HEAT RECOVERY VENTILATORS
a Carpenter’s Guide
PLEASE NOTE:

As with all technical projects, this manual does not include every available product or element of HRVs. We strongly urge you to research products, codes and climatic effects prior to building.

This publication attempts to provide general guidelines for HRV system installations and other practical information related to residential ventilation within the state of Alaska. It should not be considered a substitute for an engineered duct design.

And as with any building project, check your local, county, state and national building and safety codes before beginning construction. If you are building in an area with local codes, they may have amendments that will take precedence over national code. The Alaska Housing Finance Corporation Building Energy Efficiency Standard (BEES) has been amended to incorporate Alaska-specific changes to national design standards and energy codes, and must be complied with in order to qualify for the state-sponsored Home Energy Rating Program and its associated incentives. This includes higher minimum insulation requirements and changes in ventilation standards over national code. These amendments can be found at http://www.ahfc.state.ak.us/iceimages/reference/bees_amendments.pdf.

*Heat Recovery Ventilators* was produced by the Cold Climate Housing Research Center, ??Date. Written by Ilya Benesh, Building Educator

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The Purpose of this Manual

This publication is designed to provide an overview of HRV systems, control options, and installation guidelines to anyone who is considering installing their own system. In essence, it takes the instructions that come with a typical HRV unit one step further by providing detailed visual and written information that can be applied to various installation scenarios. Along the way it also presents pertinent information covering various aspects of indoor air quality and ventilation. Although this manual includes prescriptive information taken from code books and industry literature to assist with duct sizing, it should by no means be considered a substitute for a professionally engineered duct system.

The ventilation requirements presented in this guidebook are taken from national codes and have been amended by the Alaska Housing Finance Corporation (AHFC) to provide a set of standards specific to the State of Alaska. Alaska uses an amended version of American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Standard 62.2. It should be noted that codes regarding residential ventilation can vary significantly between states, and also between municipalities in a particular state. Consequently, we strongly recommend that the reader become familiar with local requirements before purchasing and installing a ventilation system.

Alaska is unique because it is the nation’s largest and coldest state, yet it also has the smallest and most scattered population base. Hundreds of communities are not accessible by road. This gap in distance and resources has led to a “can do” attitude among residents who build their own homes and install their own mechanical systems – without the municipal oversight that in other communities would insure that homes are being built safely and correctly. As a result, CCHRC has created this manual with the builder and homeowner in mind, in the hopes that the information provided will help ensure that every home has adequate ventilation and remains healthy throughout the seasons.

Current trends in North American home construction view a house as a complex system in which performance is based on the sum of many parts. How well the individual components of a house work together will have a profound effect on how successfully the home functions in relation to its occupants and the climate. With today’s energy-conscious approach to homebuilding, contemporary building practice asserts that it is not possible to make a house too tight, it is only possible to under-ventilate it. This reflects a “systems” approach where building performance is maximized by combining energy efficient construction and high levels of air tightness with properly designed mechanical systems.

Providing a high-performance ventilation system that is well matched to an energy efficient house design is a balancing act between cost and indoor air quality. The ventilation system has to supply enough fresh air to meet occupant needs while at the same time minimizing the energy penalties associated with over-ventilating. The Heat Recovery Ventilator (HRV) is designed to fill this role.

Unless stated otherwise, the ventilation rates and installation guidelines in this publication are taken either directly from national codes, or amendments to those codes that are specific to the State of Alaska.
Who needs an HRV?

In light of the fact that homes today are being built tighter in order to save energy, natural air leakage can no longer be counted on to adequately meet occupant needs. With this issue in mind, virtually all national residential building codes now mandate that some form of dedicated mechanical ventilation be used to insure that the indoor environment remains healthy. Nowhere does this become more important than in extreme cold climates (like those found in many parts of Alaska) where homes are some of the tightest, and occupants typically spend a far greater portion of their time indoors during the lengthy cold season.

Every current building code in the state of Alaska requires new construction to include mechanical ventilation. In 1992, the Alaska Housing Finance Corporation (AHFC) developed the Building Energy Efficiency Standards (BEES), an Alaska-specific amendment to ASHRAE Residential Ventilation Standard 62.2-2004. This requires that any home in Alaska built in accordance with BEES guidelines meet ventilation compliance by including a mechanical ventilation system that supplies a minimum of .35 air exchanges per hour. Although not every home is legally subject to these standards, it is prudent to use them as guidelines as they are designed to ensure the health and safety of occupants.

How tight is too tight?

The only way to figure out exactly how tight a house is and whether it is properly ventilated is through an energy audit. Current cold climate construction practices are yielding extremely tight homes where .07 natural air exchanges per hour, or even less, are not uncommon. This does not necessarily mean that a poorly ventilated house will exhibit obvious symptoms of air quality problems. Many houses have existed for years in subtly under-ventilated states, and often the health effects or structural damage has been attributed to other causes, or hasn’t manifested itself directly. Even if a house does ventilate passively, it may not be localized in the places you need it, such as the bathroom, kitchen and other living spaces.

Today, good building science tells us to “Build Tight, Ventilate Right,” which means maintain maximum control over air exchange and other factors affecting the indoor environment.

Occupant Behavior

It must be stated that while mechanical ventilation can be an effective tool that helps keep indoor living conditions healthy, occupants must be familiar with the concepts of good air quality and ventilation to ensure the best possible results. This means occupants must not only be capable of operating and maintaining the ventilation system, but also be able to recognize and minimize their exposure to pollutant sources both in and out of the home to begin with.

In recent years, multiple state and federally funded studies have shed more light on the importance of indoor air quality (IAQ), both in new construction and in older homes. Fortunately as a result, awareness of IAQ is growing quickly within the construction industry. Several links to Alaska-specific ventilation and air quality studies have been provided in the appendix to this manual.
Special considerations regarding indoor air quality

Carbon Monoxide

Carbon Monoxide gas (CO) is a byproduct of combustion and has many potential sources. This includes, but is not limited to, woodstoves, oil and gas-fired heating appliances, vehicle exhaust, propane or natural gas cooking ranges, space heaters, and even cigarette smoke. National building codes require all homes to have at least one CO detector in the living space. Conventional residential CO detectors are calibrated to sound an alarm once the gas count has exceeded 70 parts per million (ppm) for one hour. In an order to avoid “nuisance” alarms, virtually no detectors will sound an alarm below 30 ppm. Unfortunately, chronic, low-level CO poisoning can readily take place below 30 ppm. Because it will bond more readily to red blood cells than oxygen, CO inhibits the body’s ability to deliver oxygen to body tissues and vital organs. To complicate matters, it takes several hours for the human body to rid itself of CO. Low-level poisoning occurs when more CO is absorbed into the bloodstream than the body can safely process. With longer-term exposure, CO poisoning can occur at levels well below 30 ppm. Since it can compromise the immune system, CO poisoning can contribute to a wide range of ailments that are often attributed to other causes.

Attached garages

Attached garages, although convenient, present some significant concerns. In Alaska, a 6 mil poly vapor retarder is often installed between the common walls, ceilings and floors of a house and an attached garage. Ideally this plastic sheeting should be installed with the utmost attention to detail. Increased contaminant levels from carbon monoxide (CO) and volatile organic compounds (VOCs) can be ongoing issues in homes with poorly sealed attached garages, especially in winter time. This is largely due to the “stack effect” whereby the house draws air in from the garage.

