ENERGY EFFICIENCY BUILDING ENVELOPE RETROFITS FOR HOUSES

- Interior Retrofit for 1960s and 1970s Raised Bungalow
- 10% or 25% Space Heating Energy Savings

Figure 1: Raised bungalow

INTERIOR RETROFIT

The building envelope can be retrofitted from either the exterior or the interior. The choice will largely depend on the house's interior and exterior finish, layout and construction, lot line setback requirements, other renovation needs and whether or not the house will be occupied during the renovation. There are several advantages to airtightening and insulating a house from the interior. An interior retrofit can be done year-round; it doesn't affect exterior cladding; it may cover cracks, holes and thermally conductive materials (called 'thermal bridges'); and it doesn't reduce distances to property lines.

RETROFIT FOR ENERGY SAVINGS

One of the best ways to reduce the energy consumption of an existing house is to add insulation to the roof, walls and basement, upgrade windows and doors, and seal cracks, leaks and holes. These improvements, called "energy efficiency building envelope retrofits," help to reduce heat losses in the winter and heat gains in the summer, and should result in lower energy bills, improved comfort and reduced outside noise intrusion.

This fact sheet provides guidance for interior energy efficiency building envelope retrofits to 1960s and 1970s two-storey houses that can reduce space heating energy consumption by 10 per cent and 25 per cent. It describes the starting point (what you have now), air sealing and insulation options to achieve the targeted energy savings, technical considerations to keep in mind in the planning of the retrofit project, and general precautions.

What You Have Now

The pre-retrofit construction of a 1960s or 1970s raised bungalow will vary depending on its age and location and on whether any upgrades have already been completed. The building envelope of a typical 170 m² - 200 m² (1,830 sq. ft. - 2,153 sq. ft.) house of this vintage with finished basement will likely be clad with masonry, siding or stucco. Figure 2 illustrates common materials, insulation RSI-value (R-value), and assemblies for this type of building, subject to regional variations. Houses such as these generally have high air leakage with measured airtightness values averaging above 6.0 air changes per hour at an applied air pressure difference of 50 pascals (ACH_{50}).

Houses built in the 1960s and 1970s also tend be lightly insulated. It is common to find attics with a single layer of insulation and walls with insulating values that are half that required in new homes. Basements usually have modest levels of insulation, if any at all. Fortunately, there are many opportunities to improve the energy efficiency of the building envelope. Insulation, air sealing and window technology have evolved significantly. For example, higher RSI-value (R-value) insulation is now available; low-emissivity coatings, gas fills and superior seals and spacers improve the thermal performance of windows considerably; and airtightness techniques are better understood.

Figure 3 shows a general approach to retrofitting the same wall shown in Figure 2—from the attic to the basement. The following section describes five specific building envelope retrofit options, three of which can be used to achieve 10-per-cent space heating energy savings and two of which can be used to achieve 25-per-cent savings.

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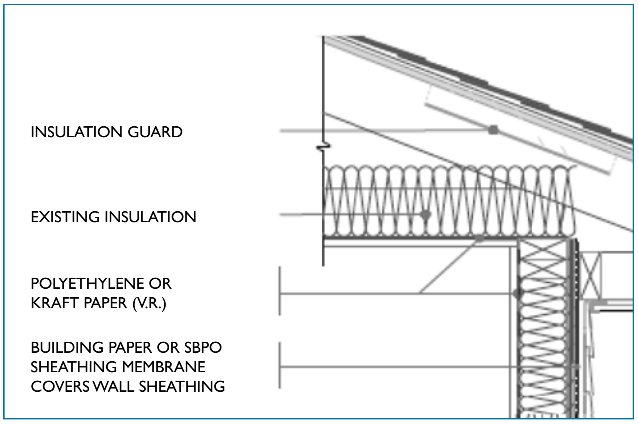
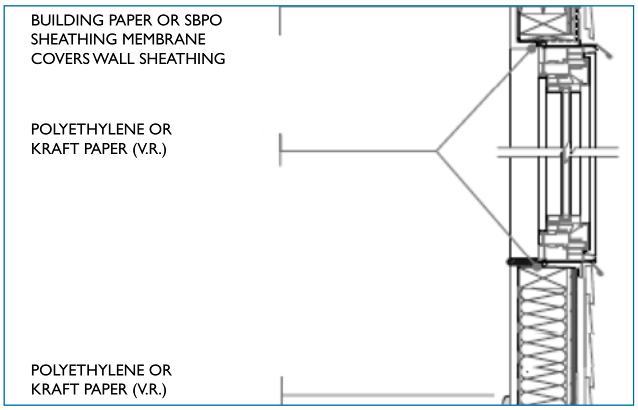


Roof and attic

Plywood or oriented strand board (OSB) on top of roof trusses or rafters with approximately 200 mm (8 in.) of glass-fibre insulation fitted between the bottom truss chords, providing a nominal RSI-3.8 – 4.6 (R-22 – 26).

The height of the roof trusses between the top and bottom chords is usually quite shallow where the trusses are supported on the exterior walls and, therefore, there may not be sufficient height at the eaves for additional insulation.

