HOME ENERGY GUIDE

TECHNIQUES TACTICS & TIPS

Home Insulation

Minnesota Department of Commerce Energy Information Center

A comfortable home - warm in winter and cool in summer - is a major priority for most homeowners . . . and they pay for it! Heating and cooling account for approximately 60 to 80 percent of the average Minnesota household's energy costs. Yet in most cases, such high costs are not necessary.

The energy efficiency of most homes can be improved, substantially reducing costs and – perhaps even more important – creating a healthier and more comfortable home environment. Furthermore, such improvements can extend the life of the house itself, reducing repair and maintenance costs.

How do we improve home energy efficiency? Increasing insulation is perhaps the first answer that comes to mind, but it is only part of the answer. Improving our home's energy efficiency involves an understanding of the "thermal envelope," that barrier to heat loss (and summer heat gain) that protects and separates the indoor living space from the outdoor climate. (See Figure 1.) Insulation is the heart of the thermal envelope, but it is only one part of an entire system that also includes siding, sheathing, sheetrock, and other materials that prevent heat loss through air leaks and keep wind and moisture from penetrating the thermal envelope, reducing the effectiveness of the insulation.

Any program to improve home energy efficiency must pay attention to the entire thermal envelope. Before insulation is added, two important steps need to be taken: first, a system for controlling the intake of air into the home (and venting stale air out) must be supplied, and second, air leaks in the thermal envelope should be sealed. See the Sidebars on Attic Bypasses and Air Ventilation for information on how to proceed with these important steps before increasing insulation.

The role of insulation

Heat naturally flows from a warm to a cool place. In winter, heat flow is from indoors to outdoors; in summer, the movement is reversed. Insulation resists this heat flow, which is why an insulated home is warmer in winter and cooler in summer. How well insulation works in resisting heat flow depends on where and how it is placed and on what and how much material is used.

Figure 1 shows a home and indicates where insulation would be placed to create a barrier to heat loss.

The type and amount of material used also affects how well the insulation works. Insulation material is rated according to its R-value, or resistance to heat flow. The higher the R-value the better the insulation is in reducing heat flow.

Is more insulation needed?

Checking current insulation level. To determine if you need more insulation, you must first find out how much insulation you have. One way to do this is to check for yourself. Look at Figure 1. You will want to see if you have insulation (and how much) in these key locations – the basement walls, exterior walls, floors above cold spaces, and ceilings below cold spaces. In unfinished areas such as attics, where structural frame elements are exposed, you can see the type of insulation and measure its thickness.

Related Guides:
Basement Insulation
Caulking & Weatherstripping
Windows & Doors
Home Heating
Home Cooling
Combustion Air
Indoor Ventilation
Attic Bypasses

Tactic:

A better insulated home is more comfortable and quiet and saves money on energy.

Checking insulation in finished walls and areas is more difficult. One way to check for wall insulation is to look directly into the wall cavity, either by removing a switchplate or by drilling holes into outer walls. After turning off the power, you can remove a switchplate cover and probe the wall around the electric outlet box with a plastic crochet hook – or other non-metal instrument – and a flashlight. The drawback to this method is that it is difficult to get an opening large enough to make an accurate check.

A more reliable check can be made by drilling holes directly into an outer wall in a closet or cupboard or other hidden area. Cut a 1- or 1-1/2-inch hole with a keyhole, reciprocating, or hole saw, and determine whether there is any insulation and, if so, how much. These holes should be filled and finished with patching plaster and touch-up paint.

Don't be concerned that old wall insulation may have "settled" into the lower part of the walls. The insulation level you see, whether at a high or low section of the wall, should give you an accurate picture of the insulation level for the entire wall. Drilling holes in the walls can also reveal any obstructions in the wall. For instance, some homes built between 1910 and 1945 have a sheet of tar paper or other material in the wall cavity to reduce heat-robbing air convection (air movement) within the walls.

Another type of convection barrier often used in homes built before 1930 is backplaster, which is another layer of plaster within the wall cavity. Backplaster makes insulating walls more difficult, but it is still worthwhile to do. Discuss your options with an insulation contractor and call the Energy Information Center.

If you do not wish to check for insulation yourself, a second possibility is to have your utility do an energy "audit" or evaluation. A number of utility companies in Minnesota will do energy audits. Call your utility and ask for an energy audit.

Another possibility is to have a qualified independent energy contractor do an evaluation, possibly using such technology as infrared thermography and blower door technology. Such an evaluation is reliable and provides valuable information about your home. If you have any questions about applying these techniques to your house, call the Energy Information Center.

Evaluating benefit of added insulation. The decision whether to add insulation will depend on a number of factors. A better insulated home is more comfortable and quiet. It will save you money on utility bills for years to come. And by using less energy to heat and cool your home, you reduce the negative impacts on the environment caused by energy use.

The graph "Insulation–The Difference it Makes," compares the annual heating bills for three versions of the same home – one with limited insulation and the others with improved levels of insulation. The heating bill for your home may differ considerably from amounts on the graph, depending on the size of your home, the type of heating fuel you use, the insulation levels, furnace efficiency, etc. The numbers will, however, give you an idea of the potential energy savings to be gained by weatherizing your home, depending on its present insulation level. The costs of various improvements can help you decide which improvements to make.

