

# Forced-air Systems

*Deliver Clean, Conditioned Air Where You Want It*



Touchstone Energy<sup>®</sup>  
Cooperatives

## SKILL SET

Be sure you have the experience needed for these maintenance tasks. If you are in doubt, hire a contractor.

## SAFETY

These upgrade tasks may require working in tight clearances and under task lighting. Exercise common sense when working on a ladder.

## TOOLS

Utility knife, drywall saw/zip saw for cutting drywall

## MATERIALS

Rigid foam board, caulk, spray foam sealant, duct mastic, foil tape, fiberglass mesh tape, paint brush, gloves

## COST BENEFIT

Increased energy savings and improved comfort and indoor air quality

### PRIORITY LEVEL

LOW MED HIGH

### SKILL LEVEL

DIY PRO

## Forced-air Heating and Cooling Systems

Whether located in an attic, crawlspace, basement, garage or outside, many homes use a forced-air heating and/or cooling system such as an electric heat pump or a gas furnace with an air conditioner. Both types of systems contain a blower motor and fan in what is referred to as the air handling unit (AHU) that is then connected to the associated distribution system (ductwork). The importance of proper airflow through the duct system cannot be underestimated as it impacts:

- Comfort and health
- Energy usage
- Equipment life

**Definitions** - Return ducts pull air from grills in the living space of the home via the blower in the AHU. Supply ducts deliver conditioned air from the AHU to the home. Typically every room has at least one supply duct that provides conditioned air through a register. A home may have one or more grills for return air.

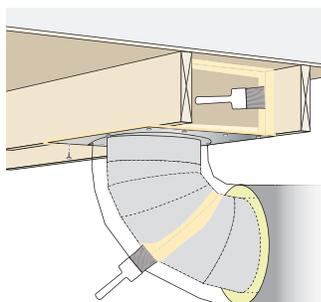
**Design** - For new installations, the *Air Conditioning Contractors of America* have a series of procedural manuals that outline the design process:

- » **Manual J** - for determining the heating and cooling loads on the home
- » **Manual S** - sizing the system
- » **Manual D** - designing the ductwork

## Ductwork

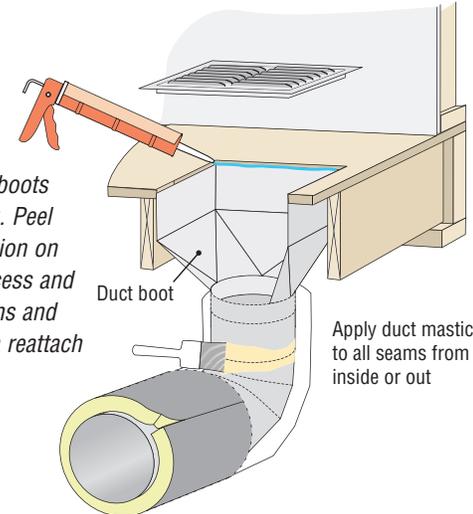
Use a qualified contractor to coordinate energy efficiency improvements to ensure that the heating and cooling system is the right size for the improved home. A system that is either too big or too small will not maintain comfort and can drive up operating costs.

Today, most ductwork is constructed from sheet metal, rigid fiberglass duct board or flexible insulated duct. Older homes often have ducts made from building cavities such



*Panned joist and shelf returns that use structural members as part of the duct system are not a good idea. Sealing from the inside and outside of this return will improve its performance.*

as wall or floor framing (shelf and panned returns). These cavities are often leaky and compromised over time from wiring and plumbing penetrations. Also, many homes have flexible ductwork that has deteriorated in attics and needs to be replaced.



*Seal where boots join flooring. Peel back insulation on ducts to access and seal junctions and seams, then reattach insulation.*

Apply duct mastic to all seams from inside or out

**Duct Leakage** - Duct system leakage can cause high utility bills, poor comfort and indoor air quality and pressure imbalance problems (which under extreme conditions could cause backdrafting of fireplaces and combustion appliances). Many HVAC contractors and energy auditors can use special equipment to test for duct leakage.

A visual inspection may also find problems. Try to trace each duct run from the grill or register inside the home back to the air handler. If a building cavity is used as a duct, it should be sealed at all joints with mastic—a thick paste—or lined with an appropriate duct material such as metal or duct board that is then sealed. Look for ducts that have become detached at connections. These should be reattached with foil tape and mastic that completely covers the tape and both metal components. After sealing, make certain all duct surfaces are insulated.

Duct systems can leak anywhere, but the most common locations include the AHU itself, plenum seams and collar connections, butt joints in metal and duct board, split connectors, elbows and tees, and supply and return boots. Seams and gaps are the most likely culprits and duct sealing mastic with embedded fibers is the preferred sealant – don't use duct tape. Usually duct insulation must be pulled back to access the seams of metal ductwork and the collar connections for flex duct. Span any large gaps with fiberglass mesh tape prior to applying mastic. For fiberglass

ductboard, the mastic should be applied to the outside (silver) skin. And, don't forget the boot to drywall and boot to floor gap – seal with mastic or caulk.