The stack effect is a common occurrence in homes during winter, and is largely driven by the differences in density between the warm indoor air and the cold outdoor air, and the height of the building. The difference in air densities results in a positive pressure that forces air out of penetrations in the upper regions of the building envelope. Because any air flow out of the top must be matched by an equal amount in from below, this results in air being drawn in through leaks at the lower levels, including those between the house and garage. The greater the difference in indoor and outdoor temperatures, and the taller the house, the greater the stack effect pressure will be. The more air leakage pathways that exist at the top of the building envelope, the more easily air will be drawn in under the stack effect pressure.
HRV Overview
There are currently two dominant technologies in the residential mechanical ventilation market that recover heat from outgoing exhaust air: the heat recovery ventilator (HRV) and the energy recovery ventilator (ERV). The two systems are very similar in concept, but have several functional differences.

The primary difference between HRV and ERV systems is the method by which they exchange air and recover heat. Most HRV units use a cross flow system with an aluminum or polypropylene core, where the streams of incoming “fresh” air and outgoing “stale” air travel through adjacent passages but never mix. A significant portion of the heat in the exhaust air is transferred to the incoming air by conduction through the walls of a heat exchanger. The core of the heat exchanger consists of a honeycomb of many small air passages, both incoming and outgoing, which increases the surface area available for heat transfer.

An ERV is designed to exchange a certain amount of humidity by using a core with a moisture-permeable separator. Since many homes in Alaska are small and very tight, indoor humidity control is a priority. Circulating excess humidity back into the home is not a desirable feature and as a result, HRV systems are generally considered a better choice.

Image 1. The system in this photo uses an aluminum exchanger core. Incoming air enters through the insulated duct at the upper right of the unit, and travels diagonally through the core to the warm-side supply duct at the lower left. Warm side exhaust air enters via the duct on the upper left and exits through the insulated duct in the lower right.
Sizing HRV Systems for Alaska

The Alaska Housing Finance Corporation (AHFC) is a state housing agency that adopts state-specific amendments to the national codes, including those codes concerning mechanical ventilation. Typically these amendments are agreed upon by a code council consisting of industry experts in both the private and public sectors. Local municipalities may make additional changes to state amendments, often through a similar process. Determining the right size HRV for a house depends on square footage and occupant load. There are two approaches for sizing HRV systems: the calculation method or the table. Both can be found in the AHFC amendments to the ASHRAE Standard 62.2-2004 (p. 10) and are reprinted below. In most cases the calculation approach will yield slightly more conservative numbers than the chart.

Figure 1.

<table>
<thead>
<tr>
<th>Floor Area (ft²)</th>
<th>Ventilation Air Requirements (CFM)</th>
<th>0-1</th>
<th>2-3</th>
<th>4-5</th>
<th>6-7</th>
<th>&gt;7</th>
</tr>
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<tbody>
<tr>
<td>&lt;1500</td>
<td>35</td>
<td>55</td>
<td>75</td>
<td>95</td>
<td>115</td>
<td></td>
</tr>
<tr>
<td>1501-3000</td>
<td>50</td>
<td>70</td>
<td>90</td>
<td>110</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>3001-4500</td>
<td>65</td>
<td>85</td>
<td>105</td>
<td>125</td>
<td>145</td>
<td></td>
</tr>
<tr>
<td>4501-6000</td>
<td>80</td>
<td>100</td>
<td>120</td>
<td>140</td>
<td>160</td>
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</tr>
<tr>
<td>6001-7500</td>
<td>95</td>
<td>115</td>
<td>135</td>
<td>155</td>
<td>175</td>
<td></td>
</tr>
<tr>
<td>&gt;7500</td>
<td>110</td>
<td>130</td>
<td>150</td>
<td>170</td>
<td>190</td>
<td></td>
</tr>
</tbody>
</table>

4.1 Ventilation Rate. Equations 4.1a and 4.1b shall be replaced by:

Qfan = 0.01A_{floor} + 10(N_{br} + 1)

An example of the calculation method

Q_{fan} = Fan flow rate in cfm
A_{floor} = Floor area in square feet
N_{br} = Number of bedrooms

Ventilation requirements for 1800 square foot home with 2 bedrooms

Q_{fan} = 0.01A_{floor} + 10(N_{br} + 1)
Q_{fan} = 0.01(1800sqft) + 10(2br + 1)
Q_{fan} = 48cfm
Calculating CFM by Volume

The sizing calculations below demonstrate how to determine the cfm requirement for a given room size. This example uses a bathroom, as some municipalities require a specific number of air exchanges per hour (ACH) in this area. In the example, the target rate is 5 ACH.

Room Volume in cubic feet = length x width x height

then

volume x air changes per hour = amount of air to be moved

then

\[ \frac{\text{ft}^3}{\text{hr}} \times \frac{1\text{hr}}{60\text{ min}} = \text{cubic feet per minute} \]

An example:

then for a 5x8 bathroom

5 ft x 8 ft = 320 ft³

5 ACH x 320 ft³ = \( 1600 \frac{\text{ft}^4}{\text{hr}} \)

1600 \( \frac{\text{ft}^3}{\text{hr}} \) x \( \frac{1\text{hr}}{60\text{ min}} \) = 26.6 cfm

NOTE: ASHRAE Standard 62.2-2010 (2010, sections 7.2.1 and 7.2.2) requires that all continuous ventilation fans be rated for sound at a maximum of 1 sone and intermittent fans be rated for sound at a maximum of 3 sone unless their maximum rated airflow exceeds 400 cfm.
Installation

Both code-related concerns and site specific conditions will influence how and where the HRV unit is installed.

Power

The HRV must have a nearby source of power, usually a 110 volt receptacle. It is good practice to supply the HRV with power from a circuit that sees frequent use, rather than wiring it into a stand-alone circuit. This way, if the circuit malfunctions, it will be more likely to be discovered in a timely manner.

Location

There are multiple options for locations that meet current code requirements. Deciding factors in choosing a location are: availability of power and an exit path for the condensate drain, such as a floor drain or the plumbing drains. Ready access to the outside for the duct work is also an important consideration.

Garages

Garages may be tempting first choices because they often include access to plumbing drains and good locations for the ducting to the exterior. Unfortunately, the potential for drawing contaminated air into the system also increases significantly, and this risk typically outweighs the advantages. From a best practices standpoint, garage locations should be considered a last resort. For reference, an excerpt from ASHRAE 62.2-2010 section 6.5.2 states: ""HVAC systems that include air handlers or return ducts located in garages shall have total air leakage of no more than 6% of total fan flow when measured at 0.1 in. w.c. (25 Pa), using California Title 24 or equivalent."

Mechanical Rooms

Will usually provide a source of power and drains and keep the HRV easily accessible for inspection and maintenance.
Crawlspace
HRV systems should only be placed in conditioned crawlspaces and be readily accessible for easy service. The HRV should be located no more than 20 feet from the access point. A 30”x30” clear, level working area is required in front of the unit; it should be suspended at least six inches above the ground; and the code requires a light and a receptacle be readily accessible near the unit. If the HRV condensate drain will be tied into the crawlspace plumbing it will require a P-trap and a one-way check valve. If those precautions aren’t taken it will likely be the lowest spot in the drain system and the first exit point for sewage if the septic backs up. Because an HRV generally only produces a small amount of waste water, the code allows a condensate drain to be run underneath the vapor barrier in the crawlspace if the surrounding soils have good drainage.

Laundry Rooms
Installing the HRV above or near the washer and dryer gives ready access to power and plumbing and situates the system in a place where it is accessible and visible.