Basement. Insulating the basement is relatively expensive, but it makes a significant difference in comfort and energy use and adds to the living space of the home. A description of the two methods of insulating a basement – exterior and interior – is provided in the publication "Basement Insulation," available from the DPS Energy Information Center. The information in this guide focuses on attic-ceiling and wall insulation.

Attic/ceiling. If your attic is poorly insulated, you could save significantly on your heating bill by insulating to adequate levels – provided, of course, you first seal attic bypasses (see Sidebar). Adding attic insulation is relatively inexpensive; in the examples accompanying the graph, increasing the R-value of attic insulation from 6 to 40 costs about $465 and reduces heat loss by about 14 percent! If your present attic-ceiling insulation R-value is less than 30, adding more insulation would be well worthwhile.

You can figure out your present R-value by noting the type and amount of insulation you have and checking it with information on insulation materi-

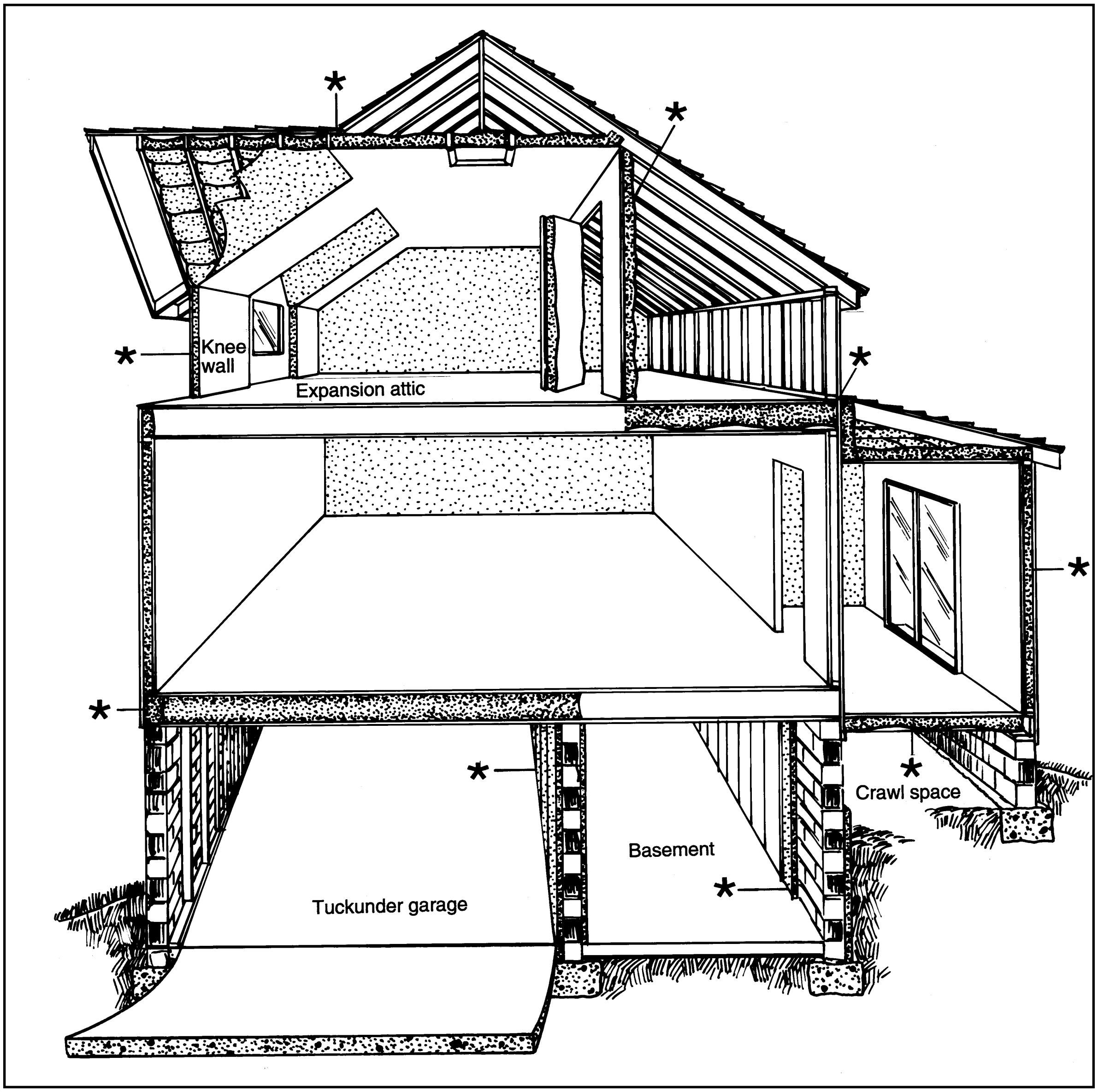


Figure 1:
Insulation is the heart of the thermal envelope. Asterisks indicate key points along the layer of insulation that encloses the home.

als and their approximate R-values listed in the Types of Insulation Table.

In unfinished attics, insulation should be put between the floor joists to seal off living spaces below. In finished attics with or without dormers, insulation should go between the studs of knee walls, between the studs and rafters of exterior walls, and in ceilings with cold spaces above (Figure 1).

