8
Mechanical Systems

Energy Efficient Lighting

Providing energy-efficient lighting for buildings is an important factor in reducing operating costs. Controlling ventilation by using heat recovery ventilation adds the operating cost of an electrical appliance. Reducing the electrical cost of lighting can more than offset the cost of operating the HRV, resulting in a total overall reduction in electrical costs.

Generally speaking, incandescent lamps, or light bulbs, are obsolete. Retrofit lamps called compact fluorescents made to screw into a light bulb socket typically use only 25 percent of the energy used by a standard light bulb. Buying these fluorescents is expensive, but they last for 10,000 or more hours, about 10 times the life span of an ordinary light bulb. The higher the electrical costs in your area, the more important efficient lighting becomes.

Other lighting options include fluorescent reflector technology and electronic ballasts. Fluorescent reflectors can be retrofitted to existing fluorescent fixtures or purchased new. The reflector acts like a mirror that directs more of the light from the fixture down and to the sides, into the working area. This makes it possible to use half as many smaller fluorescent bulbs while still generating as much usable light.

Ballasts are used to start fluorescent lights. Conventional ballasts use electricity the whole time the lights are on. Electronic ballasts use less electricity than conventional ballasts when starting the lamps and use no electricity after startup. Conventional four-foot long, four tube fluorescent fixtures typically need two conventional ballasts to start the four lamps. Retrofitting four-tube fluorescents into two-tube reflector types reduces the number of ballasts per fixture from two to one. Using reflector type fluorescents and electronic ballasts can provide a 60 percent savings over conventional fluorescents. In a retrofit situation, using the existing fixture, adding the reflector, changing the lamps, and disconnecting one of the conventional ballasts while leaving it in place as a spare can result in a 40 percent reduction in operating costs. This is a less expensive solution than buying all new components, thus making such a retrofit more cost effective.

The most cost effective lighting solution is to plan your building and site orientation to take advantage of daylight. Many areas of Alaska have short daylight hours for part of the year and many cloudy days.

Build Tight and Ventilate Right

A well-sealed outer shell and a properly working mechanical ventilation system are among the key components for any building that is designed and constructed to be healthy, safe, comfortable, and energy- efficient. These two components are essential to each other and to the building system as a whole. When the shell is carefully sealed to reduce drafts, maintain structural durability, and conserve energy, the fresh air exchange rate is reduced below the level needed to maintain good indoor air quality. A mechanical ventilation system must be designed and installed to provide enough air exchange. The ventilation system exhausts stale, moist air from the building and brings in fresh air from outside and distributes it evenly throughout the building. All buildings must comply with American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standard 62-1989, revised 1997.

Heating, ventilating, and air conditioning a building requires integrating these three subsystems into the building as a whole system. For example, if heat recovery ventilation is called for, then the heating system must be correctly sized for a lower design heat load. Because the structure will be airtight, you will be in control of energy use related to air flow. Since energy-efficient lighting, appliances, and motors will be specified, there will be smaller internal heat gains. This will reduce the need for air conditioning.

Heating

Five important issues surround the heating of all buildings: (1) occupant health and safety, (2) building durability, (3) occupant comfort, (4) environmental effects, and (5) affordable and efficient operation.

1. Health and Safety

Providing a safe, healthy, and secure environment must take priority, since a building without protection from earthquakes, fire, or high wind cannot adequately serve your needs. Poor indoor air quality, such as carbon monoxide build-up or radon gas, is important to consider. The continuous slow input of combustion gas from a leaking or back drafting heating flue can slowly poison the building's occupants with carbon monoxide.

To avoid back drafting of combustion devices, you must provide a separate room for the heating plant, with fresh air supply for combustion, unless it is a sealed-combustion heater. Follow all manufacturer's instructions for installing all mechanical systems.

2. Durability and Maintenance

The durability of the heating system and how it interacts with the flow of heat, air, and moisture is also critical. Frequent replacement or repair of heating systems, or buildings, is neither efficient nor desirable.

Whatever type of heating system you install, be sure to follow the manufacturer's instructions for regular maintenance. This will prevent many problems in the long run.

3. Comfort

A building is only comfortable when the interior temperature and humidity are controlled without wide fluctuations. Comfort is a basic requirement of shelter, and a well-designed and installed heating system is a very important part of comfort.

4. Environmental Impact

Effects on the environment must also be considered, especially in this age of litigation. Frequent fuel handling provides more chances for spills to occur. Responsible, well-informed designers must minimize carbon dioxide contributions to the global environment. The system approach to building will accommodate these environmental considerations and lessen the impact of any building through proper sizing and design of the heating system.

5. Affordable and Efficient Operation

If we are successful in providing health and safety, building durability, occupant comfort, and low environmental impact in our building project, then energy-efficient affordable operation is the result.

Appropriately sizing the heating system to the building and producing heat and hot water efficiently make operating such a building affordable.

Three Types of Efficiencies

When buying a boiler, steady-state efficiency is the efficiency measurement claimed by most manufacturers and is almost always higher than seasonal figures.

Annual fuel utilization efficiency, or AFUE, is the second most quoted efficiency. AFUE is a measure of the effectiveness of a system's heat transfer, but it does not consider jacket heat loss or distribution losses or efficiencies of combined domestic water heating and space heating systems.

Seasonal efficiency is an indicator of how efficiently a heating system operates over the entire heating season. Frequent start-up cycles, running, and cooling down—all under different weather conditions—can significantly reduce a system's efficiency. The seasonal efficiency is the truest measure of how efficient any appliance is.

Integrated systems, which combine space heating and domestic hot water production typically have the highest efficiencies. Both the indirect fired and integrated units have longer life expectancies than direct-fired hot water tanks, making them more economical.

Insulating Domestic Hot Water Pipes

There are two reasons for insulating hot water pipes. First, it saves money by reducing pipe heat loss and thus fuel use. Second, it is more convenient since the water in the pipes stays hotter and so hot water is delivered more quickly after a faucet is opened.

Forced-air Distribution

Forced-air systems include a furnace with a fan that circulates heated air through supply ducting to deliver the heated air, and return air ducting to allow cool air to return back to the heater. Gas units without a pilot light are most efficient, and oil-fired units with high static pressure flame-retention head burners are best where gas is not available. The fan that distributes heated air takes more electricity to run than a water circulating pump for a boiler, making forced air more expensive, especially where electric costs are high.

Forced-air systems must be installed to provide a balanced air flow when interior doors are both closed and open. Grilles may be placed in doors or in walls between rooms. Doors may also be undercut 1" or more, although this may not always be effective. It is best to have both a supply and a return duct to each room.

Sealed-combustion furnaces are becoming more popular because they provide a greater margin of safety against back drafting when the building experiences slight depressurization due to other mechanical devices or wind effects. However, these are currently only available in gas-fired models, and natural gas is not available in most parts of Alaska.

Forced-air ducts must be screwed together, must use smooth metal runs (not flex duct), and must be sealed with mastic, not duct tape. All ducts should be run inside the heated space.

Sealed Combustion Cabinet Type Heaters

Sealed combustion cabinet-type space heaters are widely used in Alaska and come in a variety of sizes, types, and heat outputs. Units such as Monitor, Toyostove, and Rinnai have computer boards, fans, and sophisticated set-back controls. These features, combined with sealed-combustion design, provide above-average heating efficiency and eliminate back-drafting problems. The heater uses a pipe-within-a-pipe forced venting system that doesn't require a conventional chimney. The unique intake and exhaust design usually requires that the units be placed against an outside wall, although extensions may be available for different placement or for clearance from drifting snow. The heaters can be installed in energy-efficient buildings, and several units may be used to provide zone control for larger buildings.

When selecting the heater, consider the fuel source. Some models need number one fuel oil or kerosene. Others require natural gas or propane. Most rural villages have supplies of number one heating oil, while kerosene is rarely used in Alaska. Some kerosene models may allow the use of number one fuel oil, but check with the manufacturer. Natural gas, when accessible, should be the least expensive fuel choice. Heating with propane is usually more expensive.

