

Simple Whole-House Ventilation

by Andrew Shapiro



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*An upgraded bath fan
and well-placed air inlets
can effectively ventilate
smaller homes*

An energy contractor installs a Panasonic FV-08 bath fan. These quiet, energy-efficient fans are deeper than most, but the housing still fits in a 2x8 joist bay.

Indoor air quality has aroused increasing concern in recent years, with home buyers worried about everything from carpet fumes and formaldehyde to excess moisture and dust mites. These problems have been compounded by improved building practices that, in many cases, have created tighter homes. But a house doesn't have to be airtight, or even close to it, to have poor indoor air quality.

Of course, the best solution to indoor air problems would be to eliminate from the home all the products that emit air pollutants, but this is impractical and costly. And moisture from people, plants, pets, cooking, and bathing is a fact of indoor life. The most practical way to remedy problems from moisture and pollutants in a home is to install a simple ventilation system. Adding good ventilation is also an easy way to reduce callbacks from excess moisture on windows in cold climates.

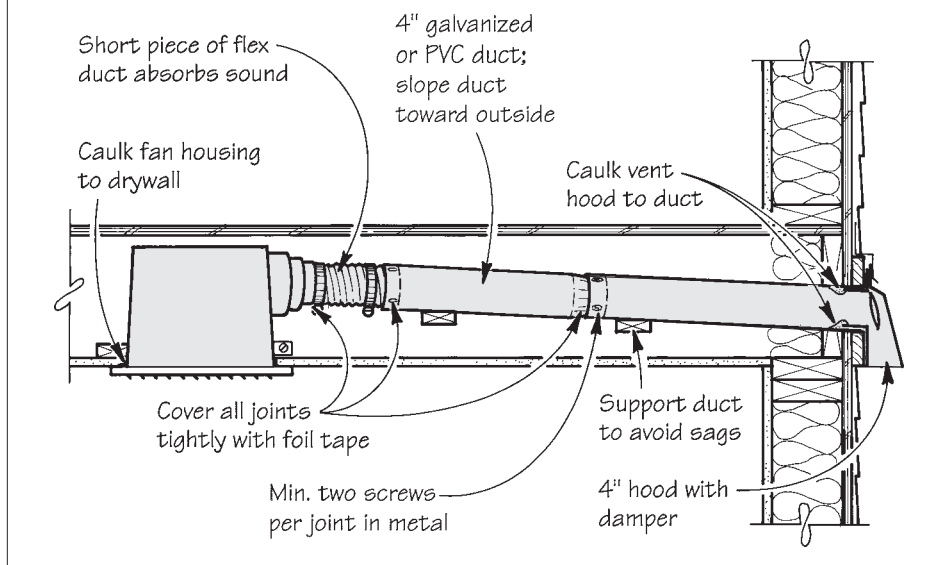
This article will focus on a system I've used that relies on a new fan from Panasonic (Matsushita Electric Corp. of America, One Panasonic Way 4A-4, Secaucus, NJ 07094; 201/392-6782).

New Fan on the Block

Many manufacturers now offer relatively quiet exhaust fans. I typically use the Panasonic FV series of bathroom fans (see photo, above) because they're affordable (less than \$100), extremely quiet, and energy efficient. This combination is critical for a ventilation system for a couple of reasons. First, most low-cost fans are so noisy you can't wait to turn them off, if you ever turn them on at all. If you expect a fan to be used, it must run quiet. The Panasonic fans run at 1/2 sone for the 50-cfm model, and 1 sone for the 90- and 110-cfm models. (One sone is about as quiet as a relatively new refrigerator.) Compare this with 3 sones for many cheap fans with similar capacities.

Also, since the fan is going to run for long periods to exhaust a whole house, it must not consume too much electricity. The Panasonic FV-08 fans use 17 watts, compared with 100 or even 150 watts for some cheap fans of similar capacity. A 100-watt fan used for 8 hours per day would cost about \$29 per year to operate (at 10¢/kWh), while the 17-watt Panasonic fan would cost \$5.

Typical Bath Fan Installation



For a quiet installation, separate the fan from the rigid duct with a short length of flex duct. Remember to support the rigid duct on blocking to prevent it from sagging. The illustration above shows metal duct, which is required by some fire codes.

Ventilation System Components

A fan by itself does not make a whole-house ventilation system. A complete system consists of a way to get stale air out, a way to get fresh air in, and a way to control the fans.

