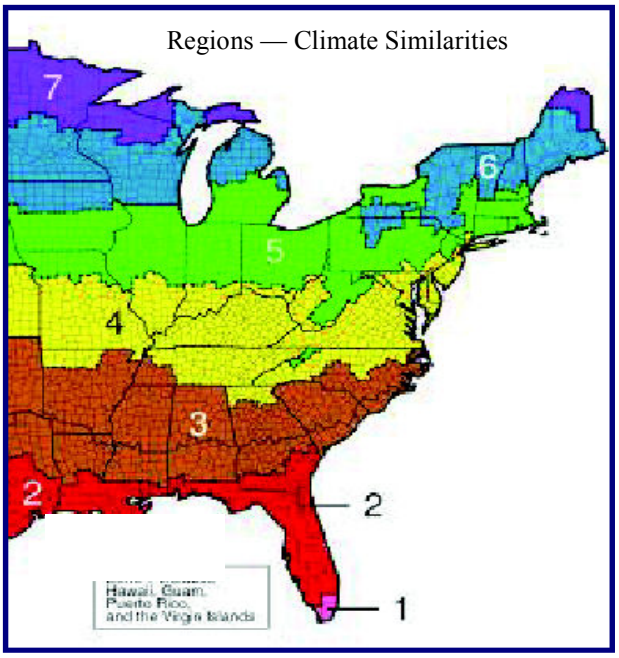
Insulation Guidelines

ENERGY SAVING FACT SHEET

Introduction

Inadequate insulation of a building structure can increase significantly the monthly cost to maintain the comfort level for occupancy. The seasonal temperature averages of a geographical region determines to a large extent the insulating performance properties and subsequent resistance to heat losses or gains from weather extremes. In North Carolina, there are three zones that define insulation performance — the central piedmont area and lower southeastern area (Region 3), the central east to west area (Region 4), and several mountain counties in the upper northwest of the state (Region 5).

Each of these Regions have specific requirements for providing a building insulation envelope to minimize the use of energy.

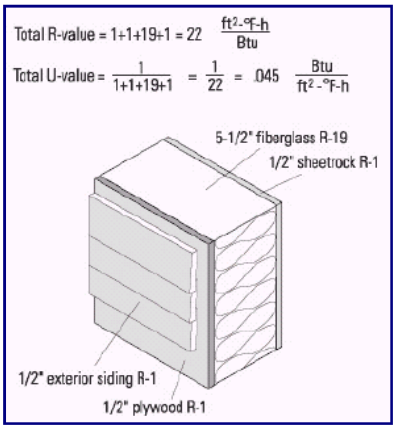


Resistance to Heat Flow

All insulation is rated according to its resistance to heat flow, measured in units of "R"- value. The inverse of thermal resistance is thermal conductance, referred to as "U"- value or $U = 1/R_{total}$ which is measured in the units of Btu/square foot-hr- °F . Whereas R-value is easier to understand. (the higher the R-value the better the insulating properties) U-value is more useful in calculating the gain or loss of heat flow to and from the building. The basic equation is:

$$Q = UA\Delta T = UA(T_H - T_L)$$

where ΔT is difference from higher temperature to lower temperature. In the above example if the temperature inside the building was 70°F and the temperature outside was 40°F what would be the heat flow per 100 square feet of insulated building?



Insulated

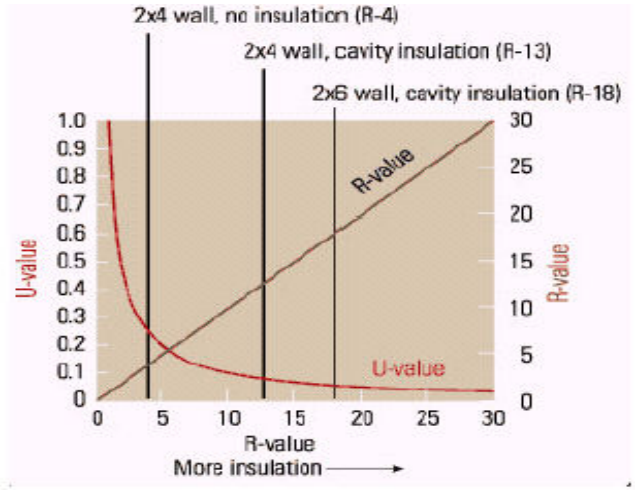
Q = 0.045 btu/sf-hr -°F X 100 sf x (70°F — 40°F) = 135 Btu/hr per 100 square feet. If there were no insulation and just a bare wall the heat flow would be:

Uninsulated

Q = 0.5 btu/sf-hr -°F X 100 sf x (70°F — 40°F) = 1,500 Btu/hr per 100 square feet or just a little over 10 times the heat flow out of the building without an insulating barrier. Superior insulating performance equates to energy savings!

What Is the Optimum R-V Value?

There is a point where more insulation has little return. While high R- values sound attractive, the real effect of insulation—the U- value diminishes with each additional inch of insulation. For example, an insulated 2 x 4 wall has an R- value of 13 and a U- value of 0.077. Upgrading to a 2 x 6 wall and R- value of 19 adds 6 points to the R-value(19 — 13) but only drops the U– value by 0.024 (0.077— 0.053) adding another 6 points would lower the U– value even less — by only 0.011



R- value and U- value Relationship Graphical Plot

Types of insulation - Fiber, Foam, and Reflective.

