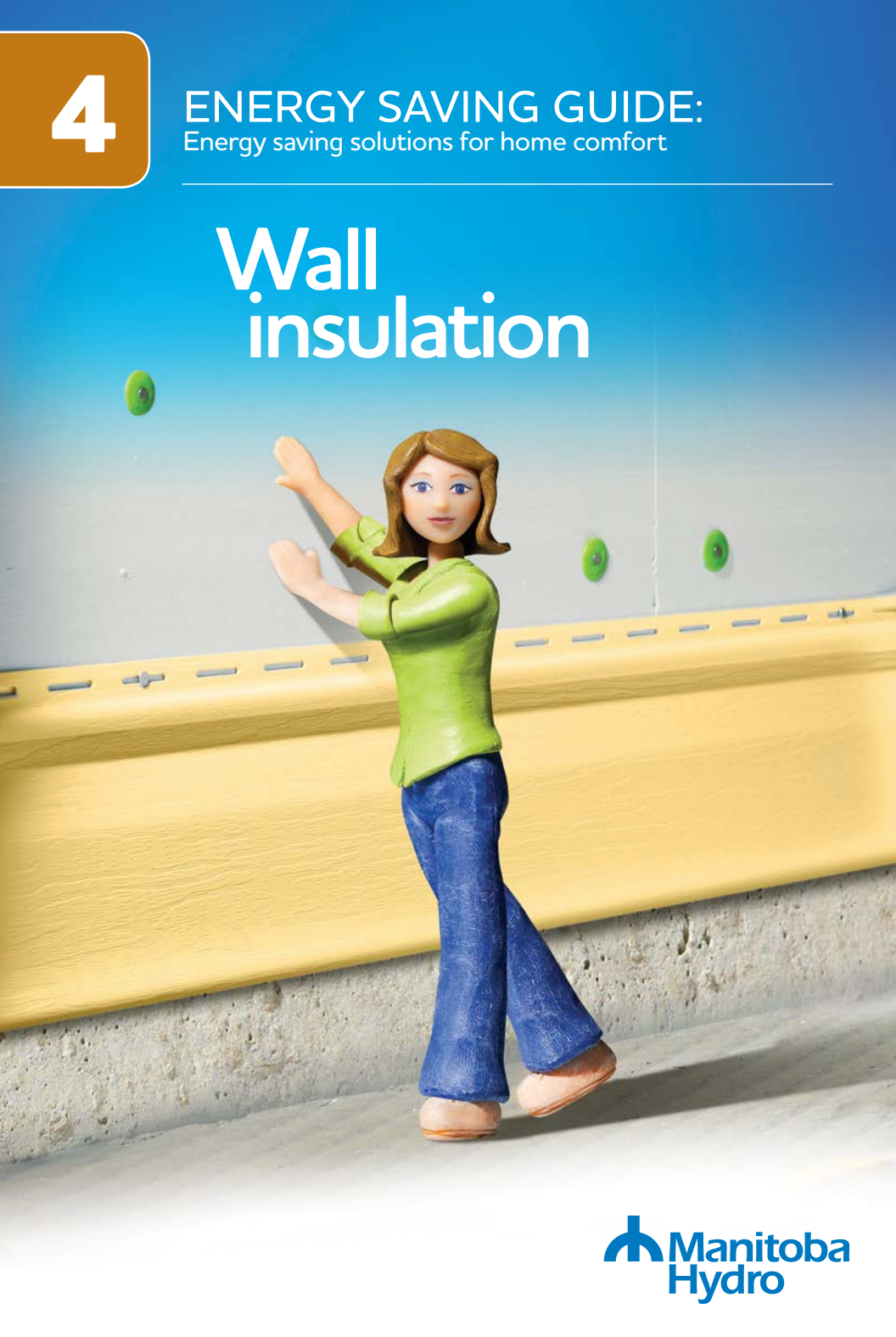
4

ENERGY SAVING GUIDE:
Energy saving solutions for home comfort

Wall insulation



Manitoba Hydro

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Publications in this series

1. Sealing, caulking & weatherstripping
2. Basement & crawlspace insulation
3. Attic insulation
4. Wall insulation
5. Doors & windows
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BOOKLET #4

4

Wall insulation

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 wall insulation 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?

Save money — Heating a home, especially in our climate, can be expensive. Exterior walls that are poorly insulated can add significantly to your heating bill. Although it can be expensive, retrofitting your home's exterior walls can be a good long-term investment. This is especially true if you combine the retrofit with other renovations such as residing.

Increase comfort — A well-insulated house is a comfortable house. A thorough exterior wall retrofit will reduce uncomfortable winter-time drafts. Often, it will also help you to achieve an even temperature throughout your home.

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.

Help the environment — Making your home more energy efficient means lower greenhouse gas emissions, which is good for the environment.

In addition to these major benefits, a well-planned exterior wall retrofit may improve the appearance and value of your home. The retrofit may also reduce or eliminate moisture-related problems such as condensation or mold and mildew on the inside surface of cold exterior walls.

Do-it-yourself or hire a contractor

Since exterior wall retrofits are a major undertaking, and mistakes are highly visible, it is recommended that this work be undertaken only by experienced "do-it-yourself-ers" or a contractor.

If you choose to do the work yourself, the savings and job satisfaction can be high. Please read this booklet carefully. For additional information, please contact us (see inside front cover), or your local building material 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 consumers@gov.mb.ca.

Each home is unique, and you or your contractor may find it necessary or desirable to modify the techniques shown in this booklet.

Checking your walls

Precautions before starting

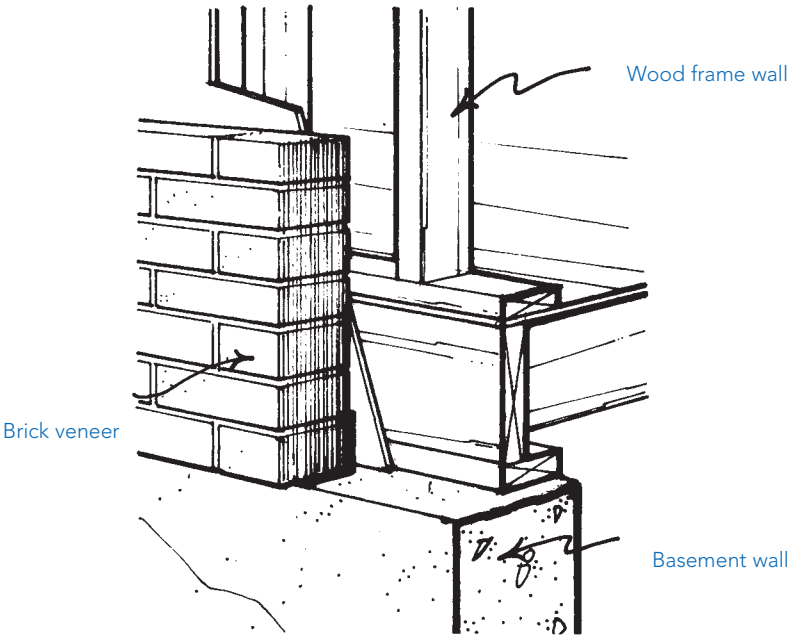
The techniques discussed in this booklet are for wood frame walls, the most common type in Manitoba homes (see **Figure 1**). Your house may have a stone or brick veneer over wood frame walls. In these cases, this booklet is still for you.