In deciding whether to add insulation, you should check not only the present level of insulation, but also its condition. Is it level, or are there bare spots or piles of material? Look for signs of moisture damage – wet or compacted insulation, water staining on rafters or joists. Moisture problems can seriously damage the house structure and insulation, and therefore they must be solved before insulation is added. See sidebar on sealing attic bypasses, page 4.

Walls. Insulating an unfinished attic or crawl space is simple and fairly inexpensive compared to adding insulation to finished walls. As shown in the graph and examples, adding wall insulation costs approximately $1,250. You should definitely consider adding wall insulation when:

- Your wall cavity has a void or air space. Filling in this space with blown-in insulation would probably result in significant savings.

First - Seal Attic Bypasses

Preventing air leaks into walls and ceiling is essential for insulation to be effective. One-third to one-half of the home's heated air in winter (and cooled air in summer) is lost to the outdoors through leaks around doors and windows, pipes and ducts, electric outlets, chimneys, and other openings. At other times, depending on wind speed and direction, cold (or heated) air comes in through the same passages. Before you insulate, you should eliminate these air leaks.

Attic bypasses are a major source of air leaks. Bypasses are hidden air passageways that lead from the heated space into the attic. Because warm air rises, it continuously moves up these passageways and escapes into the attic during cold weather.

In addition to being a source of heat loss, attic bypasses also cause indoor moisture problems. Warm air leaking into the attic causes moisture to condense onto cool surfaces, such as wood joists and insulation. This moisture can rot the wood and reduce the effectiveness of the insulation. Ice build-up on the roof is still another problem caused by attic bypasses. Heat escaping into the attic melts the underside of snow on the roof, causing water to flow to the edge of the roof where it freezes, eventually forming an ice dam.

Common attic bypasses are located around chimneys, ceiling light fixtures, heating ducts, kitchen and bath exhaust fans, plumbing and electrical penetrations, and at the tops of interior walls and junctions of ceiling and exterior walls. The Home Energy Guide, "Attic Bypasses," provides instructions on how to seal bypasses.

Two other Home Energy Guides - "Caulking and Weather-stripping" and "Windows and Doors," also provide information on preventing air leaks,

Copies of Home Energy Guides are available by calling the Energy Information Center, 651-296-5176 in the Twin Cities, or statewide toll free, 1-800-657-3710.

- You are planning to add new exterior siding. Insulation should be blown into wall cavities at this time. Blowing in insulation under new siding does not require the expense of resurfacing exterior access holes. Once the new siding is in place, it will be difficult and expensive to add blown-in insulation.

  For added heat loss protection, you should also consider adding one-inch of rigid insulation to the exterior walls before installing the new siding. This further strengthens the thermal envelope, reducing outside air penetration and preventing wet siding from transmitting moisture into the wall cavity. Because rigid insulation is an excellent moisture retarder, and because it keeps the wood in the wall cavity warmer, walls with exterior insulating sheathing are significantly drier than walls without it.

- You are planning extensive interior renovation. If you plan to gut the walls of your home during a major rehabilitation project, you should spend the extra time and money to fill the cavities with insulation as long as they're open anyway.

  (If you plan to repaint or wallpaper rather than rebuild the walls, you can blow insulation into the walls from the inside.)

Buying insulation

Once you make the decision to add insulation, your next major decision will be selecting the type and amount of insulation. Your selection will be based on a number of factors, such as the structure of your home, where you are going to add insulation (walls and/or ceiling), whether you intend to install the insulation yourself, and perhaps most important, the insulation R-value.

Minnesota requires that all residential thermal insulation sold in the state meet certain standards regarding fire resistance, accuracy in R-value rating, recommended use, and other important characteristics. The Federal Trade Commission (FIC) requires manufacturers to provide fact sheets listing important characteristics, including the R-value per specified amount. In Minnesota, the manufacturer must also state the R-value for that material at winter design conditions. The table lists information on various kinds of insulation, including the approximate R-value per inch. Ask to see the FTC Fact Sheet for a precise and accurate R-value listing.

If you have insulation installed, the installer is required to provide a receipt. In the case of attic or ceiling insulation, the installer must provide a completed insulation receipt or “attic card.” This card identifies the type of insulation installed, the manufacturer, the installer, the R-value, the design settled thickness, the square footage of attic coverage area, and the number of bags installed. The card is signed and dated by the installer.

Installing insulation yourself

Putting insulation in unfinished floors, ceilings, and walls is fairly easy for the do-it-yourselfer. Installing insulation in the cavity of exterior walls is more difficult and usually performed by a contractor. Do-it-yourselfers may rent equipment for sidewall insulation. If new siding is to be installed, make sure the existing walls are filled and then add one inch of rigid insulation beneath the new siding. Research indicates that installation of blown insulation at higher densities performs better than insulation installed at traditional densities. For cellulose insulation installed in walls, densities of more than 3.5 pounds are desired. This is roughly 10 pounds of cellulose per stud cavity, or two stud cavities per 20-pound bag. Fiberglass insulation will need a three-pound density and mineral wool will need a four- to six-pound density.

When installing attic insulation, place baffles around the perimeter of the attic to prevent “wind wash.” Wind wash occurs when cold air enters the soffit vents and blows through the insulation, creating cold areas where moisture condenses and reduces the effectiveness of the insulation. A baffle need be nothing more than a piece of sheathing (see Figure 4).