Out with the old. One FV-08, installed with less than 20 feet of smooth-wall duct and no more than two elbows, will deliver about 70 cfm. Just one of these is enough ventilation for a one-story, 1,800-square-foot house if the fan runs at least part of each hour that the house is occupied. Larger houses will require two or more fans (see "Sizing Fans," next page).

Fresh air in. Whenever you have this much air exhausted from a house, you must provide a way for fresh air to get in — and get in where you need it. Cracks around windows and doors, and other unavoidable air leaks, will also let in air, but this may not always provide enough fresh air in the occupied areas of the house.

I use through-the-wall inlets to do the job. I place one inlet in each bedroom, usually near the ceiling, where the colder outside air will mix with the warm house air before it contacts occupants.

Controls. One key difference between a simple bath fan and a whole-house ventilation system is the length of time the fan runs. In most cases, the fan will run for 6 to 8 hours per day. Also, since

most houses have more than one fan, the fans should be coordinated to run at different times to provide ventilation where and when it's needed. This requires reliable automatic timers.

Fans will need to run longer for people with "wet" lifestyles — lots of houseplants, cooking, Jacuzzis, or the like — and more during the first winter of occupancy in a new house when there is still a lot of moisture coming out of the building materials. This assumes that the occupants don't smoke, and there are no unusual sources of moisture or air pollution inside the house.

Sources of supply. Good mail-order sources for all the components of a whole-house system, including the Panasonic fans, fresh air inlets, and automatic timers, are Energy Federation (14 Tech Circle, Natick, MA 01760; 800/876-0660; 508/653-4299), Positive Energy (1503 Spruce St., Boulder, CO 80302; 800/488-4340), and Shelter Supply (1325 E. 79th St., Minneapolis, MN 55425; 800/762-8399).

Fan Installation

The Panasonic fan installs in the bathroom ceiling just like any other bath fan (see illustration above). Be aware that the fan housing is larger than that of typical bath fans — 9 inches square by 7⁷/₈ inches deep. This will fit in a 2x10 floor joist bay above the

drywall. In a 2x8 floor system, however, you have to plan the installation so that the lower lip of the fan housing is flush with the bottom surface of the drywall. Panasonic provides a trim collar that can be secured with two thumbscrews from inside the fan housing.

Filters. Since the fan is going to be running frequently, it will collect a lot of lint and dirt. This can eventually clog fan blades and cooling holes in the motor, lowering air delivery and shortening the life of the fan. To protect the fan, use an ordinary cut-to-fit air conditioner filter. Cut a square that fits just inside the grille and push the grille springs through the filter before pushing the grille in place. Explain to the owners that this filter will need periodic cleaning or replacement. Also, if you run the fans during drywall finishing to help the mud dry faster, be sure the filter is in place during sanding and plan on replacing the filter before the owners move in.

Ductwork. If there is any "fine print" about Panasonic's FV series fans, it is that they cannot move air against a lot of back pressure, which is resistance to airflow caused by ductwork and other obstructions. This means the ductwork needs to be full 4-inch-diameter rigid duct. A little flex duct — up to 2 feet or so — to connect to the fan and to the termination outside helps reduce noise and makes the installation easier without decreasing airflow too much.

For ductwork, I often use 4-inch thin-wall PVC pipe — the nonperforated type used for foundation drains. This material is easy to work with and the joints can be sealed tight with PVC cement.

If you use galvanized ducts, put at least two screws per joint. Then use foil duct tape — the type with a peel-off paper back — *not* cloth duct tape. Conventional cloth duct tape will eventually deteriorate, releasing moist air into the attic or floor structure.

Flexible duct should be clamped first with metal hose clamps or Panduit straps, then taped to the rigid duct. Do it right from the start so you don't ever have to get in there again.

Keep the total duct run to no more than 20 feet, and use no more than three elbows or 2 feet of flex duct. In most cases, this will be plenty of duct to get to an outside wall. If you need more, reduce the number of elbows and eliminate as much of the flex duct as possible.