If your home has *solid* stone, brick, or wood walls, special techniques not covered by this booklet may be required. Obtain advice from a professional with experience with these types of construction.

Before you tackle the job of checking and retrofitting your walls, make sure you are familiar with the following safe working procedures:

- Locate electrical wiring in the walls, and then avoid all unnecessary contact with it. If it doesn't look safe (e.g. cracked covering, bare wires, open junction boxes) have it inspected by a qualified electrician.
- Use ladders correctly; support them properly and have a helper steady them.
- Provide good lighting.
- Wear goggles when using power tools or a hammer, or if there is a possibility of particles coming in contact with the eyes.
- Wear a dust mask.
- Wear gloves and thick, loose clothing with long sleeves and tight cuffs to minimize skin irritation when handling insulation.
- A hard hat can be worn to keep insulation particles out of your hair and to prevent head injuries.
- Wear safety boots if available. Otherwise wear shoes with good traction.
- Most types of rigid insulation are very flammable and should be kept well away from sources of heat. If used indoors, cover any exposed rigid insulation with 13 mm (1/2 inch) gypsum wallboard or equivalent.
- Kraft paper facing on insulation batts and polyethylene air-vapour barriers are also fire hazards and should not be left exposed.
- When cleaning up insulation fibres or dust, use a vacuum cleaner. If you can only sweep up the material, dampen it first to prevent particles from becoming airborne.
- After the work is complete, vacuum your work clothes and then wash them separately from other clothing.

Figure 1



How to inspect your walls

The first step is to determine the existing condition of your home's exterior walls. A good understanding of what shape the walls are in is essential in planning what has to be done, and in choosing the best materials or selecting the proper contractor.

You'll need to determine the type, amount and condition of any existing insulation. You will also have to assess whether the walls are sealed adequately against air leaks (drafts) and if they have a moisture problem.

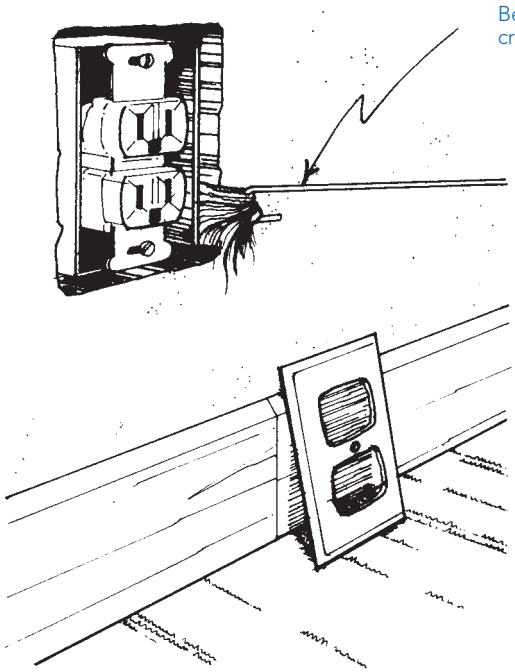
The next few pages describe how to inspect your walls to determine your retrofitting needs.

Determining insulation values

There are several ways of finding out the amount and type of insulation in the exterior walls:

- It may be possible to see into the wall space by removing a cover plate at a light switch or outlet box *(be sure to turn off the power first)*. Use a bent wire or crochet hook to pull out a sample of insulation and gauge the depth of the wall cavity (see **Figure 2**).
- In some houses (especially older ones), the wall space may be visible from the attic space.
- In some houses, you can drill upwards into the wall space from the basement. (Don't forget to plug the hole after you have finished your inspection.)
- It may be necessary to drill a small hole into the wall in a closet or some other out-of-sight location. The hole could also be drilled from the outside, if the walls are to be refinished anyway. In either event, patch the hole as soon as possible.

Figure 2



In some homes, the amount and type of insulation may not be the same in all the exterior walls. This is often the case in homes that have had an unheated porch converted into heated living space or an addition. If you suspect that there may be a variation in the amount and type of insulation present, explore the wall spaces in a least two or three different locations. Calculate the value of the insulation using the RSI-value (R-value) shown in **Table 1** (on page 26). If you have trouble identifying the insulation type, take a small sample to a local building supply outlet for help.

If you suspect that your home has been insulated with urea formaldehyde foam insulation (UFFI), consult a professional to verify its presence. UFFI can be easily crumbled with the fingers and does not bounce back when an object is lightly pressed into it. It is usually white or cream coloured or, in some cases, blue.

In the time since UFFI has been banned for use in Canada, outgassing from UFFI installations should have ceased. Nonetheless many homeowners with UFFI decide to implement some form of corrective measure (usually removal of the UFFI). This is because some people exposed to UFFI gas and particles experience health problems and also because the resale value of a UFFI-insulated home is often adversely affected. For additional information on how to identify UFFI, its health effects or corrective measures, contact Canada Mortgage and Housing Corporation at (204) 983-5600.

Some walls in older homes may contain vermiculite insulation. Vermiculite in the loose form is light brown/grey/gold in colour and is a pebble-like material ranging from 2 to 10 mm in diameter. Vermiculite, commonly sold under the trade name Zonolite, may contain asbestos.

The best way to reduce the risk of asbestos exposure is to avoid disturbing the vermiculite insulation in any way. You should not attempt to remove this type of insulation yourself, and should instead hire a contractor certified for asbestos abatement procedures. For more details on vermiculite insulation, check out the Safe Manitoba bulletin available through Manitoba Workplace Safety and Health or online at http://safemanitoba.com/bulletins.aspx.

If your inspection reveals that the walls do not contain any insulation, a practical, cost-effective solution is to fill the wall cavities with insulation by pouring or blowing it in, as described on pages 14 to 18.

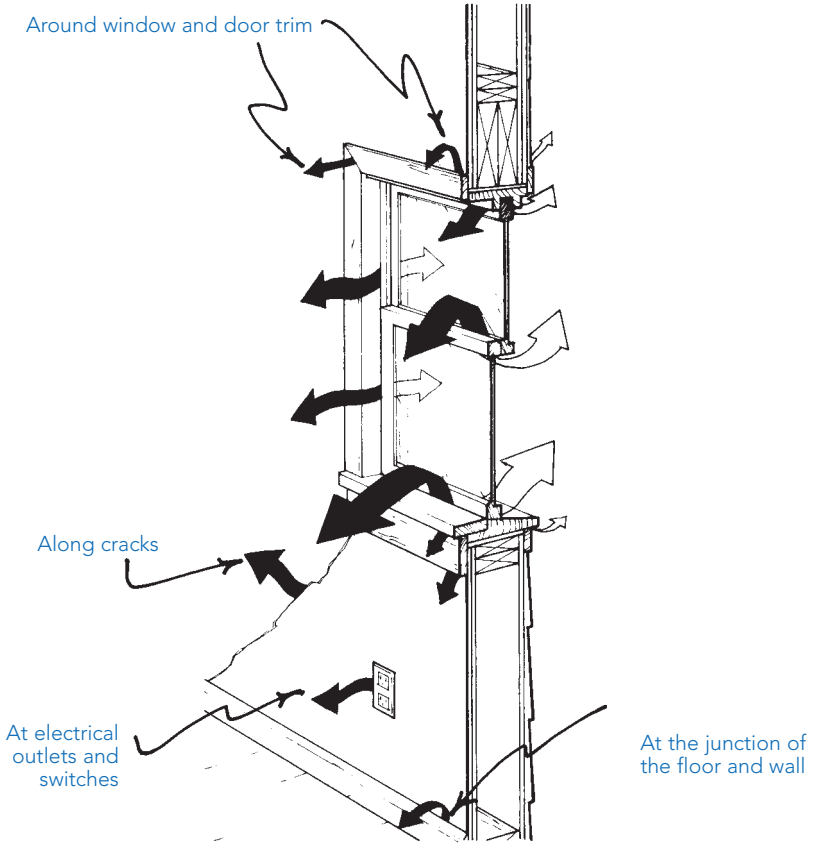
If the walls are partially or fully filled with insulation, adding more will be costly and the payback (in terms of energy savings) lengthy. However if you plan major interior renovations or if you intend to refinish the exterior of your home anyway, adding more insulation at the same time can be a good long-term investment. Techniques for this type of situation are described on pages 18 to 24.

