

Infiltration, the Real Story

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Every spring and fall we are told to get ready for the coming heat or cold season by sealing up our homes. Weatherstrip the doors and caulk the windows is the message we hear in newspapers and on TV. While this advice will help, it only addresses part of the problem.

The science of air flow (infiltration)

There are three basic principles that need to be understood when looking at air infiltration (air moving into or out of a house).

- 1) For air to move into or out of a building you need two things, a hole and a pressure to force air through the hole. No hole -- no leakage. No pressure -- no leakage. For the past 30 years we have been told over and over to seal the holes. When was the last time you heard anything about pressures?
- 2) Air will move from an area of high pressure to an area of low pressure. If something causes the pressure inside the home to be lower than an adjacent space (outside, attic, garage...) the air will move from that area into the house. Conversely if the pressure inside the house is higher than an adjacent space, the air will move from the house into the adjacent space.
- 3) When air moves out of a house, the same amount has to come in. Or, if air flows into a house, the same amount has to leave the house.

Pressures, what pressures?

There are three things that will cause pressures in a building; wind, stack (hot air rising, cold air falling) and fans.

In the past when we looked at the energy use of residential buildings caused by infiltration, only the impact of wind and stack was considered. Because these are natural forces which we can not control, reducing pressures was not included in actions we could take to control infiltration.

Today, we now know that these natural pressures are not the only cause of pressures and infiltration. In some climates (desert southwest), these natural pressures may only play a minor role in a home's total infiltration. Fans (exhaust fans, dryers, air handlers) can create pressures in a home that can cause infiltration rate that are much higher than infiltration caused by natural pressures. Studies have shown that infiltration caused by fans can be as much as three to ten times higher than infiltration caused by natural pressures. How can this happen, simple, the fans can create pressures in a home that are much higher than natural pressures. The higher the pressures created, the higher the amount of air movement through the holes.

Air Flow and Energy

Air flow is the most important factor in a home's performance when it comes to being healthy, safe, durable, comfortable and energy efficient. If you cannot get control of air flow it is very difficult to control performance.

Regardless of climate, we all strive to keep the hot or cold outside air out and the air we spent

money conditioning in. To accomplish this we need to understand how pressures created by fans impact infiltration. In this article I will concentrate on the impact that the air handler can have on pressures and air flow into and out of a home.

Air Handler

The air handler is the large fan that moves the home's conditioned air through the duct system to all parts of the house. If designed and installed properly, the air handler will not create pressures. Unfortunately, in a large percentage of homes there are problems with the air handler's design or installation that can cause large house pressures and infiltration rates that will greatly increase heating and cooling costs. The two main areas of concern with the air handler are duct leakage and door closure.

