

5

POWER SMART GUIDE:
Energy saving solutions for home comfort

Doors and windows



 **Manitoba
Hydro**
POWER SMART[®]

*Manitoba Hydro is a licensee of the Trademark and Official Mark.

For more information on Power Smart:

Telephone: 204-480-5900 in Winnipeg

Toll-Free: 1 888 MBHYDRO (1-888-624-9376)

Or visit hydro.mb.ca

Publications in this series

- ① Sealing, caulking & weatherstripping
- ② Basement & crawlspace insulation
- ③ Attic insulation
- ④ Wall insulation
- ⑤ Doors & windows
- ⑥ Heating systems
- ⑦ Water heaters
- ⑧ Indoor air quality & ventilation
- ⑨ Energy saving tips



BOOKLET #5

Doors & windows

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 doors or windows 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.

Contents

Introduction

Why retrofit?	3
Do it yourself or hire a contractor	3

Doors

Assessing your doors	4
Upgrading an existing door	5
Replacing a door	11
Adding a storm door	12

Windows

Assessing your windows	13
Window condensation	13
• Relative humidity and condensation	13
• Sources of moisture	14
• Recommended humidity levels	15
• Reducing condensation	16
Upgrading existing windows	17
• Repair deteriorated windows	17
• Caulk and weatherstrip	18
• Install storm windows	27
• Upgrade window glazing	29
• Methods of sun control	30
Replacing existing windows	30
• Full frame or box unit	30
• Window styles	31
• Glazing options	31
• Low-e coatings	31
• Spacer bars	32
• Frame and sash materials	32
• Air space gas fill	33
• Weatherstripping	34
• ENERGY STAR® symbol	35
• Climate zones	36

Tables

Table 1 — Weatherstripping materials	39
Table 2 — Weatherstripping for door bottoms	42
Table 3 — Glazing type vs. relative heat loss	43
Table 4 — Sources of moisture	44
Table 5 — Comparison of common window styles	44

Introduction

Why retrofit?

Save money — Heating a home, especially in our climate, can be expensive. Exterior doors and windows that are in poor condition can add needlessly to your home's heating bills.

Increase comfort — A proper job of retrofitting your home's doors and windows will keep out cold winter drafts, make your home more comfortable, and may reduce or eliminate condensation.

Conserve energy — Approximately 13 per cent of Manitoba's annual energy use goes to heat our homes. Much of that energy can and should be saved. Retrofitting your home will help save our valuable energy resources at a cost lower than producing new energy supplies.

In addition to these major benefits, a well-executed door and window retrofit can improve the appearance and value of your home.

Do-it-yourself or hire a contractor

This booklet has been designed to meet the needs of both the experienced and the inexperienced “do-it-yourself-er”. Much of the work described can be done by a homeowner with common household tools. By doing it yourself, both the savings and job satisfaction can be high. Please read this booklet carefully. For additional help, please contact us (see inside front cover) or your local door and window supplier.

If you intend to have a contractor do some or all of the work, this booklet will still be of interest to you. You are more likely to get the results you want if you are knowledgeable about the work and take an active interest in what the contractor does. For further information on how to hire a contractor, call the Consumer Protection Office at (204) 945-3800 (Winnipeg), 1-800-782-0067 or email consumersbureau@gov.mb.ca.

Whether you do it yourself or hire a contractor, please remember that this booklet does not describe every possible technique for retrofitting or replacing a door or window. *Each home is unique, and you or your contractor may find it necessary or desirable to use techniques that are not shown in this booklet.*

Doors

Assessing your doors

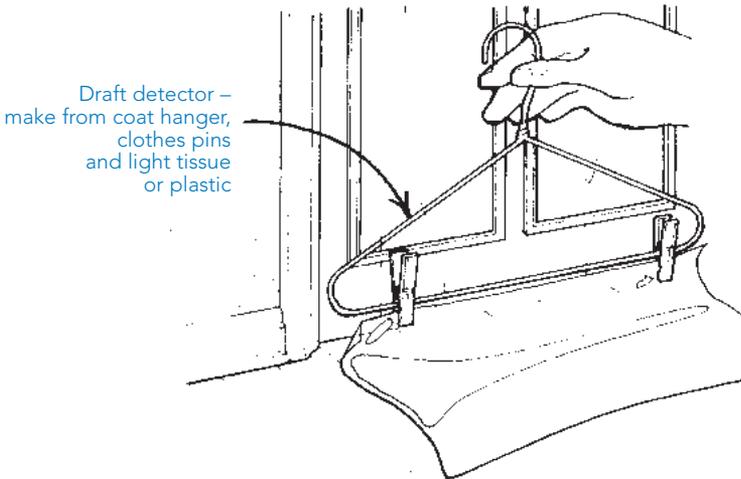
Carefully assess the condition of your home's exterior doors to determine whether they should be upgraded or replaced.

Examine the door for ease of operation, loose structural joints, loose panes of glass, excessive warpage or rot. Make a draft detector as shown in **Figure 1** to check for air leaks. As an alternative, smoke pencils specially designed to identify leaks and drafts are commercially available. If the door is in reasonable condition, it will be far more cost-effective to repair any defects and seal the door against air leakage than to replace it with a new unit.

If a door is in very poor condition, and it is not feasible to repair it, replace it with a new unit. Even if the existing door can be repaired, you may want to replace it anyway to improve the appearance and security of your home.

If the door does not have a storm door, it is recommended that one be added. The storm door will protect the main door from weather effects in winter and, if equipped with a screened, sliding window, serve as a ventilation opening in summer.

Figure 1

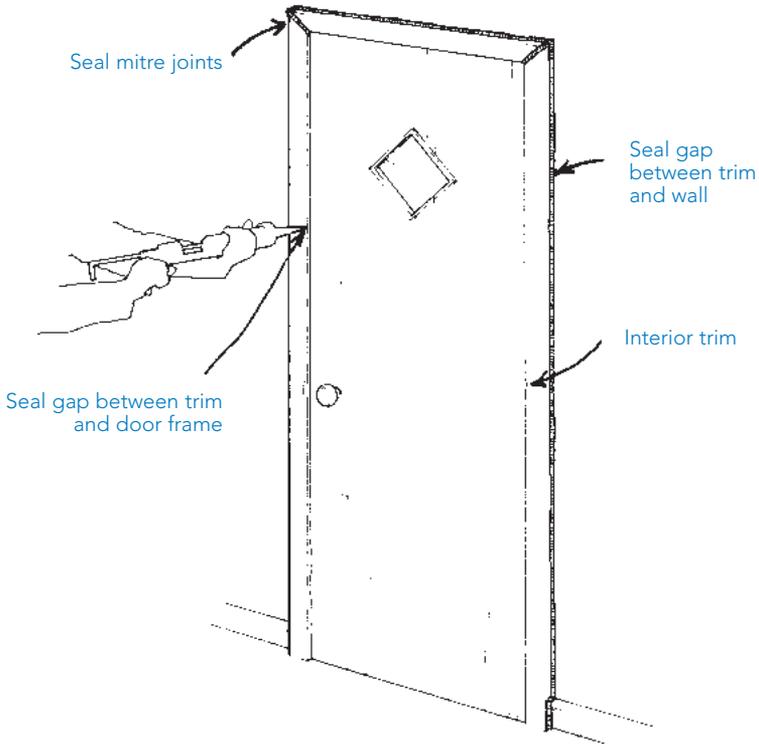


Upgrading an existing door

Significant heat loss and discomfort from doors is caused by air leakage. Use the following methods to reduce air leakage:

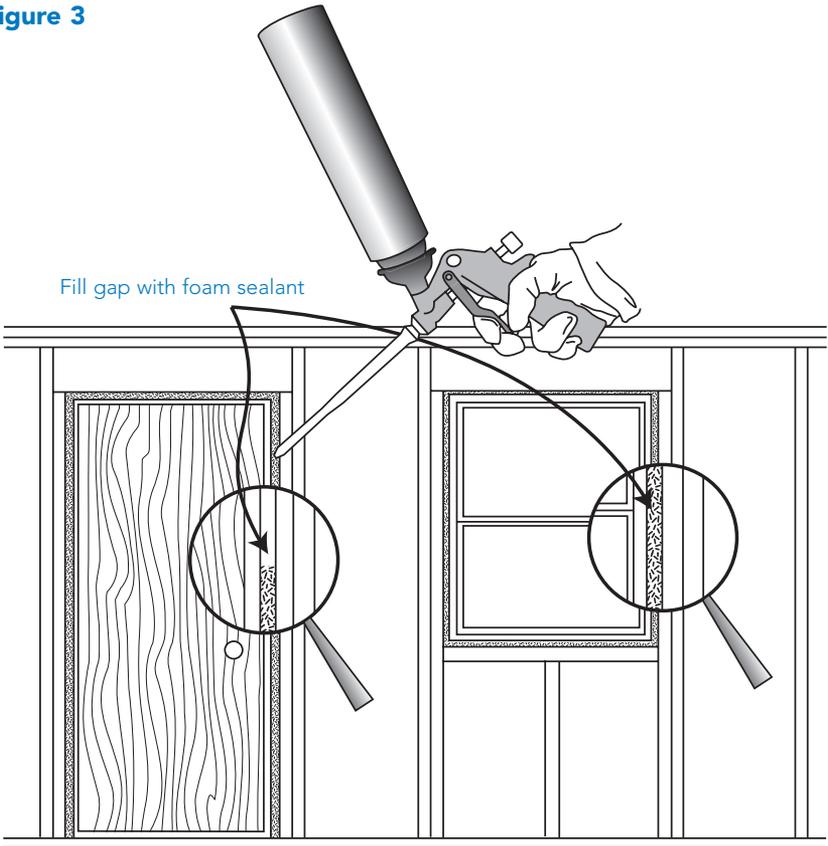
Interior trim — Run a continuous bead of clear or paintable caulk along the gap between the trim and wall, as shown in **Figure 2**. Similarly, run a bead along any gap between the trim and door frame and the trim mitre joints. Since door frames and trim are subjected to considerable vibration from repeated opening and closing of the door, use only high quality sealants.

Figure 2



It is also possible to seal behind the trim, if the previous technique is unacceptable on aesthetic grounds. Carefully remove the trim and caulk the gap. Larger gaps can be sealed with single component foam. Take care to allow for expansion of the foam and trim the excess foam, if necessary.