While these heaters can be more efficient and affordable than a furnace or boiler, they may have shorter warranty periods and cannot be used to heat domestic hot water. Install flue pipe and fuel lines using accepted airtight procedures for penetrations through exterior walls. Oil heaters have problems with fuel contamination, and a good filtering system should be installed. Always follow manufacturer's installation instructions and local building codes when installing any heating system.

Boilers

When considering the choice of a forced-air or hydronic (boiler) system, you should also consider domestic hot water. If the building needs to provide a large amount of domestic hot water, as in a cafeteria or day care setting, the advantage obviously goes to the boiler.

Boilers allow zoning to be easily incorporated into the building design. Distribution options for boilers include forced air (through a fan coil or unit heater), radiant floors, perimeter baseboard, or radiators. Hot water run in small-diameter piping will take up less space than forced-air ducting. It is this flexibility in distribution options that often makes hydronic systems more appealing.

It is vital to fill the pipes with a propylene glycol solution so that if the boiler fails or the power goes out, the pipes don't freeze, break, and cause flooding damage. Ethylene glycol, the type used in automobile radiators, should **never** be used because it is highly toxic.

Solid Fuel Equipment

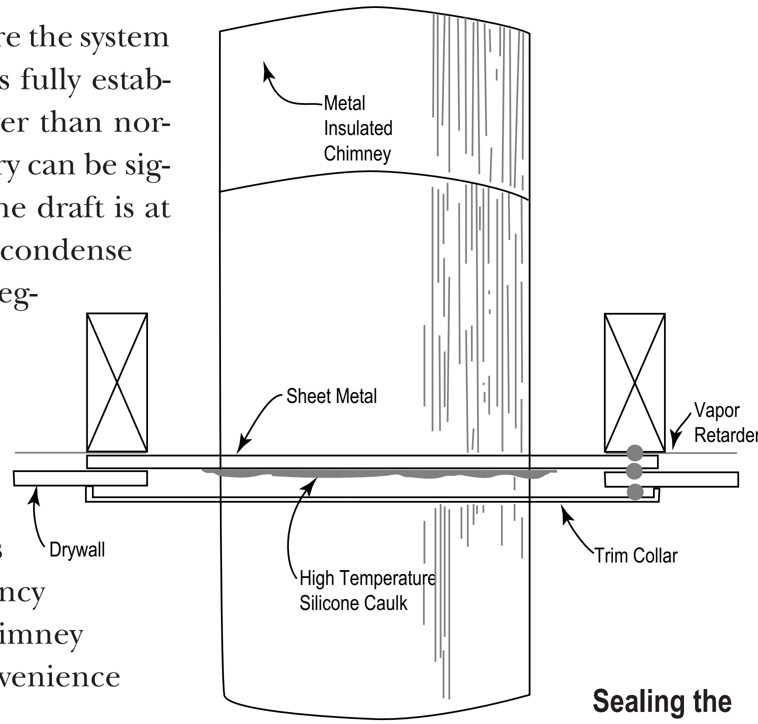
Heating appliances using solid fuel, usually wood or coal, are available today with efficiencies as high as 85 percent. The most efficient are direct vented, stoker-fired wood pellet units. Wood and coal appliances without automatic features have typical efficiencies of around 60 percent.

Maintenance is the biggest complaint from owners of this equipment. Chimneys need frequent cleaning to be safe from stack fires, and catalytic converters must be replaced every few years with associated high expense. The fuel must be handled twice before being burned, and ashes and clinkers must be removed every few hours or days, depending on the design of the appliance. Buying such a unit is also expensive, especially considering the lack of control and automatic operation compared to gas and fuel oil fired appliances.

However, the airtight wood stove can be an excellent backup heating source when electricity is unreliable and for any and all emergencies. Wood, used efficiently and safely, is also a renewable fuel. All such installations must include outdoor combustion air ducting directly connected to the stove, and only the most airtight models should be considered. The manufacturer's minimum installation specifications should always be followed and exceeded whenever possible, since fire danger is always high in our long winters. See BEES, pages A-12 and A-43–46 for more requirements for fireplaces and wood stoves.

Chimney design affects heat loss more than any other single heating system installation option. Not only does heat escape up the chimney, but air leaks around the chimney's penetration through the roof are a major source of heat loss (see Sealing the Chimney Penetration).

If the chimney is allowed to cool before the system starts, it must heat up before the draft is fully established. At start-up, when the draft is lower than normal, reductions in combustion air delivery can be significant, causing lower efficiency until the draft is at or above the minimum. Flue gas will also condense in the cold chimney, resulting in rapid degradation from the acidic condensate. There are many examples of efficient heating systems vented into cold exterior chimneys where the chimneys had to be replaced every two years due to the acid condensate ruining the stainless steel liners. In this case any gain in efficiency is lost in the frequent and expensive chimney replacement, not to mention the inconvenience of replacement and the danger of fire.



Sealing the Chimney Penetration

Draft will increase as the difference between the inside and outside temperatures becomes greater in the winter. If the draft is too high, too much air is supplied by the burner and the flame temperature drops. If the draft is too low, the flame is starved for air and more smoke is produced. Sealed combustion and isolated combustion appliances are not affected by seasonal draft fluctuations, since their chimneys are not equipped with barometric dampers and combustion air is supplied directly to the burner.

The optimum chimney design, one that would overcome most common heat losses, is low mass, short, and well-insulated, without a barometric damper. You must maintain a two-inch minimum clearance between the insulated chimney and any combustible material. Follow manufacturer's instructions for a safe, durable chimney.