Insulation - the Difference it Makes

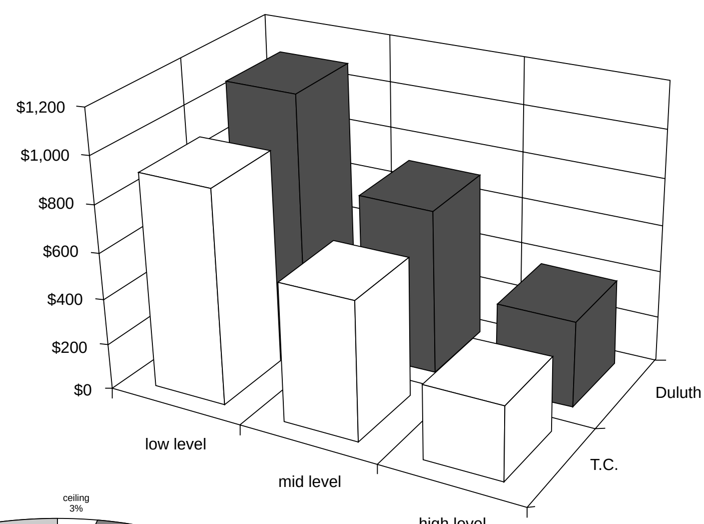
The bar graph below illustrates the drop in annual home heating costs—anywhere from 35 to 65 percent—when insulation is added. The calculations are based on a pre World War II, two-story home with a 28-by-26 foot foundation.

The **low-level home** has a minimum amount of attic insulation; the walls, rim joist, and basement walls are not insulated. The house has its original doors and windows.

The **mid-level home** has added attic insulation (to R-44), and the walls are insulated with a “densepack” insulation system, which uses a higher level of density than is normal: 3 lbs. per cubic foot for cellulose or fiberglass, and 4-6 lbs. per cubic foot for mineral wool. Insulation is also added to the rim joist. The cost of these improvements totals about $1,843: $129 for rim joint insulation, $465 for added ceiling insulation, and $1,248 for wall insulation. The mid-level home also includes replacement of window sashes at a cost of $4,675. This is an expensive improvement that does not substantially reduce window heat loss unless storm windows continue to be used. Compare with the home described below, where for about $900 more, high performance windows providing R-4 insulating value (and eliminating the need for storms) can be installed. Improving the low-level home to this mid-level costs about $6,500 and saves about $325 a year in heating costs in the Twin Cities and about $379 a year in Duluth.

The **high-level home** has the same insulation as the mid-level home, but in addition, basement walls are insulated and windows and doors have been improved. Air leaks in the attic and rim joist also have been sealed. Costs for these improvements are: $2,030 for insulating interior basement walls (or $2,592 for insulating exterior basement walls), $5,582 for upgrading windows, and $500 for improving doors. Total cost of improving the low-level home to high-level is about $9,900 and saves $600 to $700 a year in heating costs.

The pie chart shows the percentage of total heat loss from various parts of the high-level home described above. Biggest sources of heat loss are air leaks and the foundation. Insulating basement walls substantially reduces heat loss from the foundation, but the uninsulated basement floor continues to account for about a third of the home's total heat loss.



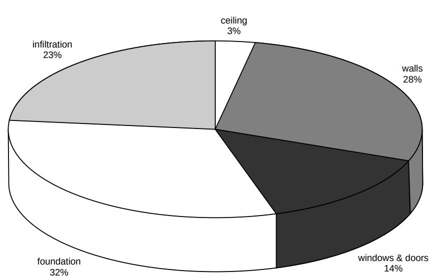


Figure 2:
Wear protective clothing when installing insulation.

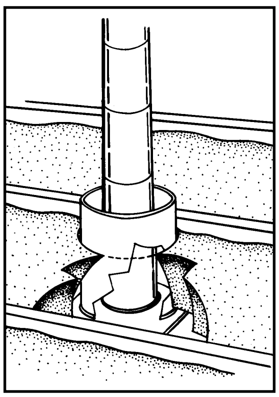


Figure 3
Keep at least a three-inch space between insulation and bare stove pipes, motors, and other heat-producing equipment.

When installing insulation, observe these precautions:

- Wear protective clothing (Figure 2). Consider buying a disposable coverall to use over clothing. Handling insulation can temporarily irritate the skin, so keep shirt sleeves rolled down and wear gloves and always use a face mask rated for asbestos. When handling cellulose, do not wear contact lens. Always wear goggles. When you are done, take a cold shower. The cold water closes your pores and allows you to wash off the insulation. If you are working around old vermiculite, do not stirs it up, since this material often contains asbestos.
- Avoid working in the attic on a hot, sunny day. Temperatures can reach 140°F. in the summertime.
- When working in the attic, put up a wide board that you can stand on. Don't step between the joists or your foot may go through the ceiling.
- Use a portable light with plenty of extension cord if your attic isn't lighted.
- Do not cover or hand pack insulation around bare stove pipes, electrical fixtures, motors, or any heat-producing equipment such as recessed lighting fixtures (unless they are IC – insulation contact – rated). Keep at least a three-inch space between these materials and insulation (Figure 3). The "Attic bypasses" Home Energy Guide gives detailed instructions on how to seal air leaks around these fixtures.
- When insulating the ceiling, be sure to install as much insulation as possible – and extend it as far as possible – over the top of the exterior wall, making sure there are no gaps.
- Be sure to provide fire protection for polystyrene and other insulation, per manufacturer's instructions.

