# The Word

A look at terms used in home inspection reports

# HVAC Forced-Air Ducts

BY BRUCE BARKER

**ONCE AGAIN THE WORD INVITES YOU TO TRAVEL** into the dark realm of subjects that are sometimes misunderstood by home inspectors. The Word hopes you will find this trip informative and maybe a little entertaining.

***The Word's topic this month is the HVAC forced-air ducts. It's been about eight years since The Word's last rant on this topic. In the interim, people are paying more attention to problems with these ducts. Leaky and improperly installed forced-air ducts are inefficient and problematic on several levels. Excess energy use, higher HVAC system operating costs, and reduced occupant comfort are some of the well-known problems. Lesser-known, but serious, problems can include moisture damage and mold in attics, crawlspaces, and wall cavities.***

The 2012 International Residential Code (IRC) requires testing new forced-air HVAC equipment and ducts for leakage. That's a good start. The IRC also requires using ACCA Manual D to design the duct system. Enforcement of this requirement, in terms of on-site inspections, appears sporadic at best. Unfortunately, there's still nothing in the IRC about duct installation beyond the general requirement about installing components in compliance with manufacturer's instructions. Of course, none of this addresses problems that occur after initial installation. Damage, deterioration and improper repair of existing work also create problems.

Without consistent on-site enforcement of good HVAC duct design and installation practices, a lot of questionable work gets by. This lack of enforcement, however, creates an opportunity for home inspectors who perform predrywall inspections. The ASHI Standard of Professional Practice for Predrywall Inspections requires inspection of HVAC ducts. The Word almost always finds improperly installed HVAC ducts during these inspections and during other home inspections.

Home inspectors are not going to hook up a Duct Blaster® to test ducts. Nor are we going to check the ducts against Manual D. We can, however, serve our clients by understanding correct duct installation practices and the effects of incorrectly installed ducts.

## Stealth Problems

Homeowners are often unaware of HVAC duct problems. Why should they be, unless the problem manifests itself with a symptom like uncomfortable rooms or self-closing doors? Even awareness often doesn't always motivate action. They may believe the cost to cure is too great. They may be told by some "professional" that

the problem is normal, and they should just live with it. Let's look at one of these "normal" problems, especially what's happening beyond the homeowner's immediate awareness.

### The Self-Closing Door

Spring-loaded hinges aren't the only way to make a door self-closing. Pressure differences caused by duct problems can be just as effective. What causes these pressure differences?

One common cause of self-closing doors is the lack of a return air duct serving the room. Rooms with a door should be served by a return air duct that runs back to the furnace or air handler. The return duct should have about the same area as the total area of the supply air ducts serving the room. This configuration should maintain neutral air pressure in the room; no slamming door.

It's easy to understand why builders don't install returns in every room with a door. Each return can cost $150 or more in materials and labor. In a three-bedroom home, that's at least a $450 extra expense that many homeowners won't appreciate, even while claiming to value well-built homes. Builders know that people often choose short-term bling over long-term value.

There is a less expensive method to achieve results similar to a return duct. But before we go there, let's discuss a couple commonly proposed methods that often don't work.

### Return Duct Alternatives

Cutting the bottom of the door to achieve some return air flow is better than nothing, but it rarely provides completely satisfactory results. The math doesn't work in many cases. Assume the bedroom is supplied by an eight-inch round duct. This duct has an area of about 50 square inches. Assume the bedroom door is a 32-inch door. You would have to leave at least 1½ inches above the finished floor to provide enough area to let the air escape. Many people would find this gap aesthetically unacceptable, not to mention the privacy issues. Extend this to the owner's bedroom and bathroom, which often have a significantly larger air supply, and you'd wind up with an opening large enough for the children to crawl under. Most parents would find this unacceptable, for obvious reasons. We've also ignored the air circulation issues that might occur if the supply is in the floor. In this case, the air would tend to flow along the floor, especially in cooling mode, and not circulate throughout the room.

Another method of achieving return air flow is the opening above the door. An opening is cut in the drywall above the door and a grill is installed on each side. This method can work from an opening area perspective. The primary problem is privacy. The air opening is also an opening for light and sound. Installing a baffle in the opening can help a little, but not much. Many people find this method unacceptable as well.

The best alternate method is the transfer duct, also known as a jumper duct. The duct gets its name from the fact that the duct jumps in the attic or floor system between a grill-covered opening in the room's ceiling and an opening in the hallway. Air flow through these jumper ducts helps equalize pressure inside and outside the door and does so without the privacy problems.

### Whole-House Pressure Differences

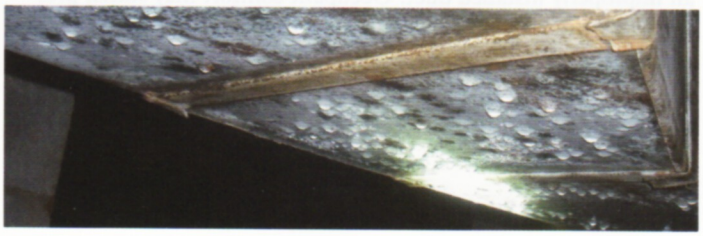
Lack of a return will cause pressure differences in individual rooms. Duct problems may cause pressure differences throughout the house. Let's look at some of the ways duct problems cause pressure differences.