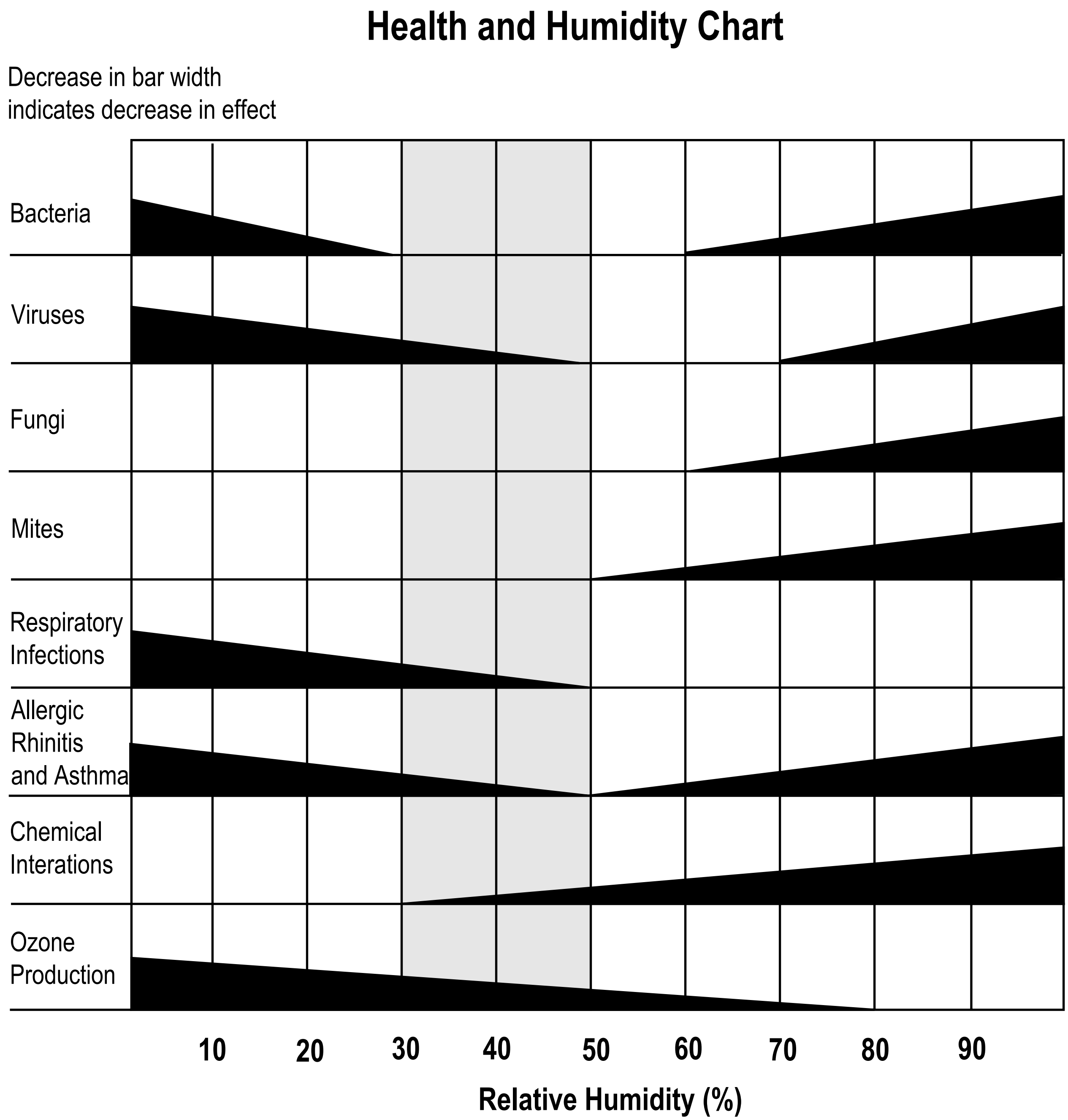
Ventilation

The types of materials (paints, sealants, glues, carpet, cleaning aids etc.) that are installed or used can have a significant effect on the indoor air quality. Some building materials are known to outgas, that is, emit gases, long after the manufacturing or application process is done. Chemicals used in cleaning agents are released into the air that we breathe. Reducing the use of materials that release fumes is called source control. Source control is the first step in addressing indoor air quality. If the pollutant is not introduced into the building, then the ventilation system does not have to remove it. Contact the Research Information Center at Alaska Housing Finance Corporation, phone (800) 478-INFO, or your local Alaska Cooperative Extension agent for more information on product emissions and indoor air quality.

A ventilation system, when properly designed and installed, will provide comfortable and healthy indoor air. An effective ventilation system brings in fresh outside air and distributes it evenly throughout the building. Also, the system removes stale air containing moisture and other pollutants that are produced in the building (see health and humidity chart). The system must be capable of ventilating all primary habitable areas of the building. This excludes mechanical rooms, garages, and storage areas. This section is intended to provide you with the basic information to understand the essentials of ventilation systems. It is not intended to be a complete design and installation reference.

Ventilation System Types

There are three basic methods of mechanically exchanging air across the building envelope: supply only, exhaust only, and a balanced supply and exhaust system. Whichever type of system is selected, the system must be capable of operating continuously when the building is in use and distributing fresh air throughout the occupied areas of the building. The ventilation system must be acceptable to the occupants. If the fresh air is delivered to the building and the occupants feel a draft, the ventilation system will be turned off, which means that the building system fails also. **Do not use an electric preheat coil to warm incoming air,** because the long-term operating costs will be too high, especially with the high electric costs in rural Alaska. However, waste heat from a generator could be used effectively to preheat incoming air and would be a good use of otherwise wasted Btus.



Source: Sterling, Arundel, and Sterling. "Criteria for Human Exposure to Humidity in Occupied Buildings." ASHRAE Transactions, 1985, vo. 91, Part 1. **Note:** optimum zone moved 10% to left by the authors.

It is essential that the ventilation system is cost-effective not only to install but to operate. High energy costs in rural Alaska mandate a thorough review of local energy costs and appropriate ventilation strategies. This analysis may be performed using the Hot 2000 or AkWarm software.

The proper installation of the ventilation system is an essential aspect of the building's operation. The ventilation system shall be installed and tested according to the manufacturer's instructions.

Supply-only Systems

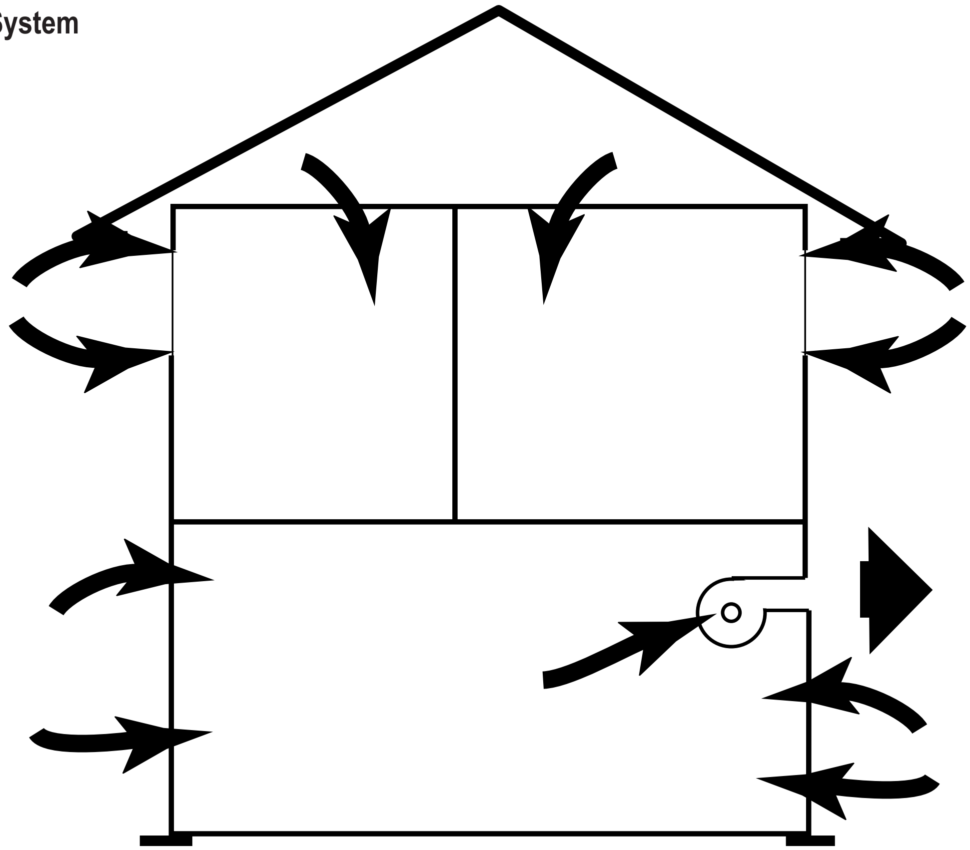
Supply-only systems typically consist of a fan that brings in outdoor air and discharges it in the building. This creates a higher pressure indoors relative to the outdoors. Air flow is always from areas of high pressure to areas of low pressure, so moisture-laden air will be forced out through any gaps or holes in the building shell. When the air reaches its dew point temperature, it will condense into water. Water that condenses inside the building shell will greatly reduce insulation values and cause rot. **A supply-only system is not recommended due to the high potential for moisture damage in the building shell.**

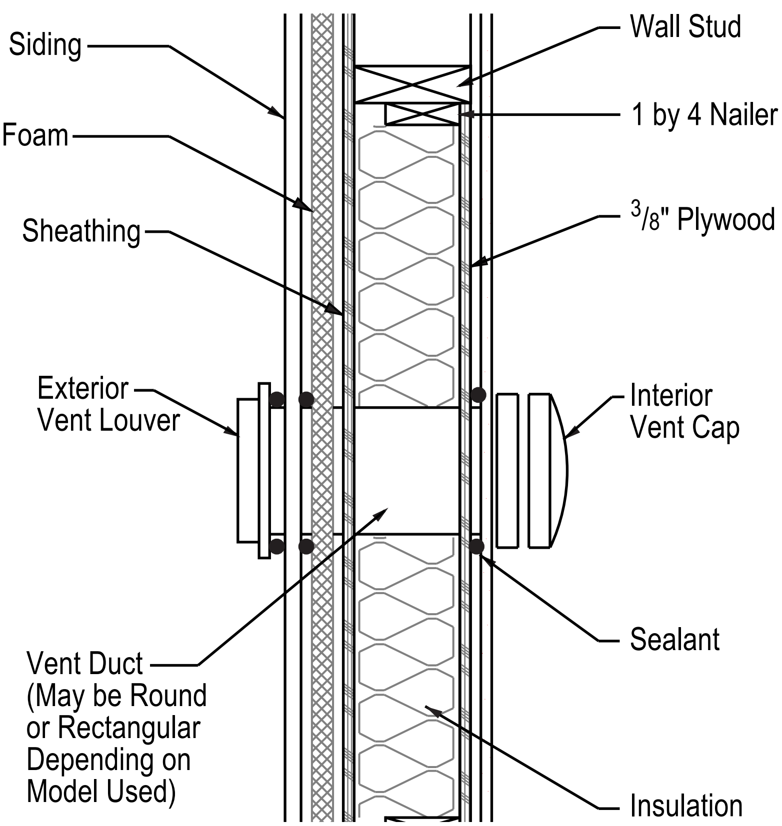
Exhaust-only Systems

An exhaust-only type of system operates by mechanically exhausting air from the building, using a fan. The operation of an exhaust-only ventilation system creates a negative or lower pressure in the building relative to the outside. Outdoor air, which replaces the air being exhausted by the fan, enters the building through intentional fresh air inlets and through any breaks in the building's air retarder. Closable air inlets are installed in each room to allow small amounts of air into the building to replace the air being exhausted by the exhaust fan. The inlets are typically located high on exterior walls or are incorporated into the window frame. This system is inexpensive to install and maintenance is minimal. The air entering the building through the openings will be cold during the winter months and may create discomfort. The inlet openings must be carefully located to reduce this concern. Typical inlet openings might include Fresh 80 or through-the-wall vents.

