Heat-Recovery Ventilators

by Bill Rock Smith

A good spot for an HRV is next to an exterior basement wall. The short duct runs that carry cold air to and from the exterior hoods are insulated to prevent condensation.

In the 20 years that I've been building homes, I've seen a dramatic rise in the demand for mechanical ventilation in general and for heat-recovery ventilators (HRVs) in particular. Much of this demand is thanks to the growth of utility-sponsored new-construction programs. These programs recognize that natural ventilation is not a reliable way to provide fresh air for the people in a modern home. Mechanical ventilation is the only reliable way to do the job.

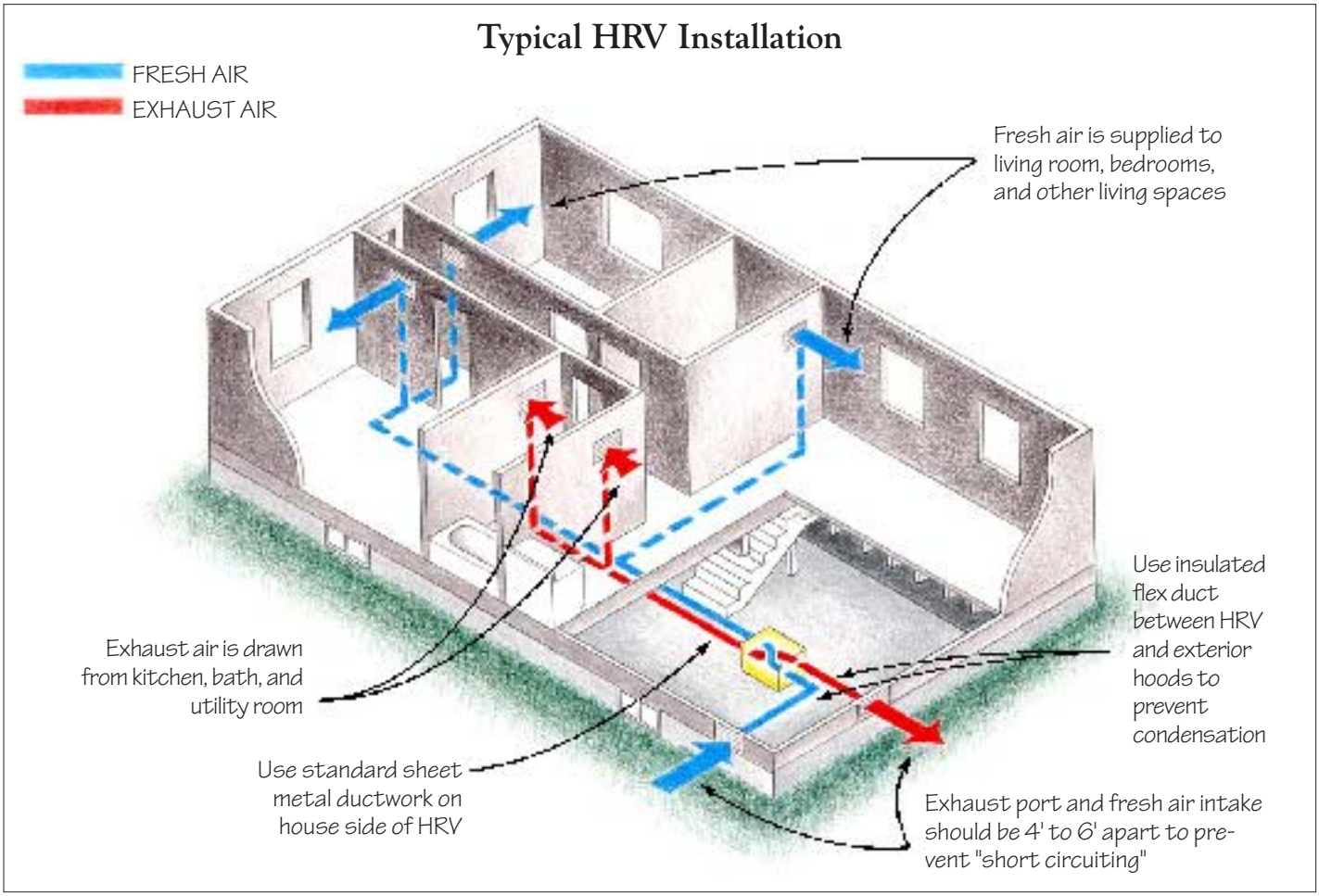
HRVs bring fresh air — not cold air — into tight homes, but you have to accurately size and balance the ductwork

Despite the new awareness, many builders still think that ventilating a home means putting in a range hood and a bath fan. Unfortunately, that's not enough. A good ventilation system not only removes stale air from kitchens and baths, but it also supplies an equal amount of fresh air to the living and sleeping areas (see Figure 1, next page). A good system is also a lot quieter than the traditional bath fan; ideally, it won't remind the homeowner that it's there.