We previously discussed the fact that supply air in should equal return air out to maintain neutral air pressure. What happens if the return ducts leak and the supply ducts don't (or leak less)? More air enters the home than leaves the home resulting in positive pressure in the home. What happens if the supply ducts leak and the return ducts don't (or leak less)? More air leaves the home than enters the home resulting in negative pressure. Self-closing doors may not be an issue, but far worse problems may be lurking out of sight.

Ever see a dirt line on the carpet along an exterior wall? That's often dirt entering the home along with unconditioned air and water vapor. The carpet is acting as a filter. You'll often see very dirty insulation if you remove the casing around windows and doors. The insulation is acting as a filter. Negative pressure inside the home is one reason this occurs. Wind is another reason. Positive pressure inside the home can have a similar effect. With positive pressure, though, it's not usually dirt that moves along with the air, it's water vapor from inside the home.

Dirt isn't a big problem, unless you're allergic to dust. Water vapor, however, can be a big problem if it becomes liquid water.

Water vapor condenses into liquid water when the air temperature falls to the dew point. Ever see dark stains on attic sheathing where there's no indication of a water leak? Does the staining appear worse around a penetration such as a recessed light fixture? One cause could be condensation of water vapor that was forced out around the fixture by positive air pressure in the home. Vapor diffusion between the warm house and the cold attic is another likely cause. Inadequate attic ventilation could allow the water vapor to collect, condense and leave moisture stains on the sheathing. With enough moisture, mold can grow.



A similar effect can occur in exterior wall cavities, especially around penetrations such as electrical boxes. Negative pressure inside can suck air and water vapor from outside into the cavity. Positive pressure inside can force air and water vapor from inside into the cavity. If enough water vapor condenses in the wall and doesn't dry, hidden damage and mold can occur.

### Vapor Drive

Now that The Word has opened the door to condensation in the wall cavity, somebody is going to bring up vapor drive. While unrelated to this discussion, we might as well briefly deal with it.

Vapor drive occurs when exterior wall coverings, such as brick, get wet and then are heated by the sun. Since energy flows from hot to cold, the water vapor in the wall covering can be driven into the wall cavity. This water vapor can condense in the wall cavity, especially during air conditioning season.

### Duct Sealing

Air leakage in forced-air duct systems ranges from not too bad in new systems to very leaky in older systems. Seams between duct sections, collars where ducts attach to plenums, and connections at supply and return boots are the most likely places to find leaks (and sometimes completely disconnected ducts). Duct mastic is by far the best way to seal seams and attachment collars. Foil tape is acceptable. Flexible ducts should be attached to collars and boots using foil tape around the inner core and collar then strapped to the collar using a zip tie.

### Flexible Duct Installation

Air moves best when it moves in a straight line, but straight lines are an unrealistic expectation in real-world flex-duct installation. Bends and dips in flex ducts are going to occur. When done gently, they will reduce air flow somewhat. Sharp bends, however, create two problems. The duct area is usually reduced at a sharp bend. Air flow through a duct is only as good as its smallest point. Air flow in a duct that's reduced in size at a sharp bend can be significantly reduced.

Sharp bends also create disturbances (currents and eddies) that further disrupt the air flow and can further reduce the number of cubic feet per minute that the duct can provide. Duct compression can also disrupt air flow. The duct system is usually designed to supply a room with the cubic feet per minute provided by a properly installed duct. The room will get less air than it needs through an improperly installed duct. Occupant comfort may suffer, pressure problems may occur, and in some cases, equipment problems can result.

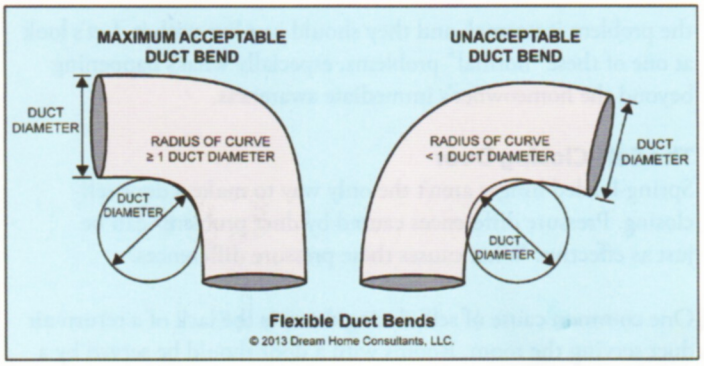



*Figure 1*

The maximum bend radius in flexible duct is one duct diameter. *Figure 1* demonstrates this rule. You can find other flexible duct installation rules at www.flexibleduct.org. You might also want to look at The Word's last rant on the subject in the November 2005 *Reporter*. It's available at www.ashireporter.org.

## The Bottom Line

***Poorly installed forced air ducts cost our clients money and comfort every minute the system runs. We perform a valuable service both to our clients and to the environment by looking for and reporting deficiencies in the forced air distribution system.***

Memo to Aeolus (god of the wind): The Word does not reside on Mt. Olympus (just at its base) and welcomes other viewpoints. Send your lightning bolts or emails to Bruce@DreamHomeConsultants.com. The thoughts contained herein are those of The Word. They are not ASHI standards or policies.

*Bruce Barker operates Dream Home Consultants. He has been building and inspecting homes since 1987. He is the author of "Everybody's Building Code" and currently serves as chair of the ASHI Standards Committee. To read more of Barker's articles, go to* ***www.dreamhomeconsultants.com****.*