



Why

We Need

Duct ?



Duct is a channel to distribution air from one location to another.

The major Requirements of Duct work for an Air Conditioning system are:

1. Design duct system properly basing on its air flow rate, static pressure, velocity and friction rate convey the specified rates of air flow to the prescribed locations.
2. Its cost should be economical.
3. It should not generate objectionable noise.
4. It equally distributes the air at different objects.
5. We balance the distribution of air through duct system.
6. It is source to clean the contamination air from interior through Return Air Duct.

The well-designed ductwork system delivers maximum interior comfort at the lowest operating cost while also preserving indoor air quality (AIQ) and attain the values of set temperature of the interior area.



NOTE: All Correspondence including P.O. & Financial will be carried out with the name of
Fact: 14/S, Quaid-E-Azam Industrial Estate, KotLakhpat, Lahore -53100 Pakistan
OFF: 23-A, Nicholson Road, Capton Azmat Shaheed Market Lahore 54000 Pakistan
e-mail: hvac@orientmarketing.com.pk Website: www.orientmarketing.com.pk

“ORIENT MARKETING”
+92 (0) 3225200003
+92 (0) 42 36365113
+92 (0) 3351000013



AIRTECHZ Sole distributor of Air Curtains China



Member of Pakistan HVAC Society

Kinds of Duct

Duct is designed in Metallic and Non-Metallic Duct

A. Metallic Duct:

1. Galvanized Steel (sheet Metal Duct -GI):

It is most common used in fabricating ductwork for comfort air conditioning systems. It is commonly known as **GI Metal duct**. The specifications for galvanized steel sheet are ASTM A653, coating G90.



2. Aluminum:

Uses: It is widely used in clean room applications. These are also preferred systems for moisture laden air, special exhaust systems and ornamental duct systems. The specifications for Aluminum sheet are ASTM B209, alloy 1100, 3003 or 5052.

3. Stainless Steel (SS Duct):

Uses: It is used in duct systems for kitchen exhaust, laboratories, moisture laden air, and fume exhaust. The specifications for stainless steel sheet are ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct.

4. Carbon Steel (Black Iron):

Uses: It is widely used in applications involving flues, stacks, hoods, other high temperature and special coating requirements for industrial use.

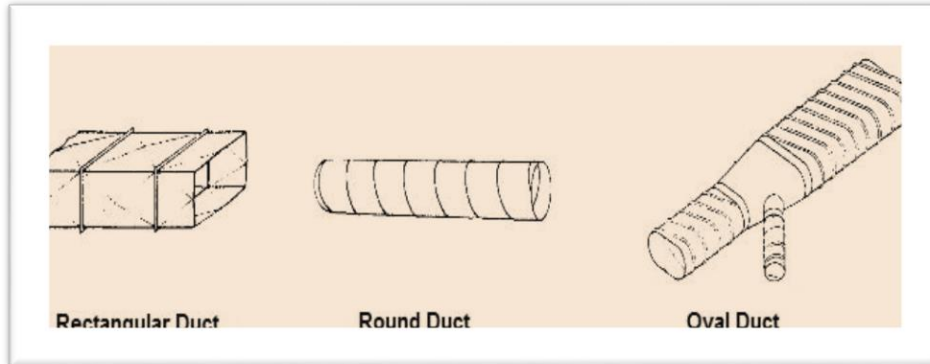
B. Non-Metallic Duct:

it includes ducts made from plastic or foam boards. Boards are faced usually with an aluminum coating, both internal and external.

Non-Metallic ducts are Fiberglass Reinforced Plastic (FRP); Polyvinyl Chloride (PVC); Fabric (Textile Duct); Flex Duct:

TYPE OF DUCT SHAPES

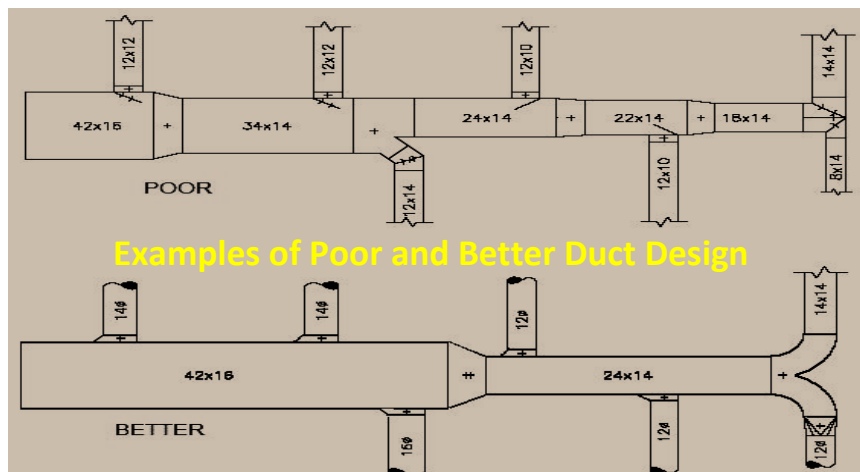
Ducts are commonly used for carrying air in round, square, or rectangular shape.