To HRV or Not To HRV

You can satisfy a home's ventilation requirements in two ways: with a central exhaust fan and fresh-air inlets or with an HRV. The question is which to use when.

The first thing to realize is that ventilating costs money. You have to pay to heat or cool any outside air brought into the home. You must also pay to run the fans or blowers. Although HRVs typically cost $500 to $1,000 more than non-heat-recovery units, they recover a portion of the heat leaving the home in the exhaust air. This allows the homeowner to recoup the extra cost — called "payback." The rate of payback depends on the severity of the climate, the cost of heating fuel, the efficiency of the HRV, and how often and at what speed the homeowners ventilate. But



NATE CLEVELAND & ROBERT HUNTOON

Figure 1. *A heat-recovery ventilator uses heat from the exhaust stream to temper the incoming air. Exhaust air should be drawn from kitchens, baths, and laundry; fresh air is supplied to living room and bedrooms.*

despite the potential savings, most people choose an HRV for the comfort it provides. Preheating the incoming fresh air lets you introduce it to the living space without causing cold drafts. In regions with 5,000 heating degree-days or more per year, in fact, I won't install anything but an HRV.

Features of a Quality Machine

A number of companies make HRVs, but as far as I'm concerned only a few make really good ones. The best, in my opinion, are Honeywell's Energy Recovery Ventilator series and Conservation Energy Systems' vanEE. My first choice — the one I install on most of my jobs — is the vanEE 2000 VLD. The vanEE is whisper quiet. I've had people stand next to one running at low or medium speed ask me if it was turned on. The manufacturer also provides an excellent design and installation manual. And the vanEE comes with all the hardware needed for a clean, professional-looking installation.

If you want to go shopping for an HRV, there are certain qualities you should look for:

- A painted galvanized steel or ABS/PVC plastic case.
- Hinged doors for service access, and easily removable fans and other parts.
- A core that's easily removed for cleaning.
- Washable or easily replaced filters that protect the core and the fans.
- Quiet fans and motors that are rated for continuous operation, use little energy, and require little maintenance (PSC, or permanent split capacitor, motors offer the longest life and most trouble-free operation).
- A minimum two-speed control for continuous ventilation, and a high-speed boost override.
- Installation accessories, including hanging straps to isolate vibration, vinyl flex connectors, drain hose connectors, quality exterior hoods, and balancing dampers.
- Double-duct collars for easy attachment of insulated flex duct and vapor barrier jacket.
- A defrost system to keep ice from forming in the core — the colder the climate the more important this feature becomes.
- UL listed components.

One caution: The defrost system in some HRVs works by running the exhaust blower with the supply blower turned off. If left on for too long, this can create a negative pressure in the home and cause backdrafting of combustion appliances. Look for a system that does not run under negative pressure or that only does so for short periods of time (10 to 15 minutes).

In addition, make sure that any HRV you consider has been tested by Ortech International, a Canadian testing lab. Ortech looks at ventilation performance, energy recovery, and electrical use. The Home Ventilating Institute (30 W. University Dr., Arlington Heights, IL 60004; 708/394-0150) publishes a directory of HRVs that have

The Core of the Matter

The heart of an HRV is its heat exchanger core. These come in two varieties. Plate cores consist of thin sheets of plastic, paper, or metal that separate the supply and exhaust air streams. The heat from the exhaust stream moves through the core material and is transferred to the incoming fresh air. The air streams do not mix. Typical recovery efficiency of a plate-type HRV is about 70% at 100 cfm.

The rotary, or heat wheel, HRV, slowly rotates between the exhaust and supply streams, removing heat from the first and giving it up to the second. Typical efficiency is around 80%. Rotary-type HRVs have slightly more cross leakage between the air streams than plate types because the spinning wheel tends to wear down the weatherstripping that separates them. You can compensate for this by slightly raising the ventilation rate. The rotary core on Honeywell's Energy Recover Ventilator includes a dessicant coating that transfers moisture between the air streams. This is useful for large homes in cold climates where the occupants don't generate enough moisture to maintain proper humidity levels. A dessicant wheel is also a must in a hot, humid climate like Florida. The wheel removes moisture from the incoming air and precools it to lessen the load on the air conditioner.

Some manufacturers offer a paper core that can transfer moisture, but I haven't used one yet.