Locating air leaks

Check for sources of air leaks in the exterior walls so that you can seal them before insulating. Excessive air leakage not only adds to your heating bills but can also carry significant amounts of moisture into the walls where it can damage the insulation and framing. *To insulate the walls without first sealing air leaks may defeat the purpose of the insulation, and unnecessarily expose the house to a higher risk of moisture damage.* It is worth investigating the possibility of air leaks in exterior walls at the following locations (see **Figure 3**):

- around door and window trim,
- around electrical switches and outlets on outside walls,
- at the junction of the floor and exterior wall,
- along cracks in the wall finish.

Figure 3 • Typical air leakage paths in exterior walls



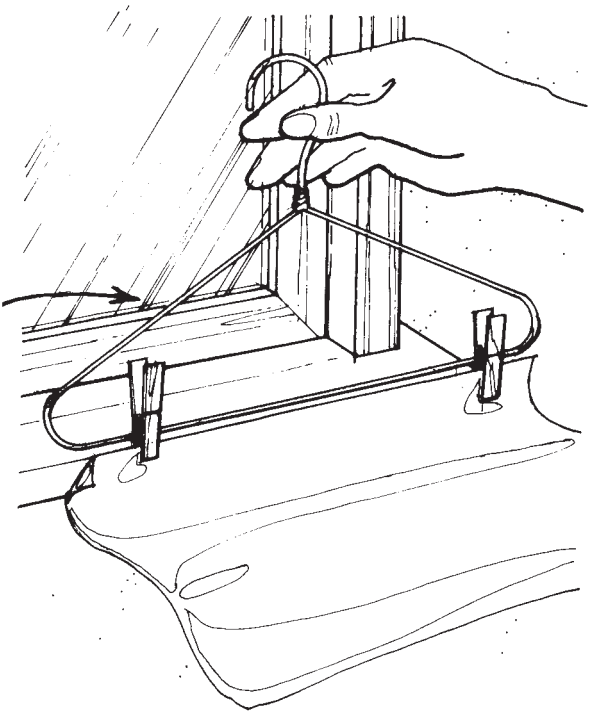
One way to detect air leaks is to make a *draft detector*, as shown in **Figure 4**. Hold the detector steady next to a suspected source of air leakage. If there is a draft, the plastic or tissue will flutter.

Smoke pencils, specially designed to identify leaks and drafts, are commercially available. As an alternative, you may prefer to use the smoke from an incense stick as your indicator.

It is easier to locate air leaks on cold and windy days. Turn down your thermostat to prevent the furnace fan from affecting the test. You can also intensify the air leaks by turning on any exhaust fans or appliances (e.g. central vacuum) that are vented to the outdoors.

Methods for sealing air leaks are described on pages 10 to 13.

Figure 4



Checking for moisture problems

Examine the exterior walls for moisture-related damage from both inside and outside the house. *It is important that any damage be repaired and the cause of damage eliminated before adding insulation to the walls.*

Examples of moisture related damage to exterior walls include:

- stains on drywall or plaster,
- mold or mildew (especially in corners),
- damp or wet insulation,
- damp or rotten wood framing members,
- corroded electrical boxes,
- peeling or blistering paint,
- rotten wall sheathing or siding.

As noted previously, excessive air leakage is a common source of moisture related damage in exterior walls. Methods for reducing air leaks are described on pages 10 to 13.

Excessive humidity levels in the home during winter can also contribute to moisture damage in walls. Other possible sources of moisture damage in exterior walls which should be corrected prior to insulating include:

- faulty roofing,
- improper flashing at the top of door or window openings,
- gaps around the exterior trim of doors, windows, or other penetrations of the home's exterior shell.

Retrofit techniques

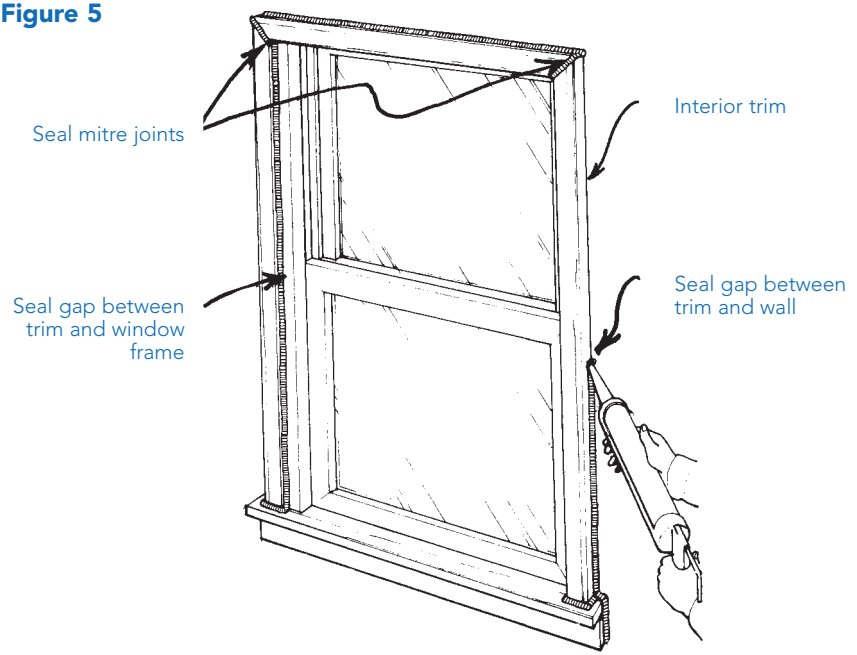
Sealing air leaks

Before adding any insulation, seal as many potential sources of air leakage as possible. It is important to spend a little extra time and be thorough when doing this work. As previously described, excessive air leakage not only adds to your heating bills but can also carry significant amounts of moisture into the exterior walls where it may damage the insulation and framing.

Methods of sealing common sources of air leakage are listed below and illustrated in **Figures 5** to **9**. Another publication in this series, Booklet #1: Sealing, caulking and weatherstripping, provides additional information on the types and applications of sealants and weatherstripping materials.