Caution: prevent back drafting of combustion appliances. With any exhaust-only system there is the possibility that the exhaust fans will create enough negative pressure to draw combustion gases back down the flue of either the space heating or domestic water heating appliances. This is called back drafting. For this reason, only sealed-combustion appliances shall be used if they are located in the occupied zone. Alternately, the combustion appliance room could be air sealed from the building's primary occupied zones, which contain the exhaust fan. Negative pressure developed by the fan then would not effect the combustion appliance room pressure. You must follow the negative pressurization limits for buildings presented in BEES,

Exhaust-only Ventilation System





"Fresh 80" Vent Installation

page A-43. This is a health and safety issue that must be addressed in the design, construction, and final testing of the building.

Soil Gases. For buildings with foundations such as crawl spaces, full and daylight basements, and slab foundations, there is a concern that harmful soil gases will be drawn into the building during negative pressurization. These gases include radon where it is found in the soil and various fertilizers and insecticides that may be used around the building.

Balanced Ventilation System

The recommended approach to providing effective ventilation combines balanced exhaust and supply air flow in a single ventilation system. It is then possible to control both the amount of air exhausted from the building and the amount of air supplied to the occupants.

A balanced system provides a neutral pressure in the building relative to the outside. Each room or area would have provision for fresh air supply and stale air exhaust, either directly in the room or indirectly from an adjoining space. This is accomplished with a mechanical ventilation system through an independent system of ducts or integrated with the ductwork and fans of a forced-air heating system. Stale air is generally exhausted from contaminant-generating areas such as kitchens, bathrooms, and workrooms.

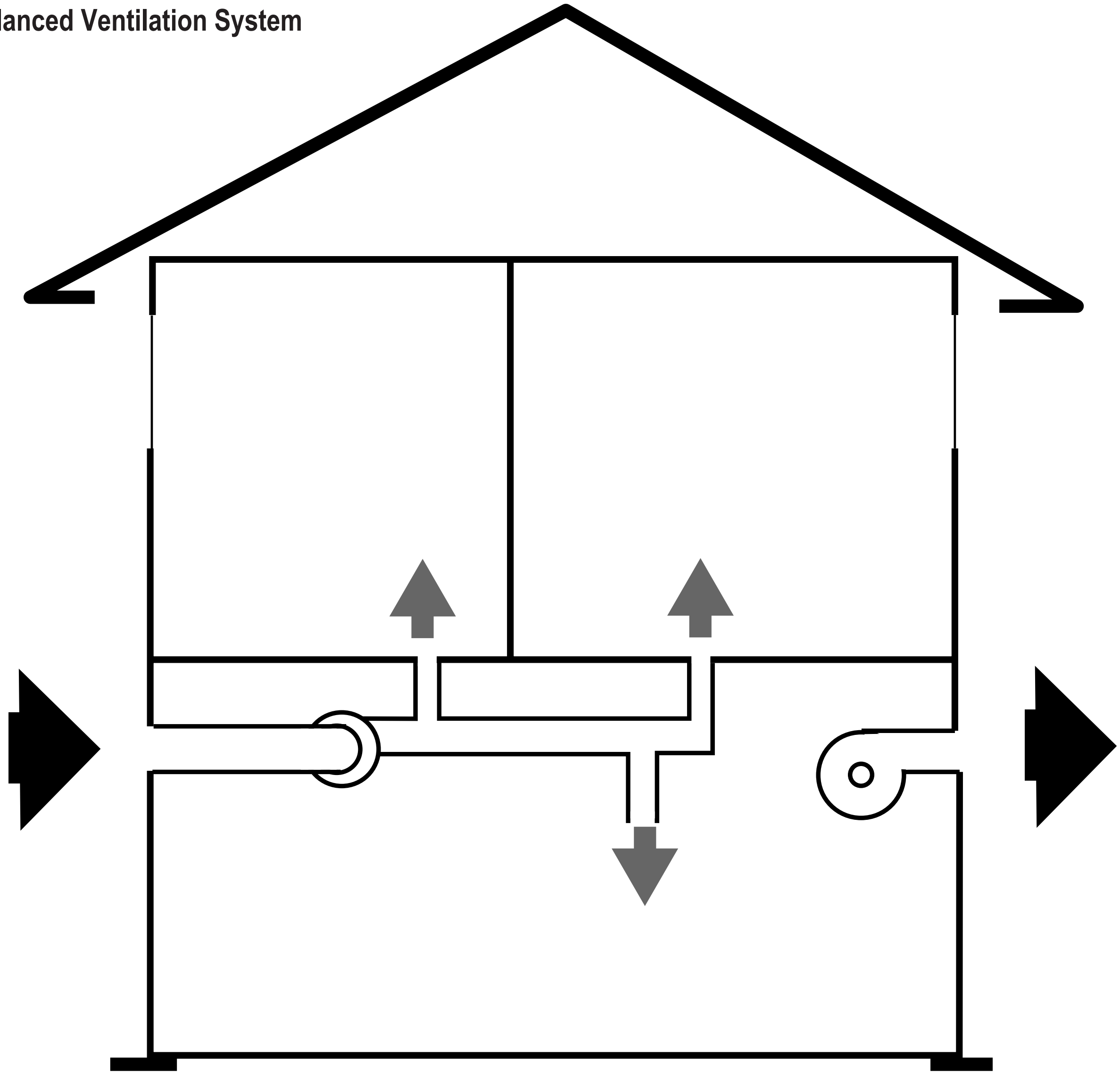
It will be necessary in most regions of the state to preheat or temper the incoming air for comfort reasons. A central balanced system affords the opportunity for exchanging heat from the exhaust air stream to the incoming air stream. The heat transfer provides tempered air to the building. This is called a **heat recovery ventilator, or HRV**. It also allows filtering and treatment of outdoor air prior to entering the building if necessary.

Fans intended for use as the primary ventilator must be capable of continuous operation.

Heat Recovery Ventilators

The balanced ventilation process involves warm indoor air being exhausted outdoors and then being replaced with cold outdoor air that must be heated. Installing a heat recovery ventilator (HRV)—also referred to as an air-to-air heat exchanger—reduces the cost of heating the fresh air by extracting heat from the outgoing air and using it to heat the incoming air.

