WHAT IS INSULATION?

Most materials will offer some resistance to the passage of heat. Those materials which offer high resistance to the flow of heat are called thermal insulators or simply insulation.

WHICH HOMES NEED INSULATION?

Insulation is needed in all homes that use heating systems in the winter or are exposed to high temperatures in the summer. The more severe the heat or cold, the greater the need for insulation.

WHAT INSULATION DOES

IT ADDS TO YOUR COMFORT BECAUSE:

1. The exposed walls are warmer, and as a result less heat is radiated from your body to the cold walls.

2. There is a smaller volume of cool air moving down the wall surfaces to cause drafts near the floor.

3. More uniform heating will be obtained throughout the home.

4. Cooler houses in summer are the result of retarded flow of heat into the house from outdoors.

INSULATION SAVES MONEY BECAUSE:

1. Less heat loss from your home will mean less fuel required. See pages 6 and 7 for a table which will help estimate this saving.

2. Smaller heating equipment can be used satisfactorily. (This is true of new houses and replacement units.)

3. In an existing house, less load on the old heating equipment makes it last longer.

4. Less cleaning of walls and ceilings is required because dust and dirt are not attracted so much to warm surfaces as to cold surfaces.

Insulation is simpler and less expensive to install at the time the house is under construction than afterwards. A good insulation job depends as much on good workmanship as on proper materials.
WHAT TYPES OF INSULATIONS ARE AVAILABLE?

FLEXIBLE INSULATION is usually in the form of “blankets” or “quilts” (either of which may be in rolls several hundred feet long) or “batts” up to 48 inches long. Since flexible insulation should be built into the hollow spaces in walls or ceilings, the blankets or batts are sized in width to allow them to be fitted into the space between the structural framing members. This form of insulation is available in thicknesses from ½ to 3½ inches. One surface of the batt or blanket is usually covered with asphalt-impregnated paper, which serves as a vapor barrier.

The flexible insulations as well as the fill-type described below are frequently mineral wool, which is a fluffy or fibrous material made from slag, glass, or rock. Although the color may vary from white to dark grey or brown, little difference exists in their insulating value. Flexible forms of insulation are also made from processed vegetable or animal fibers, such as wood, cotton, marine plants, or cattle hair.

FILL-TYPE INSULATION is usually delivered in bales or bags; it can be poured into place, or packed by hand into the small spaces around window frames or chimneys. This type of insulation is used to fill the spaces in a vertical wall or to build up any thickness of insulation desired on horizontal surfaces. When a large amount is used, it is often blown into the walls or ceilings by special equipment.

Fill insulations are made from much the same type of materials as those used in batts or blankets.

INSULATING BOARDS (usually made from some form of wood or cane fiber) are available in a wide range of sizes, from tile 8 inches square to sheets 4 feet wide and 10 or more feet long. These insulating boards are usually from ½ inch to 1 inch in thickness. They may be smooth or rough, either light-colored or dark, depending on whether they are to be left exposed as a room finish or to be built into the wall. They may be used as a plaster base (lath), as a structural member replacing wood sheathing, or as a room finish in the form of panels or planks.

No single insulating material is best for all the various applications possible in a house.

IN ADDITION TO OFFERING HIGH RESISTANCE TO HEAT, INSULATION SHOULD BE OF A TYPE THAT:

1. Will not attract insects and mice
2. Will not form a fire hazard
3. Will not absorb moisture and get soggy
4. Will not deteriorate or settle

TECHNICAL RATING OF INSULATION

Standard methods of testing insulating materials have been established. The results obtained in these tests give a comparison of the rate at which heat will pass through a given thickness of insulating material. Some materials allow heat to pass through them readily, but the better insulations slow down the transfer. The rate of heat flow is represented by numbers which may vary from .24 to .38. However, these numbers are of little importance to the home owner because each of them represents the heat flow through one material alone, and not through the walls or ceilings, which are combinations of several materials. Your architect, engineer, or materials dealer can supply figures which represent the rate of heat flow through a wall or ceiling. An estimate of the fuel bill for a house can be based on this information.
INSULATE CEILINGS

WHERE TO INSULATE

Both ceilings and side walls should be insulated. The best location of the insulation depends on the design of the house and the use to be made of the attic spaces. In general, there are two types of walls which should be insulated: (1) all exterior walls, (2) all walls adjacent to unheated areas, such as attached garages and attic stairs.

- If a house has an unoccupied attic or a space between the ceiling and a flat or shed-type roof, **insulate the ceiling.** This arrangement is the most satisfactory, especially for comfort in the summer.