Figure 3



Gaps in doors — There can be a significant amount of air leakage through the door itself. Repair and seal loose structural joints in the door. Seal any loose panes of glass in the door (see page 18).

Air leakage can also occur through hardware in the door including the door knob, lock, and mail slot. Where practical, seal these components.

Jambs — The width of a gap between the door and the jambs or frame can vary considerably around the door. The gap may also vary from season to season due to warpage of the door and settlement of the house.

It is important to select weatherstripping that can accommodate this movement without requiring excessive force to close the door. It is also important that the weatherstripping not become rigid and ineffective at low temperatures. The most common jamb weatherstripping consists of a polyclad foam, mounted on a vinyl, wood, or aluminum carrier. The weatherstripping is flexible to create a tight seal, even if the gap between the door and frame varies.

Various options for weatherstripping the gap between the door and the jambs are described in **Table 1** on page 39 and illustrated in **Figure 4**. If the door is fitted with custom-made weatherstripping, try to obtain a replacement set from a weatherstripping supplier or the door manufacturer.

If you sand or plane the edge of a wooden door to accommodate new weatherstripping, refinish the edge to match the rest of the door. This will often reduce the amount of warpage the door will undergo due to changes in humidity.

Sills — The gap between the bottom of the door and the sill can be weatherstripped with a threshold seal, door bottom seal, or a sweep. Different types of commonly available weatherstripping, suitable for door bottoms, are described in **Table 2** on page 42, and illustrated in **Figure 5** on page 9.

If the gasket in an existing threshold seal is worn out, try to purchase and install a new insert. If the whole threshold seal must be replaced, select one with replaceable gaskets and good resistance to the damaging effects of steady pedestrian traffic. Also give preference to a threshold seal that does not require trimming the door.

Door bottom seals or sweeps are usually installed on doors with no existing bottom weatherstripping. Use door bottom seals or sweeps that can be adjusted to compensate for wear and movement.

Figure 4

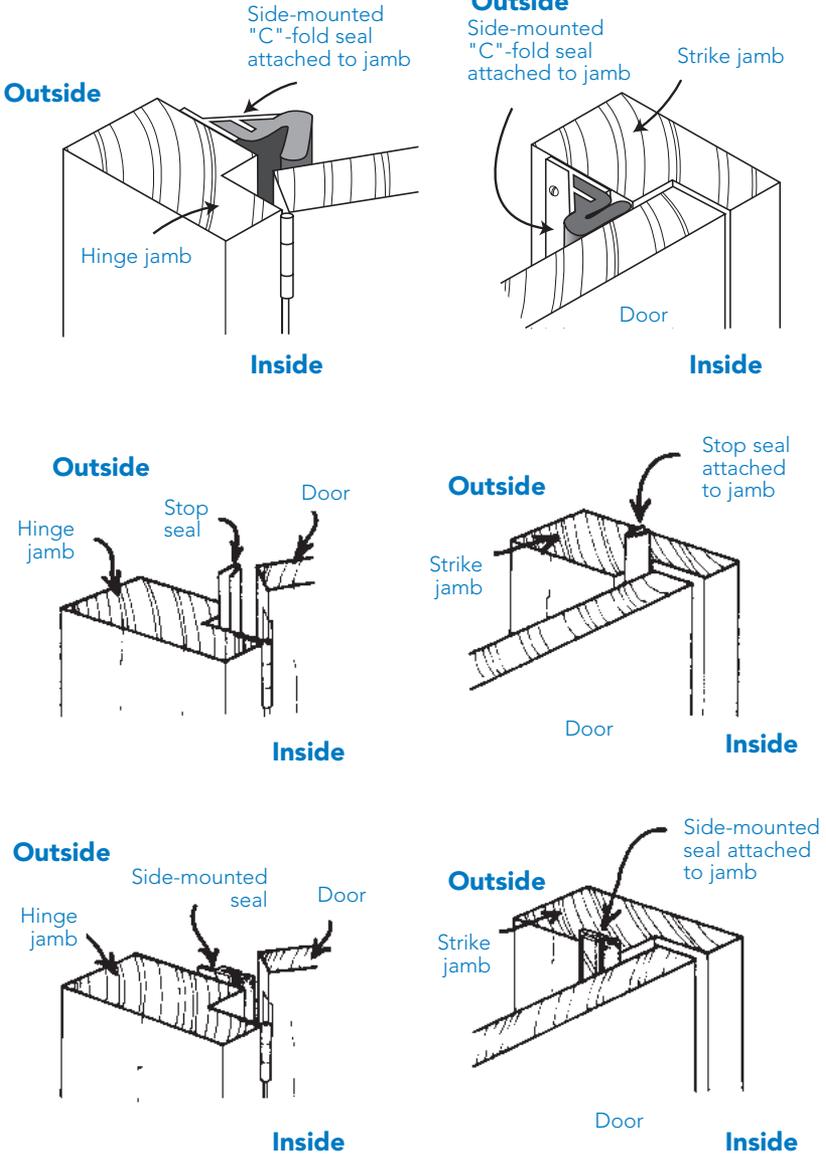
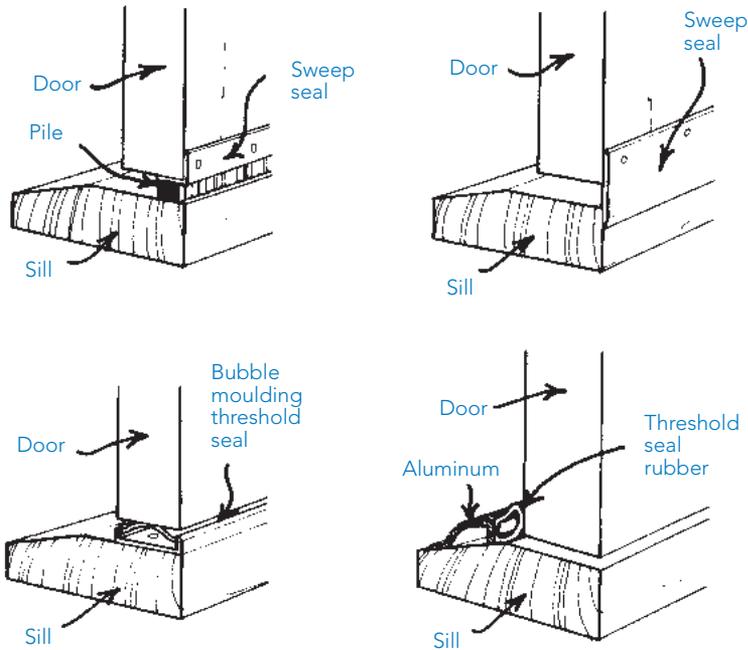


Figure 5



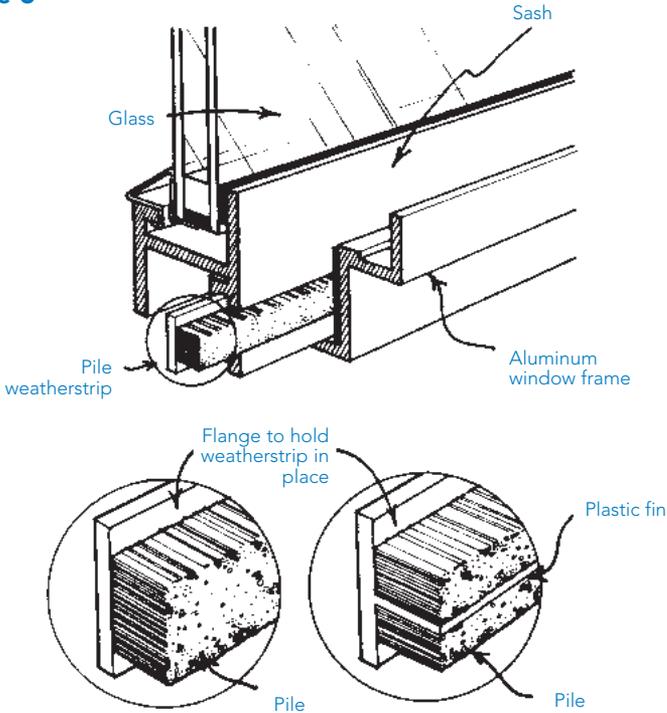
Sliding doors — Most sliding doors are supplied with pile weatherstripping. The pile is normally held in place by a flange that is inserted in a slot or groove in the sash or track as illustrated in **Figure 6**. Remove the existing weatherstripping by pushing a screwdriver blade under the weatherstripping at a corner. Beginning with this free edge, use pliers to pull out the full strip.

To obtain the proper size of replacement weatherstripping, take a sample to a weatherstripping supplier or the door manufacturer. Cut the replacement pile weatherstrip with mitred corners to ensure a close fit at the corners. Snap or slide the weatherstrip into place.

Because there are so many types of sliding doors, some innovation may be required by the homeowner. For example, sliding doors which cannot be properly weatherstripped can be sealed with “seal-and-peel” caulking or weatherstripping tape that is applied in the fall and removed in the spring.

Some types of patio doors require special weatherstripping and installation tools. In these cases, it is advisable to have the work done by a specialist who is familiar with the particular door type.

Figure 6



Storm doors — Weatherstripping work should be concentrated on the main doors, leaving the storm doors as unsealed units. This will prevent moist house air from being trapped between the storm and main door which can cause condensation build-up on the storm door.

If both the storm and main doors are tight, an airlock is created making it difficult to properly close either door. Sealing both doors also creates the potential for another problem if the storm door is mostly glass and faces south or west. In these cases, direct sunlight may cause the space between the storm door and main door to overheat. This can damage any decorative plastic mouldings on the main door or cause the main door to bow excessively. Overheating is especially a problem when the main door is painted a dark colour.

Leaving the storm doors unsealed has a low heat loss penalty. The principal functions of a storm door are to protect the main door from weather effects in winter and to serve as a ventilation opening in summer.

Replacing a door

If the existing door is beyond repair, or just looking old and tired, it may be time to replace the door. The door (and frame) is made up of many components, providing almost limitless options. Following is a brief overview of door components.

