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MAD-AIR On The Rise: John Tooley Advocates "Ducts Limited"

BASIC EQUATION TELLS ALL

Air + Hole + Driving Force = Air Flow

This basic building science equation is important in understanding quite a few building problems. Moist air plus a hole plus a driving force causes moisture problems in the building envelope. Radon plus a hole plus a driving force causes the possibility of radon indoor air quality problems. Combustion gases plus a hole plus a driving force create backdrafting problems. Eliminate or reduce any one of the elements and the air flow is eliminated or reduced. For two decades we've been "hole conscious", focusing on sealing any leaks in the building envelope. While no one is suggesting we give up that focus, more and more building scientists are realizing the importance of the driving force. No matter how big the hole, the driving force is what makes it important. If you understand the driving force you will know which holes are the most important to attack.

THE DRIVING FORCES

Driving forces may include wind, stack pressure, and temperature differences. Recent research has documented the tremendous impacts of a fourth and most significant force, pressures produced by mechanical system interactions, including duct leaks, closed interior doors, and exhaust fans. This influence on air infiltration can be greater than the combined influences of wind, stack effect and temperature difference.

John Tooley, from Natural Florida Retrofit, Inc. came to Anchorage in December to give weatherization crews a workshop on stopping what he has coined "MAD-AIR" and reducing duct leakage. Although Tooley began his research in warm climates evaluating the effect of air conditioner fans and duct leakage, he has since travelled throughout the U.S. and Canada and has found that MAD-AIR is a significant problem everywhere.

SO WHAT'S GOING ON?

The dynamics behind the increased air infiltration when the heating or air conditioning unit (HAC) is turned on are easily understood. HAC systems are designed to be closed loop systems. Air is supplied to the living area by means of the supply ducts. The intent is that the same amount of air should be returned to the air handler for reconditioning by means of the return air ducts. Leaks in the supply or return systems will create a pressure imbalance in the house. Supply leaks will suck makeup air from the house, resulting in depressurization and infiltration of unconditioned air. Return leaks may cause the living area to become pressurized and drive moisture laden air into the walls. Tooley has found that across North America the dominant leaks are in the return air ducts (although mobile homes may have more supply leaks). This is because it has been standard practice to seal the supply side as much as possible, but there has been little consideration for return side leaks.

Many people have thought that duct leakage within the conditioned space is not a problem - "what does it matter if they leak inside the building?" **This thinking is wrong.** To be truly considered in conditioned space, ducts must be <u>inside the air and thermal barriers</u> of the house. Many ducts located in soffits and dropped ceilings, unfinished basements are within the thermal boundary, but are not truly inside the air barrier. If they leak they will either lose or draw air from outdoors through the insulation, framing and attic bypasses. If they are truly inside the house air barrier, leaking ducts seldom lose or gain very much air to the outdoors, but can cause other problems. These include discomfort (often resulting in increased energy use), moisture, mold and mildew growth, and health and safety problems.

Supply air leaking to areas where it was not designed to go can cause discomfort in the intended area of delivery. Often these ducts are encased in framed areas, where, if pressurized, conditioned air could be forced into exterior walls and the attic through even the smallest of holes. In cold climates this can result in condensation, mold and mildew inside the walls, on the back side of the exterior sheathing, and on the underside of the roof deck during the winter.

Return leakage in these areas reduces the pressure at the return grill . If this leakage occurs at the first floor then the second floor returns may suffer pressure loss resulting in less air returned from the second floor. Comfort on the second floor may be a complaint in these cases. If this leaking return is in a closed room there may be excessive pressurization of that room, resulting in moisture damage in walls and attics.

When these systems are located in equipment rooms, unfinished basements, interior air handler closets or unvented crawlspaces, the return ducts and plenum connections to the air handler often leak. This leakage can be at a magnitude great enough to depressurize these areas and cause backdrafting of combustion equipment, flame roll-out of gas water heaters, and increased soil gas entry when the area is in contact with the soil.

It should also be noted that indoor air pollution may result from duct leaks in a garage. Air handlers are often located in garages where garage air can be drawn into the house if either the return plenum or the air handler leaks. Whatever air pollution sources exist in the garage - gasoline fumes, stored chemicals, herbicides, paints, etc. - are also pulled into the house.

WHY SEAL LEAKS?

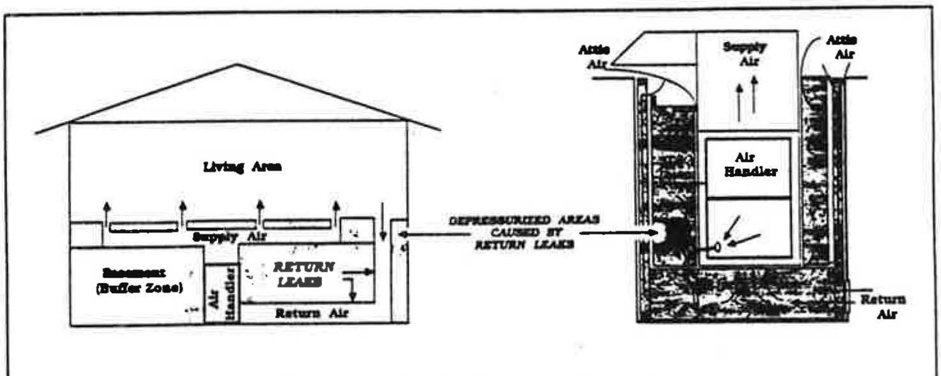
There are then, three reasons that duct leaks should be repaired. First and above all others is the health and safety concern. Duct leaks should not be permitted to create unhealthy or dangerous situations which can result in indoor air quality deterioration or combustion safety problems. Second, ducts should be repaired if they are contributing to building degradation, such as moisture, mildew and rot. Third, if duct leaks are causing an increase in energy use and can be cost effectively repaired, they should be.

DON'T LEAP RIGHT IN!

We must, however, never forget that the house operates as a system, and making any changes will have an impact on other parts of the system. There may be important health and safety reasons why ductwork should not be done until other repairs are made. Blower doors are now being used to do "duct diagnostics" that do more than find the leaks. A properly administered duct system test procedure will include measurement of pressurization imbalances in different areas caused by opening and shutting doors and turning on exhaust fans or furnace blower; adequacy of combustion air for all combustion appliances including fireplaces; adequacy of draft pressure; and furnace efficiency, including flame color and carbon monoxide emissions. If any of these problems exist, they must be corrected before ductwork is sealed.

CREATE AN AIR BARRIER

The forced air system must become a closed system by means of a good air barrier. The materials used to produce or seal a duct system air barrier should have a flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke development rating of not over 50 when in the final dry state. It should also not contain any toxic products that could off-gas into the air stream of the system. It must be continuous and impermeable to the passage of air, be sufficiently rigid to withstand any pressures, and durable enough to last the life of the system. Common "duct tape" or pressure sensitive aluminum foil tapes have so many requirements for application procedures that they will most likely lead to failure when used for repairing ducts. Mastic has long been used as a duct sealer on commercial buildings and will work well on residential ducts. A good mastic should have a high percentage of solids content, so there will be less shrinkage when it dries. It must also have a good cohesive and adhesive strength so it does not crack or peel. Fiberglass mesh can be added during the application of the mastic to add strength. Two brands of mastic Tooley has found that meet all of the above requirements are RCD Corporation's *#6 Mastic* and Foster Products Corporation's *Aqua-Fas Mastic 38-00*.



Depressurized Basement and Interior Air Handler Closet