Fiber insulation is available in either **loose-fill** form or in **batts**. **Loose-fill insulation** consists of fiberglass, cellulose, rock wool, or some other type of fibers that are blown into wall cavities or attic joist spaces. If properly installed, loose-fill insulation can provide more complete cavity coverage than batts, because the fibers can fill around wires, piping, and other obstacles. Loose-fill is usually installed by specialized contractors, whereas batts can be installed by nearly anyone with a desire to insulate a space. R-values per inch for loose-fill insulation range from R-2.2 for fiberglass to about R-3.2 for rock wool or cellulose.

Batts are available made of fiberglass, cotton, or rock wool, and all achieve an R-value of about R-3.2 per inch.

Be aware that loose-fill insulation can settle over time. When loose-fill insulation is located in a wall, its settling creates a void above the insulation that can serve as a conduit for heat. In an attic, settling results in a nonuniform distribution of the insulation, which can reduce its effectiveness. Some types of insulation use acrylic-based or other binders to help prevent settling, though there is some question as to how well they work.

Loose-fill cellulose can be mixed with water and blown in wet, usually without any added binders. This sticky mixture molds itself into gaps and seals them to a degree, which helps to eliminate air leakage and infiltration, and has an R-value of about R-3.5 per inch. Loose-fill cellulose can also be installed dry with a blowing machine and a reduced-size application nozzle that packs the insulation tightly, creating dense-pack, or **high-density cellulose**.

Though this method does not seal as well as wet-spray cellulose, dense-pack cellulose also reduces air infiltration. Because it is packed tightly, little settling occurs and, unlike **wet-spray cellulose**, it can be used on wall insulation retrofits. It too has an R-value of around R-3.5

Foam insulation comes in either **rigid sheets** or **spray**.

Rigid foam insulation generally has a higher R-value per inch than fiber insulation, because it uses HCFCs instead of air to create pockets or bubbles in the foam sheet, thereby achieving values from R-3.6 (expanded polystyrene) to R-7.7 (isocyanurate). Rigid foam insulation is also easy to install with nails or glue. Its cost per unit R, however, is much higher than that of fiber.

Sprayed-in foam can be used in open or closed cavities as well as around ducts or pipes that pass through the building envelope.

Low-density urethane spray foams can achieve up to R-11 per inch, though most foams are rated much lower, with values around R-4 to R-6. Like wet cellulose, spray foams are effective at sealing out drafts.

Care should be taken in selecting rigid foam insulation, as it can contribute to **insect problems**. Carpenter ants and termites will tunnel through polystyrene and polyisocyanurate foams to either create nesting cavities or to create a protected passage to wood inside a building. To combat this problem, one company has added a boric acid insect repellant to its foam insulation. Testing to date has shown the treatment to be fairly effective in keeping insects away.

Reflective insulation is different from the other kinds in that, instead of reducing conductive heat flow, it reduces radiant heat flow. It also does not use a gas to insulate. In its most basic form, it consists of a single sheet of a reflective material, which reflects heat emitted from a warm surface back to that surface. It must be positioned adjacent to an air gap to be effective, otherwise heat will simply conduct through to the next solid layer that it touches.

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ASHRAE Standards

Insulation performance recommendations for geographic regions are obtained from standards of the American Society Heating, Refrigeration, and Air Conditioning Engineers.

For instance - Small Office Buildings. (< 20,000 sf)

Bldg. Part	Region 3	Region 4	Region 5
Roof above deck	R-20 ci	R-20 ci	R-20 ci
Metal Bldg	R-13 + R-13	R-13 + R-19	R-13 + R-19
Attic	R-38	R-38	R-38 + R-5ci
Surface Reflectance/Emitance	0.65/0.86	No Recommendation	No Recommendation
Walls Mass	R-9.5 ci	R-11.4 ci	R-11.4 ci
Metal Bldg.	R-13	R-13	R-13 + R-13
Steel Framed	R-13 + R-38	R-13 + R-7.5 ci	R-13 + R-7.5 ci
Wood Framed	R-13	R-13	R-13 + R-3.8 ci
Below Grade	No Recommendation	No Recommendation	R-7.5 ci
Floors Mass	R-8.3 ci	R-8.3 ci	R-10.4 ci
Steel Framed	R-19	R-30	R-30
Wood Framed	R-30	R-30	R-30
Doors Swing	U- 0.70	U- 0.70	U- 0.70
Non-Swinging	U – 1.45	U - 0.50	U - 0.50
Windows	U-0.45	U-0.42	U-0.42
Solar Heat Gain—SHGC	S,E,W- 0.31, N – 0.46	N,S,E,W- 0.46	N,S,E,W - 0.46
Sky Lights SHGC	0.19	0.34	0.39

Savings to Be Realized

Insulation installation which brings a building up to standard can result in a savings of 1—5% of HVAC costs depending on the conditions before the improvements are implemented.

References & Resources:

ASHRAE website: www.ashrae.org

DOE website: www.ornl.gov/sci/roofs+walls/insulation/ins_08.html

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