Insulation Check-Up

Housing
Fact Sheets

Introduction

Heating and cooling account for the majority of energy costs in homes throughout the United States. Although current energy prices are relatively low, they will almost certainly increase significantly in the future. And because few homes are insulated to optimal levels, you may want to investigate the levels in your home to help you decide if adding more insulation would save money. This fact sheet provides information to help you determine if adding insulation to your home could reduce energy costs. Also included is information to help you decide whether to do the work yourself or hire a professional. Insulation products commonly available to do-it-yourselfers are listed along with the advantages and disadvantages of each.

How Insulation Works

A basic physical law of nature is that heat travels from warmer areas to cooler areas. So if the outdoor air temperature is 10 degrees and you are maintaining the air temperature within your house at 70 degrees, heat has a strong tendency to flow out of your house. It does so in three basic ways:

- Conduction—the transfer of heat through a solid material
- Convection—the flow of heat through a fluid substance, such as air or water
- Radiation—the transfer of heat energy via invisible light rays

Thermal insulation works primarily by decreasing conductive heat loss, the flow of heat through wall, ceiling, and floor assemblies. An insulation material's ability to resist conductive heat loss is measured by R-value. The higher the material's R-value, the greater its resistance to the flow of heat.

R-values of building insulation are determined through scientific testing carried out at specially equipped laboratories. Insulation manufacturers are required to list the R-value per inch on each package of insulation they produce. This allows you to make easy comparisons about the insulating value of different insulation materials and products.

An Insulation Check-Up

To help you decide if you should add insulation, first check existing levels and types of insulation in your home. Use Figure 1 to guide you in where to look.

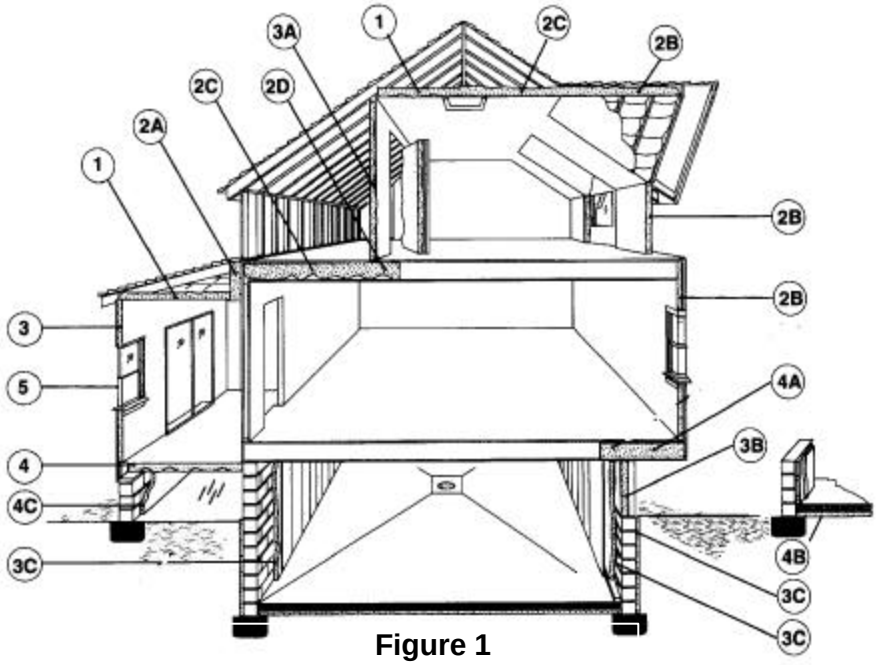

Figure 1

This figure adapted from US DOE Insulation Fact Sheet

(DOE/CE-0180)

Each area to check in your home is noted in Figure 1. Below, table 1 is annotated with the number/letter symbols in Figure 1, and gives a written description of each area. R-values, as recommended by the United States Department of Energy, are also listed for each corresponding area.

Table 1: Where and How Much to Insulate

	Upstate New York	Long Island, New York City and Westchester	
Areas are coded with numbers in Figure 1	All heat systems	Electric Heat-pump LPG	Fuel oil Gas
(1) Unfinished attic spaces			
Between the ceiling joists to insulate spaces below	R-49	R-49	R-38
(2) Finished attic rooms with or without dormers			
(2A) Between studs of knee walls	R-25	R-25	R-19
(2B) Between studs / rafters of exterior walls	R-11/R-19	R-11/R-19	R-11/R-19
(2C) Ceilings with cold spaces above	R-49	R-49	R-38
(3) All exterior walls including:			
(3A) Walls between living spaces and unheated garage or storage spaces	R-11	R-11	R-11
(3B) Foundation walls above ground level	R-11-13	R-11-13	R-11
(3C) Foundation walls in heated basements	R-11-13	R-11-13	R-11
(4) The underside of floors that are between warm spaces above and cold spaces below, such as vented crawl spaces and unheated garages, should be insulated. The open spaces between the wood floor framing members should have insulation in them.	R-25	R-25	R-25
(4A) Any part of a floor in a room that is cantilevered beyond the exterior wall below	R-25	R-25	R-25
(4B) Slab floors built directly on the ground	R-25	R-25	R-25
(4C) Foundation walls of crawl spaces and perimeter floor joists	R-25	R-25	R-25

