

Keeping the Heat In

3 Materials

3.1 Insulation

3.2 Insulation values table

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3.1 INSULATION

To be effective, insulation must resist heat flow, fill the space completely and evenly, be durable, and for some locations, withstand exposure to heat or moisture. Different materials may be used at different locations in the house envelope depending on the space available, ease of access and other installation requirements.

In addition, consider the following:

- Is the material available locally?
- Is it relatively easy to install, especially for do-it-yourselfers?
- Is it the best buy for the space available (either high insulating value per dollar if you have a lot of open space, or high insulating value per thickness if space is restricted)?
- Can it conform to surface irregularities?

MATERIALS

Choosing the right materials and installing them properly ensures the finished job lives up to your expectations. This chapter describes insulation, air barrier and vapour barrier materials.

- Is it rigid enough to provide support for finished materials or resist pressures against its surfaces?
- Does any single type of insulation require more accessory products than another (e.g. fire protection, air and vapour barrier or framing)?

For proper application, material handling, safety equipment and protective clothing requirements, follow the manufacturer's instructions (see Section 1.4, Health and safety considerations).

3.1.1 Do your research

Once you have selected a product, get the facts about it and find out about proper installation techniques. Compare the advantages, limitations and intended use of different products.

Materials (or their packaging) may be marked indicating that they comply with Canadian product standards. If they do not, they may have an evaluation number issued by the Canadian Construction Materials Centre (nrc-cnrc.gc.ca/eng/services/irc/ccmc.html). Your local municipal office can tell you if certain products are acceptable for use in your municipality.

Manufacturers, suppliers and contractors should be able to provide you with information about products. They should also be able to advise you on any health and safety issues (such as indoor air quality and fire safety) and what they will do to reduce these risks.

Ask for a Material Safety Data Sheet (MSDS) that lists the hazardous ingredients, safety information and emergency measures related to specific products. An MSDS is required for certain industrial and chemical products used in the workplace like paint, caulking, spray foam insulation and cleaners. An MSDS is not required for manufactured items (e.g. insulation) or consumer products, but it may be available from the manufacturer or supplier.

Manufacturers and suppliers are responsible for making sure that the products they sell comply with

Canadian legislation. If you are concerned about the safety of a particular product, find out if it is prohibited or regulated under the *Hazardous Products Act* (the Act), other relevant federal, provincial or territorial legislation, or municipal bylaws.

For example, as of the date of publication, one type of insulation product is prohibited and two others are regulated under the Act.

Prohibited

- Urea formaldehyde-based foam insulation (UFFI) foamed in place (prohibited in Canada in 1980): This includes insulation products that are available in the United States that are urea-formaldehyde based and are installed via a foaming process.

Regulated

- Cellulose fibre insulation (regulated in Canada in 1979): This commonly used and effective insulation material must meet certain performance standards with respect to flammability, among other things.
- Asbestos: A product composed entirely of asbestos cannot be sold as a consumer product. Asbestos products applied by spraying must have asbestos fibres coated with a binder during spraying and cannot come loose after drying.

For more information about the Act and for clarification on these requirements, contact Health Canada's Consumer Product Safety Office. Refer to healthcanada.gc.ca/cps-contact, call 1-866-662-0666 or send an e-mail to cps-spc@hc-sc.gc.ca. The *Hazardous Products Act* can be viewed on the Justice Canada Web site at laws.justice.gc.ca/PDF/statute/H/H-3.pdf.

3.1.2 Cost of materials

Generally, the cost per RSI value is lower for loose fill or batt type materials than for rigid board or foam type insulations. However, the price of the basic material is just one aspect. High

material costs may be offset by lower installation costs or the installer's preference for a particular insulation technique.

3.1.3 Thermal performance: How effective is that material?

Thermal resistance values (RSI and R) are listed in Table 3-1. This table also provides average design specifications because values for different manufacturer's products of the same class may vary.

3.1.4 If it sounds too good to be true . . .

Some manufacturers may claim that an insulation product offers remarkable insulating value. Any product that is promoted as offering a long-term thermal resistance exceeding RSI 1.14/25 mm (R-6.5/in.) may be making a claim that is not

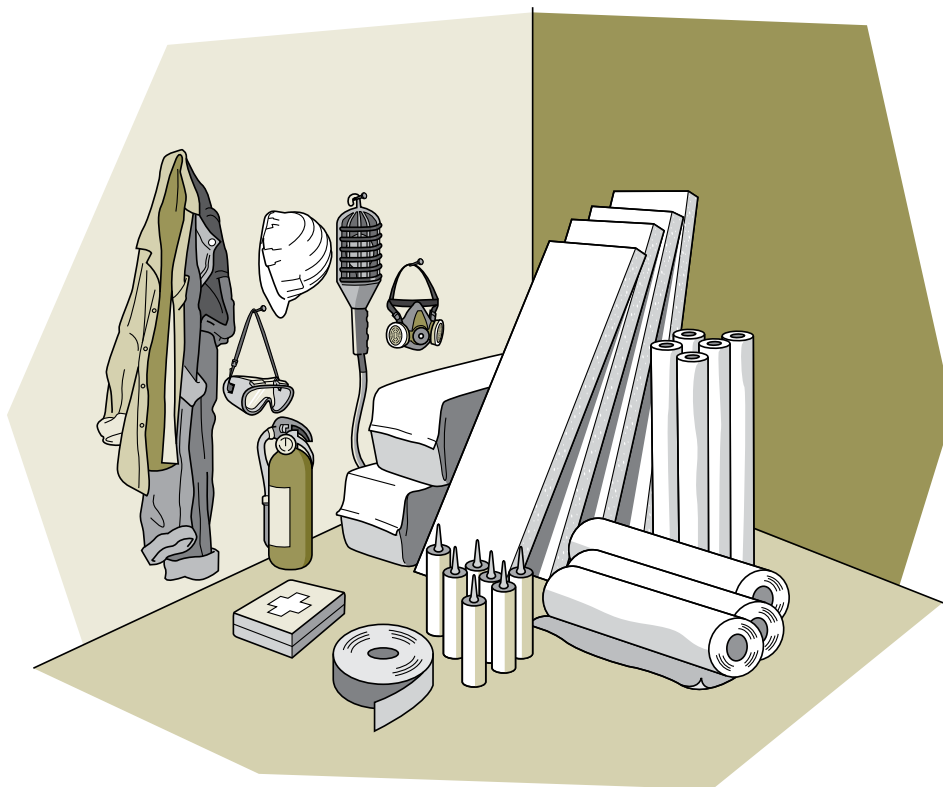
substantiated by industry-recognized tests to specific accepted standards. Also, be alert to any manufacturer's thermal performance claims that are based on building envelope systems (e.g. whole wall or ceiling configurations) that are not identical to those configurations or conditions in which the product is being considered for use.

