Dust Collection

The importance of dust collection & choosing the right type of duct for dust collection

Why you need a dust collection system

Installing an efficient dust collection system should be a priority for the small shop as well as the large shop, whether the material being machined is wood, plastic, or a composite. Not only is this essential for health reasons and compliance with many national and local codes, but it is also good business because it saves money and helps to maintain the quality of the finished product.

The harmful health effects of inhaled particulates (many of which are carcinogens) are well documented, and skin, eye, and nose problems as well as allergic reactions are frequently reported. In addition, a dusty shop increases the risk of worker injury and fire, which can result in lost production, higher insurance rates, and lawsuits.

A dusty shop compromises the quality of the finished product: Accurate measurements and cuts are more difficult due to lack of visibility; airborne dust finds its way into finishing areas causing defects in the final product; and larger particles cling to surfaces cause scoring and other defects.

Finally, dust that is not automatically collected must be collected manually as a recurring direct labor expense.

By any measure, an efficient dust collection system is an investment that more than pays for itself.

Designing a dust collection system

In the simplest terms, a dust collection system is comprised of a ducting system to transport the dust from the source (table saw, planer, etc.) and a collection device (such as a bag and filter system or a cyclone), which pulls the dust through the ducting and collects it. The very first decision you must make is whether your ducting will be metal or plastic—and here there is only one logical choice: metal. (See "Metal vs. Plastic Duct" below.) The next step is to size your system. (See "Designing Your System" on pages 41-44.)

Metal vs. Plastic Duct

Plastic pipe (or PVC pipe) is unsuitable for dust collection for three reasons:

- First, plastic pipe fittings are not offered in the diversity required to meet design requirements.
- Second, plastic pipe elbows have a short radius, which encourages clogs and compromises system efficiency.
- Third, and most important, plastic pipe is non-conductive and builds up a static charge as charged particles pass through it. This static charge can discharge at any time causing shock and surprise, which is dangerous around running machinery. More serious is the risk of explosion and fire. Fine dust particles suspended in air have significant explosion potential—all that is needed is a spark, which the static charge on plastic pipe conveniently supplies. Grounding plastic pipe requires wrapping it in wire both inside and out—an expensive (and never certain) proposition that negates the minimal price savings in going to plastic in the first place.

Spiral steel pipe has none of these disadvantages. An incredible variety of fittings are available and custom fittings can be easily fabricated. The fittings are designed with long radius to minimize clogging, and special fittings such as clean-outs and quick disconnects are available. Most important, Spiral metal pipe is conductive, and simple and easy to ground, even when flexible rubber hose is used to connect the duct to the machine.

Spiral Manufacturing Co., Inc.
11419 Yellowpine Street N.W. • Minneapolis, MN 55448-3158
Phone: 763-755-7677 • 800-426-3643 • Fax: 763-755-6184

Standard dust collection components
& accessories

Dust Collection

Spiral Manufacturing has all the duct components you need to design and build a safe and efficient dust collection system

Laterals *(Pages 12-14)*

Reducers *(Page 15)*

Elbows *(Pages 5-6)*

Blast Gates *(Pages 31-32)*

Clean-outs *(Page 30)*

Floor Sweeps *(Page 17)*

Clear Flex Hose *(Page 33)*

Manifolds *(Page 14)*

Custom Hoods *(Page19)*

Clamps *(Page 34)*

Bellmouth *(Page 17)*

Duct Sealants *(Page 27)*

Dust Collection

How to design an efficient dust collection system with Spiral pipe.

Designing Your System

There are two phases to designing your dust collection system: The first phase is sizing your duct work for adequate volume and velocity of flow for the type of dust you will be creating; and the second phase is computing the *static pressure* (SP) of your system to determine the size and power of your dust collection unit.

Prior to making your calculations, diagram the floor plan of your shop to scale on graph paper. Include the size and location of each machine, and the location of its dust port or outlet; the floor to joist dimension; the location of the dust collecting unit; and the most efficient (fewest number of turns or bends) path for routing your duct lines. This is also a good time to start your take-off list of duct components for your system.