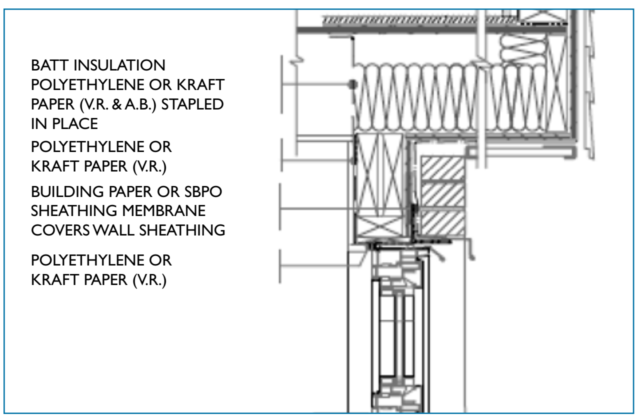


Windows and doors

Wood- or vinyl-framed windows, either single-glazed or double-glazed with metal spacer bar and air-filled cavity.

If they haven't already been replaced, windows are often leaky and provide poor thermal performance.

The space between the window and the rough opening might be leaky.

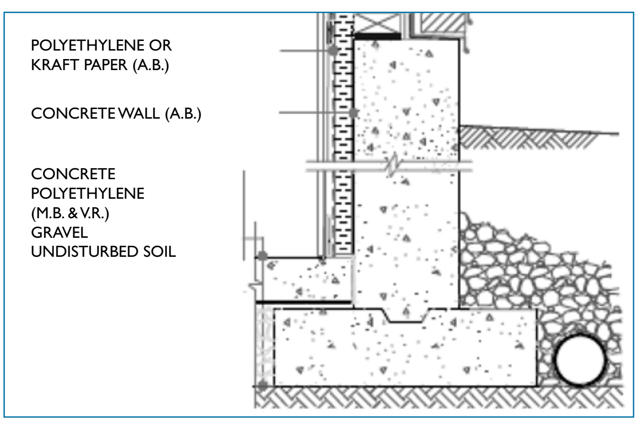


Above-grade walls

Siding, stucco, masonry or other cladding over OSB or plywood sheathing with 38x89 mm (2x4 in.) wood-frame walls. The wood-frame cavity may contain fibreglass batt insulation, providing a nominal RSI-2.0 – 2.6 (R-11 – 15).

A polyethylene sheet vapour retarder might be installed on the inside of the wall framing and covered with gypsum board; in some cases, kraft paper-backed batt insulation may be present and stapled to the wood studs to secure the insulation in place.

The interior surface of the rim joist might have batt insulation stuffed in the space between floor joists. A polyethylene sheet vapour retarder on top of the insulation may or may not be present.

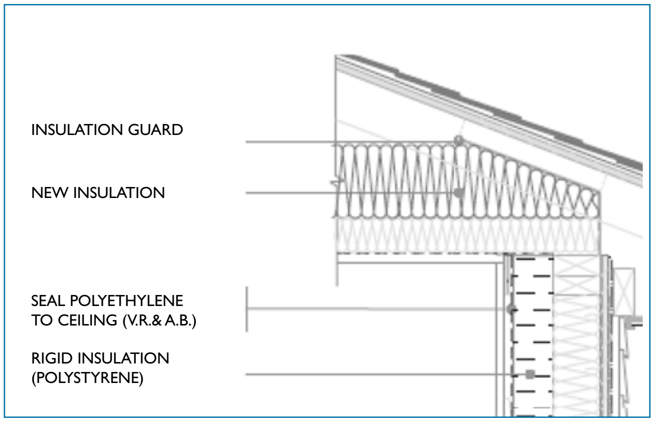


Below-grade walls

Concrete or concrete block foundation wall with exterior dampproofing. Interior wood-frame wall filled or partially filled with batt insulation, providing a nominal RSI-1.1 –1.6 (R-6 – 9).

The interior surface of the rim joist might have batt insulation stuffed in the space between floor joists. A polyethylene sheet vapour retarder on top of the insulation may or may not be present.

Figure 2: Pre-retrofit section through roof and ceiling, above and below grade walls, floors and basement slab of a two-storey house

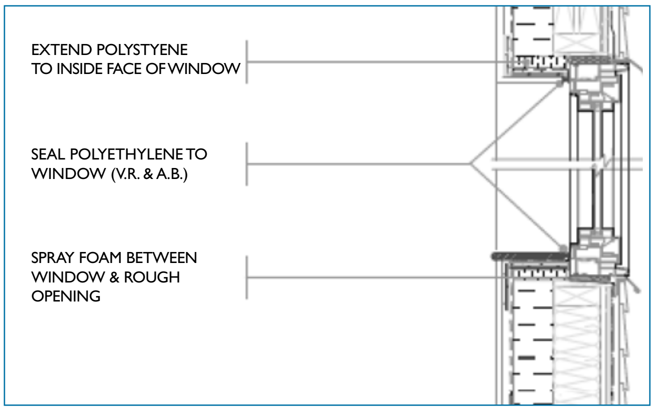


Roof and attic

Install additional fibreglass batt or blown-in insulation on top of existing ceiling insulation.

Ensure insulation guards (baffles), installed between trusses on underside of roof sheathing are unblocked, providing adequate ventilation to the attic space.

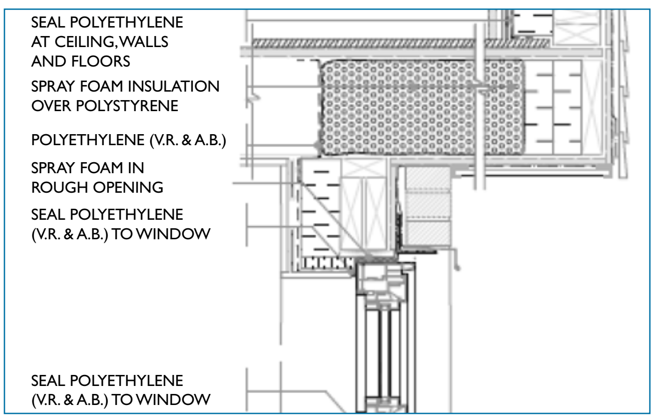
Seal new polyethylene vapour retarder/air barrier in wall to existing ceiling gypsum board or polyethylene vapour retarder (if one is present), using compatible tape or sealant.