3.1.5 Summary of insulation types

This section explains the following insulation types:

- batt or blanket
- loose fill
 - cellulose fibre
 - glass fibre
 - mineral fibre (mineral wool or rock wool)

Figure 3-1 Insulating materials and safety gear



- rigid board
 - expanded polystyrene
 - extruded polystyrene
 - mineral fibre rigid board
 - polyurethane and polyisocyanurate boards
- spray foam
 - closed-cell polyurethane foam
 - open-cell polyurethane foam
- cementitious foam
- reflective bubble foil insulations and radiant barriers

Batt or blanket insulation

Glass fibre and mineral fibre (slag or rock wool) batt or blanket insulation is relatively easy to install in accessible spaces such as exposed wall cavities and some attics. This type of insulation does not settle, it conforms to slight surface irregularities, and it can be cut to fit. To gain the maximum insulating benefit, batts and blankets should completely fill the space they are fitted into and neither be compressed nor have gaps (especially avoid compressing the edges).

Some products are available in non-combustible form. Check with the manufacturer to verify that the products are non-combustible. Safety equipment and protective clothing are required during installation.

TECHNICAL NOTE: Glass and mineral fibre insulations are typically poor air sealing products. Sometimes these products are stuffed into cracks and gaps (at the header in the basement or around a window) in an attempt to block air leakage. This practice is not effective. Always air seal by using appropriate materials and techniques.

Loose-fill insulation

Loose-fill insulation is suitable for walls and floors and excellent in attics and enclosed spaces, such as roofs, where the space between the joists may be irregular or cluttered with obstacles. You can use it to top up existing insulation in attics and accessible enclosed wall cavities and to fill in cracks and small or uneven spaces. It is not appropriate for below-grade application. Use safety equipment and wear protective clothing during installation.

SAFETY WARNING: Never allow insulation materials to come into contact with a chimney or a combustion vent, an exposed recessed lighting fixture or old knob and tube wiring because these can pose a fire hazard. See Section 1.4, Health and safety considerations.

Loose-fill insulation may be poured or blown into cavities. Pouring will generally require more material than blowing to achieve a specified RSI value. Check the manufacturer's information on the quantity of material required to provide a specified RSI value.

Most loose-fill materials installed in walls will settle after installation, creating gaps at the top of the cavities. There are different installation approaches for each type of material to lessen this effect.

Loose-fill insulation options include cellulose fibre, glass fibre and mineral fibre described as follows.

i) Cellulose fibre

Cellulose fibre is made from shredded newsprint treated with chemicals that resist fire and fungal growth and inhibit corrosion. Because of its small particle size, it can fill any gaps around obstructions such as nails or electrical wires that are within cavities. However, blowing cellulose fibre can create a lot of dust. Be sure to make allowance for settling.

Cellulose fibre offers limited additional air sealing when blown into cavities that already have insulation. However, it will provide increased air sealing when blown into empty and restricted cavities at dense-pack levels, typically around 56 kilograms per cubic metre (kg/m^3) (3.5 pounds per cubic foot [$\text{lb.}/\text{cu. ft.}$]).

To reduce settling, some companies offer a wet-spray installation technique for their products for open wall cavities that may require a fabric net. Drying time varies for the different types and brands of product. A trained and manufacturer-licensed technician typically performs the installation.

ii) Glass fibre

Loose-fill glass fibre is a similar material to glass fibre batts, but chopped up for blowing or pouring applications. Hand-poured glass fibre works best in open horizontal surfaces such as attics. Blown glass fibre can be used in both horizontal and vertical applications.

At conventional application pressure, it may be difficult to install in cavities that are partially blocked by nails, framing, electrical wiring, etc. At dense-pack levels (i.e. around $40 \text{ kg}/\text{m}^3$ [$2.5 \text{ lb.}/\text{cu. ft.}$]), higher RSI (R) values are achieved and can better fill cavities that have restrictions. For walls, application density is usually two to two-and-a-half times the manufacturer's recommended rate of application for horizontal surfaces. This higher density ensures better overall application and performance.

Some products are classified as non-combustible. Check the manufacturer's specifications for verification.

iii) Mineral fibre (mineral wool or rock wool)

Mineral fibre is treated with oil and binders to suppress dust, maintain shape and ease the blowing process. It is similar to glass fibre in appearance and texture. Mineral fibre is suitable for accessible attics and inaccessible areas such as wood-frame walls,

roofs or floors. For walls, the density of application is usually two to two-and-a-half times the manufacturer's recommended rate of application for horizontal surfaces.

Mineral fibre may be acceptable for insulating around masonry chimneys as it will not support combustion. However, check with your local building inspector to learn what is accepted.

Rigid board insulation

Rigid board insulation (insulating boards) is currently manufactured from mineral fibre or foam plastic materials. These materials have a high insulating value per unit thickness although the cost per RSI value is greater than that for loose-fill or batt or blanket insulations.

Insulating boards are lightweight and easy to cut and handle. Fitting them into irregular spaces, however, can be a tedious process. Some boards are available with special coverings (e.g. a fire-resistant material) and their own system of attachment. Some board materials can be ordered pre-cut to specific sizes for an additional cost.