Tips for installing various types of insulation:

Batts and blankets: On walls, begin at the top and work down. If you use batts or blankets with a facing (air-vapor retarder), place the retarder toward the inside of the house. Fit the insulation snugly between the wood frame studs, cut off the excess length where necessary, and staple or tack the facing to the edge of the stud. Use a broad blade putty knife to "tool" the batt into the stud cavity. (Figure 5) Where there already is some insulation, place batts over existing insulation. After the insulation is in place, cover the entire wall with 6 mil polyethylene to serve as a vapor retarder.

On unfinished attic floors, loose fill insulation is preferred. If you choose to use batts and blankets, they must be cut and installed around such obstructions as cross bracing between floor joists and window frames in walls. Strips of insulation may be cut off and placed into tight spaces by hand. Be as precise as possible in trimming the insulation pieces to fit the spaces. Do not fold or bunch the insulation. If there is already some insulation on the floor, simply lay blankets (without an air vapor retarder) on top of the existing insulation.

Subsequent layers of blankets should be placed at right angles to the layer below, and they can be placed on top of the joists.

Make sure additional layers do not have air-vapor retarders, and make sure there are no gaps. Air gaps reduce the effectiveness of insulation.

Loose-fill: Blow loose-fill insulation into place. This insulation can be placed over existing loose-fill or over batts and blankets. Remember to seal attic bypasses before installing the insulation. To keep loose-fill from shifting into vents or eaves or from coming into contact with fan motors or other heat-producing equipment, place sheet metal flashing or other non-flammable material around these areas (Figure 6). Install the insulation from the outer edges inward. Dividing the attic into segments and installing the proportionate amount of insulation in each segment will help you cover the entire attic area evenly.

Special problem areas. Three types of areas fairly common in houses are likely to give the do-it-yourselfer some problems:

Crawl spaces. Often one or more rooms – in some cases the whole house – will not rest on a basement foundation but have only a crawl space underneath. Any part of the house that is heated should be included in the thermal envelope and should be separated from unheated space by an insulation barrier (see Figure 1).

If the crawl space has a bare earth floor, you should completely cover the earth with a sheet of plastic (polyethylene film – at least 6 mils thick) to prevent moisture from coming up into the house (Figure 7). Spread it over the smoothed ground and extend it up four to six inches onto the walls of the crawl space. Hold it in place with bricks or sand. (Do this immediately, whether or not you insulate.)

You have two choices as to where to place the insulation barrier: between the floor joists of the heated area, or on the interior or exterior walls of the crawl space. Placing nine-inch thick batts or blankets between the floor joists will provide you with the minimum recommended R-value of 30. Installing the insulation may be difficult, however, requiring you to lie on your back if the crawl space is very shallow. Secondly, because the insulation is applied from underneath (the unfinished side), there is the problem of how to hold it in place. You can use snap-in wire holders (placed at intervals between the joists and available from building suppliers), or chicken wire can be stretched across the entire area (Figure 7). You should use unfaced fiberglass insulation for this location. Two coats of an oil-based paint applied to the flooring would serve as a vapor retarder.

A second choice is not to insulate the floor of the heated area, but to insulate the walls of the crawl space. Fiberglass batts could be used to insulate the interior walls (Figure 8), or a rigid board insulation (see table) could be applied either to the outside or inside of the walls, following essentially the same techniques as when insulating a basement. (Call the Energy Information Center for information on basement insulation.) If the added insulation is applied to the exterior wall, the above grade portion also will need to be covered with material to protect the plastic board from the ultraviolet rays of the sun.

Story-and-a-half house. This house features a finished "expansion attic" which is a problem area when adding insulation. As Figure 9 shows, unheated attic spaces are often created when these attics are finished. These spaces are the source of air leaks–mainly through the open space between the first floor ceiling and the second floor floring–and result in energy loss and often lead to severe moisture problems. Instructions for blocking these

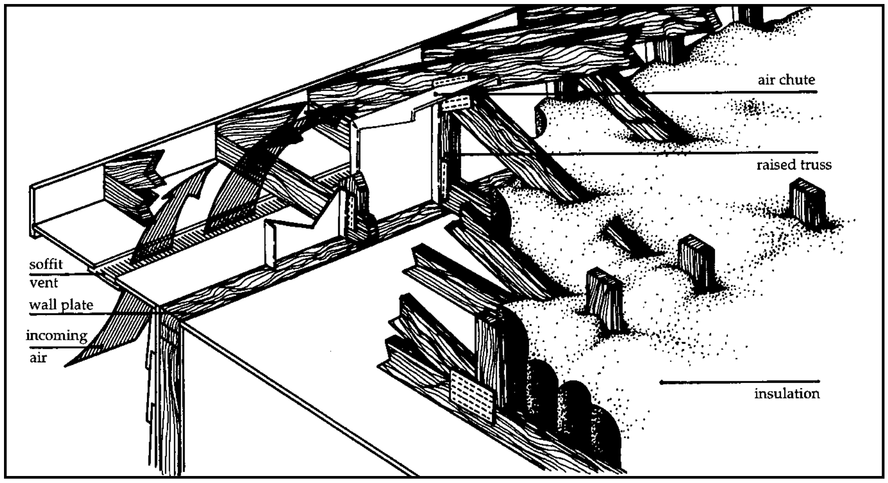


Figure 4:
Air chutes or baffles prevent wind blowing through insulation.

