Nine Steps to Ventilation System Design

by John Bower

Too often, a house is completely designed before the ventilation system is fit in. The resulting installations are often less effective and more expensive than they should be. You'll get better results if you plan out the entire ventilation system early in the design process.

Because every house is different and occupant requirements vary, the best ventilation system for one house may be completely different from the system next door. All the various strategies have both advantages and disadvantages, which you should consider while a new house is still in the design phase.

Compared with new construction, installing a ventilation system in an existing home usually involves some extra planning and expense. But with a little forethought, it can still be done well.

The following steps will give you the basics.

1. Fix any existing problems.

First, you should analyze the house to determine if there are any existing problems that should be taken care of. If a chimney is susceptible to backdrafting or spillage, if radon or other dangerous soil gases are entering the house in excessive amounts, if hidden moisture problems exist, if a house is excessively leaky, or if leaky heating ducts are causing excessive infiltration or exfiltration, you must first take steps to correct the situation.

2. Determine the needed capacity.

The capacity of a ventilation system is measured in cubic feet per minute (cfm) and will generally be based either on a certain number of cfm per person (based on average occupancy) or on a certain number of air changes per hour (ACH). To convert between cfm and ACH, you will need to calculate the volume of the house. Large houses generally need fewer air changes per hour than smaller houses. If a central ventilation system is going to operate intermittently when the house is occupied, the equipment should be oversized so the average ventilation rate is suitable.

3. Select a strategy.

Once the capacity has been determined, the basic strategy should be selected: central exhaust, central supply, balanced, or passive (see illustration, page 62). If you have decided on a balanced system, you should determine whether or not you require heat-recovery capability. Before selecting a heat-recovery strategy, you should always compare all of the costs with alternative strategies.

There are two basic approaches to installing controlled ventilation systems: They can be connected to a forced-air heating/air-conditioning system or they can be installed as a stand-alone system. In many houses there will be both a central ventilation system and one or more local-exhaust fans.

There are several key questions to ask when evaluating a house to determine the best central ventilation strategy. For example, could negative pressures cause backdrafting or spillage to occur? Will pollutants be drawn indoors from outside the living space? Are hidden moisture problems likely? Is the climate harsh enough to result in a high operating cost? What is the budget for equipment installation?

4. Select the equipment.

There are many companies producing ventilation equipment in North America. Some utilize similar technologies, while others have very different design ideas. Few systems are inherently better than others; they are just different. Before selecting a particular ventilator, you should define your specific needs. For example, a allergenically sensitive person might look for a unit that has well-sealed cabinet insulation, that doesn't have many plastic parts with the potential to outgas, and that doesn't have the motor in the fresh air stream. Someone in a hot, humid climate may lean toward an HRV capable of transferring moisture between the air streams. Someone in a very cold climate may opt for an HRV with maximum energy efficiency.

If a filter is to be coupled with a ventilator, the two should be selected together. Because high-efficiency filters designed specifically for use with ventilation systems aren't very common, it is important to select equipment that is compatible so that adequate airflows can be maintained.

During the equipment-selection process, you should determine how the incoming air will need to be tempered. For example, will through-the-wall vents provide enough mixing to successfully temper the air, will an HRV be necessary, or is the climate mild enough that tempering won't be a significant consideration? Whatever equipment is selected, it should be reliable and designed for continuous operation. It should also be quiet and easy to maintain.

5. Select a control.

Controls should be accessible, reliable, and easy to understand. They can be either manual (operated by the occupants) or automatic, and it is possible to use a combination of several different controls on the same system. The types of controls available include: on/off switch, speed control, timer, motion switch, carbon monoxide monitor, and others.

If heating/air conditioning ducts are also used to distribute ventilation air, the ventilation control will usually need to activate both the ventilation fan and the forced-air furnace/air-conditioner fan. One of the simplest controls is no control — in other words, let the ventilation

system run continuously.

6. Plan the general flow of air.

Locate the fresh air inlets where the outdoor air is the cleanest, and place the outlets where the stale air won't create problems outdoors. Also select effective locations for supply and exhaust grilles. The airflow from the outdoors, through the house, and back outdoors can take a variety of paths. For example, air can enter and leave the house through a duct or through several through-the-wall vents, it can pass from room to room by way of ducts or by passing under doors, or it can move from closets to rooms or from rooms to closets, and so forth.

There can be a system of ducts that only contains ventilation air, or ventilation air can be combined with air passing through a forced-air furnace/air-conditioning system. When planning the pathways for air to follow, be sure to consider the consequences of air moving through the random holes because of pressurization or depressurization.