When installed on interior surfaces, all plastic-based rigid board insulation must be covered with a fire-resistant material – typically 13-mm ($\frac{1}{2}$ -in.) drywall – that is mechanically fastened to the building structure. Plastic boards must be protected from prolonged exposure to sunlight, solvents and some sealants. Be sure to ask your supplier for a compatible sealant.

Rigid board insulation options include expanded polystyrene, extruded polystyrene, mineral fibre rigid board and polyurethane and polyisocyanurate plastic boards described as follows.

i) Expanded polystyrene

Expanded polystyrene (EPS), often called bead board, is made by using pressurized steam to expand and form polystyrene beads into rigid foam plastic boards. High and low-density products are

manufactured using steam as the blowing agent. High-density board is more moisture resistant and can be used on the exterior of foundation walls in dry, sandy soils.

ii) Extruded polystyrene

Extruded polystyrene (XPS) is a foam plastic board with fine, closed cells containing a mixture of air and non-ozone depleting refrigerant gases (fluorocarbons). If joints are sealed properly, it can perform as an air barrier and, at certain thicknesses, may perform as a vapour barrier. Low permeability means that it does not absorb or pass on moisture, making it suitable for below-grade applications.

iii) Mineral fibre rigid board

Mineral fibre insulation, when compressed and held together with a combustible binder, forms semi-rigid board stock. The fibres are aligned vertically so that any water that penetrates the surface will run down, making it suitable as a drainage layer. High-density, semi-rigid mineral fibre board for residential use is designed for below-grade exterior applications.

iv) Polyurethane and polyisocyanurate boards

Polyurethane and polyisocyanurate plastic boards are made of closed cells containing non-ozone depleting refrigerant gases (fluorocarbons) instead of air. They usually come double-faced with foil or are sometimes bonded with an interior or exterior finishing material. These products must be protected from prolonged exposure to sunlight and water. If the seams are well sealed, they can act as an air and vapour barrier. Use is generally limited to areas where a high RSI is desired and space is limited.

Spray-foam insulation

Spray-foam insulation is made of plastic resin (e.g. soy-based resins or resins made from recycled plastic) and a catalyst, which is prepared and applied on the job site. Spray kits for this type of insulation are available to the consumer, but employing a certified installer who is trained in the application

of the specific product will ensure the best results. The liquid foam is sprayed directly onto the building surface or poured into enclosed cavities with a pump-driven applicator. The foam expands in place and sets in seconds.

There are two types of foam: low density and high density. When installed on interior surfaces, all plastic-based foam insulation must be covered with a fire-resistant material – typically 13-mm (½-in.) drywall – that is mechanically fastened to the building. All foam plastics must be protected from prolonged exposure to sunlight.

Options for spray-foam insulation include closed-cell polyurethane foam and open-cell polyurethane foam described as follows.

i) Closed-cell polyurethane foam

Closed-cell polyurethane foam (also called high-density or two-pound foam) is sprayed onto surfaces in layers not more than 50 mm (2 in.) thick at each pass (if greater thicknesses are desired), where it hardens in seconds. A 24-hr curing and off-gassing period is required before occupancy can resume. The foam can expand 28 to 35 times its initial volume and should not be used in enclosed cavities.

This product can be used as an air barrier. When applied to a thickness of 50 mm (2 in.), it can sometimes act as a vapour barrier. It can be used below grade and it bonds well to clean cement and masonry where it also makes a good moisture barrier. Though high-density foam is a premium,

TECHNICAL NOTE: The RSI (R) value listed in Table 3-1 may be lower than that quoted by the vendor because it takes into account the loss of the blowing gases over time and the recent changes that ban the use of ozone-depleting blowing agents.

hard textured, multi-task product, it is not generally used to completely fill cavities due to its high cost.

ii) Open-cell polyurethane foam

Open-cell polyurethane foam (also known as low-density or half-pound foam) is made from a combination of isocyanurate resins and catalysts, resulting in an open-celled, spongy semiflexible material. With a very high expansion rate – up to 100 times its initial volume – and its lower comparative cost, this product is more effective than closed-cell foam for filling larger cavities. It can be used as an air barrier but not a vapour barrier.

Cementitious foam insulation

Recently introduced into Canada, cementitious foam insulation is a non-plastic based non-combustible

material with a soft chalky texture. When poured or injected into cavities by a trained installer, it has the consistency of shaving cream and may require some drying out time. This insulation can be used as an air barrier but not a vapour barrier.

Reflective bubble foil insulations and radiant barriers

Reflective bubble foil insulation is essentially a plastic bubble wrap sheet with a reflective foil layer and belongs to a class of insulation products known as radiant foils. Reflective bubble foil insulations – and other radiant barrier products like paints and sheeting – are noted for their ability to reflect unwanted solar radiation in hot climates, when applied properly.

However, all of Canada is considered a cold climate, so these products do not perform as promoted. Though they are often marketed as offering very high insulating values, there is no specific standard for radiant insulation products, so be wary of posted testimonials and manufacturers' thermal performance claims.

Research has shown that the insulation value of reflective bubble foil insulations and radiant barriers can vary from RSI 0 (R-0) to RSI 0.62 (R-3.5) per thickness of material. The effective insulating value depends on the number of adjacent dead air spaces, layers of foil and where they are installed.

If the foil is laminated to rigid foam insulation, the total insulating value is obtained by adding the RSI of the foam insulation to the RSI of the dead air space and the foil. If there is no air space or clear bubble layer, the RSI value of the film is zero.

3.2 INSULATION VALUES TABLE

This table lists the thermal resistance ranges and the accepted design specification values or averages of insulation materials, including older and less common materials that you may find in a house.

