



Retrofitting an HRV

The challenges are finding a good place for the unit and installing the ductwork without butchering interior finishes

Alaskan winters are long and cold, so here in Fairbanks we build tight houses. In general, tighter houses have lower heating costs, but without adequate ventilation, they can also suffer from excessive humidity and poor indoor air quality. This problem, though usually associated with new construction, is increasingly cropping up in retrofit projects. The Alaska Housing Finance Corporation (AHFC) offers rebates for air-sealing and other energy upgrades,

and mandatory before-and-after energy audits performed in the course of the program have found that many upgraded homes are too tight to meet AHFC ventilation requirements.

Meeting the standard calls for mechanical ventilation. In our climate, that means a heat-recovery ventilator (HRV), which pulls in fresh outdoor air while exhausting stale air from indoors. The streams pass, without mixing, through opposite sides of a heat-exchanger core, where up

to 70 percent of the heat in the outgoing air is transferred to the incoming air (see **Figure 1, page 3**). During the winter in this part of Alaska, outdoor air is very dry, so running the HRV also reduces indoor humidity.

Air-conditioned homes in humid climates, by contrast, are often better served by an energy-recovery ventilator, or ERV, which helps control humidity as well as temperature. The core of the ERV is permeable to moisture, so some of the humidity

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in the incoming air can cross over to the outgoing air stream, reducing cooling and dehumidification loads. Although running an ERV in an air-conditioned home in humid weather will bring additional moisture into the building, the moisture load will be lower than if an HRV had been used instead.

My company specializes in installing HRVs. Of the many brands on the market, we install Venmar, LifeBreath, and Fantech; these are top-quality products and are readily available in our area. We average between 75 and 100 installations per year — most of them retrofits — with a typical installation taking two to five days. Material costs don't vary much from job to job, but the labor it takes to install ductwork in an existing building can vary considerably. Installed costs are typically between \$5,000 and \$8,000; in new construction or where air will be distributed through existing ductwork, they're somewhat lower.

System Sizing and Design

An HRV is connected to two pairs of ducts. The pair on the unconditioned side of the unit go to the exterior, with fresh air entering the building through one duct and stale air exiting through the other. The conditioned-side ducts are connected to indoor supply and exhaust registers throughout the house.

Exhaust and supply ducts. If a home has forced-air heat, the HRV unit's warm-side ducts can feed in to the existing distribution system. But because most of the homes in our area have hydronic baseboard heat, we usually install fully ducted systems, in which every room in the house is connected to a dedicated duct. Habitable rooms, like bedrooms, living rooms, playrooms, and the like, each get a supply duct. Rooms where pollution is generated — kitchens, bathrooms, and laundry rooms — get exhaust ducts. Basements

and unvented crawlspaces receive both supply and exhaust, while pantries and closets require no ventilation.

Multiple sizing standards. Most state codes incorporate some version of an ASHRAE or IECC ventilation standard. HRV manufacturers typically recommend sizing their products on the basis of an old ASHRAE standard that requires .35 air changes per hour in the house. The International Energy Conservation Code (IECC), on the other hand, requires 15 cfm of ventilation air for each occupant, assuming two occupants for the first bedroom and one occupant for each additional bedroom.

Under the most recent ASHRAE ventilation standard, ASHRAE 62.2-2007, the required airflow can be calculated using a formula or it can be taken from a published table. The table lists the required airflow for specified combinations of occupancy and floor area, while the formula requires 1 cfm of outdoor air for every 100 square feet of floor area, plus 7.5 cfm per occupant. Both the table and the formula count occupants the same way the IECC does.

In most cases, the number in the table will be equal to or higher than the calculation. It will only be lower if the house is over 7,500 square feet or has more than seven bedrooms. It's up to the installer to consider both figures and use whichever one is higher.

In our area, things are slightly different. To receive rebates from the AHFC, we must comply with a modified version of ASHRAE 62.2-2004. Like 62.2-2007, that local modification gives us the option of calculating the airflow or taking it out of a table. The main difference between it and the normal 2007 version is that its cfm-per-occupant figure is set at 10, rather than 7.5 — a figure intended to reflect the greater tightness of Alaskan homes relative to those elsewhere.

To give a simple example, under the AHFC standard the calculated airflow for a four-bedroom 2,500-square-foot house would be 75 cfm: 50 cfm for the bedrooms ($2 + 1 + 1 + 1 \times 10$ cfm) plus 25 cfm for the floor area ($2,500 \div 100 \times 1$ cfm). According to the table the house would require 90 cfm. Using the higher of these two numbers, we would install a 100-cfm HRV because it's the closest size capable of providing the required 90 cfm of airflow.