Door slab – This is the biggest component of the opening. Historically, doors were made of solid wood, however, doors with an insulated core are more common and provide better thermal resistance than a wood door. The core material is typically a polystyrene or polyurethane insulation. This insulation is usually contained within a wood frame, and then covered with a steel or fiberglass skin. Using an embossed finish and stain, these doors can look very similar to wood doors. The most common considerations for a door are aesthetics and security, and this usually comes down to personal preference. It is impossible to determine the thermal performance (U-Factor) of a door simply by looking at it. Performance data is available for most doors, and this is explained at the end of this section.

Door frame – Door frames provide the transition between the door slab and the wall framing. The frames can be made of wood, wood composites, metal, fiberglass or PVC, and may be wrapped, clad or stained/painted with a finish material. Once again, aesthetics and security play a major role, but the thermal performance of these frames also varies.

Weatherstripping – The purpose of the weatherstripping is to reduce air leakage between the fixed frame and the operable door slab. Since most materials are affected by temperature and moisture, the weatherstripping should allow for movement between the door and the frame and still seal tightly. The weatherstripping is subject to a lot of wear and tear, and should be readily available and easily replaceable.

Glazing Insert – Glazing inserts have gained popularity in recent years. Aside from being a decorative addition to the door, they provide practical aspects such as visibility and natural daylighting, and in some cases, openings for ventilation. With advances in glass technology, the glazing inserts do not necessarily reduce the overall thermal performance of the door. Since the insert is essentially a window in a door, more details are included in the window section. In some door types, glazing inserts are installed separately, and can be easily removed for repair or replacement, while in some cases the inserts are manufactured into the door and can therefore not be easily replaced if the glass is broken.

Hardware – The primary function of door hardware is to allow the door to operate easily and provide security when the door is closed. There are numerous options for locks, including single-point, deadbolt, multi-point locks and cam locks. Your door supplier will be able to provide options and benefits of the various lock types. In all cases, the locking mechanism should hold the door tightly against the weatherstripping.

Thermal performance of doors – With all the door options available, a universal rating system is required to compare different doors. While R-value (thermal resistance) has been used in the past, it generally refers to the insulation value at the centre of the door, which is not representative of the entire door assembly. Energy efficiency ratings and manufacturer literature now commonly use a term called ‘U-factor’. U is the symbol for conductivity, and is the inverse (or opposite) of R, the symbol for resistance. This means that a lower U-factor equates to a higher R-value, or a higher performance door. The U-factor includes all aspects of the door, and is therefore a better representation of overall thermal performance.

Adding a storm door

If adding or replacing a storm door, select a unit with a screened, sliding window so that it can be used for ventilation in warm weather. The window need only be single-pane.

Follow the recommendations previously discussed regarding leaving the storm door as an unsealed unit.

Windows

Assessing your windows

The condition of your home's windows should be carefully assessed to determine whether they should be upgraded or replaced.

Check windows for ease of operation. Note whether the windows have any defects such as loose structural joints, loose or broken panes of glass, excessive warpage, rot, or faulty hardware. Make a draft detector as shown in **Figure 1** to check for air leaks. An alternative is to use smoke from an incense stick as your indicator. *If the windows are in reasonable condition, it will be far more cost-effective to repair any defects and upgrade the windows with caulking and weatherstripping than to replace them with new units.*

If the windows are in very poor condition, and it is not feasible to repair them, replace them with new units. Even if the existing windows can be upgraded, you may want to replace them anyway for a variety of reasons (e.g. improved appearance, less maintenance, ease of operation, etc.).

If the existing windows are single-pane, the addition of permanent or seasonal storm windows will be a good investment. The heat loss through the glazing of the windows will be cut approximately in half (see **Table 3** on page 43). The storm windows will also make your home more comfortable by reducing drafts and increasing the temperature of the windows, which would otherwise produce a cold feeling. An added benefit is that condensation problems will be significantly reduced due to the increased temperature of the inner pane of glass.

The benefits of adding a storm window to a dual-pane window are much more modest. Only inexpensive, seasonal storm windows will have a good payback in terms of energy savings. More expensive, permanent storms usually have long paybacks but may still be desirable to install if you have significant condensation or comfort problems with your existing dual-pane windows.

Window condensation

Condensation is one of the most common problems with windows. This section describes what causes condensation and what can be done to reduce it.

Relative humidity and condensation

Relative humidity is a measure of how much moisture there is in the air compared to how much moisture the air is capable of holding. If the air in

your house contains only half as much moisture as it is capable of holding, it has a relative humidity of 50 per cent.

Warm air can hold more moisture than cold air. For example, air at 20°C (68°F) can hold approximately nine times as much moisture as air at -10°C (14°F).

When air is cooled to the point where it cannot hold any more moisture, the relative humidity is 100 per cent and the air is said to be saturated. Any further drop in temperature will cause some of the moisture to condense. Whether the condensation forms as water droplets or frost will depend on whether the temperature is above or below freezing. The inside surface temperature of windows is usually lower than the surrounding walls, and therefore condensation will form on the windows first.

Sources of moisture

Normal household activity is the principal source of water vapour or moisture in most houses. **Table 4** on page 44 shows typical amounts of moisture generated by a family of four.

The amount of moisture produced can be much higher than shown in **Table 4** if the house contains a gas cooktop or stove, pets, plants, aquarium, exposed earth floor in the crawlspace or basement, or an unvented kerosene heater.

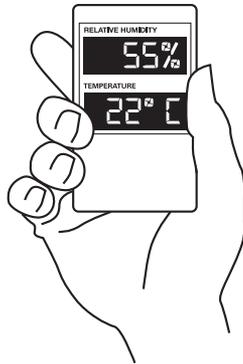
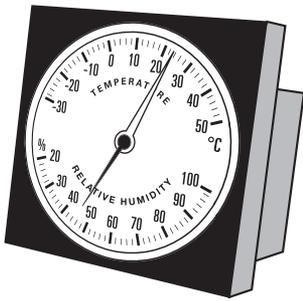
Seasonal storage of moisture in a house can also contribute to a condensation problem. During warm, humid summer weather, the moisture content of the various construction materials and furnishings inside a house increases. When winter arrives, this added moisture is released into the house air. In fact, a substantial portion of this stored moisture can be released quickly in the fall, when the outdoor temperatures fall rapidly. This is one of the major causes of condensation problems at this time of year.

Condensation problems also tend to be the worst within the first year or two after a house has been constructed. The concrete, lumber, and other construction materials in a newly built house contain significant amounts of moisture. As these materials cure and dry out, the moisture released can contribute to high humidity levels and condensation problems if the home is not adequately ventilated.

Recommended humidity levels

Indoor humidity levels will vary from season to season and there are many factors to consider when making decisions about the relative humidity (RH) in your home. For comfort and health, the minimum recommended RH is in the range of 30 to 35 per cent during the heating season. Even in this range, you may be faced with excessive fogging, sweating, or frosting of older windows in your home. If your windows cannot sustain this level of humidity, you may want to upgrade or replace them. Low humidity levels can result in static electricity, dust, and dryness of the skin and throat.

The relative humidity in your home can be monitored with an instrument called a hygrometer (a moisture meter). In many cases, hygrometers and room thermometers are combined into a single piece of equipment. Mechanical or electronic hygrometers are available at electronics, department or building supply stores. Unfortunately, these devices can be inaccurate unless they have been properly calibrated. A simple calibration method can be found by searching “hygrometer calibration” on the Canada Mortgage and Housing Corporation (CMHC) website at cmhc-schl.gc.ca.



Reducing condensation

When trying to solve a window condensation problem, always try the simple no-cost or low-cost steps first. If they do not work, then try the more complex and costly solutions.

Steps to reduce condensation problems include:

Reduce amount of moisture produced

- If the furnace is equipped with a humidifier or if you operate a separate humidifier, turn it down or off until the condensation is reduced;
- Cover cooking pots to reduce steam;
- Don't hang clothes indoors to dry;
- Vent the clothes dryer to the outdoors;
- 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. (details can be found in Book #2: Basement and crawlspace insulation).

Improve air circulation

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

Increase ventilation

- Use the kitchen exhaust fan while cooking and the bathroom exhaust fan while bathing. The fans should be vented to the outdoors;
- Briefly open windows or exterior doors to reduce localized condensation.

Upgrade windows

- Condensation on single or dual-pane windows can be greatly reduced by installing storm windows as described on page 27. A more costly solution is to replace the window with a new, more energy-efficient unit (see page 30)
- Condensation between a storm unit and a window is an air leakage problem and can be reduced with proper caulking and weatherstripping (see **figure 8**). An interior storm window should be more tightly sealed against air leakage than the window it covers. With an exterior storm, the main window should be more tightly sealed than the storm. This will prevent warm, moist air from the house being trapped between the main window and the storm causing condensation to build up.
- Condensation inside a window that has a factory sealed glazing unit indicates a compromised seal. In this case, the only solution is to replace the sealed unit. Most sealed units are guaranteed against seal failure for at least five years — check with the manufacturer regarding their replacement policy.

If you install storm windows or new energy-efficient windows, the humidity level in your home during winter will probably rise. This is because the storm or new windows will allow less warm, moist air from the house to escape and be replaced by cold, dry outdoor air. If the air in your home was too dry, the increased humidity resulting from upgrading the windows will probably improve your comfort.

However, if the humidity level was already too high, you may still see condensation after improving the windows. In this case, reduce the amount of moisture produced in the home, improve air circulation, and increase the ventilation as previously described.

A dehumidifier will reduce the amount of moisture in the air, thereby lowering the relative humidity.

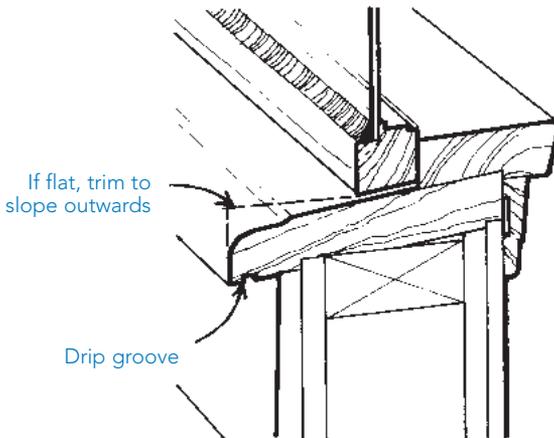
Upgrading existing windows

Repair deteriorated windows

Water is the major cause of deterioration in most windows, especially wood windows. It is important to eliminate causes of water damage before repairing the window.

