

TECHNICAL SPECIFICATIONS

DUCT WORK AND OUTLETS

1.0 General:

- 1.1 The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, exhaust system ready for operation as per drawings.
- 1.2 Except as otherwise specified all duct work and related items shall be in accordance with these specifications.
- 1.3 Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

2.0 Duct materials

- 2.1 The ducts shall be fabricated from galvanized steel sheets class VIII GSS sheets conforming to IS: 277-1962 (revised) or aluminium sheets conforming to IS: 737-1955 (wherever aluminium ducts are specified) as manufactured by TATA/SAIL/HSL/ JINDAL/ BHUSAN (for GSS sheets) or Nalco/Balco/Hindalco (for Aluminium sheets)
- 2.2 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) or latest

The thickness of the sheet shall be as follows: -

Size of duct	Sheet thickness		type of joints	bracing if any
	GI	Aluminium		
2.2.1 Upto 750mm	0.63 mm	0.80 mm	GI flange	
2.2.2 751 mm to 1000 mm	0.80 mm	1.00 mm	25x25x3 mm Angle iron Frame With 8 mm dia. nuts & bolts.	25x25x3 mm at the rate of 1
2.2.3 1001 mm to 1500 mm	0.80 mm	1.00 mm	40x40x5 mm angle iron frame with 8 mm dia. Nuts & bolts.	40x40x3mm at the rate of 1
2.2.4 1501 mm to	1.00 mm	1.50 mm	50x50x5 mm	40x40x3mm

	2250 mm			angle iron to be cross braced diagonally with 10 mm dia nuts & bolts at 125 mm center.	at the rate of 1.2
2.2.5	2251 mm and above	1.25 mm	1.80 mm	50x50x6 mm angle iron frame with 10mm nuts & bolts at 125 mm centre.	40x40x3 mm at the rate of 1.6

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

2.4 Ducts larger than 450 mm shall be cross broken, duct sections upto 1200 mm length may be used with bracing angles omitted.

2.5 Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. 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.

2.6 All ducts shall be supported from the ceiling/slab by means of M.S. rods of 9 mm (3/8") dia with M.S. angle at the bottom.

3.0 Installations

3.1 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.

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

3.3 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 tight and shall be made in the direction of air flow.

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

3.4 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. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in IS specifications shall be adhered to and shall be considered as an integral part

of these specifications.

- 3.5 The duct work shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted air-conditioning duct design and subject to the approval of the engineer-in-charge. The contractor shall verify all measurements at building and shall notify the engineer-in-charge of any difficulty in carrying out his work before fabrication.
- 3.6 Sponge rubber or approved equal gaskets 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 galvanized steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by engineer-in-charge.
- 3.7 The ducts shall be supported from the structure by means of suitable supports grouted in the R.C.C. work. The type of support should meet the approval of the engineer-in-charge and should involve minimum damage or breakage. In no case the duct will be rested upon the false ceiling/boxing or on supports grouted in the wall.
- 3.8 Flanges and supports are to be black, mild steel and are to be primer coated on all surfaces before erection and painted with aluminium thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
- 3.9 Joints, seams, sleeves, splitters, branches/ takeoffs and supports are to be as per duct details as specified, or as decided by engineer-in-charge.
- 3.10 Joints requiring bolting or riveting may be fixed by hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All fixing must have a permanently non-corrosive finish such as cadmium plating or galvanizing as appropriate. Spot welds and bronze welds are to be coated on all surfaces with zinc rich paint, as approved by engineer-in-charge.
- 3.11 The flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvas or as directed by engineer-in-charge. On all circular spigots the flexible materials are to be screwed or clipband 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.
- 3.12 The flexible joints are to be not less than 75 mm and not more than 250 mm between faces.
- 3.13 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.

4.0 **Dampers**

- 4.1 At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided. Dampers shall be two gauges heavier than gauge of the large duct, and shall be rigid in construction to the passage of air.
- 4.2 The volume dampers shall be of an approved type, lever operated and complete with locking devices which will permit the dampers to be adjusted and locked in any positions.
- 4.3 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 interface with the operation of dampers, nor cause any turbulence.
- 4.4 Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.5 mm steel and blades shall not be over 225 mm wide. 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 packing.
- 4.5 Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and thumb screw lock. Provide damper rod and damper block with upset screws.
- 4.6 After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.
- 4.7 The fire dampers shall be provided wherever shown on the drawings. The damper shall be multi blade type as per drawings. The blades shall be minimum 1.6 mm thick mild steel. The frame shall be of 1.6 mm thickness. Other materials shall be as per the drawings attached and shall include return spring, locking device, fusible link etc.