Installation Requirements

Finding a suitable place to install a retrofitted HRV can be a challenge. An HRV requires power, so it should be close to a 110-volt receptacle. We prefer to share a circuit that sees frequent use. That way, the homeowners will notice right away if the breaker trips. The unit must also be accessible for servicing and for periodic cleaning of the internal filters. To reduce energy loss and prevent freezing, it should be located in an area that stays above 50°F.

The HRV's core produces a small amount of condensate that drains out through a fitting on the bottom of the housing. The installer connects the fitting to a drain hose that carries the condensate away. The IRC requires that this condensate be directed to "an approved place of disposal." A floor drain, laundry sink, standpipe, or other open drain is our first choice. If that's not possible, many inspectors will allow you to run condensate into a footing drain or French drain.

Utility room, garage, crawlspace. A utility room or laundry is an ideal location for an HRV — both are accessible conditioned space with power and a drain readily available. Closets can be an excellent option in new construction, but they're less desirable for retrofits because they lack the necessary plumbing and electrical connections.

An attached garage can be a good place

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to install an HRV, provided it is at least partially conditioned. But extra care must be taken to completely seal the ductwork so that no auto exhaust or chemical fumes find their way into the house through the HRV. The 2009 IRC requires that both ducts in the garage and any ducts that penetrate the wall separating the garage from the dwelling must be made from 26-gauge or thicker sheet metal. Flex duct is not allowed, because it could burn through in a fire and allow smoke to enter the home.

We frequently install HRVs in unvented conditioned crawlspaces. The crawlspaces in this area are typically quite deep and provide easy access to joist bays and the stud bays in partition walls where we like to run our risers. By code, any equipment in an attic or crawlspace must be within 20 feet of the access point and have a level work area in front of it that is no less than 30 inches deep and wide. If the equipment is hung from the floor above, there must be at least 6 inches of clearance between the equipment and the ground.

Ductwork Options

We use the Air Conditioning Contractors of America (ACCA) Manual D to size the ducts and determine the equivalent duct length for various combinations of fittings. The manual typically requires 6- to 8-inch ducts at the HRV. At the far ends of supply runs, 4-inch duct may be permitted. But because it's inconvenient to stock and handle every size of duct and fitting, we use 6-inch material even where Manual D would let us use 4- or 5-inch.

Easy on the flex duct. Flex duct impedes airflow, so we use smooth metal duct for the warm-side ducts wherever we can. However, difficult transitions in retrofit work sometimes force us to use short sections of noninsulated flex duct. Using a short section of flex duct between the metal ductwork and the HRV itself can

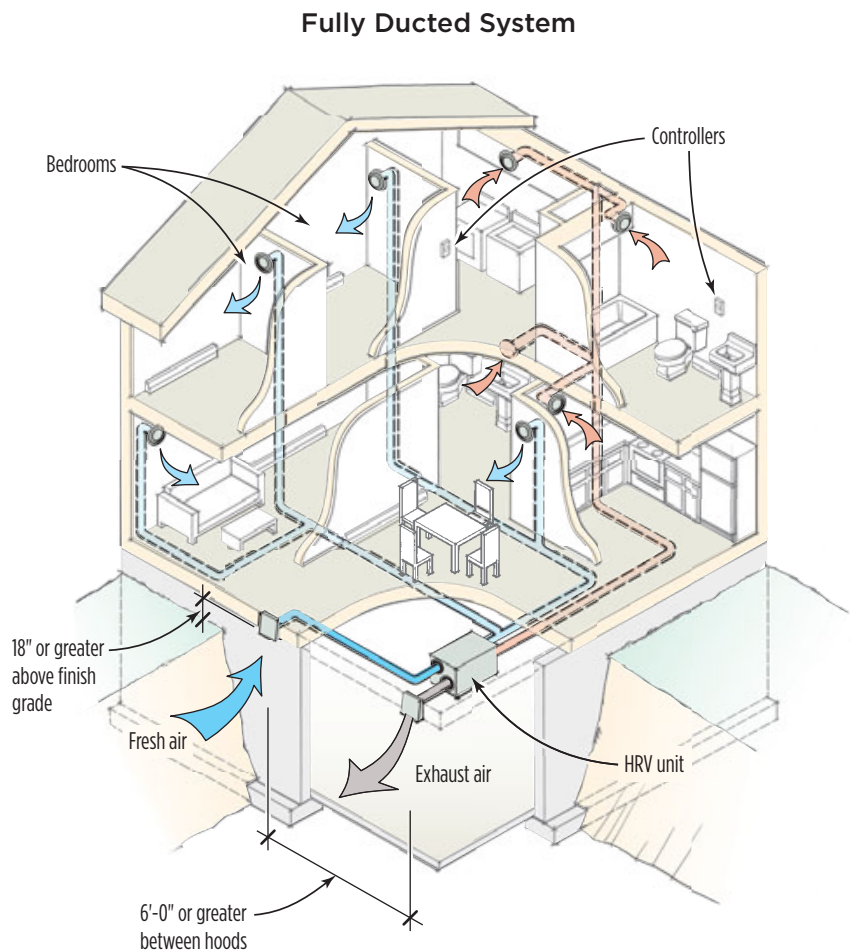
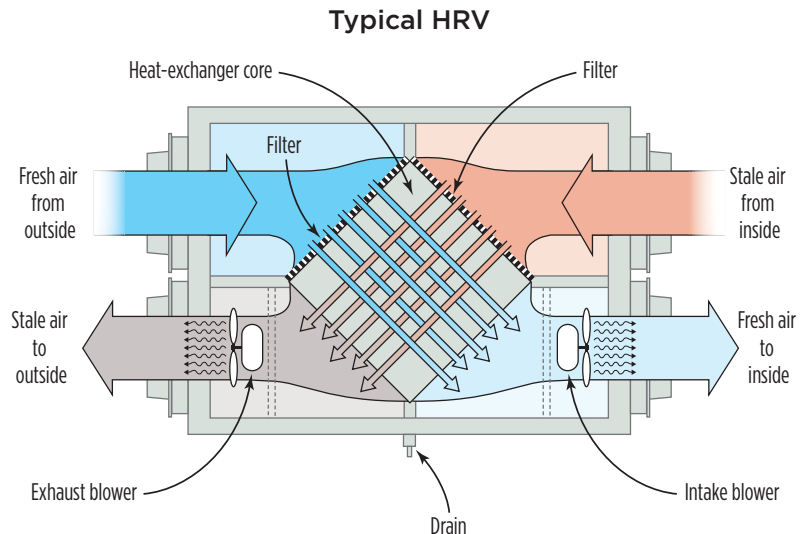


