



## COOPERATIVE EXTENSION SERVICE

Departments of  
Human Environment and Design  
Agricultural Engineering  
Urban Planning and Landscape Architecture

MICHIGAN STATE UNIVERSITY

Extension Bulletin E-813

### WEATHERPROOFING MICHIGAN HOUSES

One area with potential to conserve a lot of natural resource energy is in the heating of homes. Adequate insulation, together with properly weather-stripped storm windows and storm doors and wisely selected control units, can reduce energy needed for heating by sizable amounts. This is true regardless of the energy source for the heating equipment being used.

Energy conservation in any type of building begins with the effective thermal treatment to make the structure "tight" so that it requires less energy for heating and cooling. A tight building is one that is properly insulated and otherwise structurally sealed.

Projections indicate that with proper thermal treatment in both new and existing construction, potential savings in energy could total approximately 16 percent of projected total residential energy usage.

FILE COPY  
DO NOT REMOVE

#### HEAT LOSS

The term "heat loss" refers to the movement of heat from warm areas or surfaces to cold areas or surfaces. Heat can be lost from a room by passing through building materials, air spaces, and cracks or openings. Insulation itself does not completely stop the passage of heat; it merely reduces the rate of heat movement.

Loss of heat occurs in one of the following ways or by a combination of conduction, convection and radiation heat transfer.

Heat movement occurs by conduction whenever there is direct contact between the hot and the cold areas. For example, if one surface of the material is heated, the heat will be conducted through the material to the colder surface.

Heat movement by convection depends on some medium, usually air or water, to convey heat from the warm areas to the cold areas. When air moves across a hot surface it becomes warm and rises, thus carrying heat away from the surface.

Heat loss by radiation occurs when there are two separate bodies or surfaces at different temperatures. The warmer body or surface will radiate heat to the colder body or surface without heating the air between them.

-----  
**Information Obtained From:**

1. Bates, D. W.; Cloud, H. A. "Home Insulation and Heat Loss," Agricultural Engineering Department, University of Minnesota, No. 18, 1974.
2. Hansen, Ralph. "Building Insulations," Agricultural Engineering Department, Colorado University No. 4.601.

Les Mack and James S. Boyd (Ret.), Agricultural Engineering Department, April 1980.  
*MSU is an Affirmative Action/Equal Opportunity Institution*

In every house, heat escapes through the ceiling, roof, walls, floor, windows, doors and by ordinary air leakage.

Improvements such as insulation, weatherstripping, storm sash and storm doors can reduce heat losses to less than one-fourth of the amount occurring in houses without thermal protection.

### Types of Insulation

Three general types of insulation are commonly used in dwellings: batt or blanket, fill or pour-type, rigid.

Batt or blanket insulation is manufactured in thicknesses of 1" to 6" and in widths to fit between supports (studs, ceiling joists, furring strips) on 16- or 24-inch spacings. A vapor barrier may be attached to one side but an additional polyethylene vapor barrier is usually needed to provide protection from moisture. When you add the polyethylene there is no reason to pay additional money for a vapor barrier attached to the product. If you are adding insulation to a ceiling or wall NEVER PLACE INSULATION WITH AN ATTACHED VAPOR BARRIER OVER INSULATION ALREADY IN PLACE.

Fill-type insulation is usually packaged in bags. It works well above ceilings because it will fit into any shaped space. Also you can cover the tops of the lower chords of trusses or possibly ceiling joists, thus providing more uniform insulation over an entire ceiling than if batt or blanket material were used.

Fill insulation is usually the easiest type to add to a ceiling. There is a severe problem in providing an adequate vapor barrier if fill insulation is added to existing walls. It is not recommended for new walls because it will settle over a period of years.

Rigid insulation comes in board form and is of two general types. One is wood or vegetable fiberboard which has some structural strength and is suitable for sheathing. This has a relatively high density and thus a lower insulation value than materials which do not have structural strength. The second type, formed plastic insulations of polystyrene and polyurethane will support their own weight over spans recommended by the manufacturer. They have little structural strength but do have a higher insulation value than wood or vegetable fiberboard.

### Insulation Value

One way to compare insulating materials is by thermal resistance (R), or ability to resist the passage of heat. This resistance, determined by standard testing procedures, may be expressed per inch of thickness or thickness as manufactured. The higher the R value the better the insulation properties. There is considerable misunderstanding and perhaps some misinformation about the insulation value of specific materials. One of the most common misunderstandings relates to the difference between a mineral such as fiberglass and plastics such as polystyrene and polyurethane. Table 1 may help you select insulation that will best meet your needs.