- If a house has no space between the top-floor ceiling and the roof, either because the attic is occupied or because there is a flat or shed roof with no separate ceiling construction, **insulate the roof.**

- If a house has no basement or has a room over an unheated space such as a room over a porch, **insulate the floor over the cold space.**

HOW MUCH TO USE

The amount of insulation that should be used depends on (1) the cost of the fuel, (2) the severity of the climate, and (3) the reason for insulating (comfort or economy). To the average home owner comfort and cleanliness are of equal importance to savings. The tables on pages 6 and 7 show the savings made by the use of various amounts of wall and ceiling insulation. The use of insulation in thicknesses greater than the maximum shown in the tables is seldom recommended or necessary from the standpoint of comfort or economy.

CONDENSATION AND VAPOR BARRIERS

The formation of frost on windows or the sweating on the outside of a glass of ice water are familiar examples of condensation of the water vapor present in the air of a room. Under certain conditions, this water vapor will pass through building materials, and in cold weather may condense within the wall structure. Such condensation may in time lessen the value of the insulation and also may cause paint and building materials to deteriorate. A **vapor barrier** (a membrane through which water vapor will not pass readily) is essential to prevent moisture from reaching the insulation. Metal foils make excellent vapor barriers, as do asphalt-treated felts or laminated kraft papers. To be effective the asphalt must form a continuous, unbroken glossy coat. Ordinary tar paper or roofing felts are not satisfactory. The vapor barrier should be installed on the room side of the insulation, under the lath and plaster or other finish material. In existing houses where such a membrane cannot readily be installed, two coats of aluminum or other good quality oil paint applied beneath the usual decorative room finish have been found satisfactory.

VENTING OF ATTIC SPACES

The space above an insulated ceiling should be ventilated to the outside air in order to allow the removal of any water vapor which may be present. These ventilators (which should provide about 4 square feet of free area for each 1000 square feet of attic floor area) should be left open the year around.
WHAT TO USE

Under proper conditions any of the four types of material described on page 3 may be used to insulate ceilings, walls, or floors. The selection of one type of material over another depends on (1) the degree of insulation needed, (2) the cost of material and labor, and (3) limitations of the building itself. The sketches below are not intended to be installation guides, nor are they intended to give all the approved variations possible in installing these materials. They do show the more common types and how they may be handled.

INSULATING BOARD

When insulating board is used as a finish material, a chair rail should be installed to protect the board from wear, as this material is softer than the more commonly used lath and plaster. Mouldings can be used to cover the spaces between boards, or the joints may be left exposed if they are of the tongue-and-groove or similar type. In most cases, such decorative insulating boards require the use of wood furring strips for support.

Insulating board used as wall sheathing on the outside of wood studs should, as far as possible, be installed in full, uncut sheets. This requires more care in the layout of the framing members, but reduces the cost of fitting and installing the sheathing.

FLEXIBLE INSULATION

Wall insulation is usually installed from the inside of the house. If the blanket is less than the full thickness of the stud space, there may be an air space on either or both sides, depending on the manufacturer's variation in the treatment of the edges of the blanket. Ceiling insulation can be put in place from below or from above if the attic space is accessible.

Stapling is often the most convenient method for fastening batts or blankets to wood studs or furring strips. The stapling machine is made in the form of a hammer, with the staples feeding automatically from the hollow handle.

Unless the finish material is removed, "fishing" new wiring into a wall filled with insulation is difficult. This is especially true when fills or full thickness batts are used, as few open spaces are left in the wall. If you are planning to insulate an existing wall, be sure the wiring for convenience outlets, phones, and bells is completed before the insulation is put in place.

FILL-TYPE INSULATION

This is most useful in insulating the outside walls of existing houses, where a blown-in fill is the only possible method of applying insulation without resorting to extensive alterations or to changes in room finishes. If fill-type insulation is used, care must be taken to see that all spaces in the exterior wall are filled with insulation. Often the small spaces under windows or below fire-stops are missed. The uninsulated areas, being colder, will become soiled more rapidly than the rest of the wall, and will detract from the appearance of the room. Fills are not adapted to use with solid masonry walls.
REDUCTIONS IN FUEL BILL WITH USE FOR TYPICAL ONE-STORY HOUSE