Windows and doors

Ensure that replacement windows and doors are ENERGY STAR® rated or better, and appropriate for your location (heating-degree-day zone).

Consider higher water penetration criteria for operable units (for example, sliding, single- and double-hung, casement, tilt-and-turn windows and awning), especially in regions where wind-driven rains are commonly experienced. Use sub-sill flashings to drain moisture away from the rough opening and the wall assembly.

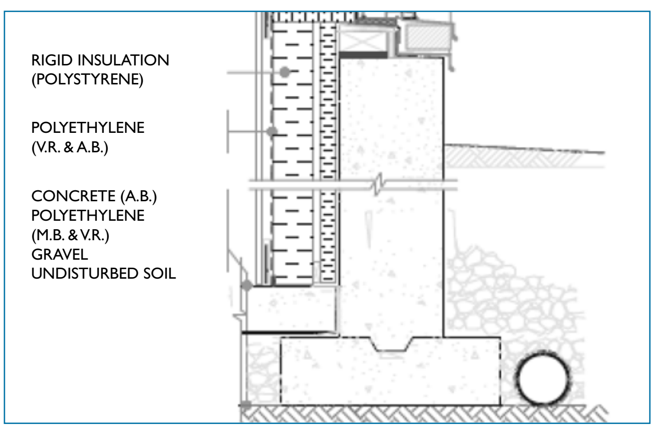


Above-grade walls

Remove existing gypsum board finish and polyethylene vapour retarder. Install continuous rigid insulation (in layers, if appropriate) over the interior wall areas.

Install polyethylene vapour retarder (that is, the air barrier) over the rigid insulation, ensuring all joints, laps and penetrations in and through polyethylene are properly sealed to form a continuous, airtight system.

Install furring over the rigid insulation and vapour retarder/air barrier, fastened directly to the studs, then cover with gypsum board.



Below-grade walls

Remove existing gypsum board and polyethylene vapour retarder. Install rigid insulation (in layers, if appropriate) continuously over the interior wall areas.

Install polyethylene vapour retarder (that is, the air barrier) over top of the rigid insulation, ensuring all joints, laps and penetrations in and through polyethylene are properly sealed to form a continuous, airtight system. Install furring over the rigid insulation and polyethylene vapour retarder/air barrier, fastened directly to the studs, then cover with gypsum board.

Figure 3: Post-retrofit section through roof and ceiling, above- and below-grade walls, floors and basement slab of a raised bungalow

Before planning a retrofit for a specific house, CMHC recommends that a qualified residential energy service provider undertake an EnerGuide audit of the house. The audit should measure the airtightness of the pre-retrofit house, suggest upgrades to the heating system, and locate areas where air leaks should be sealed and insulation should be added. Audits and ratings can be obtained from service organizations licensed under Natural Resources Canada's EnerGuide program. For more information on finding a qualified service organization, visit *http://oee.nrcan.gc.ca/residential/personal/16352*.

BUILDING ENVELOPE RETROFIT OPTIONS FOR SPACE HEATING ENERGY SAVINGS

The following energy efficiency retrofit measures can be cost-effective subject to the condition of the house, assemblies and materials, local renovation costs and energy prices:

- Improve airtightness.
- Add insulation in the roof or attic.
- Add insulation on the interior of below-grade (basement) walls.
- Add insulation on the interior of above-grade walls.
- Replace windows and doors with ENERGY STAR® windows and doors.

Improving airtightness by sealing cracks, holes and gaps in the building envelope is relatively inexpensive and has a big effect on reducing energy loss, making it the most cost-effective measure. In other words, it leads to the greatest savings of heating energy per dollar spent. Moreover, an airtight house gains the full benefit of all the other retrofit measures because air leakage can reduce the thermal resistance of some types of insulation. Because of this, all proposed retrofit options include improving the airtightness by 30 per cent. Improved airtightness reduces air leakage into the house and may require more mechanical ventilation, such as that provided by a heat recovery ventilator, to maintain acceptable indoor air quality. The measures required to achieve this level of airtightness can be determined by an energy audit.

Table 1 identifies three different building envelope retrofit options that target space heating energy savings of approximately 10 per cent or more and two additional retrofit options that target space heating energy savings of 25 per cent or more. For example, retrofit option 1 involves improving the airtightness of the house by 30 per cent and adding RSI-3.52 (R-20) insulation to the attic to achieve a 10-per-cent energy saving. Retrofit option 4 involves improving airtightness by 30 per cent and adding RSI-3.52 (R-20) insulation to the roof or attic, and RSI-2.64 (R-15) to below-grade walls and above-grade walls to achieve a 25-per-cent energy saving.

For all options, greater energy savings can be achieved by undertaking more measures or by using more insulation than specified. The choice of retrofit options and the measures they include will depend on what suits the house, as well as the desired energy savings and the renovation budget.

