welded construction with polyester powder coating.

Impeller shall be fabricated from sheet steel with backward curved, properly designed, blades with heavy C.I. Hub and shall be both dynamically and statically balanced to a close tolerance for quiet and vibration free performance.

Shaft shall be of C45 carbon steel, sized adequately and shall be accurately ground and polished to a close tolerance. It shall be coated with anti-corrosion varnish after assembly.

Bearing shall be self-aligning, heavy duty deep grooved ball or spherical roller type with integral dust and grease seals. They shall be mounted on cast iron supports with grease points.

Fans shall be provided with suction inlet vane damper as wherever specified.

Movable inlet vanes shall be complete with necessary linkages for actuation by automatic controls if required.

The impeller shall be provided with polyester powder coating finish.

The fan shall be selected for a speed not exceeding 1800 RPM. The fan outlet velocity shall not exceed 2000 FPM.

The imported forward curved fans shall be double inlet double width type.

The wheel & housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid C40 carbon steel shaft supported to housing with angle iron frame & pillow block heavy duty ball.

The fan shall be selected for a speed not exceeding 1400 RPM. The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 1800 FPM.

Fans shall be driven by are electric motor as specified in the schedule of equipment Motor ratings are only tentative and where a fan requires high-capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor rating shall be at least 10% over limit load plus transmission losses.

Drive assembly for each blower shall consist of blower pulley, motor pulley, a set of 'V' belts, belt guards and belt tension adjusting device.

Pulley shall be selected to provide the required speed. They shall be multi-groove type with section and grooves selected to transmit 33% more load than the required power and shall be statically balanced.

The belt guards shall be fabricated of M.S. Sheet (Powder coated at factory) with angle iron reinforcements and expanded metal screen to avoid finger insertion.

The motor for each blower shall be squirrel cage induction type and conform to specifications as given under section on control panel, motor and switchgear. The motor H.P. shall be at least 20% more than the

limit load of fan and of minimum rating as given under 'Schedule of Equipment'. The motors shall be as per IS-325-1996 (Revised to date) with F-Class of Insulation

5.0 Vibration Isolation:

The Fan assembly shall be installed on floor vibration isolation system of heavy-duty spring isolators



TECHNICAL SPECIFICATIONS: SCRUBBER (DRY TYPE/WET TYPE)

1. General

The kitchen scrubber shall be complete in all respects and shall generally comply with the following specifications given below:

2. Air Scrubber (Wet Type)

The scrubber shall be of 16G G.I. Sheet metal fan section, mixing box and SS-304 made spray section, filter section and eliminators.

2.1 Enclosure/Housing

The enclosure shall be double skin design with the main framework made of extruded aluminum structural section.

The panels shall be of double skin sandwich type with 0.60 mm pre-coated galvanized sheet on the outer and 0.60 mm galvanized sheet on the Inside.

The front panels shall be easily open able for servicing the fan and motor. The insulation shall be CFC – FREE P.U. insulation of 42 (+/- 5%) kg/Cu M

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

The sandwich panels shall be fixed to the frame work with self-tapping stainless-steel screws and both ends of the screw shall be provided with rubber caps.

The access door to fan section is to be provided with a switch to shut the fan when the door is open.

2.2 Fan Section

2.2.1 Blower (DIDW Type)

The fan shall be Imported forward curved, double inlet double width type.

The wheel & housing shall be fabricated from heavy gauge galvanized steel.

The fan impeller shall be mounted on a solid carbon steel shaft supported to housing with angle iron frame & pillow block heavy duty ball.

The fan shall be selected for a speed as follows:

Maximum fan outlet velocity for fan up to \varnothing 450 mm shall not exceed 1800 FPM.

Maximum fan outlet velocity for fan above \varnothing 450 mm shall not exceed 2400 FPM.

Maximum fan speed for fan up to \varnothing 450 mm shall not exceed 1450 RPM.

Maximum fan speed for fan above \varnothing 450 mm shall not exceed 1000 RPM.

Fan housing with motor shall be mounted on a common aluminum base mounted inside the air handling housing on antivibration springs mounts or cushy foot mount.

The fan outlet shall be connected to casing with the help of fire-retardant flexible canvas (as part of machine price only, not payable as separate item).

The Fan shall be complete with multi 'V' belt drive and adjustable motor mounting base.

Inspection door shall be installed with microswitch arrangement with lighting within the fan section.

Microswitch shall be interlocked with blower & light with resetting arrangement.

Unless specified, Fan shall be backward curved if total SP \geq 50 mm and forward curved if total SP $<$ 50 mm.

2.2.2 Plug Fans

Fans shall be backward curved plug fan with aero foil design blades to give maximum efficiency for given duty condition.

The entire fan with casing will be certified by a reputed, internationally acclaimed certifying body which will be a 3rd party like Euro vent or ARI or AMCA and the entire Fan + Motor assembly will be balanced at supplier's works before dispatch.

Fans driven by variable frequency drive shall be backward inclined irrespective of static pressure value.

Fans shall be selected for minimum efficiency of 70%.

Fan array with multiple fans shall be used for capacities more than 15000 CMH.

Plug fan in fan array shall have individual VFDs for every motor fan set.

Fan motor assembly shall be statically and dynamically balanced as per relevant ISO/AMCA/EUROVENT standard.

Certified computerized selection for Fan Section shall be with fan selection.

Motors shall be mounted inside the Fan Section casing on slide rails for alignment and be totally enclosed, fan cooled with class 'F' insulation.

Both fan and motor assemblies shall be mounted on powder coated MS/galvanized steel (depending on size) base frame.

Heavy duty anti-vibration mounts shall be provided for isolating the unit casing. Flame retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan discharge.

2.2.3 Spray Section

Spray section and tank shall be fabricated from 18 G 304 A stainless steel sheets with bolted construction having suitable stiffeners.

The section shall be complete with SS 304 water distribution header having ports and sized for uniform and adequate water flow through perforated SS 304 pipes. The spray nozzles shall be of brass construction.

The tank shall be fitted 3/4" (20 MM) float valve of commercial grade brass.

The spray section shall have provision for fixing one or two sets of air filters as specified later.

2.2.4 Water Sump

The water sump below the spray section shall be of 3mm MS plate with welded joints. The tank shall be complete with makeup, overflow and drain connections. A float valve shall be provided for makeup water line. The tank shall be given 2 coats of corrosion resistance paint and final coat of black enamel paint.

2.6 Drift Eliminators

Drift eliminators shall be of PVC 4 Bend type, supported at the top and bottom fixed to the spray section by means of GI notched bars. Eliminators shall be a set of vertical plates with a series of bends and deflections to give large surface area on which water drops and dust shall be impinged. Eliminators shall be properly stiffened at the sides.

2.7 Distribution Plate

Distribution plate shall be GI 18G with sufficient number of circular openings uniformly spaced for even distribution of air for spray type air washer.

2.8 Pumps

The water distribution pumps shall be of heavy duty, vertical type mounted inside the tank. It shall be complete with adjustable bleed of arrangement to prevent concentration of undesirable salts.

2.9 Grease Filter & Carbon filter (as specified in the BOQ)

The standard pre-filters shall be with 5 layers of SS-304 wire mesh, fixed in a 22 G GI frame with handles for ease of removal.

The above set of filters shall be fixed in filter frames made of 22 G.I. sheets, shaped to prevent air leakage. The filters shall be easily removable. The filter section may form part of the spray section or may be bolted separately to the spray section.

Carbon filter shall be installed to eliminate the particles in the smoke.

2.10 Motors and Starters

The motor for each blower, shall be totally enclosed, fan cooled, squirrel cage induction type and conform to IE-2 Ratings.

The starters shall be "direct on line" type up to 7.5 H.P. All larger starters shall be of fully automatic star delta type.

The pumps shall be provided with single phase, self-tripping starter of suitable make.

2.11 Miscellaneous

Necessary accessories shall be provided wherever necessary for proper operation and shall also include z/ w type PVC eliminator fixed to the spray section to avoid water spillage.

Necessary piping for water circulation.

Vibration isolators for the blowers and pumps.

Canvas connections at the outlet of each fan.

Nuts, bolts, shims etc., as required for the grouting of the equipment.

Float valve in the spray tank, along with quick fill connection.

Gate valves in drain, make up, quick fill line etc., as required.

Built in isolator switches for the fan and pump motor and wiring from the isolators up to the respective motors.

2.12 Limitation

The air velocity limits are as follows :-

Velocity across scrubber not exceeding 2.54 M/s (500 FPM).

Velocity at blower outlet-not exceeding 10.16 M/s (2000) FPM.

3. Scrubber (Dry Type)

3.1 Electrostatic Section:

Electrostatic precipitation technology based dry type air cleaner to remove Oil, Smoke & fumes from the Kitchen exhaust air.

The unit shall provide minimum efficiency of 90% or better for single pass based on ASHRAE test method.

Multiple units can be joined together for the specified air capacities.

The system shall be suitable to connect to fan section with average velocity of not more than 3.2 m/s, considering the cross-sectional area of the ESP CELLS in the unit.

3.2 Construction:

3.2.1 Housing

Housing shall be minimum 1.2 mm thick zinc coated steel construction to protect against rust and corrosion.

Each section shall include single door access, located one side of the unit.

The access door shall be mounted on steel hinges and secured with adjustable, gasket sealed lever latches allowing for component access and removal.

All doors shall be gasketed to prevent air and water leakage.

Doors to charged high voltage components shall be equipped with electrical interlocks, for interconnection into the primary power supply, to prevent access when the components are energized.

The housing shall be furnished completely assembled for ease of shipment and installation. Between each section, a permanent 1/8" thick gasket shall be installed to prevent leakage.

The bottom drain pan under ESP section containing integral washing systems shall be pitched downward 1/4" per foot minimum toward a 3"NPT drain nipple.

3.2 Base Construction

The sections are to be mounted on a structural C-channel or floor mounting or ceiling suspension. Lifting lugs shall be incorporated in the base channel to allow for rigging, if ordered.

3.3 Finish

Made of 16-gauge galvanized sheet, High bake epoxy powder coated.

