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POWER SMART GUIDE:
Energy saving solutions for home comfort

Indoor air quality and ventilation

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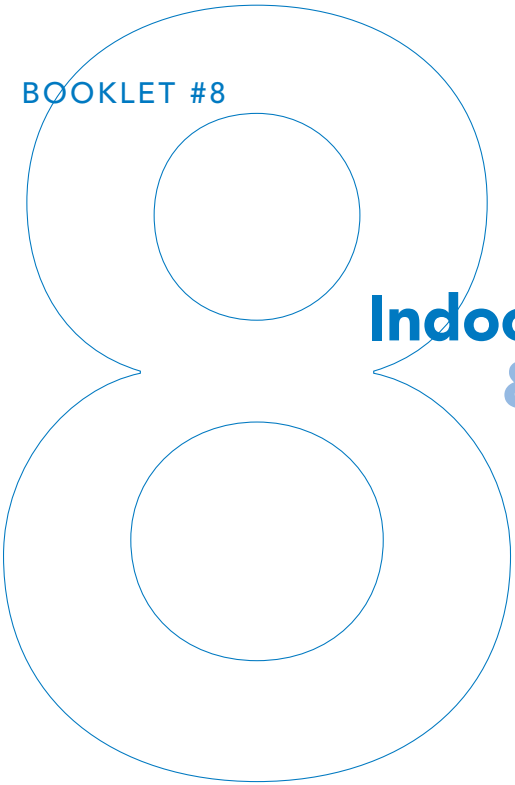
BOOKLET #8



Indoor air quality & ventilation

Acknowledgement

A portion of this booklet has been adapted from the publication **The Inside Story: A Guide to Indoor Air Quality**, published by the United States Environmental Protection Agency.

Important Notice

Care has been taken to ensure the accuracy of this booklet. However, because of changing codes, standards and equipment design, you should seek professional advice before you modify or replace the ventilation system in your home. Manitoba Hydro cannot assume responsibility for injury, loss or damage that results from relying solely on the information contained in this booklet.

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Introduction

Who should read this booklet

Whether you are a novice or experienced homeowner, this illustrated guide will help you:

- understand the relationship between energy efficiency, indoor air quality, ventilation, and your health;
- take action to reduce your exposure to common indoor pollutants;
- improve the performance of your home's ventilation system; and
- select and work with a contractor.

The focus of this booklet is existing single-family homes, duplexes, rowhouses, and mobile homes. However, this publication is also helpful if you are planning to build a new home. Many of the principles for ensuring good air quality are the same in both new and existing homes.

This booklet concentrates on common air quality and ventilation issues in Manitoba homes. Persons with acute environmental sensitivities or unusual sources of pollution in their homes may require specialized information that is beyond the scope of this publication. Canada Mortgage and Housing Corporation's (CMHC's) Canadian Housing Information Centre is an excellent source for more information about healthy-housing issues.

The importance of indoor air quality and ventilation

The quality of indoor air can have a major impact on your health, comfort and sense of well-being. An effective and properly maintained ventilation system is a key component for ensuring that your home not only is energy-efficient, but also has a healthy indoor environment.

All of us face risks to our health as we go about our day to day lives. Some risks are unavoidable. However, poor indoor air quality is one risk that you can do something about.

How to use this booklet

Before you undertake any work discussed in this publication, read carefully. Only perform maintenance tasks that are within your level of expertise. If you want to modify or replace the ventilation system in your home, consult a licensed contractor who has expertise in this field. Insist that all work comply with the Manitoba Building Code.

It pays to spend some extra time to find a knowledgeable indoor air-quality specialist or contractor. It is also important to know your rights as a consumer. Refer to the section **How to get the help you need** (page 37).

Indoor air quality

This section looks at the relationship between energy efficiency, indoor air quality, ventilation and health. It provides advice on how to have a healthier home by minimizing exposure to common pollutants and what to do if you have one of the most common indoor air quality problems — too much or too little humidity.

Indoor air quality, ventilation, and your health

Many ordinary household activities release and spread pollutants (see **Figure 1**). While pollutant levels from an individual source may not pose a significant risk by themselves, there can be a risk from the cumulative effects of these sources.

The people most susceptible to the effects of indoor air pollutants often spend an above-average amount of time in their homes. These are the young, the elderly, and those with chronic illnesses.

The health effects of indoor pollutants fall into two groups: those experienced immediately upon exposure and those which do not show up until years later.

Examples of reactions that may show up soon after exposure are irritation of the eyes, nose and throat, headaches, dizziness, and fatigue. Your likelihood of developing an immediate reaction to indoor air pollutants depends on many factors, such as age and medical condition. Individual sensitivity also may vary greatly from one member of your household to another.

Other health effects may show up only after repeated or long exposure over many years. However, there is considerable uncertainty about what concentrations or periods of exposure to a pollutant are necessary to produce a specific health effect.

It is often difficult to determine if symptoms are a result of exposure to indoor air pollution. Keep track of whether symptoms fade or go away when you are away from home and then reappear when you return. If this occurs, the information in this booklet may help you to identify the possible source of your indoor air-quality problem. However, you may want to consult your physician, who can refer you to a specialist in environmental medicine if health issues are a concern.

Figure 1 • Some common sources of indoor pollutants

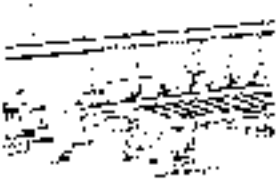
Smoking

Pets

Cooking

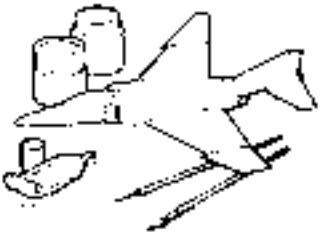
Fireplaces

Stored paints, cleaners and other chemicals



New flooring or other renovations

Soil gases



Hobby materials

How to tell if your home has poor air quality

Some signs of poor air quality are easier to spot during winter. Symptoms to look for are:

- lingering or unusual odours,
- irritation of the eyes, nose and throat, headaches, dizziness, and fatigue,
- excessive condensation or frost on windows,
- damp spots, mould or mildew on walls, ceilings or in closets,
- peeling paint and wallpaper.

The air in your home can be tested if there is reason to suspect a specific source or pollutant is causing a problem. Unfortunately, proper testing for many pollutants can be expensive. To locate indoor air quality specialists who offer this service, refer to the section "Environmental Consultants" in the Yellow Pages™.

Radon is a soil gas that you cannot see, smell or taste and can get into your home undetected. If it accumulates to a high level, it can become a serious health hazard. The only way to know the radon level in a home is to measure it. There are two options for radon testing: purchase a do-it-yourself radon test kit or hire a certified radon measurement professional.

The need for source control and ventilation

The most effective method to improve indoor air quality is usually to eliminate individual sources of pollution or reduce their emissions. This technique is known as "source control."

However, it is impractical to completely eliminate all sources of pollutants. Ventilation of a home and the exchange of "stale" indoor air with "fresh" outdoor air are essential to keep pollutants from accumulating to levels that pose health and comfort problems. This ventilation can be provided by a combination of:

- air leakage through cracks and other openings in the exterior of the home,
- natural ventilation by air movement through opened windows and doors,
- mechanical ventilation by fans.

Heating or cooling the air that ventilates your home requires energy. By practicing source control of pollutants, you can maintain a healthy indoor environment with lower ventilation rates, and reduce your energy bills.

Why a "Leaky" Home is Not a Solution

New homes are designed and constructed to minimize the amount of air leakage. This improves comfort, prevents costly moisture damage to the structure of the home, and reduces heating bills. Current construction standards require new homes to have a mechanical ventilation system, called a heat recovery ventilator (HRV).

By using an HRV the occupants can vary the ventilation rate to control pollutants, keep humidity levels within a reasonable range, and save energy.

Older homes are typically much "leakier" and usually lack a mechanical ventilation system. Instead, the ventilation rate depends on wind, temperature differences between the indoors and outdoors, and how often windows and doors are opened. This results in poor control over when and how much ventilation is provided. Leaky homes also tend to suffer from cold drafts and uncomfortably low humidity levels during much of the heating season.

Minimizing exposure to common pollutants

There are many sources of indoor air pollution. The relative importance of any single source depends on how much is emitted and how hazardous those emissions are.

What to do about soil gas entry

For most of the year, the air pressure inside your home is lower than the pressure in the soil surrounding your foundation. This difference in pressure can draw air and other gases in the soil, including radon, into the house.

Radon is the second leading cause of lung cancer after smoking and the leading cause of lung cancer for non-smokers. When radon enters an enclosed space, like a home, it can accumulate to high levels and become a health hazard. You should fix your home if your radon level is higher than the Canadian Guideline of 200 Becquerels per metre cubed (Bq/m^3).

Active Sub-Slab Depressurization — Sub-slab depressurization (also called active soil depressurization) is the most effective and reliable radon reduction technique. This method involves installing a pipe through the foundation floor slab and attaching a fan that runs continuously to draw the radon gas from below the home and release it into the outdoors where it is quickly diluted. This system

also reverses the air pressure difference between the house and soil, reducing the amount of radon that is drawn into the home through the foundation.