For maximum year-round comfort and lowest heating and cooling bills, the following "R" values are recommended for home construction:

Ceilings	R-33 to R-38
Outside Walls	R-19
Floors over Unheated Spaces	R-22

Table 1. Thermal Resistance Values of Commonly Used Materials.<sup>1</sup>  
 Values do not include surface resistances

Material	Thermal Resistance (R)	
	per inch thickness	for thickness as manufactured
Batt or blanket insulation		
Glass wool, mineral wool, or fiberglass	3.50	
Fill-type insulation		
Glass or mineral wool	2.50-3.00	
Vermiculite (expanded)	2.20	
Shavings or sawdust	2.22	
Cellulose products (milled pulverized paper or wood pulp)	3.13-3.70	
Rigid insulation		
Insulating board		
Sheathing, regular density 1/2 in.		1.25
Sheathing, regular density 25/32 in.		2.06
Expanded polystyrene, extruded, plain	4.00-5.26	
Expanded polystyrene, moulded beads	3.75	
Expanded polyurethane (aged)	6.25	
Glass fiber	4.00	
Ordinary building materials		
Face brick	.11	
Concrete, poured	.08	
Concrete block, 8 in.		1.11
Concrete block, 8 in. with cores filled		1.93
Light weight concrete blocks, 8 in.		2.00
Light weight concrete blocks, 8 in. with cores filled		5.03
Plywood	1.25	
Plywood, 3/8 in.		.47
Plywood, 1/2 in.		.63
Hardboard, medium density	1.37	
Plasterboard 3/8 in.		.32
Plasterboard 1/2 in.		.45
Cement asbestos board	.25	
Lumber (fir, pine, and similar soft woods)	1.25	
Asphalt shingles		.44
Wood shingles		.94
Windows (includes surface resistances)		
Single glass		.91
Single glass with storm windows		2.00
Double-pane insulating glass 3/16 in. air space		1.45
Double-pane insulating glass 1/2 in. air space		1.73
Triple-pane insulating glass 1/4 in. air space		2.56
Doors		
Solid wood 1 3/4 in.		2.17
Solid wood 1 3/4 in. + storm door		3.23-3.92
Insulated core door		Up to 7
Air spaces		
3/4 in. to 4 in.		.90
Surface resistances		
Inside surface (still air)		.68
Outside (15 mph wind)		.17

<sup>1</sup> From American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Handbook of Fundamentals, 1977, at mean temperature of 75° F.

### Determining Total R Value

The total R value of a wall or ceiling can be determined by adding the R value of all component parts. In addition to the ability of a material itself to resist the flow of heat, the surfaces and interior air spaces offer some resistance. For well-insulated walls and ceilings these are quite small. However, the combination of surface resistances and interior air spaces provides almost the total R value for windows.

To illustrate the use of the table, the total R value of an uninsulated wall section is shown in Figure 1.

The R values for each part of the wall can be obtained from the table.

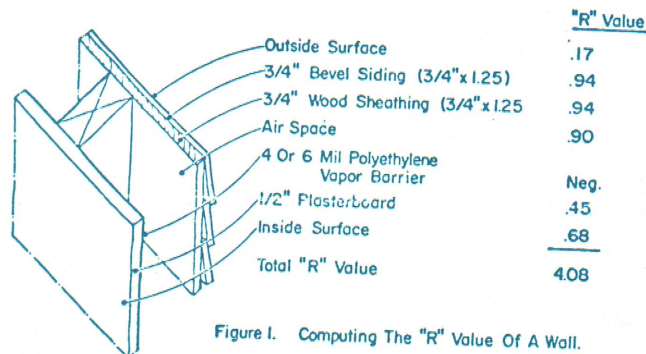


Figure 1. Computing The "R" Value Of A Wall.

A 1-1/2" fiberglass batt placed next to the inside surface of this wall would add an R value of 5.55 (1.5 inches x 3.70). The total R value would then be 9.63, more than twice that of the uninsulated wall. If the 2" x 4" stud space (3-1/2") was filled with a "full-thick" fiberglass batt, the total R value of the wall would be 16.13, almost four times that of the uninsulated wall.