3.4 Cells Wash Module

The Cells Wash module, whenever specified in SOQ shall incorporate mechanical filtration.

The stationary filter from the direction of airflow will be a metal mesh filters with single, gasketed access doors. Wash manifolds and headers are supplied to wash the module during the normal wash cycle.

3.5 Electrostatic Precipitator Module

The electronic air cleaner shall be the two-stage dual voltage plate type cells, rated at not less than 90% efficiency as per the ASHRAE test standards for dry particulate.

The collection cells shall be in Single Pass arrangement to provide for maximum collection efficiency.

3.6 Ionizing Collection Cell

Ionizing-Collecting cell(s) shall be of one-piece construction minimum 13.38" inches deep in direction of airflow.

All support framing, end plates and ionizer ground electrodes shall be 0.090-inch-thick aluminum.

Both repelling and collector plates shall be 0.020-inch-thick aluminum, minimum 230 mm deep in direction of airflow and rigidly retained in place with tubular spacers and tie rods.

Spacing between plates shall be no less than 6 mm. Ionizing electrodes shall be heavy duty tungsten wire or 24-gauge stainless steel spiked design, rigidly supported both vertically and laterally.

High voltage support insulators shall be of made of Teflon or self-glazing Cordierite ceramic with all surfaces, including center hole, glazed to enhance dielectric strength and retard tracking.

Minimum collection area per 1000 CMH of air flow thru ESP Cell shall be 2.0 sqm.

Pre Filter: Washable type aluminum mesh pre-filter

Post Filter: Washable type aluminum mesh.

Ionizer: Stainless steel spiked ionizers to create high voltage DC field.

Collector Plate: aluminum collector plates which should be alternatively charged positive & negative with large collecting area with 14" deep cell, to work as magnet for charged smoke & oil particles

Average efficiency of 90-95% in single pass as per ASHRAE test method.

Electrostatic Precipitator should be able to charge particles from 0.01 micron to 10 micron through solid state power supply

Collector cell should be of permanent type and slide out facility for easy removal for cleaning.

3.7 Power Supply:

Power supplies shall be 100% solid state UL Listed and operate on 230 VAC, 50 Hz, 1 Phase input and provide a dual high voltage output of (+) 12 to 13 KVDC for the ionizer and (+) 6.0 to 6.5 KVDC for the collector. Module of capacity above 3000 CFM shall be equipped with Pulse width modulating (PWM) to maintain the specified collection efficiency by maintaining a constant charge in the event of Low/High Voltage from source thus ensuring that the unit functionality is not affected with these voltage fluctuations. Power Consumption should not be more than 50 watts per cell.

System should be fitted with interlock switch for safety.

The system should be able connected to a fan section to achieve airflow of 500 FPM across the aircleaner and should be interlocked with the fan to prevent dry run of the units.

3.8 ARC Suppression Auto Start

The power pack shall incorporate a short circuit arc protection with automatic power restoration system to prevent overload.

Should arcing takes place (due to collection cells being loaded with contaminants or should there be a fault in the unit), the power pack shall be able to automatically cut off the supply to stop the arcing and reset after a few seconds.

This is to prevent and drastically reduce the risk of fire from continuous arcing.

3.9 Static Pressure Drops

The pressure drop shall not exceed the following (inches H₂O):

ESP Section 5-8MM

Metal Mesh prefilter or after filter 0.10

The ESP section must have both an internal prefilter and an after filter, select and add for each.

External losses for ductwork, exhaust hoods, manufacturing equipment with associated entry losses, kitchen hoods, etc. Must be added with the above internal equipment losses to calculate total fan static pressure required.

3.10 BMS Interface

The power supply (pack) shall have a 2 wire dry contacts (NO/NC) for remote link to Building Management System.

This is for performance indication of the air cleaning system. Should there be a fault or if service is required, the dry contacts close, and a signal is sent to the building BMS System.

Should there be multiple units, all the dry contacts can be looped into a set of signals.

This ensures proper monitoring of the status of each unit. There shall be 2 LED lights (Green & Red) installed on the access door of the unit to indicate the status of the air cleaning system.

TECHNICAL SPECIFICATIONS: DUCTING (FACTORY/ SITE FABRICATED)

1.0 Scope

The scope of this section comprises supply fabrication, installation and testing of all sheet metal ducts, supply, installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

The work under this part shall consist of furnishing labor materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.

Except as otherwise specified all duct work and related items shall be in accordance with these specifications. Ductwork shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

2.0 Duct Materials

The ducts shall be fabricated from galvanized steel sheets class VIII/ Galvanizing shall be of 120gms/sq.m. (total coating on both sides) conforming to ISS:277-1962 (revised) or aluminum sheets conforming to ISS:737-1955 (wherever aluminum ducts are specified).

All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with amendment-I (1971 edition)

3.0 Governing Standards

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

4.0 Raw Material

4.1 Ducting

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/m². (total coating on both sides).

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

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

5.0 Duct Connectors and Accessories

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

6.0 Fabrication Standards

All ductworks including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory fabricated except to suit pieces which shall be fabricated at site as per the requirement. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply.

Lines ensure location of longitudinal seams at comes/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.

All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.

All edges to be machine treated using lock formers, flanges and roller for fuming up edges.

Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints is specified.

7.0 Selection of G.I. Gauge and Transverse Connectors

Duct Construction shall be in compliance with 1" (250 Pa) w.g. static norms as per SMACNA.

All transverse connectors shall be the 4-bolt slip-on flange system or similar 4-bolt systems with built-in sealant if any to avoid any leakage additional sealant to be used.

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

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

8.0 Duct Construction

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

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

Each and every duct piece should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.

Ducts shall be straight and smooth on the inside Longitudinal seams shall be airtight and at corners only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.

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

Plenums shall be shop/factory fabricated panel type and assembled at site.

Factory Fabricated ducts shall have the thickness of the sheet shall be as follows:

For Ducts with External SP up to 250 Pa , Duct Section Length 1.2 m (4 ft)

S.No.	Size of Duct	Sheet Thickness/ Gauge	Fastener Size	Type of Joints	Bracing with GI tie rods of following sizes	Support Angle
i)	Upto 500 mm	0.5 mm / 26 Gauge	3/8"	C & S Connector	Nil	25x25x3 mm with GI threaded rods of 10 mm dia
ii)	501-750 mm	0.5 mm / 26 Gauge	3/8"	C & S Connector	Nil	
iii)	751 mm to 900 mm	0.63 mm/ 24 Gauge	3/8"	TDF Flange	Nil	
iv)	901 mm to 1200 mm	0.63 mm/ 24 Gauge	5/8"	TDF Flange	Nil	40x40x5 mm with GI threaded rods of 10 mm dia
v)	1201 mm to 1500 mm	0.80 mm/ 22 Gauge	5/8"	TDF Flange	JTR or ZEE Bar	40x40x6 mm with GI threaded rods of 12 mm dia
vi)	1501 to 1800 mm	0.80 mm/ 22 Gauge	5/8"	TDF Flange	JTR or ZEE Bar	50x50x6 mm with GI threaded rods of 12 mm dia.
vii)	1801 to 2100 mm	1.0 mm/ 20 Gauge	5/8"	TDF Flange	JTR or ZEE Bar	
vi)	> 2100 mm	1.25 mm/ 18 Gauge	5/8"	TDF Flange	JTR or ZEE Bar	

Site Fabricated ducts shall have the thickness of the sheet shall be as follows :

For Ducts with External SP up to 250 Pa , Duct Section Length 1.2 m (4 ft)

S.No.	Size of Duct	Sheet Thickness/ Gauge	Fastener Size	Type of Joints	Bracing with GI tie rods of following sizes	Support Angle
i)	Up to 750 mm	0.63 mm/ 24 Gauge	3/8"	C & S Connector	Nil	25x25x3 mm with GI threaded rods of 10 mm dia.
ii)	751-1500 mm	0.80 mm/ 22 Gauge	3/8"	TDF Flange	Nil	40x40x6 mm with GI threaded rods of 12 mm dia.
iii)	1500- 2250 mm	1.0 mm/ 20 Gauge	3/8"	TDF Flange	Nil	50x50x6 mm with GI threaded rods of 12 mm dia.
iv)	> 2250 mm	1.25 mm/ 18 Gauge	5/8"	TDF Flange	Nil	50x50x6 mm with GI threaded rods of 12 mm dia.

Note: FOR ALUMINUM DUCTS MATERIAL SHALL BE ONE COMMERCIAL GAUGE HIGHER WITH 22 G AS MINIMUM

The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.

Ducts larger than 600 MM shall be cross broken, duct sections up to 1200 MM length may be used with bracing angles omitted.

Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-Charge.

All ducts shall be supported from the ceiling/slab by means of M.S. Rods of 10 MM (3/8") DIA with M.S. Angle at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners of approved make.

9.0 Installations

During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.

Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

The ducts shall be re-in forced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.

The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.

Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.

Flanges bracings and supports are to be as per manufacturer standards. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish like the adjacent ducting, as specified.

Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.

Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed center top rivets or spot welding. Self-tapping screws must not be used. All jointing material must have a finish such as cadmium plating or galvanized as appropriate.

Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.

The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

Duct passing through brick or masonry, wooden framework shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

10.0 Wire Hangers

Wire Hangers shall be used to suspend all static HVAC Air Distribution services.

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design.

The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking grip (double channel lock) at the other end.

Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip.

Only wire and/or supports supplied and/or approved, shall be used with the system.

Wire Hangers should have been independently tested by Lloyds Register, APAVE, TUV, UL NEBS, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002

The contractor shall select the correct specification of wire hanger to use for supporting each service from Table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire hanger required is determined using the following formula.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.

The contractor shall select the correct length of wire rope required to support the service.

Lengths from 1-10m lengths. Specials can be made, check with manufacturer.

No in-line joints should be made in the rope.