Other Techniques — Other techniques include: sump hole depressurization, drainage system depressurization, or active sub-membrane depressurization.

More information can be obtained at www.healthcanada.gc.ca/radon.

What to do if your home is too humid or too dry

To have a healthy, comfortable and durable home, keep indoor humidity levels within a reasonable range. Potential problems that may occur if the humidity in your home is too high or too low include:

Humidity too high — This can cause respiratory problems by increasing the growth of moulds and dust mites, as well as prolonging the survival of bacteria and viruses. High humidity also can cause expensive condensation damage to the structure of your home and deterioration of interior surfaces such as windows or hidden inside the attic and walls.

Note that excessive condensation on your windows could be a sign of flue gas spilling or backdrafting. See Booklet #6: **Heating systems**, for more details.

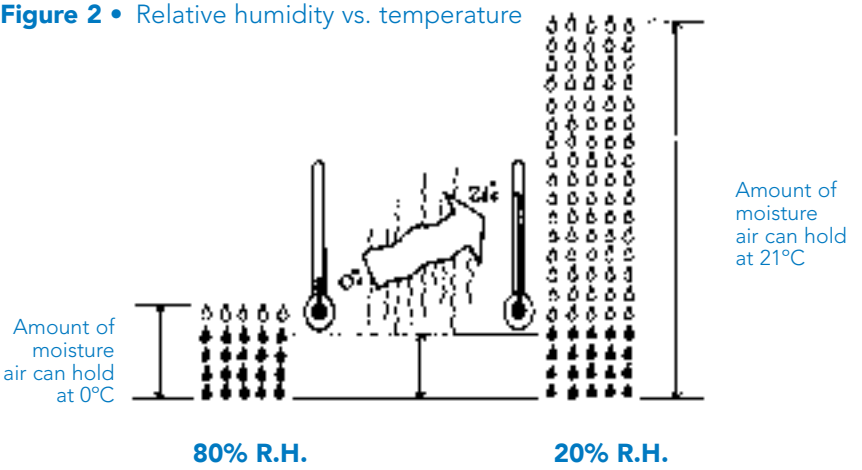
Humidity too low — This can cause dryness of the skin, irritation of mucous membranes leading to nosebleeds, and increased levels of airborne dust. Low humidity can also damage furniture, artwork, plants, and other household items.

An explanation of relative humidity

Relative humidity (R.H.) is a term used to describe the moisture content of air. Expressed as a percentage, R.H. is the actual amount of moisture in the air compared with the maximum amount of moisture the air can hold at the same temperature.

Warm air can hold more moisture than cold air. For example, outdoor air at 0˚C (32˚F) and 80 per cent R.H. will drop to 20 per cent R.H. when heated to an indoor temperature of 21˚C (70˚F) (see **Figure 2**).

Figure 2 • Relative humidity vs. temperature



Recommended humidity levels

Personal preferences vary about acceptable levels of relative humidity. Air temperature, air movement, your activity level, age, and clothing will affect the humidity level you find comfortable.

Based on health considerations, the ideal range for relative humidity is 40 to 60 per cent. Unfortunately, maintaining this narrow range in a home is usually not practical given the extremes of our climate. Health Canada suggests maintaining indoor levels at 30 to 80 per cent R.H. in the summer and 30 per cent to 55 per cent R.H. during winter.

When the temperature outdoors drops below -10˚C, limit the indoor R.H. to about 30 per cent. Unless your home has energy-efficient windows and is well insulated, higher R.H. levels will result in excessive condensation. Refer to **Booklet #5: Doors and windows**, for more information about solving window condensation problems (contact Manitoba Hydro for a copy).

How to measure the humidity level in your home

An instrument called a "hygrometer" can be used to measure your home's humidity and determine if it is within the recommended range. They are available at hardware stores, building supply centres, and electronics stores.

There are two basic types of hygrometers (see **Figure 3**):

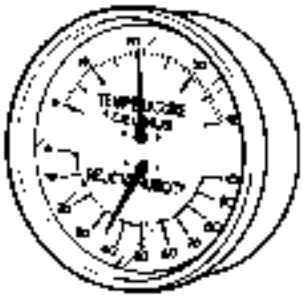
- **Mechanical hygrometers** typically have a pointer and round dial. They are usually inexpensive (less than $25) and reasonably accurate once calibrated. Some models are adjustable.
- **Electronic hygrometers** feature a digital display. They are slightly more expensive (about $35 to $60) but tend to be more accurate. They generally cannot be adjusted.

Indoor humidity levels may vary at different locations in your home and with changes in weather or your lifestyle. Keeping a written record can allow you to track how humidity levels in your home change.

For accurate readings, keep the hygrometer out of direct sunlight and away from sources of heat such as a register or radiator. Remember that a hygrometer doesn't respond instantly – it may take an hour or two to provide a steady reading in a new location or adjust to a sudden change in the humidity level.

To be confident that your hygrometer is accurate, calibrate it at least once a year. Follow the manufacturer's instructions to calibrate your hygrometer, or refer to the appendices.

Figure 3 • Hygrometers



Mechanical

Electronic

How to reduce or eliminate condensation problems

A cold surface can cool air to the point where it cannot hold any more moisture. When this occurs, condensation forms. Whether the condensation forms as water droplets or frost will depend whether the temperature is above or below freezing. The water or frost that collects on the inside surface of windows is a visible example of condensation.

If your home produces condensation, it can be a sign of any or all of the following:

- too much moisture in your home;
- insufficient ventilation;
- poor air circulation is allowing pockets of cool air to form;
- the windows and other surfaces in your home are too cold.

Excessive condensation can also be caused by flue gas spillage or back-drafting. See **Booklet #6: Heating systems**, another booklet in this series, for more details.

When you attempt to solve a condensation problem, try simple no-cost or low-cost steps first. Consider these steps to control condensation:

1. Reduce the amount of moisture produced.

- Turn humidifiers down or off until the condensation diminishes;
- Cover pots when cooking to reduce steam;
- Don't hang clothes indoors to dry;
- Vent the clothes dryer to the outdoors (see **Figure 4**);
- Take shorter showers or baths;
- Reduce the number of houseplants;
- Don't store firewood indoors;
- Cover exposed earth in basements or crawlspaces with a moisture barrier (see **Figure 5**);
- Improve drainage around the foundation.

2. Improve air circulation.

- Open drapes or blinds over windows;
- Move furniture or objects blocking warm and cold air registers;
- Remove heat deflectors to allow warm air to flow over windows;
- Run the furnace fan continuously at low speed.

Figure 4 • Vent clothes dryer to the outdoors

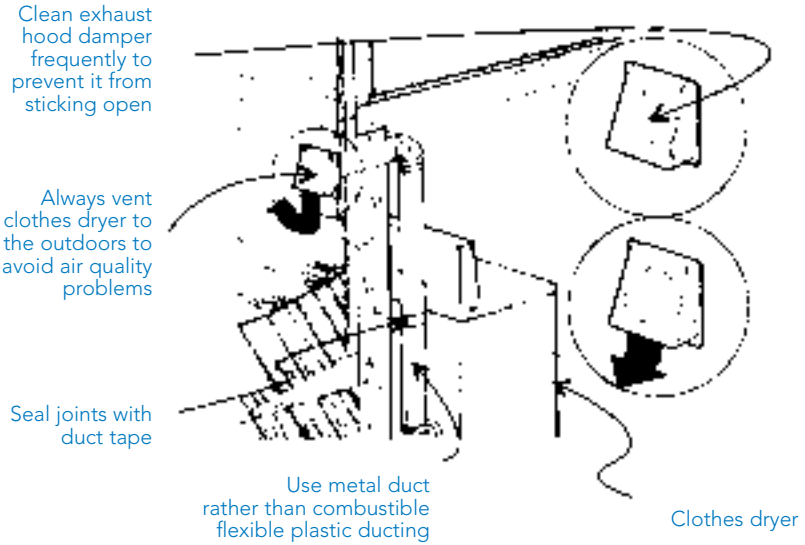
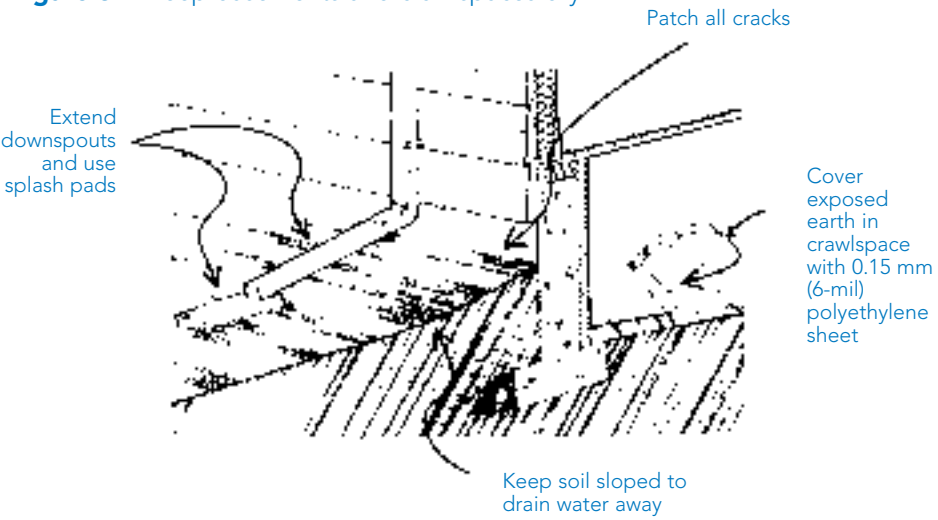


Figure 5 • Keep basements and crawlspaces dry



3. Improve ventilation.

- Use the kitchen exhaust fan while cooking and the bathroom exhaust fan while showering or bathing;
- Make sure that exhaust fans vent to the outdoors;
- In winter, briefly open windows or exterior doors to deal with a sudden increase in humidity;
- Improve the effectiveness of the ventilation system as described in the section on **Upgrading an existing ventilation system**;
- Install a new ventilation system as described in the section on **Options for a new ventilation system**.