Retrofit Option #	Retrofit Measures					Space heating energy saved
	Improve airtightness by 30%	Add insulation in roof or attic	Add insulation to interior of below-grade walls	Add insulation to interior of above-grade walls	Replace windows and doors with ENERGY STAR® windows and doors	
1	✔	RSI-3.52 (R-20)				**10%** (or more)
2	✔		RSI-1.76 (R-10)			
3	✔			RSI-1.76 (R-10)		
4	✔	RSI-3.52 (R-20)	RSI-2.64 (R-15)	RSI-2.64 (R-15)		**25%** (or more)
5	✔				✔	

Table 1: Suggested interior retrofit options with improved airtightness and nominal added RSI-value (R-value) to achieve space heating energy savings of 10 and 25 per cent or more

Retrofit options 1 and 2 can be undertaken without affecting the above-grade walls of the house. Option 3 requires removing and replacing the interior finish, baseboards and trim on the exterior above-grade walls. Because the insulation will be added on the interior of the framing, the rooms will become slightly smaller.

Option 4 is a more comprehensive retrofit that targets a 25-per-cent space heating energy reduction. It entails adding insulation to both the above-grade and below-grade walls to achieve a higher thermal insulating value than that used in the 10-per-cent options. This means using insulation that is thicker or that has a higher RSI-value (R-value) per unit thickness.

The window and door replacement in option 5 entails removing and replacing the existing units with ENERGY STAR® rated windows and doors and insulating and air sealing the junction between the new windows or doors and the wall air barrier. This is typically done by spraying insulating foam into the cavity between the windows and doors and their respective rough openings.

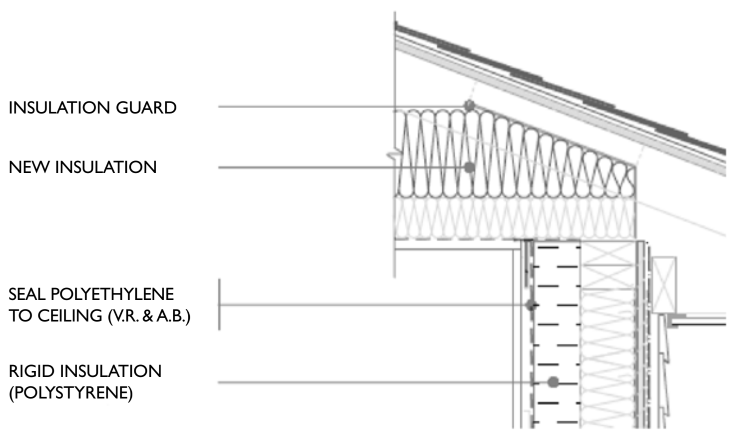
TECHNICAL CONSIDERATIONS

Roof and attic

Insulation

Retrofit work in the attic provides a good opportunity to ensure that the attic space is properly vented. Attic venting depends on air flow from the soffits and helps prevent moisture build-up, which can lead to deterioration of framing, roof sheathing and other building components. If the house doesn't have insulation guards (baffles) under the roof sheathing where the rafters or trusses sit on the exterior wall, these should be installed prior to adding more insulation.

The existing attic likely contains batt or blown-in insulation above the ceiling, which will remain in place while the roof and attic retrofit is carried out. The shape and slope of the roof will determine where and how much insulation can be added. Where space permits, RSI-3.52 (R-20) insulation can be added by blowing approximately 150 mm (6 in.) of loose-fill glass-fibre, mineral wool or cellulose directly on top of the existing insulation. Alternatively, 150 mm (6 in.) of glass-fibre or mineral wool batts can be placed over the existing insulation (Figure 4).



Additional batt or blow-in insulation is installed in the attic space over top of the existing insulation.

The gypsum board and/or the polyethylene at the ceiling can function as the air barrier. It is essential that airtightness continuity is maintained at all joints, cracks, gaps and penetrations through the ceiling assembly and with the adjacent wall airtightness plane.

Figure 4: Roof and attic - insulation added over existing insulation

Where there is limited or insufficient space for insulation at the roof-exterior wall junction, closed-cell foam insulation with a higher RSI-value (R-value) may be sprayed between the top of the wall and the underside of the insulation guards (baffles) from the exterior by removing the soffits, as shown in Figure 5. It can also be done from the inside of the attic if the clearance between the roof sheathing and ceiling below permits. To provide backing against which the insulating foam can be applied, a vertical 'dam,' made of suitably rigid material such as plywood, can be installed against the existing insulation between the ceiling and the insulation guard. The closed-cell foam insulation provides an airtight connection between the wall and ceiling air barrier systems. This also prevents air movement from reducing the effectiveness of the insulation (called 'wind washing'), and wind gusts from displacing the loose-fill insulation.

Figure 6 presents an alternative approach to insulating the ceiling from the interior. In this approach, the existing gypsum board ceiling and polyethylene (if it exists) must be removed, and polystyrene insulation is installed on the underside of the roof framing followed by a new polyethylene sheet and new gypsum board.

Airtightness

Experience has shown that the installation of a continuous air barrier system, properly detailed and constructed, can reduce air leakage by 30 per cent. It can also optimize the performance of the insulation by preventing air movement through it.

The airtightness of the ceiling assembly between the house and attic space should be improved prior to the insulation upgrade to prevent heat loss and, more importantly, moisture migration from the house to the attic. The ceiling air barrier is ideally located below or at the insulation level, and can consist of either existing polyethylene in the ceiling or the gypsum board as the primary air barrier materials. Take care to seal all penetrations through the ceiling air barrier as follows:

- Replace existing ceiling-mounted electrical boxes with airtight electrical boxes and caulk the joint between the box and the ceiling air barrier.
- Enclose recessed pot lights in approved galvanized airtight metal boxes to prevent the light fixture from contacting the insulation and overheating, and to prevent air leakage from the house to the attic through the pot light assembly. Seal the joint between the metal box and the ceiling air barrier with caulking. If the retrofit work provides an opportunity to move the lighting out of the attic and into the house, this would be a preferable approach, as the fewer penetrations through the ceiling into the attic, the better.
- Construct and install airtight gypsum board or foam board boxes around the recessed portions of bathroom exhaust fans. Caulk and seal the joint between the boxes and the ceiling drywall or polyethylene air barrier. Ensure exhaust ductwork is insulated and air sealed from the fan housing to the exterior. Exhaust fans must not vent into attic spaces.