The easiest place to add insulation to an existing home is with loose fill above the ceiling in the attic if the attic does not have a floor. Loose fill insulation is commonly used here. An uninsulated ceiling and roof combination has a total R value of about 3.5. The following table shows the effect of adding loose fill mineral wool insulation to this ceiling:

Total R value	Depth of Loose Fill Mineral Wool				
	0"	2"	4"	6"	8"
	3.5	10.7	17.9	25.1	32.3
Reduction in heat loss (compared to uninsulated ceiling)	0	67%	80%	86%	89%

This example illustrates an important concept, each additional inch of insulation saves less heat than the preceding inch. The savings from additional insulation decreases quite rapidly. However, this does not imply that additional attic insulation is undesirable. The heat loss through the ceiling is important and can be easily reduced by the addition of fill type insulation.

### Heat Loss From the Home

The total heat loss from a house can be divided into two major parts: 1) the heat lost by conduction through the structure and 2) that heat lost through air "infiltration". All homes have some air exchange, cold air entering the house and warm air leaving. This is called infiltration. This cold air must be heated and constitutes a significant load on the heating system.

Some air infiltration is necessary in any home. Fuel burning furnaces require air for combustion and to remove the products of combustion from the house. All homes require some air exchange to remove water vapor which is produced within the home. If the house is extremely tight and there is not enough air exchange, severe condensation may occur on windows and other cold surfaces during cold weather.

Infiltration is commonly expressed in air changes per hour. Loosely constructed houses may have an infiltration rate of 2 air changes per hour, whereas tight houses may have an infiltration rate of 1/2 air change per hour or less. The average home will have an infiltration rate of about 1 air change per hour. Infiltration can be reduced by weatherstripping doors and windows, caulking sills and other openings, keeping fireplace dampers closed, and reducing the operating time of exhaust fans.

Saving Fuel by Adding Insulation, etc.

The effect of adding insulation to part of the house, adding storm windows, reducing infiltration, etc. must be determined on the basis of present house construction. To illustrate these effects, the heat loss from a 1,300 square foot, single story house with a total window area of 150 square feet has been determined for different degrees of insulation, infiltration rates, window combinations, etc. The heat loss was based on a temperature difference of 70° F. between inside and outside. The comparative heat losses will be nearly the same for other temperature differences.

Heat losses were determined for three types of house construction:

- 1) Uninsulated, loosely constructed, single pane windows.
- 2) Moderately insulated, average construction, single pane windows with storms.
- 3) Heavily insulated, tightly constructed, triple pane insulating glass windows.

The moderately insulated house has 2 inches of loose fill mineral wool in the ceiling and a 1-1/2" fiberglass batt in the walls. The heavily insulated house has 6 inches of loose fill mineral wool insulation in the ceiling and a 3-1/2" fiberglass batt in the walls. Air infiltration rates of 1/2, 1 and 2 air changes per hour were used for the tight, average, and loose construction.

The following table gives the heat losses from these houses in BTU per hour.

	<u>Uninsulated, single windows loose const.</u>	<u>Moderately insulated, storm windows average const.</u>	<u>Heavily insulated, triple windows tight const.</u>
	BTU per hour	BTU per hour	BTU per hour
Ceiling	26,000	8,100	3,600
Walls	21,800	8,600	5,300
Windows	11,800	5,900	4,900
Infiltration	26,800	13,400	6,700

From this table you can compare different levels of insulation and types of construction. It can help you decide which improvements will do you the most good and best fit your circumstances.

It is evident that very substantial savings can be achieved if a loose house is weatherstripped, etc., to reduce infiltration. Moderately and heavily insulated houses may have high infiltration rates. If this is the case, tightening up the house by weatherstripping, caulking, etc., is an excellent way to save a substantial amount of heat. Figures 2 and 3.

Storm windows save considerable heat and reduce window condensation. They are necessary in Michigan's climate.

Adding insulation to an uninsulated ceiling is very effective in reducing heat loss. Adding insulation to a partially insulated ceiling is not as dramatic but still saves considerable heat.

#### VAPOR BARRIERS

Every insulated building must be protected from moisture by a vapor barrier. Some insulation materials come with a vapor barrier attached. If not, a separate one must be provided.

Vapor barriers prevent moisture condensation and accumulation in the insulation. Vapor barriers are rated according to the amount of water vapor passing through them. Some of the materials used include: polyethylene (plastic) film, duplex or laminated paper consisting of a continuous sheet of asphalt between two sheets of paper, and aluminum or other metal foil (usually paperback). Aluminum, asphalt, lead and oil paints or varnishes in sufficient coats (usually two or three) in a smooth glossy finish can provide a reasonably effective vapor barrier.

Vapor barriers are installed on the warm side of the insulation only, under the inside sheathing. Splices or joints should be lapped and folded to properly seal. The vapor barrier must be kept continuous with no holes punched in it during installation.