Figure 3-2 Foil-faced foam board acts as an air and vapour barrier

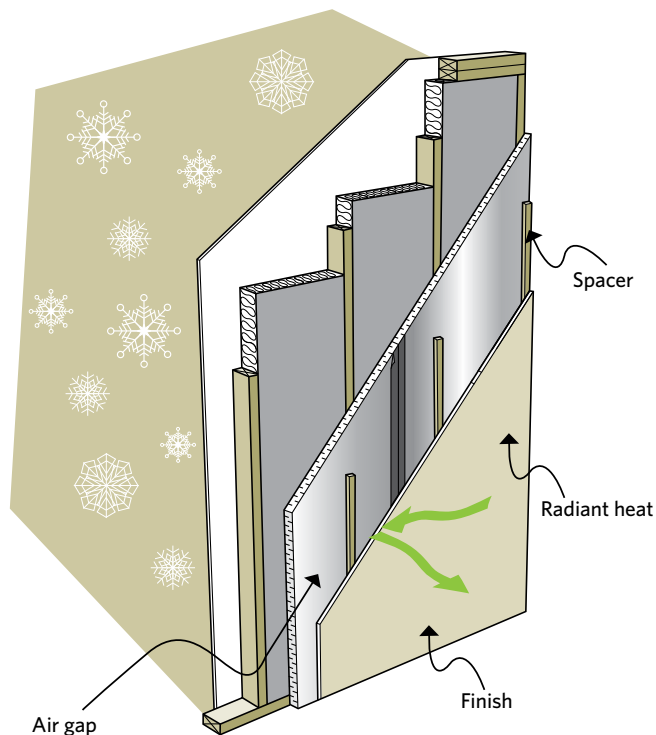


Table 3-1 Insulation values

Material	Ranges RSI/25.4 mm (R/in.)	Design spec or average RSI/25.4 mm (R/in.)
Polyurethane closed-cell spray foam	0.97 to 1.14 (R-5.5 to 6.5)	1.06 (R-6)
Polyurethane board	0.97 to 1.2 (R-5.5 to 6.8)	1.06 (R-6)
Extruded polystyrene board (XPS)	0.88 (R-5)	0.88 (R-5)
Polyisocyanurate spray foam	0.85 to 1.46 (R-4.8 to 8.3)	0.88 (R-5)
High-density glass fibre board	0.63 to 0.88 (R-3.6 to 5)	0.7 (R-4)
Expanded polystyrene board - Type I (EPS)	0.67 (R-3.8)	0.67 (R-3.8)
Expanded polystyrene board - Type II (EPS)	0.7 to 0.77 (R-4 to 4.4)	0.7 (R-4)
Glass fibre roof board	0.67 (R-3.8)	0.67 (R-3.8)
Cementitious foam	0.69 (R-3.9)	0.69 (R-3.9)
Cotton fibre batt	0.67 (R-3.8)	0.67 (R-3.8)
Cork	0.65 to 0.67 (R-3.7 to 3.8)	0.65 (R-3.7)
Polyurethane open-cell spray foam	0.63 to 0.67 (R-3.6 to 3.8)	0.63 (R-3.6)
Polyurethane open-cell foam, poured	0.7 (R-4)	0.7 (R-4)
Cellulose fibre, wet sprayed	0.53 to 0.67 (R-3 to 3.8)	0.63 (R-3.6)
Cellulose fibre, blown, settled thickness	0.53 to 0.67 (R-3 to 3.8)	0.63 (R-3.6)
Mineral fibre batt	0.53 to 0.7 (R-3 to 4)	0.6 (R-3.4)
Wood fibre	0.58 (R-3.3)	0.58 (R-3.3)
Mineral fibre, loose fill, poured	0.44 to 0.65 (R-2.5 to 3.7)	0.58 (R-3.3)
Glass fibre batt	0.55 to 0.76 (R-3.1 to 4.3)	0.56 (R-3.2)
Glass fibre, loose fill, poured	0.39 to 0.65 (R-2.2 to 3.7)	0.53 (R-3)
Mineral fibre, loose fill, blown	0.51 to 0.56 (R-3 to 3.8)	0.53 (R-3)
Glass fibre, loose fill, blown	0.48 to 0.63 (R-2.7 to 3.6)	0.51 (R-2.9)
Fibreboard (beaverboard)	0.41 (R-2.3)	0.41 (R-2.3)
Mineral aggregate board (Insulbrick)	0.41 to 0.7 (R-2.3 to 4)	0.46 (R-2.6)
Wood shavings	0.18 to 0.53 (R-1 to 3)	0.42 (R-2.4)
Vermiculite*	0.37 to 0.41 (R-2.1 to 2.3)	0.38 (R-2.2)
Compressed straw board	0.35 (R-2.0)	0.35 (R-2.0)

Material	Ranges RSI/25.4 mm (R/in.)	Design spec or average RSI/25.4 mm (R/in.)
Eel grass (seaweed) batt	0.53 (R-3)	0.53 (R-3)
Cedar logs	0.18 (R-1)	0.18 (R-1)
Softwood logs (other than cedar)	0.18 to 0.25 (R-1 to 1.4)	0.22 (R-1.25)
Hardwood logs	0.12 (R-0.7)	0.22 (R-1.25)
Straw bale	0.23 to 0.28 (R-1.3 to 1.6)	0.26 (R-1.45)
Radiant foil insulation	See Radiant foils	

*See the vermiculite health and safety warning in Section 1.4, Health and safety considerations.

3.3 AIR BARRIER MATERIALS

The main purpose of an air barrier system is to protect the building structure and the insulation from moisture damage. It must resist air movement; be continuous, completely surrounding the envelope of the house; be properly supported by rigid surfaces on both the interior and exterior (to prevent movement in high winds); and be strong and durable. Attention to detail during installation is critical for good performance.

Various materials throughout the envelope act as an air barrier. Large-surface building materials such as drywall, baseboards or structural members and windows and doorframes are incorporated into the air barrier by sealing them to the adjoining materials. Caulking, tapes and gaskets are used for joints between materials that do not move, and weatherstripping, for joints that do move.

3.3.1 Choosing an air barrier material

If the material that you are considering using offers resistance to airflow and is strong and durable, consider the following installation factors:

- Is it easy to install without help?
- If installed in a concealed location, will it last the life of the building or will it be accessible and easily repairable?