1. Rectangular Ducts

Square or rectangular ducts fit above ceilings and into walls, and they are much easier to install between joists and studs.

- keep the width-to-height ratio (aspect ratio) low, when rectangular ducts are used due to space limitations. Its aspect ratio should be close to "1"
- A duct with an aspect ratio above 4 is much less efficient in use of material and experiences great pressure losses.
- Aspect ratios of 2 to 3 are ideal in trading off added duct cost of material and fan energy for headroom savings.



2 Round Ducts:

Round duct is the most efficient (offers the least resistance) in moving air because it has the greatest cross-sectional area and a minimum contact surface. It uses less material as compared to square or rectangular ducts for the same volume of air handled.

For Example: An 18 inch diameter duct, has the same air-carrying capacity as a 26" x 11" rectangular duct. The round duct has a cross-sectional area of 254.5 sq.-

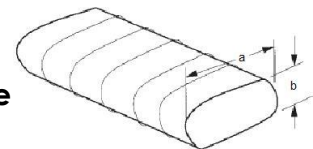
in and a perimeter of 4.7 ft., while the rectangular duct has a 286 sq.-in area and a perimeter of 6.2 ft. The rectangular duct thus has 32% more metal in it and would cost proportionately more. Also the insulation, supports and labor are higher for rectangular ducts of similar capacity.



3 Oval Ducts

Flat oval ducts require smaller height than round ducts. Its disadvantages include:

1. Difficulty of handling and shipping larger sizes;
2. Tendency of these ducts to become more round under pressure
3. In large aspect ratios, difficulties of assembling oval slip joints.



NOTE: All Correspondence including P.O. & Financial will be carried out with the name of
Fact: 14/S, Quaid-E-Azam Industrial Estate, KotLakhpat, Lahore -53100 Pakistan
OFF: 23-A, Nicholson Road, Capton Azmat Shaheed Market Lahore 54000 Pakistan
e-mail: hvac@orientmarketing.com.pk **Website:** www.orientmarketing.com.pk

"ORIENT MARKETING"
 +92 (0) 3225200003
 +92 (0) 42 36365113
 +92 (0) 3351000013



AIRTECHZ Sole distributor of Air Curtains China



Member of Pakistan HVAC Society

Classification of Duct System

Ducts are classified in terms of velocity and pressure.

1.Velocity Classification: Ducts are classified into 3 basic categories

1. **Low Velocity Systems:** (Air velocities up to 2000 fpm).
2. **Medium Velocity Systems:** (Air velocities range of 2,000 to 2500 fpm)
3. **High Velocity Systems:** (Air velocities greater than 2,500)

2.Pressure Classification

Low Pressure: Low-pressure applies to systems with fan static pressures less than 3 inches WC. Generally, duct velocities are less than 1,500 fpm.

Medium Pressure: Medium pressure applies to systems with fan static pressures between 3 to 6 inches WC. Generally, duct velocities are less than or equal to 2,500 fpm.

High Pressure: High pressure applies to systems with fan static pressures between 6 to 10 inches WC. Usually the static pressure is limited to a maximum of 7 inches WC, and duct velocities are limited to 4,000 fpm. Systems requiring pressures more than 7 inches WC are normally unwarranted and could result in very high operating costs.

Principles of Duct Design

1. Basic Definitions
2. Air Flow Principles
3. Total Pressure,
4. Velocity Pressure
5. Static Pressure
6. Air Flow Characteristics in Duct



NOTE: All Correspondence including P.O. & Financial will be carried out with the name of
Fact: 14/S, Quaid-E-Azam Industrial Estate, KotLakhpat, Lahore -53100 Pakistan
OFF: 23-A, Nicholson Road, Capton Azmat Shaheed Market Lahore 54000 Pakistan
e-mail: hvac@orientmarketing.com.pk Website: www.orientmarketing.com.pk

“ORIENT MARKETING”
+92 (0) 3225200003
+92 (0) 42 36365113
+92 (0) 3351000013



AIRTECHZ Sole distributor of Air Curtains China



Member of Pakistan HVAC Society

Methods of Duct Sizing/Designing

There are three methods for duct size.

