

# Insulation

## Introduction

Electricity bills, oil bills, gas bills - all Premise owners pay for one or more of these utilities, and wish they paid less. Often many of us do not really know how to control or reduce our utility bills. We resign ourselves to high bills because we think that is the price we have to pay for a comfortable Premise. We encourage our children to turn off the lights and appliances, but may not recognize the benefits of insulating the attic.

## Why should you Insulate?

Heating and cooling (space conditioning) account for 50 to 70% of the energy used in the average American Premise. About 20% goes for heating water. On the other hand, lighting and appliances and everything else account for only 10 to 30% of the energy used in most residences. It makes good sense to turn lights and appliances off when they are not needed, and you'll save even more on your energy costs if you reduce the amount of energy needed for heating and cooling.

**The Crucial Role of Thermal Insulation** Inadequate insulation and air leakage are leading causes of energy waste in most Premises. Insulation saves money and our nation's limited energy resources. It can also make your Premises more comfortable by helping to maintain a uniform temperature throughout the Premises. Walls, ceilings, and floors will be warmer in the winter and cooler in the summer. Insulation can also act as a sound absorber or barrier, keeping noise levels down. It is possible to add insulation to almost any Premises. You may be able to do the job yourself if the structural framing is accessible – for instance, in unfinished attics or under the floor over an unheated space. Or, you may prefer to hire an insulation contractor. In either case, it is important to choose and install the insulation correctly. The amount of energy you conserve will depend on several factors: your local climate; the size, shape, and construction of your Premises; the living habits of your family; the type and efficiency of the heating and cooling systems; and the fuel you use. Once the energy savings have paid for the installation cost, energy conserved is money saved – and the annual savings will increase if utility rates go up.

**Insulation Priorities:** It is most important to:

- Insulate your attic to the recommended level, including the attic door, or hatch cover.
- Provide the recommended level of insulation under floors above unheated spaces, around walls in a heated basement or unventilated crawl space, and on the edges of slabs-on-grade.
- Use the recommended levels of insulation for exterior walls for new Premises construction. When remodeling or re-siding your Premises, consider using the levels recommended for new construction in your existing walls.

## How Does Insulation Work for you?

Heat flows naturally from a warmer to a cooler space. In the winter, this heat flow moves directly from all heated living spaces to adjacent unheated attics, garages, and basements, or to the outdoors; or indirectly through interior ceilings, walls, and floors – wherever there is a difference in temperature. During the cooling season, heat flows from outdoors to the Premises interior. To maintain comfort, the heat lost in winter must be replaced by your heating system and the heat gained in summer must be removed by your air conditioner. Insulating ceilings, walls, and floors decreases this heat flow by providing an effective resistance to the flow of heat. Insulation is rated in terms of thermal resistance, called R-value, which indicates the resistance to heat flow. The R-value of thermal insulation depends on the type of material, its thickness, and density. In calculating the R-value of a multi-layered installation, the R-values of the individual layers are added. Installing more insulation in your Premise increases R-value and the resistance to heat flow.

*The effectiveness of an insulated wall or ceiling also depends on how and where the insulation is installed.* For example, insulation which is compressed will not give you its full rated R-value. Also, the overall R-value of a wall or ceiling will be somewhat different from the R-value of the insulation itself because some heat flows around the insulation through the studs and joists. That is, the overall R-value of a wall with insulation between wood studs is less than the R-value of the insulation itself because the wood provides a thermal short-circuit around the insulation. The short-circuiting through metal framing is much greater than that through wood-framed walls; sometimes the metal wall's overall R-value can be as low as half the insulation's R-value. With careful design, this short-circuiting can be reduced.