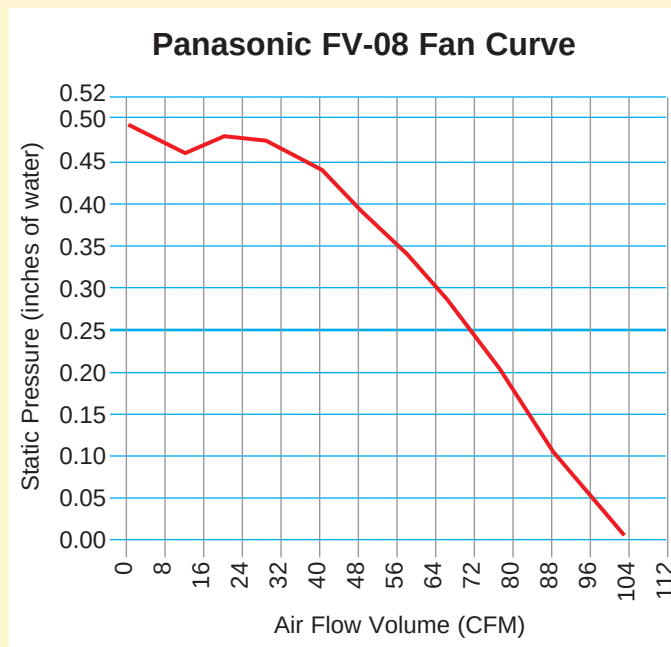
Sizing Fans

Ventilation fans are sized to provide specific air flow rates in cubic feet per minute (cfm). The size of the fan needed for ventilation depends on the size of the house and the number of occupants. The ASHRAE Standard recommends a minimum of 0.35 air changes per hour (ACH), but not less than 15 cfm per occupant during the time the house is occupied. You should calculate minimum whole-house fan size based on both house size and number of occupants, then use the higher number.

Here's how to calculate 0.35 air changes per hour:

- 1) Multiply the exterior square footage of the house or apartment by the average ceiling height to calculate total volume. Then multiply by 0.85 to account for the wall and partition thicknesses.
- 2) Multiply the volume by 0.35.
- 3) Divide by 60 (minutes per hour) to get the required cfm.

So, for example, an 1,800-square-foot, three-bedroom house with 8-foot ceilings would need a ventilation rate of



The fan curve shows how much air a fan will move as the static pressure increases with longer duct runs, elbows, grilles, and dampers. The 0.25 measure approximates the static pressure of a typical duct installation.

71 cfm to ensure 0.35 ACH.

Now compare this with the other ASHRAE recommendation of 15 cfm per occupant. Since the number of occupants in a house or apartment changes over time, the assumption is made that there are two occupants in the master bedroom and one occupant in each of the other bedrooms. So a three-bedroom house requires 60 cfm of ventilation by this mea-

sure. Because the ACH measure — 71 cfm — is higher, that is the one to use. In this case, one Panasonic FV-08 will meet the required ventilation needs.

Most fans' airflow ratings are usually listed at 0.1 and 0.25 inches of water. When choosing a fan, use the CFM rating at 0.25 inches of water, which approximates the static pressure of a typical duct installation.

If at all feasible, avoid running duct inside 2x4 walls. However, running down and out may sometimes be the shortest route to the outside. If you run the duct in partition walls, use 4-inch oval duct. Don't reduce the duct size below 4 inches.

Vent termination. As a termination outside, I use a simple low-cost dryer vent with a flap-type backdraft damper. The dryer vent terminations with three louvers can freeze up in the winter, so I recommend the hood-type outlet instead.

Insulation. If the duct is in the attic, it should be under the attic insulation; otherwise, condensation will form on the ductwork and leak into the house. If this is not possible (as when the duct runs across the top of the ceiling joists), insulate the duct separately. If you are using blown-in attic insulation, you can put up

"dams" using any available material, such as drywall, plywood, cardboard, or window screen. Fill the dammed-off area with insulation, mounding it over the ductwork to the proper insulation depth.

Support the duct with blocking to prevent any sags, and slope the rigid duct down toward the exterior as much as possible. With metal duct, "nest" the joints in the direction of flow, as a further hedge against condensation problems.

Controls

An automatic timer gives occupants the most options for controlling the fans. I install one timer for each fan (up to two fans). If there are additional fans located away from normally occupied areas (a guest-room bathroom, for example), a switch for each of these is adequate.

Don't wire the fan into the light switch. Doing so makes it impossible to

turn the fan on long enough for good ventilation without leaving the light on and wasting electricity.