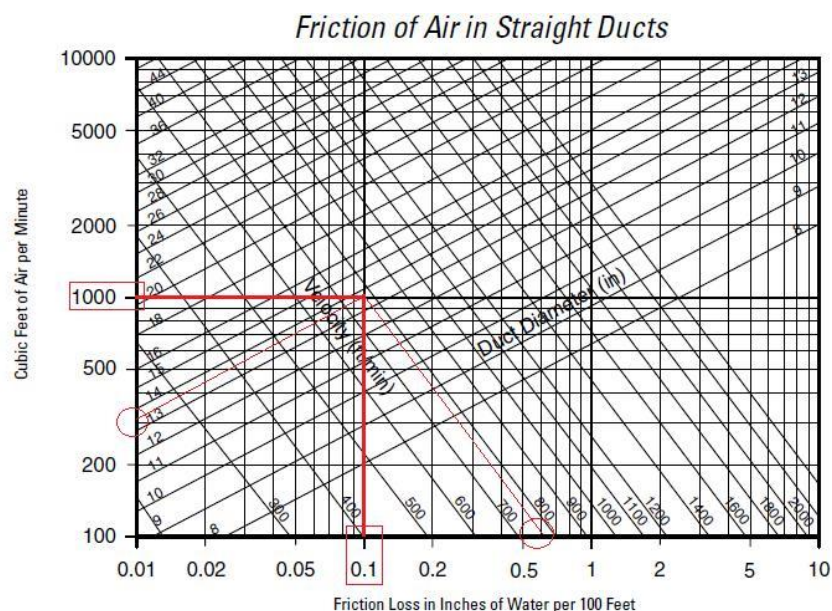
1. Velocity reduction Method
2. The equal friction method.
3. Static regain Method.

Method No.-1: Velocity Reduction Method

This method sizes the duct by varying the velocity in the main and branch ducts. The various steps are taken involving Selection of suitable velocities in the main and branch ducts.

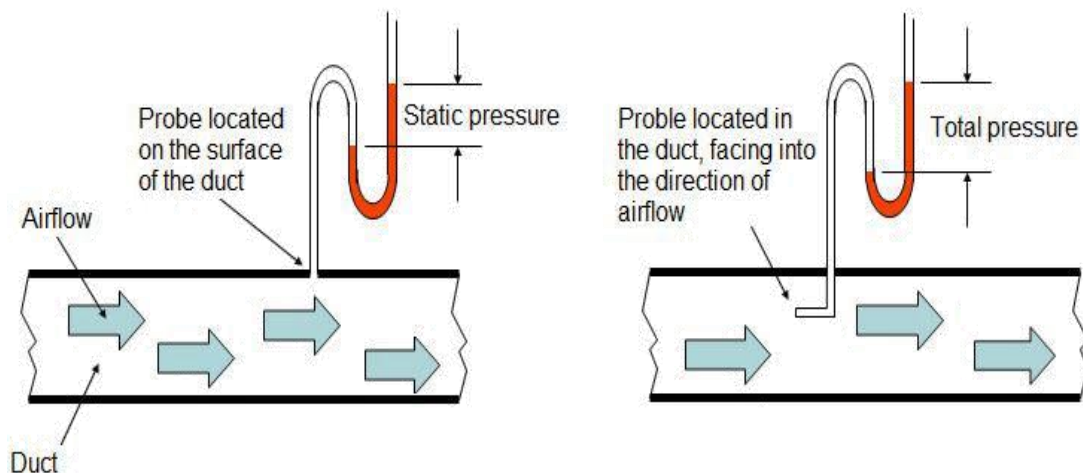
Method No.-2: Equal Friction Method

In the Equal Friction design method, we size the ducts for a constant “Friction Rate”, which describes the average pressure drop per 100 feet of duct in a system. A very common friction rate for a reasonably well designed system is 0.1 in.-wc per 100 ft. of duct length.



Method No-3: Static Regain Method

Static regain is the process of converting velocity pressure (VP) to static pressure (SP). It is based on Bernoulli's equation, which states that when a reduction of velocities takes place, a conversion of velocity pressure into static pressure occurs. With this method, the duct velocities are systematically reduced over the length of the distribution layout, which allows the velocity pressure to convert to static pressure, offsetting friction losses in the succeeding section of duct. This means there is the same static pressure near all the branches and all the diffusers and, therefore, the system design requires little or no balancing.



Uses of Gauge of Metal and Aluminum sheet as per Dimension

Rectangular Duct			Round Duct		
Greater Dimension	G. Steel (gauge)	Al (gauge)	Diameter	G.Steel (gauge)	Al (gauge)
Up to 30 inch	24	22	Up to 8 inch	24	22
31 – 60 inches	22	20	9 – 24 inches	22	20
61 – 90 inches	20	18	25 – 48 inches	20	18
> 91 inches	18	16	49 – 72 inches	18	16

Note that the lower the gauge, the thicker is the sheet metal.

3 Aspect Ratio

The aspect ratio is the relationship between the width (w) and height (h) of a duct, expressed as a ratio of w/h. Increasing the aspect ratio, increases both the installed cost and the operating cost of the duct system. A rectangular with an aspect ratio closer to 1 will use the lowest sheet metal. Other benefits include low friction drop, low weight of metal, and lower insulation and installation costs.