Closets
Closets can be convenient in that they are easy to access during maintenance, but it may be difficult to meet other system requirements when retrofitting. If planned into new construction, closets can be an excellent option and should be located close to exterior walls in order to shorten the cold-side duct runs.

Image 4. HRV retrofitted into a crawlspace. Code-related concerns apply. See description.

Image 5. A laundry room provides easy access to plumbing for drainage.

Image 6. This closet was custom-framed for the HRV, which is easier in new construction.
HRV INSTALLATION

Mounting the Unit

In a typical installation, the HRV is one of the first components of the system to be installed, as its location will define the converging point for all of the ducting. As illustrated in the previous pages, the HRV should be located in conditioned space, ideally above 50°F. The interior of the cabinet and the control panel should be easily accessible. Most HRVs will come with some form of vibration isolator to be used in hanging installations. Common variations are springs combined with chains and heavy-duty plastic or rubber strapping. The unit must be installed level in order for the condensate drain to function properly. Even when using isolators, fan noise can be transmitted from the HRV through the warm-side ducting and into the rooms. If this is a concern, installing a very short section of flex duct between the ports and the ducting will usually alleviate the problem.
Power Usage

Electronically commutated motors (ECM) have been making inroads into the HVAC industry, dramatically reducing electrical consumption. ECM motors can produce 2 to 2.5 cfm per watt, depending on system size and speed settings. These reductions in power usage yield pronounced energy savings over traditional permanent-split capacitor (PSC) motors. In addition, the prescriptive requirements for ventilation in the state of Alaska have become more conservative since HRV systems hit the mainstream more than 20 years ago. Over the years this has led to smaller motor requirements and less run time.

Controls

Ideally, the HRV should move just enough air to maintain proper air quality and humidity levels and meet minimum code requirements. Typically this is interpreted to mean that the system should be sized and balanced to run continuously on low speed, or timed to run at frequent intervals in order to help prevent the build-up of pollutants (such as VOCs) over the course of the day. In addition to the main control, which should be located in an easily accessible and convenient location, most systems also offer localized control options. Bathroom fan boosters can be installed, which will increase the exhaust speed when needed to provide spot ventilation. This can be done with a manually-operated timer, or with a humidistat that automatically signals the HRV to increase ventilation when a pre-set level of humidity has been reached. Due to high ambient humidity levels in maritime climates, humidistatic controls may need to be adjusted or disabled during summers to prevent the energy penalties associated with overventilation.

Most current HRV brands will allow for some degree of user programming, however the occupants must be made aware that programmable and “smart” controls may not necessarily meet prescriptive ventilation requirements. With these considerations in mind, programming can provide several benefits:

- If the home is unoccupied during working hours, the system can be timed to default into standby mode to accommodate occupant lifestyles. Since the house is no longer exchanging air when it isn’t needed, this will result in energy savings, particularly at very cold temperatures.

- Newer systems may also allow the user to select “Smart Modes,” which monitor indoor humidity and temperature relative to outdoor temperature and ventilate based on those conditions. This can allow the occupants to better tailor the ventilation rate to specific living conditions. Timed recirculation mode is another variation of this type of programming. This feature stops outside air exchanges and circulates air through only the warm-side supply and exhaust ducting to help even out localized temperature and humidity levels in the home. If an air filtration system is included in the supply ducting, periodic recirculation will help remove pollutants such as smoke and allergens from the indoor air. Also, simply by recirculating indoor air the HRV can be an effective vehicle for heat distribution. As a case in point, wood stove heat that is concentrated in one room can be redistributed evenly throughout the house by using air flow to supply hard-to-reach areas. Intermittent control settings will vary by make and model.

Wiring

The wiring used is usually 18 gauge thermostat wire. 18/3 wire can be run to operate the boosters while 18/4 can be used to operate the main control. In many cases, such as when running wire to control override timers in bathrooms, the wiring can follow the ducting to the room that will be served. In retrofits, “old work” electrical boxes can then be installed in the desired locations and the wiring can be run down the stud bays to the box.
Image 9. Retrofit HRV Installation. This particular wire will operate a booster control. The electrical box is a single gang low voltage “old work” bracket, rather than a box. It can be readily installed into a properly sized hole in the sheetrock.

Image 10. Here the installer has cut a small notch in the drywall directly next to the ducting in order to be able to guide the 18-3 thermostat wire back to the main control, which in this case is located at the HRV. Often holes cut for the ducting can also be used as a path for the wiring rather than attempting to drill extra holes for the wiring.

Image 11. In the picture above, the installer is using a wire hook attached to a fishing pole to pull a wire.

Image 12. Here the main HRV control is being installed at the junction of the hallway and the living room where it is easily visible and accessible.
Defrost

One component of almost all HRV systems – one that is of particular importance in cold climates – is the ability to fall back into a defrost cycle as needed. The defrost mode is automatic and is triggered by a sensor set to respond to incoming air temperatures at a temperature setting usually close to 20°F. In many cases, the amount of time the HRV spends in defrost can be adjusted on the unit by following the manufacturer’s directions in the installation manual. HRV defrost works in one of three ways:

1. When the preset air temperature is reached, a damper in the HRV closes the duct drawing fresh air from the outside. At this point, outgoing air circulates through both intake and exhaust passages in the core for a preset period of time. Air continues to be exhausted outside.

2. When the preset air temperature is reached, a damper in the HRV closes the incoming fresh air duct and opens a fifth port in the HRV that draws warm air from the room. Simultaneously another damper closes the outgoing exhaust air duct, shutting down any air transfer to the outside.

3. Although it is uncommon, some systems include options for electric preheaters as a component of the defrost system. While effective, they can lead to higher energy costs than methods one and two.

Adding dedicated air filtration

Systems are entering the market which have very high levels of built-in filtration, but older models are generally only equipped with coarse debris filters whose primary purpose is to keep the core clean. To help insure good air quality, a simple filtration system can be built and attached in line with the warm-side supply port on the HRV. Depending on the filter arrangement, indoor and outdoor pollutants can be filtered. These include, but are not limited to, pollens, dust mites, wood smoke, car exhausts, tobacco smoke and off-gassing from building components such as carpeting and finishes.

The housing for the filtration system can be manufactured with a sheet metal fabricator based on the pictures shown in this manual, or it may be possible to purchase a similar version online. The housings shown in the pictures will accommodate 16” x 20” filters. This comparatively large surface area insures that the face velocity of the air is low enough that air flow losses within the system are minimal. This size is large enough to work in most homes requiring a small to medium-sized HRV. If the HRV is unusually large, then it may be necessary to consult an engineer to determine the best filter size.

Air filters are measured using the Minimum Efficiency Reporting Value (MERV), developed by ASHRAE to provide a standard for filter comparisons. The MERV rating system is set up to measure a filter’s ability to trap particles ranging in size from 10 microns to 3 microns. The higher the MERV rating, the more particles a filter will trap. The filters used in the air filtration system are also referred to as “furnace filters” as they are also used to keep the coils and heat exchangers clean on heating and air conditioning systems.

The standard filter setup is a three-tiered bay which holds:

- 1” Merv 8 pre-filter – 70% minimum efficiency at capturing particles sized 3.0-10.0 microns
- 2” Merv 11 pleated filter – 85% minimum efficiency at capturing particles sized 3.0-10.0 microns
- Carbon filter – designed to trap odors and noxious gases. These also come in different grades depending on the pollutant to be filtered. Each brand and type of carbon filter should have a set of specifications that list those chemicals and pollutants that the filter can contain effectively.
Image 13. The filter housing is plumbed into the supply ducting. The ducting can also enter the box from the sides, the front, or the back.