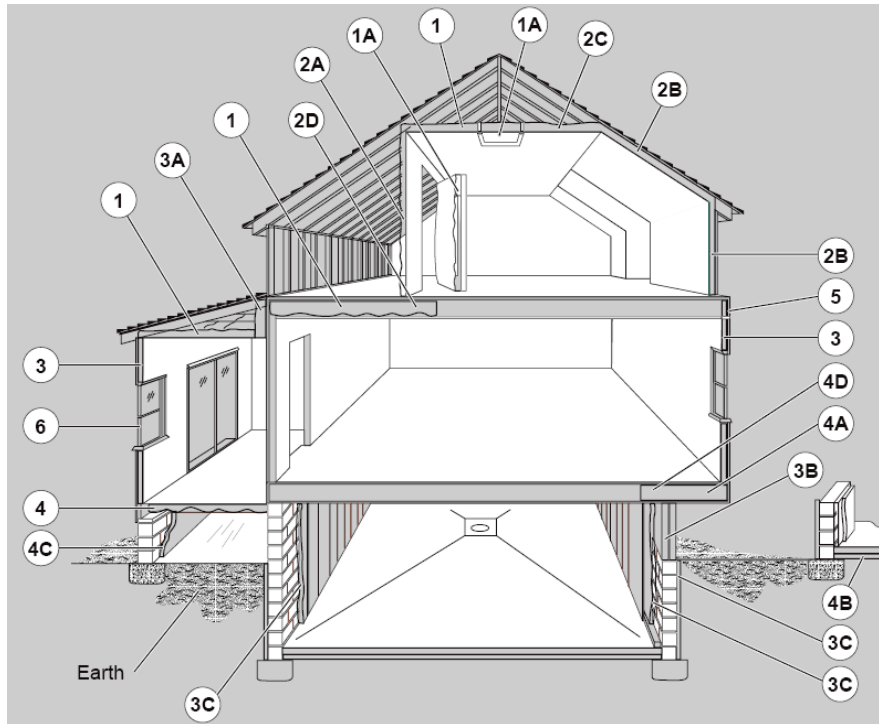


Figure: Insulate areas

Types of Insulation:

Table 1. Types of Insulation—Basic Forms

Form	Method of Installation	Where Applicable	Advantages
Blankets: Batts or Rolls Fiber glass Rock wool	Fitted between studs, joists and beams	All unfinished walls, floors and ceilings	Do-it-yourself  Suited for standard stud and joist spacing, which is relatively free from obstructions
Loose-Fill (poured in) Vermiculite or Perlite*			
Loose-Fill (blown-in) or Spray-applied Rock wool Fiber glass Cellulose Polyurethane foam	Blown into place or spray applied by special equipment	Enclosed existing wall cavities or open new wall cavities  Unfinished attic floors and hard to reach places	Commonly used insulation for retrofits (adding insulation to existing finished areas)  Good for irregularly shaped areas and around obstructions
Rigid Insulation Extruded polystyrene foam (XPS) Expanded polystyrene foam (EPS or beadboard) Polyurethane foam Polyisocyanurate foam	Interior applications: Must be covered with 1/2-inch gypsum board or other building-code approved material for fire safety  Exterior applications: Must be covered with weather-proof facing	Basement walls  Exterior walls under finishing (Some foam boards include a foil facing which will act as a vapor retarder. Please read the discussion about where to place, or not to place, a vapor retarder)  Unvented low slope roofs	High insulating value for relatively little thickness  Can block thermal short circuits when installed continuously over frames or joists.
Reflective Systems Foil-faced paper Foil-faced polyethylene bubbles Foil-faced plastic film Foil-faced cardboard	Foils, films, or papers: Fitted between wood-frame studs joists, and beams	Unfinished ceilings, walls, and floors	Do-it-yourself  All suitable for framing at standard spacing. Bubble-form suitable if framing is irregular or if obstructions are present  Effectiveness depends on spacing and heat flow direction

\*not currently used for home insulation, but may be found in older homes

## Determining the R-Value:

The amount of insulation you need depends on the climate, type of heating (gas, oil, electricity) you use, and the section of the Premises that you plan to insulate. The attic is the first area to consider because it is exterior walls. One method is to use an electrical outlet on the wall, but first be sure to turn off the power to the outlet. Then remove the cover plate and shine a flashlight into the crack around the outlet box. You should be able to see whether or not insulation is in the wall. You may need to pull a small amount out to determine which type of material was used. Also, you should check separate outlets on the first and second floor, and in old and new parts of the Premises, because wall insulation in one wall doesn't necessarily mean that it's everywhere in the Premises. An alternative to checking through electrical outlets is to remove and then replace a small section of the exterior siding. Next, inspect and measure the thickness of any insulation in unfinished basement ceilings and walls, or above crawl spaces. If the crawl space is not ventilated, it may have insulation on the perimeter wall. If your Premises is relatively new, it may have been built with insulation outside the basement or foundation wall. However, this insulation would not be visible because it would be covered by a protective layer of stucco, plastic, fiber glass, metal flashing, or a rigid protection board. The builder or the original Premiseowner may be able to tell you if such exterior insulation was used.

