Designing Your Dust Collection System

There are five simple steps to designing an effective and efficient dust collection system.

1. Draw a floor plan of your shop
2. Determine Duct Velocity (FPM)
3. Determine Diameter and CFM of each Branch
4. Determine Diameter and CFM of Main Duct
5. Figure System Resistance (SP - Static Pressure)

We ALWAYS recommended you do these calculations BEFORE you purchase your dust collector or ductwork. To properly size your dust collector, you NEED to know your CFM requirements and at what Static Pressure your system will be operating. Use the CFM and Static Pressure to compare the performance of your dust collector. The dust collector performance ratings should show that at your given Static Pressure, the CFM it will provide.

Important Terms to Remember

CFM - Air Volume in cubic feet per minute.

FPM - Velocity of Air in feet per minute.

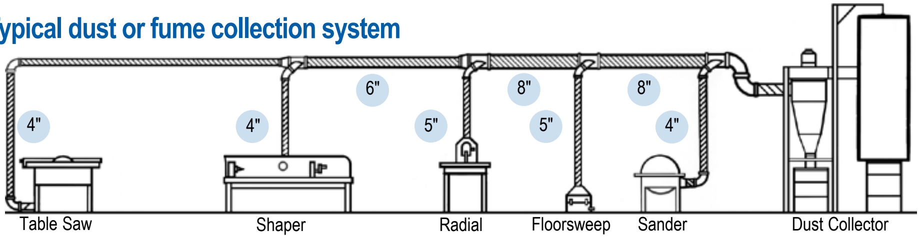
SP - Static Pressure. This is expressed in inches water gauge. It is resistance to air at rest in a duct, and is also commonly called "resistance," friction," "friction loss" or "pressure loss".

VP - Velocity Pressure: expressed in inches water gauge. It is kinetic pressure in the direction of flow necessary to cause air at rest to flow at a given velocity.

Important TIPS to Remember

- Machines with the biggest draw (highest CFM) should be placed nearest to the dust collector.
- The shorter the run the better, less resistance to air flow.
- The final duct run entry into the dust collector should be straight pipe and not an elbow or branch fitting. Minimum of 3 x diameter of straight pipe, for example 8" diameter x 3 = 24" straight pipe.
- If clean air return is utilized from the dust collector, the outlet diameter should be a minimum 2" larger than the inlet to minimize resistance, slow down the air flow, and decrease the noise level.
- One hanger is required for every 10ft of main duct, and at least one on each 10ft branch or less.
- The less flex hose used the better; flex hose has approximately 3 times the resistance to air flow than straight pipe.
- Lateral tees off the main trunk line should be horizontal, with elbows attached to drop vertically. This will prevent dust flowing through the main duct from falling into a lateral tee positioned vertically.

Typical dust or fume collection system



1. **The first step in designing your system is to draw a floor plan of your shop area including the following (see example, page 13):**
   - Location of dust producing machines, indicate size & location of dust pick-ups on each machine. Remember - Machines with the biggest draw (highest CFM) should be placed nearest to the dust collector.
   - Desired location of dust collector unit.
   - Floor to joist measurement.
   - Any obstructions that would interfere with the run of the duct.

2. Determine Duct Velocity (FPM)

Use the chart below to determine the Velocity of your system.

Type of Dust	Velocity in Branches	Velocity in Main
Metalworking Dust	4500 FPM	4000 FPM
Woodworking Dust	4000 FPM	3500 FPM
Other Light Dust	4000 FPM	3500 FPM

3. Determine Diameter and CFM of each Branch

There are several ways to determine the diameter of the branches.

- If the machine has a factory installed collar, the manufacturer has determined that the machine needs that size branch under normal circumstances.
- If the machine has a metric diameter outlet, convert it into inches, and round off to the nearest inch. When writing up your parts list you may need to order a custom reducer.
- If the outlet is rectangular you need to determine the equivalent round diameter. This will require a Transition, see page 35.
- If the branch is smaller than 3" dia., requirement is high velocity vacuum, not volume dust collection, it is recommended to use a shop vac.