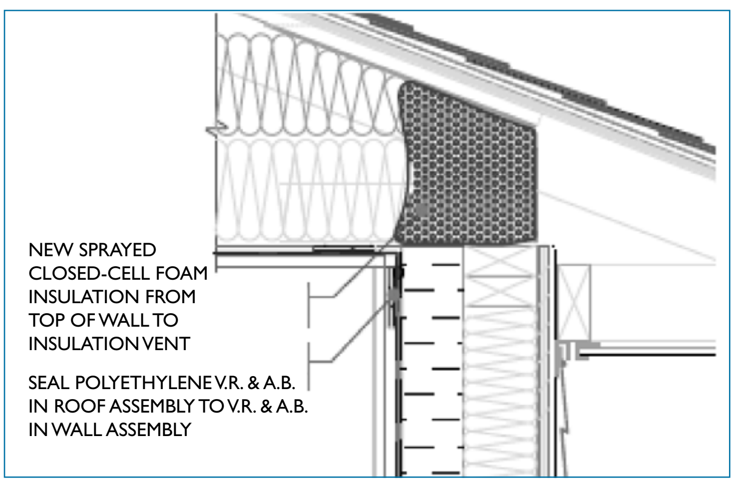


Figure 5: Roof at wall - sprayed closed-cell foam

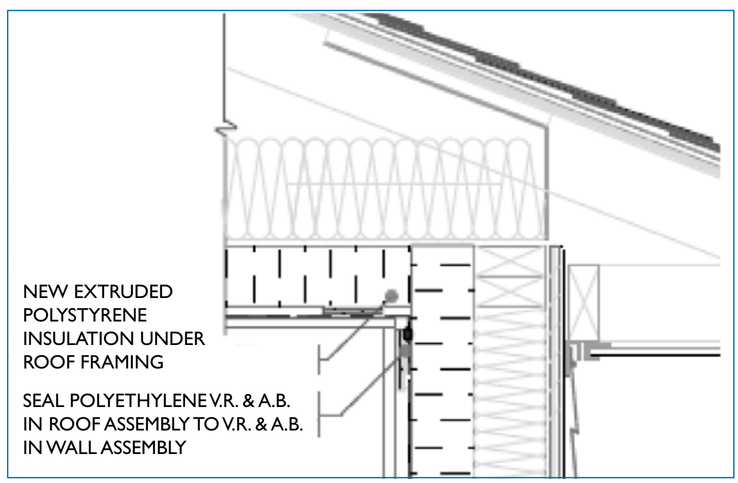


Figure 6: Polystyrene added under roof framing

- Install metal flanges to seal the space between masonry chimneys and the ceiling air barrier, where gaps are common. Caulk the joint between the flange and ceiling and the flange and masonry. For metal flues serving furnaces and hot water heaters, install special metal flange collars to seal the joint between the flue and air barrier system. Consult a qualified mechanical contractor experienced with the venting system of the appliance served.
- Install neoprene collars around plumbing stacks and seal between the flange and ceiling air barrier.
- Place a compressible foam gasket around the attic hatch opening. Install fasteners to hold the hatch down firmly against the gasket.
- Locate and caulk the holes allowing wiring to pass through the wall top plates into the attic space.
- If necessary, caulk or spray insulating foam along any ceiling-wall joints to improve the continuity of the air barrier system over top of the interior partition walls.

The ceiling air barrier should be sealed to the air barrier in the exterior wall assembly to provide continuity between the attic and wall air barrier systems (Figures 4 to 6). The closed-cell sprayed foam insulation where the roof meets the wall can act as a transition to connect the ceiling air barrier with the wall air barrier.

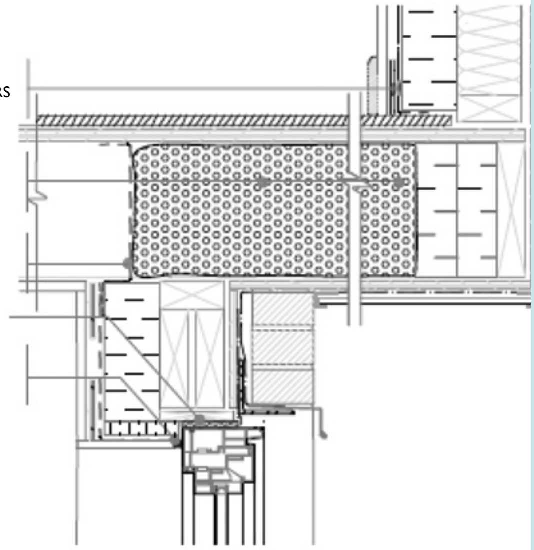
Above-grade walls

Insulation

When retrofitting above-grade walls from the interior, it is recommended that finishes and vapour retarder (if one exists) be removed before adding more insulation, a new vapour retarder and new interior gypsum board. This provides an opportunity to visually assess the condition of the underlying structure for moisture problems and make appropriate repairs before continuing with the interior retrofit work. If the loss of interior space is a concern due to the installation of additional interior insulation, the stud space insulation can be replaced with higher RSI (R-value) insulation thereby reducing the thickness of the added insulation and still attaining the thermal levels outlined in Table 1. The existing vapour retarder, if not removed prior to the installation of new insulation and vapour barrier, may increase the risk of condensation occurring and becoming trapped between the two vapour impermeable materials (that is, the polyethylene sheets), especially with higher amounts of insulation being added to the interior, which may lead to potential moisture damage to the wall finish, insulation and structure.