Examine the sill. It should slope away from the window, allowing water to drain off. If the bottom of the sill is flat, a drip groove can be cut as shown in **Figure 7** to ensure proper runoff.

Figure 7



Check the wood for decay, especially where the paint is cracked or chipped. If the decay is not extensive, the area can be dried and damaged wood replaced with epoxy resin filler.

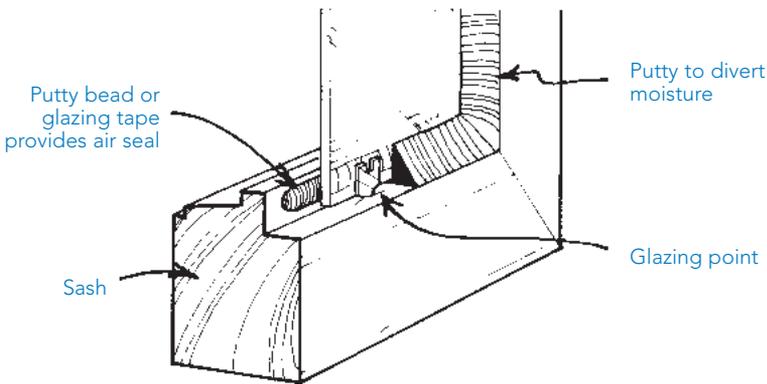
If the window has loose or broken panes of glass, remove the existing putty, the glazing points, the glass and any putty behind the glass. Apply a bead of putty or glazing tape to form a bed for the glass as shown in **Figure 8**. Press the glass into the bed and secure with glazing points. Fill the outside edge of the glass with a beveled layer of putty to seal against water penetration. Finally, trim off any excess putty that has been squeezed out on the reverse side of the glass.

When repainting the window, first remove excess layers of paint that make the window difficult to operate. Caulk and weatherstrip the window and repair or replace any defective hardware. Apply a primer to any bare areas of wood and paint the window with good quality latex or oil-based paint that is compatible with the type currently used on the window.

Caulk and weatherstrip

Excessive air leakage can add considerably to the heat loss from windows. Use the following methods to reduce this air leakage:

Figure 8

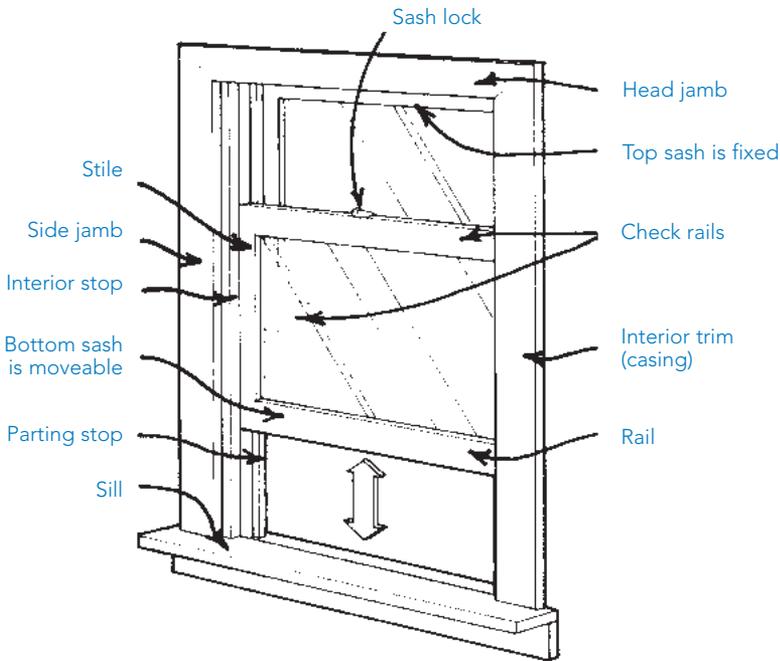


Interior trim — Gaps between the trim and the wall, as well as the trim and the window frame, can be sealed the same way as previously described for interior trim around doors (page 5).

Single-hung windows — Single-hung wood windows are very common in older homes. They have one fixed and one moveable sash, as illustrated in **Figure 9**.

To seal the fixed sash, apply a continuous bead of clear or paintable caulking along cracks between the sash and stops. If the cracks are very small, seal them by applying a new coat of paint to the sash and window frame.

Figure 9

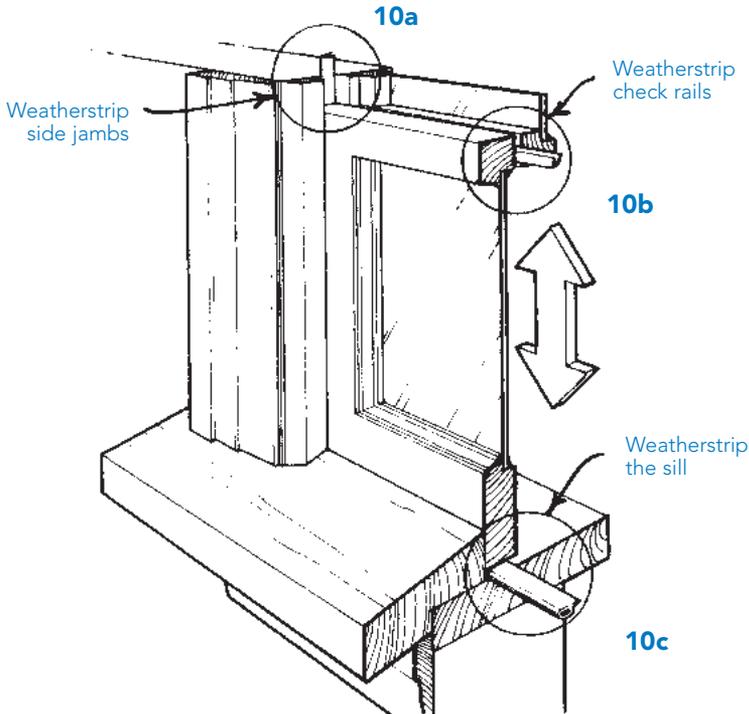


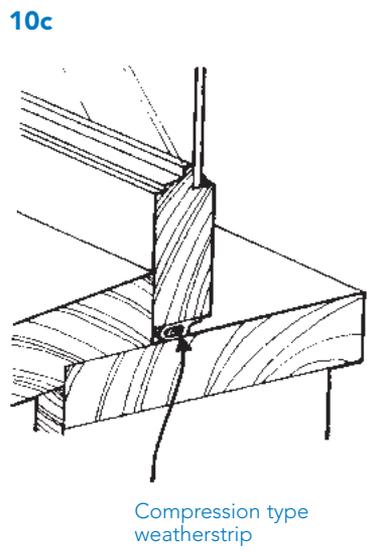
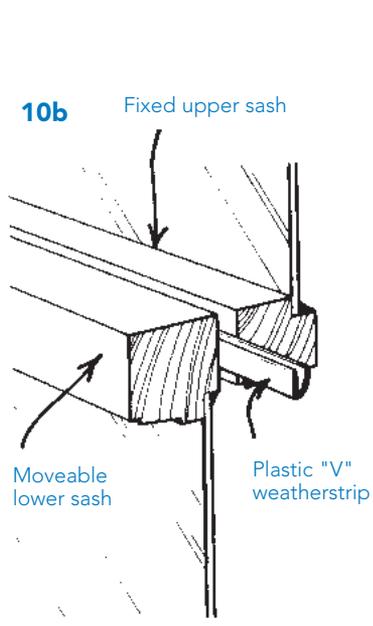
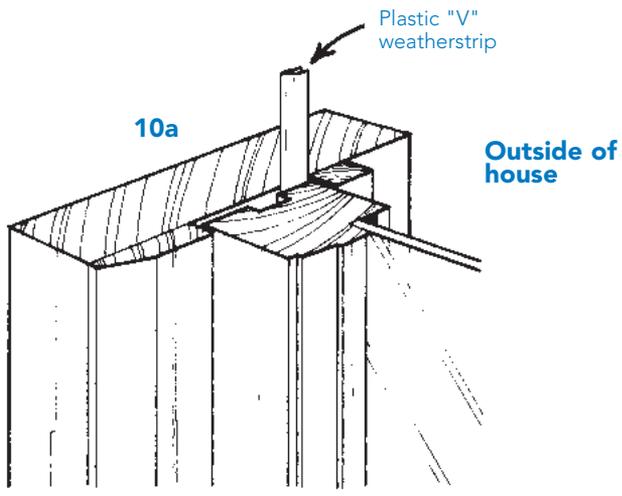
To weatherstrip the moveable sash, carefully remove the interior stops and the sash. Plane the sash, if necessary, to make room for the weatherstripping. Apply adhesive-backed plastic “V” weatherstrip and compression-type weatherstrip, as shown in **Figure 10**. Re-install the sash and replace the interior stops. Check to ensure that the window can still be opened easily. If not, apply a dry lubricant and adjust the stops.

The moveable sash in windows that do not need to open for ventilation, or as a fire exit, can be sealed the same way as the fixed sash, described above.

Sliding windows — These can usually be sealed by using the same techniques outlined for sliding doors (page 9).