The underside of floors in unheated basements or crawl spaces are usually not covered with boards or paneling, making them easy to inspect. Attic areas above ceilings are also relatively easy to inspect. In older homes, attic access is usually provided with stairs. In newer homes, access to the attic may be through a ceiling panel, usually located in a hallway or bedroom closet. Another important place to check is the rim joist area (see Figure 2) at the top of the foundation wall inside basements or crawl spaces. It often gets overlooked when houses are initially insulated. The rim joist area should be insulated in both heated and unheated basements and crawl spaces.

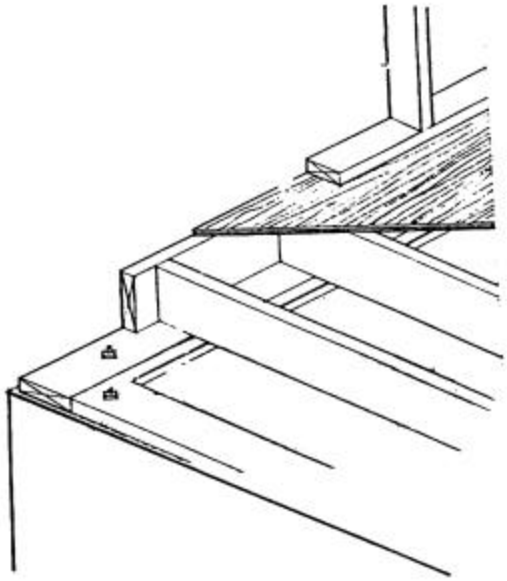

Figure 2

If existing insulation levels in attics, basements, or crawl spaces are below those recommended in Table 1, then investments in more insulation can pay for themselves in reduced annual energy costs. Table 2 (below) provides information to help you identify insulation materials and R-values for existing insulation in your home.

An easy way to check for insulation in wall cavities **is to turn off the electricity**, then probe behind the face plates of electrical boxes on exterior walls (Figure 3). If you find there is no insulation in wall cavities, consider hiring a professional to blow insulation into these areas. You may also want to hire a professional if paneling, floor boards, or ceiling boards have to be removed to determine existing insulation levels.

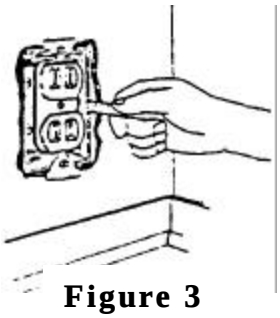

Figure 3

Table 2: R-values and Description of Previously Installed Insulation

Type of Insulation	Description	R-value/ 1" thickness
Spun-glass blankets or batts	Pink, yellow, or white—blanket-like in form	3.2/inch
Loose-fill spun-glass	Pink, yellow, or white—loose fibers	2.5/inch
Loose-fill rock/slag wool	Denser than spun-glass—woolly texture Usually gray with black specks	2.8/inch
Loose-fill cellulose	Shredded newspaper, gray	3.5/inch
Perlite/vermiculite	Gray, brown, white, or yellow beads	2.7/inch
Urea formaldehyde foam	Whitish gray or yellow brittle foam	4/inch

Air Infiltration

To fully realize the benefits of adding insulation, you must also limit air leakage into the house. Some studies estimate that up to 40% of a home's heating costs are from air leaking through the building envelope (walls, ceilings, and floors). Insulation by itself will not reduce air leakage. So if you do nothing else but reduce the amount of air leaking into your home, you can reduce heating costs with a small investment of time and money. (See Housing Fact Sheet *Air Sealing Your Home* for more information.)

Vapor Retarders

If you are insulating a new house, an addition, or a renovation project where you have removed existing wall, ceiling, or floor boards, you should install a vapor retarder. Vapor retarders are materials such as treated paper, plastic sheets, or metallic foils that reduce the passage of water vapor into wall, ceiling, and floor cavities. In cold climates like that of New York, the vapor retarder should be installed on the heated side (the lived-in side of the space). Vapor retarders are required because during cold winter months, warmer inside air holds much more water vapor than colder outdoor air. If this warmer, moisture-laden air gets into wall, ceiling, or floor cavities that separate heated from unheated spaces, water will form as the heated air travels toward the colder outer surfaces and condensation will occur. And if insulation within these enclosed spaces gets wet, moisture can remain trapped for extended periods of time. This can cause mold growth and can even cause a home's wood structure to rot. Also, most insulation materials lose their ability to insulate when they get wet.