Figure 1. The HRV pulls fresh air into the house while exhausting stale air to the exterior. The two streams pass, without mixing, through a heat-exchanger core, where heat from the outgoing air is transferred to the incoming air (top). In fully ducted systems, habitable rooms are served by supply ducts, while rooms where pollution and humidity are generated get exhaust ducts (above).

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also be a good way to dampen vibration.

Warm-side ducts need not be insulated except where they pass through unconditioned space. Cold-side ducts, on the other hand, must be insulated to save energy and prevent condensation in and on the ductwork. We typically use insulated flex duct for cold-side ducts and compensate for its effect on airflow by keeping the cold-side runs as short as possible. If the HRV is in the garage — where flex duct isn't permitted — we use smooth metal duct covered by an insulating jacket (**Figure 2**).

Running the Ductwork

After locating and hanging the HRV, we cut holes in the exterior walls for the weather hoods that let air into and out of the building. The AHFC requires that the hoods be at least 6 feet away from each other horizontally (**Figure 3**). And the IRC requires that the intake be located a minimum of 10 feet from any sources of contamination, such as chimneys, plumbing vents, and areas where car exhaust is present. The manufacturers recommend placing hoods at least 18 inches above the ground.

Locating registers. Exhaust registers have to go near the ceiling, because this is where the warm, humid air we want to get rid of naturally accumulates. Supply registers also work best if they can be placed in or near the ceiling, because that allows the relatively cool supply air to mix with the warmer room air as it sinks. Another good practice is to site both supply and exhaust registers across the room from the door, so air can mix as it travels into or out of an area.

Retrofitting ducts and registers into an existing home can be difficult. The drywall is up, the framing is where it is, and the budget may not allow you to open up walls. In a house with baseboard heat where we can't put the supply duct in the wall, we often install supply registers in the floor



Figure 2. Where a cold-side run of rigid duct is unavoidable, as in a garage, the pre-assembled duct can be slipped inside the foil-faced insulating jacket from a length of flex duct.



Figure 3. A duct carrying stale air from the HRV passes through the rim joist and connects to a riser hood (above left) that directs the exhaust to an exit point 18 inches above grade (above). In the installation shown at left, the exhaust and intake are high in the wall and separated 6 feet horizontally to meet code. The intake louvers are permanently open, but the exhaust louvers open only when the HRV is running.



Figure 4. Although supply registers are best placed high in a wall, they can also be successfully installed in the floor. This duct run in a joist cavity (far left) terminates at a boot that supplies a floor register (left). Convection currents from the heat strip will help to mix the incoming air with the air in the room.

next to the heat strip (Figure 4). As fresh air comes out of the register, convective currents from the heating system disperse it throughout the room. While not ideal, this approach does allow us to put the register across from the door and next to an exterior wall in which we couldn't or wouldn't want to install a duct. The floor registers themselves are easy to install — they fit into a supply boot connected to a main duct run in or under the joist bay below.