Image 14. This filter housing is situated in a separate room as lack of space prevented the HRV and filtration system from being installed in the same location.

Image 15. The filters have been partially removed to show the different types.
Filter Upgrades

A rating of MERV 15 represents 85% - 95% arrestance efficiency for particles of 0.3-1.0 microns, above 90% efficiency for particles of 1-3 microns, and above 90% efficiency for particles of 3-10 microns. This range includes mold spores and most bacteria. The recommended intervals for filter changes are 2-3 months on the one-inch pre-filter and 6-8 months on the two-inch main filter and carbon filter.

Figure 2.
DUCTING INSTALLATION

Introduction

This manual references general prescriptive duct sizing information taken from product literature and national standards. It is not a substitute for a professionally engineered duct design that includes the design friction rate calculations necessary to guarantee that a system will operate correctly. In particular, an engineered design will ensure that long or complex runs will adequately supply air to a given location. Excessive friction losses from too many elbows and other restrictive duct components can result in insufficient air delivery, while increases in air velocity due to under-sized ducting may cause undesirable noise. More detailed information covering HVAC engineering principles can be found in *Manual D – Residential Duct Systems* (Air Conditioning Contractors of America, 2009) and in the US Edition of *Residential Mechanical Ventilation* (HRAI - Heat Refrigeration and Air Conditioning Institute of Canada, 2004).

Duct Types

For residential heating and cooling systems, the 2006 International Residential Code (IRC) specifies a minimum of 30 gauge thickness be used for galvanized steel ducting 14” or smaller. (p. 337 Section M1601 and Table M1601.1.1 (2) ) As a general rule ducting less than four inches in diameter should not be used, as it can be too restrictive.

There will be times, particularly in retrofit situations, where a short section of flex duct will make the best transition around an existing obstacle. In order to prevent localized air flow restrictions, *Manual D* (ACCA, 2009, p. 25) recommends, “The radius of a bend or turn shall not be less than the diameter of the airway (R/D shall be 1.0 or greater).” From a best practices standpoint, the use of flex duct should be avoided in all parts of the HRV system unless absolutely necessary.

The Code

Although national codes may still allow stud bays and joist cavities to be used as air ducts under certain conditions, this is considered poor practice in cold climate construction because of potential moisture-related problems. Local codes may also prohibit this type of installation. AHFC code amendments to the 2009 International Energy Conservation Code (IECC) and ASHRAE Standard 62.2-2010 include the following statement:

403.2.4 Duct material. [New subsection] A duct transporting ventilation air shall be constructed of a smooth-walled material, such as galvanized steel or lined fiberglass (rigid or semi-rigid), as much as possible. When necessary to use flexible ducting, it shall be supported along its full length with no sags and no bends greater than 90 degrees (AHFC, 2009, p. 9).
General Rules for Sizing

Fortunately, the low air flows in residential HRV systems allow for some flexibility in ducting installations, and a typical system can be made to function properly with a few fittings and duct sizes. By referencing the cfm requirements provided in AHFC table A4.1a on page 7 of this manual, any home of 3000 square feet or less will require a maximum of 125 cfm. With such comparatively low air flows, properly-sized HRV duct runs will generally still perform efficiently, even if minor design changes are required due to unforeseen site conditions. On the other hand, the low air flows also necessitate good duct sealing practices as duct leakage can easily compromise performance.

As a rule of thumb, many installers will use six-inch round duct and equivalent size oval duct exclusively for the majority of small and mid-sized home installations. The rationale behind this approach is that if one duct size meets the needs of the entire system, it greatly simplifies the installation process. Ducts smaller than 6 inches are often avoided as they may quickly become too restrictive if they contain multiple bends and transitions. It is also important to keep in mind that the smaller and more restrictive the duct, the more electricity will be required to move the same amount of air (provided the HRV has enough power to overcome the additional resistance). In addition, air velocities inside the ducting may become great enough to cause problems with noise. Upsizing beyond six inches may still be required for very long or complex runs. If duct sizing is not undertaken in those situations, a more conservative rule of thumb approach to duct sizing would be to upsize the ducting one inch diameter larger than the HRV ports in order to supply the rated cfm. The prescriptive tables provided on page 20 can be used as general guidelines for duct sizing. The tables have been provided courtesy of Venmar CES Inc. and ASHRAE (American Society of Heating, Refrigeration, and Air-Conditioning Engineers).

Friction Losses and Total Effective Length

Friction is an important aspect of duct design. Every type of fitting has a specific resistance to air flow which results in some pressure loss as compared to straight pipe. Consequently, every fitting is assigned a corresponding length in lineal feet of straight pipe based on the amount of friction it produces at a given size and flow rate. In a duct run, the term total effective length (TEL) refers to the sum of all the straight section lengths plus the lineal foot equivalents of all the fittings. If the HRV can properly move air to or from the outlet with the longest total effective length (TEL) in a specific duct size, then it will be able to deliver air to all other duct runs in the system using that duct size. The engineering considerations required for individually sizing duct runs are beyond the scope of this manual, however the prescriptive information reprinted on page 20 provides general guidelines for many situations. As a rule, installing sharp bends should be kept to a minimum since they produce the greatest resistance to air flow. As stated in the footnotes in ASHRAE 62.2-2007 Table 7.1 (reprinted on page 20), 15 lineal feet of straight pipe needs to be deducted for every elbow in the run. The equivalent lengths of fittings common to HRV duct systems have been provided on pages 21 & 22. (need to cite source)

Duct Orientation

Regardless of whether a duct is exhausting or supplying air, it is good practice to face the seams in the direction of air flow as much as possible. With some branch fittings it may be unavoidable to occasionally have a crimp facing the wrong way. In some cases it may be possible to correct the situation by hammering the crimp out against a piece of solid pipe of the correct diameter. Duct crimping pliers are useful tools if it becomes necessary to reduce a section of pipe to correct the air flow direction.
TABLE 7.1 Prescriptive Duct Sizing

<table>
<thead>
<tr>
<th>Diameter, in. (mm)</th>
<th>Flex Duct</th>
<th>Smooth Duct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>3 (75)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>4 (100)</td>
<td>70 (27)</td>
<td>3 (1)</td>
</tr>
<tr>
<td>5 (125)</td>
<td>NL</td>
<td>70 (27)</td>
</tr>
<tr>
<td>6 (150)</td>
<td>NL</td>
<td>NL</td>
</tr>
<tr>
<td>7 (175) and above</td>
<td>NL</td>
<td>NL</td>
</tr>
</tbody>
</table>

This table assumes no elbows. Deduct 13 ft (4 m) of allowable duct length for each elbow.

NL = no limit on duct length of this size.

X = not allowed, any length of duct of this size with assumed turns and fitting will exceed the rated pressure drop.
Figure 5. Common fittings and other duct components used in HRV systems. Image from Canada Mortgage Housing Authority

- Angle boot (Broadway boot) equivalent length = 30 ft.
- Flex pipe equivalent length is smooth pipe x2
- Flex fitting equivalent length is smooth fitting x2
- 45° parimatar pipe elbow equivalent length = 5 ft.
- 900 parimater pipe elbow equivalent length = 10 ft.
- Y - side branch equivalent length = 35 ft.
- Y - equal sides equivalent length = 10 ft.
- Tee - take off equivalent length = 50 ft.
- Hard increaser/reducer equivalent length = 8 ft.
- Tapered increaser/reducer equivalent length = 4 ft.
- Take off no taper equivalent length = 40 ft.
- Steel grille 50% free area equivalent length = 15 ft.
- End boot equivalent length = 35 ft.
Steel grille and stack head equivalent length = 30 ft.

