# Airflow Restriction

**... The resistance to the flow of air through the air cleaner system; typically measured in inches of $H_20$ or kPa.**

## What Exactly is Restriction?

Restriction across the air cleaner is the difference in static pressure between the atmosphere and the outlet side of the system being measured. *Analogy: trying to pull liquid through a straw that is kinked vs. one that is not. Obviously, the greater the kink, the harder it is to move liquid through.*

Air in an intake pipe acts much the same way. Any time the direction of the air is changed, there is a resulting pressure that increases the restriction of the system. While we can't totally avoid direction changes, they should be minimized.

**Conversions:**

1" $H_2O$ = 0.0361 psi = 0.249 kPa
1 cfm = 0.0283 $M^3$/minute
1" = 25.4 mm
1 lb-ft = 1.35 N•m

## Include Entire Airflow System When Calculating Initial Airflow Restriction

Any intake system design should incorporate the best protection at the lowest initial restriction possible. Because each intake component contributes to the total restriction of the system, it is recommended that the position of the air cleaner be as close to the engine as possible. It is also important to minimize the elbows, bends and long runs of ductwork.

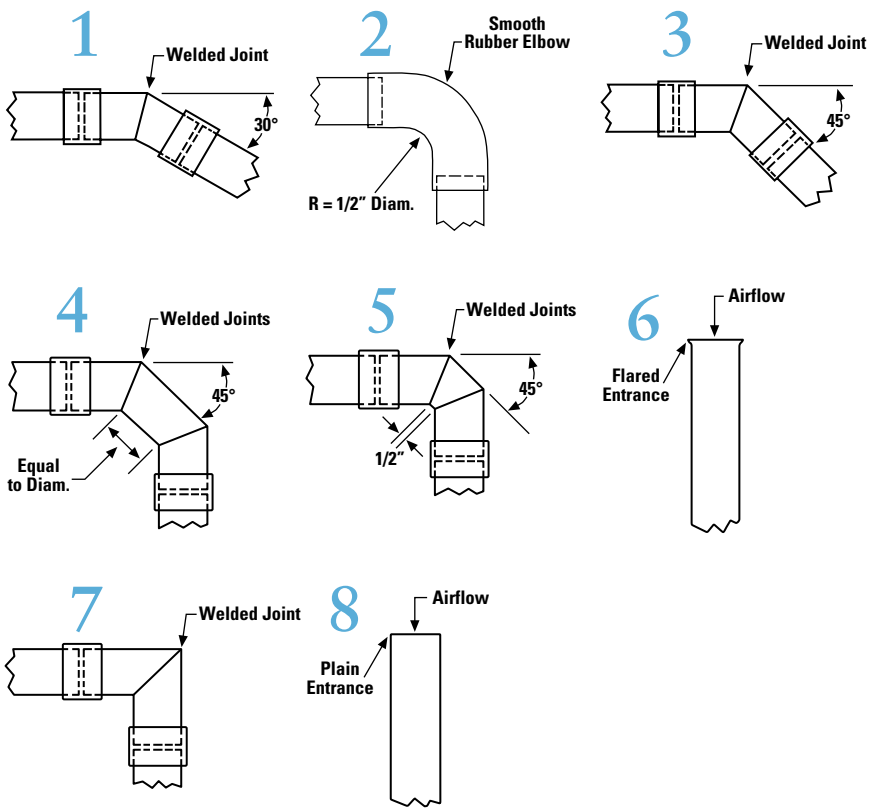
Changing the direction of the intake air movement causes restriction, which causes the engine to work harder. While this is something we like to avoid, the reality is that it cannot be avoided totally...but just how much is too much, and what can be done about it?

## The Affect of Elbows & Entrance Diameters on Air Cleaner System Restriction

Generally, the smoother the direction change, such as radiused tubes versus mitered bends, the lower the restriction. A 30° bend (figure 1) adds the least amount of restriction, while the 90° bend (figure 7) adds significantly more.

Remember that even straight pipe causes restriction and pipe with a cut-off blunt end will add much more than one with a flared inlet end. The slight flare makes a major difference in air turbulence, and consequently, in restriction.

Not only bends, but length of pipe is also a factor. For further details on the amount of restriction added to the system by piping and bends, see the next page.



# The goal...

1. Minimize the number of bends AND
2. Use bends that cause the least amount of restriction



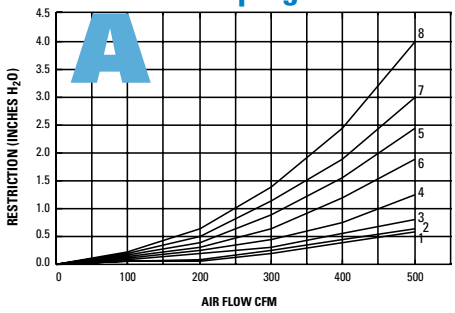
Graphs A, B, C, D and E show the amount of restriction of different piping diameters, with various types of bends (illustrations 1-8 as shown on opposite page), at various airflow levels. You will notice that the smoother the direction change, such as radiused tubes versus mitered bends, the lower the restriction. A 30° bend (shown in illustration 1) adds the least amount of restriction, while the 90° bend (shown in illustration 7) adds significantly more.

