Fi-FOIL™ COMPANY
RADIANT INSULATION SOLUTIONS

Building Green with Radiant Insulation Solutions

Presented By:
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CONTINUING EDUCATION AIA

LEARNING OBJECTIVES

- Defining sustainable building
- Energy efficient design
- Building Envelope Science
  - Fundamentals of Heat Flow & Heat Transfer
- Insulation rating: R-values
- Basic principles of insulation
- Reflective insulation and radiant barriers
- The “greening” of insulation
- LEED criteria for reflective insulation
- Installation and application

Defining “Sustainable” Design and “Green” Building

- Definitions:
  - Green Building
  - Sustainability

Government and private initiatives are driving the sustainability movement, which is resulting in energy efficient "green" buildings with less impact on the environment over their lifespan.
The U.S. Department of Energy reports heating and cooling can consume 70 percent of the energy used in American homes. US Green Building Council findings suggest that buildings constructed using its LEED Rating System have healthier indoor air quality. These are ongoing considerations today for building teams and materials specifiers.

Sustainable and Green Building Initiatives

www.sustainable.doe.gov/freshstart/articles/ptipub.htm

www.usgbc.org

There are the numerous recent green building initiatives programs, including the US Green Building Council's LEED rating system (www.usgbc.org), the EPA's High Performance Building programs, the Collaborative for High Performance Schools (http://www.chps.net), and the Sustainable Buildings Industry Council's (http://www.psic.org) Building Green Guidelines.

Green Product Attributes

- Renewable materials
- **Durable/Lifecycle attractive**
- Re-useable materials
- **Recycled content**
- **Locally manufactured**
- **Energy efficient**
- **Engineered for Deconstruction**
- **Environmentally friendly**

The positive health and environmental impacts of products make them green. Some attributes of "green" products include: renewable materials, recycled content and engineered for deconstruction.

Green Certification & Label Programs

California EPP Database Project

Product evaluation programs are both government sponsored and non-government organizations (NGO's) and classify products into four categories, which are: single environmental attributes, life cycle assessment, certified eco-profile, and environmental preferred. Some examples of the programs include Greenguard, Energy Star, etc.

Assessing Product Sustainability

- Cursory Evaluation ASTM E 2129 –

  <u>Applied</u> Standard Practice for Data Collection for Sustainability Assessment of Building Products www.astm.org

  <u>Data areas:</u>

  - Materials
  - Manufacturing Process
  - Operational Performance of Installed Product
  - Indoor Air Quality
  - Corporate Environmental Policy

Designation: E 2129 – 01

Standard Practice for
Data Collection for Sustainability Assessment of Building Products[1]

1. Scope

1.1 This practice offers a set of instructions for collecting data to be used in assessing the sustainability of elements or products for use in both commercial and residential buildings.

1.1.1 There are many features of a building that contribute to sustainability; one of them is the selection of products for use in a building. Other key features influencing sustainability include, but are not limited to: overall efficiency of the design of the building, the impact the building has on the habits of the occupants, and the impact the building has on the microclimate and macroclimate. This standard addresses sustainability issues related to building elements. This standard does not address sustainability issues related to overall building design, site selection, building operations, or other features influencing sustainability.

1.1.2 While it is recommended that users rely on professional judgment informed by both environmental expertise and specific knowledge of the intended use of the product, this standard provides no instruction as to interpretation of the data obtained. Interpretation of the data obtained is the responsibility of the user of this standard.

1.1.3 This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to supplant or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title means only that the document has been approved through the ASTM consensus process.

1.2 This standard is organized according to UNIFORMAT II principles in accordance with Classification E 1557 to ensure consistency in the evaluation of building products.

1.3 This standard includes general, comprehensive data requirements. Depending upon the product, certain data requirements may not apply given the unique characteristics of the element and the potential environmental impacts related to the intended use of the element. Depending upon the product or element, certain data requirements may need to be added as appropriate to the unique characteristics of the product and the potential environmental impacts related to the intended use of the element.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 150 Specification for Portland Cement

C 208 Specification for Cellulosic Fiber Insulating Board

C 595 Specification for Blended Hydraulic Cements

C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

C 989 Specification for Ground Granulated Blast Furnace Slag for Use in Concrete and Mortars

C 1157 Performance Specification for Blended Hydraulic Cement

C 1240 Specification for Silica Fume for Use in Hydraulic Cement Concrete and Mortar

D 5359 Specification Glass Cullet Recovered from Waste for Use in Manufacture of Glass Fiber