It is difficult to install a vapor barrier in an existing building. Two or three coats of a good quality alkyd base, semigloss paint, preferably over a base coat of an aluminum paint, will offer some vapor protection.

A second vapor barrier should never be installed near the outside of the walls since it will result in moisture being trapped between the two vapor barriers. Use a porous wind-barrier type of paper on the outside areas to provide an exit for entrapped moisture.

#### VENTILATION

Areas above insulated ceilings should be vented to the outside to provide adequate air circulation above the insulation. If the vents have louvers or are screened, two square feet of vent area for each 300 square feet of ceiling area should be provided. The vents should be uniformly and equally spaced to assure good air circulation above the insulation.

Excessive interior humidity from household activities can be disposed of by kitchen, laundry and bathroom ventilating fans. The outlet of these fans should be vented to the outside of the home, not into the attic, and the vents should be provided with an effective back draft damper. In the kitchen, range hood fans (vented to the outside) are the most efficient way to ventilate because they trap and exhaust heat, odor, moisture and smoke before they can circulate in the room. The Small Homes Council-Building Research Council recommends that hood fan capacity should be 100 cubic feet per minute (cfm) for each lineal foot of hood length. For example, a 3-foot hood would require a 300 cfm fan.

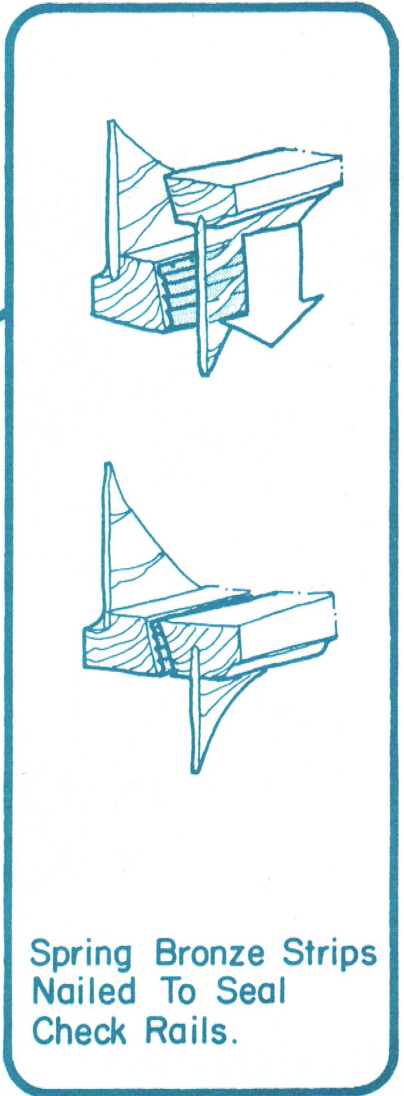
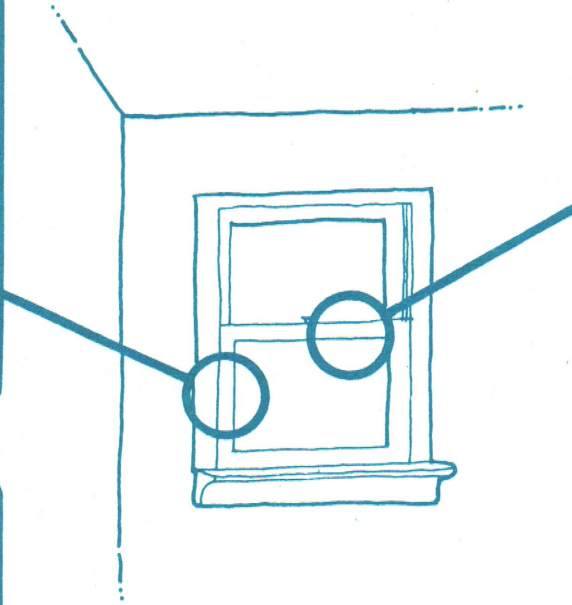
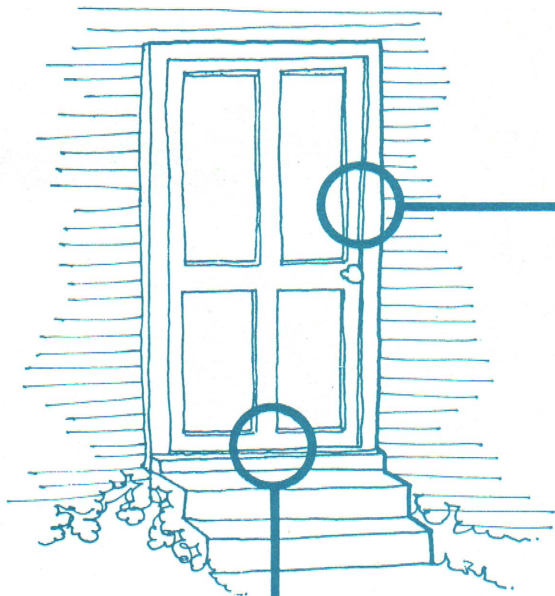
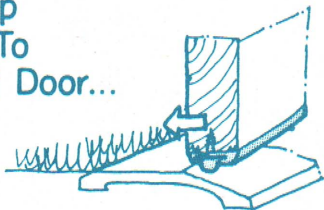