4. Improve windows and insulate cold surfaces.

- Condensation on a single or dual-pane window can be reduced by installing a storm window or a window seal kit in the winter. A more costly solution is to replace the window with a new, more energy-efficient unit. Refer to **Booklet #5: Doors & windows** for more information on solving window condensation problems. Contact Manitoba Hydro for a copy.
- Add insulation to uninsulated or poorly insulated basements, ceilings and walls. Refer to **Booklet #2: Basement & crawlspace insulation**, **Booklet #3: Attic insulation** and/or, **Booklet #4: Wall insulation**. Contact Manitoba Hydro for a copy.

The humidity levels in your home may increase if new windows are installed or storm windows added. Replacing your furnace or boiler with a more efficient unit, or applying caulking and weatherstripping to reduce drafts, will also increase humidity. In these cases, look for ways to reduce the amount of moisture produced in the home, improve air circulation, or increase ventilation as described above.

Dehumidifiers are also useful in reducing humidity during summer, especially in a damp basement. However, they are of only marginal help in winter. This is because they lack the ability to reduce relative humidity to the levels needed during winter to prevent condensation.

How to increase humidity levels

If your home is too dry during the heating season, increase your humidity by reducing air leaks and ventilation or by using a humidifier.

1. Reduce air leaks — During the heating season, cold, dry outdoor air replaces warmer, more humid indoor air that escapes or is exhausted from your home. This may make your home too dry if you are generating too little moisture compared to the air leakage rate.

Sealing your home will reduce air leakage and increase humidity levels. Reducing drafts also improves comfort and reduces your heating bills. **Booklet #1: Sealing, caulking & weatherstripping**, explains how to locate and seal air leaks. Contact Manitoba Hydro for a copy.

The amount that the humidity levels will increase when you reduce air leaks depends on how thorough you are and the characteristics of your home. Older, drafty homes benefit most. You may even see enough improvement that you can reduce or eliminate the need for a humidifier.

Make sure that your home has an effective mechanical ventilation system before you undertake extensive work to reduce air leaks. Also have your heating contractor check that all combustion appliances in your home (e.g., furnaces, boilers, water heaters, fireplaces, and wood stoves) have an adequate supply of air and are venting safely. See the section that describes how to **Install combustion air and fresh air intakes**.

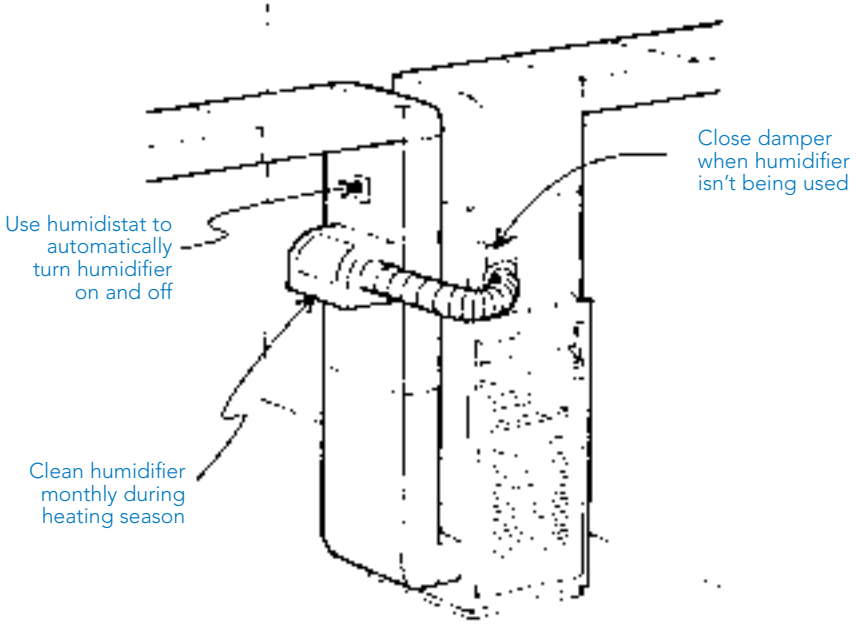
Another booklet in this series, **Booklet #6: Heating systems**, identifies how to prevent or correct a backdrafting or spillage problem. This is especially critical in newer, tightly sealed homes. Contact Manitoba Hydro for a copy of the booklet.

2. Install a furnace humidifier — If your home has a forced-air heating system, consider having your heating contractor install a furnace humidifier.

A furnace humidifier diverts some of the air heated by the furnace through the humidifier (see **Figure 6**). This air passes through a water-soaked evaporator before returning to the furnace for distribution throughout the house. A humidistat mounted on the return air duct or near the home's thermostat turns on the humidifier when the humidity drops below a pre-set limit, which you can adjust.

Do-it-yourself installation of a furnace humidifier is possible if you have skills in cutting sheet metal, wiring, and plumbing. If you install the humidifier by yourself, follow the manufacturer's instructions carefully. Consider doing the work just before your heating contractor's annual service call so the installation can be checked to ensure that the furnace still has the proper air flow.

Figure 6 • Furnace humidifier



3. Use portable humidifiers — A portable humidifier is an alternative to a furnace humidifier if:

- you only need to humidify a room or two; or
- your home doesn't used forced-air heating.

There are five basic types of portable room humidifiers.

Evaporative units use a fan to blow room air over a rotating foam wheel or pads wetted by a water reservoir.

Steam vaporizers use an electric heating element to boil water in a reservoir to create steam. These units have fallen out of favour because they post a burn risk, especially to small children.

Warm-mist humidifiers use a heating element to boil water from a reservoir. The resulting steam combines with filtered air and escapes into the room as a warm mist. Unlike a steam vaporizer, these units are not dangerously hot to touch.

Impeller humidifiers use a rapidly spinning disk to convert water from a reservoir into a cool mist.

Ultrasonic humidifiers use high-frequency vibrations to change water from a reservoir into a mist. A tiny fan expels this cool mist from the humidifier.

The price and capacity of portable humidifiers vary widely. Check back issues of magazines such as Consumer Reports™ for the names of top-rated models. If your home is large or unusually dry, a high-capacity humidifier or more than one unit may be necessary to make a worthwhile improvement.

A special caution about humidifiers

Improper operation and maintenance of a furnace or portable humidifier can promote the growth of bacteria and fungi. This can lead to health problems ranging from flu-like symptoms to serious infections. Follow the manufacturer's instructions and maintenance tips in this booklet.

Exercise extra caution if you use an impeller or portable ultrasonic humidifier. Failure to demineralize the water can result in the minerals being released in the mist from the humidifier and settling as a fine white dust. This dust can interfere with the proper operation of sensitive electronic equipment, such as DVD players, or computers.

Ventilation

This section looks at how to maintain the ventilation system in your home or modify it to improve performance. Options for installing new, more effective ventilation equipment are also covered.

Maintenance tips

Several maintenance tasks are required to ensure the safe and effective performance of your ventilation system. Most of them do not require professional assistance.

With forced-air heating and cooling systems, the ducts, furnace filter and humidifier are part of the ventilation system. If you are unsure whether your home has a specific piece of ventilation equipment, ask your heating contractor. If your home is new, ask your builder.

Clean or replace the furnace filter

Furnace filters should be cleaned or replaced regularly. Besides affecting air quality, a clogged filter restricts airflow, reducing the furnace's efficiency and shortening its life.

Before you service the filter, ensure that the power to the furnace is turned off. If your furnace uses a disposable filter, replace it when dirt begins to accumulate. This could be as often as once a month during the heating season. If the filter is a permanent type, wash it in warm soapy water, rinse with clean water, and allow to dry before reinstalling it.

If you use a better-quality extended-surface disposable filter (see **Figure 11**), they usually require replacement every three months during the heating season, although you may find it necessary to replace them more or less frequently.

For furnaces with an electronic air cleaner, the cells and protective pre-filters inside the air cleaner should be serviced every two to three months. It is normal for an electronic cleaner to make an occasional cracking or popping noise. A sharp increase in the frequency of these noises can be a sign that the cells need cleaning.

Check your owner's manual for servicing instructions. Generally, the first step is to ensure the power is turned off to both the furnace and air electronic cleaner. Next, open the access door and remove the cells and pre-filters. Wash and them rinse them in a laundry tub or dishwasher. After the cells and pre-filters are dry, reinstall them and turn the power back on.