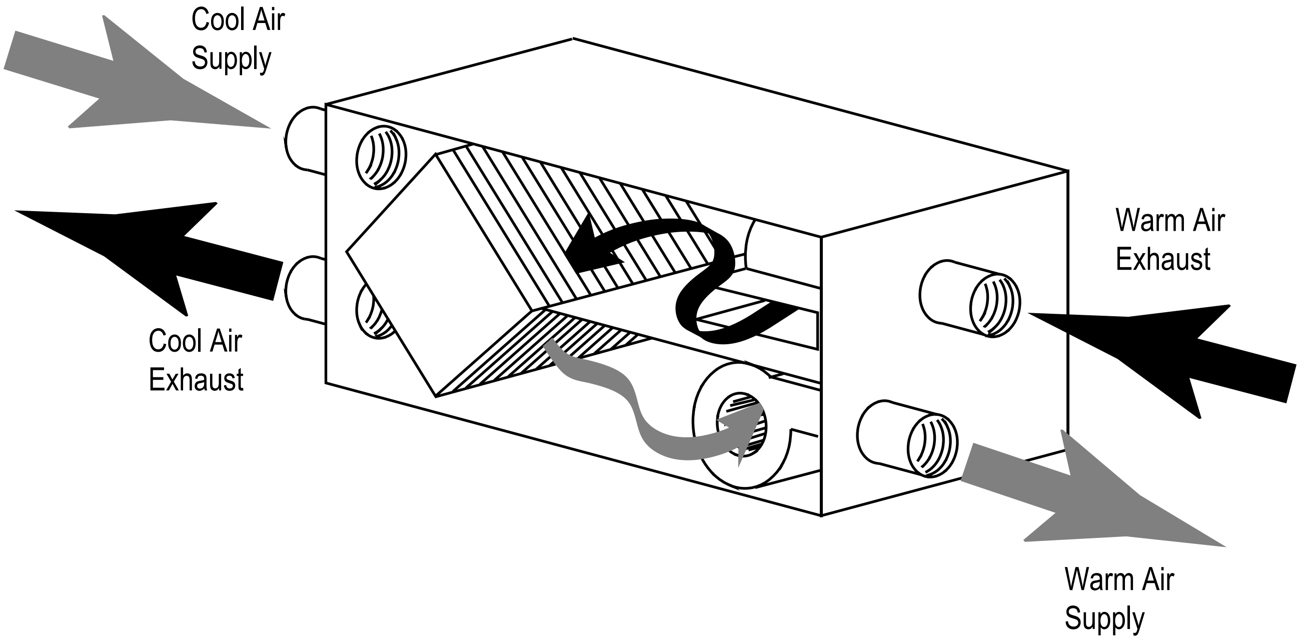
Balanced Ventilation System



The economics of installing an HRV will depend on the cost of energy and the severity of the weather in a particular location. HRVs can reduce the amount of energy needed to preheat ventilation air but usually have higher initial costs than ventilation systems without heat recovery.

In addition to the capital costs of the system, heat recovery ventilation systems require ductwork to bring the exhaust and supply air to one location for the heat exchange process. Since moist, stale indoor air is being cooled through the HRV, the HRV system must also be able to drain humidity that condenses out of the exhaust air and must also provide effective defrosting.

Plate Type Heat Recovery Ventilator (HRV)



Performance Testing and Rating

The performance of an HRV is determined by its air handling capabilities and the percentage of heat it can transfer from the exhaust air to the supply air. HRVs must be rated in accordance with CSA-C439, "Standard Methods of Test for Rating the Performance of Heat Recovery Ventilators." These Canadian standards describe the test equipment, instrumentation, procedures, and calculations needed to determine air flows and heat recovery efficiency. The tests are carried out at a variety of air flows and two temperatures: 32°F (0°C) and -13°F (-25°C).

The results of these tests are reported on an HRV Design Specification Sheet, which you should request from the supplier of the equipment. A sample specification sheet is shown in Appendix B. The specification sheet is a useful tool, but bear in mind that it should not be the sole basis for selecting an HRV. Cost, warranty, proven reliability, servicing, and suitability of the unit for the climatic zone are some of the other issues that must be considered.

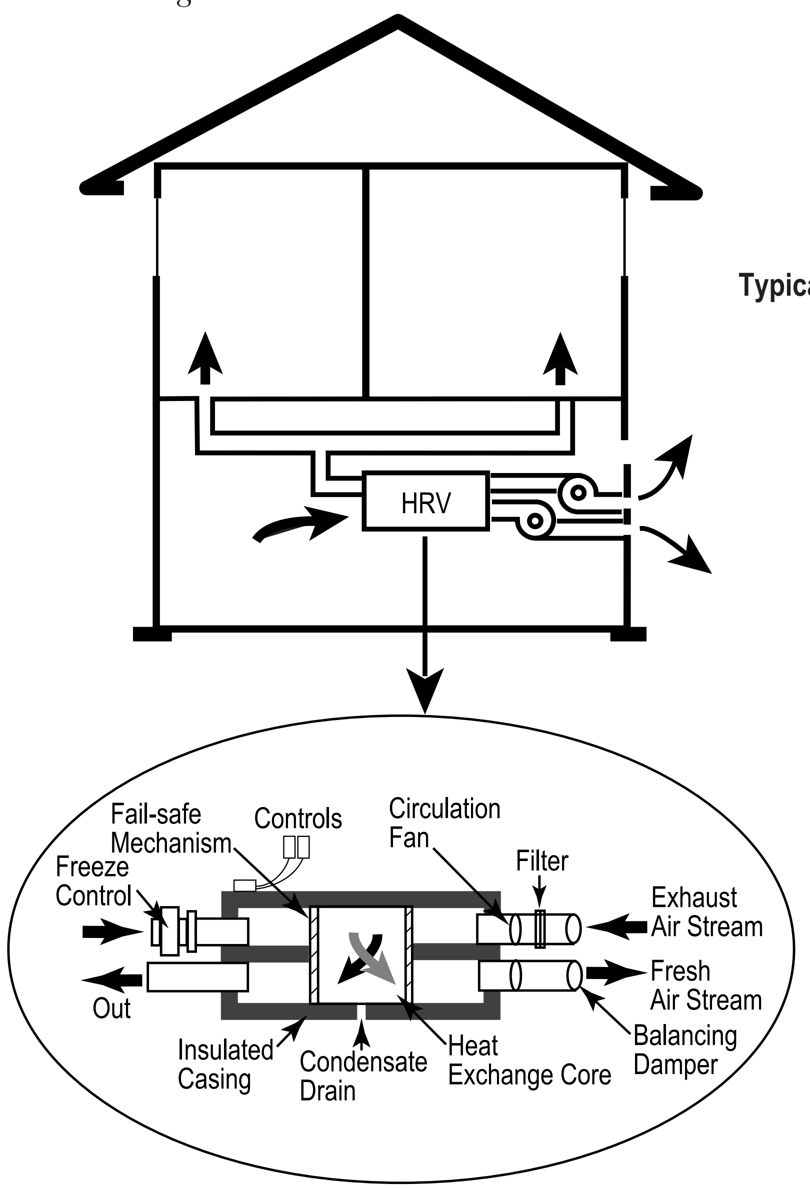
Selecting the Equipment

Before selecting an HRV or fan unit for a ventilation system, determine what air flow is needed to meet the requirements for sufficient air exchange.

Locating the Ventilator

In determining the location of the ventilating unit, consider the inlet and outlet locations, noise levels, drainage, power supply, etc.

- The unit should be located in the heated interior, away from noise-sensitive areas. Hang the unit from rubber straps to minimize noise and transmission of vibration through the building.
- It should also be close to an outside wall to minimize insulated duct runs (six feet is suggested, if possible), centrally located to optimize the distribution system, above a drain for condensate disposal, and close to an electrical outlet.
- The unit should also be readily accessible for maintenance.
- Minimize the length and number of fittings required for the distribution ducting.