Figure 10

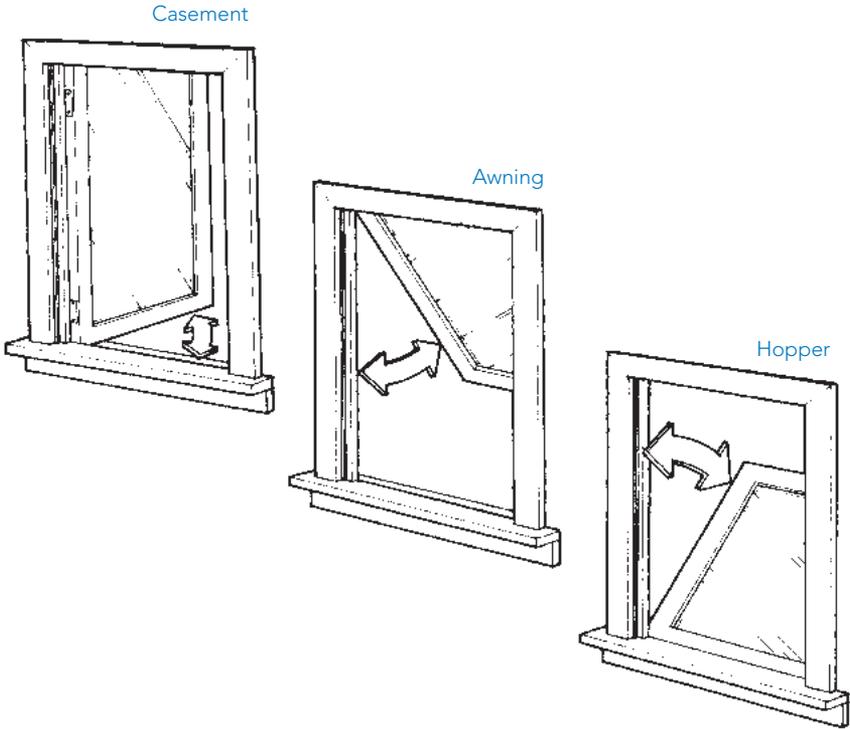




Casement, awning, or hopper windows — There are three common types of hinged windows, as shown in **Figure 11**.

With these types of windows, considerable improvement in the window's seal against air leakage can often be achieved by adjusting or replacing ineffective sash locks and by installing additional sash locks on large windows. Repair of other defective hardware, such as hinges, can also reduce air leakage.

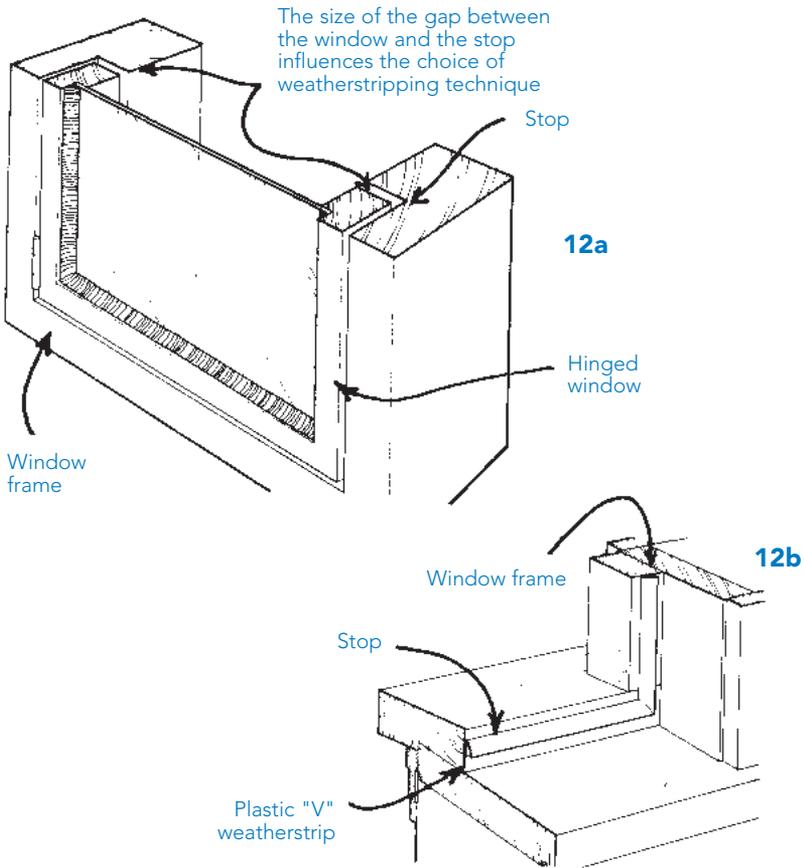
Figure 11



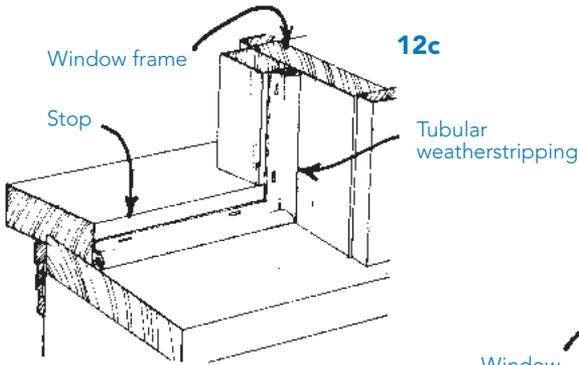
If the original weatherstripping is ineffective, or if the window has no weatherstripping, consider the options shown in **Figure 12**. “Seal-and-peel” caulking or weatherstripping tape can be applied in the fall and removed in the spring on windows that do not need to open for ventilation or as a fire exit.

New windows often have double weatherstripping. This feature can also be applied to existing windows. For hinged windows, put one strip of weatherstripping on the edge of the sash that moves and another compression strip attached to the window frame on the inside.

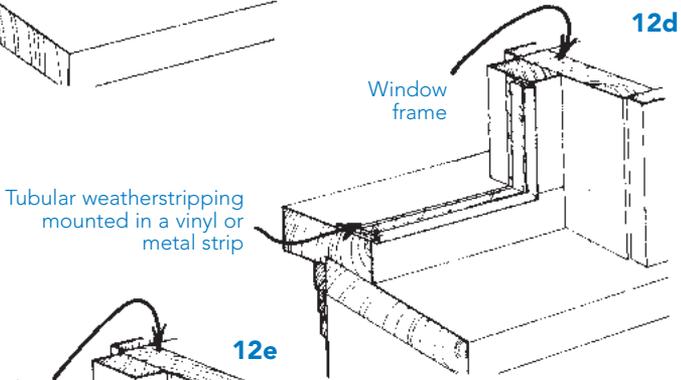
Figure 12



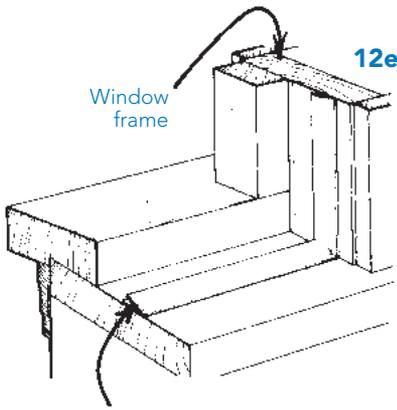
Continued on next page



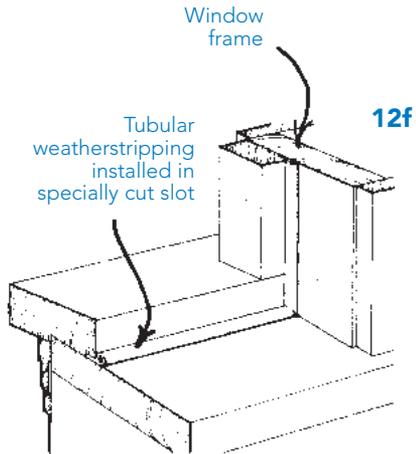
12c



12d



12e



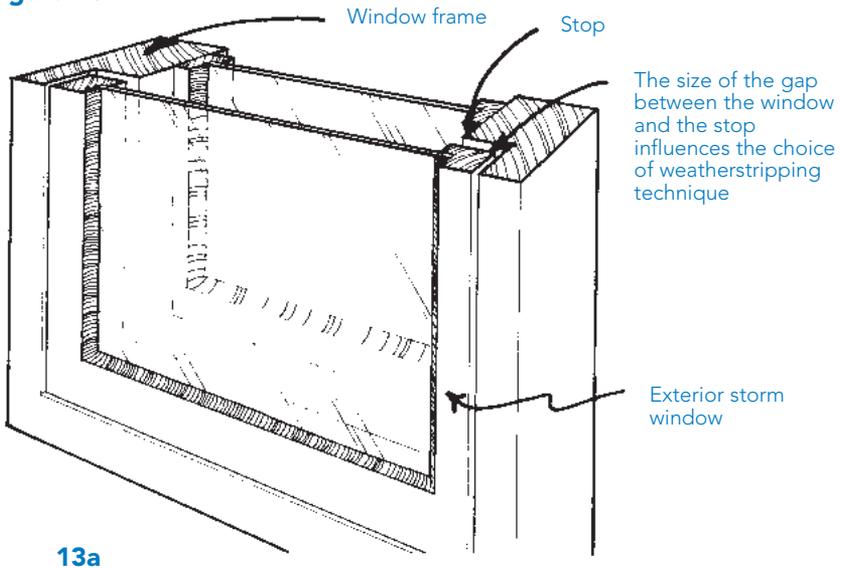
12f

Exterior storm windows — Storm windows are often in poor condition. Cracks in the sash and loose panes of glass should be dealt with as previously described on page 18. If the weatherstripping on the storm window has deteriorated, install matching replacement seals. If there is no weatherstripping, seal the storm with plastic “V” weatherstripping as shown in **Figure 13**.

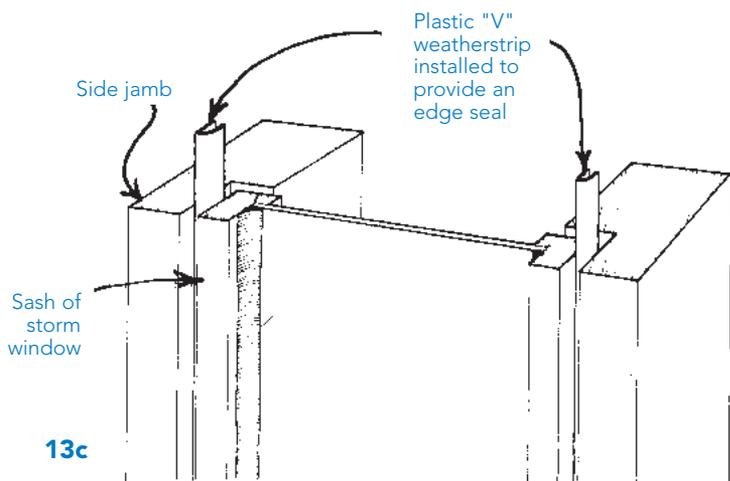
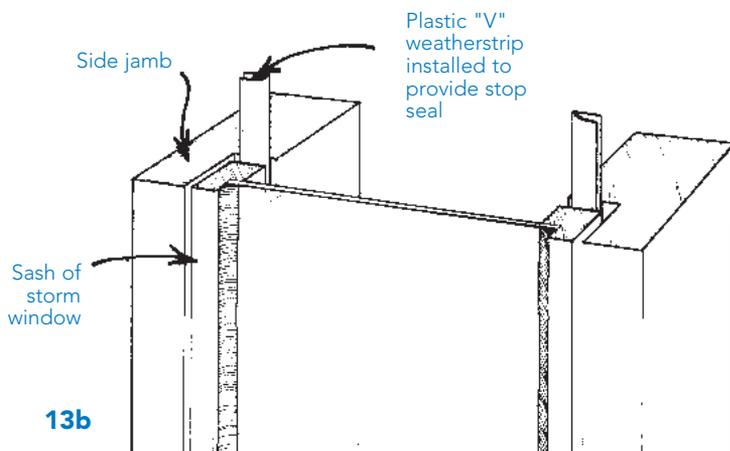
It is important that the exterior storm window not be sealed more tightly than the main window unit. This is to prevent moist air in the home from being trapped between the main window and the storm causing condensation on the storm window.