Example: A duct with a cross-sectional area of 4 sq.-ft. and 100-ft. length can be fabricated as 2' x 2' or 1' x 4' dimensions. In the **1st case**, 2' x 2', the perimeter=8 ft, total sheet metal required is 8 x 100=800 sq.-ft. In the **2nd case**, 1' x 4', the perimeter = 10 ft, total sheet metal required is 10 x 100 = 1000 sq.-ft.

As the aspect ratio increases from 1:1 to 1:4, the surface area and insulation requirements increase 40% percent.

4. Standard Duct Sizes

A standard air conditioner moves 400 cfm of air per ton. 1 ton-12000btu per hour. one Btu raise the temperature of water to one-degree Fahrenheit.

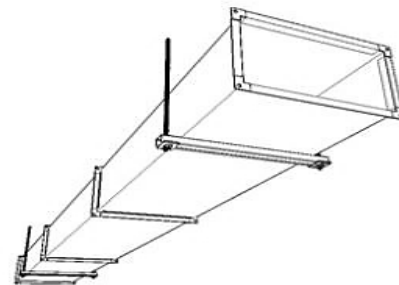
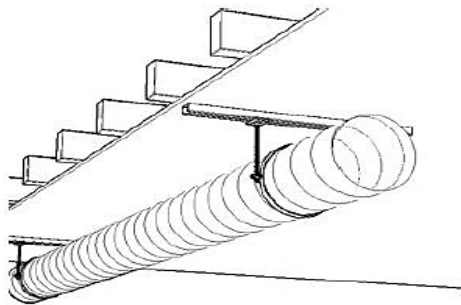
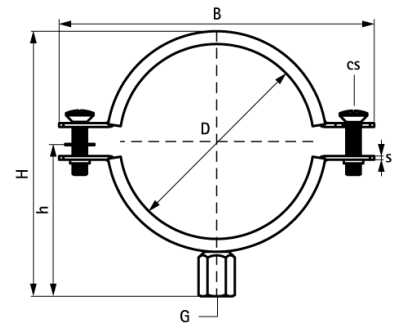
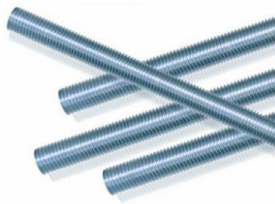
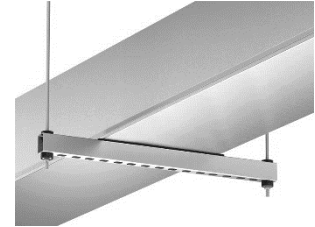
A 6-inch duct and an 8-inch duct carry about 100 cfm and 200 cfm of cool air, respectively. Here are some sizes for the supply duct that can be used.

Air Flow	Duct Diameter	Duct Size (1)	Duct Size (2)	Tonnage
100 cfm	6" round	5" x 6"	4" x 8"	
200 cfm	8" round	6" x 8"	4" x 12"	½ ton
300 cfm	9" round	10" x 7"	5" x 14"	¾ ton
400 cfm	10" round	8" x 10"	6" x 14"	1 ton
600 cfm	12" round	10" x 12"	8" x 14"	1½ tons
800 cfm	13" round	10" x 14"	8" x 18"	2 tons
1000 cfm	14" round	10" x 16"	12" x 14"	2½ tons
1200 cfm	16" round	10" x 20"	12" x 16"	3 tons
1400 cfm	16" round	12" x 18"	10" x 20"	3½ tons
1600 cfm	18" round	14" x 16"	12" x 20"	4 tons
2000 cfm	18" round	12" x 25"	16" x 17"	5 tons

Make sure that the return ducts are larger than, or at least the same size as, the supply ducts.

Hangers & Spacing For Hanging of Duct

Cross-Sectional Perimeter of Duct	Maximum Spacing between Hangers
Horizontal ducts less than 4 ft.	8 ft.
Horizontal ducts 4 ft. to 10 ft.	6 ft.
Horizontal ducts greater than 10ft.	4 ft.



Duct Hanger

Return Duct System

The duct through which it removes air from the conditioned building spaces and returns the air to the air handling unit. In some cases, part of the return air in this ductwork is exhausted to the building exterior.

The supply air must be balanced to maintain neutral air pressure within the space. This is done by designing ductwork with an adequate number of return ducts (or grilles). Return duct systems are generally classified as either central or distributed return.

1. Distributed Return

In a distributed return, each room has a return duct that provides a pathway for air to flow back to the air handling unit. The scheme ensures that the air flow is returned from all rooms, avoids too much positive pressurization, minimizes pressure imbalances, improves privacy, and is quiet. However, design and installation costs are generally higher than for a central return system, and higher friction losses can increase blower requirements.

2. Central Return

In a central return duct system, return grilles are located in central locations on the common plenum, usually close to the air handling unit. To ensure proper air flow from all rooms, especially when doors are closed, transfer grilles or jumper ducts must be installed in each room.

Central return ducts should have at least one 90 degree bend between the air handling unit and the central return grille, and the air speed at the face of the return grille should be designed at 350 fpm.