— *B.R.S.*

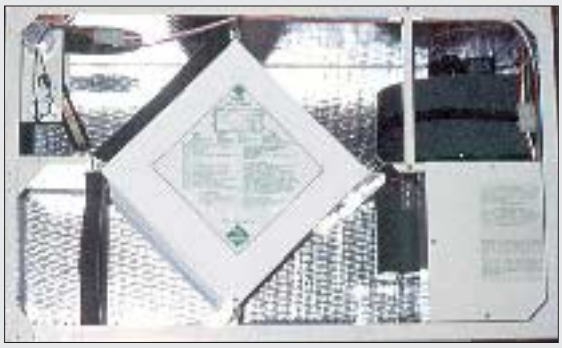


Plate core HRV

HONEYWELL

Rotary core HRV

been Ortech tested. You can also ask the manufacturer for Ortech's Certified HRV Sheet.

The first thing I look for in the test results is whether the HRV has the ventilation capacity I need. If the unit will double as a bath fan, it needs to deliver at least 200 cubic feet of air per minute (cfm) in the boost mode. That's enough to provide spot ventilation for two or three baths and general ventilation for the kitchen. I then examine the unit's power consumption in the continuous mode — usually 70 to 100 cfm. I prefer 100 watts or less. The last thing I check is the heat recovery efficiency. This can range from as low as 60% to as high as 85%. I'm satisfied with a 70% efficiency at 70 to 100 cfm if the unit is easy to install. Efficiency is only one slice of the pie, though. I have bought HRVs based solely on their efficiency, only to discover too late that they were a nightmare to install, made too much noise, used too much electricity, or didn't provide enough air flow.

If possible, arrange to see a unit in operation before buying it. Your local supplier may have a demonstration unit in their facility or there may be one installed in your area. Talk to other contractors who have installed HRVs and get the names of homeowners who own them. This extra effort in the beginning can save headaches and callbacks.

Getting Design Help

The main requirement for an HRV installer is a familiarity with ductwork. The Home Ventilating Institute (HVI) publishes a good general installation manual. Some manufacturers also have good manuals; others don't do an adequate job of guiding the first-time installer.

As with most jobs, start with the plans. If the system was designed by an hvac designer and the plans show the location of the ducts, your job will be easier. If not, then hire a designer for your first job. First-time installations (including my own) tend to have undersized ducts that make too much noise and deliver too little air. They also tend to have oversized fresh-air grilles of the wrong configuration that don't let the cool incoming air mix properly with the house air.

Fortunately, some distributors offer in-house design services. These include the Energy Federation in the Northeast (14 Tech Circle, Natick, MA 01760; 800/876-0660), Shelter Supply in the Midwest (1325 E. 79th Street, Minneapolis, MN 55425; 612/854-4266) and Energetechs in the West (P.O. Box 184, Victor, MT 59875; 406/642-3950). The fees for this service are quite reasonable. In my area, the Energy Federation will design a system for about $75. Once you have the design in hand, be careful about changes. Rearranging the floor plan may invalidate the designer's air flow estimates — regardless of whether you have to reroute your ducts. You may need to use larger-diameter ducts or a different HRV. Again, check with your designer.

Installing an HRV

Regardless of who designs a heat-recovery system, the installer should be familiar with a number of rules. These are fairly simple.

HRV placement. Always install the unit in a tempered space, such as a


Figure 2. *The author uses double-ducted collars (left) to seal the outside vapor barrier of insulated flex duct to the exterior intake and exhaust hoods. He applies a bead of sealant around the collar before attaching it to the band joist (right).*

basement. In most HRVs, moisture condenses on the exhaust side of the heat exchange core during cold weather. (Units without condensate drains preheat the incoming air or use a Tyvek-like core that transfers outgoing moisture to the supply air.) Keeping the unit warm prevents the condensate from freezing. In addition, the condensate should be drained to a sink, a floor drain, or (if local codes permit it) a plumbing trap. The best location is a basement close to an outside wall: It's tempered yet out of the way, and the other mechanicals are usually close by. One of the worst places is an attic, where you'll need to build a special insulated room around the machine to keep it from freezing.

You should also put the HRV someplace where you won't hear it. The best spots for this are under a kitchen, bath, or closet. The worst is below a bedroom (although I wouldn't hesitate to put a vanEE in either of these locations; I would even put one in a master bedroom closet if it were the only space available).