Duct Leakage

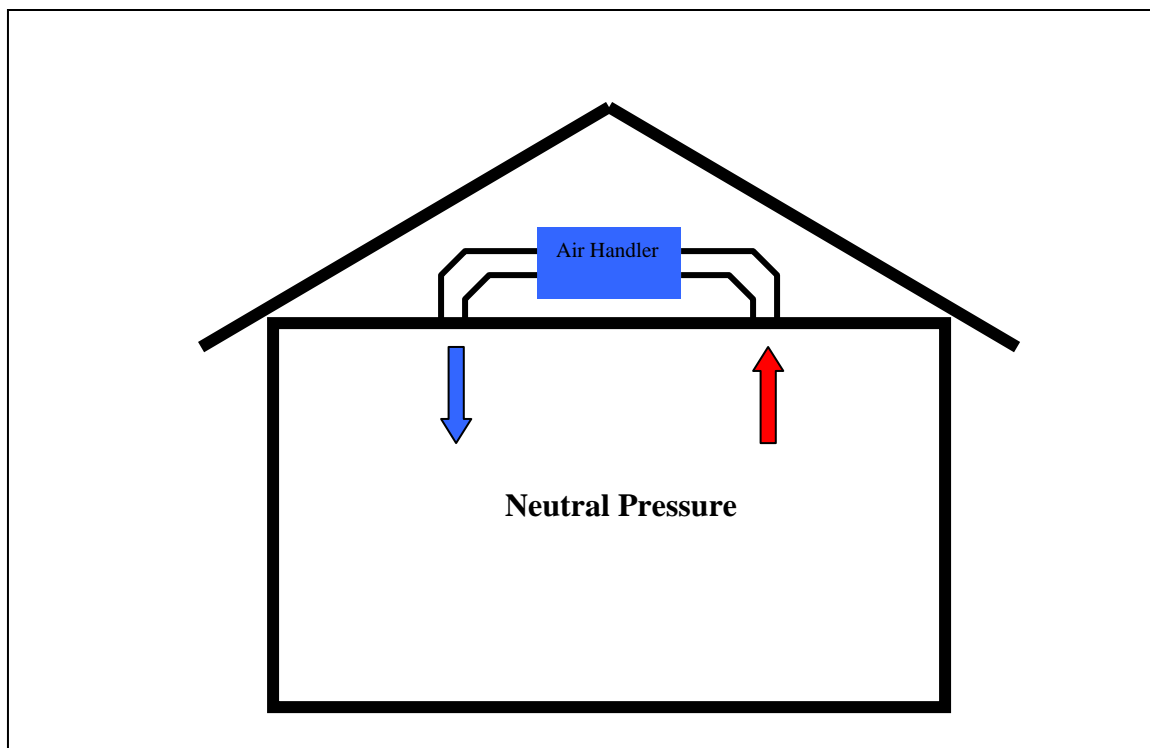
Studies have found that on average 20 percent of the air in a forced-air duct system leaks. In and of itself this leakage is bad. After all, who wants to heat or cool air and then just blow it outside!

For more information on duct leakage visit:

www.energystar.gov/ia/products/heat_cool/ducts/DuctSealingBrochure04.pdf

www.codecollegenetwork.com/az/air_cond.html

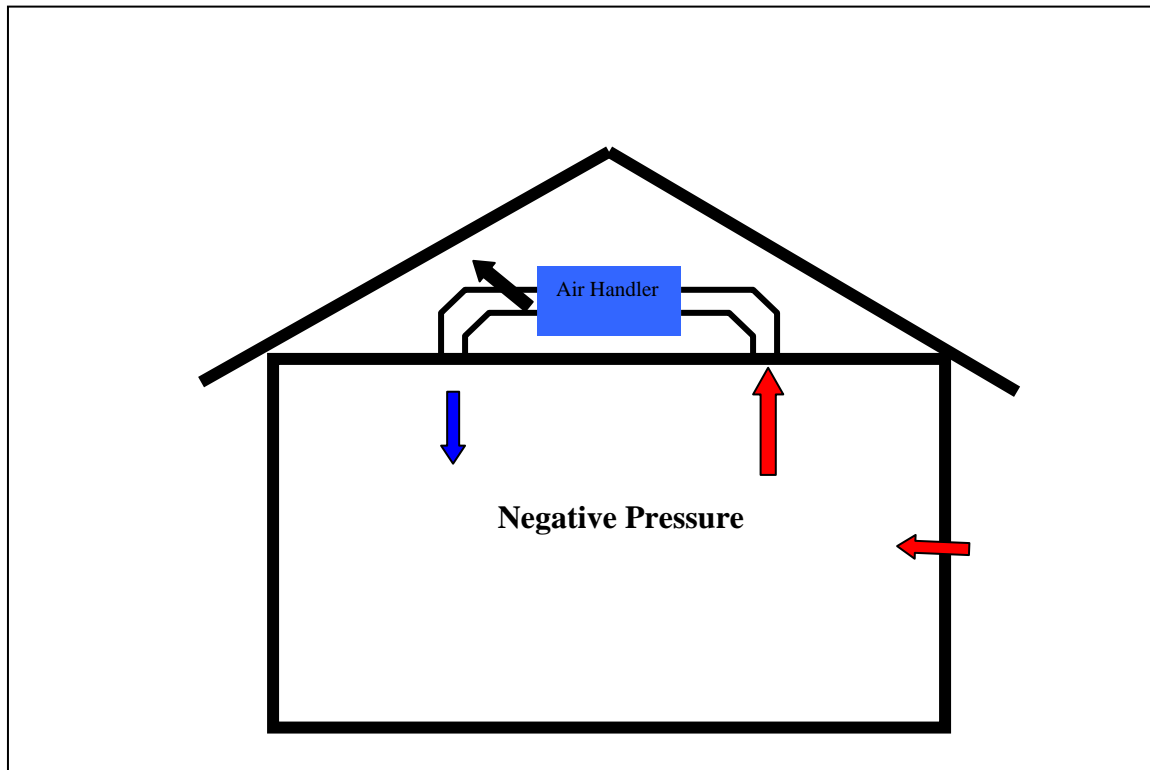
But there is an additional impact this has on your home, duct leakage also increase the infiltration rate in your home.