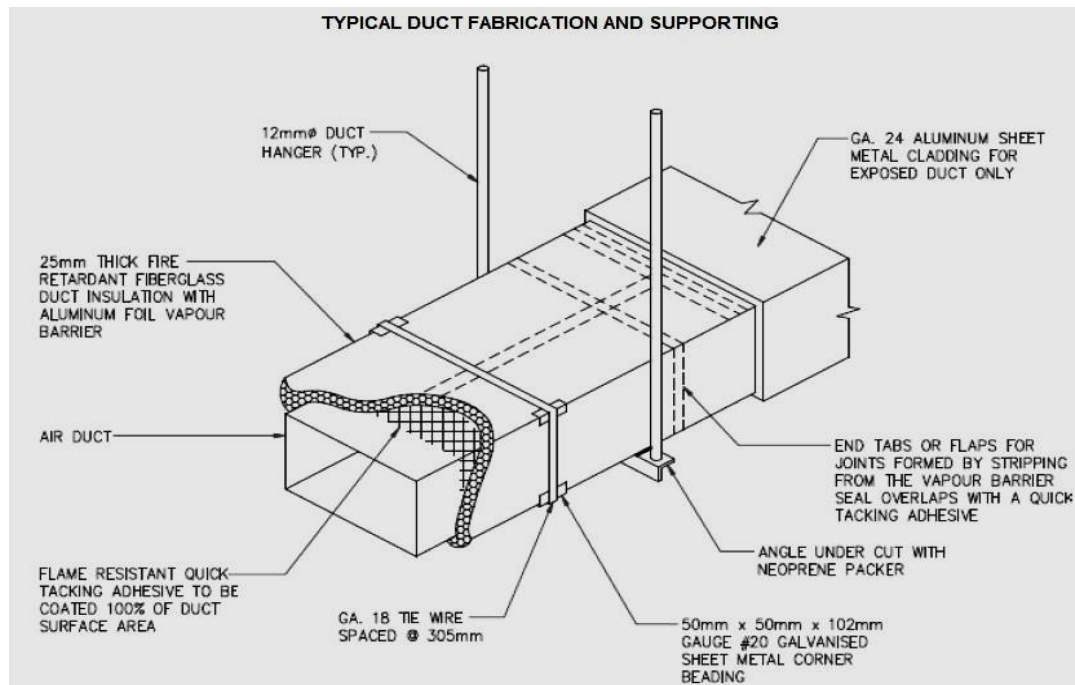
Duct Components

Plenum or Main Trunk: The plenum is the main part of the supply and return duct system that goes directly from the air handler to the “Trunk Duct”.

Trunk Duct: A duct that splits into more than one duct is called a “trunk”, Ducts that are on the end of a trunk and terminate in a register are called branches.

Take Off: Branch ducts are fastened to the main trunk by a takeoff-fitting. The takeoff encourages the air to enter the takeoff to the branch duct.

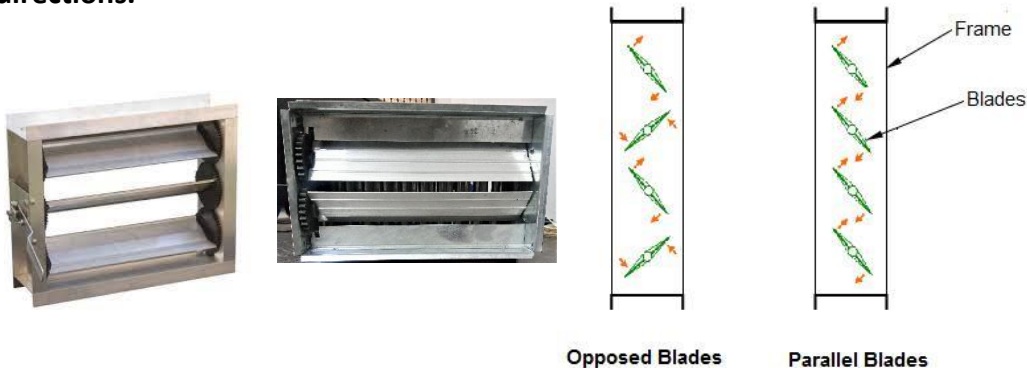
Air Terminals Devices: These are the supply air outlets and return or exhaust air inlets.



Air Devices

1. Volume Control Dampers (VCD)

Dampers are used to control air flow. They may be required to fully shut off air flow or regulate flow. Two main types are in use: parallel blades where the blades rotate in one direction, or opposed blades where the adjacent blades rotate in opposite directions.



Pressure loss across the damper and leakage through a closed damper are two performance criteria affecting the selection of dampers. Parallel blade dampers are best suited for full-open or closed requirements or for fine control between 80% to 100% full flow. Opposed blade dampers are best for systems where air volume is changed over a wide range. AMCA recommends using an opposed-blade damper when volume control is needed.

