

Haunted Ducts and FAT Ducts

In some homes, the ducts just seem to be haunted. Everything seems to be fine: the duct design is correct, the house is air tight, and the insulation is installed properly. But still, something is wrong, and the house continues to show high energy use, poor air quality, and inadequate levels of comfort. It's as if the home has a mysterious phantom, robbing the home of comfort and efficiency. And the more you chase the problem and try to pin it down, the more elusive it becomes. While some building professionals would shrug their shoulders and blame the problems on the homeowner (or evil spirits), recent investigations have helped to shed a bit of light on this mysterious problem.

The Ghosts in the Ductwork

Excessive energy use and comfort problems are often blamed on poor design of the HVAC distribution system. And while this may be true in a number of homes, in many cases the real culprit is unidentified duct leakage. Even the best distribution system designs can be rendered ineffective by poorly-sealed or badly-installed ductwork. Duct leakage can drastically reduce the amount of air delivered to the conditioned space of a home. It can also draw unconditioned outdoor air into the system, which can double or even triple house infiltration rates. Even when the HVAC equipment is sized properly, and the ducts designed per Manual "J" and "D", neither may be able to make up for severe losses from leaky ducts.

When conditioned air leaks out of the duct system, the homeowner loses twice. Supply-side leaks dump conditioned air to the outside, wasting the energy used to heat or cool the air. And for every cubic foot of conditioned air that leaks to the outside, the same amount of unconditioned outside air must be drawn into the house. In the winter, this means that the duct system is leaking heated, 110° air into the crawlspace or attic, and replacing it with

30° air from outside – a temperature difference of 80°! This equates to a huge loss of energy, and a corresponding loss of comfort within the home. The larger the supply leakage, the higher the energy use. Similar losses can occur during the summer as well, with the home leaking cool air, and replacing it with hot, humid air from outside.

Leaks on the return side of a duct system can have similar unwelcome effects. Return side leaks in the attic can draw in air heated to 120° or above. The cooling system must then work overtime to remove this extra heat from the air, before delivering it to the living space. And for every cubic foot of air drawn in at the leaking return side duct, another cubic foot of conditioned air is forced out of the house at some point.

These haunted, leaky ducts obviously result in higher energy costs for the homeowner. But leaky ducts may also be the source of a number of health concerns. Any air migrating into or out of the house can carry any number of contaminants or pollutants with it, including moisture, radon or other gases, dust, pollen, asbestos, and insulation fiber. In some instances, infiltration of these contaminants can trigger health problems, which may end up costing the homeowner more in doctor bills than utility bills.

The amount of energy loss through leaky ductwork, as well as the level of pollutant infiltration, is controlled by a number of factors. The source strength (cfm) of the air handler, along with its operating cycle, both have a direct effect on the amount of air drawn into or pushed out of the leaky ducts. The size of the holes in the ducts and in the house envelope obviously have an impact on the amount of leakage. Even the location of the leaks within the ductwork is important, since the air pressure in some locations may be as high as 0.2 to 0.5 inches of water column (wc), which directly affects the amount of air leakage.

Hiding Doesn't Help

Some building professionals might respond to such problems by saying, "Just put all the ducts inside the conditioned space of a building." While on the surface, this may look like a good idea, in reality it creates a whole other set of problems. In most air distribution systems, conditioned air is designed to enter and exit the house through supply registers and return grills only. Any conditioned air that does not enter or exit the house by these designed routes is in effect duct leakage. This air then causes overpressurization or underpressurization of certain rooms, which again leads to leakage of conditioned air from the home, and infiltration of unconditioned, outside air into the home.

In one test case, the downstairs of a home could not be heated higher than 60°, while the upstairs sweltered above 80°. The home's entire duct system was located inside the conditioned space, with an interior air handler closet and floor system. But the more the homeowners tried to heat the downstairs, the hotter the upstairs became. No leakage to the outside was discovered. However, testing did find over 670 cfm of conditioned air leaking from the ductwork into the floor system. So the higher the homeowners pushed the thermostat, the more hot air they pumped into the floor system, which in turn delivered the air to the already overheated upstairs rooms of the house.

FAT Ducts to the Rescue

The solution to this type of problem is the use of FAT (Fabricated Air-Tight) ducts. To ensure proper performance, all ducts are (or at least should be) sealed with a long-lasting sealant. FAT ducts, though, are designed to be virtually airtight. By preventing air leakage, FAT ducts reduce energy losses, guard against poor indoor air quality, and prevent many moisture-related building durability problems. These ducts are also completely fitted with insulation along

their length, reducing radiant heat losses to the unconditioned crawlspace, attic, or chaseway. A FAT duct system complements the proper design and sizing of any HVAC system. Even more importantly, FAT ducts greatly increase both the comfort and satisfaction of the homeowner.

Many utilities have begun to include tight duct system specifications in their new home construction programs. The duct systems are pressurized to 0.1 wc and tested to assure that the leakage rate (rated in ft³/hr) is less than 3% of the conditioned floor area. In simple terms, this means that the duct system cannot show more than 30 ft³ of leakage for every 1,000 square feet. Many new construction FAT duct programs are achieving leakage rates even better than 3 %, a direct result of good training and proper installation.

While any connection in the duct system is a potential site for leakage, the most severe leakage is often found at the spots listed below:

- § Plenums to the air-handler cabinet.
- § Framed duct chases.
- § Take-off collars.
- § Boot-to-house connections.
- § "S" and drive corner holes.
- § Air-handler cabinet panels and penetrations.

Any energy-efficient and environmentally-sensitive building design must account for – and eliminate – all air leakage from the forced air HVAC system. And to meet the designed performance levels, the builder must ensure that the air systems are airtight and insulated properly– in other words, FAT ducts. With proper design and installation, FAT ducts will protect the homeowner against drafts, infiltration, and moisture problems. They'll also prevent the builder from being haunted by the ghosts of duct leakage and customer complaints.