In a duct system with no leakage, the same amount of air is pulled in to the return side (red arrow) as is blown out of the supply side (blue arrow) of the system. The flow into the return is equal to the flow out of the supply so there is a neutral pressure.

Supply Leaks

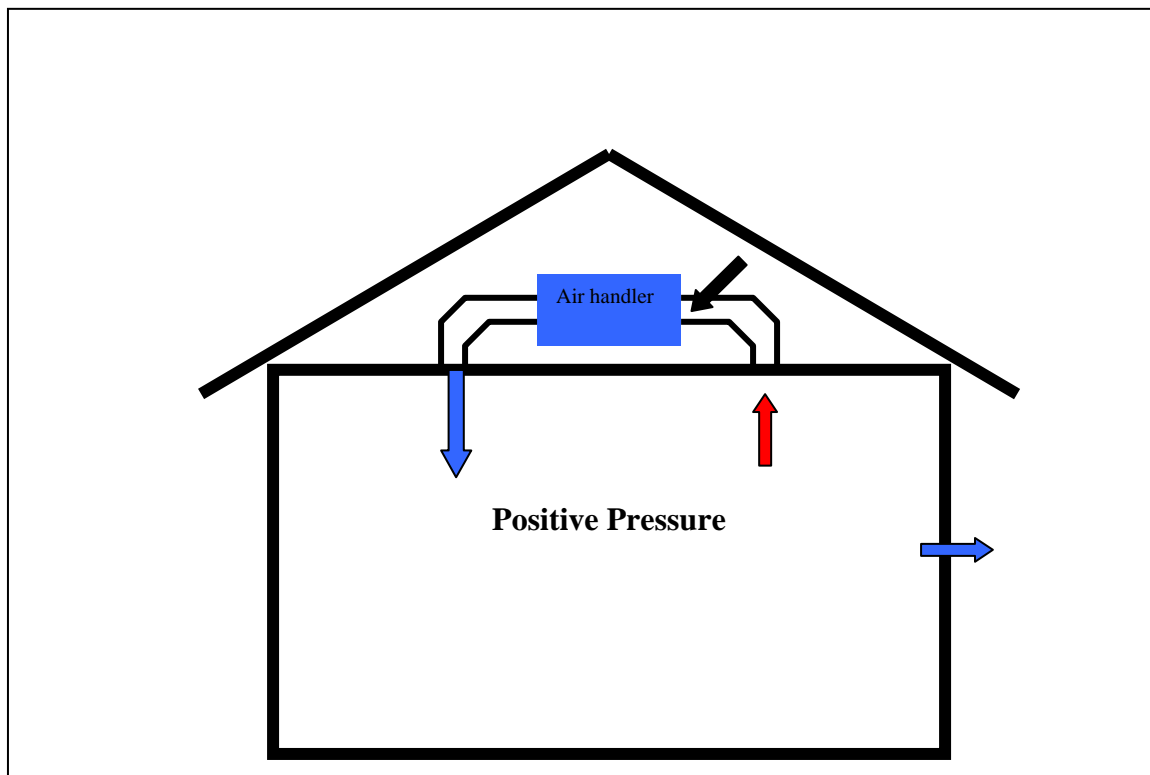
The air handler distributes the heated or cooled air through the supply ducts to all the rooms in your home. What happens if there are leaks in the supply side of the duct system that will lose air to the outside or attic?