Balancing/volume adjusting dampers should be installed close to the main supply, as far away as possible from the outlets. Terminal dampers such as those used in registers and diffusers should not be considered in branch balancing as they are meant to be used for fine adjustment only and would normally be in an almost fully open position to prevent unnecessary noise.

Diffusers, Grilles & Registers

Diffusers are the terminal devices that supply air in various directions through the use of their deflecting vanes.



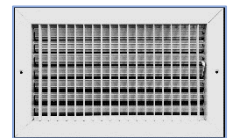
Grilles are defined as air devices that are typically used to return air back to the fan or to exhaust air from a space.

Registers look like grilles but are comprised of one-way or two-way adjustable air stream deflectors and dampers to restrict the amount of air flow required to be returned, supplied or exhausted.



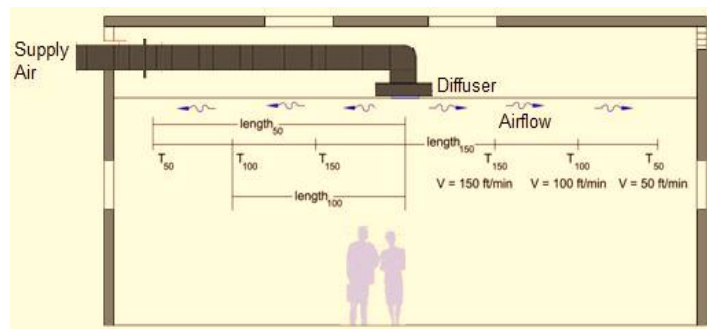
Air velocity: It is the normal air velocity used for comfortable air distribution is 50 fpm while the acceptable range is from 25 to 75 fpm.

Pressure drop: It is the pressure drop across the diffuser increases at higher velocities.



Noise Criteria (NC): NC increases at higher velocities. If a typical space requires a NC rating of 28-32, the corresponding maximum air flow is somewhere between 85 and 95 cfm.

Throw: Throw is defined as the horizontal distance from a diffuser at a specified velocity.



Air Leakage in Ductwork

A duct leakage test measures how much air leaks out of a duct system by pressurizing or depressurizing it. The air leakage can occur at joints, seams and penetrations. This leakage causes:

- 1) Reduce of air flow end of the run
- 2) The fan energy increases as the cube of the air leakage increases.

For example, if a system has 10% leakage and the fan design was originally 20 Horsepower (HP), the new motor required to overcome the 10% loss will be $20 \text{ HP} \times (1.1)^3 = 26.6 \text{ HP}$. In this case, the owner pays the equivalent of 6.6 HP in additional fan energy for the life of the building.

Duct Leakage Tests:

Air leakage in duct is tested commonly tested through Smoke Test Methods and Light Test Methods.

Removal of Air Leakage in Duct:

The approved material of duct sealant is applied on the duct joints prone to air leakages locations



Approved Sealants:

Sealants should be UL 181 listed, water based, non-toxic, and water resistant with high solids content. Approved sealants are flexible gaskets, fiber-reinforced mastic, or mastic used with mesh tape. Duct systems sealed with mastics generally exhibit lower leakage. Mastic sealant utilized should be water-based, non-toxic, consist of at least 50% solids, and be UL 181 approved.

Non- Recommended Material of Sealant:

Foil tapes, cloth-backed duct tapes, or pressure sensitive tapes are not suitable. Oil base caulking and glazing compounds should not be used.

ASHRAE Standard 90.1-2004 Ductwork Seal Classes

SMACNA-HVAC Ductwork Seal Classes:

- **Seal Class A:** 2 to 5 percent total system leakage (all transverse joints, longitudinal seams, and duct penetrations).
- **Seal Class B:** 3 to 10 percent total system leakage (all transverse joints and longitudinal seams).
- **Seal Class C:** 5 to 20 percent total system leakage (all transverse joints).
- **Unsealed:** 10 to 40 percent total system leakage.