To avoid trapping moisture, the seal on the storm window unit should be made slightly imperfect by leaving small gaps in the weatherstripping at each corner. The main window unit should be properly sealed or weatherstripped before you weatherstrip the storm unit.

Figure 13



Continued next page



Install storm windows

Storm windows can be mounted on either the inside or outside of an existing window. The most common glazing for interior storm windows is a flexible plastic film or rigid acrylic sheet. For exterior storm windows, glass is the most common glazing. *With either type, most of the increased thermal resistance comes from the air space created and not the type of glazing material.*

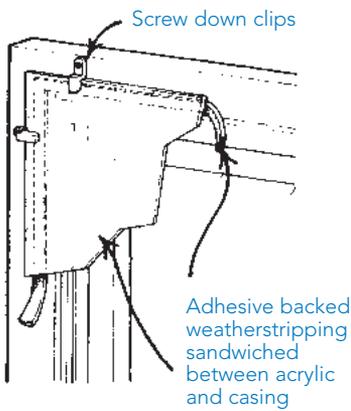
There are several different types of interior storm windows. If a room requires ventilation or an emergency exit (eg. bedrooms), choose an interior storm window that can be easily removed. The two most common types of interior storm windows include (see **Figure 14**):

- **Heat shrink film and double-sided tape** — This is the least expensive system and provides an excellent seal. Once the film is in place, heating it with a hair dryer draws it tightly across the window opening. This system is generally not reusable and removing the tape sometimes damages finishes.
- **Magnetic seal and rigid acrylic** — This is the most expensive system but is easier to remove and has a more finished appearance. The high thermal expansion and contraction rates of the acrylic glazing may cause the magnetic seal to fail and the acrylic sheet to fall off the window it covers. It may be necessary to install a few retainer clips, if this is a problem. This will, of course, make the glazing more difficult to remove in an emergency.

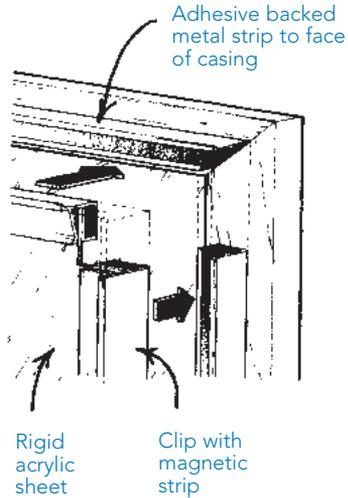
Exterior storm windows of wood or metal are an alternative to interior storms. The metal units are usually more durable than wood units and require less maintenance. They are often available prefinished in white or brown to eliminate the need for painting. Many storms are available with a sliding window and built-in screen so they can be left in place year-round.

Figure 14

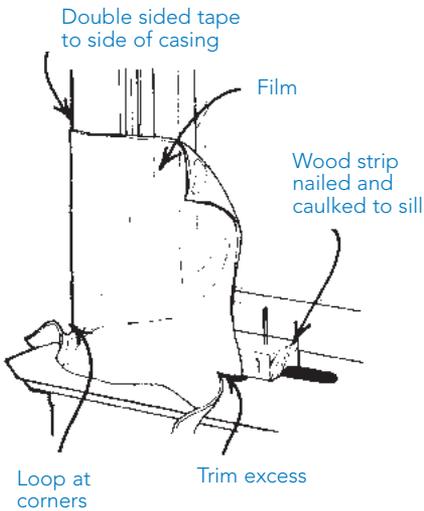
Weatherstripped acrylic and retainer clips



Magnetic seal and rigid acrylic



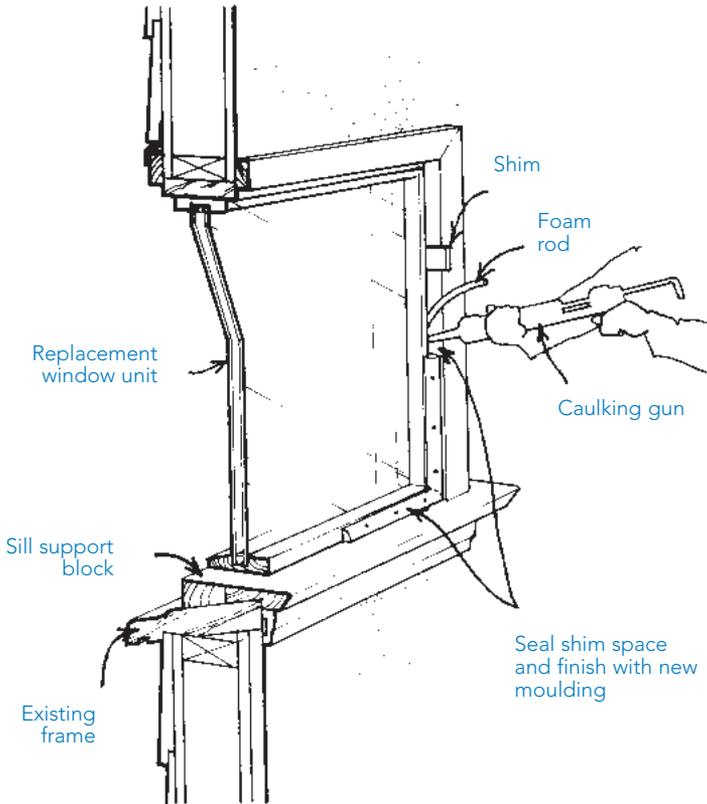
Heat shrink film and double sided tape



Upgrade window glazing

An alternative to adding storm windows is to replace the existing glazing with sealed multi-glazed units. This is usually only practical to do with fixed windows, since the added weight and bulk of sealed multi-glazed units is difficult to retrofit into windows which open (see **Figure 15**).

Figure 15



The replacement sealed unit should be a minimum of either dual-glazed with a low emissivity (low-e) coating, or triple-glazed. The air space between each layer of glazing should be at least 13 mm (1/2 inch) and filled with argon gas. Refer to page 31 for a more detailed description of glazing options.

Since improper installation of a sealed unit will void the manufacturer's warranty, consider hiring a qualified contractor. If you decide to do the work yourself, obtain detailed installation information from your glass supplier.

Methods of sun control

Rooms with large window areas facing west, south, or east can receive excessive amounts of sunlight during certain parts of the day and year. This may result in overheating, glare, and fading of furnishings.

Although drapes and blinds are used to block incoming sunshine, they obscure vision and darken the room. It is preferable to stop sunlight before it passes through the window. Where possible, consider outdoor shading with trees, overhangs, awnings, or shutters to provide sun control.

Solar films applied directly to the inside of a window provide an alternative solution. They are available with different sun-screening capabilities. Solar films should be considered a permanent application because they are not easily removed. They can scratch, so care must be taken when cleaning the window.

A drawback of these films is that they cause the inner layer of glazing to which they are applied to heat up and expand. If the appropriate film is not applied, a large window may expand too much and crack, or cause the seal to fail. If this occurs, the manufacturer's warranty for the sealed unit is void. For this reason, the application of solar films is best handled by an experienced contractor.

If you are installing permanent exterior storm windows, or are upgrading the window glazing anyway, you can specify tinted or coated glass. Although this is a more expensive option than solar films, it is more durable and less prone to glass breakage.

Replacing existing windows

If you choose to replace the windows in your home, consider the following:

Full frame or box unit

In most cases, windows will be replaced with new windows of the same size, however there is still a choice to be made regarding window frame type. Full frame replacement involves removing the entire window, including interior trim and exterior brick mould. By removing the entire window, the rough opening can be seen, and repairs can be made if water damage or rot is discovered. This also maximizes the size of the new window to be installed. Windows can be ordered with a wide variety of brick mould to fit exterior finishes and jamb extensions to the interior to match wall thickness.

Box unit windows consist of frame and glass only, and are designed to fit into an existing window frame. The existing glass and/or sash is removed, the box unit is installed, and a wood, metal, or PVC trim finishes the gap between

the existing frame and new window. This is a lower price alternative, but does not improve the existing frame and should therefore only be considered for special circumstances such as heritage windows or in cases where existing window frames are difficult to remove without damaging the surrounding wall areas.

Window styles

Before shopping for new windows, review [Table 5](#) and decide on the styles you want.

For operable windows, hinged (casement, awning or tilt and turn) windows provide the best combination of low air leakage, ventilation and ease of cleaning.

A fixed window is the best choice for a window which is not required for ventilation or as an emergency exit. Fixed windows have lower air leakage rates and are less expensive than operable windows.

Glazing options

To minimize heat loss and condensation problems, the glazing in replacement windows should be a *minimum* of dual-pane with a low emissivity coating (low-e), or preferably triple-glazed. The space between each layer of glazing is typically 13 mm (1/2 inch). With some windows, the middle layer of glazing is a suspended film, rather than glass, to reduce weight.

Low-e coatings

Low-e coatings on glass have revolutionized the window industry. Low-e glass is regular float glass with a microscopically thin metallic layer applied. This coating is virtually clear but dramatically improves the energy performance of the glass.

Low-e coatings can be compared to paint, in that they come different types, each suited for specific applications. In general terms, there are two types of low-e coatings: hard coat or pyrolytic, and soft coat or sputtered. Each type has different properties and can be used to control the amount of heat and light passing through the window.