Typical HRV system

Locating the Exterior Supply Inlet and Exhaust Outlet

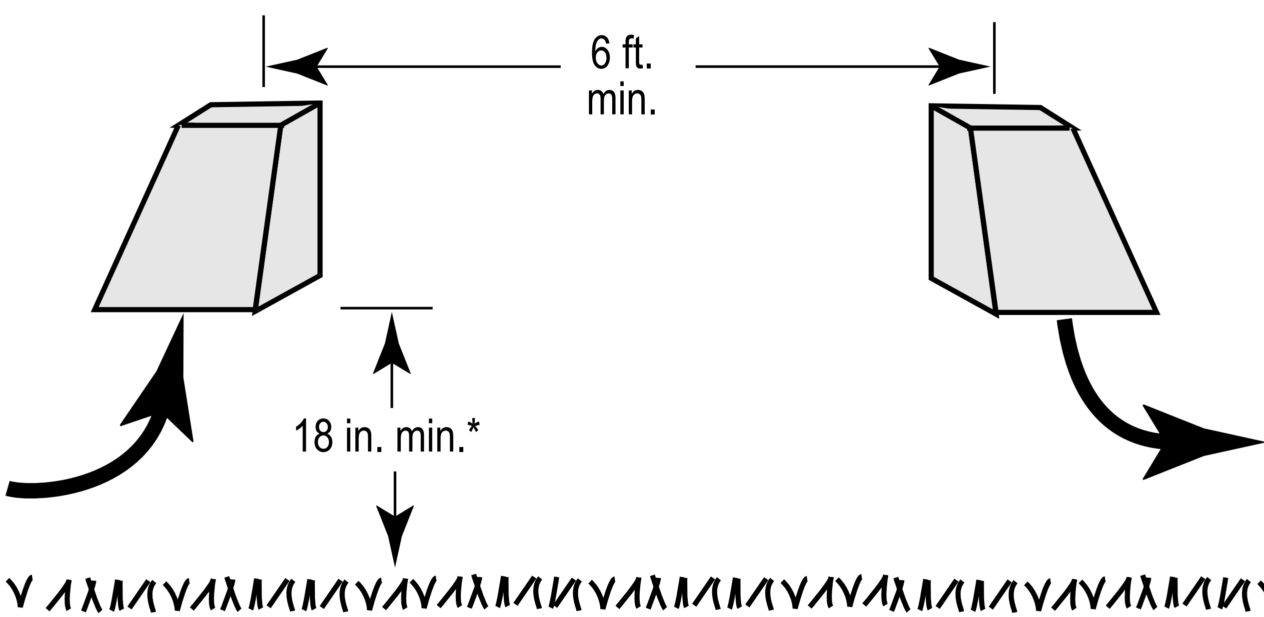
Supply air inlets and exhaust air outlets must be carefully located and installed to avoid contamination and other problems.

Supply Hoods

The fresh air supply from the outside should be the cleanest possible and unobstructed by drifting snow. Don't locate it near sources of bad air such as where vehicles will be idling, or near garbage cans, oil tanks, gas meters or propane tanks, garages, dryer vents, furnace flue vents, corners of the building, or dog yards. Don't locate it in the attic or crawl space. The supply inlet should be at least six feet from the exhaust outlet.

The air inlet should be located where it will not be blocked. Current installation codes specify that the air inlet must be a minimum of 18 in. above the finished grade. Local wind conditions and snow levels should also be considered when locating the hoods. The openings must be screened to keep out birds and rodents. The screens must be accessible for maintenance and removable for winter operation.

Location of Exterior Exhaust and Supply Air Hoods



* May need to be much higher in deep snow drift conditions

Exhaust Hoods

The exhaust outlet should not be located where it could contaminate fresh incoming air, nor in attics or garages or by windows or near walkways where condensation, moisture, or ice could create problems. The exhaust outlet should be a minimum of six feet horizontally from the supply inlet. The bottom of the hood must be a minimum of 18 inches above grade or above expected snow levels.

Fresh Air Distribution

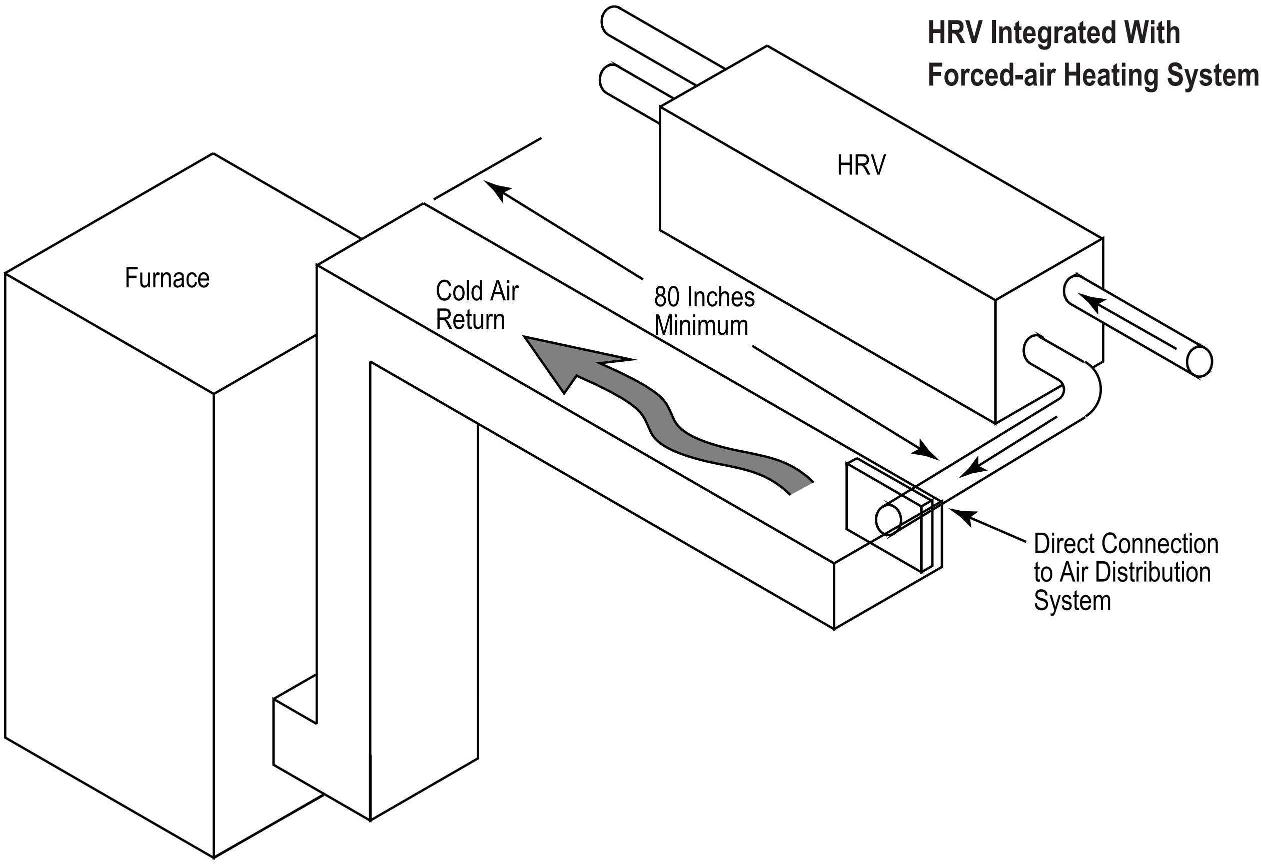
Outdoor supply air can either be distributed through an independent duct system or integrated with, and distributed through, the ductwork of a forced-air heating system.

Independent Systems

This approach is used in buildings that do not have a forced-air distribution system. In winter, the air supplied to each room may be below room temperature. The cooler supply air will behave like cool air supplied by an air conditioning system. The best way to supply cool air to a room is through a high interior wall or intermediate level ceiling diffuser. With this approach the incoming air has time and space to mix with the room air before dropping down to the occupied zone. This also helps to destratify and mix the air in the building (see graphic of grill locations).

Integrated Systems

Combining the ventilation system with a forced-air heating system will eliminate the need for separate supply ducts. The supply air can be delivered to the cold air return of the furnace. The furnace blower must operate continuously, on a lower speed, to distribute the fresh air throughout the building and mix it with the interior air. If the furnace fan is not operated continuously along with the HRV, the fresh air will exit by the nearest available opening and the remainder of the space will not be effectively ventilated. The energy costs to continuously operate the furnace fan should be accounted for in the economic analysis.



Exhaust Locations

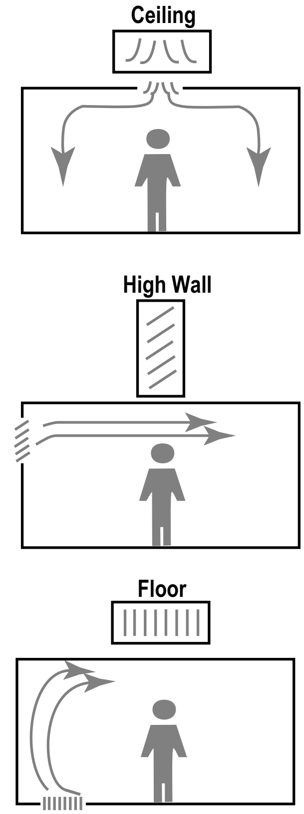
Exhaust air grilles should be located in the rooms where the most water vapor, odors, and contaminants are produced, such as kitchens, bathrooms, and workrooms. Rooms with only exhaust grilles will receive fresh air only indirectly, from other areas of the building. Undercut doors or install transfer grilles to provide adequate air flow to these rooms.