Ducts. To maximize air flow, keep duct runs short and make as few changes in direction as possible. Duct elbows create significant resistance to air flow. The sharper the angle, the greater the drop. Try to minimize them, and use the shallowest angles possible. Position the HRV at a height that accommodates the incoming ducts without major changes in duct direction or elevation. It's a good idea to tape duct joints to prevent leakage. I usually only tape the joints where sections of duct or two fittings meet. Taping all joints and elbows may be ideal but adds too much to the cost while adding very little to the performance. It also looks terrible.

I use round sheet metal ducts for the trunk and branch lines that run from the HRV to living space. In an ideal world these ducts would be insulated, but in my market insulated duct would make the system too expensive. However, because the supply and exhaust ducts from the HRV to the outside carry cold air, they *do* need to be insulated and vapor tight to prevent condensation. I use insulated flex duct here. When using insulated flex duct it's crucial to properly seal the vapor barrier jacket; otherwise (and this a common problem on first-time installations) warm air from the basement will condense on the pipe and wet the insulation. Double-ducted collars on the HRV and at the exterior hoods make air sealing clean and easy (Figure 2).

With the ductwork in place, measure air flow using a flow station and magnehelic gauge (Figure 3). The gauge gives an air pressure reading that can be converted to cfm using an accompanying chart. To prevent backdrafting of combustion appliances (furnaces, water heaters, and the like), the system should be balanced, which means that it should supply as much air to the home as it exhausts (within 10%). Adjust the system's balancing dampers until you achieve equal air flow in the supply and exhaust streams. The Home Ventilating Institute's installation manual and some manufacturers' manuals have instructions on how to balance HRVs. And though you probably don't have a flow station and magnehelic gauge lying around in your pickup truck, you can usually rent them from the supplier.

Grille location. Fresh air should be supplied to all living spaces, especially bedrooms. But be careful to place grilles where they won't cause drafts. The best place is high on a wall or ceiling, where the incoming fresh air can mix with conditioned room air before falling to the breathing zone (Figure 4). This mixing happens fairly quickly; a properly designed system can supply 50°F air to the living space even when the outside temperature falls to –10°F. Use a grille that pushes air out into the room *and* up towards the ceiling. A long, rectangular grille is best. Avoid placing a supply grille on or near the floor; cool



Figure 3. *A flow station (left) and magnehelic gauge (center) are used to measure air flow and static pressure in the duct system. To balance the intake and exhaust sides, the installer adjusts in-line dampers (right).*

Figure 4. *Placing supply and exhaust grilles high on the walls reduces drafts and helps cooler incoming air mix with the house air. For routing through stud bays, the author prefers oval ductwork because it is less expensive and easier to install than rectangular.*

Figure 5. *To prevent "short circuits," the author separates intake and exhaust hoods by 4 to 6 feet. He also keeps them at least a foot above grade to prevent snow infiltration.*

air will simply pool around it, creating a cold spot that you'll feel whenever you go near it.

Stale air should be exhausted from kitchens, baths, and laundry rooms. Exhaust grilles should also be placed high up on the wall rather than near the floor. That's because the makeup air for these rooms usually comes in beneath the door. If you place the exhaust grille too close to the floor, it will short-circuit the makeup air before it can ventilate the upper half of the room (the very place where warm, moist air likes to gather).

Exterior hoods. To prevent short circuits between the exterior intake and exhaust hoods (Figure 5), the Home Ventilating Institute says to separate them by at least 6 feet. In my experience, though, 4 feet is a workable minimum and 5 feet 4 inches is more than adequate. You should also keep intake hoods away from driveways, garbage cans, animal pens, and other pollutant sources, as well as one foot above the snow line (hoods penetrate the house at the first floor band joist, so this usually isn't a problem). When I can, I place intakes on the downwind side of the building. Snow is less likely to build up there, and the system won't be at the mercy of wind so much of the time. It's also best to keep hoods 3 feet away from the corner of the building to avoid high turbulence, which could affect the balance of the unit. Be aware, too, that in winter the exhaust air may be very humid and may create a fog when it hits the outside air. Because this moisture could easily turn to ice, don't place hoods above a gas or electric meter. The hoods themselves should be designed to prevent rain entry and must have a rodent screen. Local codes may require a backdraft damper.

Don'ts. There are certain things you shouldn't ask an HRV to do. For instance, never connect one to a kitchen range hood — you'll quickly clog the HRV with grease. And don't use one to supply makeup air to a combustion appliance like a furnace. An HRV is designed to provide fresh air for breathing. Using it for combustion air may unbalance the ventilation system and probably won't provide a reliable source of combustion air anyway. For maximum safety, use sealed-combustion appliances, each with a dedicated external air supply.