Determine CFM requirement for each branch, use Chart 1. Under the proper velocity note the CFM of each branch. If working with wood dust, use 4000 FPM in branches.

Chart 1

CFM requirements at specified velocity.

Dia.	3500 FPM	4000 FPM	4500 FPM
3"	170	195	220
4"	300	350	390
5"	475	550	610
6"	700	785	880
7"	950	1100	1200
8"	1200	1400	1570
9"	1550	1800	1990
10"	1900	2200	2450
12"	2800	3175	3600
14"	3800	4300	4800

4. Determine Diameter of Main Duct

Determine which machines are your primary machines. A primary machine is the machine(s) that will operate at the same time under the worst conditions. (If you normally operate two machines, but once a week need to operate a third machine at the same time, then you must size your system for all three machines.) We generally highlight the primary machines on the drawing.

Sizing the Main Trunk Line. When sizing the main trunk line start with the primary machine **farthest** from the dust collector. Run that size duct until the next primary branch enters the main. Increase the main size at that junction to accommodate the CFM total of the two primaries. You will follow this practice all the way to the collector, sizing all primary junctions to accommodate total CFM of all primaries at that point. Do not increase main duct size when a branch other than a primary enters. Your total CFM requirement is the total of all primary branches. When not using a primary machine you will close blastgate and divert suction to a secondary machine.

EXAMPLE - A 4" branch will be run from the Table Saw until it joins with the 4" branch from the Shaper. At this point your main starts and you need to increase the pipe to handle the combined CFM (350+350 = 700). Using the CFM Chart 1 look up 700 CFM under the appropriate velocity (3500 FPM in the main for wood dust), then look at the corresponding diameter (6"). Run 6" pipe in the main from the Shaper until the branch of the Radial Saw joins the main.

Here again you need to increase your main to handle the total CFM (700+550=1250 CFM). Using the chart again you will see that 1250 CFM is slightly more than volume for 8” diameter. Drop back to 8” diameter so as not to go below transport velocity. Run the 8” duct in your main from the Radial Saw to your Dust Collector.

(continued on page 12)

5. Figure System Resistance (Static Pressure)

Static pressure is resistance to flow caused by friction and the channeling of airflow through a round pipe. If you turn on a dust collector with out anything attached to it - pipe, flex or filter bags, it will pull max volume at free air without any resistance. Attach filter bags and 10' of pipe to the inlet and you have added resistance. Add 20' more of pipe and so on - you increase resistance as you add more pipe and fittings.

It is the dust collector's job to overcome the ductwork resistance and pull the proper amount of CFM when you open a branch or branches in a central dust collection system. When you drink a soda with a regular straw it does not take much effort. If you have seen kids trying to drink a soda with those curly straws, they strain trying to get the soda to flow. They are trying to overcome the resistance of the long run.

You can run as much duct work in a system as long as the resistance has been compensated for and the CFM is delivered as required. "Inches of water" on a scale is used to measure the resistance in a duct system. It can be equated to the resistance to lift water by inches in a tube.

The total static pressure is several factors added together. They are entry loss, dirty filter loss, static pressure of the worst branch duct, static pressure of main duct, and static pressure of the return duct.

1. There are more complicated ways to figure the entry loss of your system, but we find it usually equals a loss of 1" watergauge. (**Use 1" as a constant**).

2. If your system has filters, add in a **2"** loss. (If you do not have filters add zero).

3. The Worst Branch, is the branch with the greatest resistance. The branch with the greatest resistance is usually a smaller diameter with the most lineal footage of pipe and elbows. Static pressure of worst branch and main duct can be calculated by using Chart 2. Chart 2 is based on 100 feet of pipe; therefore, you have to convert all elbows to an equivalent of pipe.

To convert 90° and 45° elbows to equivalent feet of pipe use Chart 2. When figuring the feet of pipe count lateral type branches as 45° elbows.