Table. 1

Wire Hanger Safe Working Loads		
Hanger size	Minimum breaking load of Wire Rope (Kg / lbs.)	working load limit (kg/lbs.)
No. 1	80kg/176 lbs.	0-10 kg / 0-22 lbs.
No. 2	260kg/572 lbs.	10-45 kg / 23-100 lbs.
No. 3	580kg/1276 lbs.	45-90 kg / 101-200 lbs.
No. 4	1500kg/3300 lbs.	90-225 kg / 210-495 lbs.
No. 5	2160kg/4752 lbs.	225-325 kg / 496-715 lbs.
No. 6	2500kg/5500 lbs.	325-500 kg / 715-1100 lbs.

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless-steel wire rope as per the application, the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385.

Comply with manufacturer's load ratings and recommended installation procedures.



TECHNICAL SPECIFICATIONS: AIR DISTRIBUTION PRODUCTS

1.0 Dampers

1.1 Splitter Dampers

At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided. Dampers shall be two gauges heavier than the gauge of the large duct and shall be rigid in construction.

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

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

1.2 Opposed Blade Dampers (Duct)

Automatic and manual volume opposed blade dampers shall be complete with frames and nylon bush as per drawings. Dampers and frames shall be constructed of 1.6 MM steel sheets and blades shall be of extruded aluminum of aero foil design. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 MM thickness with fine mesh.

Wherever required for system balancing, a balancing opposed blade damper with quadrant and thumb screw lock shall be provided.

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

1.3 Fire and Smoke Damper (Motorized)

All supply and return air ducts at AHU room crossings and at all floor crossings or as indicated in the drawings shall be provided with Motor operated Fire & smoke damper of at least 90 minutes rating.

These shall be of multi-leaf type and provided with Spring Return electrical actuator having its own thermal trip for ambient air temperature outside the duct and air temperature inside the duct.

Actuator shall have Form fit type of mounting, metal enclosure and guaranteed long life span. The dampers shall meet the requirements of NFPA90A, 92A and 92B.

Dampers shall have a fire rating of 1.5 Hrs. in accordance with latest edition of UL555 and shall be classified as Leakage Class 2 smoke damper in accordance with latest version of UL555S.

Each fire/smoke damper shall be AMCA licensed and bear the AMCA seal for air Performance.

Pressure drop shall not exceed 7.5Pa when tested at 300m/min face velocity on 600x600mm size damper. Actuator shall be UL listed.

Each damper shall be supplied with factory mounted sleeve of galvanized steel of thickness as per SMACNA and of minimum 500mm long or as specified in schedule of quantities depending up on the wall thickness.

The damper shall be fitted in to sleeve either using welding or self-tapping screws. All welded joints shall be finished using heat resistance steel paint.

UL listed and approved Silicon sealant shall be applied at all corners as well as at joints between damper frame and sleeve.

Damper Frame shall be a roll formed structural hat channel , reinforced at corners, formed from a single piece of 1.6mm galvanized steel .

Damper blades shall be airfoil shaped (equivalent to 2.3mm thickness strength) roll formed using 0.8mm thick single piece of galvanized sheet.

Bearings shall be of stainless steel fitted in an extruded hole in the damper frame. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked in to the blade edge (adhesive type seals are not acceptable).

Side Jam seals of stainless steel and Top and bottom seals of galvanized steel shall be provided. All galvanized steel used shall be with minimum 180 gm / sqm Zinc coating.

Bigger size Dampers shall be supplied in Multiple modules of sizes not exceeding in dimensions of certified module, jack shafted together. Multiple actuators shall be provided for large dampers with higher torque requirements as prescribed in UL.

The electric actuator shall be energized either upon receiving a signal from smoke detector installed in AHU room supply air duct / return air duct.

Electric Actuator of suitable Torque and as approved by UL shall be factory mounted and tested. The actuator shall be suitable for 24V AC supply. In addition, actuator shall have elevated temperature rating of 250 deg.F.

Electric Actuator shall have been energized hold open tested for a period of at least one year with no spring return failure.

Each fire/smoke damper shall be equipped with a heat actuated release device which shall allow controlled closure of damper rather than instantaneous to prevent accident. (Electrical /fusible link).

The EFL shall allow the damper to reopen automatically after a test, smoke detection or power failure condition. The damper shall be equipped with a device to indicate OPEN and CLOSE position of Damper blades through a link mounted on the damper blade.

Each damper shall be provided with its own control panel, mounted on the wall and suitable for 240 VAC supply. This control panel shall be suitable for spring return actuator and shall have at least the following features:

Potential free contacts for AHU fan ON/ Off and remote alarm indication.

Accept signal from external smoke / fire detection system for tripping the electrical actuator.

Test and reset facility.

Indicating lights / contacts to indicate the following status:

Power Supply On

Alarm

Damper open and close position.

Actuators shall be mounted on the sleeve by the damper supplier in his shop and shall furnish test certificate for satisfactory operation of each Motor Operated Damper in conjunction with it's control panel.

Control panel shall be wall mounted type. It shall be HVAC Contractor's responsibility to co-ordinate with the Fire Alarm System Contractor for correctly hooking up the Motor Operated Damper to Fire Detection / Fire Management System. All necessary materials for hooking up shall be supplied and installed by HVAC Contractor under close co-ordination with the fire protection system contractor.

HVAC Contractor shall demonstrate the testing of all Dampers and its control panel after necessary hook up with the fire protection / fire management system is carried out by energizing all the smoke detectors with the help of smoke.

HVAC Contractor shall provide Fire retardant cables wherever required for satisfactory operation and control of the Damper.

HVAC Contractor shall strictly follow the instructions of the Damper Supplier or avail his services at site before carrying out testing and installation at site.

Fire/smoke damper shall be provided with factory fitted sleeves; however, access doors shall be provided in the ducts within AHU room in accordance with the manufacturer's recommendations.

The Contractor shall also furnish to the Owner, the necessary additional spare actuators and temperature sensor (a minimum of 5% of the total number installed) at the time of commissioning of the installation.

1.4 Fire Dampers

Whenever a supply/return duct crosses from one fire zone to another, it shall be provided with approved fire damper of at least 1½ hour fire rating as per UL555/1995 tested by CBRI. This shall be curtain type fire damper.

Fire damper blades shall be one piece folded high strength 16 gage galvanized steel construction. In normal position, these blades shall be gathered and stacked at the frame head providing maximum air passage and preventing passing air currents from creating noise or chatter.

The blades shall be held in position through fusible link of temp 74oC (165°F).

The HVAC contractor shall supply UL classified Fire Dampers meeting or exceeding the specifications.

Fire Dampers shall be furnished and installed at locations shown in Drawings and as described in Schedule of quantities. Fire Dampers shall have a fire rating of 1.5/3 Hrs.as specified in BOQ, in accordance with latest edition of UL555.

Each Fire damper shall be AMCA licensed and shall bear the AMCA seal for air performance.

Damper shall be equipped with UL labelled Fusible Link with Temperature setting 74oC (165°F) or as specified in Schedule of quantities. Fire dampers shall have been tested to close under dynamic air flow conditions with pressure up to 1000 pa and velocities up to 10.2 m /sec.

Fire damper shall be approved for Horizontal or vertical installation as may be required by the location shown in the drawings. Damper Frame shall be a roll formed structural hat channel, reinforced at corners, formed from a single piece of 1.6mm galvanized steel. Damper blades shall be roll formed 3-v groove (1.6mm thick) or airfoil shaped in case of 3 Hrs.

Fire rating (equivalent to 2.3mm thickness strength) roll formed using 0.8mm thick single piece of galvanized sheet. Bearings shall be of stainless steel fitted in an extruded hole in the damper frame. All galvanized steel used shall be with minimum 180 gm / sqm Zinc coating.

Bigger size Dampers shall be supplied in Multiple modules of sizes not exceeding in dimensions of certified module jack shafted together.

Fire damper shall be equipped with a electric limit switch to indicate open and close position of the damper blades.

Fire Damper shall be installed in wall or floor opening using galvanized steel sleeve of minimum 500mm length of sheet thickness for fire & smoke damper as per SMACNA and as per Installation instruction of Manufacturer.

In case of fire, the intrinsic energy of the folded blades shall be utilized to close the opening. The thrust of the suddenly released tension shall instantly drive the blades down and keep it down without the use of springs, weights or other devices subject to failure.

Fire damper sleeves and access doors shall be provided within the duct in accordance with the manufacturer's recommendation.

The contractor shall also furnish to the Owner, the necessary additional fusible links (spares), minimum of 5% of the total number installed, at the time of commissioning of the installation.

All supply and return air ducts shall be provided with approved make fire and smoke dampers of at least 90 minutes fire rating certified by CBRI Roorkee as per UL 555: 1973.

2.0 Flexible Ducts

The flexible ducts shall be machine made of spiral design with aluminum sheets.

The duct shall be factory insulated.

The connections shall be complete with adjustable clip bands of G.I.

3.0 Access panel

A hinged and gasketed double skin, factory fabricated access panel measuring at least 450 MM x 450 MM shall be provided on duct work before each fire damper and at each control device that may be located inside the duct work.

4.0 Miscellaneous

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

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

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

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

Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-In-Charge.

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

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

All the angle iron flanges to be connected to the GSS ducts by rivets at 100 MM centers.

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

The ducts should be supported by approved type supports at a distance not exceeding 2.0 Meters.

5.0 Standard Grilles

The supply and return air grilles shall be fabricated from extruded aluminum sections. The supply air grilles shall have single/double louvers.

The front horizontal louvers shall be of extruded section, fixed/adjustable type. The rear vertical louvers where required shall be of aluminum extruded sections and adjustable type.

The return air grille shall have single horizontal extruded section fixed louvers. The grilles shall have an outer frame on all four sides.

The grilles shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air grilles shall be extruded aluminum construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (one on top & bottom).

The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8 mm in rear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect.

The grilles shall be suitable for concealed fixing.

Volume control dampers of extruded aluminum anodized in black color shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be & suitable for clip fixing, permitting its removal without disturbing the flanges.

Grilles longer than 450 MM shall have intermediate supports of black color for the horizontal louvers. Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivotable to provide pattern with 0-to-+45-degree horizontal arc and up to 30-degree deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.