I use the Grasslin KM2/I 24-hour in-wall timer (Grasslin Control Corp., 31 Industrial Ave., Mahwah, NJ 07430; 201/825-9696). The Grasslin timer I use (see photo, next page) fits into a standard electrical box, and can be programmed to turn on in 20-minute intervals. It can also be manually turned on and off. The timer needs a separate 2x4-inch electrical box, as the cover doesn't fit a ganged box. It sells to the trade for about \$35.

Another option is the new Airetrak from Tamarack Technologies (P.O. Box 490, West Wareham, MA 02576; 800/222-5932). This timer is a bit more expensive (contractor price about \$80), but it allows the fan to cycle for part of every hour at full or reduced speed. You



A complete whole-house ventilation system needs accurate controls and a source of fresh air. To control the exhaust fan, the author uses a Grasslin automatic timer that can be set at 20-minute on/off cycles (left). As a fresh air source, he uses Fresh-80 inlets (above).

select the fraction of the hour, plus the speed of the fan. A single push-button allows you to bump up the fan to full speed for 20 minutes when the bathroom is being used.

Inlet Installation

Since the fans are exhausting air from the house, makeup air must be supplied through inlets. Although there are other air inlets on the market, I use Fresh-80s (see photo above), available from Therma-Stor Products (P.O. Box 8050, Madison, WI 53708; 800/533-7533). These are relatively inexpensive, easy to install, and have several good features, including an adjustable damper and an easy-to-get-to filter to keep out dust.

Install one air inlet in each bedroom and in any “extra” rooms such as home offices, dens, or other perimeter rooms that will be occupied. The goal is to move air from perimeter rooms toward the bathrooms. If the living room doesn’t have any exterior doors, install an inlet in the living room, as well. A typical small house will have three or four inlets.

Locate the inlet as near the ceiling as possible, and keep away from beds,

couches, or other locations where cool, incoming air might be uncomfortable to occupants. Over a window is ideal, but this may mean drilling a big hole in a header, which isn’t a great idea. If there isn’t room over the header, locate the inlet anywhere in the exterior wall near the window. Keep the inlets near operable windows so that the vent’s outside louver and screen can be cleaned (as often as once a year) by sticking a vacuum cleaner hose out the window.

These inlets install easily by drilling a 3¼-inch hole through the drywall, sheathing, and siding. The plastic duct that goes through the wall telescopes to fit various wall thicknesses. Caulk the duct to the drywall to keep moist air from getting into the insulation, and to the siding or trim to keep water out. For retrofit work, it’s worth taking the time to align the hole so the outside grille, which is 4¼ inches square, fits on one clapboard. For new construction, install the inlet before the siding goes on so you can plan a 1-by block to go under the grille.

Be sure the inlets are away from garages, exhaust vents, or any other

source of fumes. Also be sure the doors in rooms with an air inlet and in the bathrooms are undercut a minimum of ¾ inch (1 inch is better) above finish floor height (including carpet) so that air can move through the room with the door closed.

Once the inlets are installed, adjust the inlet for maximum opening. With the filter, the outside screen, and the inside diffuser, these inlets don’t let in very much air, and they don’t do much at all if they are only partially open. The Fresh-80 has a string to open and close the inside diffuser. I usually open the diffuser, then wind up the string and stick it inside, so no one closes the inlet.

Critical Cautions

An important caution about any exhaust-only ventilation system is the potential for backdrafting fireplaces, wood stoves, and natural-draft appliances, such as gas boilers and furnaces. While the negative pressure created by the Panasonic fans is quite low — much lower than that induced by a clothes dryer or most range hoods — there is still a chance for backdrafting when the bath fans, the dryer, and the range hood all run at once. The best way to avoid this is to use only sealed-combustion fuel burners and to supply combustion air to wood stoves and fireplaces.

Also, if the house is leaky, the fan will draw air from the nearest air leak. In this case, the inlets will not do their job, and the ventilation effect will be very localized. Dropped ceilings in the bathrooms can be a disaster — a leaky dropped ceiling can provide all the air the fan draws, leaving the rest of the house without any ventilation. In general, exhaust-only ventilation works well with houses that average ¼ to ½ ACH (air changes per hour). This includes most reasonably tight new homes, built with vapor barriers and good seals around windows, band joists, and ceiling penetrations, such as vent stacks, chimney chases, and attic hatches. Older homes that are not built to these tightness standards should be air-sealed by a qualified weatherization contractor before retrofitting a ventilation system. ■

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