Through the plate and into the wall. For exhaust ducts, we like to go from the main underfloor duct run to a wall-mounted register by cutting an opening through the subfloor and bottom plate of a partition wall and sliding an oval duct riser into the stud cavity above (Figure 5). Once the duct is in position, we cut a hole through the drywall — aligned with a precut hole in the side of the riser — and snap in the register (Figure 6, next page). If the register has to be in the wall and there's no way to get the duct into the framing cavity, we'll cut a hole in the floor and bring a round exhaust duct through it. With luck, we can go through a closet to a wall register, but in some cases we have to box it into a corner or run it along the ceiling and build a soffit around it (Figure 7, next page).

Each joint in the metal ductwork is connected with three self-tapping sheet-metal screws and carefully sealed with duct mastic or butyl tape (Figure 8, page 7). We use canned spray foam to seal around ducts where they penetrate floors and rim joists.



Figure 5. After one end of an oval riser is capped and sealed with tape (above left), it's slipped into a hole cut through the subfloor and bottom plate of a partition wall (above). A round hole in cut in the side of the riser (not visible here) will later accept a wall register. The lower end of the riser transitions to a 6-inch round duct for connection to the warm-side run leading to the HRV (left).

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Controls

The ventilation system can be equipped with a variety of control mechanisms. We recommend using a top-of-the-line programmable controller from the HRV manufacturer. These controllers can be set to run intermittently or continuously at varied speeds, or programmed to respond to indoor and outdoor humidity. In the recirculation mode, they can move air from place to place within the home to equalize variations in temperature. An example of this would be a house with a wood stove, where the room with the stove is too warm and the back bedrooms too cold.

Spot ventilation. In addition to the master control in the main room of the house, there should be booster controls in bathrooms and kitchens. These units — which work by either turning on the HRV or increasing the exhaust speed — can be used to provide extra ventilation in those areas. Different types are available, from simple push-button timers to



Figure 6. As a drill-operated hole saw cuts through the finished drywall, a shop vac collects dust before it has a chance to spread (left). The oval riser behind the drywall was previously cut out to accept the wall register (above), which can now simply be snapped in place.



Figure 7. If the duct can't be placed in the wall, another possibility is to route it through a concealed area, such as a closet (above left). When all else fails, it can be installed in the room (above) and boxed in later on (left).

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more sophisticated, programmable units that respond automatically to changes in humidity.

Balancing the System

Although an HRV's intake and exhaust blowers are designed to move the same amount of air, they can't do so unless the static pressure in the supply ducts matches the pressure in the exhaust ducts. But given the variations in the size and layout of the ducting, that's unlikely to happen on its own. That's why all newly installed systems must be balanced, or adjusted to make sure that the same amount of air comes in through the HRV as goes out.

To balance a new system, we start by turning the HRV fan on high and connecting a Magnehelic differential pressure gauge to the measuring ports. The procedure from that point on varies, depending on the HRV used. Some models have built-in balancing dampers that can be adjusted to equalize the airflow; on other models, we have to adjust the speed of the blower motors.

Air Filtration

We offer our customers an optional high-efficiency air-filtration system as an \$800 upgrade. The filter unit is installed on the warm-side supply ducts so that it removes particles from the incoming air and repeatedly filters indoor air when the unit is run in the recirculation mode.

Custom-made housing. Although we could buy off-the-shelf filter units, we prefer to have our filter housing custom-made so that it can be configured to hold our preferred filter media (**Figure 9**). Also, our housings hold three filters — rather than the usual two — and accept standard 16-by-20-inch media, a readily available size that is inexpensive to replace and does not unduly restrict airflow. We specify the location of the duct collars and the direction of airflow, which saves us from



Figure 8. Joints in metal duct must be sealed with mastic (left) or butyl tape (right). Here, a joist is obstructing the back of the duct riser, so the tape is positioned all the way around before the release paper is peeled off and the tape pressed in place.



Figure 9. The enclosure to the right of the HRV is a custom-made filtration box with the cover removed to expose the filters. To cut down on noise and vibration, short sections of uninsulated flex duct have been used to connect the HRV to the metal ductwork.

having to adapt a factory-made unit.

Filter options. The custom housing typically contains a 1-inch MERV 8 pre-filter, a 2-inch MERV 11 pleated filter, and a carbon filter (MERV refers to minimum efficiency reporting value, the ASHRAE standard for air filters). A MERV 8 filter traps at least 70 percent and MERV 11 at least 85 percent of particles between 3.0 and 10.0 microns in size. The less-expensive prefilter extends the life of the pleated filter behind it.

As a further upgrade, we can offer MERV 15 pleated filters — which capture

85 to 94 percent of particles from 0.3 to 1.0 micron in size — for performance rivaling that of a HEPA filter. We don't recommend HEPA filters themselves because they are expensive and greatly compromise airflow. The carbon filter is designed to trap odors and noxious gases, and is available in different grades and for use with a variety of pollutants.

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