6.0 Diffusers

The ceiling type square diffusers shall be of aluminum extruded sections with flush face with fixed pattern and neck. The diffusers shall be provided with blank plate suitable of grid ceiling (T-Bar) of size 600 mm x 600 mm.

All supply diffusers shall be provided with extruded aluminum dampers, with arrangement for adjustment from the bottom. Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as required in specific applications and as per requirements of schedule of quantities.

All extruded aluminum diffusers shall be provided with removable central core and concealed key operation for volume control damper.

Acoustically lined G.I. plenum, perforated diffusion plate and circular spigot shall be provided as per requirement of Schedule of Quantities.

Slot Diffuser shall be extruded aluminum construction multi slot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. It shall be provided with acoustically lined G.I. plenum box with circular spigot.

The acoustic lining shall be done with 12mm thick glass wool of 32 Kg/cu.m. density with rubberized lining on one face. The acoustic lining shall be fixed with self-adhesive stick pins.

7.0 Linear Diffusers/Grilles

The linear diffusers/grilles shall be fabricated from Aluminum extruded sections.

The diffusion blades shall be extruded, flush mounted type with single or double direction air flow.

The frame shall be of aluminum extruded section and shall hold the louvers tightly in fixed position. The frame shall be provided on all four sides.

The dampers as described under grilles shall be provided wherever specified.

8.0 Perforated Diffusers

The perforated diffusers shall be fabricated from aluminum sheet.

The sheet shall have uniform perforations to allow minimum 50% free area.

The supply air diffusers shall be provided with fully adjustable air pattern deflectors.

The frame shall be of extruded aluminum sections with blanking plate bonded to frame for grid ceiling (T-bar) application.

9.0 Exhaust Grilles

The exhaust grilles shall be fabricated from aluminum extruded sections.

The exhaust grilles shall be horizontal fixed bar grilles with 150 blade inclination.

10.0 Exhaust / Fresh Air Louvers

The louvers shall be fabricated from aluminum extruded sections.

The blades shall be extruded flush mounted type with single horizontal throw. The depth of blades shall be 75 mm for Basement Ventilation and 35 mm for AHU fresh air

The frame shall be of aluminum extruded section and shall hold the louvers tightly in fixed position.

11 VARIABLE AIR VOLUME (VAV) BOXES

These shall be of the low velocity variable air volume boxes without re-heat coils and shall be of open protocol as marketed by a firm specializing in this field. The contractor shall supply and install units to the quantity and locations as specified.

The unit shall be complete with damper, airflow ring, and solid-state electronic controls to provide accurate room temperature control. The damper shall be aero foil type construction with bearings.

Boxes shall be supplied with all internal attenuation treatment and acoustical damped casing necessary to achieve the required noise criteria. Casing shall be of 22G GSS minimum fitted with a completely sealed, easily removable means of access to all internal parts. Access to all boxes must be from the underside only.

The actuator shall be of 24V AC Bi-directional, direct coupled to the damper shaft. The required transformer to step down of the voltage range from 230V to 24V shall be part of the unit. The power point with an isolator near the VAV will be provided by other agencies.

The unit shall be complete with transformer, access panel and other accessories as per the standard.

The noise level shall be less than 35dbA.

Maximum allowable static pressure to the boxes for its satisfactory operation shall not exceed 0.10WG, otherwise fan and motor selections may be affected.

Boxes shall be able to reset any air flow between 10% and the maximum air quantity that the boxes can handle without changing orifices or other parts. Air quantity limiters will not be accepted.

A suitable device shall be provided for the field adjustment of minimum airflow. All boxes shall be initially factory set at minimum air quantity of 10% and maximum quantity of 110% of the design requirements.

Under shut-off conditions, all boxes shall not have air leakage more than 2% of the maximum air quantity at 75mm static pressure.

The VAVs shall be used in standalone mode complete with its own temperature sensor and controller and shall perform the function of maintaining the temperature and airflow.

Where ever specified, the VAVs shall be BMS compatible to enable to network the VAVs to a Network Control Unit and onto BMS. In this mode all VAV data shall be available at the BMS workstation and it shall be possible to change set points and flow settings from the BMS workstation. All such controllers used for the control of VAV boxes shall be compliant with BACnet/ MODBUS protocol and be freely communicable to third party BACnet/ MODBUS IP controllers.

All boxes shall be electrically controlled. The boxes shall be pressure independent.

VAV Box shall have provision to support from floor/ wall/ ceiling and in vertical/ horizontal condition.

12.0 Painting and Vision Barrier

All grilles, and diffusers shall be powder coated, before installation, in approved color.

All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matt finish.

The return air and dummy portion of all linear grilles shall be provided with a vision barrier made of 24-gauge galvanized sheets. The vision barrier shall be fixed to the false ceiling frame with self-tapping screws and shall be given two coats of black paint in matt finish. Care shall be taken to ensure that the return air path is not obstructed.

13.0 Documentation to Measurements

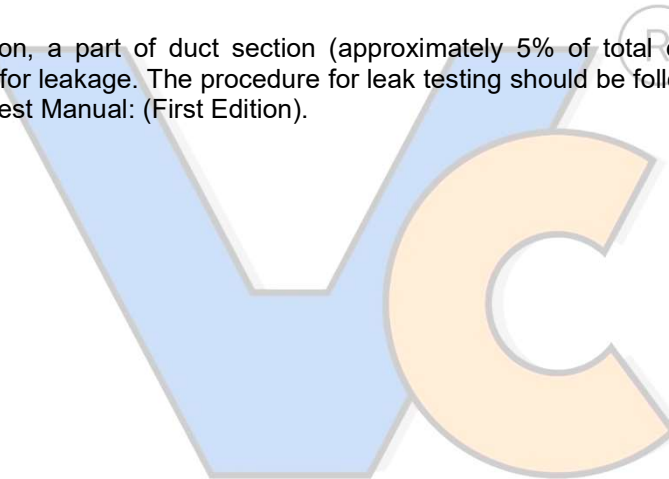
For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of material indicating all relevant duct sizes, dimensions, and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

14.0 Testing

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



TECHNICAL SPECIFICATIONS: INSULATION WORK

1.0 SCOPE

This chapter covers the requirements of thermal insulation for chilled water /hot water piping, pumps and tanks, duct work, and acoustic lining in duct work and weather maker rooms. This does not cover exposed roof insulation and under deck insulation work.

The insulation material shall be Closed Cell Elastomeric Nitrile Rubber / Expanded Polystyrene Cross-Linked Polyethylene Foam / Glass wool or any other as defined in schedule of quantities.

2.0 Thermal Insulation

2.1 Material Specifications

The insulation material shall satisfy the following requirements: -

2.1.1 Thermal insulation of ducts:

S.No	Material	Minimum Density (Kg / cu.m)
1	Resin bonded glass wool	24
2	Nitrile Rubber	40
3	Chemically cross-linked polyethylene Foam (FR XPE)	27-33

2.1.2 Thermal insulation of pipes.

Material	Minimum Density (Kg/cu.m)	Maximum Thermal conductivity (K.cal/ hr. degree C/m at 10 Deg C mean temp.)
Resin bonded glass wool	32	0.031
Expanded polystyrene	20	0.035
Nitrile Rubber	45 - 55	0.034
Chemically cross-linked polyethylene	27-33	0.034

3. Thermal Insulation on Ducts

3.1 Material (closed cell Nitrile rubber):

Thermal insulation material for Duct insulation shall be with factory laminated black fiber glass cloth closed cell Nitrile rubber. Density of the nitrile rubber shall be 40-60 Kg/m³.

Thermal conductivity as per BS 874 part 2 – 86 (DIN 52613, 52612) /DIN EN 12667/ EN ISO8497 of the insulation material shall not exceed 0.038 W/m-K or 0.212 BTU / (Hr-ft²-oF/inch) at an average temperature of 30oC. The product shall have temperature range of –40 °C to 105 °C. The insulation material shall be fire rated for Class 0 as per BS 476 Part 6 : 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapor permeability shall be not less than 0.024 per inch (2.48 x 10⁻¹³ Kg/m.s.Pa i.e., μ>7000: Water vapor diffusion resistance) as per DIN 53122 part 2, DIN 52615 / EN 12086 & EN13469.

In addition to above properties the insulation material for ducts shall be antimicrobial.

Microbiological growth on insulation surface shall be in accordance with ASTM G-21 and bacterial resistance to ASTM2180/ ISO22196. The Material shall comply to ISO 5659 / BS 6853 / ABD 0031 for

smoke density and toxicity values. The thermal conductivity of insulation material shall not be affected by aging as per DIN 52616 standard.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for density and thickness.

Adhesive used for sealing the insulation shall be non-flammable and with low VOC content (maximum 850 gm/l less water) as per IGBC guide lines) strictly as per manufacturer's recommendations. Adhesive shall be externally applied by contractor on site.

Ducting insulation thickness shall be as per table below.

Ducting position	Thickness for non-coastal places
SA duct in RA path	13 mm
Ducted return air system	SA duct: 19 mm RA duct: 13 mm
Both SA & RA exposed	Both 25 mm

3.2 Chemically Cross-Linked closed cell Polyethylene foam (FR XPE)

Material For Duct thermal insulation, chemically cross-linked closed cell Polyethylene foam (FR XPE) insulation material with factory laminated Aluminium Foil, Class O MATERIAL

Insulation material shall be Chemically cross-linked closed cell polyethylene foam (FR XPE).

Density of material shall be 30+_3 kg/m³

Thermal conductivity of Fr XPE foam shall be 0.034 W / (M.K) at an average temperature of 23°C.

Flammability, Smoke Density and non-dripping of material shall be as per DIN 5510 (Pt-2)-54837 Horizontal Flammability test should classify 94 HBF as per UL -94

The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O.'