Low-e glass can be used to control:

- visible light (what we see),
- infrared (solar heat),
- ultraviolet (plant growth, fading of materials),
- heat loss through long wave energy.

Hard coat low-e usually lets in more of the sun's heat and light, while soft coat low-e is better at blocking the sun's rays. Hard coat low-e is generally not as effective as soft coat at stopping heat lost from a room. Depending on size,

orientation, and shading of a window, a specific type of low-e can be chosen to optimize the thermal performance of the window. While it would be ideal to choose specific low-e coatings for each window, from a practical perspective, it is most common to choose one low-e coating which will provide reasonable performance for all windows in a home.

Spacer bars

The layers of glazing in a sealed window unit traditionally have been separated with hollow metal spacer bars (usually aluminum or steel) at the edges as shown in **Figure 16**. The spacer bars are filled with a substance that absorbs moisture from the air spaces between the glazings.

Due to the high thermal conductivity of these metal spacer bars, the temperature of the sealed window unit can be considerably lower at the edges than at the centre of the window during cold weather. This lower temperature contributes to condensation problems along the perimeter of the glass.

Although metal spacer bars are still available, it is more common for manufacturers to use low conductivity or 'warm edge' spacers between the panes. As the name implies, these spacers reduce heat flow through the spacer, which effectively raises the interior glass surface temperature along the edges, thereby reducing potential for condensation. Common warm edge spacers are made of either silicone foam or stainless steel.

Frame and sash materials

Replacement windows are constructed from a variety of materials including wood, metal, fiberglass or a plastic called polyvinyl chloride (PVC).

Wood is a good natural insulator. The exterior of wood windows can be painted any colour to match the trim of your house. Many manufacturers offer wood windows that are clad on the exterior with prefinished coloured aluminum, or vinyl to provide low maintenance and increased durability. The interior of the window can be stained to retain a natural finish.

Metal windows, on the other hand, are poor insulators. They require a thermal break such as plastic or rubber in the frame and sash to reduce heat loss and condensation. Metal windows are often coated with a baked-on enamel which requires little maintenance.

PVC and fiberglass windows, like wood, are good insulators. However, unlike some wood windows, PVC and fiberglass windows are virtually maintenance-free and will not warp, twist or rot.

PVC and fiberglass windows are the most common for retrofit application. PVC extrusions are available in white or light colours. For custom colors, the

PVC can be painted. There has been tremendous progress in paint technology for PVC, however, be sure to ask your window supplier about window performance and warranties related to painted PVC windows.

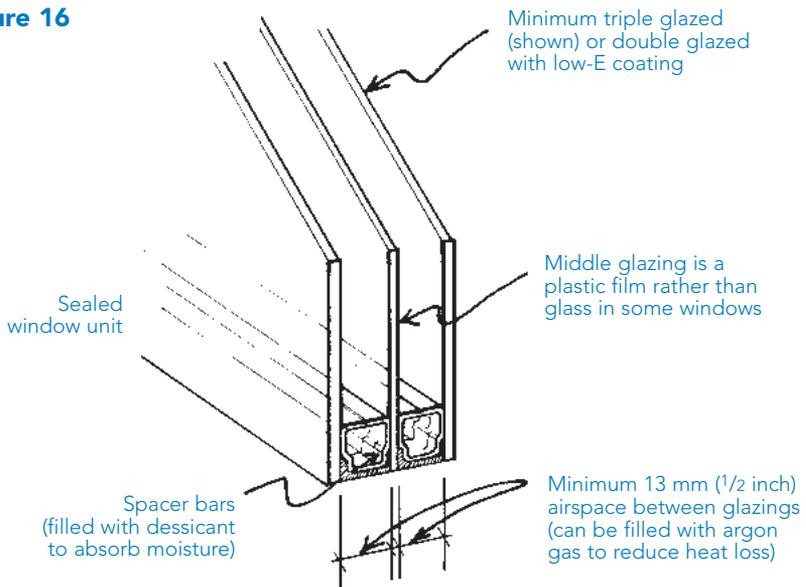
Fibreglass windows are typically available in white or brown, but can be painted any colour. Some manufacturers provide simulated wood grain finishes for the interior of the windows. These can be film type laminate or real wood veneer. Be sure to ask about the long-term performance of these products or how they might be affected by condensation on the windows.

The length and type of warranty provided with the various brands of windows can vary significantly. Check with the window supplier for details. Also ask the supplier whether the window you are considering has been tested to the Canadian Standards Association A440 window standard.

Air space gas fill

In multi-pane glazing, the air trapped and sealed between the layers of glass is a good insulator. To increase thermal resistance and reduce heat loss even further, window manufacturers offer inert gas fill in sealed units as an option. The gas used is odourless, colourless, and non-toxic. Under normal conditions it will remain inside the glazed unit for many years. Argon, which comprises approximately one per cent of the air we breathe, is the most common type of inert gas fill. Krypton, performs slightly better than argon, especially if the glass panes are close together. Due to the high cost of krypton, it commonly comprises only a small percentage of an argon/krypton gas blend.

Figure 16



Weatherstripping

Weatherstripping not only minimizes drafts from a window, it also keeps out wind-driven rain and noise from the outdoors.

Inquire about the type and quality of weatherstripping when shopping for a replacement window. Good quality windows will have at least two, or even three, lines of weatherstripping on the frame and sash. Open and close a sample window to see whether excessive force is required because of the weatherstripping. Ask about the cost and availability of replacement weatherstripping and have the salesperson demonstrate how to replace it.

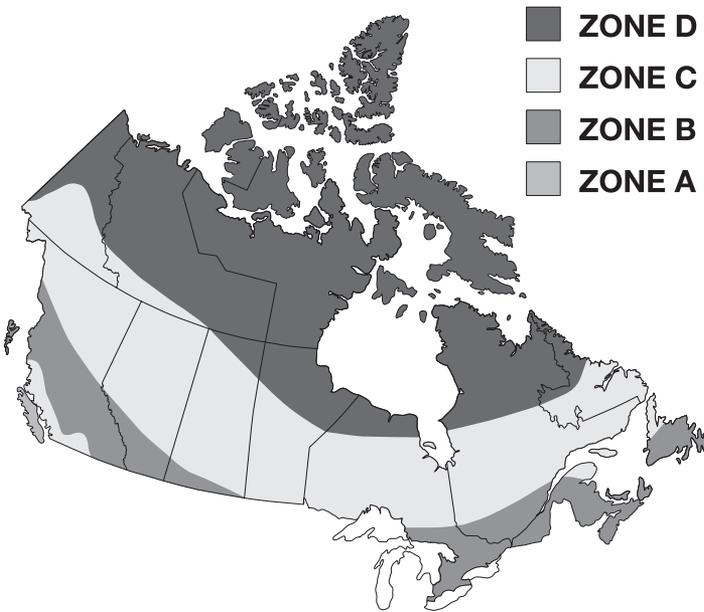
The international ENERGY STAR® symbol

The international ENERGY STAR symbol is a simple way for consumers to identify products that are among the most energy-efficient on the market. Only manufacturers and retailers whose products have been tested and meet the ENERGY STAR criteria can label their products with this symbol.

Windows, doors and Skylights

How does it work?

1. Canada has been divided into four climate zones.



2. The climate zones for which a window, door or skylight is ENERGY STAR certified will be shown on a label or on its sales literature.
3. Simply choose a product model that is qualified for the climate zone you live in.

Many products will qualify for more than one zone in Canada. The more zones a product qualifies for, the more energy efficient it is. So if you buy a product that is qualified for one or more zones that are colder than where you live, you can save more on your energy costs.

More about the climate zones

The four climate zones in Canada are based on a temperature indicator called Heating Degree Days (HDD). Heating Degree Days are the annual sum of the difference between the average daily temperature and 18°C for all days below 18°C.

This accumulated sum is then averaged over a 30 year period to provide a good indication of the average temperature in a certain location. The higher the average HDD value, the colder a location and the longer the heating season is, usually with very cold winter temperatures.

The number of zones and their boundaries simply and logically group Canadian cities and regions together to ensure that the colder areas of Canada require the more energy efficient windows and sliding glass doors. Zone A is the mildest region in Canada and Zone D is the coldest region.

Zone D: >8,000 HDDs

Zone C: >5,500 to <=8,000 HDDs

Zone B: >3,500 to <=5,500 HDDs

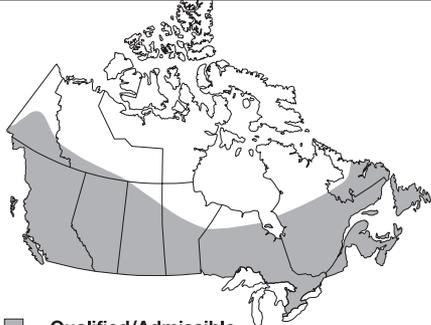
Zone A: <=3,500 HDDs

Manitoba

Location	Heating Degree Days	Zone
Boissevain	5,500	C
Brandon	5,760	C
Churchill	8,950	D
Dauphin	5,900	C
Flin Flon	6,440	C
Gimli	5,800	C
Island Lake	6,900	C
Lynn Lake	7,770	C
Morden	5,400	B
Steinbach	5,700	C
Swan River	6,100	C
The Pas	6,480	C
Thompson	7,600	C
Winnipeg	5,670	C

Sample labels for windows, doors and skylights

 <p>ENERGY STAR</p>	<p>Canada • Zones</p> <p>A B C</p> <p>1 800 387-2000 energystar.gc.ca</p>
---	--

<p>Qualified for highlighted area. Répond aux exigences pour les régions indiquées.</p>	
<p>Canada</p>  <p>ENERGY STAR</p> <p>1 800 387-2000 energystar.gc.ca</p>	 <p>■ = Qualified/Admissible</p>

<p>Qualified for highlighted area. Répond aux exigences pour les régions indiquées.</p>	
<p>Canada</p> <p>1 800 387-2000 energystar.gc.ca</p>  <p>ENERGY STAR</p> <p>U.S. / É.U.</p> <p>1 888 782-7937 energystar.gov</p>	 <p>■ = Qualified/Admissible</p>

Qualifying criteria

For ENERGY STAR, windows and doors are certified for their energy efficiency by either a U-factor or Energy Rating (ER) for each of the four Canadian zones. Skylights are qualified by their U-factor only. The energy efficiency values were developed primarily for low-rise (three floors or fewer) residential dwellings.