3 1/4 x 10 wall cap spring damper or screen equivalent length = 40 ft.

Round wall cap spring damper or screen equivalent length = 60 ft.

Universal boot equivalent length = 5 ft.

Stack head equivalent length = 15 ft.

Stack elbow short way square throat equivalent length = 30 ft.

Stack elbow short way round throat equivalent length = 10 ft.

Stack elbow 45° round throat short or long way equivalent length = 5 ft.

Stack elbow long way round throat equivalent length = 10 ft.

Stack elbow long way square throat equivalent length = 40 ft.
HRV CFM (Cubic Feet per Minute) Considerations

HRV systems manufactured and sold in North America will have a Home Ventilating Institute (HVI) certified performance label detailing the model’s ventilation specifications. An HVI label will include the actual airflow rates for that model of fan, as tested under independent laboratory conditions at a given resistance. Typically an HRV will have at least two speeds, with the lower speed designed to provide continuous ventilation. Additional cfm information may also be available for variable speeds or individually for supply and exhaust. If there is any question about the ability of the HRV to deliver air at a given cfm rate, the manufacturer should be consulted. The duct airways must be sized to accommodate the maximum cfm rate produced by the HRV (this assumes the HRV has been selected in an appropriate cfm range).

Some brands of HRV may allow the fan motor speed to be adjusted to better meet the cfm requirements of the home. The closer the HRV’s highest speed can be matched to the homes air flow requirements, the more efficient the electrical use will be.

In most cases, the port sizes and the highest cfm rating on the HRV unit will be aligned with upper size limit of the ducting. The HRV may have different cfm ratings, one for supply and one for exhaust – it takes more effort for the blower to “push” air rather than “pull” it. The larger duct diameter should take precedence for the entire system. Although it is more common with dedicated bathroom fans, occasionally a system will require a smooth increaser directly on the HRV port to bring air flow up to an acceptable level, provided it is within the capacity of the fan (see Figure ?? page 24). For most small- to medium-sized houses, six inch ports are most common.

HRV units for large houses may have higher cfm requirements and bigger ports than six inch ducting will be able to accommodate. Some systems may start their trunk lines with 7 or 8 inch ducting if that is what the port size dictates. Typically an installer will take these larger ducts to the first one or two branches, then reduce the next several branches one duct size (see Figure ??). After several branches have been made with larger sizes, the branch lines will then revert back to the six inch size, capable of meeting all further cfm requirements. The prescriptive tables referenced on page 20 provide useful guidelines in these instances.

When splitting trunk or branch lines, it should be done as evenly as possible. For example, a trunk line feeding supply air to four bedrooms would ideally branch into two lines that would then themselves branch into two lines to supply air to two points each. As a general rule, the duct work can range within a few fixed sizes and rely on the diffusers to make ultimate adjustments in air delivery. If a single duct must branch off of the trunk line early in the run, however, it may be desirable to reduce the duct size to limit the amount of air flow to that location.
The HRV pictured here is one of the smallest commercially available. The unit uses 4” ports and is designed to have only a single duct serving each the warm side supply and exhaust. Because the 4” port size may be too restrictive for a longer duct run, a 5” smooth increaser as shown can help offset friction losses. More commonly, most bathroom fans contain 4” ports and will benefit from upsizing to a larger duct size if the exhaust path is too long or complex. The prescriptive sizing tables on page 25 can be used as guidelines.

Cold Side Intake & Exhaust

On the “cold” side, an HRV will require one insulated supply and one insulated exhaust duct, each leading to the outside. Where these ducts exit the structure will play a major role in an HRV’s location, as these duct runs should be kept short, if possible. Insulated flex duct is commonly used for the supply and return ducts to the outside. The use of flex ducting should be kept to a minimum due to the higher friction losses from this material, ideally 10 feet or less. Flex ducting must be properly supported with no bends or sags. A much better method of installing insulated ducting is to use smooth wall pipe of the correct diameter and then slide the next larger diameter insulated flex duct over the pipe. The insulation jacket can also be removed from flex duct of the same diameter and slid over the smooth wall pipe as shown in Image 12, however if the duct section has many bends, the insulation jacket will be more prone to tearing as it is being pulled over the pipe.

AHFC amendments to ASHRAE (AHFC BEES, 2010) allow ventilation systems supply and exhaust vents to be separated by less than ten feet as long as they are separated by a minimum of six feet horizontally (Image 17). Exceptions to this are dual vents where both the supply and exhaust are engineered to be part of the same fitting.

The fresh air intake should be located away from pollutant sources such as exhaust vents, chimneys, vehicle exhaust, plumbing stacks, and areas where lawn clippings and other debris can get pulled into the system. The intake opening must be screened with a screen size of half-inch or less. ASHRAE Section 6.8 of Standard 62.2-2007 (2007, p. 10) states that the HRV intake must be at least 10 feet from any known pollutant sources. Intake and exhaust riser hoods must be a minimum of 18 inches above the ground, and higher if there is any chance that snow will plug the openings (see p. 30). From a best practices standpoint, locating both the supply and exhaust hoods on the same exterior wall will minimize outside pressure imbalances especially in windy areas.
Image 17. A “hard to reach” joint being taped – this time on the cold side ducting. The paper strip is being removed with the installer’s upper hand while tension is being kept on the tape with the lower hand.

Image 18. Exterior penetrations are sealed to the drywall before the insulation jacket is fixed in place. Silicone or spray foam work well, depending on the situation. As an alternative, a gasket can be cut of EPDM rubber with a hole slightly smaller than the pipe. Once the pipe is inserted, the gasket is caulked to the sheetrock. Indoor air should not be allowed to contact the cold pipes as this can lead to problems with condensation.

Image 19. Although technically correct from a ducting perspective, this installation violates fire code as the chimney pipe underneath requires a minimum of 18” of clearance. This cold side exhaust duct uses hard pipe sleeved with insulation to bypass the boiler chimney. The duct is supported by plastic strapping cradling a scrap piece of ducting to keep the strapping from pinching the duct insulation.
Image 20. In this case the exterior hoods are up high, rather than in the ground level rim joist area. They are separated 6 feet horizontally to meet code. The intake is on the left and exhaust is on the right. Intake louvers are permanently fixed open, exhaust louvers will open when the exhaust is running. The smaller brown vent to the upper right of the intake is supply air to the utility room. As shown here, exhaust vents should be kept away from windows and soffit vents to prevent moisture and condensation issues.

Image 21. Here is an excellent example of a poor choice of locating exhaust ducts underneath a soffit. As shown, the moist air can easily find its way into the soffit vents where it has the potential to damage roof framing or insulation.

Image 22. The crawlspace rim joist installation for supply and return air starts with a 6 ¼" (or bigger) hole saw cutting through from the exterior. Once the pipe is installed, the space remaining between the duct and the foam is resealed with spray foam, and tightly packed fiberglass if required.

Image 23. With the ducting installed and sealed, a zip tie cinches the insulation sleeve tight to the point where the ducting penetrates through the foam.
Image 24. In this case the exterior wall and window located directly above prevented running the supply ducting up high in the living room. Since this is a supply duct and air is being pushed rather than pulled, a “Y” fitting was used instead of a “T” to reduce resistance.

For 6” ducting, a 4x10’ floor supply boot works well in order to distribute air through a floor. At times, especially in retrofits where wall locations may not be available, floor access for supply air provides an effective compromise between installation costs and ventilation performance. Note insulating the rim joist has been addressed beforehand.