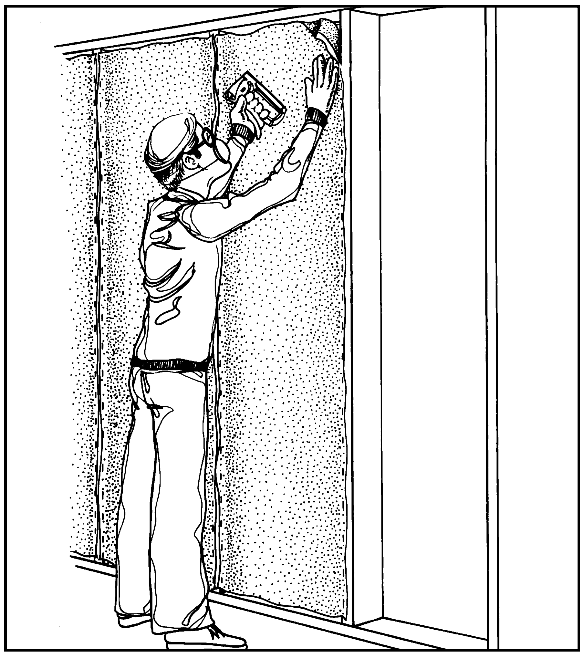


Figure 5:
The facing (air-vapor retarder) on batts and blankets should be toward the inside of the house.

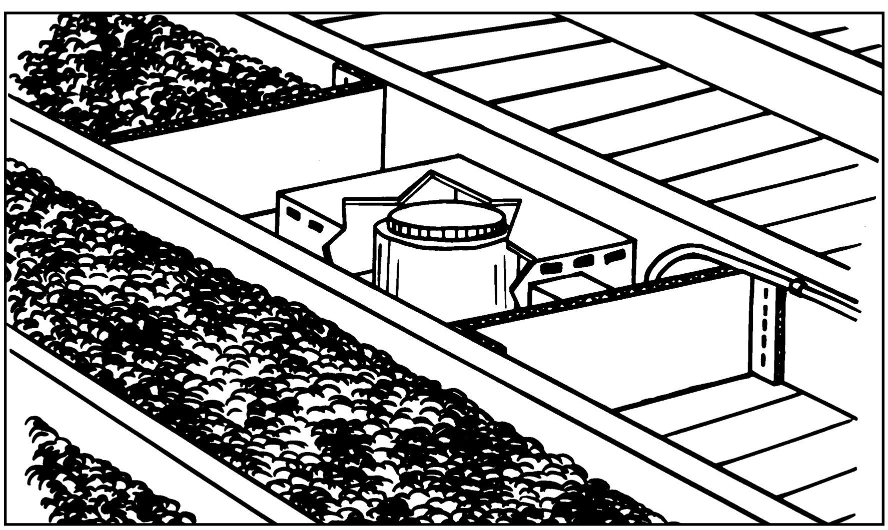
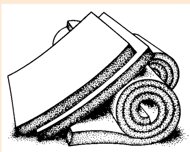
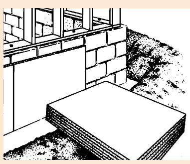


Figure 6:
Use sheet metal flashing or other non-flammable material to prevent loose-fill insulation from coming into contact with heat-producing equipment. If the fixture is insulation-contact rated, it is not necessary to keep insulation from contact with the fixture.

Type	Materials	R-value/inch	Installation Method	Where Applicable	Characteristics
Loose-fill 	Cellulose Fiberglass Mineral Wool	3.1 - 3.7 2.5 - 4.0 2.4 - 4.0 Note: at extreme winter temperatures, R-values of fiberglass and mineral wool loose-fill insulation may be reduced.	Blown into place by machine	Finished walls. Unfinished attic floors and hard to reach places. Enclosed cavities.	Generally installed by contractor. Skilled do-it-yourselfer can rent a machine to blow in loose cellulose. Easy to use for irregularly shaped areas and around obstructions.
Blankets or Batts 	Fiberglass Mineral Wood	3.1 - 3.4 3.1 - 3.4 4.0 for high density fiberglass and mineral wool	Fitted between studs, joists, and beams. Some may be formed in place.	All unfinished walls, floors and ceilings.	Suited to do-it-yourselfer. Suited for standard stud and joist spacing that is relatively free from obstruction. Comes with or without vapor retarder facing. If used with facing, vapor retarder must be on the side toward the inside of the house.
Rigid Board 	Expanded polystyrene (beadboard) Extruded polystyrene (colored styrene) Polyisocyann-urate (foil faced) Rigid fiberglass	3.5 -5 5 5.4 - 7.5 4.2	Rigid board insulations are typically cut to fit and glued, caulked, or mechanically fastened into place. Polystyrene must be covered with 1/2-inch sheetrock for fire protection.	All used on exterior sheathing or basement interior walls. May be used below grade (the exterior or interior of foundation walls). Also used on flat rook and cathedral ceiling.	
Spray-in Insulation and high-density blown-in products	Cellulose Fiberglass Mineral wool Polyurethane	3.2 - 3.7 3.2 - 4.1 3.4 5.4 - 7	Spray applied to surfaces. Spray applied behind a net facing. Also can be blown into cavities.	Walls Ceilings Other enclosed cavities such as flat roofs.	40° or above for 72 hours after application. Specifically formulated polyurethane may be applied at below 40°F.
Reflective	Aluminum foil (single sheet and multiple sheet)	Varies depending on heat flow direction. See FTC fact sheet for the particular product.	Staple to studs or joists.	Floors and walls.	Works best when heat flow is downward (i.e., in floors). Air space between foil and adjacent surface is essential for performance.
Others	Perlite Vermiculite Polystyrene beads Urea formalde-hyde Air entrained cement Other foam plastics	Approximately 4 or more, depending on product	Pour into place. Contractor installed.	Pour-in products are not as readily available as other insulation systems. They also allow for considerable air movement, thus reducing their performance. Urea formald-hyde is not recommended for residential applications.	Suited for do-it-yourself. Perlite, vermiculite, and polystyrene beads are expensive and have lower R-value than other types of insulation. Vermiculite contains asbestos.