- Is it compatible with other materials in the system? Can it be successfully sealed to adjacent materials?
- Is the choice of material appropriate for any other work being done?
- Does it serve other functions such as acting as insulation, a vapour barrier or part of a drainage plane?

Sheet materials

i) House wrap (typically made from a spun polyolefin plastic)

- is generally used to wrap the exterior of a house
- acts as a wind barrier when installed on the exterior; prevents wind from reducing the nominal RSI value of insulation
- acts solely as an air barrier; does not function as a vapour barrier
- can function as a drainage plane surface when the upper sheet overlaps the lower sheet and the flashings and all edges and penetrations are sealed with acoustical sealant or sheathing tape
- application in wide sheets minimizes the number of seams required
- should be protected from extended exposure to sunlight

- when installed with stucco or embedded in stone veneers, requires an additional 5-mm ($\frac{3}{8}$ -in.) gap for a drainage plane (use a drainage mat) to prevent the stucco from bonding to the house wrap
- should not come in direct contact with cedar because the oils in the wood can cause deterioration in the product

ii) Polyethylene sheeting

- is commonly installed as a vapour barrier in the thickness of 0.15 mm (6 mil) because it is more durable on the construction site
- should be labelled showing that it conforms to the Canadian General Standards Board (CGSB) standard for polyethylene
- application in wide sheets minimizes the number of seams required
- should have the seams and edges supported on both sides to maintain the seal
- requires an appropriate sealant and overlapped joints
- functions as a vapour barrier. Should always be used on the interior or follow the $\frac{1}{3} - \frac{2}{3}$ rule (see Section 1.4, Health and safety considerations). Follow local building codes for placement of a polyethylene vapour barrier.

TECHNICAL NOTE: If the sheeting will be exposed to sunlight over an extended period during renovations, use a UV-stabilized polyethylene.

iii) Polyamide sheeting

- is also known as Nylon-6 vapour retarder film or smart barrier
- adapts its permeability to the conditions. In cold temperatures, it offers high resistance to vapour pressure; in warmer conditions, it becomes more permeable, allowing the structure to dry out.

- can be installed as a vapour barrier or an air barrier
- should not be used in indoor areas that have high humidity such as an indoor spa or pool or a bathroom

iv) Rigid materials

Most solid building components including drywall, plaster, plywood, glass, wood, rigid foam insulation and poured concrete (not concrete blocks) will act as air barriers. Seal all seams between these materials with the appropriate caulking, weatherstripping, tape or gasket. For example, caulking can be used between the baseboard and a wall as well as between the baseboard and the floor, linking the air sealing qualities of three building components.

3.3.2 Sealants

Caulking seals joints between building components. Most joints move because of changes in moisture and temperature in the building. Some materials can seal a larger joint and accommodate more joint movement than others. Choose carefully because there is wide variation among the same type of products produced under different brands. If possible, always select the premium product for long-term durability. Choosing the proper product and paying attention to the quality of application are crucial.

All sealants will require extra ventilation of the house after application to let the material cure. Typical curing time will be two or three days for interior applications. For application directions, see Section 4.2, Caulking and other air sealing materials.

Materials labelled “for exterior use only” may not be suitable for indoor applications because they may contain volatiles that may be hazardous if inhaled in a confined space over an extended period. Read the manufacturer’s literature carefully.

The following factors limit the effectiveness of caulking:

- the flexibility and elasticity of the product. Some products can span a larger gap than others. Use a backer rod or foam rope in joints of 6 mm (1/4 in.) and larger before applying caulking to ensure an effective seal.
- its compatibility with the materials being joined. Read the manufacturer's literature carefully.
- its durability, paintability and curing time. If the product will be exposed to sunlight, make sure it is appropriate for this condition.
- its ease of removal and reapplication. Some products can be used over previous applications while others cannot; some clean up easily with water, some require solvents, and some are very difficult to remove once cured.

Table 3-2 lists caulks and sealants available at most building supply stores. It is designed to help you select the best product for each application. If possible, always select a premium product for long-term durability.

TECHNICAL NOTE: Be mindful when using caulks and sealants. Urethane foams are impossible to remove once cured, other products are flammable. Read manufacturers' literature and take proper precautions during installations (wear gloves, etc.).

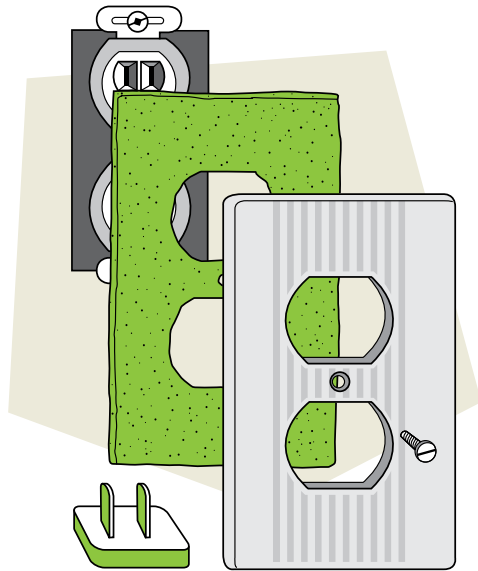
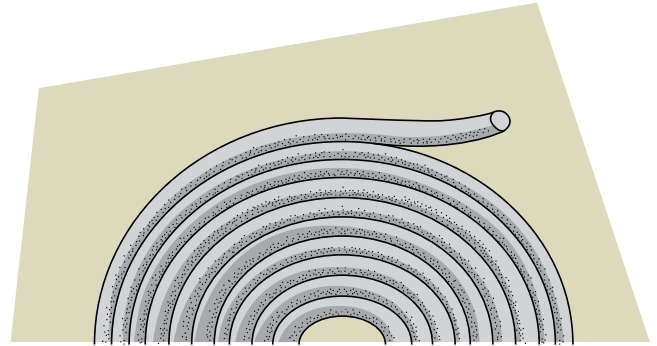
Table 3-2 Air barrier caulking and sealants