<table>
<thead>
<tr>
<th>Relative Fuel Bill of Home (without storm sash and insulation)</th>
<th>100</th>
<th>104</th>
<th>107</th>
<th>111</th>
<th>118</th>
<th>126</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION OF WEATHER-PROOFING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WINDOWS AND DOORS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Weather stripping on all windows and doors</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2. Storm sash and storm doors on all openings</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>3. Weather stripping plus storm sash and doors</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>CEILING INSULATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Insul. lath (1/2”), Attic not vented</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>2. Insul. lath (1”), Attic not vented</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>3. 1” insul. board over joist. Attic vented</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>4. 1” insul. board and 1/2” insul. lath vented</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>5. 2” blanket between joist. Attic vented</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>6. 4” blanket between joist. Attic vented</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>WALL INSULATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Insul. board lath (1/2”) with plaster</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>2. Insul. lath (1/2”) with insul. sheathing 25/32”</td>
<td>8</td>
<td>10</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>3. 1” blanket between stud or furring</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>18</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td>4. 2” blanket between stud or furring</td>
<td>12</td>
<td>15</td>
<td>18</td>
<td>22</td>
<td>29</td>
<td>36</td>
</tr>
<tr>
<td>5. 35/8” blanket between stud or furring</td>
<td>13</td>
<td>16</td>
<td>20</td>
<td>24</td>
<td>31</td>
<td>39</td>
</tr>
</tbody>
</table>

DERIVATION AND USE OF THESE TABLES

Storm sash and insulation are usually applied only to rooms above the ground level. Hence, weather-proofing the house will reduce the heat-loss of these rooms, but will not affect the heat-loss from the basement. However, the fuel burned will heat the entire house including the basement. The savings of fuel units shown in these tables are based on heating the entire house and correspond more closely to test results than do tables based on calculations in which the basement heat-loss is neglected.

The houses used in the derivation of these tables were a one-story structure 36 ft. by 28 ft. and a two-story structure 28 ft. by 24 ft., each with a full basement. The ceiling height of all rooms was taken to be 8 ft., and the area of windows and doors was assumed to be 15% of the total exterior wall area.

These dimensions are average for typical one- and two-story houses. Reasonable changes from these dimensions, in the ratio of length to width or in the percentage of glass area, will not seriously affect the tabulated results. If a house is without a basement but uses a first-floor utility room, this table may still be used.

The figures across the top of the table give a comparison of the fuel bill for different constructions—all without insulation. For example, where 100 fuel units are used in a two-story frame house (column 1, page 7) the same house with brick-and-concrete-block exterior walls (column 4, page 7) would require 116 fuel units, or approximately a 16% larger fuel bill. The figures in any one vertical column give the reductions in the fuel bill to be expected by the addition of insulation. See the examples on page 7.
### OF STORM SASH AND INSULATION FOR TYPICAL TWO-STORY HOUSE

**FRAME**  
Wood or Shingle Siding

**VENEER**  
Brick or Stucco on Frame

**MASONRY**  
Stucco on Tile or Concrete Block

**MASONRY**  
Brick and Concrete Block

**MASONRY**  
Brick and Concrete

**MASONRY**  
Stone 8”

---

### Relative Fuel Bill of Home

(without storm sash and insulation) ........................................ 100 105 111 116 127 138

<table>
<thead>
<tr>
<th>DESCRIPTION OF WEATHER-PROOFING</th>
<th>NUMBER OF FUEL UNITS SAVED BY WEATHER-PROOFING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WINDOWS AND DOORS</strong></td>
<td></td>
</tr>
<tr>
<td>1. Weather stripping on all windows and doors.</td>
<td>5 5 5 5 5 5</td>
</tr>
<tr>
<td>2. Storm sash and storm doors on all openings</td>
<td>18 18 18 18 18 18</td>
</tr>
<tr>
<td>3. Weather stripping plus storm sash and doors</td>
<td>18 18 18 18 18 18</td>
</tr>
<tr>
<td><strong>CEILING INSULATION</strong></td>
<td></td>
</tr>
<tr>
<td>1. Insul. lath (1/2”). Attic not vented.</td>
<td>6 6 6 6 6 6</td>
</tr>
<tr>
<td>2. Insul. lath (1”). Attic not vented.</td>
<td>8 8 8 8 8 8</td>
</tr>
<tr>
<td>3. 1” insul. board over joist. Attic vented</td>
<td>7 7 7 7 7 7</td>
</tr>
<tr>
<td>4. 1” insul. board and 1/2” insul. lath vented</td>
<td>9 9 9 9 9 9</td>
</tr>
<tr>
<td>5. 2” blanket between joist. Attic vented</td>
<td>11 11 11 11 11 11</td>
</tr>
<tr>
<td>6. 4” blanket between joist. Attic vented</td>
<td>13 13 13 13 13 13</td>
</tr>
<tr>
<td><strong>WALL INSULATION</strong></td>
<td></td>
</tr>
<tr>
<td>1. Insul. board lath (1/2”) with plaster</td>
<td>7 10 13 16 23 30</td>
</tr>
<tr>
<td>2. Insul. lath (1/2”) with insul. sheathing 25/32”.</td>
<td>12 16 16 16 16</td>
</tr>
<tr>
<td>3. 1” blanket between stud or furring.</td>
<td>13 18 22 26 35 45</td>
</tr>
<tr>
<td>4. 2” blanket between stud or furring.</td>
<td>18 23 28 32 43 53</td>
</tr>
<tr>
<td>5. 3 5/8” blanket between stud or furring.</td>
<td>19 24 30 35 45 56</td>
</tr>
</tbody>
</table>