Exhaust grilles in kitchen areas must be located a minimum of four feet horizontally from the stove edge. This will help keep grease from entering the duct system. A separate range hood ducted directly to the outside should be used in addition to the HRV exhaust duct.

Ductwork

Duct joints, longitudinal seams, and adjustable elbows shall be sealed with a suitable duct mastic to ensure adequate air flows and prevent duct-induced pressure imbalances in the building due to leaky ducts.

Remember that both the incoming air and the outgoing air from an HRV is cold. Both the supply and exhaust ducts must be sealed, insulated, and covered with an air/vapor retarder to prevent condensation from forming on the ducts or in the duct insulation. This is the only place where flexible duct should be used. The air/vapor retarder on the cold side ducts must be effectively sealed to the building air/vapor retarder. Ducts must also be carefully sealed where they penetrate the exterior air/weather retarder, using Tremco acoustical sealant or red contractor's tape.



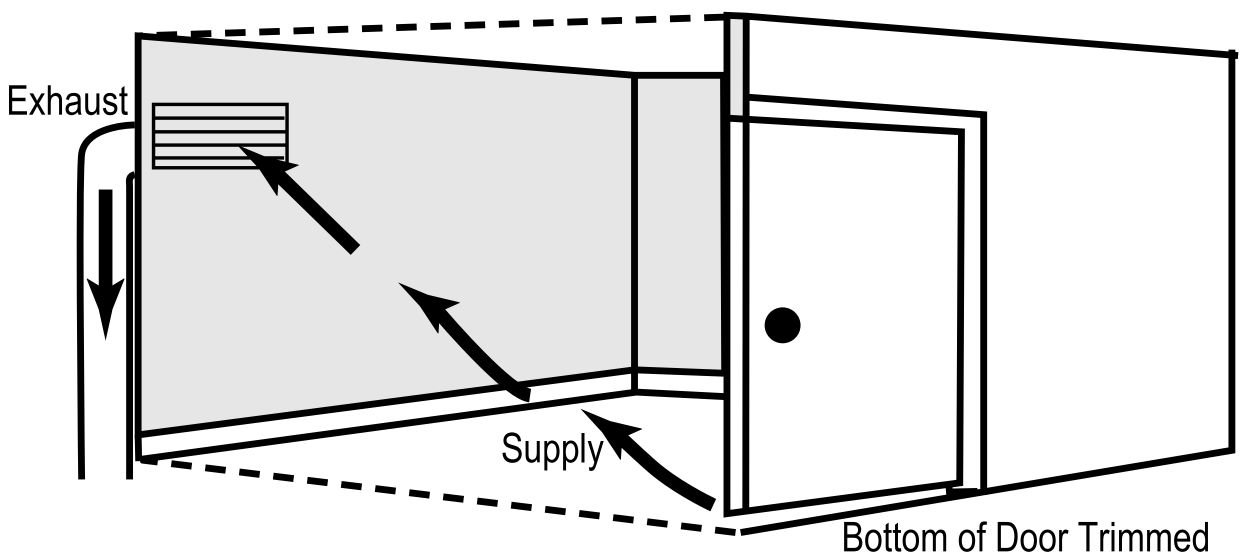
Grille Locations for Fresh Air Distribution

Controls

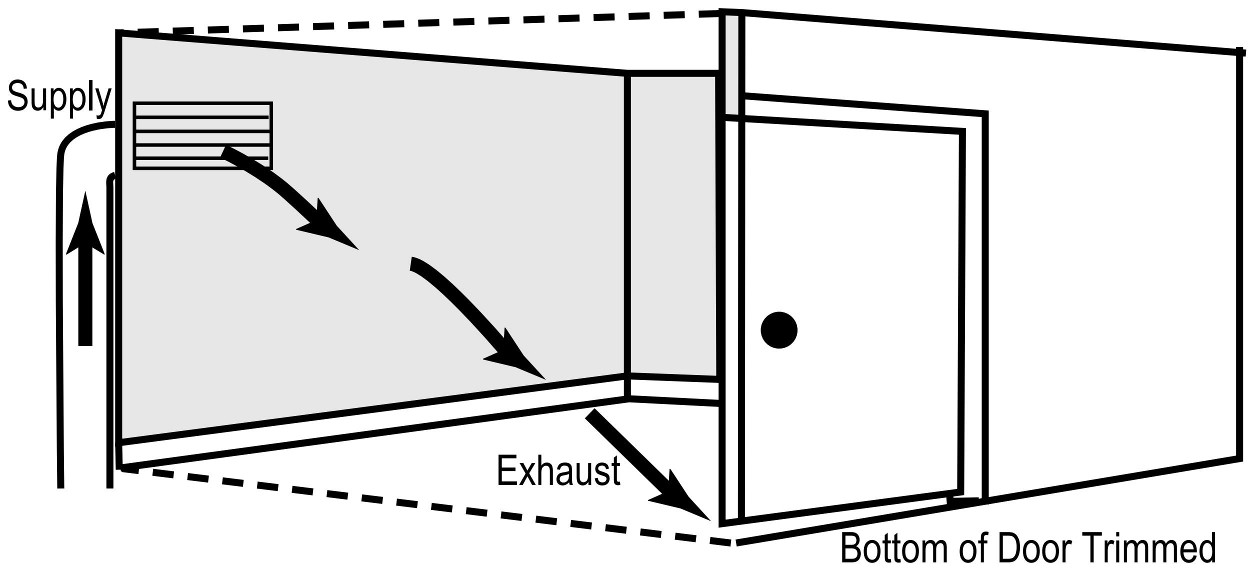
HRV systems are typically designed to operate at two speeds. On low speed, they provide the required base level of ventilation continuously. On high speed, they can handle additional occupant loads and contamination.

High speed can be activated manually by a switch or a timer. Automatic controls include dehumidistats and carbon dioxide or combustion gas sensors. A timer switch is preferable to a standard on/off switch because there is less chance the system will be left on high speed when it is not really necessary.