The new interior insulation should be installed continuously over the existing exposed framing to reduce 'thermal bridges,' thereby reducing the risk of condensation forming on the wall surface. Thermal bridges occur when conductive materials, such as wood framing and metal flashing, provide a direct path for heat to flow to the outside, and can reduce the thermal effectiveness of the insulation by as much as 25 per cent. Adding 50 mm (2 in.) of extruded polystyrene provides RSI-1.76 (R-10) thermal resistance, in accordance with Table 1, that in combination with air sealing, should lead to a 10-per-cent heating energy reduction (Figure 7). Adding 75 mm (3 in.) of extruded polystyrene, providing RSI-2.64 (R-15), will be needed for a 25-per-cent heating energy reduction unless windows are replaced. As mentioned above, to increase the thermal resistance of the wall even more, consider replacing the existing insulation in the stud cavity with low-density foam. Low-density foam is permeable to moisture and allows water that enters the assembly to dissipate and dry.

Furring strips fastened through the new insulation to the existing wall studs, provide a solid backing to which the gypsum board finish can be attached. Space can be saved by replacing the existing insulation with higher RSI-value (R-value) insulation, and using high RSI-value (R-value) insulation in the new wall.



Remove the gypsum board and install rigid extruded or expanded polystyrene on the interior of the frame wall. If one exists, the polyethylene vapour retarder must be relocated to the inboard surface of the new insulation to reduce the danger of condensation inside the wall assembly.

Install two layers of polystyrene tightly against the rim joist. Spray-apply closed-cell polyurethane foam (SPUF) insulation in the joist space where the floor projects beyond the wall. Fill the cavity to avoid drafts. The closed-cell foam acts as insulation air barrier.

Figure 7: Above-grade walls - insulation added inboard of stud-frame wall; sprayed polyurethane foam in overhang

In raised bungalows, it is common for the main floor to project out from the lower, basement wall as a cantilevered living area (Figure 7). When insulating from the interior, the best approach is to remove the batt insulation from the floor header space (if there is any) and spray closed-cell foam insulation into the space between the joists, extending inwards as far as the interior of the wall below. This will reduce heat loss and substantially improve the thermal comfort of this area of the house.

Airtightness

The wall air barrier system can be installed on the inside (warm side) of the insulation in an interior retrofit. The new polyethylene (which is also a vapour retarder) or the new gypsum board, as shown in Figures 4 through 7, can function as the air barrier. However, it is essential that the airtightness plane is continuous; at penetrations (pipes and plumbing stacks, ventilation ducts, dryer and exhaust vents, electrical switches, boxes and outlets, etc.); at cracks and openings in the system; at connections to ceilings and floor systems and at window and door openings. As much as possible, ensure the air barrier system is continuous in any interior retrofit strategy, especially across interior partitions where they intersect with exterior wall assemblies or ceilings. An effective air barrier system can reduce air leakage by 30 per cent compared to the ACH_{50} values of the base-case house.

Windows and doors

Insulation

Installing new energy-efficient doors and windows with either double or triple glazing, low-emissivity coatings and low-conductivity insulated frames (vinyl or fibreglass) can provide significant energy savings. As shown in Table 1, combining new energy-efficient windows and doors with improvements to the airtightness of the house may achieve a 25-per-cent space heating energy savings, or better.

The simplest approach to selecting energy-efficient windows and doors is to choose new ones that meet the ENERGY STAR® rating appropriate for the location's heating-degree-day zone. Alternatively, it is also possible to customize the window depending on performance needs. For instance, a low-e coating applied to the inside surface of the outside pane will reflect much of the sun's energy back to the exterior, thereby reducing unwanted solar heat gains in the summer. If the coating is applied to the outside surface of the inside pane, this will allow more of the sun's energy into the house and will also help reflect internal heat back into the house to reduce the space heating requirements. Other factors such as the type of coating, the number of panes of glazing (double or triple glazing) and the type of gas fill will also affect window performance. Consider reviewing your options with a window specialist.

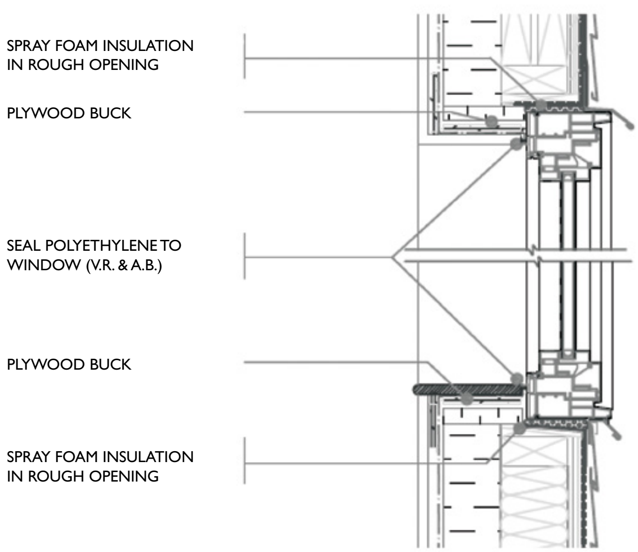
Replacing architecturally significant doors may not be desirable, but poorly insulated doors can cause a significant loss of energy in a well-insulated house, particularly in cold climates. Consider installing storm doors outside the existing ones to reduce heat loss. During summer months, the storm door ventilation window should be open if necessary to vent the airspace between the exterior door and the storm door to the exterior, thereby preventing damage to the door components due to excessive solar heat buildup.