### EXAMPLES OF THE USE OF THESE TABLES

**A one-story house has a brick veneer exterior wall and neither insulation nor storm sash. What will be the reduction in fuel cost if storm sash and storm doors are added?**

Locate the proper page and column for one-story brick veneer construction (page 6, column 2). The Relative Fuel Bill for such a house is 104 units per year. Read down the column to the figure opposite “Storm Sash and Storm Doors.” This figure, 12, represents the savings from 104 units, or about 11% of the fuel bill.

**In the same house (without storm sash or insulation), what savings can be expected from the use of both storm sash and 4-inch blanket ceiling insulation?**

From page 6, col. 2, add the savings from Storm Sash, 12 units, to the 22 units saving shown opposite “4-inch blanket between joist.”

The 34 units total is the saving from 104 units, or about a third of the fuel bill.

**A two-story house is to be built with 8”-stone exterior walls. The fuel bill has been estimated at $120 per year. What insulation must be added to reduce this to $60 per year?**

The Basic Fuel Bill for such a house (page 7, col. 6) is 138 units. If this is reduced by one half, or 69 units, the desired savings will be reached. Add—Windows and Doors, Storm Sash: 18 units; Ceiling Insulation, 4”-blanket: 13 units; Wall Insulation, 1”-blanket: 45 units. Total: $18 + 13 + 45 = 76 units, which is satisfactory.

Similarly, other combinations of savings may be added, but in each combination you must limit your choice to only one Window-and-Door Weather-proofing, one Ceiling Insulation, and one Wall Insulation.

---

University of Illinois Small Homes Council Circular F6.0 — “Insulation in the Home”
INSULATION OF PIPES AND DUCTS

When water pipes are exposed to extreme cold, either in unheated portions of the house or when the pipes are built into outside walls, insulation protects them from freezing. If the piping layout cannot be changed and pipes must be built into outside walls, hold the pipe as near the room side of the wall as possible, and fill the entire space around it with mineral wool or suitable pipe insulation.

Insulation prevents condensation on cold water pipes. (For Condensation, see page 4.) The dripping from cold water pipes can be eliminated by installing insulation in the form of "anti-sweat" pipe covering. This covering is made from cellular material in the form of a tube, split in half, to allow for its installation. Ground cork or other similar materials, in a liquid base, can be "painted" on pipes and will accomplish the same result. Rope-like insulations designed to be wrapped around the pipe are equally satisfactory.

Insulation of steam and hot water pipes prevents loss of heat from the pipes. If left uncovered, the resulting heat loss may (a) lower radiator temperatures, or (b) lower temperatures in domestic hot water systems, or (c) overheat spaces through which the pipes pass, with the resulting waste of fuel. Pipe coverings (of the tube type, similar to "anti-sweat" covering) are made in sizes to fit standard pipes. Valves and fittings are covered with material molded to shape.

Insulation on heating ducts and leaders of warm-air furnaces should be equivalent to at least one-half inch of air-cell asbestos. The bare pipes of bright tin act as reflective insulation. The common application of one layer of asbestos paper increases the heat loss and should be avoided. Building codes in some cities require that vertical stacks be covered with asbestos paper to prevent the metal from coming in contact with the wood.

CONCRETE FLOORS LAID ON THE GROUND

Tests at the National Bureau of Standards indicated that the heat loss for slabs laid on the ground is more nearly proportional to the length of the exposed edge (or distance around the house) than to the floor area. The minimum insulation at the edge of such a floor is a one-inch strip of insulating board between the floor and the outside wall. If the slab is placed directly on the ground, there should be a gravel fill from 4" to 6" deep under the concrete to reduce dampness.

If the floor slab is heated, as in a panel heating system, the slab must be insulated from the outside wall and from the ground below. This insulation must be protected from dampness. (See Small Homes Council Circular G3.1 — "Heating the Home.")

WEATHER STRIPS AND STORM SASH

Although weatherstrips are not insulation, they serve to reduce the air leakage around doors and windows. For a comparison of storm sash and weatherstrips, see Small Homes Council Circular F11.2 — "Storm Sash."