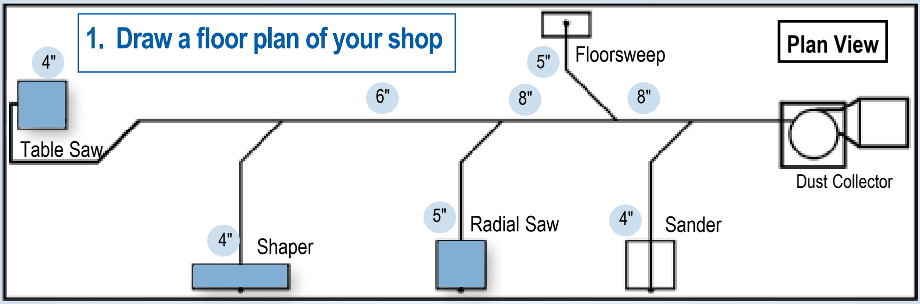
Flexhose has a lot of resistance depending on the corrugation. For this reason we suggest you keep hose to a minimum. Multiply your length of flexhose on your worst branch by 3 for equivalent length of straight pipe.

Chart 2

Static Pressure based on 100' of Pipe.				Elbow to Straight Pipe Conversion	
Dia.	**3500 FPM**	**4000 FPM**	**4500 FPM**	**90° Elbow 1.5 Dia. Rad.**	**45° Elbow 1.5 Dia. Rad.**
3"	7.5	10.0	12.0	5'	2.5'
4"	5.5	7.0	8.5	6'	3.0'
5"	4.2	5.5	6.5	9'	4.5'
6"	3.5	4.5	5.5	12'	6.0'
7"	2.8	3.8	4.5	13'	6.5'
8"	2.4	3.2	3.8	15'	7.5'
9"	2.0	2.8	3.4	17.5'	8.75'
10"	1.8	2.4	3.0	20'	10.0'
12"	1.5	2.0	2.5	25'	12.5'
14"	1.3	1.6	2.0	30'	15.0'

If you are installing an indoor recirculating dust collector you need not calculate any more duct diameters. If you are attaching ductwork to the exhaust side of your dust collector it is accepted practice to use a duct diameter two inches larger on the exhaust side than on the inlet side, thus minimizing exhaust and duct resistance. If clean air return duct is required, duct resistance should also be calculated.

Now you have all the information you need to make an educated decision in purchasing your dust collector. You have determined the Velocity, CFM, Static Pressure and the size of the ductwork. To develop your list of materials required, go through the system; this time starting at the dust collector and list each part you will need. Don't forget pop rivets, hangers, strapping, caulking, and couplings. If you have any questions while you are designing your system give us a call at 800-367-3828.



2. Determine Duct Velocity (FPM)

Wood Dust 4000 FPM in Branch and 3500 PFM Main

3. Determine Diameter and CFM of each Branch and Main Duct

You have 3 primary machines. You have assigned the branch diameter and CFM requirements.

Table Saw	4" Diameter	350 CFM
Shaper	4" Diameter	350 CFM
Radial Saw	5" Diameter	550 CFM

4. Determine Diameter and CFM of Main Duct

Total CFM of two 4" branches and one 5" branch pulling vacuum simultaneously 1,250 CFM

5. Figure System Resistance (SP - Static Pressure)

Determine Static Pressure (Inches of Water Gauge) in Worst Branch - 4" Table Saw.

Description - 4" Diameter	Equivalent to Straight Pipe
Straight Pipe	20'
2 - 90° Elbows	12'
2 - 45° Elbows	6'
5' Flexhose (3x)	15'
Total equivalent straight pipe after conversions	53'
350 CFM in 4" diameter = 7" S.P. per 100'	
350 CFM in 4" diameter = **3.71"** S.P. per 53'	

Static Pressure in MAIN DUCT 6" and 8" The static pressure of the Main Duct is done the same way, except you figure it out for each diameter in the Main, starting farthest away and working toward the collector.