air leaks are included in the "Attic Bypasses" Home Energy Guide.

The finished area of the attic should be included in the thermal envelope, with insulation placed in the knee walls, ceiling (both flat and sloping), and the floors outside the heated space. The space outside the knee walls usually can be reached through doors in closets or other openings. One easy way to achieve an R-30 value in knee walls is to fill them with a 3-1/2-inch high density fiberglass batt. Then cover with a 6-inch faced high density fiberglass batt, placing it horizontally (at right angles to the first batt), with the faced side next to the 3-1/2-inch batt. Use a staple gun to fasten the faced batt to the wall. (The facing is between the insulation layers rather than on the inner side of the thermal envelope, but this isn't a problem.) if you plan to use the outer attic space for storage and therefore will be going in and out of the area, reduce your exposure to the insulation by covering it with a "house wrap" or "air barrier," a thin paper-like sheet often used in new construction.

Insulating the ceiling in the heated area is more difficult because of access problems. If the sloped ceiling is unfinished, with rafters exposed, the job is relatively easy since it can be done from the inside. A simple method is to cut and fit rigid board insulation between the exposed rafters, leaving a 1-1/2 to 2-inch space between the insulation and outer roof to allow for ventilation. Be sure to caulk the seam between the insulation board and the framing or rafters. Other methods use a system of gussets, cross strapping, etc. to provide a deeper space for insulation, thereby improving the R-value (Figure 10). Adding insulation to the exterior side of the ceiling (both sloping and flat) is more difficult for the do-it-yourselfer. If your home has such an expansion area and you are uncertain how to proceed, call the Energy information Center and discuss your options with someone on our staff.

Tuckunder garages (see Figure 1) also need special consideration. The usual and best practice is to separate the tuckunder garage from the thermal envelope, insulating the floor above the garage and wall(s) separating the garage from the basement. Duct work is often found in the ceiling above the tuckunder garage. If this is the case in your house, be sure to seal the duct work (using mastic coating rather than duct tape). Blown-in insulation is the best choice for this area because

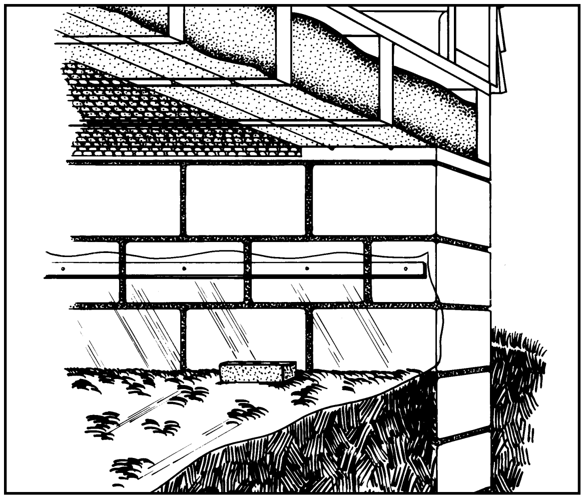


Figure 7

Insulation can be put either between the floor joists of the heated area above the crawl space (Figure 7) or on the walls of the crawl space (Figure 8).