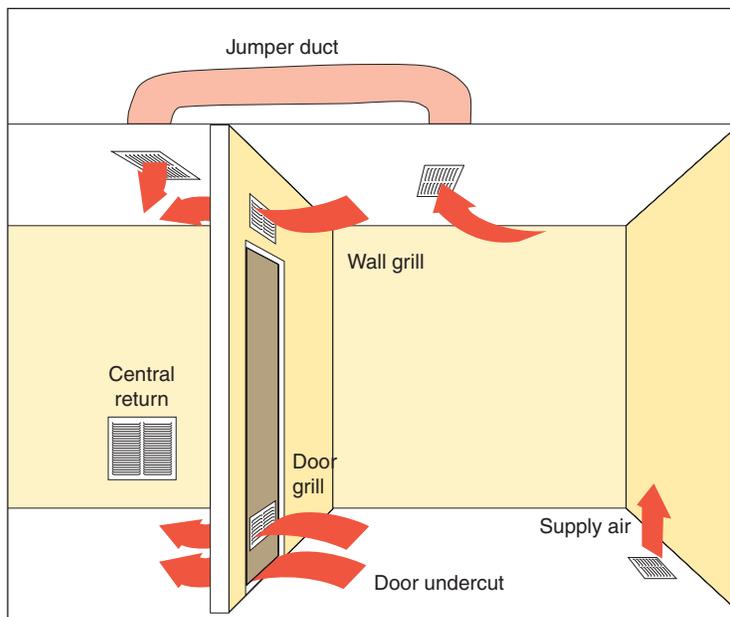
**Duct Sizing and Airflow** - Often the ducts are too small, pinched, or otherwise compressed which restricts airflow, wastes energy and strains equipment. Air flows most easily through short, straight and unobstructed ducts. The amount of air for supply and return should be balanced.

Inadequate return flow can have many causes, including undersized return ductwork, restrictive return grills, inadequate pathways for air to reach the return grills and an obstructive air filter. This can lead to increased wear on the forced-air system and pressure imbalances in the home.

Inadequate return ductwork is a significant problem for many homes. A good rule of thumb is 10-20% more return capacity than supply capacity. For example, if a duct system features three 10" supply ducts, it should have three 12" returns. The size of the ducts and the grill net free areas (surface area remaining for air to flow after subtracting out the area of the louvers and fins) are big factors in air flow performance. Adding a return duct can improve system performance and energy efficiency.

Older homes in particular can have return air grills with too little net free area. Often the slits were small to begin with and over the years have become painted over and clogged with dirt and debris. Also, highly decorative grills are often overly restrictive. Cleaning or replacing old or restrictive supply registers and return grills is an effective upgrade that will improve airflow and reduce system noise. When shopping for new grills, look for a net free area of 75% or greater.

Make sure that any air that is supplied to a room will always be given an adequate pathway back to the AHU. Inadequate air flow is a common problem in homes with supply ducts feeding bedrooms and a single central return located in a hallway. This imbalance can drive air leakage through the exterior envelope of the home.



Several examples of fixes for improving air flow between rooms.

A simple test for inadequate return path is to hold a bedroom door almost closed (1/4 inch open) with the air handler running and feel if there is any airflow through the crack in the doorway. If there is airflow from the bedroom into the hallway, then create more return path.

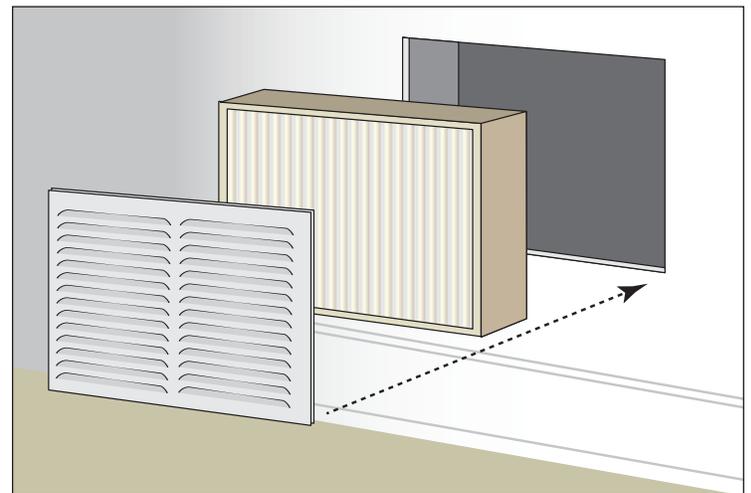
Undercutting a bedroom door an inch or two can help but is often not an acceptable solution. Jumper ducts (short duct runs that allow the air in a bedroom to flow back into the main hallway), transfer grills through the wall or door or adding more return ducts may be necessary.

Because proper air flow is so important, it is generally not recommended to close off supply vents completely, even if a room is typically not occupied. This practice can actually waste energy, particularly if that duct run is leaky, and can increase system noise. Never block grills with furniture.

**Air Filter** - The air filter is usually located at the inlet (return side) of the AHU or at the return grill itself. Filter performance is a double-edged sword in that the more particulates the filter captures, the cleaner the air will be, but the greater resistance leads to increased fan energy with less airflow. Periodic changing of the filter is a critical part of efficient operation; a filter change out log kept at each AHU is recommended to help document timely filter replacement.

Filters are rated in both effectiveness, Minimum Efficiency Reporting Value (MERV), and in pressure drop. The ideal filter will have a high MERV and low pressure drop. The standard 1" thick filter only captures large dust particles and is primarily intended to keep equipment clean. For greater air cleaning, consider higher MERV filters such as pleated filters or electronic air cleaners.

Usually a modification to the duct system is required to accept a thicker filter, however there are products that allow up to a 3" thick pleated filter to slip inside the wall cavity of a standard filter grill.



An HVAC or Home Performance contractor can test a forced-air system for "total static pressure". This is the pressure across the air handler unit, and each system specifies proper operating conditions. A high static pressure could indicate inadequate ductwork, a clogged filter or other problem that may lead to early equipment failure.