5.0 **Access panel**

- 5.1 A hinged and gasketed access panel shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct work.

6.0 **Miscellaneous**

- 6.1 All ducts above 450 mm are to be cross broken to provide rigidity to the ducts.
- 6.2 All duct work joints are to be true right angle or approaching with all sharp edges removed.
- 6.3 Sponge rubber gaskets also to be provided behind the flange of all grilles.
- 6.4 Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.

- 6.5 Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by engineer-in-charge.
- 6.6 Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.
- 6.7 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.
- 6.8 The ducts should be routed directly with a minimum of directional change.
- 6.9 The duct work shall be provided with additional supports/hangers, wherever required or as directed by the engineer-in-charge, at no extra cost.
- 6.10 All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of aluminium paint after the erection, at no extra cost.
- 6.11 All angle iron flanges to be welded electrically and holes to be drilled.
- 6.12 All the angle iron flanges to be connected to the GSS ducts by rivets at 100 mm centres.
- 6.13 All the flanged joints, to have a 4 mm thick felt packing stack to the flanges with shellac varnish. The holes in the felt packing are to be burnt through.
- 6.14 The GSS ducts should be lapped 6 mm across the flanges.
- 6.15 The ducts should be supported by approved type supports at a distance not exceeding 2.4 metres.
- 6.16 Sheet metal connection pieces, partitions and plenums required shall be constructed of 1.25 (18 gauge) sheet thoroughly stiffened with 25 mm x 25 mm angle iron braces and fitted with access doors.

7.0 GRILLES DIFFUSERS

7.1 Supply and return air grills and ceiling diffusers

The supply and return air grills and ceiling diffusers shall be made of powder coated extruded aluminium sections. The supply air grills/diffusers shall be provided with screws operated opposed blade volume control device made of extruded aluminium in black anodized finish.

All grills/diffusers shall have soft continuous rubber/foam gasket between the peripheries of the grills/diffusers and surface on which it has to be mounted. The colour of grills/diffuser shall be as per the approval of the Engineer-in-Charge.

7.2 Linear supply and return grills

The linear continuous supply/return air grills shall be made of powder coated extruded aluminium construction with fixed horizontal bars. The thickness of fixed bar louvers shall be 5mm in front and the flange shall be 20mm wide with round edges. The register shall be suitable for concealed fixing and horizontal bars of the grills shall mechanically crimped from the back to hold them.

The colour of grills shall be as per the approval of the Engineer-in-Charge. The volume control device made of extruded aluminium construction in black anodized finish shall be provided in supply air duct collars only.

7.3 Front fixed bar rear adjustable louvered grills

The grills shall be made of powder coated extruded aluminium construction with front fixed horizontal bar at 0 degree inclination with one way or two way deflection with rear vertical individually adjustable louvers in black shade mounted on Nylon bushes to hold deflection setting under all conditions of velocity and pressure.

The colour of grills shall be as per the approval of the Engineer-in-Charge. The volume control device of extruded aluminium construction in black anodized finish shall be provided in supply air duct collars.

7.4 Square/rectangular ceiling diffusers

The square/rectangular ceiling diffusers shall be made of powder coated extruded aluminium construction with flush fixed pattern. The diffusers shall have Anti-Smudge ring and spring loaded removable control core in various pattern for air flow direction. The diffusers shall be mounted by concealed screw fixing arrangement. The volume control device of extruded aluminium construction in black anodized finish shall be provided in supply air diffusers. The colour of diffuser shall be as per the approval of the Engineer-in-Charge.

7.5 Volume control device

The opposed blade volume control device shall be made of Powder Coated extruded aluminium construction in black anodised finish. Opposed blades shall be pivoted to extruded aluminium frame with Nylon bushes. Specially designed blade shall have an overlapping lip which shall ensure a tight closure.

7.6 Fresh air intake louvers with bird screen

The fresh air intake louvers at least 50mm deep will be made of powder coated extruded aluminium construction. Bird/insect screen will be provided with the intake louvers. The blades shall be inclined at 45 degree on a 40mm blade pitch to minimize water ingress. The lowest blade of the assembly shall be extended out slightly to facilitate disposal of rain water without falling on door/wall on which it is mounted.