Description - 6" Diameter	Equivalent to Straight Pipe
Straight Pipe	20'
Total equivalent straight pipe after conversions	20'
700 CFM in 6" diameter = 3.5" S.P. per 100’	
700 CFM in 6" diameter = **.70"** S.P. per 20’	

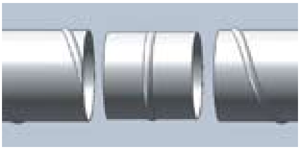
Description - 8” Diameter	Equivalent to Straight Pipe
Straight Pipe	25'
2 - 90° Elbows	30'
Total equivalent straight pipe after conversions	55'
1,250 CFM in 8" diameter = 2.4" S.P. per 100'	
1,250 CFM in 8" diameter = **1.3"** S.P. per 55'	
(8" Diameter runs to self contained Dust Collector)	

Total Static Pressure 1" (entry loss) + 2" (filters) + 3.71" (worst branch) + .70" (6” Main) + 1.3" (8” Main) = 8.71" SP Inches Water Gauge. **System Requirement: 1,250 CFM at 8.71" SPWG**

Installation of Spiral Pipe and Fittings

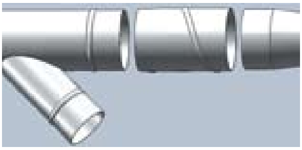
- Fittings and Small-End couplings are made small end to slip inside pipe and flexhose.
- Fitting-to-Fitting connections are made by using a large end coupling or a short length of spiral pipe.
- To facilitate installation, assemble groupings of pipe and fittings on floor. Minimize amount of connections on ladder.
- It is recommended that you place silicone caulking about one inch in and around the inside of the spiral pipe before you assemble any fitting. Secure the connection with steel (not aluminum) pop rivets. Place a second bead of silicone around the outside of the connection, and smooth around connection.

Pipe-To-Pipe Connection



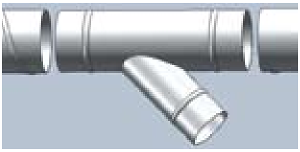
Spiral pipes are connected together by a sleeve type coupling (Part No. COUP). The coupling has a small-end and is slipped into the pipe sections. See page 18.

Fitting-To-Fitting Connection



Fitting-to-Fitting connections can be made by cutting a short length of spiral pipe and using this length of pipe as a large end coupling or by ordering a large end coupling (Part No. COU2). See page 18.

Fitting-To-Pipe Connection



All fittings are sized to slip into mating pipe sections or flexhose. No additional coupling will be needed.

Friction Loss and Air Leakage

Two problems with high velocity systems are friction loss and air leakage. The installer has to install the high-pressure system without causing possible friction losses or air leakage problems. Do not crimp the ends of the fittings to make assembly easier. The crimping puts interference in the air stream, which adds friction loss to the system. Crimping can also create noise problems. Excessive clearances in sizing of the pipe and fittings can cause problems in sealing the system to make it airtight. Hunting and patching leaks in an installed system is tedious and stressful.

Your duct and fittings are sized to fit tightly for 3 good reasons.

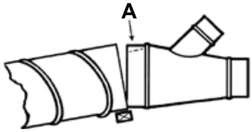
1. The joint has a minimum friction loss condition.
2. The tight fit makes the joint easy to seal against air leakage
3. Noise is reduced with a tighter joint.

Connection of duct and fitting

Starting the fitting into the duct.

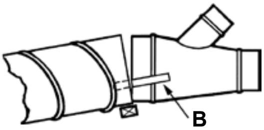
A sharp blow by a sheet metal hammer or mallet on the top of the fitting collar can help the collar to seat into the duct. Be careful not to dent the collar.

Starting the collar into duct, impact at A.



When a sub-assembly is put together on the floor, raise the end of the duct to support it off the floor with a piece of wood. Tilt the fitting slightly and start the bottom part of the fitting collar into the duct.

Starting the collar into duct, drive blade B in direction of arrow.



A strip of metal can be slipped into the space between the duct and fitting and driven around the joint circumference. The fitting is worked to keep the collar in, but do not push too hard and bind the end of the duct and fitting so the fitting can't slip into the duct.