Insulation material shall have negligible water vapor permeability, water vapor resistance factor (μ) >12000 as per DIN EN ISO :12572

Insulation material shall have good ozone resistance non-fiber erosion and CFC / HCFC free as per US EPA 5021 A(2014)

Insulation material shall have negligible effects of acids and alkalis as per IS 9845 – 1998

Insulation material shall have zero rating for fungal and bacterial growth as per ASTM G-21 and ASTM G-22 Material Specifications: Chemically Cross-linked closed cell polyethylene foam (FR XPE) Insulation,

Insulation Thickness

Application	Insulation Thickness (mm)	Location
Supply / Return Air Duct	19mm / 13mm	Non- conditioned area Outside the building
Supply / Return Air Duct	19mm / 13mm	Non- conditioned area/Inside the building
Supply / Return Air Duct	13mm / 09mm	above false – ceiling of the conditioned area
Supply Air Duct in Return Air Path	9mm	when Return Air is being taken through the false – ceiling

3.3 Resin Bonded Fiber Glass

Insulation material shall be non-toxic, chemically inert, non-combustible, non-ignitable, shall have zero ozone depletion potential, zero calorific value no heat evolution and shall be inherently proof against rotting, mold and fungal growth and attack by vermin.

The materials shall comply with following standards:

BS 476: Part 4 – Non Combustible

BS 476: Part 5 – Not easily Ignitable (Class P)

BS 476: Part 6 – Fire propagation Index ($I < 12$)

BS 476: Part 7 - Surface spread of flame (Class 1)

The material should comply Class'O' fire rating as per (BS 476 part 6&7).

The material should comply non-combustibility (BS 476 Part 4) as per National Building Code-2016 (NBC-2016 mandates that for duct insulation non-combustible material should be used)

The product shall be able to work effectively at ambient temperature range of -195°C to 230°C

Material

Insulation material of Duct shall be factory laminated WMP 30 faced resin bonded fiberglass wool. The Thermal conductivity of the insulation material shall not exceed 0.034 W/m K at 25°C mean temperature. The thickness of insulation shall be so selected as to prevent any condensation and should be able to meet R-Value requirements.

The minimum thermal resistance (R-Values) for insulation of ducts (as per ASHRAE 90.1-2004 and ECBC 2007) shall be as described below:

Supply Air Ducts $R = 1.4 \text{ m}^2 \text{ deg. /W}$ (Thickness requirement for glass wool 50MM)

Return Air Ducts $R = 0.6 \text{ m}^2 \text{ deg. /W}$ (Thickness requirement for glass wool 25MM)

The nominal density of Resin Bonded Fiberglass insulation shall be 32 kg/m^3

The minimum thickness of material used for duct thermal insulation shall be 25mm.

4.0 Kitchen Duct Insulation

All kitchen exhaust ducts connected to kitchen hoods shall be insulated with 50 mm / 75 mm thick 60 kg/m^3 density factory-laminated glass wool. PVC strap of 25 mm width shall be fixed at 300 mm interval to secure the insulation in position. Kitchen duct exposed to outside shall be further treated as under: -

Wrapping of "scrim glass fabric" and thereafter applying first coat of resin system formulated with activators and inert fillers. This coat is allowed to cure to a non-stick state.

Second coat of activated resin with suitable pigment is applied over the first coat and finished to give a though smooth surface.

Duct Insulation VOC limit shall not exceed to 850 (g/L less water).

Where ducts/pipes penetrate walls / floor it shall be insulated with intumescent properties insulation material for fire protection. The treatment shall be minimum 500 mm extended on both sides.

5.0 Chilled Water Pipe Insulation / Refrigerant and Drain Pipe Insulation

5.1 Polyurethane Foam/ Expanded Polystyrene (In Plant Room and Basement Exposed Pipes)

Expanded polystyrene (T.F.Quality) shall be used for pipe insulation like inside the A.C. plant room, exposed to outside or buried in ground.

In the case of expanded polystyrene (TF quality), Resin bonded glass wool the pipe insulation should be in rigid sections in two halves and preformed to fit snugly on to pipes (up to pipe sizes for which the preformed sections are manufactured by the manufacturer of insulation).

For higher pipe sizes insulation slabs shall be used. Resin bonded glass wool is to be used for piping inside the building due to its fire retardant properties, for considerations of fire safety.

The PUF insulation for chilled water piping, pump, expansion tank etc. shall be carried out from rigid polyurethane foam having a 'K' value of 0.018 W/mK .at mean temperature of 10°C and a density of

32kgs/m³. The material shall be factory faced on one side with aluminum foil on the outside, reinforced with kraft paper and fused to the insulation material. The aluminum foil shall be extended by a minimum of 50 mm on one side of the pipe section along the length to seal all longitudinal joints.

The aluminum foil facing shall be replaced with Kraft Paper facing wherever the pipe is to be covered with Tar felt. This will be applicable for underground piping also.

Prefomed pipe sections shall be used for pipes up to and including 350 mm dia.

Pipes above 350 mm dia. shall be insulated with insulation slabs cut in metered sections.

Pipe Size (mm)	Insulation Thickness (mm)	
	PUF	Exp. Polystyrene
150 & below	30	50
Above 150	50	75

However, all shall need to be covered with vapor barrier and cladding with aluminum sheet.

5.2 Closed Cell Elastomeric Insulation (In Shafts/ Above False Ceiling- Indoor Application)

Thermal insulation material for Pipe insulation shall be Elastomeric Nitrile Rubber with factory laminated Glass Cloth / Non-Metallic cladding system made up of double layer laminate of Aluminum, coated with special UV protection and PVC backing.

Thermal conductivity as per DIN EN 12667 of the insulation material shall not exceed 0.038 W/m²K or 0.212 BTU / (Hr-ft²-oF/inch) at an average temperature of 30°C.

Density of the nitrile rubber shall be 40-55 Kg/m³, the product shall have temperature range of -40 oC to 105oC. The insulation material shall be fire rated for Class 0 as per BS 476 Part 6 : 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapor diffusion resistance of the system i.e., μ value shall be greater than or equal to 60000 as per EN 12086

Wherever double layered insulation is used, first layer shall be plain nitrile rubber and final layer shall be factory laminated cladding system.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for density and thickness. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used for sealing shall be strictly as per manufacturer's recommendations.

Piping Insulation thickness shall be as follows.

Pipe nominal bore	Thk. for non-coastal places	Thk. for coastal places
15 mm – 25 mm	19 mm	25 mm
32 mm – 80 mm	25 mm	32 mm
100 mm – 400 mm	32 mm	38 mm
Above 400 mm	45 mm	45 mm

For the pipe sizes up to 100NB, insulation material in sleeve forms shall be used. These sleeves shall have self-adhesive type longitudinal pre-cut, throughout the length of the tube. The top cladding layer shall have self-adhesive overlapping flap. Butt joints shall be properly sealed with manufacturers adhesive and finally concealed with 50mm wide tape of same material (i.e Nitrile rubber / XLPE) as per manufacturer recommendation

5.3 Refrigerant Pipe Insulation (Closed Cell Elastomeric Insulation)

Base insulation material for Refrigerant pipe shall be same as that of CHW pipe.

The factory lamination on the base material shall be of chemically treated glass cloth of 7 mil thickness tested for UV resistance as per EN ISO 4892-2 Method-A.

Thickness of refrigerant piping insulation shall be 13mm and 19mm if not specified separately

5.4 Drain Pipe Insulation(Closed Cell Elastomeric Insulation)

Base insulation material for drain pipe shall be same as that of CHW pipe. The factory lamination on the base material shall be of chemically treated glass cloth of 7 mil thickness tested for UV resistance as per EN ISO 4892-2 Method-A.

Thickness of drain piping insulation shall be 13mm if not specified separately.

5.5 Chemically Cross-Linked Closed Cell Polyethylene foam (FR XPE)

Material technical specifications:

For Pipe thermal insulation, chemically cross-linked closed cell Polyethylene foam (FR XPE) insulation material with factory laminated Aluminium Foil, Class O Insulation material shall be Chemically cross-linked closed cell polyethylene foam (FR XPE).

Density of material shall be 30+/-3 kg/m³

Thermal conductivity of Fr XPE foam shall be 0.034 W / (M.K) at an average temperature of 23°C.

Flammability, Smoke Density, and non-dripping of material shall be as per DIN 5510 (Pt-2)-54837

Horizontal Flammability test should classify 94 HBF as per UL -94

The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 and pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O.'

Insulation material shall have negligible water vapor permeability, water vapor resistance factor (μ) >12000 as per DIN EN ISO :12572

Insulation material shall have good ozone resistance non-fiber erosion and CFC / HCFC free as per US EPA 5021 A(2014)

Insulation material shall have negligible effects of acids and alkalis as per IS 9845 – 1998

Insulation material shall have zero rating for fungal and bacterial growth as per ASTM G-21 and ASTM G-22

For Pipe Dia. Up to 15NB to 300 NB : The insulation shall be in tubular form with factory laminated with Aluminium Foil on outer skin of insulation material.

For pipe dia. above 300 NB to 600 NB : The insulation material shall be in roll form For thickness above 19mm it shall be applied in two layers. First layer shall be plain material and second layer shall be with factory laminated Aluminium Foil

Pipe Insulation Thickness

S.No	Dia of Chilled water pipe	FR XPE Insulation Thickness
1	15NB to 80NB Dia	25mm Thickness
2	Above 80 NB to 300 NB Dia	32mm Thickness
3	Above 300Nb Dia	40mm Thickness

5.6 Drain pipe insulation.

Chemically cross-linked closed cell polyethylene foam insulation material (FR XPE) - 9mm thick sleeve with factory laminated Aluminium foil lamination

6.0 Duct Acoustic Lining

6.1 Open Cell Nitrile Rubber

Duct acoustic lining material shall be Nitrile Rubber open cell foam. Thermal conductivity of the insulation material shall not exceed 0.047 W/m-K at an average temperature of 20°C. Density of the nitrile rubber shall be 140 – 180 Kg/m³.

The material should withstand maximum surface temperature of +85°C and minimum surface temperature of -20°C. The material should conform to Class 1 rating for surface spread of Flame in accordance with BS 476 Part 7 & HBF, HF 1 & HF 2 in accordance to UL 94, 1996.

Insulation should have antimicrobial product protection and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180. The insulation should pass Air Erosion Resistance Test in accordance with ASTM Standard C 1071-05 (section 12.7).