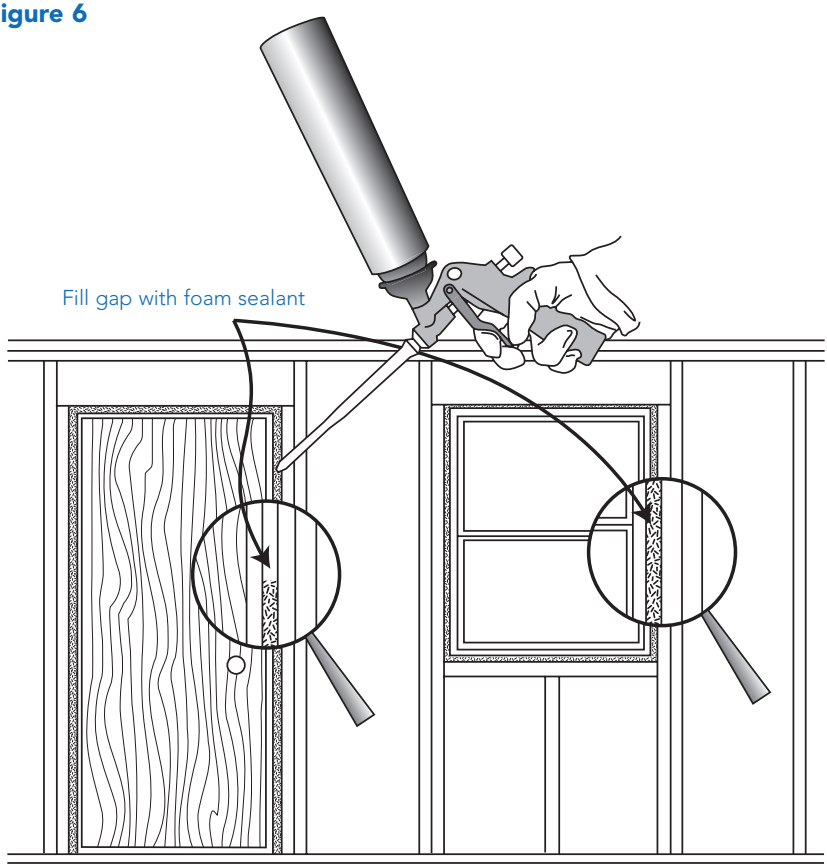
Door and window trim — Run a continuous bead of clear or paintable caulking along the gap between the trim and wall, as shown in **Figure 5**. Similarly, run a bead along any gap between the trim and window frame and the trim mitre joints.

Figure 5



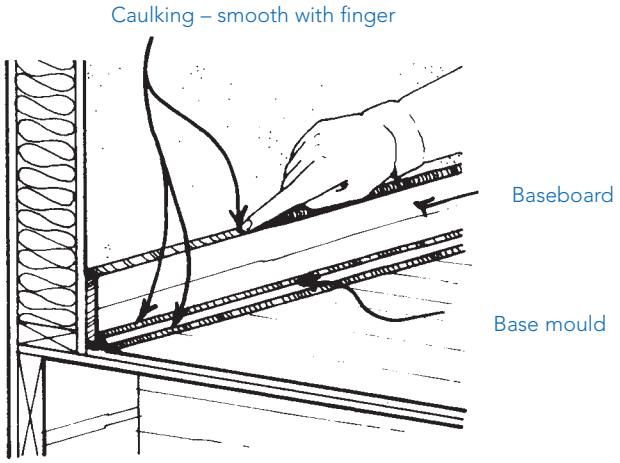
It is also possible to seal behind the trim, if the previous technique is unacceptable on aesthetic grounds. Carefully remove the trim to expose the gap between the window and the wall. For smaller gaps, caulking can be applied between the window framing and the wall finish (gypsum board, plaster, etc.). For larger gaps, the gap between the window frame and the studs can be sealed with foam sealant (see **Figure 6**). Take care to allow for expansion of the foam, and trim the excess if necessary.

Figure 6



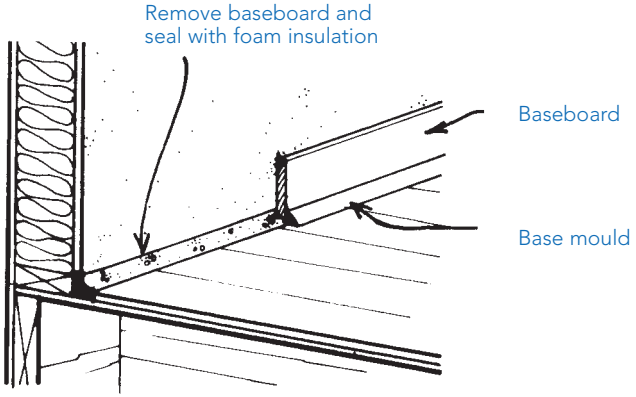
Junction of floor and exterior walls — Run a continuous bead of clear or paintable caulking along the gap between the baseboard and wall, baseboard and base mould, and the base mould and floor, as shown in **Figure 7**.

Figure 7



If exposed sealant along the baseboard is unacceptable, consider sealing *behind* the baseboard and base mould. Use foam insulation, as shown in **Figure 8.** Be careful to limit the amount of foam used, since it expands (trim the excess foam, if necessary).

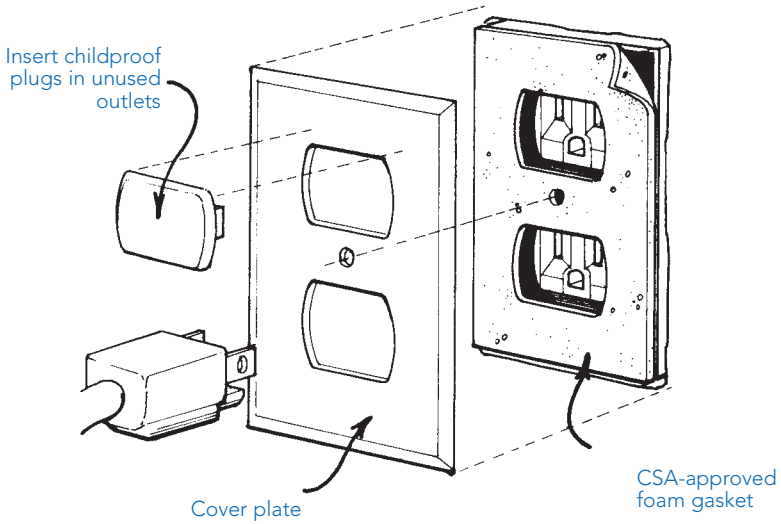
Figure 8



Electrical switches and outlets — Switch off the electricity and remove the cover plates from switches and outlets. Place a *CSA-approved* foam gasket on the receptacle, as shown in **Figure 9**. Reinstall the cover plate and insert childproof plugs in little-used outlets to further reduce air leakage.

Cracks in the wall finish — Use a sharp tool to open up the crack into a small 'V'-shaped indentation. Fill and sand the crack using standard drywalling procedures.

Figure 9



Insulating empty wall cavities

After sealing potential sources of air leakage and dealing with any moisture problems, the final step in retrofitting your home's exterior walls is to add insulation.