The service frequencies recommended above are based on an average home with normal household activities. Increase the frequency if:

- there are an above-average number of people living in your home;
- people smoke in your home;
- your home is in proximity to a dusty area (e.g. an unpaved road or industrial area);
- members of your household are sensitive to poor air quality;
- you have hobbies such as woodworking that produce a lot of dust or dirt;
- you have central air conditioning;
- the furnace fan runs continuously.

Clean or replace the filter in portable air cleaners

Portable air cleaners generally require frequent cleaning and filter replacement to function properly. Refer to the owner's manual for recommended service intervals and specific instructions on how to clean or replace the filter. On some units, these instructions may be printed on a label on the underside or inside the air cleaner.

Check outdoor intake and exhaust hoods

Intake hoods should have a screen to prevent the entry to insects, birds or rodents. Exhaust hoods should have either a screen or a backdraft damper.

Walk around the outside of your home and locate any intake and exhaust hoods. Check inside them to make sure they are free of insects, bird or rodent nests, and debris, such as leaves or grass clippings (see **Figure 7**).

Inspect the intake and exhaust hoods for blockage once each season. Also check if you begin to notice a gradual or sudden decrease in the effectiveness of the ventilation system, such as an increase in humidity or odours that linger. During winter, make sure that intake and exhaust hoods close to the ground do not become blocked by snow, especially after a storm. Also check for blockage by frost during an extended cold snap.

Clean kitchen and bathroom exhaust fans

The first step is to make sure that the fan is off. Some kitchens and bathroom exhaust fans are turned on and off by automatic controls, such as dehumidistats, timers, or occupancy sensors. In these cases, switch the circuit breaker to the "off" position or remove the fuse at the main electrical panel before servicing the fan.

The odour and grease filters found in kitchen-range hoods should be washed whenever they become noticeably dirty or discoloured (see **Figure 8**). A wall or ceiling-mounted kitchen exhaust fan may have a washable filter to capture grease and other cooking particles. Clean these filters in hot, soapy water annually or whenever you notice a build-up of grease or dirt.

At least once a year, remove the intake grilles that cover bathroom exhaust fans. Use a soft bristle attachment to remove dust and dirt from the fan, motor and its housing (see **Figure 9**). In some cases, you may also need a small bristle brush to get to those hard to reach spots.

Figure 7

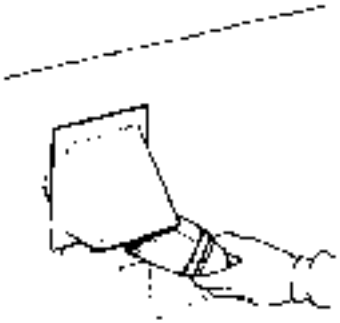


Figure 8

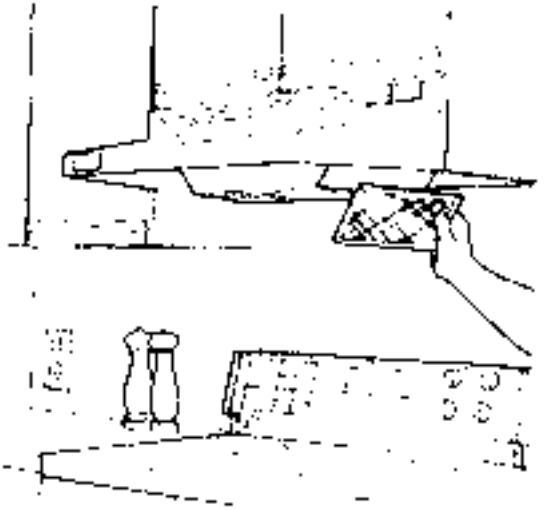


Figure 9

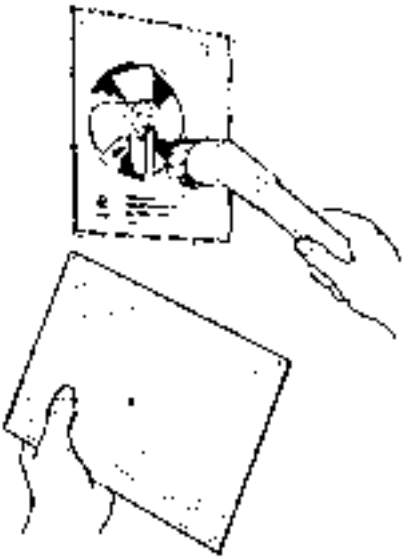
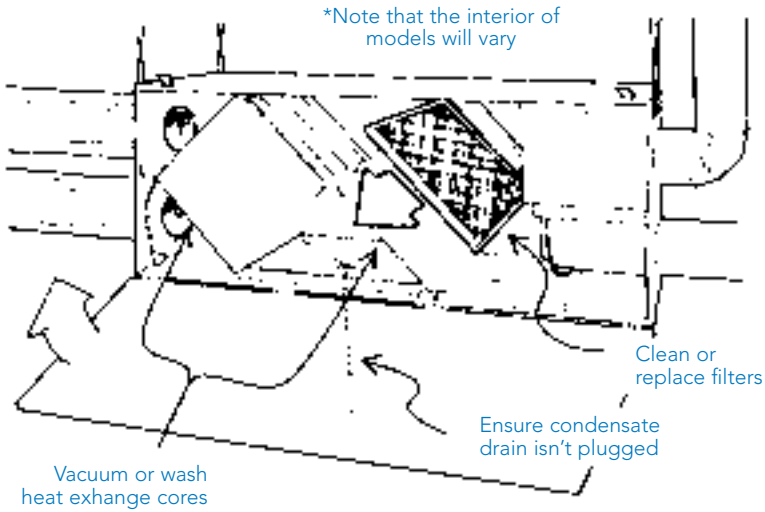


Figure 10 • Service heat recovery ventilators



Service heat recovery ventilators

If your home has a heat recovery ventilator (HRV), have it serviced annually. Follow the manufacturer's instructions or have it serviced by your heating contractor at the same time as your heating system.

There is some basic maintenance you should do between your contractor's annual visits. Check the recommendations from the manufacturer of your HRV (maintenance instructions are often placed in a pocket on the outside of the HRV or on a label inside the unit).

This maintenance typically includes (see **Figure 10**):

- cleaning or replacing air filters,
- checking outdoor intake and exhaust hoods for blockage,
- ensuring that the condensate drain isn't plugged by debris,
- vacuuming or washing the heat exchange core if it becomes dusty or dirty.

For more information about HRVs, refer to Natural Resources Canada's booklet **Operating and Maintaining your Heat Recovery Ventilator**. Contact Manitoba Hydro for a copy.

Clean air-supply registers and air-return grilles

Vacuum air-supply registers or diffusers and air-return grilles whenever you notice dust beginning to collect. At least once a year, remove registers, grilles, and vacuum inside the ducts as far as you can easily reach.

Determine whether ducts should be professionally cleaned

Duct cleaning typically involves using specialized tools to dislodge dirt and other debris in ducts, then vacuuming them out with a high-power vacuum cleaner.

If you decide to have your ducting system cleaned, confirm that your contractor will clean all components of the system. Failure to clean a contaminated component can result in the entire system being re-contaminated negating any potential benefit.

Duct cleaning includes not only supply and return-air ducts, but also other related components such as registers and grilles, diffusers, the furnace's heat exchanger, heating and cooling coils, condensate drain pans, and the furnace fan assembly.

Studies in Canada and the United States suggest that routine duct cleaning for most homes is not necessary. However, hiring a professional to clean your entire heating and cooling system is reasonable if you remove registers or grills and find that the inside of the ducts have a heavy accumulation of dust and dirt, or evidence of an infestation by rodents or insects after major renovations in your home.

Refer to Choosing an experienced and reliable contractor (page 37) for advice on finding a duct cleaning company.

If renovations or repairs are to be done to your home that could produce a significant amount of dust or debris, you may want to consider temporarily sealing off supply and return air registers in the work area. During cleanup, temporarily turn off the heating or cooling system.

Have your furnace/air conditioner serviced annually

Contractor checks

A professional heating contractor should service and maintain your furnace annually. The work should include:

- checking the venting system,
- checking the combustion air intake and piping (if applicable),
- checking condition of the furnace heat exchanger and cleaning if necessary,
- inspecting the burners and cleaning them if necessary,
- checking that all operating and safety controls are functioning properly,
- checking the blower fan wheel and cleaning it if necessary,
- checking and lubricating all bearings (if applicable),
- inspecting the belt (if applicable),
- checking the air conditioner coil, if applicable, for blockage,
- checking for loose or missing parts and fasteners,
- cleaning or replacing the air filter for forced air systems,
- checking for proper furnace operation during a heating cycle,
- checking the condensate drain and condensate lines to ensure they are unobstructed (if applicable).

Clean and adjust humidifiers

Clean and adjust the furnace humidifier once a month during the heating season, or have your heating contractor do the work at the same time as your heating system cleaning and inspection. Look for the manufacturer's maintenance instructions in the owner's manual or on the humidifier. If you cannot find the instructions, follow these guidelines.