Airtightness

Window and door openings are prone to excessive air leakage problems, particularly through the gaps between the window or door frames and the wall assembly (that is, through the rough opening). Older windows with worn gaskets and weatherstripping or warped sashes and frames can also contribute significantly to the overall air leakage of the house. If the windows are in relatively good condition from a structural and operational point of view, it may be possible to retrofit new gaskets and weatherstripping. Check operating hardware to ensure that the windows are well sealed and secure when in the closed position. Repair worn hardware and air seal the rough opening to reduce heat losses.

For both new and existing windows, it is imperative that the wall air barrier system (for example, the existing interior drywall or polyethylene or concrete foundation wall) be sealed to, and made continuous with, the window or door frame at the wall-window interface. Peel-and-stick membranes, construction tape, caulking with a backer rod, and spray-in foam are materials that can be used to achieve a continuous airtight seal at these locations (Figure 8). Many different approaches are possible depending on the window design, the wall assembly and the position of the window within the rough opening.[1] An airtight seal at the wall-window interface is also an effective means of reducing the risks of rainwater penetration. A rainwater penetration management strategy at window and door locations should also include sub-sill membranes and flashings at head and sill locations to direct water away from the windows and wall assembly.

As with many other measures, it may not be cost-effective to replace the windows and doors just to achieve energy savings. However, if the windows were to be replaced for other reasons (such as sealed unit failures, increased maintenance needs, etc.), then installing energy-efficient windows would reduce energy costs, improve occupant comfort and reduce the potential for condensation on the windows.



The thermal barrier should be continuous to avoid thermal bridging and reduce the potential for condensation in the wall assembly. Therefore, the window should be installed so that the insulation glazing is in line with the insulation in the wall, or the new insulation should return to the window.

The air barrier must also be continuous, especially at the wall-window interface. The polyethylene is returned into the window reveal and sealed to the window with a sealant that is compatible with the window frame.

Ideally the window is removed and the polyethylene is attached to the rough opening. Spray foam in the rough opening seals between the window and the polyethylene, becoming part of the building`s air barrier system and also functioning as a vapour retarder.

Figure 8: Polyethylene air barrier sealed to the inside of the window

[1] Refer to CMHC's "Design, Selection and Commissioning of Window Installations."

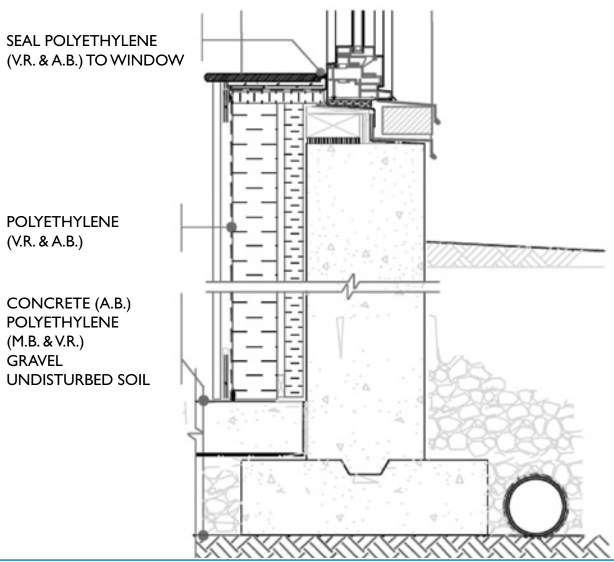
Below Grade Walls

Insulation

The existing basement wall usually consists of cast-in-place concrete or concrete block. If the house is experiencing moisture infiltration problems through the existing below-grade portions of the wall assembly, consider an exterior below-grade retrofit option in order to better address the moisture problems at the source. Otherwise, this fact sheet considers the less costly energy efficiency upgrade approach of adding the insulation on the interior of the below-grade walls (Figure 9).

In raised bungalows, the upper portion of the basement wall may be an insulated stud frame similar to the walls on the main floor of the house. For these areas, implement the same insulation and airtightening strategies that were used for the above-grade walls.

The interior retrofit strategy for below-grade wall assemblies entails removing the existing gypsum board and polyethylene (vapour retarder), if they exist. Add extruded polystyrene (as illustrated) or mineral fibre insulation in the thickness necessary to provide the thermal resistance at the desired energy performance level outlined in Table 1. Apply a 6-mil polyethylene vapour retarder, wood furring and an interior gypsum board finish to protect the insulation from exposure to fire and provide a finished surface.



Install 50 or 75 mm (2 or 3 in.) expanded or extruded polystyrene insulation on the inside of the wall. Cover with a polyethylene vapour retarder/air barrier and fasten to the concrete through wood or metal furring. The furring provides a base for attaching the gypsum board wall finish, and leaves space for wiring, if needed. The air barrier (typically 6-mil polyethylene film) should be sealed to the window, and continue to the basement floor as part of the retrofit.

Figure 9: Below-grade walls - insulation added inboard of foundation wall

Airtightness

In an interior below-grade retrofit, several elements can function as the air barrier in the wall system; the concrete foundation wall, the polyethylene (also the vapour barrier) or the gypsum drywall. Foundation walls constructed of concrete masonry blocks may not be suitable to function as an air barrier. A properly functioning air barrier system must be continuous throughout the assembly and all penetrations, cracks, holes or openings through the wall air barrier and the interface between the floor slab, footing and wall air barriers must be sealed.