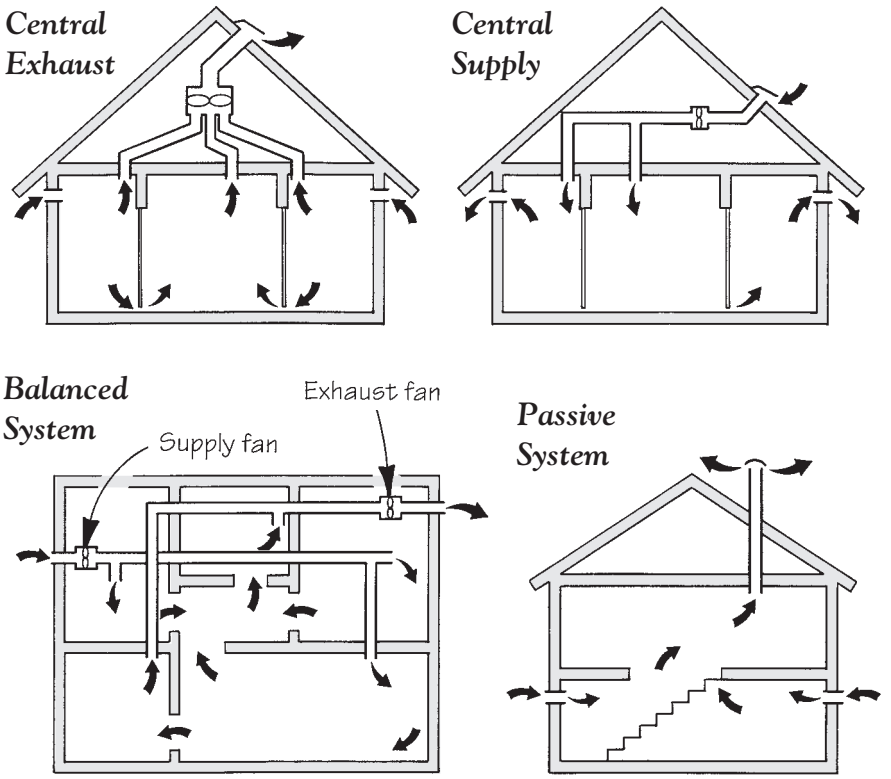
7. Design the ducts and grilles.

Select a duct material (metal or plastic, rigid or flexible). Plan the locations for the ducts (inside or outside the conditioned space), and determine where insulation will be required. Avoid excessive resistance to airflow by minimizing the use of elbows and keeping runs as short and straight as possible. Don't move ventilation air through building cavities if it can be helped. Determine the sizes for the duct runs and the grilles. In laying out the duct system, consider the future cleaning and maintenance.

8. Install the equipment.

At this point, the entire system should be carefully planned out,. Now it's time to assemble the pieces in their proper locations. A variety of issues should be taken into consideration. For example, equipment should be mounted where it can be accessed easily for servicing; vibration noise should be minimized; controls should be easy to find and labeled with basic instructions; and seams in the ducts should be sealed. Be sure to always follow the manufacturer's installation instructions carefully.

Ventilation Strategies



A central-exhaust system (top left) pulls air from several rooms, with makeup air entering through wall or window inlets. A central-supply system (top right) reverses the airflow, with the fan forcing fresh air into the building as stale air exits through the openings provided. In a balanced system (bottom left), fans and ductwork move both the supply and the exhaust air. In a completely passive system (bottom right), natural stack effects move the air, which enters the lower inlets and exits up the chimney during cold weather, but flows in the opposite direction during warm weather (passive-system airflow can be unpredictable under variable weather conditions).

9. Balance and measure the airflows.

Central-supply and central-exhaust ventilation systems generally create a pressure imbalance between the indoors and outdoors. Balanced ventilation systems (with or without heat recovery) are designed to operate at a neutral pressure, so the airflows should be measured and adjusted to ensure that the indoors is neither pressurized or depressurized.

With all ventilation systems, the actual airflow rate to or from each individual room should be measured and adjusted where necessary. If everything has been designed and installed carefully, the actual airflows should be within 10% of the design calculations. At this point, the system should be explained carefully to the occupants and they should be left with the operation and installation manuals.

If you have done anything to change the tightness of the house, or the degree of pressurization or depressurization it experiences, it is very important to determine if your changes will result in any pressure-related problems. For example, it is always advisable to check combustion appliances for backdrafting or spillage under a worst-case depressurization. You may also want to perform a radon test or consider the possibility of hidden moisture problems. ■

Adapted by permission from Understanding Ventilation *by John Bower, director of the Healthy House Institute (430 N. Sewell Rd., Bloomington, IN 47408; phone and fax: 812/332-5073).*