As previously mentioned, if an inspection of the walls reveals that they do not contain any insulation, a practical and cost-effective solution is to fill the wall cavities with blown-in or foamed-in-place insulation, as described on the next few pages.

Blown-in insulation

If your home does not have wall spaces which open into the attic, loose fill insulation can be blown in. Since this requires special equipment, you will likely have to hire an insulation contractor.

Choose a contractor carefully; you won't get a worthwhile return on your money if your contractor cuts corners. Choose the insulation in your consultation with the contractor. Refer to **Table 1** for the relative merits of the various types of loose fill insulations.

Blown-in cellulose fibre is most commonly used to insulate empty wall cavities. This is because cellulose will more readily fill irregular spaces than other insulation materials. Cellulose can also significantly reduce airflow when blown in to proper densities. The density should be no less than 56 kg/m^3 (3.5 lb/ft^3). This type of application (also known as dense pack) is approximately 1 ½ times denser than attic insulation.

When you have selected an insulation, calculate the number of bags required and have the contractor write this information into your contract (the coverage will be indicated on the bags of insulation — make sure the information used is for wall applications and *not* attics).

Only a small variation from this target is acceptable. If the contractor uses too little, the insulation will not completely fill the wall cavities or it may be prone to excessive settlement. If too much is used, some of the insulation may be wasted by escaping from the wall into a floor space or other area where it is not needed.

An access hole must be drilled by the contractor into each stud space in the walls. In most cases, two or more holes must be drilled not more than 1.2 metres (4 feet) apart. There are four possible ways to fill the cavity:

From the outside — Stucco or siding can have drilled holes of 50 to 100 mm (2 to 4 inches) in diameter to permit access to the wall cavities (see **Figure 10**). With some homes, it may be possible to remove a few rows of siding temporarily and then drill through the wall sheathing. In homes with brick facing, it may be possible to have single bricks removed.

Insulation can then be blown through these holes directly into the wall cavities. With brick facing, insulation should *not* be allowed to enter the drainage cavity between the brick and stud walls.

Ensure that the contractor patches the holes soon after insulating as a precaution against water damage from a sudden rainstorm. *A poor patch job can seriously detract from the appearance of your home; make sure your contract states that the holes are to be sealed, patched, and then finished in a manner identical to the existing exterior finish of your home.*

From the inside — This method may be appropriate if the exterior finish is in good condition but the interior requires decoration or renovation. Holes are drilled through the interior wall finish and insulation blown directly into the wall cavities.

Since this method will perforate any existing air-vapour barrier, it is necessary to seal the holes soon after the job is done. In cases where the interior finish is in very poor condition, it may be desirable to drill the holes, blow in insulation, install a well-sealed 0.15 mm (6 mil) polyethylene air-vapour barrier over the old interior wall, and apply new drywall (see **Figure 11**).

From the basement — If the bottom of the exterior wall is accessible, this can be the most appropriate method to use. It is also more practical than the previous two methods if both the interior and exterior wall finishes are in good condition.

A long hose is inserted to within 150 mm (6 inches) of the top of the stud space. The hose is then withdrawn, 300 mm (12 inches) at a time.

Figure 10

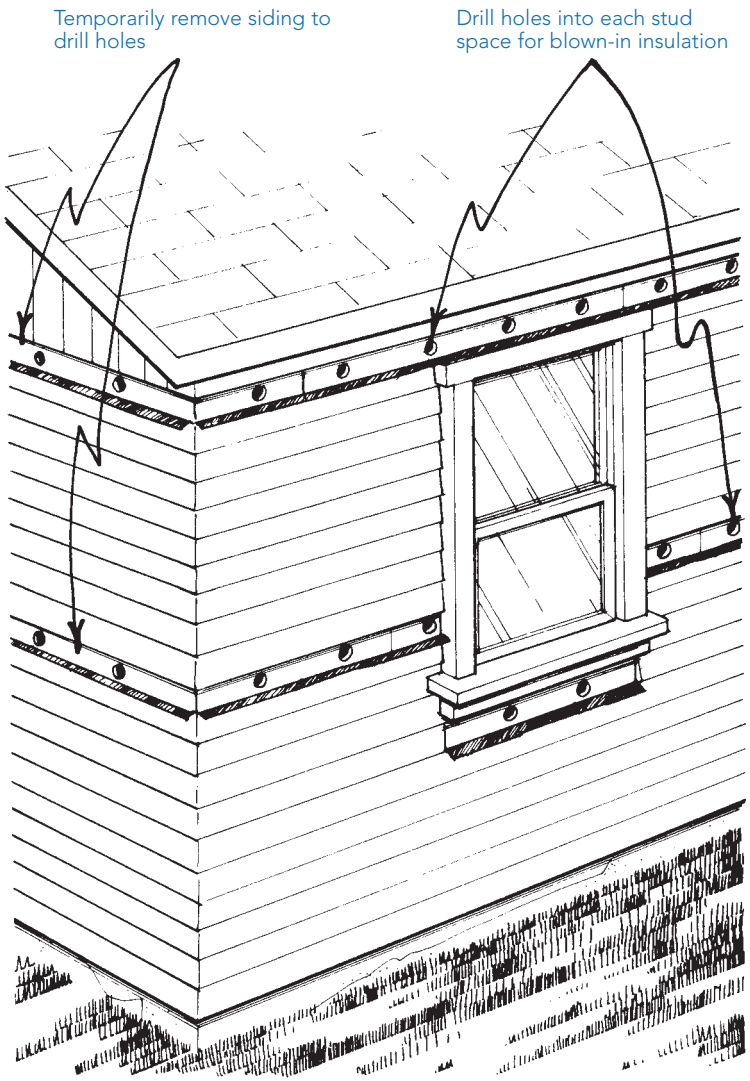
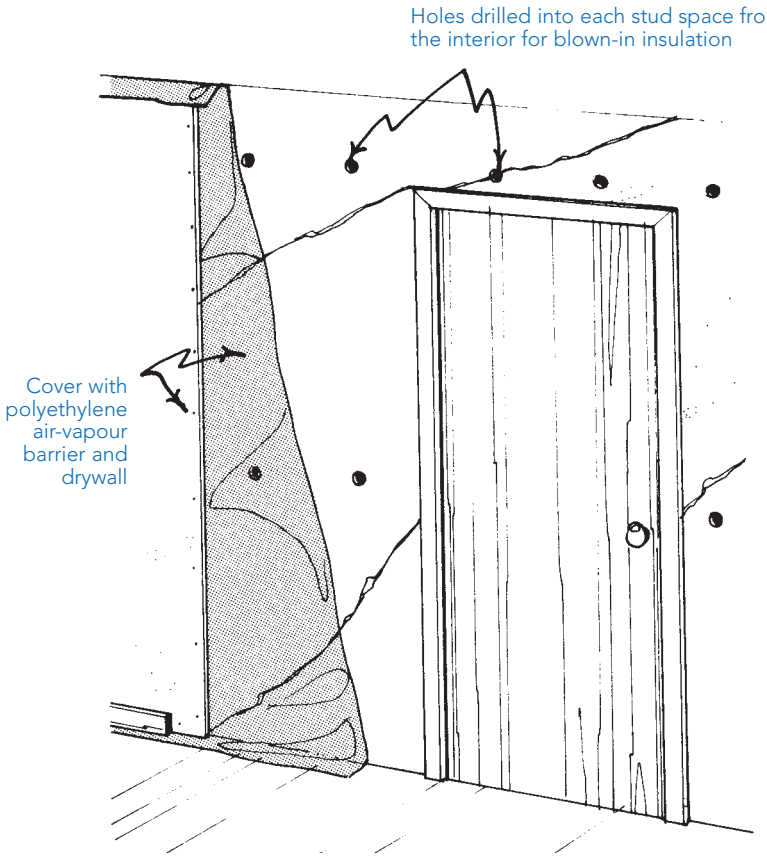