Figure 2.  
Weatherproofing For Windows.

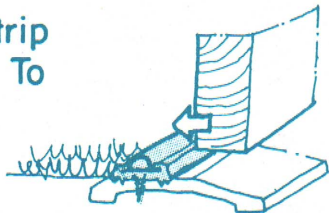


Repair Strip Attached To Bottom Of Door...



Or...

Repair Strip Attached To Old Sill.

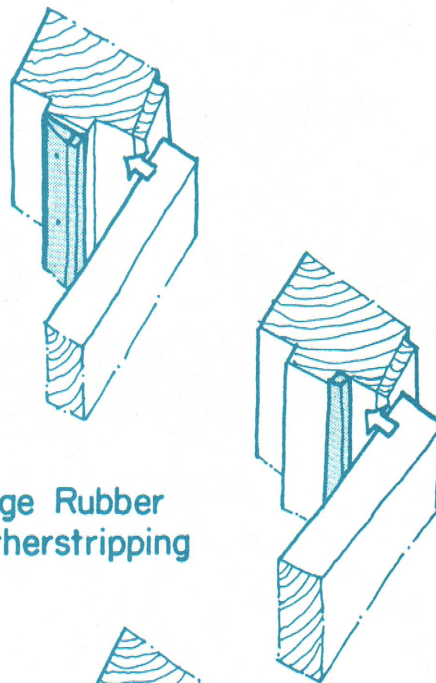


New Aluminum And Plastic Sill

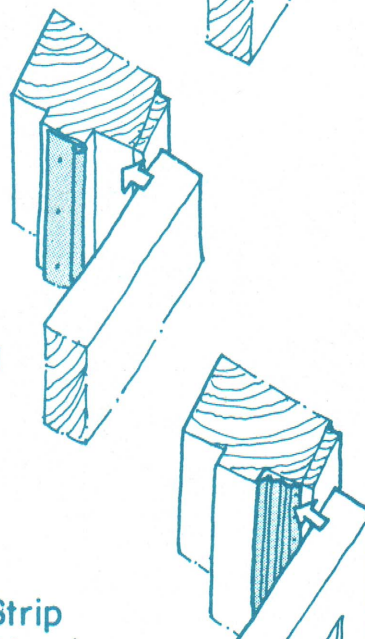


a. Bottom Of Door And Threshold

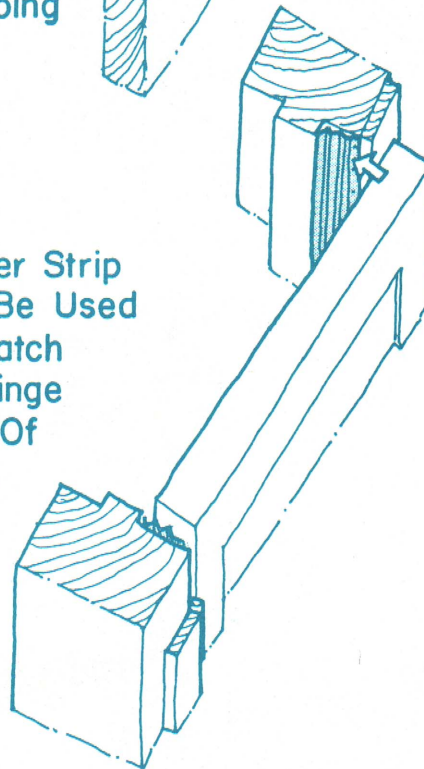
Sponge Rubber Weatherstripping



Plastic Stripping



Copper Strip Can Be Used On Latch Or Hinge Side Of Door.



b. Sides And Top Of Door

Figure 3. Weatherproofing For Doors