You will also need to familiarize yourself with the following concepts:

CFM (Cubic Feet per Minute) is the volume of air moved per minute.
FPM (Feet per Minute) is the velocity of the airstream.
SP (Static Pressure) is defined as the pressure in the duct that tends to burst or collapse the duct and is expressed in inches of water gage (˝wg).
VP (Velocity Pressure), expressed in inches of water gage (˝wg), is the pressure in the direction of flow required to move air at rest to a given velocity.

CFM is related to FPM by the formula CFM = FPM x cross-sectional area (ft^2). FPM is important because a minimum FPM is required to keep particles entrained in the air stream. Below this minmum FPM, particles will begin to settle out of the air stream, forming clogs—especially in vertical runs. Table 41-1 shows the minimum FPM that Spiral Manufacturing recommends for several types of dust in branch and main runs.

Step 1

From the Table 41-1 determine the velocity (FPM) of your system for the type of dust that will be produced. For the purpose of the following examples assume woodworking dust. Wood dust requires 4500 FPM in branches and 4000 FPM in mains.

Table 41-1: Velocity for Type of Dust

Type of Dust	Velocity in Branches (FPM)	Velocity in Main (FPM)
Metalworking Dust	5000	4500
Woodworking Dust	4500	4000
Plastic/Other Light Dust	4500	4000

Step 2

Determine the diameter of each branch line. You can use the diameter of a factory installed collar or port, or consult the manufacturer. Convert metric ports to the nearest inch. Convert rectangular ports to the equivalent round diameter. Ports less than 3" will require a reducer to 4". Record any reducers or rectangular to round transitions on your take off list.

Step 3

Using Table 41-2, determine the CFM requirement of each branch. Remember the FPM for wood dust in branch lines is 4500.

Example: Table saw 4" dia. 390 CFM (rounded)
Planer 5" dia. 610 CFM (rounded)
Lathe 6" dia. 880 CFM (rounded)
Continue for all branches.

Table 41-2: CFM for for pipe diameter at specified velocity

Diameter	3500 FPM	4000 FPM	4500 FPM
3"	277	316	356
4"	305	348	392
5"	477	546	614
6"	686	784	882
7"	935	1068	1202
8"	1222	1396	1570
9"	1546	1767	1988
10"	1909	2182	2455
12"	2749	3142	3534
14"	3742	4276	4810

For larger diameters see pages 59-60.