Type	Bonds to	Application	Maximum joint	Comments
Acoustical sealant	▪ metal, concrete, gypsum board and polyethylene	▪ use only where sandwiched between two materials (not exposed to the exterior) ▪ staples required when sealing joints in polyethylene ▪ can be reapplied over itself	▪ 16 mm (5/8 in.) ▪ accepts 10% joint movement	▪ good durability: 20 years ▪ non-hardening ▪ not paintable
Butyl rubber caulk (synthetic rubber sealant)	▪ most surfaces but particularly suited to metal and masonry	▪ generally used on exterior ▪ ventilation required during application and curing (up to three days) ▪ difficult to smooth	▪ 13 mm (1/2 in.) ▪ accepts 5 to 10% joint movement	▪ low to moderate durability: 5 to 10 years ▪ available in a variety of colours ▪ paintable after curing

Type	Bonds to	Application	Maximum joint	Comments
Silicone sealant caulk	- most non-porous surfaces - primers may be required on wood, steel or anodized aluminum - cannot be used over existing silicone	- interior and exterior grades - ventilation required during application - easy to smooth - flexible, watertight seal when cured	25 mm (1 in.) with backer rod - accepts 12 to 50% joint movement - excellent for large moving joints	- good durability: 20+ years - available with fungicide for wet locations and in a high-temperature type for use around chimneys/vents - available in colours and clear - most types not paintable - paintable types less durable
Polysulphide caulk (synthetic rubber sealant)	- stone, masonry and concrete surfaces when used with a special primer - may attack some plastics	- generally used on exterior - can be used below grade - ventilation required while curing - moderately easy to smooth - flexible upon curing	25 mm (1 in.) with backer rod - accepts 12 to 25% joint movement	- very good durability: 25+ years - available in several colours - paintable
Polyurethane caulk (urethane)	- most surfaces - preferred choice of window and door installers	- exterior use only - ventilation required while curing - long curing time - can be hard to smooth - flexible upon curing - can be reapplied over itself	25 mm (1 in.) with backer rod - very stretchable: up to 50% joint movement	- very good durability: 25+ years - limited colours - paintable
Acrylic latex caulk	most surfaces	- interior and exterior use - ventilation required when curing - easy to smooth	10 mm (3/8 in.) - accepts 7 to 10% joint movement	- low to moderate durability (varies by brand): 5 to 25 years - water cleanup - comes in colours - paintable

Type	Bonds to	Application	Maximum joint	Comments
Acrylic latex with silicone caulk	▪ most surfaces	▪ interior and exterior use ▪ ventilation required when curing ▪ easy to smooth ▪ can be reapplied over itself	▪ 13 mm (1/2 in.) ▪ accepts 10 to 15% joint movement	▪ very good durability: 30+ years ▪ water cleanup ▪ paintable
Elastomeric latex sealant	▪ most surfaces	▪ interior (some brands only) and exterior use ▪ ventilation required when curing ▪ flexible upon curing ▪ moderately easy to smooth ▪ can be reapplied over itself	▪ 25 mm (1 in.) with backer rod ▪ accepts 50% joint movement	▪ very good durability: 30+ years ▪ water cleanup limited colours ▪ paintable
Urethane foam sealant (low, medium and high expansion types)	▪ most surfaces except Teflon, polyethylene or silicone plastics	▪ interior and exterior use ▪ use only low expansion type around window and doorframes or risk bowing ▪ can be used below grade ▪ ventilation required during installation ▪ can be reapplied over previous foam ▪ protect from sunlight	▪ check the can for expansion rates and sizes of cracks that can be filled ▪ very good for filling larger joints and cavities like header/joist intersections, around indoor and outdoor plumbing and vent openings, and wiring holes	▪ good durability: 10 to 20 years ▪ available in individual aerosol spray cans and dispensing systems with spray nozzles ▪ hard consistency when cured ▪ use gloves and a drop cloth: impossible to remove residue after curing ▪ use acetone to clean up uncured foam ▪ paintable

Type	Bonds to	Application	Maximum joint	Comments
Latex foam sealant	most surfaces	- interior and exterior use - must be covered for exterior use due to open-cell structure - not for use below grade - ventilation required during installation - extremely flammable during application: read precautions on the product label - can be applied in successive layers - difficult to smooth	- will not over expand – reaches 75% of size upon application - recommended around window and door frames, but requires a vapour barrier	- good durability: 10 to 20 years - cleans up with water - soft, spongy consistency when cured - paintable
High-temperature stove or muffler cements and non-combustible sealants	- most materials - typically used in conjunction with other materials for sealing around masonry or factory-built chimneys	- interior and exterior use - for use in high temperature applications - easy to smooth	no joint movement	- very good durability - compatible with high-temperature silicone sealant - check product for CSA or UL rating for high-temperature use - available at heating equipment supply stores