The intake louvers shall be provided with factory fitted aluminium construction volume control dampers in black anodised finish.

8.0 Laminar flow diffusers

- 8.1 The laminar flow diffusers shall be fabricated from aluminium sheets supported in a framework.
- 8.2 The diffuser shall be fabricated from aluminium sheet of 1.25 mm thickness double folded and pressed with mechanical perforations of suitable size and at suitable spacing to provide the rated air quantity.
- 8.3 The framework shall be fabricated from 25 * 25 * 3 mm aluminium angle.
- 8.4 The dampers shall be fabricated from 1.25 mm aluminium sheet and shaped to form airtight joints. The damper shall be key operated from the face of the diffuser.

9.0 ACCESS PANEL

- 9.1 Hinged access doors of suitable size complete with air tight gaskets shall be provided in all fire dampers and plenums.

10.0 Painting

- 10.1 All grilles, and diffusers shall be anodised or powder coated, as required, before installation.
- 10.2 All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matt finish.
- 10.3 All grilles, diffusers & registers shall be provided with rubber gasket between flanges and the wall or ceiling.

11.0 Testing

- 11.1 After completion, all duct system shall be tested for air leakage by injecting smoke with the help of smoke generating machine.
- 11.2 The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance of air quantity through each outlet shall be submitted to the engineer-in-charge for approval.

INSULATION

1. **General:**

The insulation of water piping, air handling units, ducting, chillers etc., shall be carried out as per specifications given below :

2. **Materials:**

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere.

2.1 **Pipe Insulation:**

- a. In locations susceptible to physical damages and all exposed piping the insulation for chilled water and drain piping pump etc. shall be carried out from 'TF' quality expanded polystyrene having a 'K' value of 0.014 kcal/hr/°c. at mean temperature of 10°c. and a density of 24 to 28 kgs/cub.m.
- b. In locations not-susceptible to physical damage and locations where space is a constrained insulation of chilled and drain piping shall be carried out with closed cell nitrile rubber insulation material as specified.

2.2 **Ducting Insulation:**

- a. The materials for duct insulation shall be resin bonded glass wool, as described earlier but conforming to I.S. 8183 of 1976. The density of insulation shall not be less than 24 kg/cub/m. and material shall be in the form of blankets/rolls of uniform thickness. The 'K' value at 10°c. shall not be less than 0.03 kcal/mhr/deg.c.
- b. In locations where space is a constraint and concealed ducts shall be insulated with closed cell nitrile rubber insulation material as specified.

2.3 **Other Insulation:**

The material for acoustic treatment of ducts, rooms, roofs etc. shall be resin bonded fibre glass, as described earlier, conforming to I.S. 8183 of 1976. The density of fibre glass shall be 32 kg/cub.m and the material shall be in the form of slabs of uniform density. The 'K' value at 10°c. shall not be less than 0.028 kcal/mhr/°c. Facing shall be provided with 0.5 mm perforated aluminium sheet held with G.I. nuts bolts or nailed to the batten work as required.

3.0 **Chilled Water Piping/Drain Piping Insulation with TF quality Polystyrene:**

- 3.1 The chilled water and drain pipes shall be insulated with 'TF' quality expanded polystyrene. The thickness of the insulation for chilled water pipes will be 50 mm and for drain pipes will be 25 mm.
- 3.2 Prefabricated pipe sections shall be used for pipes upto and including 350 mm dia.

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

3.4 Installation

Chilled Water and Drain Piping

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

3.4.2 The pipes shall be treated with a coat of cold setting compound.

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

3.4.4 All joints along the circumference of the pipe sections shall be sealed with adhesive.

3.4.5 The insulation than shall be covered with 0.63 mm x 19 mm mesh wire netting than finally finished with 12 mm sand cement plaster in two layers of 6 mm each and trowled to a smooth round finish.

3.4.6 Insulation on pipes in areas exposed to weather or underground shall additionally be covered with tar-felt sheets manufactured by Shalimar tar products (1935) Ltd. and fixed with G.I. wires of 1.0 mm. The tar felt sheet shall be stuck with bitumen r 85/25.