Now we have less air being delivered to the house because some of it leaks (black arrow) out into the attic. Because of this leakage, the flow into the return (red arrow) is greater than the flow out of the supply (blue arrow). This will create a negative pressure in the home, pulling the same amount of outside air into the house that was leaked out of the supply duct. You are taking air that you spent money conditioning and blowing it outside and then replacing it with unconditioned air from outside that you need to spend money conditioning.

Return Leaks

The air handler draws air from the house to be heated or cooled through the return duct system. Leaks in the return system will also create pressures in the house that will increase infiltration.

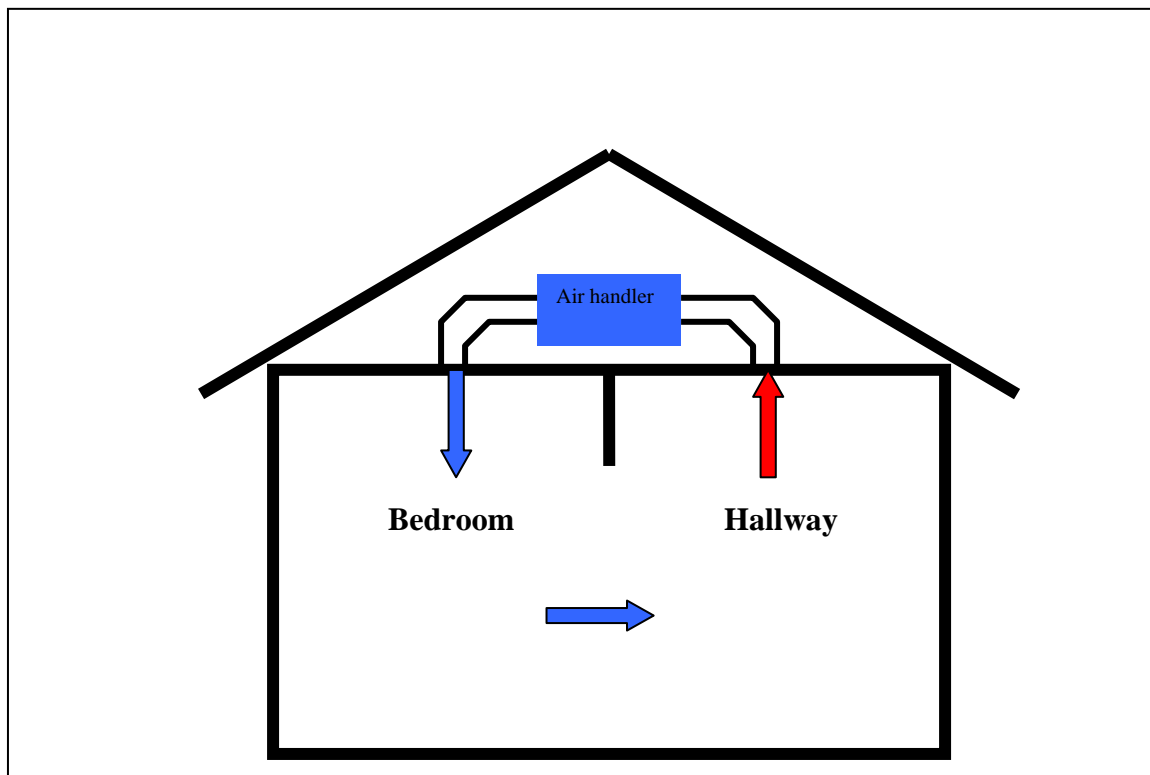


With return leaks (black arrow), air from outside or the attic is drawn into the return duct system and delivered throughout the house. Now the amount of air from the supply (blue arrow) is greater than the air flow into the return (red arrow). This will create a positive pressure, pushing the same amount of conditioned air out of the house that was leaked into the return duct. Now you are drawing hot or cold air into your duct system, spending money to condition it and then blowing it right back outside.