Furnace drum-style humidifiers

- Turn off both the electrical power and water supply to the humidifier.
- Open or remove the humidifier's access panel.
- Remove the evaporator pad from inside the unit.
- Thoroughly clean the evaporator in a solution of one part vinegar to three parts water. Rinse several times with clean tap water. If the pad is more than one year old, replace it.
- Also remove and then clean the humidifier's water reservoir with the vinegar and water solution. Rinse with clean water.
- Reassemble the humidifier, except for the access panel. Turn the electricity and water supply on and increase the humidity setting on the unit to its maximum setting. Look inside to make sure that moving or rotating parts are not binding.
- Adjust the float level so that the water reservoir does not overfill. If allowed to always overflow, the humidifier can drip on the furnace and damage it.
- Finally, replace the access cover and return the humidity control to its usual setting.

At the end of the heating season, clean the humidifier one last time. Leave the electrical power and water supply off until fall. Also, close the damper that diverts air from the furnace and through the humidifier (see **Figure 6**).

Flow-through humidifiers

Flow-through humidifiers look much like drum-style humidifiers. The main difference is that flow-through humidifiers do not have a pan of standing water.

When your humidistat calls for moisture, a solenoid valve opens, allowing water to be distributed over the evaporator pad. Some of the furnace air is re-circulated through the humidifier.

The re-circulated air picks up moisture from the evaporator pad and distributes it to your home through your ductwork. Any excess moisture in the humidifier is carried to a drain.

Manufacturers recommend that you have your flow-through humidifier serviced annually by a qualified service person, and that the evaporator pad be changed annually.

Portable humidifiers

- Unplug the unit from the electrical outlet.
- Empty the water reservoir, dry all surfaces with a clean cloth, and refill with water daily to reduce the growth of micro-organisms.
- Use distilled water to prevent the build up of scale and dispersal of minerals into the air. Although bottled water labelled "distilled" will still contain some mineral content, it should be less than most tap waters. Be aware that bottled waters labelled "spring," "artesian," or "mineral," have not been treated to reduce mineral content.
- Consider using demineralization cartridges, cassettes, or filters recommended by the manufacturer. The ability of these devices to remove minerals varies widely. If the mineral content of your water is high, using distilled water may be less expensive.
- Clean the humidifier twice a week. Unplug the unit and empty the water reservoir. Scrub and film or scale off the reservoir and interior surfaces of the humidifier. Dry all surfaces with a clean cloth.
- In the absence of recommendations from the manufacturer, clean all surfaces coming into contact with the water with white vinegar or a three per cent solution of hydrogen peroxide. After using a cleaning or disinfecting agent, rinse the water reservoir with several changes of tap water. This will prevent these chemicals from being dispersed into the air when the humidifier is used.

Clean the humidifier at the end of the heating season or when the unit will not be used for an extended period. Dispose of used filters or demineralization cartridges, cassettes or filters. Dry the humidifier and store it in a dry location. After storage, re-clean the unit, including any dust on the outside.

Upgrading an existing ventilation system

Every home should have an effective mechanical ventilation system to control indoor air quality and humidity levels. This section reviews several ventilation system improvements that may be desirable for your home.

Remember that the performance of a ventilation system can have a major impact on the health and safety of you and your family. Do not make major modifications to the ventilation system in your home without consulting a licensed contractor who has expertise in this area.

Use a more effective furnace filter

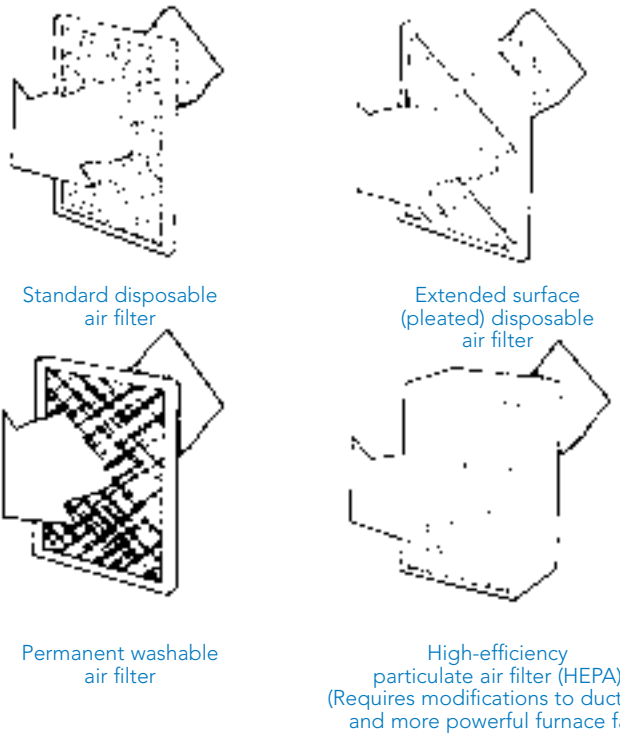
Most furnaces have a standard disposable filter or a permanent, washable type made of coarse fibres or expanded metal (see **Figure 11**).

Pleated or extended surface disposable filters cost only a few dollars more and are more effective. Their greater surface area and finer filter material traps much smaller particles that would pass through a standard disposable or permanent washable filter.

If you are thinking of installing a more efficient air filter, consider waiting until your annual furnace maintenance. Your heating contractor can install it and confirm that the furnace is still working properly.

For even better performance, talk to your heating or ventilation contractor about installing an electronic air cleaner. These devices use washable pre-filters to trap larger particles and a series of electrically charged plates to collect smaller particles. Electronic air cleaners are extremely effective, compared with standard disposable or permanent washable filters.

Figure 11



Standard disposable air filter

Extended surface (pleated) disposable air filter

Permanent washable air filter

High-efficiency particulate air filter (HEPA) (Requires modifications to ductwork and more powerful furnace fan)

An alternative to an electronic air cleaner is a high-efficiency particulate air (HEPA) filter. These filters have large, extended surface area of an ultrafine filter material. HEPA filters are very effective.

Both electronic air cleaners and HEPA filters generally require some modifications to the ducts leading to your furnace. The additional air resistance of a HEPA filter may also require that the furnace fan motor or blower be upgraded. Ask your doctor if these types of filters will help if you have respiratory problems.

Consider a portable air cleaner

Many homes do not have a forced-air heating system with a furnace filter (e.g. homes with hot water or electric baseboard heating systems). Using portable air cleaners is an alternative. Remember that portable air cleaners cannot remove all the pollutants found in the air of your home. These devices are only a supplement to a plan that should include source control of pollutants and proper ventilation.

Check that the unit you are considering displays a label from the Canadian Standards Association (CSA), Underwriters Laboratories (UL), or another recognized independent safety-testing organization.

Portable air cleaners vary widely in both cost and effectiveness. Some models may generate enough noise to bother you, even at low speed. Also, some manufacturers and distributors tend to exaggerate the benefits of their particular unit. Refer to magazines such as Consumer's Reports™ to compare performance of different brands.

To improve effectiveness, place a portable air cleaner near the specific pollutant source, if one exists. Don't obstruct the air cleaner's inlet and outlet by placing them near walls, furniture, or other objects.

Ozone air cleaners not recommended

Some portable air cleaners are designed to generate ozone, an unstable and colourless gas with a pungent odour. Although high levels of ozone can be useful in water purification or to reduce smoke odours in an unoccupied home after a fire, they are a potent lung irritant. Despite some marketers' claim, there is a lack of scientific evidence that ozone air cleaners actually improve indoor air quality. It is recommended that portable ozone cleaners not be used in an occupied home.

Figure 12 • Sealing leaky ducts

Seal joints in duct work

Much of the air flowing through ducts may never reach its intended destination. You can improve the efficiency of the ducts by sealing joints with special tape.

Follow these guidelines for a proper job:

1. Seal joints in both the supply and return ducts to avoid unbalancing the airflow in the system.
2. Clean the surfaces to be sealed. Duct tape will not stick to dusty or oily surfaces.
3. Ensure that the joints fitted together and fastened with sheet-metal screws or rivets.
4. Seal the joints with a layer of aluminum-foil duct tape (see **Figure 12**). Apply a double thickness of duct tape for added durability. Consult a contractor about duct mastic.

Install better controls

A manual on/off switch is used to control most ventilation systems. Although inexpensive and simple to operate, it does not ensure that fans will be turned on and off when required. There are other manual and automatic control devices (see **Figure 13**) you can install to increase convenience and effectiveness of your ventilation system:

Illuminated switches provide a reminder about whether the ventilation system is actually turned on. This is particularly handy if the system is exceptionally quiet or for persons with a hearing impairment.

Adjustable and delayed-off timers allow you to set how long the ventilation system will run. Both mechanical and electronic timers are available. Operating times range from a few minutes to several hours.

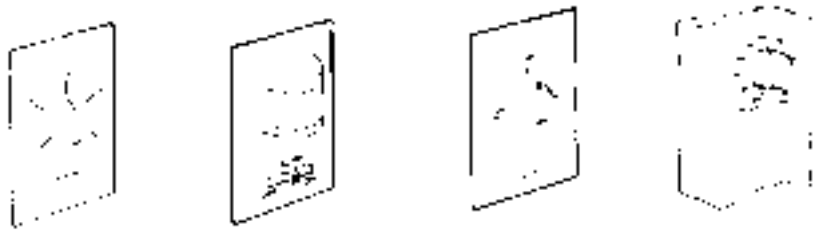
Time clocks can be used to control the ventilation system, based on the time of day or the day of the week. This can be convenient if your lifestyle follows a regular pattern. Look for time clocks with a "holiday" over-ride for increased flexibility.