4. Refrigerant Piping:

4.1 The suction line of refrigerant piping shall be insulated as per manufacturer's specifications.

5. Ducting Insulation with Resin bonded fibre glass:

5.1 The air handling ducts shall be insulated with resin bonded glass wool with density not below 24 kg/cub.m.

5.2 Duct insulation thickness shall be as follows:

Duct in conditioned space - 25 mm thick

Duct in unconditioned space - 50 mm thick

Duct with treated fresh air - 50 mm thick

Supply & Return Air Duct in O.T's - 50 mm thick

5.3 Installation

5.3.1 Clean the surface with a wire brush and make it free from rust and oil.

5.3.2 Apply one coat of cold setting compound.

5.3.3 Wrap the duct with insulation blankets of the thickness mentioned in item 5.2 above and then with 250 g polythene sheet and covered with 0.1mm thick aluminium sheet using 50 mm wide aluminium adhesive tape of Johnson or equivalent make.

5.3.4 Reinforce and tie with G.I. wire of 1.0 mm at intervals of 450 mm.

5.3.5 The ducts in areas exposed to the weather shall be additionally covered with one layer of tar felt b.h. the tar felt shall be stuck with bitumen r 85/40 or 80/25.

6.0 **Acoustic Lining:**

6.1 The acoustic lining shall consist of 25 mm resin bonded glass wool of density 48 kg/cub.m (min) then it shall be covered by 0.5 mm perforated aluminium sheets having 3 mm perforation at 6 mm centres.

6.2 **Installation**

6.2.1 The duct surface shall first be cleaned from inside.

6.2.2 The insulation boards shall be wrapped in glass cloth of 7 mil thickness with the end stitched.

6.2.3 Then the boards shall be fixed inside the duct.

6.2.4 The insulation shall then be covered with 0.5 mm thick perforated aluminium sheets.

6.2.5 The sheet and the insulation shall be secured to the duct by means of cadmium plated bolts, nuts and washers. The ends should be completely sealed off, so that no insulation material is exposed.

7.0 **Walls and Ceiling Acoustic Treatments of Plant Rooms and A.H.U. Room**

7.1 **Material**

Resin bonded glass wool of density 32 kg/cub m of 50mm thickness.

8.0 **Installation:**

8.1 Fix 40 mm x 50 mm g.i. sheet channel at 0.5 mtr interval longitudinally then fix cross battens at 1.0 mtr centre using suitable gutties, and brass screws. The battens & gutties shall be treated with fire retardant chemical before fixing.

8.2 Fill each rectangle with 50 mm glass wool wrapped in glass cloth.

8.3 Tie with 24 gauge G.I. wires at 300 mm intervals.

8.4 Then cover with 26 gauge (0.50 mm) perforated G.I. sheet having 3mm perforations at 6 mm centres. Overlap all joints and provide beading of 25 mm by

2 mm flats.

TESTS AT SITE

1. General :

The contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the architect, in accordance with the provisions of the applicable ashrae standards or approved equal and furnish necessary test certificates from manufacturers.

2.0 Duct Work :

2.1 All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus five percent (5%) of fan capacity.

2.2 Fire dampers, volume dampers and splitter dampers shall be tested for proper operation.

2.3 Manufacturer's test certificates for sheets for ducting to be submitted.

3.0 Balancing and Adjustment :

All air handling units, ventilation equipment, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities indicated, at each inlet and outlet on the drawings. If these air quantities cannot be delivered without exceeding the speed range of the sheaves or the available horse power, the architect shall be notified before proceeding with the balancing of air distribution system.

4. Electrical Equipment :

4.1 All electrical equipment shall be cleaned and adjusted on site before application of power.

4.2 The following tests shall be carried out :

4.2.1 Wire and cable continuity tests.

4.3 Insulation resistance tests, phase to phase and phase to earth, on all circuits and equipment, using a 500 volt meggar. The meggar reading shall be not less than one megohm.