Temporarily remove siding to drill holes
Drill holes into each stud space for blown-in insulation

Figure 11

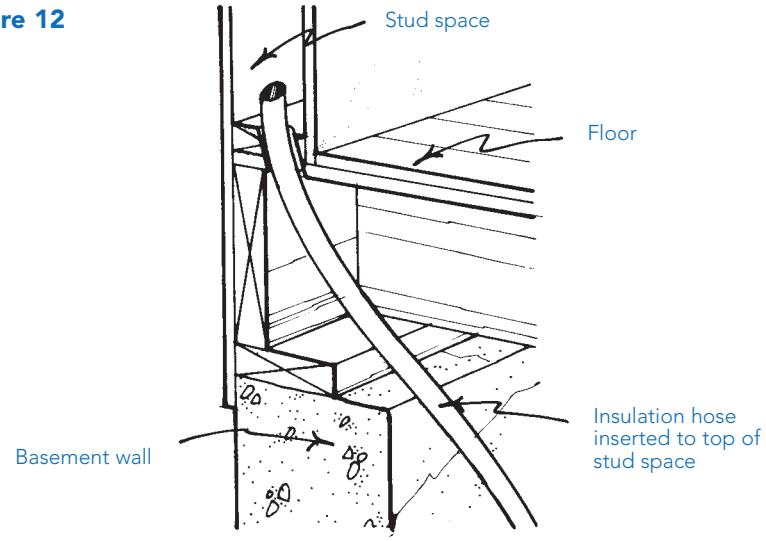


At each stage, the space above the hose is allowed to completely fill with insulation (see **Figure 12**).

All spaces in the wall should be filled. Firebreaks, windows, and other obstructions may necessitate insulating portions of the wall through holes drilled in the outside or inside faces of the wall.

From the attic — Holes can be drilled in the top plates of the exterior walls. In a manner similar to the previous method, a hose is inserted down into the wall and then withdrawn 300 mm (12 inches) at a time as the space fills.

Figure 12



Foamed-in-place insulation

There are a number of foamed-in-place insulation products which may be used to fill uninsulated or partially insulated wall cavities. The two most common products are low density (0.5 lb/ft^3) pour foams or cementitious based foams. Most of these products do not contain CFCs or formaldehydes. They are specialized products made on site using pre-packaged raw materials, and should be installed only by trained and certified personnel. The material is pumped into the wall cavity through a hose, and hardens in place.

These products are evolving, and it is recommended to use materials that have been evaluated by the Canadian Construction Material Centre (CCMC). There may however be certain circumstances where this type of insulation provides a cost-effective and viable option to insulate wall cavities.

Upgrading insulated walls

As previously described, if the walls are already partially or fully filled with insulation, adding more will be costly and the payback (in terms of energy savings) lengthy. However, if you plan major interior renovations or if you intend to refinish the exterior of your home anyway, adding more insulation at the same time can be a good long term investment.

Various methods of adding insulation to the interior or exterior of existing walls are described on the next several pages.

Insulating from the inside

If your plans include extensive interior renovations, consider the following two options:

Rebuild the existing wall

- Remove the baseboards and trim around doors and windows.
- Strip the existing drywall or plaster and air-vapour barrier.
- Replace any wood framing that has been damaged by moisture.
- Add insulation to wall cavities if the existing insulation does not completely fill the spaces (do not fold or compress the insulation to make it fit; this reduces the insulation value).
- Install a 0.15 mm (6-mil) polyethylene air-vapour barrier. Seal the edges and overlaps of the air-vapour barrier with acoustical sealant.
- Install 13 mm (1/2 inch) drywall.
- Reinstall baseboards and door/window trim.

Insulate on the interior of an existing wall

- Remove the baseboards and trim around doors and windows.
- *If the existing wall has an air-vapour barrier, reduce its effectiveness by puncturing it two or three times in each stud space. This is necessary because the existing air-vapour barrier will now be on the cold side (in winter) of the new insulation.*
- Relocate or extend existing electrical boxes to accommodate insulation and new drywall thickness.
- Extend the insulation behind any pipes rather than in front to prevent water from freezing and bursting the pipes.
- Install horizontal wood strapping and batt insulation in front of the existing wall, as shown in **Figure 13**.
  or install pre-grooved rigid insulation with wood or metal furring strips and fasten to existing studs (**Figure 14**).
- Cover the furring and insulation with a 0.15 mm (6-mil) polyethylene air-vapour barrier. Seal the edges and overlaps of the air-vapour barrier with acoustical sealant.
- Install 13 mm (1/2 inch) drywall fastening to furring strips.
- Reinstall baseboards and door/window trim.

Whether you rebuild the existing wall or build a new wall inside the old, the work can be staged on a room-by-room basis as time and money permit. Since the work is not affected by weather, it can be done at any time of year.

A factor to consider when insulating the walls from the inside is the loss of some living space.

