The Problem of Pressure

TAMARACK TECHNOLOGIES, INC.

> Section 601.4 of the New Florida Building Code: "Restricted return air occurs in buildings when returns are located in central zones and closed interior doors impede air flow to the return grill or when ceiling spaces are used as return plenums and fire walls restrict air movement from one portion of the return plenum to another. Provisions shall be made in both residential and commercial buildings to avoid unbalanced air flows and pressure differentials caused by restricted return air. Pressure differentials across closed doors where returns are centrally located shall be limited to .01 inch WC (2.5 Pascals) or less. Pressure differentials across fire walls in ceiling space plenums shall be limited to .01 inch WC (2.5 Pascals) by providing air duct pathways or air transfer pathways from the high pressure zone to the low zone."

Without central air-conditioning, the South wouldn't be what it is today. Used to be that opening the windows was the only form of relief in warm weather, and home builders had to consider how air would be able to move throughout the house. Cupolas allowed rising warm air to escape at the very peak of the house. Shutters allowed the air in and kept the sun out. Transoms allowed the air to flow between rooms even if the door was closed. (Transoms were also the stuff of mystery novels – peeking through key holes and listening at the transom.)

Room air conditioners, installed in a window, made a single room a refuge from the heat in the rest of the house. The room needed to be closed off from the rest of the house, darkened by its window shades. If there were transoms, they needed to be closed if not sealed. For a new house, central air-conditioning became the option of choice and things changed. Chilled, dry air could now be ducted to and from each room making it comfortable throughout the house. Central air-conditioning makes it comfortable to live all year 'round almost anywhere, even in places that only the mosquitoes inhabited in the past.

To keep the installed costs down, it became common practice to put supplies into each room and use a central return, eliminating the individual return runs. It's okay to use the rooms as ducts as long as all the doors in the house stay open. As soon as doors start to close, the system changes. Without the transoms, the air just can't flow throughout the house when the doors are closed.

Some rooms are pressurized and some rooms are depressurized. Air will seek to leak out of a pressurized room and leak in to a depressurized room. Even though air has always leaked into and out of houses, the reason it's a problem now is because of air conditioning. The leaks may be very small and the pressures tiny, but even a slow leak over a long term can cause serious damage. The pressures are as small as a couple of carbonated bubbles popping out of a soft drink. But in a house, those tiny pressure differences just don't go away.

Now that the walls have been nicely chilled by the air-conditioning, the warm, moist outside air that leaks into the rooms under negative pressure, slithers its way down from the attic or from the outside through the wall system until it strikes something that is below the dew point where it gives up its moisture. This can commonly be behind the vinyl wallpaper, which acts like a vapor barrier and the moisture can't get through. So there, where it's dark and damp and cool, the mold can slowly grow and not be noticed for a long time.

If the system is balanced, there won't be pressure variations. This can be accomplished by installing dedicated returns or the transoms, severely undercutting the doors (three inches or so), or using one of the alternatives such as a "jumper duct", wall to wall grilles, or a baffled return air pathway.

A "jumper duct" is simply a piece of duct that "jumps" over the partition. A grille and collector box is installed in the ceiling on each side of the wall, and they are connected by a short section of duct work. To keep the pressure below .01" wc (2.5 Pascals), the grilles should be connected by rigid ductwork, preferably 8" in diameter. If 8" flexible ducting is used, flows up to 100 cfm can be delivered to the room if the grilles are 2 feet apart or less. Using 6" flexible ducting, flows of 55 cfm or less can be delivered to the room. The bigger the duct, the smoother the curve, the easier it is for the air to move. Easier means less resistance, and less resistance means less pressure build up. Also don't ignore the back pressure generated by the grilles. They should be as open as possible.

For a simple, clear hole through the wall (no grilles), the hole can be sized using the formula:

$$\text{Area Sq In} = \text{CFM}/1.7$$

This assumes that the pressure difference needs to be .01" (2.5 Pascals). So for 150 cfm, the hole would need to be 150/1.7 or 88 square inches or (in even numbers) 12" x 8". That would be a clear hole with no grilles. Adding standard, "return air" grilles, would allow only 85 cfm to be delivered to the room. To allow 150 cfm into the room, the pathway with the grilles would have to be 12" x 14".

To size the hole including the grilles:

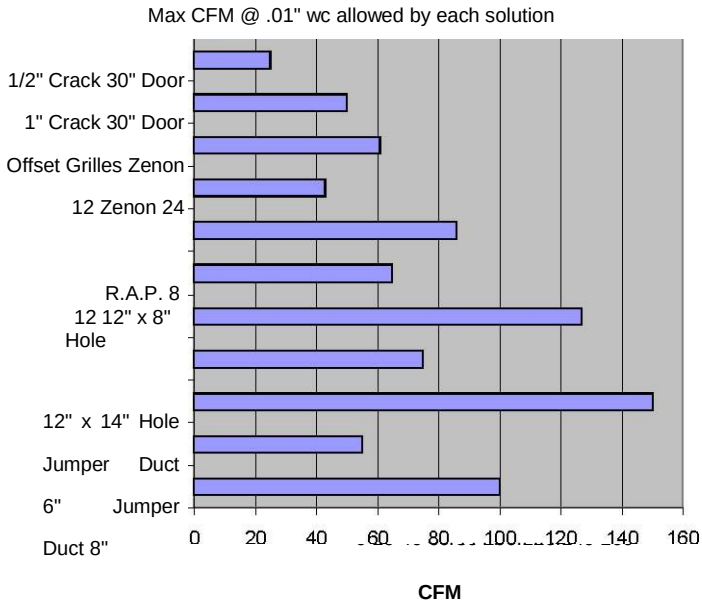
$$\text{Area Sq In} = \text{CFM}$$

Not many people would really want an open, 12" x 14" hole in their bedroom wall. If they weren't concerned about privacy, why did they close the bedroom door? An optimized, through-the-wall system is big enough to allow the air to flow through but includes a means to restrict the transfer of light and sound. Tamarack's Zenon™ and R.A.P.™ products do this by including baffles that have almost no resistance to the movement of air, but impede the transfer of light and sound by forcing them to move through indirect paths.

If the building code allows it, an entire stud cavity can be used as the return air path, inserting a grille high on one side of the wall and low on the other. The effective "hole" of this arrangement is the area of the stud cavity, which is limited to 3.5" x 14.5" or 50.75 square inches maximum. To allow a .01" wc maximum pressure difference and using standard return air grilles about 61 cfm can be delivered to the room using this method.

The accompanying table can be used to select the best method at various air flows while maintaining the pressure difference at .01" wc. Knowing how much air is delivered to the room would indicate which method would be most suitable. For example, an 8" jumper duct could be used up to 100 cfm.

Note that these transfer methods are additive so that, for example, combining a 6" jumper duct with a 1" crack under a 30" door, will allow a flow of 100 cfm to be delivered at .01" wc or combining a R.A.P. 12 with a 1" undercut would allow up to 175 cfm to be delivered. (It should be noted that door undercuts are under builder not HVAC control and that the actual dimensions are greatly effected by the thickness of the floor coverings.)



Although the problem may seem complex, these pressure relief solutions are pretty simple. And once installed, the HVAC system will perform better, the occupants will be more comfortable, and the risk of mold or deterioration in the wall structures of the house will be reduced. It's a small cost for a lot of benefit.

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TAMARACK TECHNOLOGIES, INC. (www.tamtech.com) is a principal team member of the DOE's Building America Program and a member of the Home Ventilating Institute (HVI).