Sill plates at the top of the foundation wall are prone to air leakage. Pay special attention to this location by sealing from the interior with sprayed closed-cell foam or by sealing the foundation air barrier to the wall air barrier. The rim joist location is also prone to air leakage and can be sealed from the interior. One method is to air seal and insulate the rim joist area with polyethylene air barrier/vapour retarder over batt insulation or tightly fitted polystyrene insulation and seal at the joists and at the underside of the floor sheathing (Figure 10). Alternatively, fill this area with sprayed closed-cell foam (Figure 11). Polystyrene and foamed-in-place insulation must be protected against exposure to fire with non-combustible material, such as gypsum board.

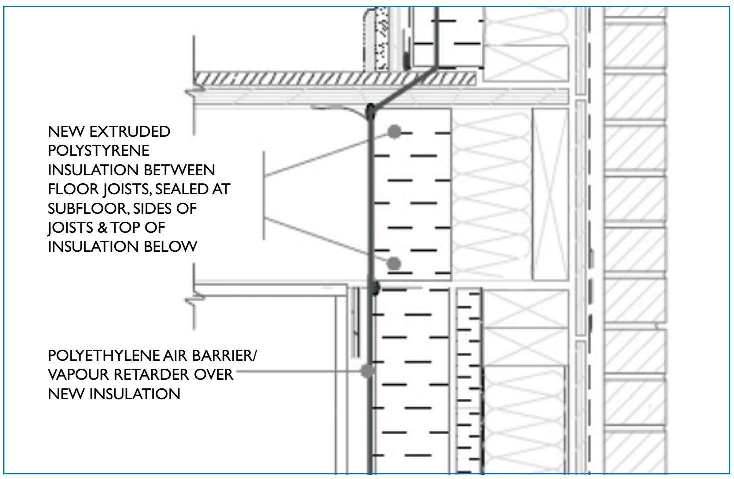


Figure 10: Rim joist - polystyrene insulation

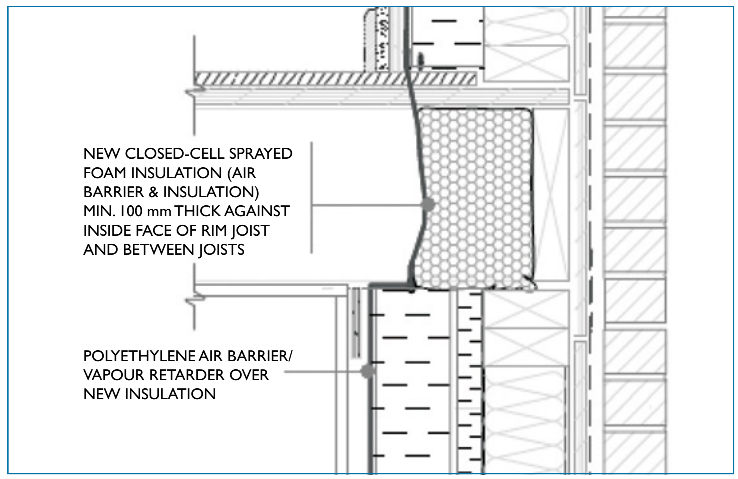


Figure 11: Rim joist - closed-cell spray foam

A WORD OF CAUTION

Assess the condition of the house for pre-existing problems and anticipate the possible effects of the retrofit work on indoor air quality, building envelope durability, heating appliance performance or other possible performance issues, in order to avoid unintended consequences of a building envelope energy efficiency retrofit.

Pre-existing problems: The house may have moisture problems (high humidity, water leaks, dampness, mold, etc.) in the roof, walls, floors or foundation; indoor air quality problems (stale air, lingering odours, soil gas, pollutant emissions from household products, etc.); radon or other soil gases; structural sags, cracks and deflections and the presence of hazardous materials such as asbestos, lead paint and rodent/bird waste. Pre-existing problems should be corrected prior to undertaking an energy efficiency building envelope retrofit so that the problems do not worsen.

Ventilation: A highly energy-efficient building envelope retrofit will provide a more air tight house, which is important for reducing energy consumption. However, this will also result in less incidental ventilation that would otherwise be provided by a leaky enclosure. This can cause the air in the retrofitted house to seem stale and odours to linger longer. Odours from previously unnoticed sources (for example, hobbies, pets, stored items) may become more apparent and more objectionable. Therefore, energy-efficient mechanical ventilation should also be included in any home energy retrofit strategy. This can be accomplished by adding a heat recovery ventilator (HRV) or an energy recovery ventilator (ERV). This ventilation should improve occupant health and comfort.

Building envelope durability: Installing additional insulation can increase the risk of moisture to the building envelope if inside and outside sources of moisture are not controlled.

Heating appliance performance: Reducing heat losses through the envelope may result in the existing furnace or boiler being oversized for the house. Oversized heating equipment does not operate efficiently as it tends to cycle on and off more frequently. Reducing air leaks in a house with chimney-vented furnaces, water heaters and fireplaces can reduce the amount of air needed for safe and efficient operation.

Consult with a qualified energy service provider, building professional, home inspector or contractor before the retrofit to better understand, and plan for, pre-existing conditions and possible unintended consequences of the retrofit project. Often, corrective measures can be planned that not only prevent problems but also add value to the overall project.

For more information on retrofit and renovation considerations, visit CMHC's website at www.cmhc.ca.

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