Duct Dictionary

- **Insulated flex duct** insulates to R-4. It's inexpensive (60¢ to 70¢ per foot for 6-inch pipe), but it won't fit in a 2x4 wall and it has at least twice the resistance to air flow as galvanized sheet metal — even more when not pulled tight. To minimize sagging, the duct must be supported at close intervals; I space my supports 3 feet apart and still get sags. If you use flex duct for the trunks and branch lines in the basement, you must account for the extra resistance in your duct-sizing calculations.

- **Metal flex duct** has about the same resistance to air flow as insulated flex duct. It's uninsulated and is available in a soft foil (53 cents for 6-inch pipe) or lightweight aluminum (96 cents for 6-inch pipe). Metal flex duct has all the disadvantages of insulated flex duct at a higher price. I never use it.

- **Galvanized sheet metal** is what I use for the HRV's trunk and branch lines. It comes in a 30-gauge thickness. Six-inch pipe costs $1 per foot, but it's well worth the price, since it offers much less resistance to air flow than flex duct and looks better. I can also space the supports farther apart; every 4 feet is more than adequate.

— *B.R.S.*

Keeping It Quiet

Another common installation error is to pay too little attention to noise. This is potentially serious, since if a system is too noisy the homeowner

Figure 6. *Interrupting a rigid duct run with a canvas connector helps keep HRV noise out of the ductwork.*

may simply turn it off. System noise includes vibration from the machine, motor noise, and the sound of air moving through the ducts. Noise is an even bigger problem in tight houses; these are quieter than older homes, so the sound of mechanical equipment may seem magnified. With a forced-air heating system, on the other hand, HRV noise is dwarfed somewhat by the furnace fan. Noise reduction strategies include:

- Using rubber straps to hang the unit from the basement ceiling joists (a good manufacturer will supply them).
- Breaking rigid duct with a canvas connector to isolate HRV vibration from the ductwork (Figure 6).
- Buying an HRV with a blower that uses a vibration-isolation mounting system. Ask the manufacturer.
- Buying an HRV whose blower wheels are balanced (like car tires) to keep them from wobbling.
- Limiting air velocity through the grilles to 500 feet per minute or less during base ventilation speed (this must be calculated when sizing the system).
- Avoiding short, straight runs from an HRV to an interior grille (this is a tradeoff — elbows reduce airflow but they also help dampen sound).

Control Choices

The best ventilation system in the world is useless without a good control. I use a 24-hour timer that lets the homeowner choose which hours of the day to have low-speed general ventilation. I also add a high-speed override — a crank timer or push-button electric timer in each bath — to boost the machine into high gear for spot ventilation.

Multispeed controls ventilate at two or three discrete speeds only, while variable-speed controls allow gradual adjustment over a defined range. Dehumidistats are also available that will kick the HRV into high speed when the air in the living space reaches a given relative humidity.

I prefer multispeed HRVs because they make it easier to diagnose certain problems. If, after installation, the homeowners call to say that the house is too dry, knowing the exact flow rate at whatever speed they're ventilating will tell me whether they're ventilating too much or not generating enough internal moisture. I don't use dehumidistats because they may lead homeowners to believe that the right amount of fresh air for the house depends on the humidity level. Dehumidistats also activate the high speed of the unit, which in turn lowers its recovery efficiency. And if a dehumidistat isn't shut off when the outdoor air is humid (in the summertime) the HRV will remain on constantly. ■

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Sources of Supply

American Aldes
4537 Northgate Ct.
Sarasota, FL 34234
813/351-3441

Conservation Energy Systems
2525 Wentz Ave.
Saskatoon, SK S7K 2K9
Canada
800/667-3717

DuroDyne Corp.
130 Rt. 110
Farmingdale, NY 11735
800/899-3876

Environment Air Ltd.
P.O. Box 10
Cocagne, NB E0A 1K0
Canada
506/576-6672

Honeywell Inc.
Honeywell Plaza West
Box 524
Minneapolis, MN 55408
800/345-6770

Nutech Energy Systems Inc.
511 McCormick Blvd.
London, ON N5W 4C8
Canada
519/457-1904

Raydot Inc.
145 Jackson Ave.
Cokato, MN 55321
800/328-3813

Research Products Corp.
P.O. Box 1467
Madison, WI 53701
800/334-6011

Stirling Technology Inc.
P.O. Box 2633
9 Factory St.
Athens, OH 45701
800/535-3448

Therma-Stor Products
P.O. Box 8050
Madison, WI 53708
800/533-7533

United Technologies/Carrier
7310 W. Morris St.
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1715 Haggerty
Drummondville, QC J2C 5P7
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819/477-6226