Image 25. Image 24 as seen from above. Placing the floor vent directly in front of the baseboard heater mixes cool incoming air with heated air, creating air circulation through a convective loop. In this regard, delivering supply air near other heat sources is often a good choice. Wood stoves and oil fired room heaters are two other options that will encourage air movement through convection. Air movement under a window can also help reduce icing on the interior of the glass in winter. The couch shown has roughly 3 inches of space underneath and should be kept several inches away from the wall. Unlike the supply air, exhaust air should always run from up high to insure proper air removal.
Basements and crawlspaces with open ceilings provide good space to run ducting. Locating partition walls can be difficult; however, plumbing vent lines and nails used to nail down bottom plates protruding through the floor can provide reliable reference points. Other indicators are supply lines, wiring, toilet plumbing, baseboards, and any framing that indicates bearing points in walls above. Note that the existing vent stack cut through the top flange of the I-Joist is a code violation.

The installer in this picture is using a 2 ¾” Milwaukee “Big Hawg” hole cutter. The aggressive tooth design and easy plug removal make it a good option for drilling into subfloors and plates. This particular drill utilizes a clutch which automatically disengages should the hole saw “bind,” reducing the chance of injury. Two holes are drilled to define the oval edges of the duct, then the waste in the center is cleaned out with a reciprocating saw, producing the finished hole on the right side of the picture. For the 8-foot walls on the floor above, 6-inch ducting uses an 8'-6" oval riser stack. The “round to oval boot” pictured at left makes the transition to the riser stack.

This picture shows the first riser section ready for installation. The bent piece of metal on the top is the offcut from the circular cutout. It will help keep wiring in the stud bay from interfering with the otherwise flat top of the duct. This tab typically stays in place and bends down when it hits the ceiling, but can be removed later if desired, once the hole for the diffuser has been cut in the sheetrock.
Image 29. In this house the exterior walls in the living spaces lined up with the stem walls in the basement, minus the thickness of the sheetrock. This allowed ducting centerline measurements to be transferred easily from below.

Image 30. In this picture the vertical center of the diffuser opening is located roughly 9" from the finished ceiling. Once the hole centerlines have been laid out, the circle cutter can cut the hole cleanly and efficiently. The above photo is a retrofit and so having a second person with a vacuum eliminates virtually all the dust. The hole can then be cleaned up with a sheetrock rock saw if necessary.

Image 31. This circle cutter is manufactured by Malco. The drive end chucks into a conventional high speed screw gun. The radius is adjusted by tightening or loosening the nut over the centerpoint. Cutting tips can cut into a variety of materials ranging from drywall to 20 gauge sheet metal. When cutting into drywall there are times when the tip isn’t long enough to cut completely through the back of the paper and the cut has to be finished by hand with a sheetrock saw.

Image 32. Diffuser installed over a 6” duct in the bedroom. The diffuser provides the primary adjustment point for the room’s air flow needs.
Image 33. Existing water supply piping presents an obstacle that is overcome by combining two 45° 6-inch ovals and then switching to 6-inch round with an oval-to-round transition. The OSB scrap will hold the ducting in place until the ceiling can be Sheetrocked. The floor joists support a thin slab radiant floor heating system and the insulation above the ducting reduces heat losses into the basement.

Image 34. In this picture, a floor joist and a bearing wall prevented using the stud bay next to the door to hide the ducting. This ducting will be left exposed as it is inside a closet. Another option would be to build a sheetrocked box into the corner to hide the ducting. In retrofits, all closets are assessed as possible candidates for supply and return ducts.

Image 35. Another transition through the floor in a master bedroom walk-in closet.
This is a 6-inch oval trunk line on the supply side with a 4 inch round duct making the transition to hard-to-reach area in a living room. The pressure in the system must be great enough to deliver air through the four inch line and the velocity must also be low enough in the main line so that it cannot reverse the flow in the four inch line and actually “pull” air from that location rather than supply it through the venturi effect. In this case, a 6” duct would have been a better choice, had the correct selection of profiles and fittings been available to make a transition without losing more ceiling height.

Here the supply duct is running through the closet. Whenever possible, the ducting should be cut and laid out from those places where a mistake will be the least noticeable. Note in the upper section of duct, the initial hole encountered an obstacle and the duct had to be moved. Patching, painting, and texturing an exposed hallway or bedroom wall would be much more difficult and expensive.
Diffusers in the kitchen should be located such that they don’t pull grease in directly from the range hood. Codes in this regard can vary by location. In most cases, the diffuser will need to be located a set distance from the range hood, typically four feet.

The diffuser shown here provides supply air to the crawlspace as indicated by the wye ducting in the line. An exhaust line is located to the right and transitions directly into the wall above with a round to oval boot.

These lines come out at the topmost shelf in a closet, after running through the shelves below. The duct on the left transitions back to round, while the duct on the right continues on as an oval to navigate around an obstacle in the closet framing.
This picture shows round ducting that has been routed around a structural beam using wye fittings in both the supply and return ducts to maintain good air flow. This situation is far from ideal, as the more bends in the ducting, the greater the possibility of restricting air flow. Milder bends provide less resistance, and hard 90 degree turns should be avoided as much as possible. The HRV is located to the left as shown in the picture below. It has 8 inch ports and uses 8 inch trunk lines until the first split shown here.

Ideally diffusers in bathrooms should be located close to the source of moisture and far enough away from the doorway to prevent “short circuiting” the flow of exhaust air from the bathroom into the ducting. Air will travel the path of least resistance and if it is easier to pull air from the room adjacent to the bathroom via the doorway, exhaust ventilation will be compromised.

Installation in progress. This utility room has plenty of space to mount the HRV and the filter box. Note: because this unit comes with oval ports, the ducting uses an oval to round transition as the first component of all duct runs tying into the HRV to reduce friction losses.

Here a pantry provided the best place to run ducting for a kitchen exhaust grille and continues on to pick up a bathroom.
Sometimes existing obstructions must be dealt with creatively to provide the best path for the ducting.

Flex duct was able to make the transition. The duct was cut long so it would be easier to reach from below and then inserted between the floors. Once installed it was trimmed to the absolute minimum required to make the transition (roughly 12”).

The floor at the heat register made a good choice for a fresh air intake… except for the pipes. Here an unforeseen problem arose in the floor. Relocating the floor vent by patching the first hole and cutting a second was not an option with the finished floor already in place.

In some cases, it may be impossible to retrofit ducting in wall partitions so that the diffuser is located properly. In these cases the ducting is installed as high as possible to the ceiling and then covered with a soffit.

Soffit covers ductwork.
Balancing & Maintenance

Balancing the HRV System

Duct systems are balanced by means of adjustable dampers located in or near the warm side distribution ports on the HRV. At the drawing table it is possible to design a perfectly balanced duct system which does not require adjustment using dampers, however this is not feasible in practice. In theory, all duct runs could be sized to move the same amount of air by mixing and matching the specific friction rates associated with an array of individual reducers and transitions. To do this, each component and length of duct would have to be accurately established in advance. In reality this is a complex endeavor, as typical residential systems have multiple supply and exhaust branch runs, and wide variations in geometry may be necessary for individual branch ducts to reach their delivery points. As a result, an enormous array of fittings would be required to produce the same amount of resistance in all branch ducts. Finally, residential framing often contains unique situations that cannot be anticipated until the ducting is installed on site. Examples might include site changes made to the plans necessitated by obstacles such as structural members, and other mechanical systems competing for space that is often at a premium. Unforseen site conditions hold especially true in retrofits, where it is often impossible to identify obstacles until the installation starts.