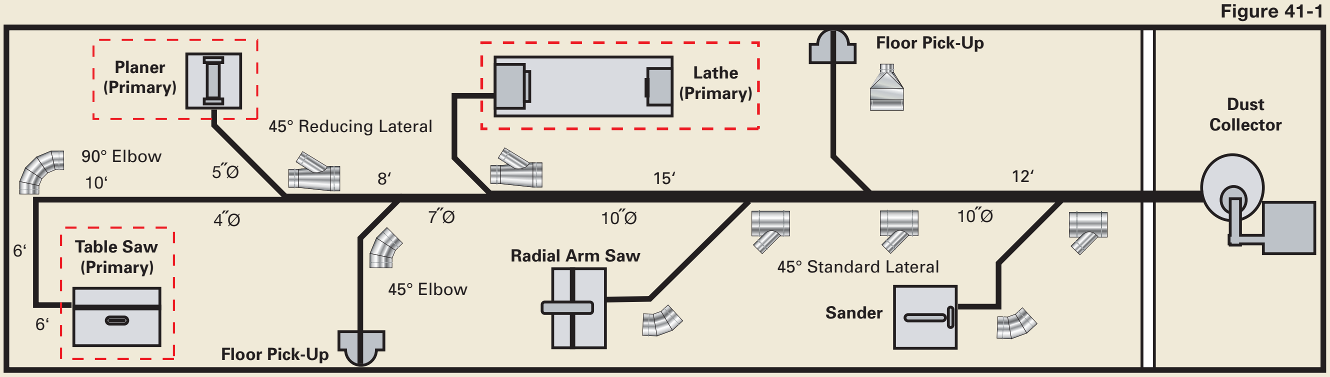
Step 4

Identify your primary or high-use machines. These are the machines that operate simultaneously on a frequent basis. The objective here is to define your heaviest use scenario so you can size your system to meet it. Including infrequently used machines and floor pick-ups in your calculations will only result in an over-designed system that will cost more to purchase and to operate. At this point, all of your branch lines are sized, and you have a list of all components required for your branch lines.

Step 5

Now you are ready to size the main trunk line. Begin with the primary machine that is *furthest* from where you will place the dust

Figure 41-1



Spiral Manufacturing Co., Inc.
11419 Yellowpine Street N.W. • Minneapolis, MN 55448-3158
Phone: 763-755-7677 • 800-426-3643 • Fax: 763-755-6184

How to design an efficient dust collection system with spiral pipe.

collecting unit. In our example, this is the table saw, which has a branch diameter of 4". Run this 4˝ Spiral pipe to the point where the second primary machine (the planer on a 5˝ branch) will enter the main. (Note: If a non-primary machine or pick-up is added to the system between primary machines, the size of the run is not increased.)

You now have a 390 CFM line (table saw) and a 610 CFM line (planer) combining for a total of 1000 CFM. Using Table 41-2 again, you will see that for 4000 FPM (the velocity requirement for main line that you determined in Step 1) the required pipe diameter falls between 6" and 7". (Note: Spiral Manufacturung recommends that you round up to 7". This not only assures adequate air flow but also anticipates a future upgrade in machine size.)

Now calculate for the addition of the third primary machine (the lathe on a 6˝ branch). You have an 1000 CFM main + an 880 CFM branch line (for the lathe) for a total of 1880 CFM. Using Table 41-2 once again, 1880 CFM at 4000 FPM requires between a 9" and 10" pipe. We recommed rounding up to a 10" main after the addition of the lathe. The main going to your dust collecting unit will be 10", and your dust collection unit must be capable of pulling 1880 CFM through a 10" duct at 4000 FPM.

Step 6

In this step, you calculate the Static Pressure (SP) or the resistance of your system that your dust collection unit must overcome. Static Pressure is measured in inches of water gage (˝wg). To do this you total the Static Pressures of the following system component groups**:**

1) The branch line with the greatest SP or resistance (see Figure 42-1). Calculate the SP of all branchs to determine which has the greatest SP. Only the branch with the greatest SP or resistance is added to the total.
2) The SP of the main run (see Figure 42-2).
3) The SP for the collection unit's filter, if any, and for the pre-separator, if any (see Figure 42-3).
(You can use the charts on pages 51-60 to assist in your calculations.)

Figure 42-1

1) Calculate the SP of the branch with the greatest SP:
(4 feet of flex hose and one 90° elbow not shown)

Starting at the machine and working toward the main, determine the SP of each branch line component, and then total them. In our example, the branch with the greatest loss is the table saw branch, and it calculates out as follows using an FPM of 4500 for branch lines:

	SP (˝wg)
Entry loss at machine adaptor collar is 1.5 SP (a constant)	= 1.5
Four feet of 4˝ flex-hose*: Chart 57-1 shows 4˝ flex-hose (at 390 CFM) = .8 SP ÷ 100 x 4 x 27.7 = .886 SP (˝wg)	= 0.886
Three 4˝ 90° elbows: Chart 51-1 shows one elbow = .28 SP loss (˝wg) x 3	= 0.84
Three branch runs of 4˝ pipe (6+6+10) = 22': Table 55-2 shows 8.8 ÷ 100 x 22'	= 1.94
Total SP loss (˝wg) for the table saw branch equals:	**5.17**

Figure 42-2

2) Calculate the SP of the main:

In our example the main has one 8' run of 7" Spiral pipe, two runs (15' and 12') of 10" Spiral pipe connecting the main to the dust collector. In addition, there are 5 lateral reducers in the main. Our calculations for 4000 FPM in the main are as follows:

	SP (˝wg)
Eight feet of 7˝ Spiral pipe: Table 55-2 shows 3.55 ÷ 100 x 8	= 0.28
Twenty-seven feet (15 + 12) of 10˝ pipe: Table 55-2 shows 2.30 ÷ 100 x 27	= 0.62
Total SP loss (˝wg) for the main run:	**.90**

Figure 42-3

3) Calculate the SP for the collection units filter and seperator:

For these calculations, consult with the manufacturer of the collection units you are considering. For this example, we will assume that there is no pre-separator an that the SP for the filter is 1.5.

Total SP for filter: 1.50

Summing the SP loss for the system, we have:

1) Highest loss branch:	5.17
2) Loss for main:	.90
3) Filter loss:	1.50
Total SP loss (˝wg) loss in the system):	**7.57**

You now have the information you need to specify your dust collector. ***Your dust collection unit must provide a mimimum of 1880 CFM through a 10" duct at 4000 FPM, and have a static pressure capability of no less than 7.57 (˝wg).***

Additional Considerations and Recommendations:

The above example is for a small system with few variables. It is recommended that for larger systems a professional engineer be consulted to assure that the system is properly designed and sized.

If the dust collector is located in a seperate enclosure, it is essential to provide a source of make-up air to the shop to prevent a down draft through the flue of the heating system. If this is not done, carbon monoxide poisoning could result. If a return duct is necessary from the dust collector, it should be sized two inches larger than the main duct entrance and its SP loss added into your calcualtions.

Some dust collection units may not include fan curve information that shows CFM or Static Pressure variables. We do not recommend procuring collector equipment without this information.

Blast gates should be installed on all branch lines to maintain system balance.

Dust suspended in air has a potential for explosion, so it is recommended that you ground all of your duct runs, including flex-hose.

If your system has areas where long slivers of material could possibly hang-up and cause a clog, install a clean-out near that area.

Many types of dust, including many woods are toxic, so take special care to choose a filtering system that will provide optimal safety.

*** Flex-hose should be wire wrapped helix hose to permit grounding. See photo on page 33.**

Dust Collection

Exhaust Volumes & Conveying Velocities for a Variety of Production Machines

This list of recommended exhaust volumes and pipe sizes for average sized metal working and woodworking machines is based on many years of experience and the work of many people. Some modern high speed or extra large machines will require higher velocities than shown. Smaller machines may use less air than shown. The air volume required to capture the dust at the machine will vary with each operation. Particle size and hood type must be considered. The following charts will provide an excellent guide to determine your total air volume requirements.

Caution: One of the most important factors in an efficient dust collection system is proper hood design. Hoods must be designed so that the dispersed particles are thrown or deflected directly into the hood opening. The large heavy particles thrown out by the cutting heads or wheels have such a high speed that their trajectories cannot be altered by a vacuum system regardless of its velocity. In addition hoods should be placed as close to the source of dust contamination as possible since the effectiveness of an exhaust hood decreases very rapidly as it is moved away from the source. The following recommended pipe sizes are based on the use of reasonably good hoods.

Wide belt and abrasive sanders, moulders and shapers with high R.P.M. spindles often call for higher duct velocity (through hoods supplied by manufacturers) than those indicated on the charts. In these cases caution must be used.

The following charts are recommended for machines with good hood enclosures. (Also check with the machine manufacturer for their recommended velocities.)

Table 43-1: Recommended Conveying Velocities for Various Production Machines

Gang Rip Saws

Recommended Velocity 4,200 to 5,000 F.P.M.