Thickness of the material shall be 15 mm thick specified for the individual application and with noise absorption properties as per IS: 8225 / ISO 354 / ASTM423C. The insulation should be installed as per manufacturer's recommendation.

6.2 Resin Bonded Fiber Glass

Acoustic material of Duct shall be resin bonded fiberglass wool. The Thermal conductivity of the insulation material shall not exceed 0.034 W/m K at 25 deg C mean temperature. The thickness of insulation shall be so selected as to prevent any condensation and should be able to meet R-Value requirements.

The nominal density of Resin Bonded Fiberglass insulation shall be 32 kg/m³

The minimum thickness of material used for duct thermal insulation shall be 25mm.

The specification for resin bonded glass wool insulation & resin bonded mineral wool insulation shall conform to IS 8183 as amended up to date. The specification for expanded polystyrene shall conform to IS-4671 as amended up to date.

7.0 Room Acoustic

7.1 Open Cell Nitrile Rubber

Walls and ceiling of air conditioning plant room and air handling unit / fan rooms may be provided with acoustic lining. The material shall be Nitrile Rubber open cell foam.

Thermal conductivity of the insulation material shall not exceed 0.047 W/m-K at an average temperature of 20°C. Density of the nitrile rubber shall be 140 – 180 Kg/m³.

The material should withstand maximum surface temperature of +85°C and minimum surface temperature of -20°C.

The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & HBF, HF 1 & HF 2 in accordance to UL 94, 1996.

Insulation should have antimicrobial product protection, and should pass Fungi and Bacterial Resistance as per DIN EN ISO 846 Method A and Method C. The insulation should pass Air Erosion Resistance Test in accordance with ASTM Standard C 1071-05 (section 12.7).

Thickness of the material shall be 20mm if not specified separately.

7.2 RESIN BONDED FIBRE GLASS:

Acoustic material of Duct shall be resin bonded fiberglass wool.

The Thermal conductivity of the insulation material shall not exceed 0.034 W/m K at 25 deg C mean temperature.

The thickness of insulation shall be so selected as to prevent any condensation and should be able to meet R-Value requirements.

The nominal density of Resin Bonded Fiberglass insulation shall be 32 kg/m³

The minimum thickness of material used for duct thermal insulation shall be 50 mm.

Application	Thickness	Material	Min. Density(Kg./Cu.M)
AHU room	50 mm	Resin bonded glass wool/ Mineral wool	32/ 48

The specification for resin bonded glass wool insulation & resin bonded mineral wool insulation shall conform to IS 8183 as amended up to date. The specification for expanded polystyrene shall conform to IS-4671 as amended up to date.

10.0 INSULATION APPLICATION

10.1 Duct Insulation

External thermal insulation shall be provided as follows:

The thickness of insulation material shall be as shown on drawings or identified in the schedule of quantity. Following procedure shall be adhered to:

10.1.1 Nitrile Rubber / FR XPE

Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.

Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubbers sheets to size with sufficient allowance in dimension.

Use good quality tools, in particular a sharp knife, fresh adhesive (Separate for Ducting and Piping), cleaner and good brush. Scissors or Hacksaw-blade shall not be allowed.

Material shall be fitted under compression and no stretching of material shall be allowed.

All longitudinal and transverse joints shall be sealed by providing 50 mm x 6 mm Tape of same material as of insulation (Nitrile rubber / FR XPE) as per manufacturer recommendations.

Never insulate plants and systems that are in operation! Only start insulated plants after 36 hours- after this time the adhesive is fully cured.

10.1.2 Glass wool duct-wrap:

The duct surface should be cleaned and rendered free from all physical and chemical impurities. The duct should be inspected, and all joints should be sealed against leakages.

For ducts having width greater than 0.6m, heavy duty self-adhesive pins are to be applied to the duct at appropriate intervals (max 300mm) as per manufacturer 's Installation Manual

For ducts having width greater than 0.6m, heavy duty self-adhesive pins are to be applied to the duct at appropriate intervals (max 300mm) as per manufacturer 's Installation Manual.

The duct should be covered with two coats of cold applied bitumen adhesive ENIFIX BA60 M/s. Paramount Polytrete Chemicals Pvt. Ltd approved product

The insulation of specific R-value and thickness should then be cut to appropriate length and stuck to the duct while the adhesive is still wet. For proper laying technique, refer to manufacturer's Installation Manual.

All longitudinal joints and circular overlaps should be sealed with aluminum foil tape (50mm width) to make the installation leak proof. For large ducts, where adhesive pins have been used, speed washers/clips should be covered completely with Aluminium foil-tape to have an air-tight finish.

The insulation should then be secured over the duct using mechanically fastened nylon/steel straps (12mm/50mm) at appropriate intervals (max 1.2m).

After the installation the vapor retarding foil should be inspected and all tears should be sealed with Aluminium foil-tape to prevent air leakage.

11.0 Application of Insulation on Pipes (including suction line insulation)

All chilled water, refrigerant, and condensate drain piping shall be insulated in the manner specified herein.

Before applying insulation, all pipes shall be brushed and cleaned. All MS pipes shall be provided with a coat of zinc chromate primer.

Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

11.1 Polyurethane Foam (PUF)

The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.

The pipes shall be given a coat of Zinc Chromate primer.

Two coats of cold setting adhesive CPRX compound shall be applied on the cleaned pipe surface (bitumen in the ratio of 1.5 kgs per m². for each coat).

The preformed sections of insulation shall be fixed tightly to the surface taking care to seal all joints.

For pipes laid inside the building, the insulation over the pipe work shall be finished with 0.63 mm thick aluminum sheet cladding over a vapor barrier of 120 gm/ m². polythene sheet with 50 mm overlap and tied down with lacing wire and complete with type 3, grade-I roofing felt strip (as per IS 1322 as amended up to date) at the joints.

For pipes outside the building laid above ground the finishing over the pipe insulation shall be finished with 0.63 mm G S sheet cladding over a vapor barrier of 120 gm/ m² polythene sheet with 50mm overlap and tied down with lacing wire and complete with type 3 grade I roofing felt strip applied by means of cold setting CPRX compound.

All joints along the circumference of the pipe sections shall be sealed with 50 mm wide aluminum faced adhesive tape.

All longitudinal joints shall be further sealed with 50 mm wide aluminum faced adhesive tape.

Insulation on pipes and valves in the AHU room and in the plant, room shall be covered with 0.5 mm aluminum sheet cladding.

The insulation on pipes running underground or exposed to atmosphere shall be finished with 19 mm/24 G wire mesh over a vapor barrier of 120 gm/m² polythene sheet with 50mm overlap and tied down with lacing wire, two layers of water proof cement plaster of 6 mm thickness each and finally finished with water proof tar-felt fixed with hot bitumen.

11.2 Closed Cell Elastomeric Insulation/ Cross linked polyethylene

Insulating material in tube form shall be sleeved on the pipes.

On existing piping, slit opened tube of the insulating material (slit with a very sharp knife in a straight line) shall be placed over the pipe and adhesive shall be applied on both MS pipe as well as on inner side of insulation material.

Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards center.

Wherever flat sheets shall be used it shall be cut out in correct dimension using correct tools. (Scissors or Hacksaw-blade shall not be allowed). All longitudinal and transverse joints shall be sealed by providing 50 mm wide same material (i.e., Nitrile rubber/XPE) as per manufacturer recommendations.

All longitudinal joints shall be sealed with synthetic glue and covered with adhesive tape of 38 mm along the length. All joints along the circumference would be sealed with 50 mm x 4mm to 5mm self-adhesive insulation sheet.

The insulation shall be continuous over the entire run of piping, fittings, and valves.

All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

Cladding for the Bends, T Section, Strainers, and other pipe accessories shall be with the same cladding material in loose form

11.3 Drain Piping

The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.

Then preformed sleeves of 9 mm thick insulation shall be slipped on the pipe.

All joints shall be insulated with sleeves cut in two sections and fixed to the pipes with cold adhesive compound.

All joints shall be covered with 3 mm x 50 mm PVC self-adhesive tapes of insulation material.

12.0 Application of Duct Lining (Acoustic Insulation)- Resin Bonded Fiber Glass

Where specified in the tender specifications, ducts shall be lined internally with acoustic insulation as detailed below:

The inside surface of duct on which the acoustic lining is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.

Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.

The insulation slabs shall then be fixed between these sections of ducts using CPRX adhesive compound and stickpins.

The insulation shall then be covered with Reinforced plastic/ fiber glass tissue with proper overlap, sealing all joints so that no fiber is visible.

The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminum sheet having perforations between 20-40%.

13.0 Application of Acoustic Lining in AHU Rooms (Open cell Nitrile Rubber)

The wall surface shall be cleaned and required surface preparation shall be done for applying adhesive.

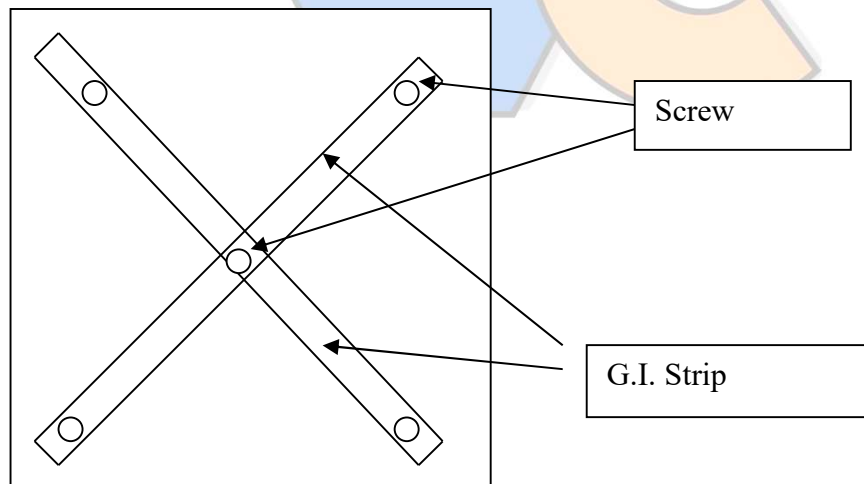
Rubber based contact adhesive recommended by the manufacturer shall be used.