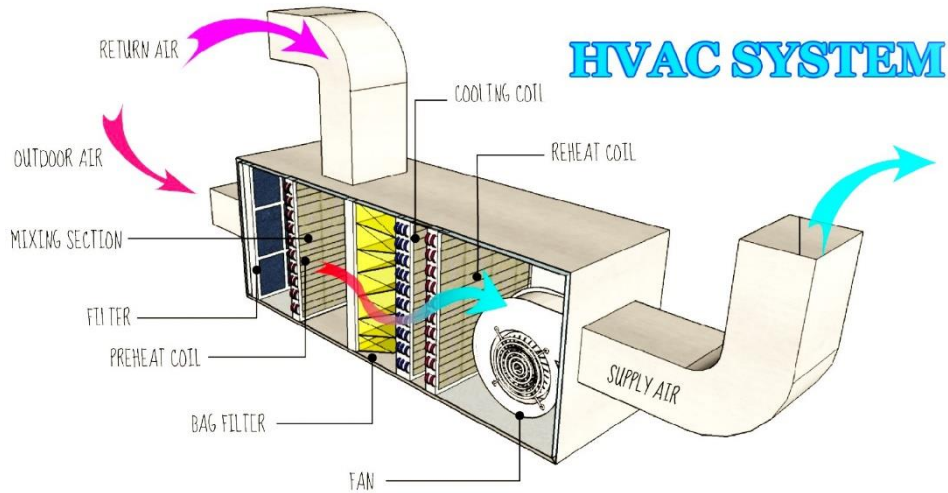
Insulation/Glass wool for Ductwork

Insulation or glass wool is applied on ductwork to minimize the rate of thermal loss through the skinny sheet metal. The Ducts may also sweat when the temperature of its surface is below the dew point of the surrounding air. This can lead to water damage and microbial growth within the building.

A 15°F temperature difference from the inside of the duct to the outside of the duct is considered the maximum difference allowed before insulation is necessary. One-inch-thick fiberglass blanket (R value of 16) is almost always sufficient for thermal protection. Return air ducts only need to be insulated if they pass through environments that adversely affect the return air temperature.

The insulation is joined by lapping it, stapling it, and taping it. A protective cover with a vapor barrier such as an aluminum foil should be included in the insulation specifications.



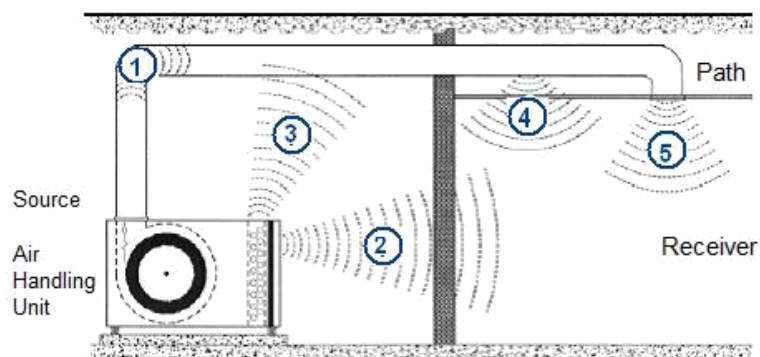


Attenuation and Noise in Duct

The HVAC industry has established noise criteria (NC) values for evaluating the acceptability of sound levels. NC values for different types of buildings range from 30 to 40 decibels. A decibel is a unit of comparative sound measurement (a whispered conversation at a distance of 6 ft. from the ear, for example, has a sound pressure level of 30 decibels).

HVAC Noise Points

The figure below shows the noise points from a typical HVAC system.



TYPICAL MECHANICAL SYSTEM NOISE COMPONENTS

The major source of noise:

The major sources of noise in air conditioning systems is due to air velocity as well as the noise from fan. The 5 distinct paths of noise are:

1. **Duct borne noise:** It is caused by the flow of air and directly dependent on the velocity of air.
2. **Radiated equipment noise:** It is caused by vibration of equipment and inherent sound pressure of the equipment.

- 3. Break-in noise:** It is radiated equipment noise that enters the ductwork and propagates down the duct system.
- 4. Break-out noise:** It transmits through the wall of the duct.
- 5. Terminal end noise:** It is caused by the air flows at the terminal devices such as diffuser or register.

Balancing Air of duct System

Air balancing is an act of adjusting the volume control dampers to equalize the friction losses.

3 Pressure Balancing

The return openings will need to be 2 to 3 times the size of the supply duct depending on system design velocities. This can take the form of transfer grille and jump ducts. A “Rule of Thumb” considers 1 square inch of wall opening per cfm delivered to the room.

Air Flow Measurement Instruments

Anemometer: The anemometer is a device used to measure the velocity of air travelling through a duct or grille. Readings are measured in feet per minute (fpm).

Air flow is measured in cfm, therefore:

$$\text{Air Flow (cfm)} = \text{Velocity (fpm)} \times \text{Area (ft}^2\text{)}$$

For example, if the mean velocity in a rectangular duct 12” x 24” is 1,000 fpm, the volume flow rate is $12 \times 24 \times 1,000 / 144 = 2,000$ cfm.

Rules of Thumb:

- **10% Rule:** For supply ducts longer than 10 feet, the air is reduced in that run by 10% for every 5 feet over 10 feet. For example, a 30 foot run yields a reduction of 40% ($30-10=20$, $20\div5=4$, $4\times10=40\%$). Minimize length and restrictions. Keep the supply duct length as close to 10 feet as possible but never less than 6 feet. Use the fewest number of bends as possible.
- **24-inch Rule:** Use at least 24 inches of straight plenum before any fitting, such as an elbow, tee, or takeoff. Electric duct heaters require 48 inches. Avoid elbows directly off units. The maximum total plenum length should be restricted to 150 ft. For the plenum, maximize length and minimize restrictions.
- **60/40 Rule:** When using a tee, split the flow as close to 50/50 as possible, no more than 60/40. Always use a turning vane.
- **70/30 Rule:** Turn the tee 90° to make a side branch with no more than 30 percent of the air. Do not use a turning vane.
- **Takeoffs:** Maintain distance between takeoffs as evenly as possible. Space the takeoffs at least 6 inches apart and 12 inches from the end cap.
- **Fittings:** Use long and radiused duct fittings instead of short or mitered fittings wherever possible.