Figure 13

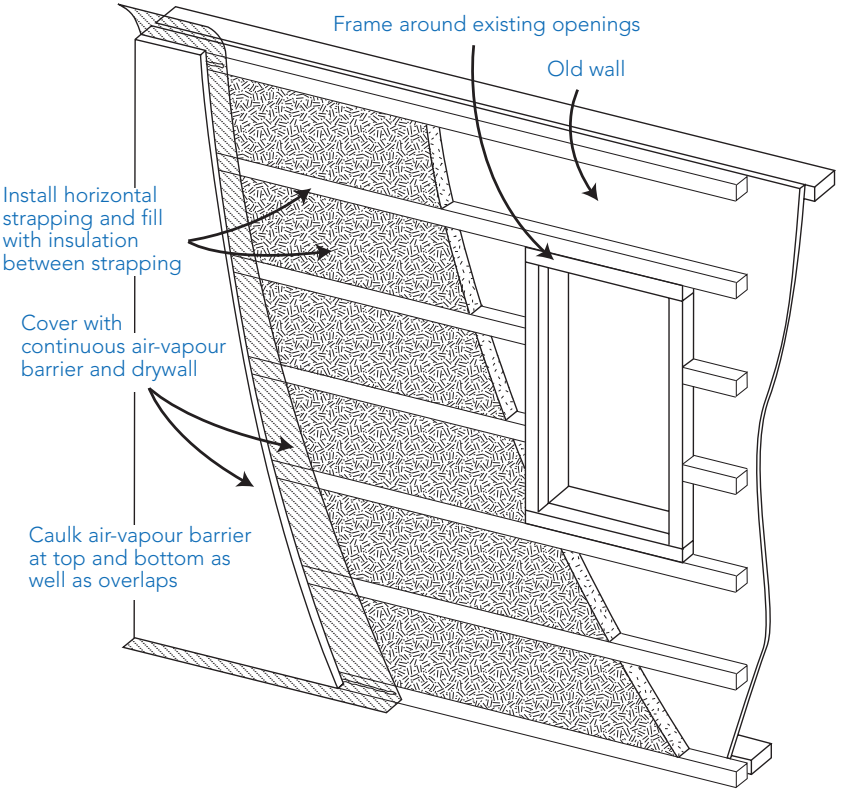
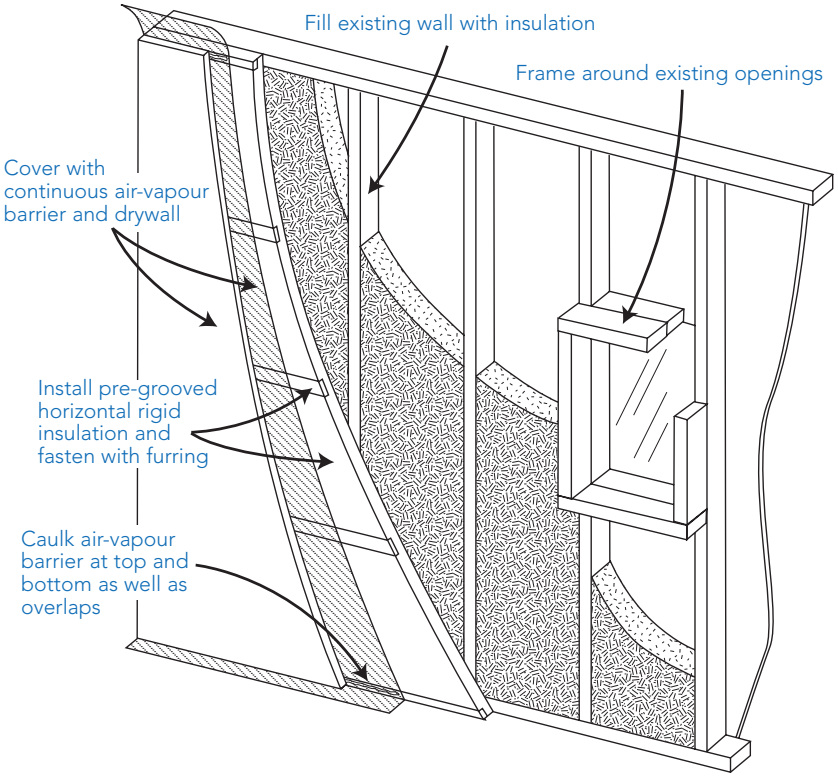

Frame around existing openings
Old wall
Install horizontal strapping and fill with insulation between strapping
Cover with continuous air-vapour barrier and drywall
Caulk air-vapour barrier at top and bottom as well as overlaps

Figure 14


Fill existing wall with insulation
Frame around existing openings
Cover with continuous air-vapour barrier and drywall
Install pre-grooved horizontal rigid insulation and fasten with furring
Caulk air-vapour barrier at top and bottom as well as overlaps

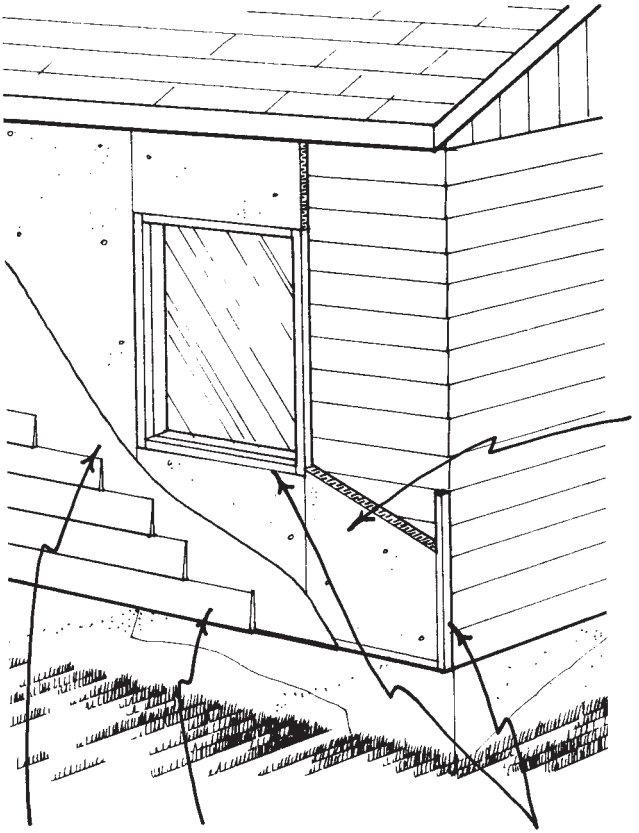
Insulating from the outside

If you plan to refinish the exterior of your home's walls, consider one of the following options:

Install rigid insulation over the wall

- Attach 38 mm (1 1/2 inch) rigid insulation directly over the existing wall finish as shown in **Figure 15**. Wood strapping should be installed between the insulation sheets or in pre-cut grooves in the insulation.
- Use special nails with large heads or washers to attach the insulation, rather than glue, to provide a more secure and permanent installation.
- Make sure there are no gaps or air pockets between the insulation and wall that could allow cold air to bypass the insulation. If the wall finish is rough or irregular, it is desirable to remove it and apply the insulation directly against the wall sheathing.
- Extend the insulation to the top of the wall. In some cases, this may require going up into the eaves (not a problem if you were planning to replace the soffits anyway).
- If the eaves do not extend far enough to prevent water from getting in between the insulation and the wall, add flashing at the top for this purpose. If you are going to have your roof reshingled anyway, consider extending the eaves at the same time.

Figure 15


Rigid insulation applied over existing wall
Building paper under new siding
New siding
Use wood framing along edges and around doors and windows

- If the cost to relocate obstructions such as the electrical service, gas meter, or steps is high, simply insulate around these obstacles rather than behind them.
- If the foundation walls are uninsulated, consider extending the rigid insulation down into the ground to cover them. Consult another publication in this series entitled Booklet #2: Basement and crawlspace insulation, for details.
- Install a building wrap as an air and moisture barrier. Seal all joints with sheathing tape.
- When covering the insulation with a new wall finish, make sure all door, window and other openings are properly flashed and caulked to prevent water penetration.

Insulate the wall cavity from the exterior

If the exterior finish and sheathing are in poor condition, it may be practical to remove them to expose the wall cavity from the exterior. This provides an opportunity to inspect the wall framing and repair any structural damage. This work should be done in stages, to ensure the wall is weathertight at the end of each day.

- Remove the existing exterior finish and sheathing. Use caution when cutting through the exterior, as the saw blade may heat up and ignite wood splinters in the wall. Cut only as deep as required to avoid structural damage to the framing.
- Repair/replace wood framing as required.
- Insulate the entire wall cavity with batt insulation or spray foam.
- Install exterior sheating.
    - Optional: Install rigid insulation and furring on the exterior as described on page 22.
- Install a building wrap as an air and moisture barrier. Seal all joints with sheathing tape.
- Install exterior finish.