4.4 Earth resistance between conduit system and earth must not exceed half (1/2) ohm.

4.5 Phasing out and phase rotation tests.

4.6 Operating tests on all protective relays to prove their correct operation before energising the main equipment.

4.7 Operating tests on all starters, circuit breakers, etc.

5.0 **Performance Tests :**

- 5.1 The installation as a whole shall be balanced and tested upon completion, and all relevant information, including the following shall be submitted to the architects.
 - 5.1.1 Air volume passing through each unit, duct, grilles, apertures.
 - 5.1.2 Differential pressure readings across each filter, fan and coil, and through each pump.
 - 5.1.3 Static pressure in each air duct.
 - 5.1.4 Electrical current readings, in amperes of full and average load running, and starting, together with name plate current of each electrical motor.
 - 5.1.5 Continuous recording over a specified period, of ambient wet and dry bulb temperatures under varying degrees of internal heat loads and use and occupation, in each zone of each part of the building.
- 5.2 Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream "on-coil" of each cooling coil. Also suction temperatures and pressures for each refrigerating unit. The current and voltage drawn by each machine.
- 5.3 Any other readings shall be taken which may subsequently be specified by the Engineer.
- 5.4 Performance / capacities of each of the equipment supplied under the scope of HVAC works like Chillers, AHU's, Hot Water Generator, Pumps etc. shall be tested and checked.

6.0 **Miscellaneous :**

- 6.1 The above tests are mentioned herein for general guidance and information only but not by way of limitation to the provisions of conditions of contract and specification.
- 6.2 The date of commencement of all tests listed above shall be subject to the approval of the architect, and in accordance with the requirements of this specification.
- 6.3 The contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the architect requests such a test for determining specified or guaranteed data as given in the specification or on the drawings.
- 6.4 Any damage resulting from the tests shall be repaired and/or damaged material replaced, all to the satisfaction of the Engineer.
- 6.5 In the event of any repair or any adjustment having to be made, other than

normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.

- 6.6 The contractor must inform the architect when such tests are to be made, giving sufficient notice, in order that the architect or his nominated representative may be present.
- 6.7 Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the architect.
- 6.8 The contractor may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the architect, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

MODE OF MEASUREMENTS

1. Unit Prices in the Schedule of Quantities :

- 1.1 The item description in the schedule of quantities is in the form of a condensed resume. The unit price shall be held to include every thing 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.
- 1.2 The unit price of the various items shall include the following :
 - 1.2.1 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.
 - 1.2.2 All the labour required to supply and install the complete installation in accordance with the specifications.
 - 1.2.3 Use of any tools, equipment, machinery, lifting tackle, scaffolding, ladders etc. Required by the contractor to carry out his work.
 - 1.2.4 All the necessary measures to prevent the transmission of vibration.
 - 1.2.5 The necessary material to isolate equipment foundations from the building structure, wherever necessary.
 - 1.2.6 Storage and insurance of all equipment apparatus and materials.
- 1.3 The contractor's unit price shall include all equipment, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

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

2.1 Sheet Metal Ducts

- 2.1.1 All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars & other fittings. Gaskets, nuts, bolts, vibration rotation pads are included in the basic duct items of the BOQ.
- 2.1.2 The unit of measurements shall be the finished sheet metal surface area in metres squares. No extra shall be allowed for lapse and wastages.
- 2.1.3 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.

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

2.2 **Grilles/Diffusers**

All grilles/diffusers as per tender requirements shall be treated as a lump sum item. Where extra grilles diffusers are ordered upto award of work, they should be measured as follows:

- 2.2.1 All measurements of grilles/diffusers shall be the actual neck size excluding the outer flanges.
- 2.2.2 The square or rectangular grilles/diffusers shall be measured in plain sq.m.
- 2.2.3 All round diffusers shall be measured by their diameters in cm.
- 2.2.4 All linear diffusers shall be measured as per actual length in metres.

3.0 **Insulation :**

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

3.2 **Pipes, Ducts & Vessels**

3.2.1 **Ducts**

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

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

LIST OF APPROVED SUBCONTRACTORS, MAKES AND MANUFACTURERS

The subcontractors/makes/brands of equipment listed below are approved for installation.

All items to be used in the works samples, catalogues and specifications are to be submitted by the contractor for approval of the Engineer. Only approved makes shall be used in the works. The approved samples shall be kept in the custody of the Engineer for comparison.

ITEM	APPROVED MAKES/SUBCONTRACTORS
GI Sheets	TATA/SAIL/HSL/ JINDAL/ BHUSAN
Aluminium sheets	Nalco/Balco/Hindalco
Grilles/Diffusers/VCD	Dynacraft/Servex/Ravistar/Caryaire/Opella/ Mapro
Fire dampers	Caryaire/Dynacraft / Ravistar
Fibre glass wool	FGP Ltd./UP Twiga/Kimmco/Owens corning