Total Blade Dia. (in.)	Exhaust Volumes and Pipe Diameters at 4500 ft. Velocity			
	CFM	Dia.	CFM	Dia.
Up to 24'' incl.	610	5"	390	4"
25'' to 36 incl.	880	6"	610	5"
36'' to 48'' incl.	1200	7"	610	5"
Over 48'' incl.	1570	8"	880	6"

Disc Sander

Recommended Velocity 4,200 to 5,000 F.P.M.

Disc Dia. (in.)	Exhaust Volumes and Pipe Diameters at 4500 ft. Velocity	
	CFM	Dia.
Up to 12"	390	4"
13'' to 18''	610	5"
19'' to 32''	880	6"
33'' to 38''	1200	7"
39'' to 48''	1570	8"

Floor Sweep

Recommended Velocity 4,200 to 5,000 F.P.M.

Size	Exhaust Volumes and Pipe Diameters at 4500 ft. Velocity	
	CFM	Dia.
5"	610	5"
6"	880	6"
7"	1200	7"

Floor Sweeps are not added to the total load of the exhauster as they are in operation only a few minutes at a time. (Mouth of floor sweep 10'' x 4'' to 12'' x 4" approx.)

Single Surfacer

Recommended Velocity 4,200 to 5,000 F.P.M.

Knife Width (in.)	Exhaust Volumes and Pipe Diameters at 4500 ft. Velocity	
	CFM	Dia.
Up to 6'' wide	390	4"
7'' to 12'' wide	610	5"
13'' to 20'' wide	880	6"
21" to 26" wide	1570	8"
27'' to 36'' wide	1985	9"
Over 36'' wide	2450	10"

Jointer

Recommended Velocity 4,200 to 5,000 F.P.M.

Knife Width (in.)	Exhaust Volumes and Pipe Diameters at 4500 ft. Velocity	
	CFM	Dia.
Up to 6"	390	4"
7'' to 8"	610	5"
8'' to 18''	880	6"

Turning Lathes

Recommended Velocity 4,200 to 5,000 F.P.M.

Turning Length (in.)	Exhaust Volumes and Pipe Diameters at 4500 ft. Velocity	
	CFM	Dia.
Up to 12"	880	6"
13'' to 24''	1570	8"
25'' to 36''	1985	9"
37'' to 48''	2450	10"

Horizontal Belt Sander

Recommended Velocity 4,200 to 5,000 F.P.M.

Belt Width (in.)	Exhaust Volumes and Pipe Diameters at 4500 ft. Velocity			
	CFM	Dia.	CFM	Dia.
Up to 6"	880	6"	610	5"
7'' to 9"	1200	7"	880	6"
10'' to 14''	1985	9"	1200	7"
Over 14"	2450	10"	1200	7"

Circular Saw

Recommended Velocity 4,200 to 5,000 F.P.M.

Blade Dia. (in.)	Exhaust Volumes and Pipe Diameters at 4500 ft. Velocity	
	CFM	Dia.
Up to 10"	390	4"
12'' to 14''	610	5"
16'' to 20''	880	6"
24'' to 30''	1570	8"
Variety Saws with Dado Heads	1200	7"

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Phone: 763-755-7677 • 800-426-3643 • Fax: 763-755-6184

Exhaust Volumes & Conveying Velocities for Dust Producing Equipment

Table 44-1: Usual Exhaust Volumes and Conveying Velocities for Dust Producing Equipment