Physical Forms of Insulation

Insulation is available in five different physical forms. The form of insulation you buy should be matched to the physical characteristics of the spaces you plan to insulate. The following section provides a brief description of each different form of insulation, along with recommendations on which forms are best suited to various areas in your home.

1) Flexible Insulation

This form of insulation is produced in batts or blankets. Blankets are in the form of long rolls; batts are short sections, typically eight feet long. Batts and blankets are commonly manufactured in widths to fit between the standard 16- and 24-inch spacing of wall, floor, and ceiling framing members**.** Flexible insulation's are available with or without a facing material. Kraft paper and aluminum foil are two common facing materials. Kraft paper is treated to resist the flow of water vapor. Aluminum foil facing serves both as a vapor retarder and a radiant barrier.

Facing materials typically include stapling flanges, allowing the blanket or batt to be stapled to wood framing members. Unfaced blankets and batts are also sold. Of the five different forms, flexible insulation is probably the easiest to install, making it a good choice for do-it-yourself work. Blankets and batts are most often used in new construction when access to wall, floor, and ceiling cavities is available. They have limited value in doing an insulation retrofit. However, blankets are often used in retrofits to add insulation above ceilings in accessible attic spaces.

2) Loose Fill Insulation

Produced in the form of loose fibers, granules, or chips, this form of insulation is typically blown into enclosed wall cavities. Access to the wall cavities is gained by drilling small holes in the wallboard or siding at the top of each cavity. Loose fill insulation can also be poured in place between ceiling joists or trusses in accessible attics. Loose fill insulation is a good choice for retrofit work because it can be blown into otherwise inaccessible spaces. It also conforms to irregularly shaped areas.

3) Foamed-in-Place Insulation

This form of insulation is sprayed into wall, ceiling, or floor cavities as a liquid and immediately turns to foam, greatly expanding to fill all areas. Specialty contractors must be hired to apply this insulation because they have access to the expensive and sophisticated equipment required. The components of the insulation are mixed at the spray nozzle during the spraying process. This insulation is ideally suited to irregularly shaped and hard to reach places. It yields a high R-value per inch thickness, but it is relatively expensive to have installed.

4) Rigid Insulation

Rigid insulation is stiff and comes in board form. Eight-feet lengths in two- and four-feet widths are the most common sizes. It is typically available in 1/2-inch-thick increments starting at 1/2 inch and up to several inches thick. This form of insulation is often installed on exterior walls underneath siding or to the exterior side of foundation walls. It can also be installed to the interior side of exterior walls before application of gypsum wallboard. It provides a high level of insulation for relatively little thickness. It can also block thermal short circuits[1] when installed continuously over wall, ceiling or floor framing assemblies.

5) Reflective Insulation

Also known as a radiant barrier, this form of insulation is typically aluminum foil attached to some sort of backing material. Unlike the other forms of insulation listed which slow conductive heat loss, reflective barriers slow radiant heat loss

[1] A thermal short circuit occurs when heat flows out of a house directly through framing members, wood or metal wall studs, for example. In fact thermal short circuiting through metal wall studs can reduce a wall's overall R-value by as mush as 50%. Because insulation is typically installed only between individual framing members, the only way to avoid thermal short circuits is by installing rigid insulation over wall, ceiling, and floor assemblies.

or gain. Some types of rigid and flexible insulation's are available with an attached reflective foil.

Purchasing Insulation Products

No ideal insulation product exists for all applications. The best material for the job depends on where it is needed, the amount and shape of the space you want to insulate, the price of the material and labor to install it, and the installation method used. Although price is an important consideration, you should also consider the following variables in your insulation purchasing decisions:

- **R-value per inch thickness**
  R-value is a measure of an insulation material's insulating power. The higher the R-value, the more effective the insulation is in preventing heat loss.

- **Dimensional Stability**
  The more dimensionally stable the product is, the more resistant it is to settling or shrinking after installation.

- **Durability**
  Durability is the insulation's resistance to deterioration caused by moisture and resistance to vermin infestation.

- **Health and Safety Considerations**
  Check the insulation's potential effect on indoor air quality and its fire resistance.

- **Environmental Considerations**
  Consider environmental impacts associated with the manufacture and use of the insulation material.

See Table 3 on the following page for a comparison of insulation products concerning the above variables.