Occupancy sensors automatically activate the ventilation system when they sense the presence of someone in the room. This is particularly convenient in bathrooms if family members always forget to turn on the exhaust fan.

Variable-speed switches can allow the speed of the ventilation system to be varied like a dimmer switch for a light to allow the system to switch between HI-LOW-OFF.

Dehumidistats turn on the ventilation system or activate its "high" speed when they sense the humidity in your home rises above a pre-set level. This setting should be reduced in cold weather to minimize window condensation, and turned to the "off" position in summer.

Figure 13 • Alternatives to an ON/OFF switch



Delayed-off timer | Occupancy sensor | Variable speed switch | Dehumidistat

Figure 14 • Choose exhaust fans with CSA and HVI labels

REPLACE NOISY OR INEFFECTIVE EXHAUST FANS

Better-quality fans usually consume less electricity and require less maintenance. They are often quieter and more likely to be used.

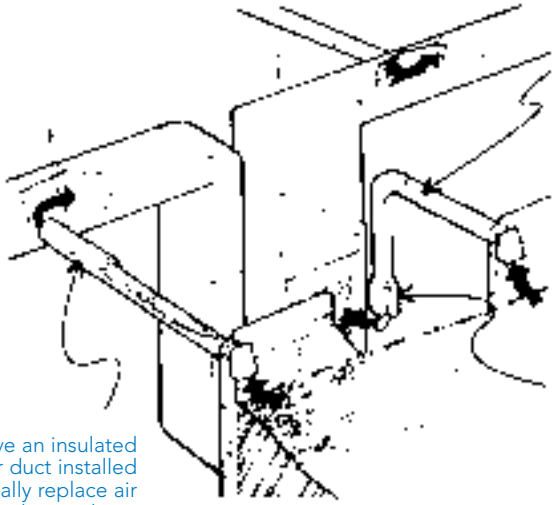
Look for fans that have a label from both the Canadian Standards Association (CSA) and the Home Ventilating Institute (HVI) (see **Figure 14**). The CSA label indicates that the fan complies with the Association's standards for electrical safety and protection against fire and personal injury. The HVI label means that the fan's quietness and ventilating performance has been tested and certified. This makes it easier to make accurate comparisons between different models or brands of fans.

The loudness of a fan is rated in "sones" (one sone is equivalent to the sound of a quiet refrigerator in a quiet kitchen). Sones follow a linear scale — a fan rated at 3 sones make half the sound of one rated at SIX sones.
Here are guidelines about fan loudness:

- Bathroom exhaust fans should have a sound rating of not more than 2.0 sones. Very quiet models are available with ratings as little as 0.3 to 0.5 sones.
- Kitchen exhaust fans should have a sound rating of not more than 3.5 sones. If this fan is to be used continuously rather than occasionally, the sound rating should not be more than 2.0 sones.
- Many older kitchen-range hood fans tend to be noisy. Most are rated between 4.5 and 8.0 sones.

Exhaust fans should be capable of moving as much air as required, but should not significantly exceed that requirement. Oversized fans can depressurize the house enough to interfere with the safe operation of combustion appliances (see **Install combustion air and fresh air intakes** next). Fan capacity is also influenced by the amount of ductwork and fittings against which air must be moved. Because there are so many variables, selecting the right fan capacity for your home is best left to a contractor with HRAI certification (see later in this booklet).

Figure 15 • Preventing backdrafting and spillage from a furnace



Have combustion air and fresh air intakes installed

Combustion appliances need an adequate supply of air to operate safely. This includes gas or oil-fired furnaces, boilers, water heaters and space heaters, as well as fireplaces and wood or pellet stoves.

Some high-efficiency combustion appliances draw their supply of air directly from outside. However, most combustion appliances draw air from the room or space they are in. In these cases, combustion air should be supplied by a dedicated duct from the outdoors (see **Figure 15**). Relying instead on cracks and unintentional openings in the exterior shell of a home to supply this combustion air, can result in poor performance and increase the risk of harmful combustion gases spilling into the living space.

It is an advantage to also have a fresh-air intake. This intake (see **Figure 15**) provides a convenient way to supply fresh outdoor air to a home while exhausting stale air from the home using fans, such as a kitchen-range hood, bathroom fan, clothes dryer, and central vacuum cleaner. The intake should be installed by a heating contractor certified by HRAI for mechanical system design and installation.

Booklet #6: Heating systems, identifies how to prevent or correct a backdrafting or spillage problem (contact Manitoba Hydro for a copy).

Options for a new ventilation system

This section reviews common options for installing a new ventilation system in an existing home. For detailed information about current standards for ventilation systems in new construction, contact CMHC for a copy of their booklet Complying with Residential Ventilation Requirements in the current edition of the National Building Code.

A ventilation system that is improperly designed or installed can harm your health and safety. Review the options presented in this section and then discuss them with a licensed contractor with expertise in ventilation systems. They may suggest other, less common ventilation solutions not presented in this booklet which may be more appropriate to your home.

General guidelines

There are several important factors to keep in mind in planning a new ventilation system for an existing home:

1. Consider the extent of the problem – The ventilation system options presented in this section are listed in order of increasing cost and effectiveness. The more serious your air quality or humidity problem is, the more likely you will need a more expensive system for effectiveness.

2. Control sources of pollutants and moisture first – Control of pollutants or moisture at the source is often the most effective and least costly method to improve indoor air quality and control humidity. This may also allow you to install a less costly ventilation system or reduce the costs to operate it.

3. Decide how long you will probably remain in your home – If you intend to sell your home soon, an improved ventilation system may be a selling feature. If you plan to own your own home for several more years, installing a quality ventilation system makes even more sense.

4. The design of your house will influence your choices – Homes with forced-air heating can use the heating ducts as a distribution system for ventilation. This makes a ventilation system simpler and less expensive to install. With a radiant, baseboard electric, or hot-water heating system, installing ducts for a ventilation system can be difficult and expensive (especially in homes with more than one storey or with finished basements).

Remember that ventilating your home can have a significant impact on your energy bills. These costs can be substantially reduced by installing a ventilation system that uses the heat of exhaust air to preheat incoming fresh air (see **Heat Recovery Ventilators** on page 35).

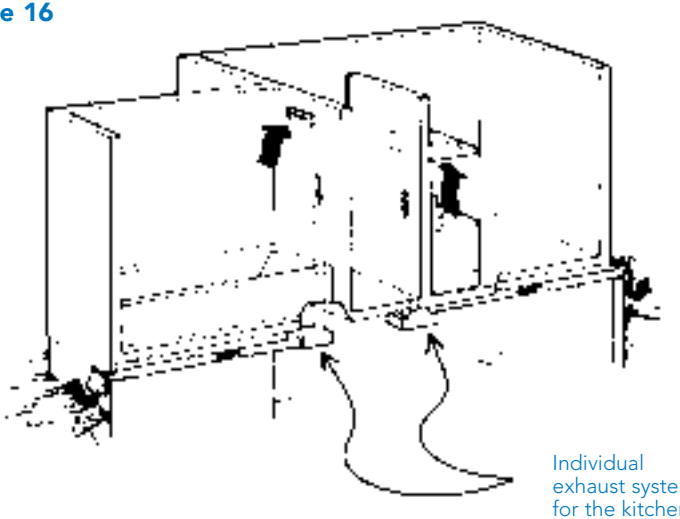
LOCAL EXHAUST SYSTEMS

These systems use individual exhaust fans to vent stale or humid air from the kitchen, bathrooms, and utility rooms directly to the outdoors (see **Figure 16**). **Fresh outdoor air to replace the air being exhausted is drawn through cracks and openings in the exterior of the home or through a fresh-air intake.**

Kitchen exhaust fans and the ducts that serve them are normally protected from grease build-up by a washable filter. A two-speed switch or a variable-speed control is commonly used to determine the ventilation rate.

Most bathroom exhaust fans have no filter and are controlled by a simple on-off switch, or are wired to operate whenever the bathroom light is turned on. Other control options include using a timer, occupancy sensor, or dehumidistat.

Figure 16



Individual exhaust systems for the kitchen, bathroom, etc.

Advantages

- low to moderate cost,
- simple to install on most homes,
- allows for spot ventilation of an individual source of pollution or humidity,
- little noise occurs in the room being ventilated if the exhaust fan is located in the basement or crawlspace.

Drawbacks

- Fresh outdoor air will enter the home to replace stale exhaust air through the easiest route. This may not be where the ventilation is needed most.
- The negative pressure created by these systems creates comfort problems and health concerns. Cold drafts during winter and the entry of radon and other solid gases year-round are increased. The risk that a gas heating system, oil-fired heating system, as well as fireplaces or wood stoves, will spill harmful combustion products into the living space is also increased.
- A fresh-air intake can be installed to reduce negative pressure concerns. However, this intake may need a heater to avoid comfort problems.
- The system can be noisy if the fan is mounted inside the wall or ceiling of the room being ventilated.

