Understanding Duct Systems

Energy Fact Sheet #3

For most homes, there is no component with more potential to effect efficiency and comfort than the duct system. Although there are ductless heating and cooling systems, such as windows units, space heaters, or packaged terminal systems, which are typically used in motels rooms, the vast majority of homes in the southeast utilize a forced air duct system. Like a $2000 stereo playing through $50 speakers, a poor duct system will result in disappointing performance. A highly efficient, very expensive heating and cooling unit will deliver unsatisfactory comfort and higher than expected energy usage if the ductwork is improperly designed or installed.

The Construction of Ductwork

A forced-air duct system consists of three major components; an air-handler, which contains a blower and is connected to a coil or furnace, supply ducts, which distribute conditioned air throughout the house, and return ducts, which bring air from the home to the air-handler to be reconditioned. In the southeast, duct systems are predominantly constructed of rigid galvanized metal or flexible ducting or flex-duct. A very small number of systems are built with rigid fiberglass ductboard. The most common method of duct design in modern homes is a combination of a rigid metal trunkline with flexible duct branch "run-outs" to each supply register. To minimize noise, flexduct is often used for return ducts.

Galvanized metal ducts are put together on-site with a combination of sheet metal and prefabricated piping, elbows, and other fittings. While the individual materials are relatively inexpensive, considerable labor is required to join these components together, seal the air leakage with mastic, and insulate all of the exposed surfaces.

Flexible ductwork is a prefabricated material with all components except the support built into a complete, flexible unit. Sold in varying lengths and diameters, each section of flexduct contains a plastic inner and outer liner, which seals the conditioned air inside and moisture outside, fiberglass insulation, and a spiral steel wire which provides structural support. Flex duct is more expensive than the individual components in rigid metal ducting, but labor time for assembly is significantly reduced. While flex duct is an attractive product to the novice or do-it-yourselfer, differences in performance between the two types of ducting require some special knowledge of installation to achieve good results. Because it has a much rougher inner surface, the diameter of flexible duct required will differ from rigid metal piping. Additionally, flex duct cannot support its own weight, so it must be carefully suspended with proper materials.

Duct Leakage

Duct leakage is a major efficiency loss and occurs in almost every duct system. Obviously, a leak in a supply duct allows air that has been conditioned to be forced outside the conditioned space. But a house is not a closed system. Air leaking out of the home from the ductwork will be replaced by outdoor air. When this infiltration comes in the form of humid, 150° attic air during the summer or 20° air on a cold winter night, heating or cooling loads increase dramatically, raising operating costs and lowering comfort. In fact, in many homes, duct leakage may result in a 25% loss of system efficiency.

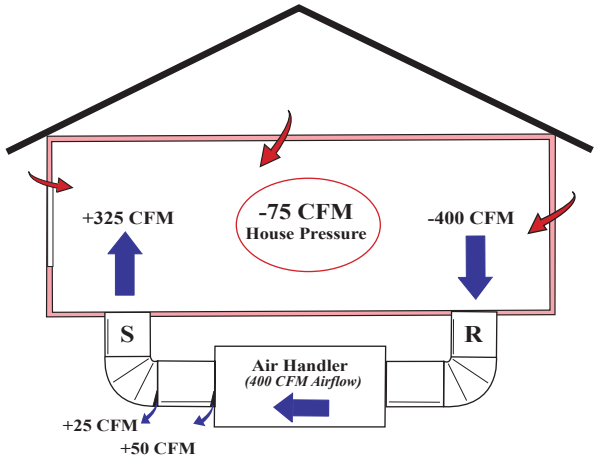

Figure 1: ***In this example, a small amount of duct leakage results in negative pressure on the home, bringing in 75 cfm of hot, humid air.***

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Duct tape is not a suitable means of sealing leakage. Because the glue will eventually dry and seperate, cloth or even foil tape does not provide a permanent seal. Mastic is the answer. An acrylic based product, mastic will strongly adhere to galvanized metal, plastic flexduct linings, wood, and almost any other surface. Retaining its flexibility over time, it will not crack even after years of constant expansion and contraction.