You may think it odd that straight pipe (shown in illustration 8) causes the highest amount of restriction! This is because of the blunt end. Compare the restriction curve to illustration 6, which shows a flared end. The slight flare makes a major difference in air turbulence, and consequently, in restriction.

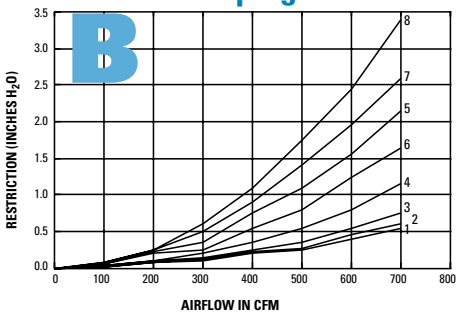
Length of pipe is also a factor, as shown in graph E. Find the line that represents your pipe diameter at the airflow level you're running to give you a restriction figure for each foot of pipe length; then multiply by the length (in feet) of your plumbing and you have the amount of restriction added by that length of pipe. (See example below graph E.)

These curves should allow you to do a quick calculation on the plumbing you are planning for your system. Add this figure to the restriction of your air cleaner (and pre-cleaner when used) to know if your system is too restrictive for the engine. Many engine manufacturers specify restriction limits for new, "clean" engine air intake systems.

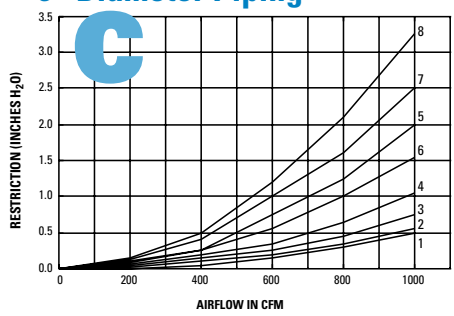
## 4" Diameter Piping



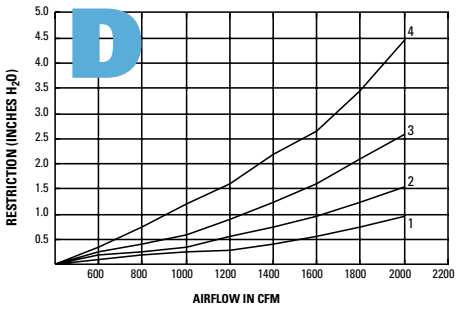

## 5" Diameter Piping



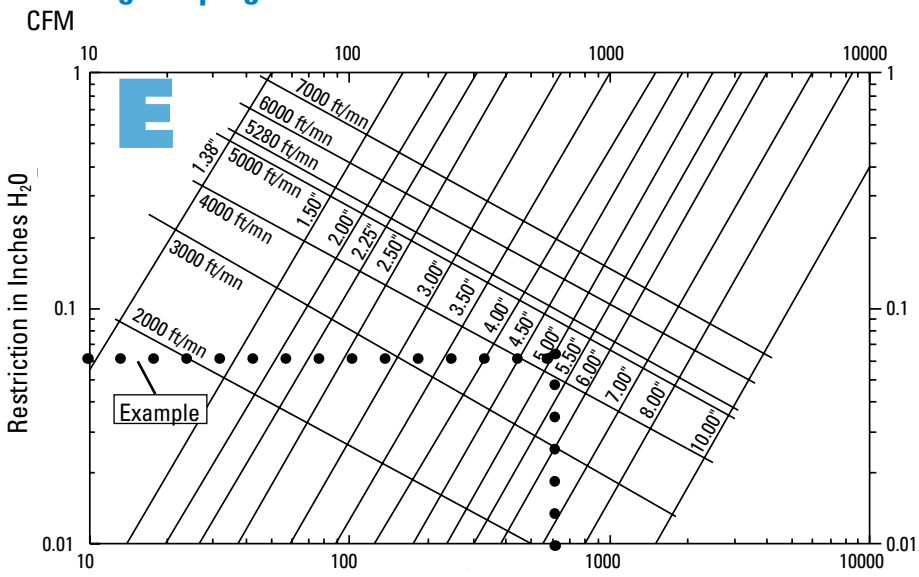

## 6" Diameter Piping




## 7" & 8" Diameter Piping




## Straight Piping of Various Diameters




**Example** **(Assuming a 600 cfm system with 5" piping)**

1. At 600 cfm on horizontal axis, draw a line up to the 5" diameter line.
2. Draw a line from that intersection point over to the vertical axis to find the restriction point, in this case .06 $H_2O$.
3. Calculate: .06 x 10 feet of piping = .6" $H_2O$. This means that the 10 feet of 5" diameter piping add .6" $H_2O$ of restriction to the engine air intake system.