Dust producing equipment	Exhaust hood	Exhaust requirements	Conveying velocities in FPM
Abrasive blast rooms (sand, grit or shot)	Tight enclosure with air inlets (usually in roof)	60 - 100 fpm downdraft (long rooms of tunnel proportions 100 fpm cross-draft)	4,000
Abrasive blast cabinets	Tight enclosure with access openings	20 air changes per minute but not less than 500 fpm through all openings. Openings to be baffled	4,000
Bag tube packer	Booth or enclosure (provide spillage hopper)	500 cfm/filling tube; 500 cfm at feed hopper; 950 cfm at spill hopper	4,000
Barrels (for filling or removing material)	Local hood 180 deg. around top of barrel	100 cfm/sq. ft. barrel top min.	4,000
Belt conveyors	Hoods at transfer point	Belt speeds less than 200 fpm - 350 cfm per foot of belt width, but not less than 150 fpm through open area. Belt speeds over 200 fpm - 500 cfm per foot of belt width but not less than 200 fpm through open area	4,000
Shakeout conveyor	Continuous hood with take-off max. of 30 ft. apart	350 cfm per ft. of belt width with air inlets every 30 ft.	4,000
Belt wiper (may required with high speed belts)	Tight fitting hood held against under side of belt	200 cfm per foot of belt width. Not recommended for wet belts as in ore conveying	4,500
Bins (closed bin top)	Connect to bin top away from feed point	200 fpm through open area at feed points, but not less than 0.5 cfm per cu. ft. of bin capacity	4,000
Bucket elevators	Tight casing required	150-200 fpm at all openings.	4,000
Ceramics Dry Pan Dry Press	Enclosure Local	200 fpm through all openings 500 fpm Automatic feed, 1-5 in. dia. branch at die. Manual feed, 1-5 in. dia. branch at die. 500 cfm	4,000 4,000
Vibrating feeders-shakeout hopper to conveyor	Complete enclosure	200 cfm per sq. ft. of opening (Provide rubber or canvas flexible seals between shake-out hopper sides and end and also feeder sides and end)	4,000
Floor grate	Side hood	For heavy loads of dry dust and continuous dumping or feeding operations, treat same as shake-out side hoods, see below	4,000
	Downdraft	When used occasionally, 200-250 cfm per sq. ft. of grate area - depending on fineness and dryness of material	4,000
Grinder Swing frame	Booth	100-150 fpm indraft through opening in booth face for large opening. Never below 100 fpm. Small opening with grinder in front use 200 fpm	3,500
Grinders Portable and flexible shaft	Downdraft grilles Use side shields where possible	Bench type, 150-250 cfm per sq. ft. of exhaust grille but not less than 150 cfm per sq. ft. of plan working area Floor grille, 200-400 cfm per sq. ft. of exhaust grille but not less than 100 cfm per sq. ft. of plan working area	4,000
Mixer	Enclosure	150 minimum fpm through working and inspection openings	4,000
Shake-outs Foundry	Enclosure	200 fpm through all openings in enclosure, but not less than 200 cfm per sq. ft. of grate area	4,000
Apron conveyor for light flask work	None	Ventilate conveyor equivalent to 75 to 100 cfm per sq. ft. of gross grate area, assuming all grates open at any one time	4,000
Belt conveyor for light flast non-ferrous castings	None	Same as above	4,000
Shaker conveyor above floor-snap flask work	Side or overhead hood	Ventilate housing at rate of 125 to 150 cfm per sq. ft. gross open area. Assume all doors open at one time. Include area between housing and conveyor sides in volume determination. Usual clearance 1 in. or less on each conveyor side	4,000
Tunnel ventilation	Enclosure	When vibrating shake-out hoppers are located in a closed tunnel, ventilate the tunnel at 100 cfm per sq. ft. of tunnel cross section. Exhaust from transfer points can provide all, or part of, air required. Any additional exhaust required should be taken in rear of shake-out hopper	4,000
Screens Vibrating flat deck	Enclosure	200 fmp indraft through hood openings, but not less than 50 cfm per sq. ft. of screen area	4,000
Cylindrical	Enclosure	100 cfm per sq. ft. of circular cross-section but not less than 400 fpm indraft through openings in enclosure	4,000
Miscellaneous, Packaging, machines, granulators, enclosed dust producing units. Packaging, weighing, container filling inspection	Complete enclosure Booth Downdraft	100-400 fpm indraft through inspection or working openings, but not less than 25 cfm per sq. ft. of enclosed plan area 50-150 cfm per sq. ft. of open face area 95-150 cfm per sq. ft. of dust producing plan area	4,000 4,000 4,000