Basic Design Guidelines

To maintain efficient performance with minimum airflow noise, ducting should be correctly sized with an emphasis placed on smooth and direct airflow paths. Although maintaining the correct amount of airflow, which is measured in cubic feet per minute (cfm), is crucial, higher than normal airflow velocity will make a home feel drafty and uncomfortable and will also elevate airflow noise levels.

The following basic rules should be followed to ensure proper duct design and installation:

- All ductwork must be designed following the Air-Conditioning Contractors of America (ACCA) Manual D guidelines, which are considered the industry standard for duct design.
- All ductwork must be sealed with an approved mastic. No duct tape of any kind is permissable.
- A trunkline must terminate in an endcap. No branch run-outs should be attached within 24" of the endcap.
- All ductwork, including supply boots and any other exposed metal or wood framing used in duct construction, must be insulated to a minimum of R-6 with a vapor barrier. Joints between insulation segments must be sealed to prevent moisture from condensing within the insulation.
- Branch run-outs from the trunkline should be made at a 45° angle.
- To reduce the velocity of the return airflow, any system over 2.5 tons must have more than one return. The face velocity of airflow at the return/filter grill should not exceed 2.0 cfm/in2. This means there should be roughly 1.4 ft^2 of free air return for every ton (12,000 BTUH) of capacity.
- Flexible duct must be suspended as straight as possible with 2" mesh supports no more than 5' apart. Hanging wire must not be used. Flexible ducting should never be laid on ceiling trusses or allowed to make contact with the ground.
- An elbow must be used on any angled connection of flexible ducting to a ceiling or floor boot.
- Supply trunklines should not exceed 25 feet without a reduction in diameter.
- Flex duct run-outs should not exceed 12 feet in length.
- Leaks around access doors in the air-handler should be sealed with removable foil duct tape.
- Return filters should be placed in filter grills if possible. Locating the filter in the attic or crawlspace results in poor maintenance practices for many homeowners.
- All condensate drains should have a trap to prevent unconditioned air from entering the air-handler or conditioned air from being forced down the drain.

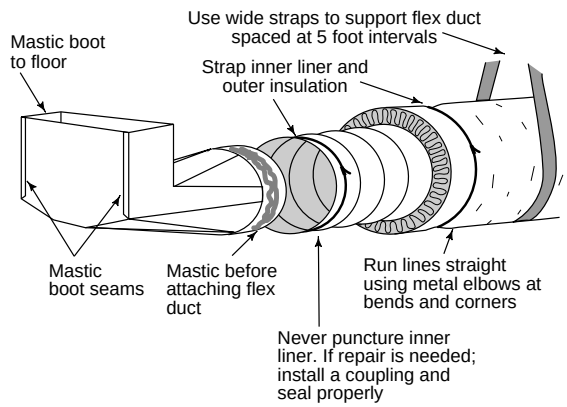

Figure 2: ***Guidelines for the proper installation of flexible ductwork.***

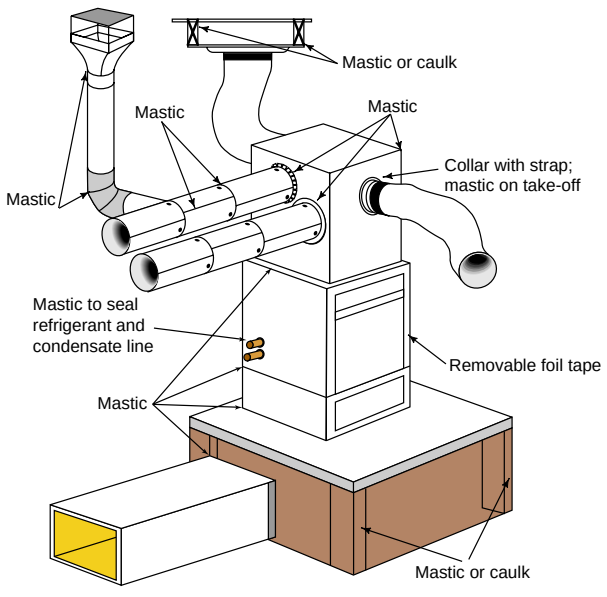

Figure 3: ***All ductwork should be properly sealed with mastic in all of the areas shown here.***