Typical Installation for Kitchen, Bathroom, or Laundry



Typical Installation for Bedroom, Dining Room, Living/Family Room



Air Flow Measuring Stations

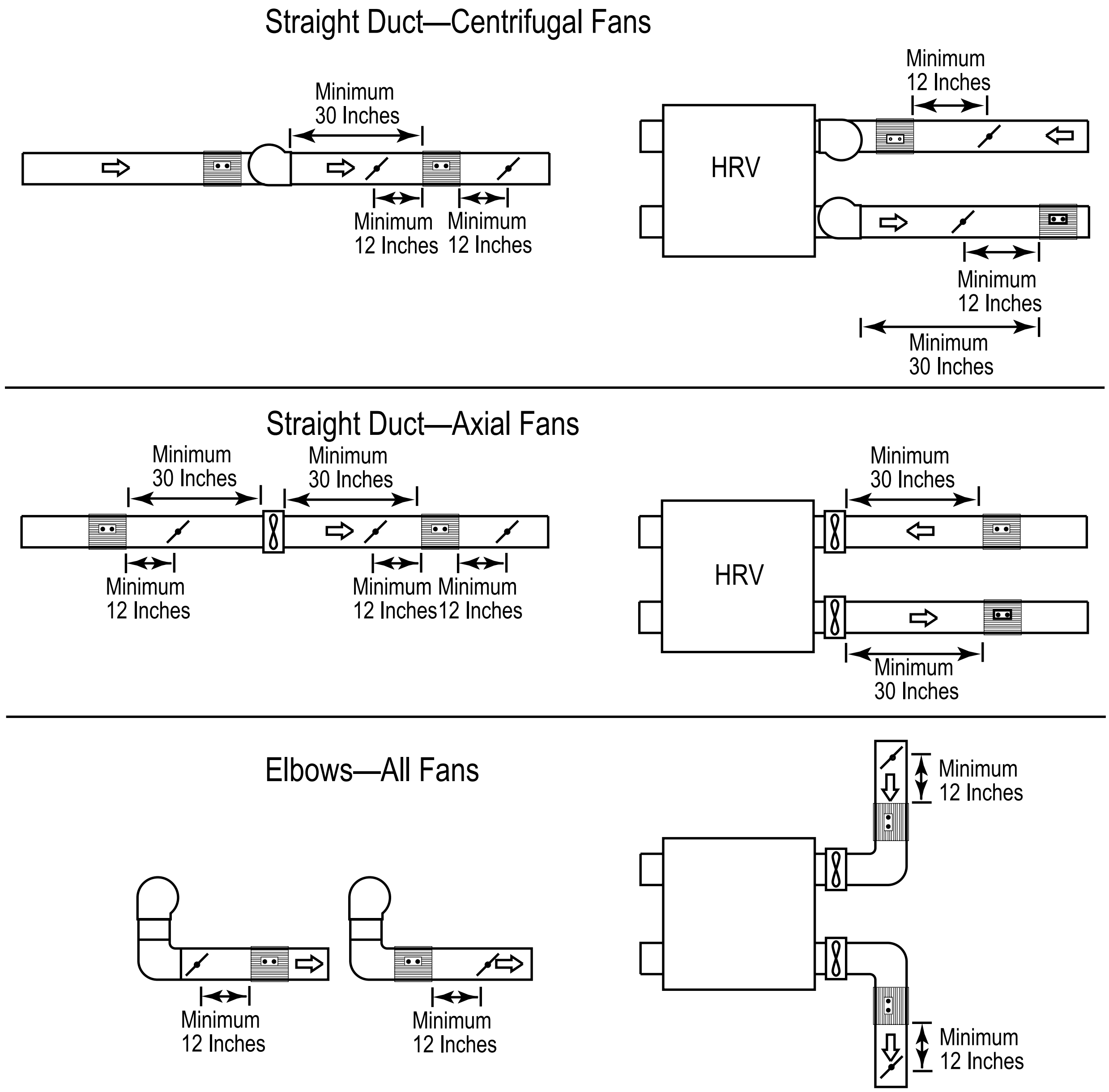
Air flow measuring stations should be installed in the warm side supply and exhaust ducts to enable the installer to balance the system. Dampers and flow measuring stations should be located in an accessible location near the ventilation system and in a position that will allow for accurate air flow measurements. The stations should be located so that all the supply and exhaust air is measured. The installing contractor should give the building owner a report that describes the installation, provides air flow measurement results, and ensures that the HRV system meets industry standards. The installer should provide a written air balance report on the ventilation and exhaust air system.

If the ventilation system includes an HRV, the air flow measuring stations should be installed in the warm side ducting. The supply and exhaust air flows are measured and then balanced to provide neutral building pressure. System balancing is performed when the system is operating in the normal continuous ventilation mode.

System Installation

Once the system has been designed, ensure that the certified installer complies with all design and installation requirements, balances the system, and fills out any required installation reports. Any field deviations should be discussed with the designer before modification to ensure a properly operating ventilation system. The ventilation supply must bring in the same amount of fresh air into the

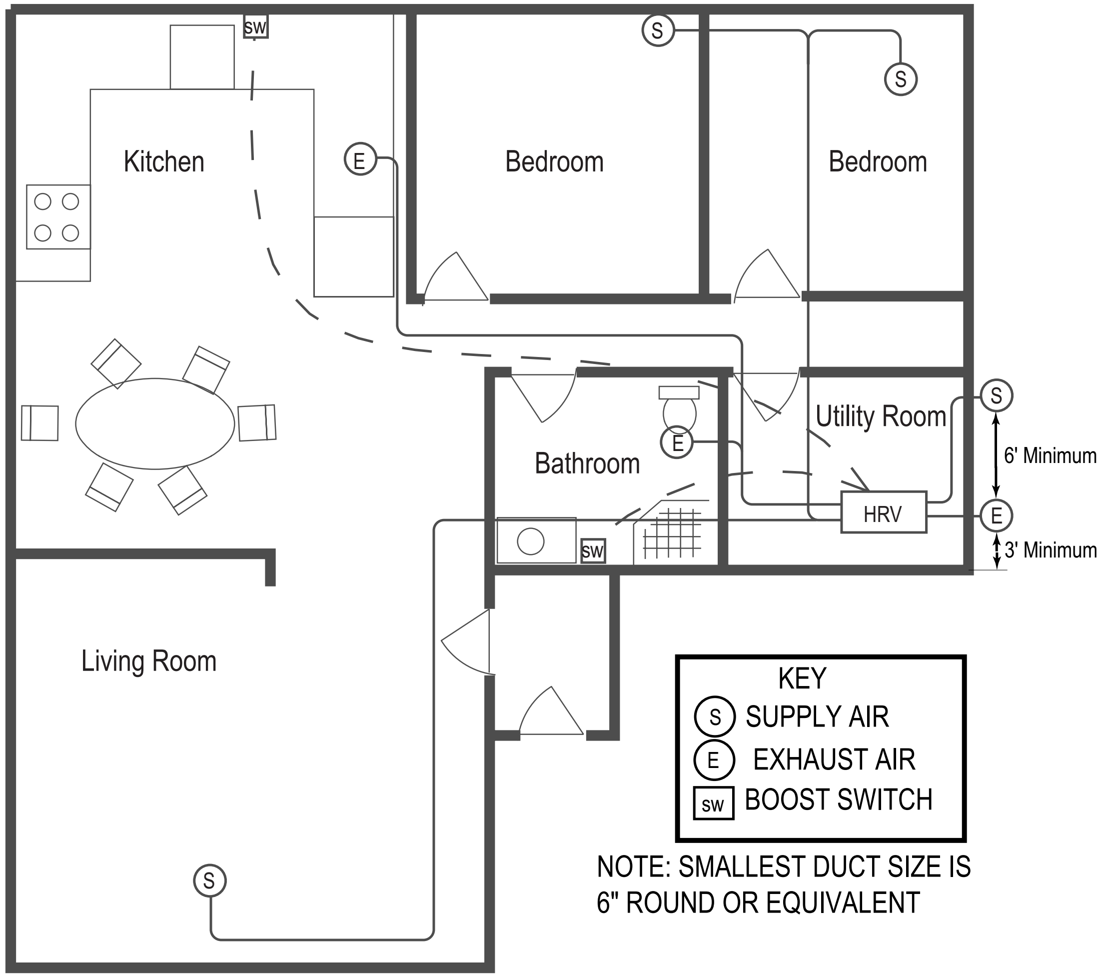
Locations of Airflow Measuring Stations



building as the exhaust fans are removing, plus or minus 10 percent. The system shall not cause a pressure imbalance greater than that allowed in BEES.

A schematic of a sample HRV system installation is shown on the next page. The operation and required maintenance of the ventilation system should be clearly explained to the manager of the building and to the maintenance personnel. Operation manuals and equipment information should be filed for future reference.

As we have discussed, the ventilation system is an integral part of the building system. If the ventilation system is not operated and maintained properly, the building system will not provide a healthy, safe, durable, and affordable building.



NOTE: SMALLEST DUCT SIZE IS
6" ROUND OR EQUIVALENT

Water Conservation

Water is such a valuable renewable resource that we must make every effort to conserve it and maintain its purity. Water supply and disposal problems in rural Alaska are a challenge not easily met by conventional southern latitude design. Consider installing a cistern connected to roof drains to provide water for washing or for flushing toilets. Drinking water must meet DEC standards. Consider installing biological waste composting systems and gray water systems along with ultra low flush toilets and low flow shower heads and faucet aerators. Water heaters should be energy efficient and well insulated to reduce standby losses. Insulate all hot water pipes and protect cold water pipes and drains from freezing. Do not put water pipes or drains in outside walls. Plumbing vents may be installed in outside walls if necessary.

The National Energy Policy Act of 1992 requires all new showerheads produced after January 1, 1994, to meet a flow rate of not greater than 2.5 gallons per minute at 80 psi. Furthermore, installing low flow showerheads will save money.