HRV systems should be balanced as close to neutral as possible, meaning the unit should be taking in the same amount of air that it exhausts. In some situations, such as exterior insulation retrofits with existing warm side vapor barriers, a slight negative pressure may be desired to reduce the potential for moisture laden indoor air to flow into the wall or roof cavities.

After any system has been installed, it must be properly balanced to insure effective and efficient operation. An unbalanced system will result in performance losses due to over- or under-ventilating. It is theoretically possible for a severely imbalanced system to contribute to problems related to excessive negative and positive pressures, particularly in cases where the home is small (with a small air volume) and very air tight. Ideally, balancing should be performed by someone with the proper measuring and balancing equipment. Most shops will be willing to make house call to perform this service. If professional balancing is not possible, a simple test that yields reasonably accurate results can be performed using a plastic garbage bag. The instructions for the garbage bag test on (pages ??) have been provided courtesy of the Canada Mortgage Housing Corporation (CMHC).

System balancing is done on the warm side supply and return ducting of the HRV. It may also be necessary to adjust the diffusers during or after the balancing process. Some diffusers may need to be turned down, as is often the case with those that have the shortest and most direct runs. In locations with long runs or complex bends, the diffusers may need to be opened fully to insure proper air flow. To some extent, diffuser adjustments can be made by feel, but if desired or required, a qualified installer can use a flow hood to individually test and adjust the cfm of air being moved at a particular diffuser.

Some newer systems have user-friendly features that make balancing easier. A system such as this can often be balanced to much higher tolerances than the “plus or minus 10%” rule of thumb. An example of such a system can be found on (page ??)
In some cases, flow stations and dampers have to be purchased and installed separately. An example of such a system can be found on (page ??). Some brands of HRVs may also have adjustable motor speeds, allowing one particular unit to meet different sizing requirements.

CMHC Garbage Bag Airflow Test
There are times when you need to know the airflow from your furnace registers, bathroom exhaust fan or clothes dryer exhaust.

For example, if a house has one cold room in the winter, it is useful to find out if this is because your furnace isn't supplying enough warm air. If you installed a new bathroom exhaust fan, you could use the test to see if it is working properly.

This fact sheet tells you how to do the CMHC Garbage Bag Airflow Test. The Test is a quick way to estimate airflow, by determining how long it takes to fill a common plastic garbage bag.

It is not a precise measurement, but it is a vast improvement over no measurement at all.

How To Do the Test
Here’s how to use the test to measure airflow from a register or exhaust:

1. Tape the mouth of the garbage bag to a bent coat hanger or a homemade ring of cardboard to keep it open (see Figure 1).
2. Crush the bag flat.
3. Place it over the register or exhaust hood (see Figure 2).
4. Count how many seconds it takes for the bag to inflate.
5. Use Table 1 or 2 below to find the airflow from the register or exhaust.

If you want to measure air going out, you can hold an inflated bag against an exhaust grill, and count how many seconds it takes for the bag to deflate. Deflation testing is not as accurate as inflation testing, but it is still a reasonable test. Low airflow is difficult to measure by deflation testing.
How To Use the Test
Using the previous examples, if the measured airflow from a forced-air register is less than 10 litres per second (L/s), the furnace is delivering only a small amount of heat to a room.

If you install a 100 cfm exhaust fan, and the fan inflates a standard bag in less than two seconds, you have the rated exhaust flow for the fan.

Canada Mortgage Housing Corporation’s Garbage Bag Airflow Test is also useful if you have changed your heating or cooling systems, or if you have made major renovations to your house.

Table 1. Small garbage bag (66 x 91 cm [26 x 36 in.])

<table>
<thead>
<tr>
<th>Time to inflate*</th>
<th>Flow of air into the bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 seconds</td>
<td>35 L/s (75 cfm)</td>
</tr>
<tr>
<td>4 seconds</td>
<td>20 L/s (40 cfm)</td>
</tr>
<tr>
<td>10 seconds</td>
<td>10 L/s (20 cfm)</td>
</tr>
</tbody>
</table>

L/s = litres per second; cfm = cubic feet per minute
* For deflation, add a second.
Therefore, 35 L/s would take about three seconds and 20 L/s about five seconds.

Table 2. Big garbage bag (79 x 119 cm [31 x 47 in.])

<table>
<thead>
<tr>
<th>Time to inflate*</th>
<th>Flow of air into the bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 seconds</td>
<td>100 L/s (210 cfm)</td>
</tr>
<tr>
<td>4 seconds</td>
<td>50 L/s (105 cfm)</td>
</tr>
<tr>
<td>6 seconds</td>
<td>35 L/s (75 cfm)</td>
</tr>
<tr>
<td>10 seconds</td>
<td>20 L/s (40 cfm)</td>
</tr>
</tbody>
</table>

L/s = litres per second; cfm = cubic feet per minute
* Deflation times are about the same as inflation times.
For convenience, this system has integral balancing ports for intake and exhaust, which are easily accessible on the front of the unit. The installer is adjusting dampers in the exhaust and supply ducts to provide equal amounts of airflow. The magnehelic gauge pictured reads pressure in inches of water column and ranges from 0 to 1” w.g. There is a conversion chart on the right side of this HRV that is used to convert the gauge readings in w.g. to equivalent cfm readings. The supply and exhaust air cfm are adjusted via the dampers to meet the house’s ventilation requirements as determined on page 7. Some type of conversion chart will be included with virtually all major brands of HRV.
This photo shows one type of flow measuring station for use on systems without integral ports. It is temporarily installed within the warm-side supply and exhaust ducting next to the HRV. This particular station provides an averaged reading of the air velocities in the four quadrants of the duct section and is accurate to +/- 5%. Included with the device is a calibration chart that provides cfm rates that correspond to the inches of water column (w.g.) readings on the magnehelic gauge. This flow station requires a gauge that can read between 0 and .25 inches. Other types of flow stations may require a gauge with a different range.

For systems that do not have integral flow stations and dampers, installing flow measuring stations (above photo) and balancing dampers (left photo) typically takes close to 5 feet if following most manufacturers’ guidelines and best practices. This distance is necessary to allow proper spacing between the HRV fan, the damper and the flow station for the most accurate readings. Be sure to consult the manufacturer’s documention regarding balancing procedures and requirements for a particular system.
HRV Maintenance

The owner’s manual will usually include a maintenance schedule, but general maintenance is as follows:

- Inspect the filters covering the HRV core every 1-3 months. Keep in mind that in summer the filters may load up more quickly with airborne organic debris such as insects, pollen and dust. Most of these types of filters are washable. The outside hoods and screens should also be examined at this time.

- The exchanger core should be cleaned every 6 months. Refer to the owner’s manual for specifics, but generally the core can be vacuumed and/or washed with soap and water.

- If possible, check the system balancing once a year. This should be done by a professional using industry-standard flow measuring devices. The Canadian Mortgage Housing Association’s “garbage bag” test, although not as accurate, can give a reasonable estimate of system function if no conventional diagnostic equipment is available.

- Clean the condensate drain and pan every 6 months. The HRV drain lines can be tested by slowly pouring clean water into the drain to check for obstructions. The lines should have a trap or loop containing water to prevent the unit from drawing in air through the line.