## Evaluating the R-value of Insulation

Insulation type	R-value per inch of thickness
Fiber glass blanket or batt	2.9 to 3.8 (use 3.2)
High performance fiber glass blanket or batt	3.7 to 4.3 (use 3.8)
Loose-fill fiber glass	2.3 to 2.7 (use 2.5)
Loose-fill rock wool	2.7 to 3.0 (use 2.8)
Loose-fill cellulose	3.4 to 3.7 (use 3.5)
Perlite or vermiculite	2.4 to 3.7 (use 2.7)
Expanded polystyrene board	3.6 to 4 (use 3.8)
Extruded polystyrene board	4.5 to 5 (use 4.8)
Polyisocyanurate board, unfaced	5.6 to 6.3 (use 5.8)
Polyisocyanurate board, foil-faced	7
Spray polyurethane foam	5.6 to 6.3 (use 5.9)

Use this formula to determine the R-value of your **existing** insulation:

$$\boxed{\phantom{000}} \times \boxed{\phantom{000}} = \boxed{\phantom{000}}$$

*Thickness (inches) x R-value per inch = Total R-value*

Use this formula to determine how much insulation you need to **add**:

$$\boxed{\phantom{000}} - \boxed{\phantom{000}} = \boxed{\phantom{000}}$$

*Total recommended R-value - Existing insulation R-value = R-value needed*

Do you want to know if you have the space available to add the insulation you need? Then use this formula to determine the *approximate* thickness you need to add:

$$\boxed{\phantom{000}} \div \boxed{\phantom{000}} = \boxed{\phantom{000}}$$

*R-value needed ÷ R-value per inch = Approximate thickness needed*

**However, remember to use the product information on the insulation packaging to determine the actual thickness for any *new* insulation.**

**BEFORE YOU INSULATE:**

## You Must Control Air Leakage

Most Premiseowners are aware that air leaks into their Premises through what seem to be small openings around doors and window frames and through fireplaces and chimneys. Air also enters the living space from other unheated parts of the Premises, such as attics, basements, or crawl spaces. The air travels through any openings in your walls, floors, or ceilings, such as cracks where two walls meet, where the wall meets the ceiling, or near interior door frames. Other openings may also be found, such as gaps around electrical outlets and switch boxes, recessed fixtures, recessed cabinets, pull-down stairs, furred or false ceilings such as kitchen or bathroom soffits, behind bath tubs and shower stall units, floor cavities of finished attics adjacent to unconditioned attic spaces, and plumbing connections. These leaks between the living space and other parts of the Premises are often much greater than the obvious leaks around windows and doors. Since many of these leakage paths are driven by the tendency for warm air to rise and cool air to fall, the attic is often the best place to stop them. *It's important to stop these leaks before adding attic insulation because the insulation may hide them and make them less accessible.* Usually, the attic insulation itself will not stop these leaks and you won't save as much as you expect because of the air flowing through the insulation. Sometimes these leak locations are visible because the existing insulation has been stained by dust carried by the air flow. Some of the openings to look for include:

- Top openings of interior partition wall cavities: staple a plastic sheet over the opening and seal it around the edges with a high quality caulking material.
- Around the chimney: pack gaps around an insulated chimney with unfaced rock wool or unfaced fiber glass insulation. Do not insulate bare, hot flue pipes. Do not use any combustible products, such as cellulose insulation or plastic foams, here.
- Around the attic trap door or entry door: weatherstrip the edges.
- Areas above staircase ceilings and dropped ceilings: staple a plastic sheet over the opening and seal it around the edges with a high quality caulking material.
- Around pipes (look under your sinks and behind your toilets) and ducts penetrating a wall or attic floor: pack insulation tightly into the gap. You can also fill the area around them with spray polyurethane foam. Sometimes joints between walls and floors allow open passage of air between the heated part of the Premises and the attic area or outdoors. Look for such joints in your attic or in the

## Design Options

Some new Premises are built using metal frames instead of wood. When you insulate a metal-framed building, it is important to recognize that much more heat flows through metal studs and joists than through pieces of wood. Because of this difference, placing insulation between the wall studs, or between attic or floor joists, doesn't work as well for metal-framed Premises as it does for wood-framed Premises. If your walls have metal frames, you will probably need to place continuous insulative sheathing over the outside of the wall frame, between the metal framing pieces and your exterior siding. (Note that this insulative sheathing cannot take the place of plywood or other seismic bracing.) If your attic has metal joists, you may want to place rigid foam insulation between the joists and the ceiling drywall.

## Ventilation

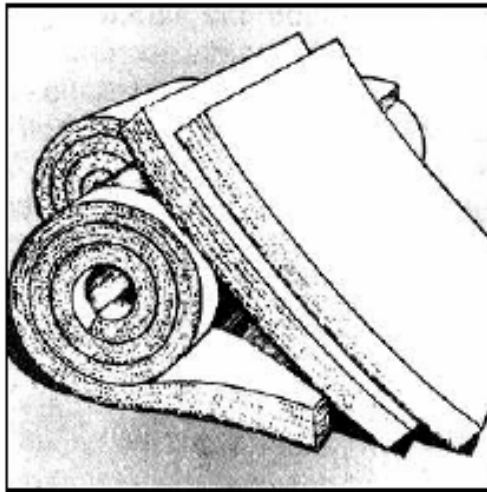
Adequate ventilation in your Premises is important for two reasons:

- Moisture Control - Ventilation will prevent elevated moisture levels within the conditioned space during the heating season. These elevated levels can lead to condensation on window surfaces and give rise to surface mold and mildew, as well as concealed condensation within walls and roof spaces.
- Avoiding Indoor Air Pollution – When natural ventilation has been sharply reduced, as in super-energy-efficient Premises, it may be necessary to provide fresh air ventilation to avoid build-up of stale air and indoor air pollutants. Special air exchange units with heat-saving features are available for this purpose. The Premise Ventilating Institute can give you more information about such heat-recovery ventilators. A well-insulated attic should be adequately ventilated to prevent moisture accumulation. Attics may be ventilated with a combination of soffitvents at eaves and continuous ridge vents. Attic vents may also be installed in gable faces. Many codes and standards require one square foot of unobstructed ventilation opening for each 300 square feet of attic floor area if a vapor retarder is included in the top floor ceiling. Twice as much ventilation is recommended if there is no vapor retarder. The net free area of a vent is smaller than its overall

dimension because part of the vent opening is blocked by meshes or louvers. The openings should be equally distributed between the soffit and ridge vents or between each gable face. Never cover or block vents with insulation. Take care to prevent loose-fill insulation from clogging vents by using baffles. Whether or not to ventilate a crawl space has been a controversial issue.

### Basic Forms of Thermal Insulation

Blankets, in the form of batts or rolls, are flexible products made from mineral fibers. They are available in widths suited to standard spacings of wall studs and attic or floor joists. Continuous rolls can be hand-cut and trimmed to fit. They are available with or without vapor retarder facings.



Batts with a special flame-resistant facing are available in various widths for basement walls where the insulation will be left exposed. BLOWN-IN loose-fill insulation includes loose fibers or fiber pellets that are blown into building cavities or attics using special pneumatic equipment. Another form includes fibers that are co-sprayed with an adhesive to make them resistant to settling. The blown-in material can provide additional resistance to air infiltration if the insulation is sufficiently dense.



FOAMED-IN-PLACE polyurethane foam insulation can be applied by a professional applicator using special equipment to meter, mix, and spray into place. Polyurethane foam can also help to reduce air leaks. RIGID INSULATION is made from fibrous materials or plastic foams and the type of insulation you use will be determined by the nature of the spaces in the Premises that you plan to insulate. For example, since you cannot conveniently "pour" insulation into an overhead space, blankets, spray or board products, or reflective systems are used between the joists of an unfinished basement ceiling. The most economical way to fill closed cavities in finished walls is with blown-in insulation applied with pneumatic equipment or with foamed-in-place polyurethane foam. The following provides a concise summary of the appropriate applications for the various types of thermal insulation. It is important to know that the different forms of insulation can be used together. For example, you can add batt or roll insulation over loose-fill insulation, or vice-versa. Usually, material of higher density (weight per unit volume) should not be placed on top of lower density insulation that is easily compressed. Doing so will reduce the thickness of the material underneath and thereby lower its R-value. In cold climates, some low-density loose-fill insulation allows air to circulate between the top of your ceiling and the

attic. This air circulation can decrease the effective thermal resistance of the insulation and may be significant for regions with more than 5000 heating degree days. A good insulation label should have a clearly stated R-value, and information about health and safety issues.

REFLECTIVE INSULATION SYSTEMS are fabricated from aluminum foils with a variety of backings such as kraft paper, plastic film, polyethylene bubbles, or cardboard. The resistance to heat flow depends on the heat flow direction, and this type of insulation is most effective in reducing downward heat flow. Reflective systems are typically located between roof rafters, floor joists, or wall studs. If a single reflective surface is used alone and faces an open space, such as an attic, it is called a RADIANT BARRIER.

Radiant barriers are installed in buildings to reduce summer heat gain and winter heat loss. They are more effective in hot climates than in cool climates. All radiant barriers must have a low emittance (0.1 or less) and high reflectance (0.9 or more). is pressed or extruded into board-like forms and molded pipe-coverings. These provide thermal and acoustical insulation, strength with low weight, and coverage with few heat loss paths. Such boards may be faced with a reflective foil that reduces heat flow when next to an air space.

*Before beginning the work, read and observe the following precautions:*

- Wear clothing adequate to protect against skin contact and irritation.
- Do not cover or hand-pack insulation around bare stove pipes, electrical fixtures, motors, or any heat-producing equipment such as recessed lighting fixtures.
- Do not cover attic vents with insulation.

**Reference:**

[http://www.ornl.gov/sci/roofs+walls/insulation/ins\\_02.html](http://www.ornl.gov/sci/roofs+walls/insulation/ins_02.html)