Figure 3-3 Electrical outlet gasket

Figure 3-4 Foam backer rod


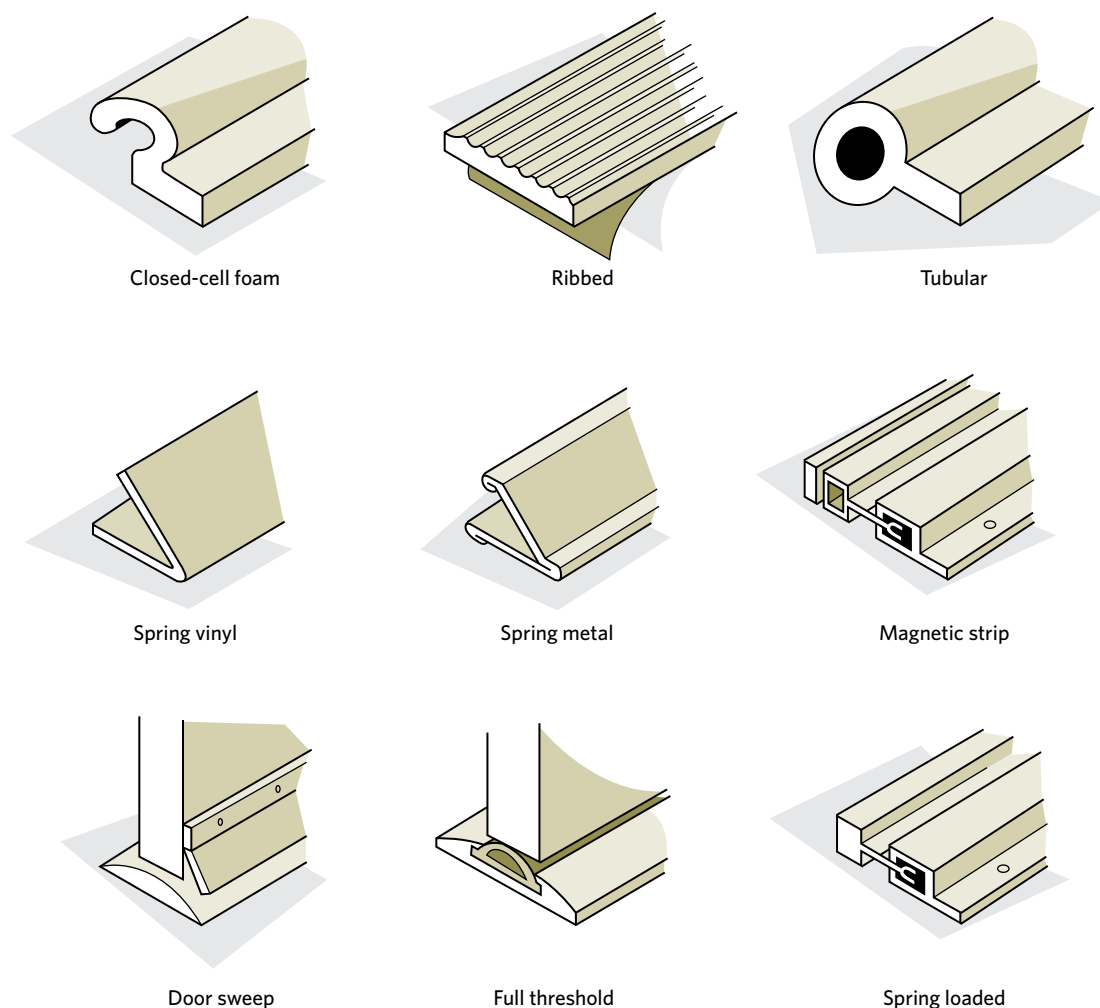
3.3.3 Gaskets

Gaskets are used to seal joints where caulking may not be appropriate. Table 3-3 describes the most common types of gasket materials and where each type works best.

Table 3-3 Gaskets

Type	Application	Installation	Comments
Sill plate gasket (polyethylene foam strips)	installed between the foundation and sill plate during construction or where existing house walls meet	- staple to hold it temporarily in place - cuts easily with a knife	available in 152 and 203 mm (6 and 8 in.) widths on 24 m (79 ft.) rolls
Foam backer rod (closed-cell compressible foam rope)	excellent for filling gaps before caulking	ensure caulking will fill the gap (see product specifications for maximum joint width)	available in diameters of 6 to 50 mm (1/4 to 2 in.)
Electrical outlet and lighting fixture gaskets (pre-cut)	designed to fit behind the cover plates of electrical receptacles, switches and lighting mounts	electrical outlet gaskets are more effective when caulked and should be used in conjunction with child-safety plugs to reduce air leakage through electrical sockets	place the centre cut-out piece of foam gasket over the end of the electrical plug or child safety plug to ensure a proper seal
Neoprene and elastomeric gaskets	excellent for sealing joints and penetrations where movement is to be expected such as plumbing stacks	- best slipped over piping, if possible - very difficult to seal if it must be cut to fit around piping	flexible and very durable

Figure 3-5 Types of weatherstripping



3.3.4 Weatherstripping

Weatherstripping is used to block air leakage around doors and the operable parts of windows. Weatherstripping comes in a variety of shapes: flat strip, tube or V (i.e. V-strips), and can be designed to work under compression or by sliding along the joint. To be effective, the product must close the gap and not allow air to pass. Some products get hard – and less effective – in cold weather when you need them the most.

When choosing weatherstripping, consider the size of the gap to be sealed and the durability, ease of installation and finished appearance of the product. Look for products that are flexible and that spring back to their original shape quickly and easily. Avoid products that make it difficult to operate the window or door. When replacing weatherstripping, bring a sample of the old material to the store with you to ensure that you purchase the correct product.

A wide range of products is available in most building supply stores, including complete sealing kits. For the best quality weatherstripping, contact window and door manufacturers or installers.

Table 3-4 lists the major types of products.

Table 3-4 Weatherstripping

Compression strips

Category	Application	Installation	Comments
Closed-cell foam (with or without vinyl covering)	use where there is a pressure stress: along the bottom of vertical sliding windows, around attic hatches or on hinged windows and doors	- adhesive-backed - easy to install - available in rolls	- available as a high-performance compressible polyurethane strip with its own carrier - good for irregular surfaces - vinyl may crack over time
Ribbed closed-cell rubber	as above	- adhesive-backed - available in rolls - very durable - easy to install	- good for irregular surfaces - less appropriate for long or varied gaps
Tubular stripping material	as above	- has its own attachment or an attachment strip - installed with nails, staples or screws	- rubber more durable than plastic - noticeable when installed - check for suitability of use in cold weather

Tension strips

Category	Application	Installation	Comments
Spring vinyl	- use in the same applications as compression strips - also in sliding joints for double-hung windows and doors	- adhesive-backed - easy to install - use small-format V-strip for narrow gaps such as tight-fitting double-hung windows - use large format for wide gaps	- good durability - polypropylene type should be chosen instead of other plastics
Spring metal	- generally used for doors - most effective under light compression	installed using small tacks	- metal can permanently deform - potential to ice-up