A central exhaust system typically uses a single, powerful exhaust fan located in the basement or crawlspace. Ducts lead from pickup points, such as the kitchen, bathroom, and utility room, to the fan (see **Figure 17**).

The fan exhausts stale or humid air from these rooms when it is started manually with an on-off or variable-speed switch or automatically by a timer, occupancy sensor or dehumidistat.

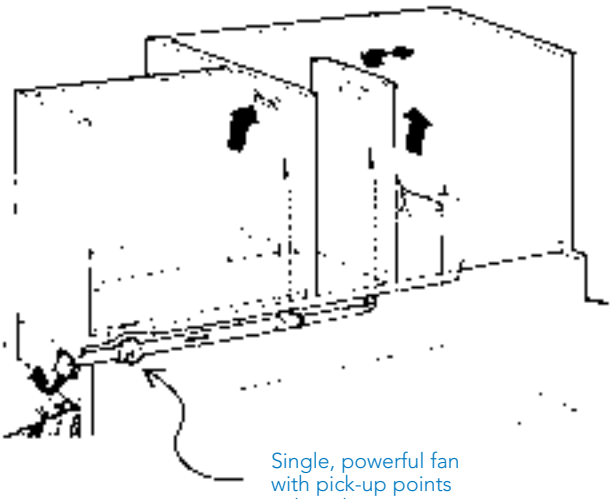
Advantages

- Moderate cost;
- Very little noise occurs in the living space if the central exhaust fan is located in the basement or crawlspace.

Drawbacks

- Central exhaust systems do not provide an even distribution of fresh outdoor air throughout the home;
- They tend to create an even larger negative pressure and related problems within the home than a local exhaust system;
- A fresh-air intake can be installed to reduce negative pressure concerns. However, this intake may need a fan heater to keep the system balanced and avoid comfort problems.

Figure 17



Heat-recovery ventilators

Heat-recovery ventilators, commonly called HRVs, are generally the most effective ventilation system. During winter, they reclaim most of the heat from stale exhaust air to preheat incoming fresh air. This allows for higher rates of ventilation with less waste of energy, compared with both local and central exhaust systems.

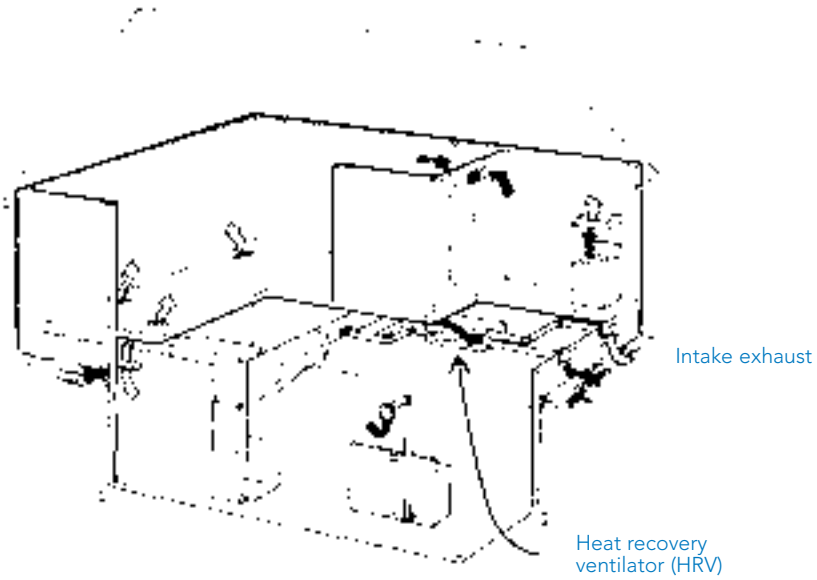
Figure 18 shows a typical HRV installation for a house with a forced-air heating system. A typical installation for a house with a radiant, baseboard electric or hot-water heating system is shown in **Figure 19**.

In summer, most HRVs are not effective because they do not dehumidify.

Advantages

- The balanced supply and exhaust airflows do not create a negative pressure within the home. This avoids the comfort and health concerns of local and central exhaust systems;
- The warmth from stale exhaust air tempers fresh outdoor air. This reduces comfort problems and reduces heating costs.

Figure 18 • HRV system for home with forced-air heating system (design may vary)

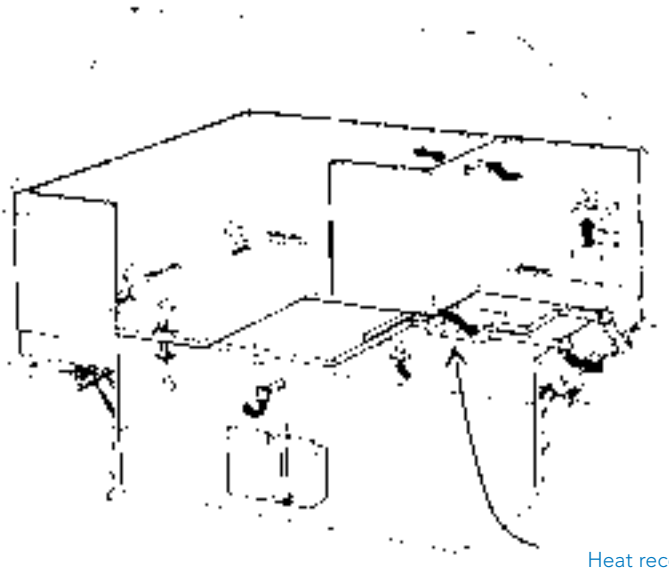


- The fans, heat exchanger, necessary controls, and filters are all in one unit. This simplifies installation.
- Provides continuous lowspeed ventilation.
- Can be switched to high speed to deal with a temporary odour, humidity, or other air-quality problems.

Drawbacks

- More expensive to install than a local or central exhaust system, especially in homes without a forced-air heating system.
- Requires additional maintenance, such as cleaning air filters and checking the condensate drain.
- With some models, the ventilation rate can be significantly reduced by the unit's need to occasionally defrost itself. The intake and exhaust airflows for some units become unbalanced during the defrost mode, causing a negative pressure within the house.
- Could distribute "cold feeling" air during extremely cold winter months.

Figure 19 • Fully ducted HRV system for home without forced-air heating system



How to get the help you need

Choose a contractor carefully. There is a wide variation in the ability of contractors to diagnose and solve indoor air quality and ventilation problems. Use this section to learn how to select and work with an experienced, reliable contractor.

Choosing an experienced and reliable contractor

How to find and select a contractor

Begin by compiling a list of potential contractors. Ask friends, relatives, or neighbours who have recently had work done in their home for recommendations. Be prepared to ask several people, since indoor air quality and ventilation retrofits are not common.

Another option is to select contractors from the Yellow Pages™ or from newspaper, radio, television or direct-mail ads. If you use this method, be selective. It is usually better to choose contractors who promote the quality of their service and products at reasonable rates rather than just low prices.

Where to look in the Yellow Pages™

Many home heating contractors also service and install ventilation equipment. Refer to Heating Contractors in the Winnipeg and Manitoba editions of the Yellow Pages™ for a listing of these companies. Although there is also a heading Ventilating Contractors, the companies in this section of the Yellow Pages usually prefer to work on the commercial buildings rather than homes.

If you want someone to test the air quality in your home, indoor air quality specialists can be found under the heading Environmental Consultants in the Yellow Pages™.

Look for ventilation contractors that are certified by the Heating, Refrigeration and Air Conditioning Contractors of Canada (HRAC) to design and install ventilation systems. HRAI is an industry association that trains and certifies contractors that design and install residential ventilation systems. HRAI also offers an arbitration service should a dispute arise between you and HRAI certified designer or installer.

If radon levels in your home are above the Canadian guideline, Health Canada recommends that you hire a professional contractor certified under the Canadian National Radon Proficiency Program (C-NRPP). To find a certified mitigator, contact the C-NRPP at 1-855-722-6777 or info@c-nrpp.ca, the Canadian Association of Radon Scientists and Technologists (CARST) at info@carst.ca or Health Canada at radon@hc-sc.gc.ca.

After you have compiled a list of contractors, consider contacting the Better Business Bureau (BBB) to inquire about their reputations. Note that not all contractors are members of the BBB and that membership itself does not guarantee high-quality work.

If you are approached by a door-to-door salesperson, exercise extra caution. Reputable indoor air-quality or ventilation contractors rarely use this method in Manitoba.

Ask to see their direct seller's license issued by the Manitoba Consumers' Bureau. Read the license carefully and check the date to see that it is still valid. Write down the name, address and telephone number of the company being represented and the name of the salesperson.

To verify that a company operating door-to-door is properly licensed and bonded, contact the Consumer Protection Office.

What an estimate should say

If you are hiring a contractor for routine servicing, a written estimate is not necessary. You should, however, ask for a list of the tasks the contractor will perform during the service call.

If you are having your ventilation system upgrade or a new one installed, a written estimate is strongly recommended.