Table 3: Comparing Insulation Materials

Organic Based Insulation	R-value per inch[2]	Dimensional Stability	Durability	Fire Resistance & Smoke Toxicity	Permeability & Moisture Absorption	Indoor Air Quality Impacts	Environmental Considerations
Cellulose	3.0-3.7	good in attics; fill to manufacturer's suggested density to avoid settling in walls	good unless wet	fire retardant; provides excellent fire resistance; retardant is slightly corrosive to building metals when humidity is high	high permeability; highly moisture absorbent; moisture ruins R-Value	fibers & chemicals can be irritants; should be sealed off from interior space	consists of about 80% recycled newspapers; manufacture consumes low amount of energy
Mineral Based Insulation	**R-value per inch**	Dimensional Stability	Durability	Fire Resistance & Smoke Toxicity	Permeability & Moisture Absorption	Indoor Air Quality Impacts	Environmental Considerations
Aircrete sprayed in	**3.9**	highly friable	easily damaged by water	non-combustible; totally inert		considered very safe	compressed air is used as the foaming agent
Spun-glass fibers	2.2-2.9	excellent for batts; loose fill may settle if not applied to proper density	excellent	spun-glass itself is noncombustible, but paper facings & resin binders will burn; few fumes	high permeability; not moisture absorbent; will settle if water-saturated	fibers & chemicals can be irritants; should be sealed off from interior space	20-25% recycled content; manufacture consumes moderate amount of energy
Perlite		excellent	excellent	excellent fire resistance	high permeability low moisture absorption	some nuisance dust	manufacture causes negligible environmental impacts
Rock/Slag wool	2.2-2.9	fill to manufacturer's suggested density to avoid settling	excellent	non-combustible	high permeability not moisture absorbant will settle if water saturated	same as fiberglass	manufacture consumes moderate amounts of energy
Vermiculite		excellent	excellent	excellent fire resistance	high permeability low moisture absorption	some nuisance dust	
Synthetic Insulation	**R-value per inch**	Dimensional Stability	Durability	Fire Resistance & Smoke Toxicity	Permeability & Moisture Absorption	Indoor Air Quality Impacts	Environmental Considerations
Expanded polystyrene (board-stock)	3.6-4.4	fair	good, but sunlight will break down	highly flammable; smoke is toxic; cover with 1/2" gypsum board	highly permeable; slightly moisture absorbent	concern only for individuals with chemical sensitivities	blowing agent is pentane, not harmful to atmosphere
Extruded polystyrene (rigid board)	5.0	fair	same as expanded	highly flammable; smoke is toxic; cover with 1/2" gypsum board	low permeability; low moisture absorption; acts as a vapor retarder	concern only for individuals with chemical sensitivities	blowing agent is HCFC-142b; causes depletion of earth's ozone layer
Low-density polyurethane sprayed in	3.6	excellent	good	will not sustain a flame upon removal of flame source	water vapor permeable	unknown, but thought to be negligible	only sprayed-in-place plastic foam insulation that does not use fluorocarbon blowing agents
Phenolic foil-faced boards	8.0	excellent	excellent	low flame spread; low smoke	varies with density	concern only for individuals with chemical sensitivities	uses ozone-depleting blowing agents
Polyisocyanurate foil-faced boards	5.6-7.7	good	good, but loses some R-value with age	least flammable plastic foam	low permeability; acts as vapor retarder; low moisture absorption	concern only for individuals with chemical sensitivities	uses ozone-depleting blowing agents
High-density polyurethane sprayed in	5.8-6.8	expands slightly when curing & from moisture	good, loses some R-value with age	hard to ignite but will burn; higher than average smoke; smoke highly toxic; cover with 1/2" gypsum board in occupied areas	low permeability; acts as vapor retarder; low moisture absorption	concern only for individuals with chemical sensitivities	uses ozone-depleting blowing agents

[2] R-value per inch thickness of this particular insulation material

Should you do the work yourself?

The underside of basement or crawlspace floors are accessible and relatively easy to insulate using batts or blankets. Most people could handle that type insulation job themselves. Adding insulation to an attic may be a bit more difficult. Many attics do not have floors, so you must be careful to not step between the wood framing members. If you do you may fall through the drywall or plaster ceiling. If you do not feel comfortable doing this type work you may want to hire a professional insulating contractor. Contractors also have access to special equipment so they can blow insulation into difficult to reach spaces. Keep in mind that blowing insulation into an attic also gives better coverage than installation of batts or blankets, another factor you may want to consider when deciding whether to do the work yourself or hire a professional. Installation of insulation into enclosed wall cavities of existing buildings is difficult. This work requires the services of a contractor. Refer to Housing Fact Sheet 16:A (*Contractors and Contract Specifications*) which gives further details on the subject of hiring a contractor.

References:

Byrne, J. (1996) Home energy's consumer guide to insulation. *Home energy* vol. 13, no. 5, pp. 21-28

Insulation Fact Sheet (1997) United States Department of Energy, publication: DOE/ce-0180

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