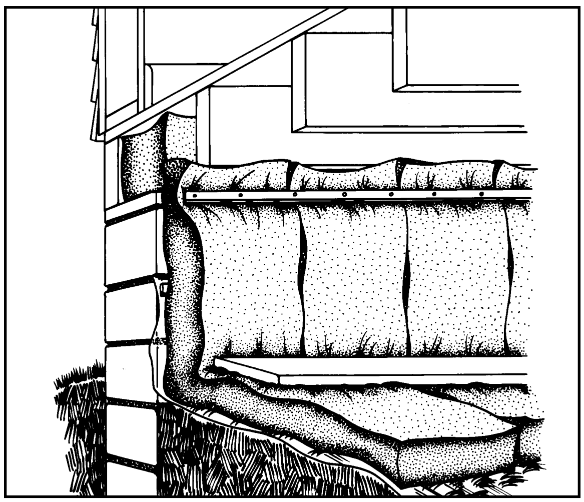


Figure 8

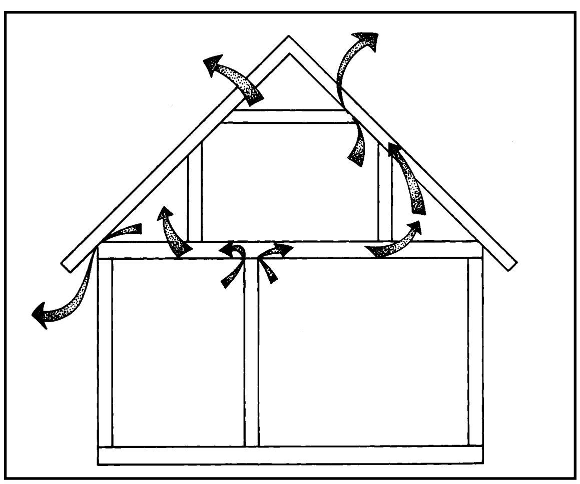


Figure 9
Unheated attic spaces often are the source of air leaks

What Is a Vapor Retarder?

You may wonder if you have a vapor retarder in the walls or ceiling of your home. Houses built prior to 1955 likely have a vapor retarder in place, in the paint applied to walls and ceiling of the home. Two or more coats of oil or alkyd paints applied to a surface perform as a vapor retarder. Other vapor retarders include foil-faced gypsum board and foil-faced and Kraft-faced fiberglass mineral wool insulation. If you are not certain whether you have a vapor retarder, call the Energy Information Center and talk to one of the energy specialists. Phone 651-296-5175 in the Twin Cities; statewide call toll free, 1-800-657-3710.

it is easier to install and also reduces air movement more effectively than batts or blankets do.

Hiring a contractor

If you decide to have your insulation installed by a professional contractor, you will want good quality work at a reasonable price. You should talk with the contractor about the R-value of the insulation and the need for sealing attic bypasses and taking other measures to control air leaks. You will also want to discuss ensuring adequate ventilation and combustion air for the furnace and water heater and other fuel-burning appliances. Ask the contractor to show you the FTC fact sheet that lists how much insulation is needed to provide different levels of R-value per square foot of area. As noted earlier under the heading "Buying insulation," the installer also should provide an "attic card" that identifies the specific type and mount of insulation installed. You could also verify sealing of air leaks by a follow-up infrared thermography or blower door test.

Air Ventilation - Indoor and Attic

An indoor-outdoor exchange of air in the home is necessary for the health, safety, and comfort of occupants. It is also necessary to remove excess moisture that can severely damage the house.

The furnace and other fuel burning appliances in the home use large amounts of air in the combustion process and therefore require a reliable supply of outdoor air. Recent model, high efficiency furnaces and water heaters have "sealed combustion," meaning they bring in fresh air directly from the outdoors and do not use air from inside the home. Furnaces, water heaters, and fireplaces without sealed combustion must rely on indoor air for combustion. If the room supply of fresh air is inadequate, combustion gases - including deadly carbon monoxide - can spill out of the draft hood rather than being taken up through the chimney. This is called backdrafting.

When tightening up your house to prevent heat loss, you must be sure to provide for an adequate intake of fresh air.

The Energy Information Center offers information on this important subject, including publications on combustion air for furnaces and other fuel-burning appliances, preventing moisture buildup, and ventilation systems and equipment. Call 651-296-5175 in the Twin Cities; statewide, call toll free, 1-800-657-3710.

Some ventilation of the unheated attic space is also necessary to prevent over heating in the summer. How much ventilation is needed? Here is a rule-of-thumb to follow:

Probe the attic insulation to see if there is a vapor retarder (see sidebar "What is a Vapor Retarder?") The retarder, often a polyethylene film or foil-faced sheetrock, will be on the bottom side, toward the house. If there is a vapor retarder or if there is a three-foot or more rise from the eave to the roof peak, one square foot of outside ventilation should be provided for each 300 square feet of attic floor area. If there is no vapor retarder and the roof has less than a three foot rise from eave to peak, one square foot of ventilation is needed for every 150 square feet of attic space. In both cases, the amount of ventilation should be split evenly between high and low roof locations (see illustration).

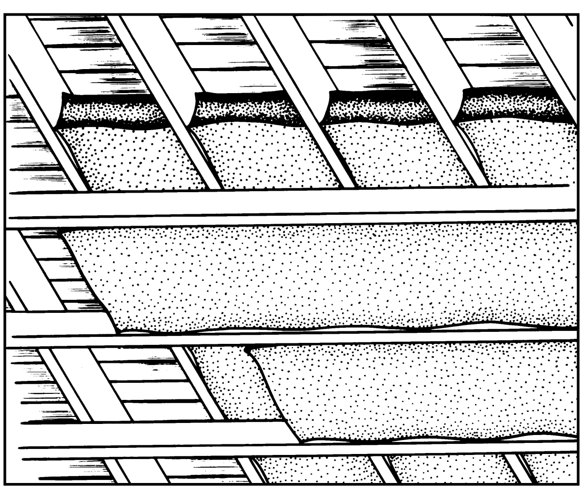


Figure 10
A system of cross-strapping provides a deeper space for ceiling insulation