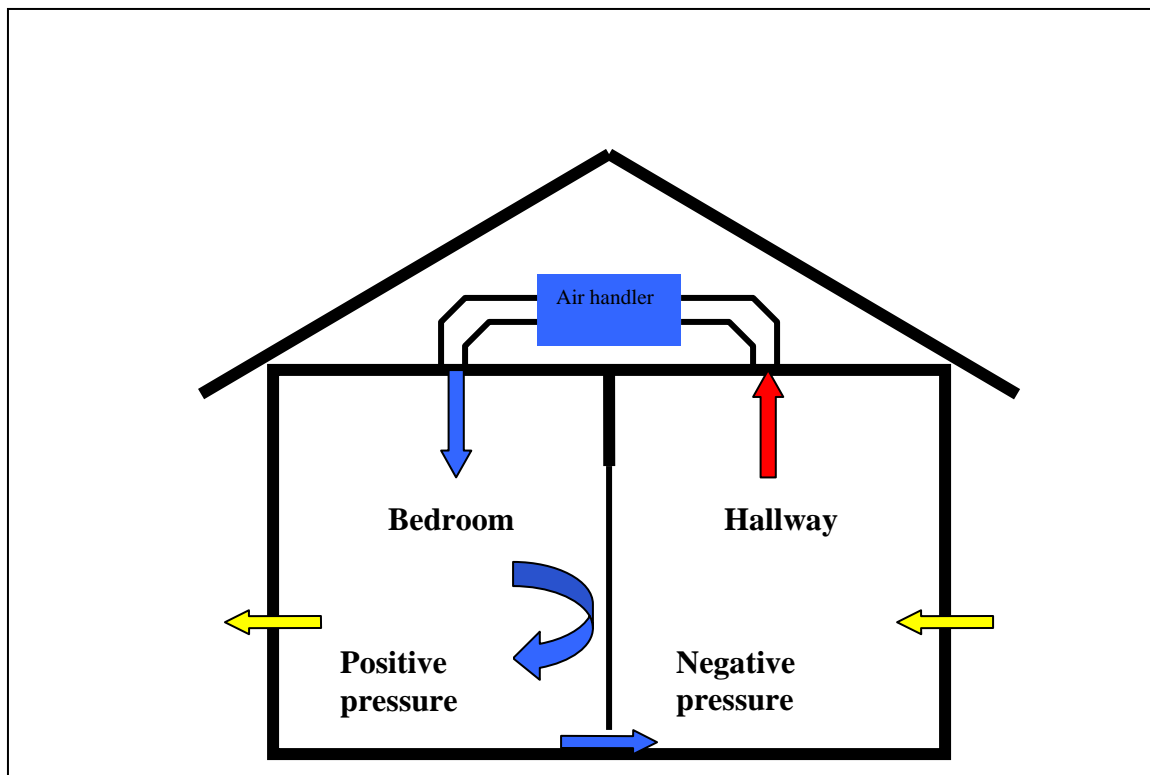
Duct leakage will get you coming and going!

Door Closure

Most people do not know this, but closing interior doors can increase your heating and cooling cost. Again it has to do with creating pressures.



In most of today's homes there is only one return located in the hallway. The return draws air from the house to be heated or cooled and distributed back to the individual rooms by the supply system. When the doors to rooms are open, the air has a free path back to the return. The one flaw in this system is the doors. Doors are designed to be closed.