NOTE: All Correspondence including P.O. & Financial will be carried out with the name of
Fact: 14/S, Quaid-E-Azam Industrial Estate, KotLakhpatt, Lahore -53100 Pakistan
OFF: 23-A, Nicholson Road, Capton Azmat Shaheed Market Lahore 54000 Pakistan
e-mail: hvac@orientmarketing.com.pk Website: www.orientmarketing.com.pk

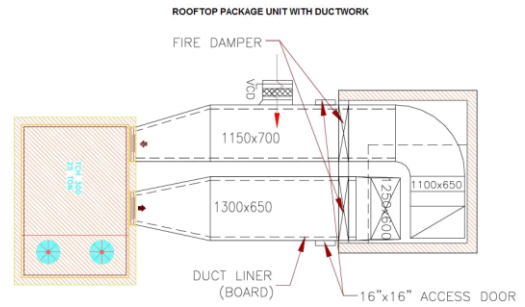
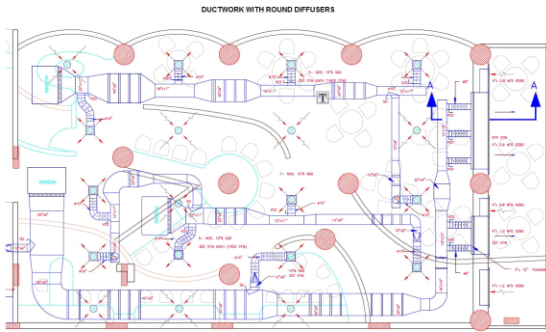
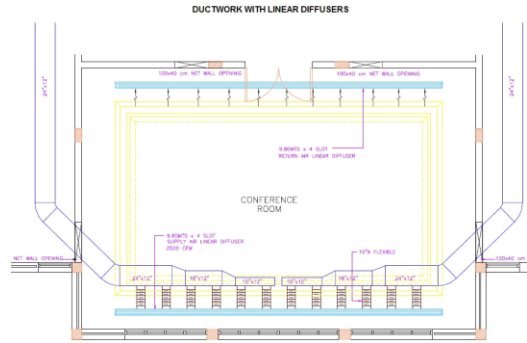
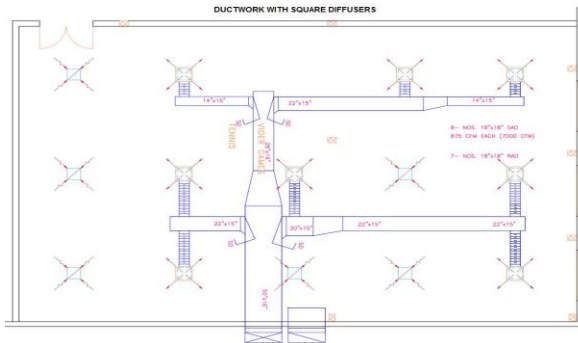
“ORIENT MARKETING”
+92 (0) 3225200003
+92 (0) 42 36365113
+92 (0) 3351000013



AIRTECHZ Sole distributor of Air Curtains China



Member of Pakistan HVAC Society



NOTES



NOTE: All Correspondence including P.O. & Financial will be carried out with the name of
Fact: 14/S, Quaid-E-Azam Industrial Estate, KotLakhpat, Lahore -53100 Pakistan
OFF: 23-A, Nicholson Road, Capton Azmat Shaheed Market Lahore 54000 Pakistan
e-mail: hvac@orientmarketing.com.pk Website: www.orientmarketing.com.pk

“ORIENT MARKETING”
+92 (0) 3225200003
+92 (0) 42 36365113
+92 (0) 3351000013



AIRTECHZ Sole distributor of Air Curtains China



Member of Pakistan HVAC Society



NOTE: All Correspondence including P.O. & Financial will be carried out with the name of
Fact: 14/S, Quaid-E-Azam Industrial Estate, KotLakhpat, Lahore -53100 Pakistan
OFF: 23-A, Nicholson Road, Capton Azmat Shaheed Market Lahore 54000 Pakistan
e-mail: hvac@orientmarketing.com.pk Website: www.orientmarketing.com.pk

“ORIENT MARKETING”
+92 (0) 3225200003
+92 (0) 42 36365113
+92 (0) 3351000013



AIRTECHZ Sole distributor of Air Curtains China



Member of Pakistan HVAC Society