The foam sheets shall be cut to required size and a thin layer of adhesive shall be applied to both the surfaces i.e., wall and insulation. When it is tack dry, it should be applied / stuck with enough pressure to the walls/ceiling.

Minimum 5 fasteners with washer (of G.I Sheet 2.5-inch x 2.5 inch) / square meter, 4 at corners & 1 at center shall be put immediately after sticking with the help of adhesive. The length of the fastener should be minimum 75 mm.

All longitudinal and transverse joints shall be covered with 22-gauge 50 mm wide GI strip with screws as shown below:-

Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental waterlogging in plant/AHU / fan rooms.



14.0 Application of Acoustic Lining in AHU Rooms (Resin Bonded Fibre Glass)

The wall/ roof surface should be thoroughly cleaned with wire brush.

A 610x610 mm frame work of 25mm x 50mm x 50mm x 25mm shape channel made of 0.6mm thick G.S.S. shall be fixed to walls leaving 610mm from floor by means of raw plugs in walls and dash fasteners in ceiling. Similar frame work shall also be fixed on ceiling by means of dash fasteners.

Resin bonded glass wool/ mineral wool as specified cut to size will be friction fitted in the frame work and covered with tissue paper.

Aluminium perforated sheet having perforation between 20-40% of thickness not less than 0.8 mm shall be fixed over the entire surface neatly without causing sag/ depression in between and held with screws. Sheet joints should overlap minimum 10mm.

Aluminum beading of 25mm wide and thickness not less than 1.00 mm shall be fixed on all horizontal/ vertical joints by means of screws.

9.0 Equipment Insulation

The materials for equipment insulation shall be slabs of expanded Polystyrene (Self-extinguishing grade) having a 'K' Value of 0.035 W/mK at 10°C and a density not less than 20 Kg./Cum.

The complete shell of the chiller as well as its two heads shall be factory insulated.

The insulation on chilled water pumps and expansion tank shall be of expanded polystyrene having a 'K' value of 0.035 W/mK at a mean temperature of 10°C and a density not less than 20 Kg/Cubm. The thickness of the insulation will be as given below

- | | | |
|-------------------------|---|-------|
| I) Expansion tank | - | 50 mm |
| II) Chilled water pumps | - | 50 mm |

10.0 Application of Insulation on Pumps

Expanded polystyrene (TF quality) 50mm thickness shall be sandwiched between two aluminum sheets of 0.5mm thickness and properly clamped to pump in two semicircular sections.

11.0 Application of Insulation on Expansion Tank

Insulation of expansion tank shall be expanded polystyrene (T.F.Quality) of thickness not less than 50mm. It shall be applied as under

Surface shall be thoroughly cleaned with wire brush and rendered free from all dust & grease.

The two layers of hot bitumen shall be applied.

The insulation slabs will then be fixed in one layer and joints shall be sealed with hot bitumen.

The insulation slab then shall be covered with 0.63 mm x 19mm G. I. wire mesh netting which shall be fixed to insulation with brass / G. I. nails .

The insulation shall then finally be finished with aluminum cladding of thickness not less than 0.5mm.

12.0 Equipment

The surface shall first be cleaned with wire brush.

Then two layers of hot bitumen shall be applied.

The insulation shall then be fixed in one layer and sealing them with hot bitumen.

The insulation shall then be covered with 0.63 mm/ 19 mm mesh wire netting which shall be fixed to the insulation with brass 'U' nails.

The final finish shall be 0.50 mm aluminum cladding.

15.0 Measurement of Insulation

Pipe insulation shall be measured in units of length along the center line of the insulated pipe.

The linear measurements shall be taken before the application of the insulation.

For piping measurements, all valves, orifice plates and strainers shall be considered strictly by linear measurement along the center line of the pipes, and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

Duct insulation and acoustic lining shall be measured based on surface area along the outer surface (ref IS14164 of 2008) of insulation thickness.

Thus, the surface area of externally thermal insulated or acoustically lined duct shall be based on the perimeter at the center of thickness of insulation, multiplied by the center-line length of ducting including tapered pieces, bends, tees, branches etc. as measured for bare ducting. In the case of tapering pieces, their average perimeter shall be considered.

16.0 Painting and Identification :

Thermal Insulation exposed to view (including that within plant rooms) shall be painted except where the insulation is protected by aluminum foil or sheet, plastics film or a weather-proof finish/ equivalent material as per the specifications. An undercoat and not less than two finishing coats shall be applied. Absorbent surfaces shall also receive an initial coat of priming paint. All paints shall be compatible with the surfaces to which they are applied and shall be approved by the owner.

The color (s) of paint (s) shall be to the instruction of the owner and shall be selected from the range contained in I.S. 4800.

All distribution services shall be color coded and provided with symbols for identification purposes. Identification coding for ductwork, including thermal insulation, shall be in accordance with I.S. codes for pipe work, including thermal insulation, the basic color and color coding shall be in accordance with I.S. codes.

Uninsulated pipe work or duct work and thermal insulation which is painted or unpainted shall be identified by bands at least 25 mm wide color triangles or at least 150 mm side. The bands or triangles shall be spaced and located to permit ready identification of the services particularly adjacent to equipment's positions, at service junctions and wall penetrations.



TECHNICAL SPECIFICATIONS: MODE OF MEASUREMENTS

1. Unit Prices in the Schedule of Quantities

The Item description in the schedule of quantities is in the form of a condensed resume. The unit price shall be held to include everything necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.

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

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

All the labor required to supply and install the complete installation in accordance with the specifications.

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

All the necessary measures to prevent the transmission of vibration.

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

Storage all equipment apparatus and materials.

Insurance of all equipment during Transit, storage, installation and up until handing over to the owner.

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

2. Measurements of Sheet Metal Ducts, Grilles/Diffusers etc.

2.1 Sheet Metal Ducts

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

The unit of measurements shall be the finished sheet metal surface area in square meters. No extra shall be allowed for lapse and wastages.

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

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

2.2 Grilles/Diffusers

Grilles / Diffusers should be measured as follows :

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

The square or rectangular grilles/diffusers shall be measured in plain SQ.M.

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

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

3. Measurements of Piping, Fittings, Valves, Fabricated items.

3.1 Pipe

(Including water piping, steam piping, oil piping, LP gas piping, air piping, vacuum piping) etc.

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

Exposing reinforcement in wall and ceiling and floors if possible and making good the same or installing anchor fasteners and inclusive of all items as specified in specifications and schedule of quantities.

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

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

The length of the pipe for the purpose of payment will be taken through the centerline of the pipe and all fittings (e.g. Tees, bends, reducers, elbows, hangers, structural supports etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings for valves and flanges, section 3.2 below applies. Rate quoted shall be inclusive of all supports, hangers etc. and no additional measurement would be taken.

3.2 Valves and Flanges

All the extra CI & CM flanged valves shall be measured according to the nominal size in MM and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length will be made, wherever valves occur.

All gun metal (gate & globe) valves shall include 2 Nos. of flanges and 2 Nos. 150 MM long M.S. nipples, with one side threaded matching one of the valves, and other welded to the M.S. Slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 MM thick insertion gasket of required temp. grade and all items specified in the specifications.

The rates quoted shall be inclusive of making connection to the equipment, tanks, pumps etc. and the connection made with an installed pipe line shall be included in the rates as per the B.O.Q.

Rates shall be inclusive of insulation, if required.

4. Insulation

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

4.2 Pipes, Ducts & Vessels

4.2.1 Pipes

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

4.2.2 Ducts

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

4.2.3 Vessels

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

4.3 Accessories Insulation

The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be un-insulated are in square meters.

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

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

4.4 Acoustic Duct Lining

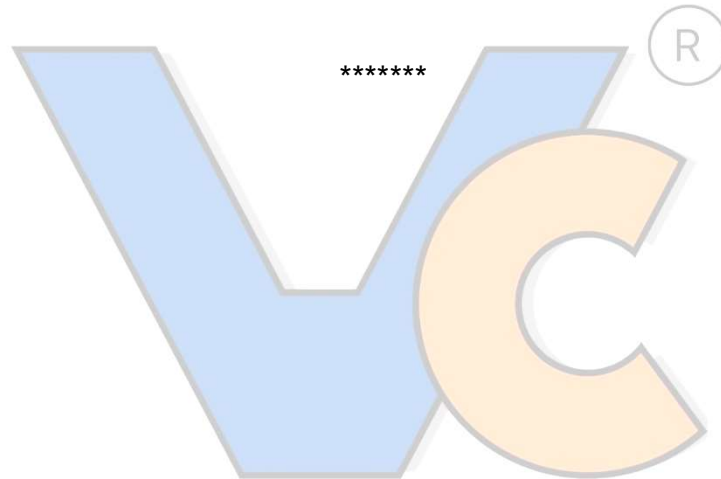
In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square meters, shall be final for billing purposes.

The insulation/acoustic panels shall include cost of battens, supports, adhesives, vapor proofing, finished tiles/boards/sheets as well as additional labor and materials required for completing the work.

4.5 Roof and Wall Insulation & Acoustic Treatment

The unit of measurement for all under deck roof insulation, wall insulation, wall/roof acoustic panel shall be the un-insulated area of walls, roofs, to be treated, in square meters.

The insulation, acoustic panels shall include cost of battens, supports, adhesives, vapor proofing, finished tiles/boards/sheets as well as additional labor and materials required for completion of the work.



TECHNICAL SPECIFICATIONS: ROOF TOP SUPPORT SYSTEM

1.0 Features and Benefits

Modular supporting system for climate installations, solar panels, walkways, Pipe work, cable ways, etc.

For flat & low-pitched roofs.

For horizontal and vertical applications.

360° rotatable insert for BIS Rapid Strut® 41x41.

With non-slip anti-vibration mat.

Moldings made of WPC, a composite of recycled plastic and wood fiber

Resistant to UV and chemical influences

2.0 Design Considerations

2.1 Allowable foot pressure and roof load will be subject to roof build-up, typical detailed by a structure engineer.

2.2 Linear Adjustment:

Cross bar spacing is adjustable to accommodate various unit sizes.