U-factor

A U-factor indicates the rate of heat transfer. The lower the U-factor number, the slower it transfers heat from a warm area to a cold area. An R-value is the inverse of a U-factor and indicates the resistance of heat transfer. The higher the R-value number, the more insulative the product is. Neither the U-factor nor R-value account for heat energy from the sun (solar gain).

Solar heat gain co-efficient

The solar heat gain coefficient (SHGC) indicates the amount of solar gain (heat which passes through a window, relative to the amount of solar heat on the outside of the window. Numbers range from near 0 (no heat gets through) to 0.9 (90 per cent of the heat gets through).

Energy rating

The Energy Rating (ER) value is calculated using a formula that includes U-factor, solar heat gain, and air tightness of a window. Numbers range from near 0 (poor performance) to about 50 (excellent performance). Consider your specific window situation (orientation, overhangs, shading) and discuss with a knowledgeable sales person to obtain the best window for your application.

Key features

An ENERGY STAR certified window, door, or skylight will have many of the following features:

- double or triple glazing with a sealed insulating glass unit,
- low emissivity or “low-e” glass,
- inert gas such as argon or krypton in sealed unit,
- low conductivity or “warm edge” spacer bars,
- insulated frames, sashes and door cores; and,
- good air tightness.

All ENERGY STAR certified windows, doors and skylights have been certified by an independent accredited agency for their energy performance. A list of ENERGY STAR certified windows and doors can be found at oee.nrcan.gc.ca.

Table 1
Weatherstripping materials

Design	Type	Comments
<p>Tape</p> 	Cloth or plastic	<ul style="list-style-type: none"> • use on any non-opening window or door, • good for one season only, • quick and easy to install, • remains in full view, • may remove paint when peeled off, • low cost.
<p>Gasket</p> 	Felt	<ul style="list-style-type: none"> • poor durability and air seal, • must be nailed, stapled or glued, • hidden from view, • made from wool, hair, cotton or polyester, • low cost.
	Foam with adhesive backing	<ul style="list-style-type: none"> • available in open- or closed-cell types, • closed cell is more durable, • poor to moderate durability and air seal, • quick and easy to install, • hidden from view, • low cost.
	Foam on attachment strip	<ul style="list-style-type: none"> • more durable than adhesive type, • poor to moderate durability and air seal, • must be nailed or screwed, • hidden from view, • moderate cost.
	Closed cell rubber with adhesive backing	<ul style="list-style-type: none"> • good durability and air seal, • quick and easy to install, • hidden from view, • low to moderate cost.

Continued on next page

Design	Type	Comments	
Tubular 	Core filled	<ul style="list-style-type: none"> • good durability and air seal, • must be nailed and stapled in full view, • made with rubber or plastic, • difficult to compress, • moderate to high cost. 	
		Hollow	<ul style="list-style-type: none"> • good durability and air seal, • must be nailed or stapled in full view, • made with rubber or plastic, • moderate cost.
		Hollow on attachment strip	<ul style="list-style-type: none"> • good durability and air seal, • usually nailed or screwed in full view, • slotted holes allow for re-adjustment, • made of rubber or plastic with aluminum, or plastic attachment strips, • high cost.
Strip  	Tension (spring metal or V-Strip)	<ul style="list-style-type: none"> • especially good for the gap where the sash of single hung windows meet, • excellent durability and good seal, • usually made of metal (bronze) or plastic, • must be nailed if metal or attached with adhesive backing, if plastic, • hidden from view, • moderate to high cost. 	
		Fin or pile on attachment	<ul style="list-style-type: none"> • especially good for sliding windows, • moderate to good seal and durability, • must be nailed or screwed in full view, • made with plastic, rubber or polyester pile with fin seal on wood, plastic or aluminum attachment strip, • moderate to high cost.

Continued on next page

Design	Type	Comments
Specialty 	Spring loaded	<ul style="list-style-type: none"> • excellent durability and seal, • must be nailed or screwed in full view, • made with aluminum or plastic, • self-adjusting, • high cost.
	Magnetic strip	<ul style="list-style-type: none"> • excellent durability and seal, • may make some doors difficult to open, • must be nailed or screwed in full view, • made with aluminum or plastic, • high cost.
	Compression polyclad foam	<ul style="list-style-type: none"> • use on door jambs, • excellent seal, • attached to carrier channel, • good range of movement, • suitable for most doors, • moderate cost.

Table 2 Weatherstripping for door bottoms

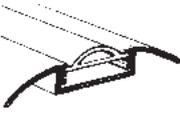
Type	Comments
Saddle threshold 	<ul style="list-style-type: none"> • requires minimum clearance of 15 mm ($\frac{5}{8}$ inch), • may have adjustable insert up to 30 mm ($1\frac{1}{4}$ inches), • check that replacement gaskets are available, • good durability and seal, • made with plastic or rubber and an aluminum base, • installed with screws, • high cost.
Bumper threshold 	<ul style="list-style-type: none"> • bottom clearance not required, • can be damaged by trapped stones, etc., • check that replacement gaskets are available, • good durability and seal, • made with plastic or rubber on a plastic, wood or aluminum attachment, • installed with screws on sill on exterior of door, • moderate cost.
Door bottom 	<ul style="list-style-type: none"> • requires minimum clearance of 8 to 13 mm ($\frac{1}{4}$ to $\frac{1}{2}$ inch), • some types can also be used as a saddle threshold, • check that replacement gaskets are available, • screwed into bottom; door must be removed for installation, • fair to good durability and seal, depending on material used, • made with rubber, metal, plastic or felt on an aluminum or plastic base, • moderate cost.
Door sweeps 	<ul style="list-style-type: none"> • good to use for uneven floors, • adjustable; some adjust automatically for sweeping over deep carpeting, • easy to attach; may be adhesive-backed, nailed or screwed, • attach to inside face on in-swinging door or outside of out-swinging door, • fair to good durability and seal, depending on material used, • made with plastic, rubber or polyester pile on an aluminum plastic or wood attachment strip, • low to moderate cost.

Table 3
Glazing type vs. relative heat loss

Single-pane	100
Single-pane <ul style="list-style-type: none"> • glass outdoor storm • 25 mm (1 inch) airspace 	46
Single-pane <ul style="list-style-type: none"> • acrylic indoor storm • 25 mm (1 inch) airspace 	44
Dual-pane <ul style="list-style-type: none"> • 6 mm (1/4 inch) airspace 	53
Dual-pane <ul style="list-style-type: none"> • 13 mm (1/2 inch) airspace 	45
Dual-pane <ul style="list-style-type: none"> • 13 mm (1/2 inch) airspace • low-e glass (hard coat) 	36
Triple-pane <ul style="list-style-type: none"> • 6 mm (1/4 inch) airspace 	36
Triple-pane <ul style="list-style-type: none"> • 13 mm (1/2 inch) airspace 	28
Triple-pane <ul style="list-style-type: none"> • 13 mm (1/2 inch) airspace • low e glass (hard coat) 	21

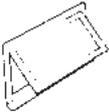
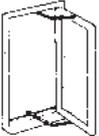
Notes:

1. Single-pane glazing has highest heat loss
2. Heat loss shown for other glazing types is relative to the heat loss for single-pane glazing

Table 4 Sources of moisture

Activity (for a family of four)	Average moisture produced (litres per week)
Cooking (three meals daily for one week)	6
Dishwashing (three times daily for one week)	3
Bathing (0.2 litres per shower) (0.5 litres per bath)	4
Clothes washing (per week)	2
Clothes drying indoors, or using an unvented dryer (per week)	10
Floor mopping per 30.5 square metres (100 square feet)	1
Normal respiration and skin evaporation from occupants	40
Total moisture production per week	66

Table 5 Comparison of common window styles

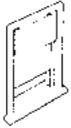
Window style	Comments
<p>Awning</p> 	<ul style="list-style-type: none"> • provides rain protection when open, • easy to clean inner and outer panes from inside the house, • provides up to 100 per cent ventilation through window area, but will not readily catch a breeze, • poor emergency exit.
<p>Casement</p> 	<ul style="list-style-type: none"> • generally, least air leakage of windows that open, • easy to clean inner and outer panes from inside the house, • provides up to 100 per cent ventilation through window area, • more expensive than sliders, • can be damaged if open in high winds.

Continued on next page

Window style

Comments

Single hung



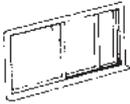
- most common in older homes,
 - provides ventilation through 50 per cent of window area,
 - generally high air leakage and frequent weatherstripping maintenance,
 - can be difficult to clean especially with small panes,
 - meeting rail between sashes can obstruct view.
-

Fixed



- least air leakage,
 - accommodates large glass areas,
 - no hardware or mechanism to fail,
 - provides maximum light and view,
 - most secure against forced entry but no emergency exit,
 - no ventilation,
 - outer pane must be cleaned from outside.
-

Slider



- easy to clean from inside if sashes removable,
 - normally least expensive of operable windows,
 - provides ventilation through 50 per cent of window area,
 - required frequent weatherstripping maintenance,
 - generally least secure against forced entry.
-

Tilt and Turn



- allows for indirect ventilation while keeping opening secure,
- provides rain protection in 'tilt' position,
- provides 100% ventilation area in 'turn' position,
- provides excellent weather seal with multi-point locking hardware,
- most expensive of window types.

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	25.40
	inches to centimetres	2.540
	feet to metres	0.3048
Area	square feet to square metres	0.09290
Volume	gallons to litres	4.546
	cubic feet to cubic metres	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	0.03937
	centimetres to inches	0.3937
	metres to feet	3.281
Area	square metres to square feet	10.76
Volume	litres to gallons	0.2200
	cubic metres to cubic feet	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.

The information contained herein is published as a convenient reference for Manitoba Hydro's customers. While every effort has been made to provide accurate and complete information, Manitoba Hydro does not warrant the accuracy or efficacy thereof. Manitoba Hydro will not be liable for any loss, costs, damage or injury whatsoever, resulting from the use of this material.

Cette information est également disponible en français.