Table 1 — Insulation summary

Material	RSI/25 mm	(R/inch)
Batt or blanket type insulation		
Glass fibre • Composed of long fibres of spun glass loosely woven together and bonded with resin; • Sizes available: Batt length 1.22 metres (4 feet) Blanket length up to 21.5 metres (80 feet) Width 381 or 400 mm (15 or 16 inches) 584 or 610 mm (23 or 24 inches) Typical thickness 63 to 304 mm (2.5 to 12 inches)	0.6	(3.4)
Rock (stone) wool • Made from natural rock which is melted, made into fibres and bonded; • Sizes available: Batt length 1.22 metres (4 feet) Width 381 or 400 mm (15 or 16 inches) 584 or 610 mm (23 or 24 inches) Thickness 89 to 184 mm (3.5 to 7.25 inches)	0.7	(3.8)

Advantages	Limitations
• easy to install in standard joist and stud spaces, • dries with little effect if exposed to moisture, • low cost, • some products are non-combustible; (check with manufacturer), • lightweight, • non-settling.	• does not fit readily into uneven spaces, • can irritate the eyes, skin and respiratory system during installation, • little resistance to air leakage.
• easy to install in standard joist and stud spaces, • highly resistant to fire, • dries with little effect if exposed to moisture, • moderate cost, • can be used as insulation and drainage layer around foundations.	• mild skin irritant during application; • little resistance to air leakage, • difficult to fill irregular spaces.

Material	RSI/25 mm	(R/inch)
Loose fill insulation		
Cellulose fibre • Manufactured from finely shredded newsprint with chemicals mixed in to resist fire and fungal growth.	0.6	(3.6)
Glass fibre • Similar material to glass fibre batts but chopped up for blowing purposes.	0.5	(2.9)
Vermiculite* • Mica material that has been expanded by a high temperature steam process; • Light brown/grey/gold in colour and is a pebble-like material ranging in size from 2 – 10 millimeters in diameter; • Vermiculate installed prior to 1990 is likely to contain asbestos. **Note:** Existing vermiculite should be handled with care.	1.6	(2.3)
Wood shavings • By-product of wood industries, shavings are often mixed with lime and other chemicals.	0.4	(2.5)

* For more details on vermiculite insulation, check out the Safe Manitoba bulletin available from Manitoba Workplace Safety and Health or online at safemanitoba.com/bulletins.aspx

Advantages	Limitations
• easily fills irregular spaces, • has a higher resistance to air leakage than other loose fill insulations, • low cost, • recycles newspaper, • may be blown into closed cavities (i.e. walls).	• permanently damaged if exposed to excessive moisture, • should not be installed in contact with high-temperature sources (e.g. chimney, recessed lights, etc.), • should not be covered with heavier types of insulation which may compress it, • eye and respiratory system irritant during installation, • may settle.
• easily fills irregular spaces, • has a light weight for its RSI-value, • dries with little effect if exposed to moisture, • some products are non¬combustible, check with manufacturer, • low cost, • may be blown into closed cavities (i.e., walls).	• can irritate the eyes, skin and respiratory system during installation, • little resistance to air leakage, • may settle, • should not be covered with heavier insulation materials.
• easiest loose fill insulation to fill irregular spaces, • highly resistant to fire.	• moderate cost, • absorbs moisture and dries slowly, • low RSI-value per unit thickness, • may settle.
• usually low cost if locally produced, • recycles wood waste.	• difficult to treat against fire, vermin and fungus growth, • absorbs moisture and dries slowly, • should not be installed in contact with high-temperature sources (e.g. chimney, recessed lights, etc.), • low RSI-value per unit thickness), • may settle.

Material	RSI/25 mm	(R/inch)
Rigid board insulation		
Expanded polystyrene ("beadboard") Type 1 & 2 • Produced by a process that results in beads containing air, bonded together into rigid, foam plastic boards. • Sizes available: Length 1.2 or 2.4 metres (4 or 8 feet) Width 406, 610 or 1220 mm (16, 24 or 48 inches) Thickness 19 to 152 mm (3/4 to 6 inches)	Low density 0.6 High density 0.7	(3.6) (4.0)
Extruded polystyrene Type 3 & 4 • A foam plastic board composed of fine, closed cells containing a mixture of air and refrigerant gases (fluorocarbons). • Sizes available: Length 1.2 or 2.4 metres (4 or 8 feet) Width 406, 610 or 1220mm (16, 24 or 48 inches) Thickness 19 to 152 mm (3/4 to 6 inches)	0.9	(5.0)
Polyisocyanurate boards 4.2 (6.0) • A foam plastic board with primarily closed cells filled with refrigerant gases (fluorocarbons). • Usually foil-faced on both sides to strengthen the board and retain the gases which give it a high RSI-value. • Sizes available: Length 2.4 metres (8 feet) Width 1.2 metres (4 feet) Thickness 25 to 100 mm (1-4 inches)	1.1	(6.0)

Advantages	Limitations
• lowest cost per RSI-value of all the rigid insulation boards, • easy to handle and install.	• can be a fire hazard unless properly covered, • must be protected from exposure to sunlight or solvents, • tedious to fit in an irregular space.
• most moisture resistant rigid board insulations, • easy to handle and install, • can perform as an air-vapour barrier if joints are sealed properly, • high RSI-value per unit thickness, • available with grooves to install wood/metal furring strips.	• high cost, • can be a fire hazard unless properly covered, • must be protected from exposure to sunlight or solvents, • tedious to fit in an irregular space.
• highest RSI-value per unit thickness of all rigid insulation boards, • easy to handle and install, • can perform as an air-vapour barrier if joints are sealed properly.	• high cost, • can be a fire hazard unless properly covered, • must be protected from exposure to sunlight or solvents, • loses some thermal resistance as it ages, • tedious to fit in an irregular space.

Material	RSI/25 mm	(R/inch)
Spray/blow in place insulation		
Spray polyurethane foam • A semi-flexible plastic foam manufactured on site using two liquid components; • Liquids are pumped through a hose and sprayed in place where they cure through a chemical reaction.	Low density 0.7 Medium density 1.1	(3.7) (6.0)
Cellulose • Made from paper or paper board stock with chemical additives for fire and fungal resistance; • Sprayed with water into a cavity to form a cohesive mat.	0.7	(3.8)
Glass fibre • Loose, glass fibre insulation, incorporating a water-activated adhesive; • The dry insulation is misted with water and installed using a blowing machine.	0.7	(3.9)

Advantages	Limitations
• easy to insulate irregular spaces, • high R-value, • no joints or gaps, • excellent resistance to air flow, • can act as a vapour barrier.	• high cost, • Can be a fire hazard unless properly covered, • installation only by trained and certified applicators, • space must be ventilated following installation in place until it cures.
• fills entire cavity with no gaps or joints, • provides good resistance to air flow, • virtually no settlement.	• should not be installed in contact with high-temperature sources (e.g., chimney, recessed lights, etc.), • should be installed by trained applicators, • may require netting to hold material in place until it cures.
• fills entire cavity with no gaps or joints, • can improve resistance to air flow, • virtually no settlement.	• should not be installed in contact with high-temperature sources (e.g. chimney, recessed lights, etc.), • should be installed by trained applicators, • may require netting to hold material in place until it cures.

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.

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July 2014