2.3 Wind loading:

Suitable for wind exposed environment, wind speed up to 100mph. Areas or zone which are cyclone prone or near to coastal area or where there is wind speed more than 100mph then balusters blocks to add wherever required as per site condition.

2.4 Working Condition:

Suitable for internal & external application in temperature between -40° C to 80° C.

3.0 Modular Roof Top Supports: For HVAC Equipment

Roof Top Mounted equipment, Piping & ducts supports system to be mounted on Modular Rooftop base supports shall be made of light weight material such as WPC, and should be resistant to UV and chemical influences, vibration isolation, weather proof, etc. must suitable for both flat and low pitch roofs and to be rested on terrace surface to prevent damage to roofing membrane.

All Equipment shall be mounted on Hot Dip Galvanized (HDG) GI Rapid strut channels along with all suitable connecting accessories such as 90deg connectors, 135deg connectors, hexagonal bolts, washers, and slide nuts, cross connectors, are also shall be of hot dip galvanized or GI.

All GI channels & accessories shall be hot dip galvanized/GI channels as per IS 2629 (1985)

Equipment and supports that are exposed to wind shall be designed and installed to resist wind pressures determined in accordance with ASCE 7 chapter 29.

For Mounting of equipment's on frame arrangement following of channel shall be selected as per below table depending on project requirement.

S.No	Rapid strut Channel Size (mm)	Gauge of Channel	Load Type	Span (L in mm)	Safe Working Load (Kgs)
1	41x41	2.5mm	UDL	1000	up to 380kgs
2	41x62	2.5mm	UDL	1000	up to 730Kgs

4.0 Frame Arrangement:

The frame structure consists of four load distributing bases with vertical strut (41 x 41) legs and a horizontal strut header (41x41 or 41x62) connected each other using 90 deg connectors and Horizontal cross channel (41x41 or 41x62) between adjacent frames to be arranged using and Cross Connectors, Slide Nut and Hexagonal Bolt.

Each Support Span Shall be determined for project specific requirements.



SAFETY CODES

1. IS 659 : (Reaffirmed 1991), Safety code for air-conditioning (revised) (Amend-1).
2. IS 660 : (Reaffirmed 1991), Safety code of mechanical refrigeration. (revised).
3. IS 3233 : 1965 (Reaffirmed 1992),
Glossary of terms for safety and relief valves and their parts.
4. IS 12992 : 1993, Part I, 1990 Part II , Safety relief valves.
5. IS 954 : 1989 Functional requirements for carbon dioxide tender for fire brigade use. (2nd revision)
6. IS 1641 : 1988 (reaffirmed 1993) Code of practice for fire safety of buildings (general) : General principles of fire grading and classification. (1st revision)
7. IS 1642 : 1989 Code of practice for fire safety of buildings. (general) : Details of construction (1st revision) (1645 supersedes 1642)
8. IS 1643 : 1988 (Reaffirmed 1993)
Code of practice for fire safety of buildings (general) : Exposure hazard (1st revision)
9. IS 1644 : 1998 (Reaffirmed 1993), Code of practice for fire safety of buildings (general) :Requirements and personal hazard.
10. IS 1646 : 1982 (Reaffirmed 1990)
Code of practice for fire safety of buildings (general) : Electrical Installation (1st revision)
11. IS 3786 : 1983 (Reaffirmed 1991)
Methods for computation of frequency and severity rates for industrial injuries and classification of industrial accidents. (1st revision)
12. IS 3808 : 1979 (Reaffirmed 1990)
Method of test for non-combustibility of building materials (1st revision)
13. IS 5311 : 1969 (Reaffirmed 1990) Code of safety for carbon tetra chloride.
14. IS 6382 : 1984 (Reaffirmed 1990), Code of practice for design and installation of Fixed carbon dioxide for fire extinguishing system (1st revision)
15. IS 7969 : 1975 (Reaffirmed 1991) Safety code for handling and storage of building materials (Amendment 1)

List of Approved Makes- Type-1

S. No	Equipment/Material	Approved Manufacturer Name	Proposal Make-1	Proposal Make-2
1.	Air Handling Unit and Fan Sections/DOAS	VTS, system Aire, Flaktwoods		
2.	VRF System	Toshiba/ Daikin/ Mitsubishi Electric/ LG/ Samsung		
3.	Fan Coil Unit	VTS, System Aire, Flaktwoods		
4.	Air washer	Zeco, Crystal, Edgetech		
5.	Centrifugal Fans (AMCA certified for Sound)	Kruger, Nicotra , Systemaire, Greenheck		
6.	EC Fans (AMCA certified)	Ebm Papst, Ziehl abbeg		
7.	Axial Flow Fan (AMCA certified)	Greenheck, Systemaire, Kruger		
8.	Inline Fans (Super silent)	Kruger, Systemaire		
9.	Propeller Fans	Marathon, Crompton		
10.	Dry Scrubber	Trion, Rydair, Espair ,Pureair, Humidin		
11.	Split Unit (5 Star as per BEE) / Package Unit	Blue Star, Voltas, Carrier Daikin, LG, Midea, Hitachi		
12.	Chilled Water Cassette Unit	Carrier, Midea Kubic, Caryaire		
13.	PHI Cell	Pureaire , Sterile Air		
14.	Variable Frequency Drive (VFD)	ABB, Danfoss, Fuji Electric, Siemens		
15.	M.S. Pipe	Jindal Hissar, Tata Steel, SAIL, Welspun, Mukut		
16.	GI Pipe	Jindal Hissar, SAIL, Tata Steel		
17.	Butterfly Valve	Audco, KITZ, Advance		
18.	Motorized Butterfly Valve	Belimo, Danfoss, Advance, Audco		
19.	Pressure Independent Balancing Valves	Honeywell, Danfoss, Flowcon, Siemens		
20.	Ball Valve	KITZ, Zoloto, Sant		
21.	Ball valve with Y-Strainer	KITZ, Zolotov, Emerald		
22.	Check Valve	Advance Valve, Kitz, Audco		
23.	Balancing Valve	Advance, VTM		
24.	Two-way FCU Control Valve	Belimo, Danfoss, Flowcon, Siemens, Honeywell		
25.	Room Thermostat with Digital Temperature Indication for FCU & AHU's	Belimo, Danfoss, Flowcon, Siemens, Honeywell		

S. No	Equipment/Material	Approved Manufacturer Name	Proposal Make-1	Proposal Make-2
26.	Pressure Gauge	Fiebig, H Guru		
27.	Thermometer	Fiebig, H Guru		
28.	Al/GI Sheets	Bhushan, Essar, Jindal, SAIL, TATA		
29.	Factory Fabricated ducts	Ductofab, Eco duct, Edgetech, Zeco, Rolastar		
30.	Flexible duct	Atco, Titus, UP Twiga, Seven Star, Caryaire		
31.	Pipe / duct supports	Diamond, Seven star, Gripple, Doby		
32.	PUF section for pipe support	Lloyd, Malanpur		
33.	Grille/Diffuser/Dampers/ Louvers	Caryaire, Ruskin, Conair, Systemaire, Airmaster, Trox		
34.	Smoke / Fire Damper	Caryaire, Ruskin, Conair, Systemaire, Trox		
35.	Constant Volume Damper	Titus, Mapro, Trox		
36.	Sound Attenuator	Caryaire, Greenheck, Kruger, Systemair, Trox		
37.	Anchor Fastener	Fischer, Hilti		
38.	Duct Insulation (Nitrile Rubber)	Trocellen, Armacell, K-Flex, A-Flex		
39.	Nitrile Rubber with GC Cloth	Armacell ,Cani, K-Flex, A-Flex		
40.	Fire Sealant	Birla 3 M, Hilti, Promat		
41.	Vibration Isolator	Dunlop, Easy flex, Flexionics, Resistoflex		
42.	Flexible Pipe Connection	Dunlop ,Easy flex, Flexionics, Resistoflex		
43.	Electronic Filters	Honeywell, Magneto		

Electrical Equipment-HVAC

S. No	Equipment/Material	Approved Manufacturer Name	Proposal Make-1	Proposal Make-2
1.	LT Panels & Distribution Boards	Advance, Adlec, Tricoloite/ Application control		
2.	Air Circuit Breakers / Moulded Case Circuit Breaker / MPCB / Contactors/Changeovers	Siemens, Schneider Electric, L&T, Legrand ,Mitsubishi, ABB		
3.	Final Distribution Boards / MCB/RCCB / Timers	Siemens, Schneider Electric, L&T, Hager, Legrand.		
4.	Control Transformer / Potential Transformers (Epoxy Cast Resin)	Automatic Electric, Gilbert & Maxwell, Precise Pragati, Matrix, Kappa		
5	Indicating Lamps LED type / Selector switches and Push Button	Schneider Electric, Siemens, ESBEE, Teknik, Vaishno		
6.	Digital Meters	Siemens, Schneider Electric, L&T, ABB, Legrand, CG		
7	LT Cables	Polycab, KEI, Havells, Finolex		
8	Fire Survival Cables	FrTek, KEI, Polycab, Fusion Polymers		
9.	Termination kits	3M, Raychem		
10	Double Compression Cable Glands with earthing links	Dowells, Comet		
11	Bimetallic Cable Lugs	Dowells, Comet, Cosmos		
12.	PVC Insulated HFFR Wires (RoHS)/ FRLS Cables	Polycab, KEI, Havells, Finolex		
13.	Terminal Blocks	Connect well, Elmex, Wago		
14.	Industrial Socket outlets	BCH, Neptune Balls, Crompton Greaves Clipsal, Legrand		
15.	Cable Trays & Raceways	Profab, MEM, MK, Slotco		
16.	Accessories for Supporting system	Hilti, Fisher		
17.	Fire Sealant & Paints	3M , Hilti, Promat		
18.	Insulating Mats	DL Miller & Co., Premier Polyfilm Ltd, RMG Polyvinyl India Ltd		

Note: The choice of the Final makes shall be made by the owner / consultant. The Consultant reserves the right to demand any of the approved makes as per his requirements.