- Many fans are designed to function without lubrication, but older models should be serviced every 3-6 months.
Ventilation in Alaska

Today’s houses are different from those built even 10 years ago, particularly in light of improvements in energy efficiency prompted by recent fluctuations in fuel prices. With homes becoming tighter nationwide, industry awareness regarding the importance of healthy indoor environments has grown too, and many building codes, such as the ASHRAE Standards, are becoming very specific in regard to ventilation requirements. In places like Alaska, where the need for energy efficiency is producing some of the tightest home construction in the country, good indoor air quality must continue to be a priority.

The vast majority of systems used and approved by code to provide whole-house ventilation include either an HRV or exhaust ventilation (without heat recovery) coupled with Fresh Air Inlets (described on page 45). Homes that do not have an HRV should have another form of mechanical ventilation. This section describes ventilation requirements throughout the house and options besides HRVs.

Ventilation Requirements for Bathrooms

The ASHRAE Standard 62.2-2007 (2007) requires that a bathroom be supplied with either 50 cfm intermittent ventilation (such as a dedicated bathroom fan with a switch) or 20 cfm of continuous ventilation that can be supplied as part of the HRV system.

Ventilation Requirements for Kitchens

All kitchens must have independent mechanical ventilation ducted to the outside. This can be a range hood, microwave/hood combination, downdraft fan, or some other type of ceiling or wall fan suited to the kitchen environment. The fan must be capable of moving 100 cfm intermittently or provide five air exchanges per hour continuously. The same calculation used to size bathroom fans in the example above applies to kitchens. ASHRAE 62.2-2010 section 7.2.2 states that intermittent exhaust fans should be rated for sound a maximum of 3 sone, unless their maximum rated airflow exceeds 400 cfm.

The HRV exhaust diffuser must be located a minimum of four feet away from the range to prevent vaporized grease and other contaminants from collecting in the system. Depending on the tightness of the house, a kitchen range hood with airflow greater than 250 cfm may cause problems with natural draft combustion appliances (such as woodstoves) and a separate source of makeup air will be required.

Image 54. The damper actuator here is turned on manually with a remotely operated switch to provide makeup air to a fume hood. Automated versions are also available, which only open a duct to the outside when a range hood is turned on.
Backdraft Dampers

Alaska state building codes require that both bathroom and kitchen fans have a backdraft damper. An exterior hood designed for this application will have a “flapper” attached to the hood which lifts opens under exhaust pressure. Generally this exterior damper design does not provide a tight seal and some degree of air infiltration takes place. An inline damper, like the model shown in Image 55 and 56 provides a much better seal as it relies on an O-ring to seal the flapper and a compressible gasket to conform to the ducting. This type of damper should be several inches within the thermal boundary of the exterior wall, where it will stay warm and remain accessible. Note: DO NOT use this type of damper for dryer vents as it may collect lint and obstruct airflow.

Ventilation Appliances

A range hood with airflow greater than 250 cubic feet per minute (cfm) sharing the same air space as natural draft combustion appliances such as woodstoves, boilers, furnaces, and gas-fired water heaters will be at increased risk for pulling combustion gases into the home. Clothes dryers and bathroom fans, which mostly operate at less than 200 cfm, can also contribute to problems as their individual effects add together. It is worth noting that in addition to generating negative pressure, if an exhaust fan cannot draw air in (from the building’s interior) at the same rate that it is trying to push it out (to the building exterior), it will perform below its rated cfm. To find out whether a fan is causing problems with excessive negative air pressure, an energy rater or HVAC technician can be hired to do a “Worst-Case Depressurization Test.” This relatively simple test uses a manometer to compare combustion appliance stack pressures to house pressure when all of the exhaust appliances in the house are turned on at their highest speeds. If the combined effect of the exhaust fans generates unsafe levels of negative pressure, then corrective measures must be taken.

Based on the potential for air quality problems listed above, the added utility bills due to heat loss, and the expense associated with the solution, the best course is to size appliances such as range hoods conservatively. If a high-cfm exhaust is truly warranted, many commercial kitchen range hood companies sell fan or damper actuator systems designed to provide make-up air when the fan is turned on. It is strongly advised that these systems be tested under worst-case draft conditions to make sure the fan is not depressurizing any chimneys or flues.

Image 55. The backdraft damper has a very sensitive butterfly hinge which opens outwards under air pressure. The leaves of the hinge close against an O-ring for a tight seal when the fan isn’t operating. The outside of the damper housing is wrapped in a strip of compressible weatherstrip tape for a snug fit inside the duct.

Image 56. To compensate for any air gaps between the weatherstrip and the duct, a bead of silicone can be run all the way around the perimeter of the damper housing. This also helps keep the damper assembly from moving once it has been positioned within the duct.
Other Ventilation Considerations

Since the State of Alaska adopted the ASHRAE ventilation standards on April 1, 2007, all homes now require some form of mechanical ventilation. However, as long as it is properly sized and installed an HRV system is not required. The installed price for a typical HRV system can range from $4,000 - $7,000 and so may be cost-prohibitive, especially in retrofits. Outdoor air inlets (also called “fresh air vents”) are a less expensive ($1,000 or less) alternative used frequently in Alaska. These are installed in combination with a centrally-located exhaust fan, such as a bathroom fan, and sized to meet the cfm needs of the house. The inlets take the place of the supply ducting on the HRV and are placed in the living spaces of the house. The air inlet must be capable of bringing in the required minimum of 10 cfm and rely on the negative pressure created by the bathroom fan to supply air, so each room must have an available path of air exchange with the room where the fan is located. In order to insure that the inlet will draft properly, the bedroom doors must be undercut by at least a half-inch, or there must be some type of vent grille installed through the shared wall or door that connects to the rest of the living space. Naturally, the same considerations apply to the room housing the fan.

Table C Maximum Passive Air Flow Met By Relief or Make-Up Air Vents

<table>
<thead>
<tr>
<th>Vent Diameter (inches)</th>
<th>ELA* (in.²)</th>
<th>Air Flow Met by Vent** (cfm)</th>
<th>Pressure Difference</th>
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</thead>
<tbody>
<tr>
<td>3</td>
<td>7</td>
<td>8</td>
<td>5 Pa (.02&quot; WG)</td>
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<td></td>
<td>10</td>
<td></td>
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<tr>
<td>4</td>
<td>13</td>
<td>16</td>
<td>10 Pa (.04&quot; WG)</td>
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<tr>
<td>5</td>
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<td>31</td>
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</table>

* ELA means equivalent leakage area.
** Calculated flow rates for passive make-up or relief air vents assuming an equivalent length of 66 feet. If more airflow is needed than shown, use two or more vents spaced throughout the building.
Fresh Air Inlets

The “Fresh 80” and “Fresh 100” brand of inlet is common in Alaska and brings air in through three-and-one-quarter inch or four inch openings respectively. In most situations the Fresh 100 is a better choice since the larger opening will more readily introduce fresh air at lower negative pressures. Since these vents have a full range of adjustment from open to closed, the larger size is not detrimental.

Although a properly installed fresh air inlet system with a dedicated exhaust fan is the most cost-effective and complies with current Alaska state ventilation codes, it is often a performance compromise when compared to the different control options and heat recovery function that are standard with an HRV.
Conclusion

While having a duct system engineered specifically for your house is ideal, it’s not always possible due to budget constraints and logistics. While this guide does not substitute for a professional engineered system, it provides prescriptive information taken from code books and industry literature and is designed to bridge the gap between engineered duct systems and carpenters who sometimes install HRV systems.

The industry is continually improving and developing new technology in heat recovery ventilation, so it pays to research different systems, and different manufacturers, before investing in one. Prices continue to come down on HRVs, and it’s not uncommon for priceworthy models to enter the market periodically.