Combination types

Category	Application	Installation	Comments
Spring-loaded, self adjusting	- spring mechanism adapts to long unequal distances from the weatherstrip to the door or window - effective for doors and hinged windows	installed with screws through an attachment strip	- can be used in conjunction with V- strips - cannot adjust to small irregularities - limited colours - highly visible
Magnetic-strip systems	- magnetic strips on the frame and on the door/window provide the seal - effective for doors and hinged windows	ensure a clean, smooth surface for installation of self-stick products	- good durability - highly noticeable when installed - limited colours - for doors: works best on modern steel doors - may not provide good seal in cold conditions because of condensation and frost formation (i.e. the PVC case may stiffen and split)

Door bottoms, sweeps and thresholds

Category	Application	Installation	Comments
Door sweeps (attach to the door)	- vinyl, pile, silicone or rubber sweep - screwed with a metal or plastic attachment strip	easier to install than a threshold	- effective with low-pile carpet or no carpet - height variable attachment - some models have replacement seals available - more durable than thresholds, but often provide a less effective seal - some vinyl types are very flexible and more durable
Door bottoms	- combination strips of vinyl, pile or compressible rubber - attachment strip fits over the door bottom	requires a clearance of 8 to 13 mm (1/3 to 1/2 in.) under the door	more durable than thresholds, but often provide a less effective seal
Thresholds (attach to the floor or door frame beneath the door)	a vinyl rubber or combination metal/vinyl or rubber strip attached to the threshold	requires clearance below the door, see the manufacturer's instructions	- can become damaged by traffic and weathering - some models have replacement seals available - provides an excellent seal - less durable than door sweeps, but a more effective seal

Other air barrier materials

Category	Application	Installation	Comments
Duct tape	- approved foil and flexible plastic duct tapes can be used to seal seams of heating duct to reduce air leakage - do not use on heating equipment vents or chimneys	- may require removal of paper backing to expose the adhesive - clean surfaces before applying - do not use common vinyl or cloth-backed duct tapes because the adhesive fails over time	use especially where ducts pass through unheated areas
Sheathing tape (i.e. red technical tape)	used to seal the seams of house wrap, wind barrier material and polyethylene air barrier material	try to place tape joints between building materials to help further secure it, if possible	- very sticky adhesive - do not apply temporarily to finished surfaces because the adhesive may remain on the surface after the tape is removed
Electrical box air barriers	placed around electrical outlet and switch boxes before installation	equipped with a flange for sealing to the main air barrier	- also act as a vapour barrier - seal the wiring hole with an appropriate sealant
Mastic putty	- hole filler - usually applied around pipes and cabling on exterior walls	sticks or ribbons of putty are softened and pushed around pipes or cables on existing walls or furnace plenum	- poor adhesion when the product dries out - do not use below grade or where subject to wetting
Mastic latex sealant	seals joints on heating, cooling and ventilation ducts	apply to cleaned joints with a brush or a cotton glove with non-latex liner (then discard!)	- easy cleanup - good bond - not noticeable - water-based type has low to no fumes
Pot light covers (recessed light covers)	seals pot light fixtures to the top of the ceiling	- installed from above with screws - some come with sealants on gaskets	designed for high temperatures

3.4 VAPOUR BARRIER MATERIALS

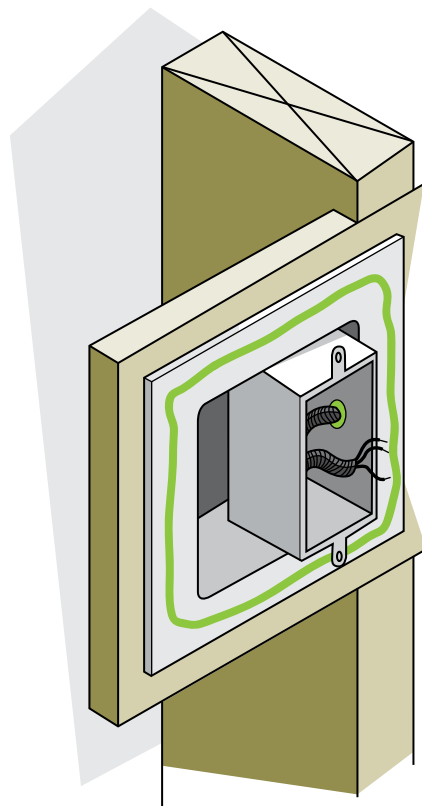
The vapour barrier is an important component of the house envelope because it provides the structure and insulation some protection from moisture damage. The vapour barrier must resist the flow of water vapour from the interior, be durable and be located on the warm side of the insulation. In some cases it may be part of the insulation or air barrier. It should be easy to install and appropriate for other work being done on the home.

Install the vapour barrier to protect the entire surface areas of insulated walls, ceilings and floors. Give special attention to all penetrations, joints and junctions (e.g. light fixtures, wall plugs, switches and window frames) and areas that receive high humidity such as bathrooms and kitchens.

Usually located on the warm side of the insulation, the vapour barrier can also be installed part way into the wall, provided that no more than one third of the insulating value of the wall is on the warm side of the vapour barrier. (For information about the $\frac{1}{3} - \frac{2}{3}$ rule, see Section 2.4, Control of moisture flow.)

This amount of insulating value should be reduced to one quarter or less in very cold climates or in buildings with high moisture sources such as swimming pools. Like an air barrier, the vapour barrier can be made of various materials, including existing building components such as plywood, OSB, paint or vinyl wallpaper. In most older homes, the layers of oil-based primer and paint can function as an adequate vapour barrier for walls and ceilings.

Figure 3-6 Sealing an electrical box



Vapour barrier performance

The effectiveness of a vapour barrier (also known as a vapour diffusion retarder) is measured in terms of its permeability (perm) rating. The lower the perm rating, the more effective the moisture barrier will be. Materials considered to be effective vapour barriers include polyethylene, aluminum foil, polamide film (smart barrier), oil-based and latex vapour barrier paints (varying by type and thickness, some types and thickness of insulation and even some vinyl wallpapers).