Important information that should appear in the contractor's written estimate includes:

- the name, street address and telephone number of the contractor;
- the cost and details of equipment or materials to be used (e.g. brand name, model number, size or capacity, etc.);
- the total cost, including all applicable taxes and permit fees;
- the estimated starting and completion dates for the work;

- a statement that the contractor carries liability insurance and Workers Compensation Board coverage that protects you if someone is injured or property is damaged while the work is being carried out;
- responsibility placed on the contractor for cleanup upon completion of the work;
- details of warranties or guarantees;
- a description of what you are expected to do (e.g., make the work area accessible); and
- a statement that the contractor will demonstrate how to operate and maintain the ventilation system and provide any owner's manuals.

When you evaluate proposals from contractors, the lowest price may not be your best choice. Make sure the quotes you receive cover the same work. If the proposed work differs, ask the contractors to explain why.

An unusually low quote may simply mean that the contractor has made a mistake or does not know enough about the work to estimate properly. In these cases, the contractor may cut corners or add unjustified extras to the bill to avoid losing money. In extreme cases, the contractor may simply abandon the job.

To be fair to contractors, avoid asking too many of them to bid. For most jobs, at least two but not more than four or five bids is reasonable.

Signing the contract

The next step is to ask for the contractor you select to prepare a contract based on their estimate or proposal.

Do not sign the contract until you have read it carefully. Never sign an incomplete contract. Check all standard terms and conditions — read the fine print. Cross out and initial any standard terms which you are not willing to accept. Make sure that everything in the contract matches the original estimate or proposal.

If you sign a contract with a licensed door-to-door salesperson, you have the right to change your mind and cancel the contract within seven days (see **Figure 20**). This excludes the day you sign, Sunday, and statutory holidays.

Figure 20

If you sign a contract with a licensed door-to-door salesperson, you have the right to change your mind and cancel the contract within seven days. This excludes the day you sign, Sunday and statutory holidays

You can cancel the contract by:

- fax,
- certified letter,
- registered letter, or
- delivering a written letter of cancellation in person.

Door-to-door sellers must provide you with written information about your right to cancel a direct sales contract. Upon cancellation, the company must return any deposits. For further information on your cancellation rights, contact the Consumer Protection Office.

Paying for the work

A deposit normally is not required for routine service or repair work. However, if your contractor has to order special equipment or materials, a nominal deposit to show your "good faith" may be requested.

Since most work on ventilation systems takes no more than a day or two, usually only one payment is usually required. However, it is common practice to make interim payments on larger jobs. In these instances, pay only for the work that has been completed.

For major jobs, you have the right to withhold some money from all payments to protect yourself against liens. Suppliers or workers who were not paid by your contractor can place a lien on your home. The lien holds your property as security for the contractor's debts, even if you paid the contractor in full.

In Manitoba, the law limits your liability to 7.5 per cent of the contract price. The correct procedure is to withhold this amount from all payments for 40 days. This period is the time limit that creditors have to place a lien on your property.

Do not make a final payment or sign anything that releases the contractor from further responsibility until everything promised in your contract is done. It is advisable to pay down payments, interim, or final payments by cheque rather than cash. This will give you a record of the transaction.
For added protection, ask the contractor for a signed receipt when you make any payments.

How to handle problems with your contractor

If you have a disagreement with your contractor, carefully review your contract. Listen to what the contractor has to say and be reasonable. If you remain dissatisfied, seek another opinion before taking action. Contact the Consumer Protection Office for advice at 204-945-3800 (Winnipeg), toll-free at 1-800-782-0067 or e-mail consumers@gov.mb.ca

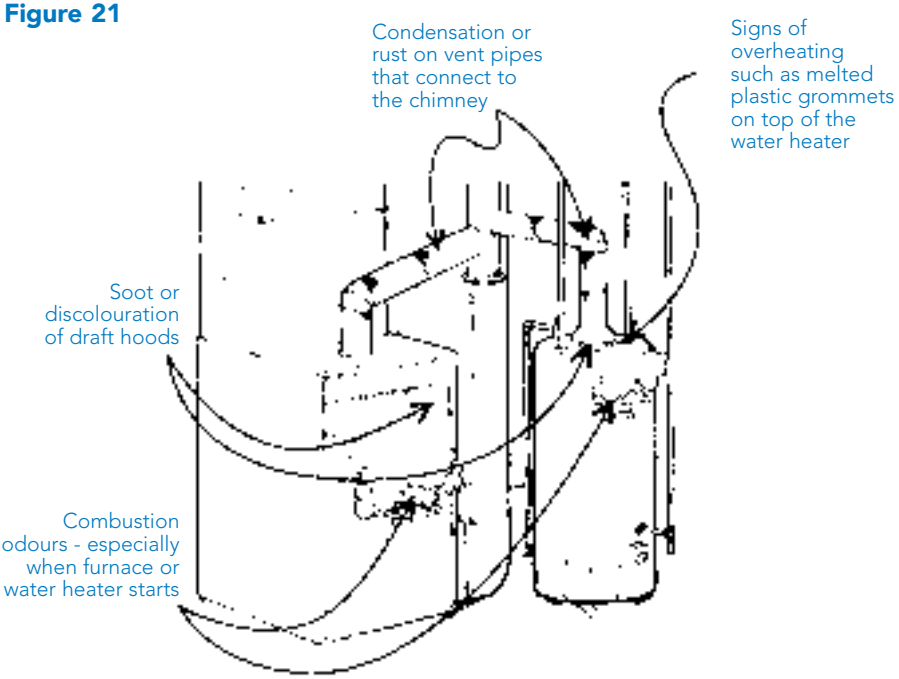
Appendices

Appendix 1
Indicators of backdrafting or a spillage problem

Combustion gases from fuel-burning heating equipment can sometimes escape into a home rather than go up the chimney (see **Figure 21**). This situation is called either back drafting or spillage. Regardless of the name, it can be a serious health and safety concern.

For details on why back drafting occurs, how to recognize it, and what to do about it, see **Booklet #6: Heating systems**.

Figure 21



Appendix 2
Calibrating your hygrometer

To be confident that your hygrometer is accurate, calibrate it at least once a year. Follow these simple procedures developed by CMHC.

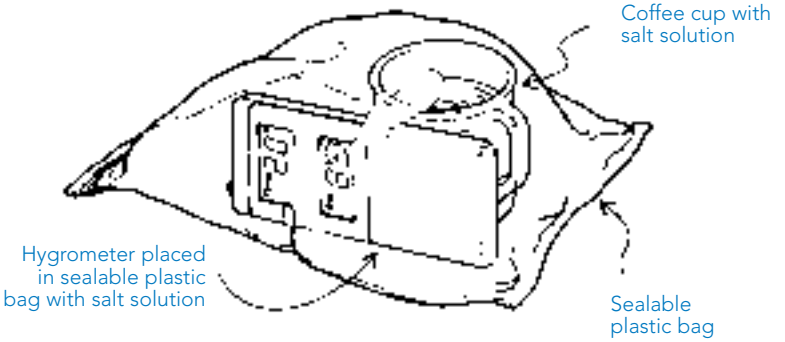
Step 1: If your hygrometer has a pointer, look for a screw or knob that moves the pointer. If there is none, or if you have an electronic hygrometer with a digital readout, adjustment will not be possible. However, you can still calibrate.

Step 2: Pour 50 ml (about 1/4 cup) of tap water and 125 ml (about 1/2 cup) of table salt into a coffee cup and stir for about one minute. Seal the coffee cup and hygrometer in a large, clear plastic bag (see **Figure 22**) in a place that is draft-free, out of direct sunlight, and where the room temperature will remain even. To avoid damage, do not splash the salt-water solution on the hygrometer.

Step 3: After at least eight hours, note your hygrometer's relative humidity reading. It should read about 75 per cent. If it does, no adjustment is needed. If the hygrometer doesn't read 75 per cent record the difference.

Step 4: If your hygrometer is adjustable, immediately adjust the reading to 75 per cent. If your hygrometer cannot be adjusted, use the difference recorded in Step 3 to add or subtract each time you take a future reading.

Figure 22 • Method for calibrating your hygrometer



Metric Conversion Factors

A. Converting Imperial Units into Metric Units

Unit	Conversion	Multiply By
Thermal Resistance	R values to RSI values	0.1761
Length	inches to millimetres inches to centimetres feet to metres	25.40 2.540 0.3048
Area	square feet to square metres	0.09290
Volume	gallons to litres cubic feet to cubic metres	4.546 0.02832
Mass	pounds to kilograms	0.4536
Density	pounds/cubic feet to kilograms/cubic metre	16.02

B. Converting Metric Units into Imperial Units

Unit	Conversion	Multiply By
Thermal Resistance	RSI values to R values	5.678
Length	millimetres to inches centimetres to inches metres to feet	0.03937 0.3937 3.281
Area	square metres to square feet	10.76
Volume	litres to gallons cubic metres to cubic feet	0.2200 35.31
Mass	kilograms to pounds	2.205
Density	kilograms/cubic metre to pounds/cubic foot	0.06243

If you are uncertain of, or have any question or concern regarding, any subject matter herein or the safety and/or proper handling of any material(s) and/or product(s) that you may encounter in your undertaking, please consult resources such as Health Canada (Health Links) @ 1-888-315-9257, the Manitoba Department of Labour @ 1-800-282-8069,
or (Canada Mortgage & Housing Corp.) @ 1-800-668-2642.

Cette information est également disponible en français.

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