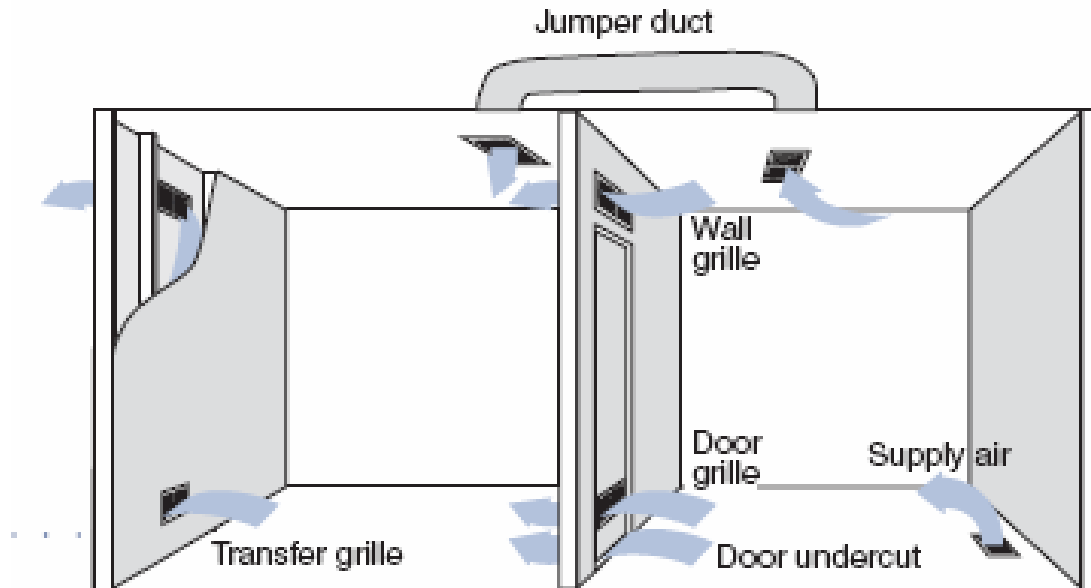


When a door is closed into a room with a supply, the air handler is forcing air into an enclosed space, creating a positive pressure. Think of this as blowing up a balloon. This pressure will force air out of the room in all directions. Some of this air will make its way back to the return, but some will also be forced outside. On the other side of the door the return is creating a negative pressure in an attempt to draw the trapped air back. But because some air was forced outside by the positive pressure, the return will draw the same amount of air in from the outside. It is amazing the amount of pressures that can be created in a house just by closing interior doors. It is not uncommon for pressures created by just closing doors to be five to ten times greater than natural pressures.

There is a very simple test to determine if this is happening in your home. When your air handler is on, get your hand wet (this makes it easier to feel air flow), and open a door about a quarter of an inch. Standing in the hallway, put your hand by the gap, if you feel air moving out of the room your air handler is creating pressures and costing you money. The faster it moves, the more it is costing you.

Remove your doors?

We do not have to remove the doors to solve this problem. A way for the air to get out of the room back to the return, called a return path, must be created. There are a number of ways that this can be done.



Return paths

You can just under cut the door, but in most cases you would need to cut off about six inches of the bottom of the door. The door undercut can be used in combination with one of these other methods, reducing the size of the additional return path.

The simplest method is a grill straight through the wall or in the door (wall grille/door grille). With this method there are issues with light and sound transfer through the grille. To reduce light and sound transfer, the grilles through the wall can be offset, using the wall cavity to move the air. One method that is being used more and more in new construction is what is called a jumper duct. With this method, a flex duct installed in the attic is used to jump the interior wall. Jumper ducts also perform very well in reducing light and sound transfer between rooms.

How much do I need?

Today there are a number of programs that have specific pressure specifications that must be met. The most common is a standard of “no more than + or - 3 Pascal of pressure created by the air handler during normal house operation (closing doors)”. If you do not have a device to measure pressures there are a number of simple ways to determine the amount of return path you will need.

The first one is based on the amount of air being delivered into the room. For every cubic foot of air delivered per minute (CFM), you will need .75 square inches of net free return path. To be sure, I suggest using 1 square inch per 1 CFM, you can't have too much return path.

In existing homes where the CFM delivered to the room may not be known, you can also size the return path based on the size of the supply registers in a room. For each square inch of

supply register, you need two square inches of net free return path. When sizing return paths, it is important to make sure it is net free area of a grill, not the size of a grill. The net free area will always be less (up to 50% less with some grills) than the size of the grill.

For more information on room pressures visit:

www.codecollegenetwork.com/az/pressures.html

This year, don't forget the pressures.

In getting ready for this year's heating or cooling season, remember to also look at what you can do to reduce the pressures in your home. In today's world we can all do with a little less pressure.