E 631 Terminology of Building Constructions[2]

E 1480 Terminology of Facility Management (Building-Related)[2]

E 1557 Classification for Building Elements and Related Sitework – UNIFORMAT II[2]

E 2114 Terminology for Sustainability Relative to the Performance of Buildings

2.2 *Other Referenced Standards:*

AASHTO Standards[3]

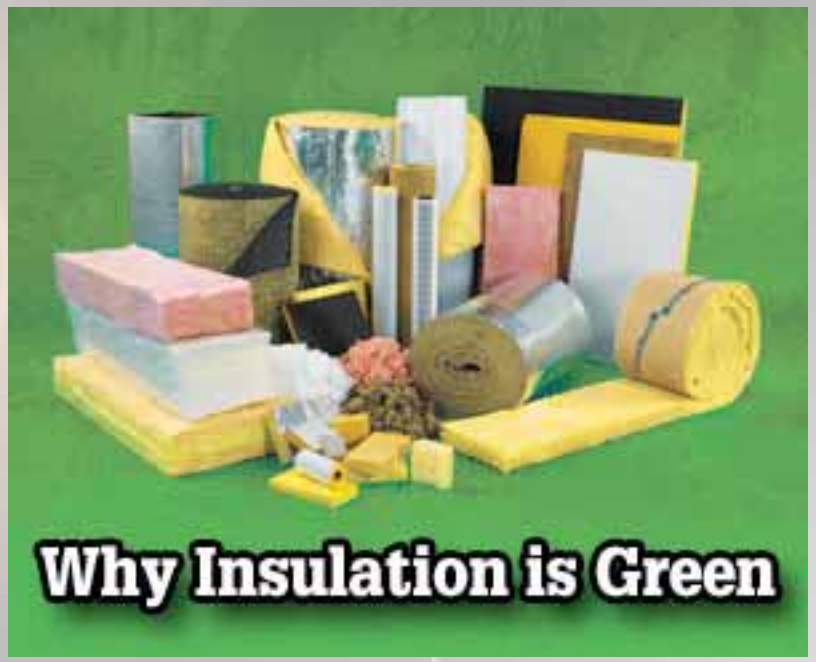
American Concrete Institute Standards[4]

ASHRAE Standards[5]

ASME Standards[6]

- LCA - Lifecycle Analysis
  - **ASTM** - Standard Guide for General Principles of Sustainability Relative to Buildings - Item 1 WK5566
  - **ASTM** - Standard Guide for Environmental Life Cycle Assessment (LCA) of Building Materials/Products 1
- EPP – Environmentally Preferred Products

The original green assessment standard was ASTM E 2129 – 01. This standard addresses product data collection, which is important because manufacturers may not have verified their data. Specifiers can include this standard in project specifications to avoid unsubstantiated claims about "green" products. Since this standard was originally developed, a new set of sustainable building standards are under development.



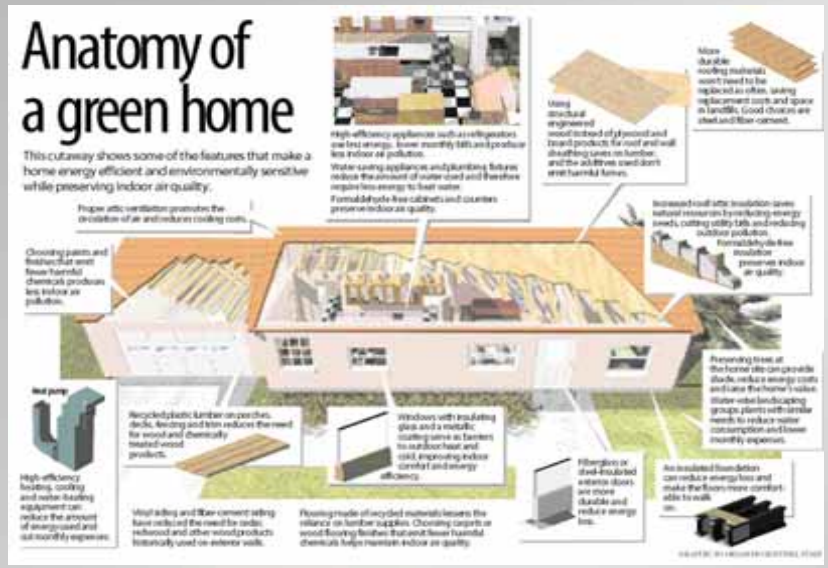
What is “Green” insulation?

- Environmentally friendly insulations are available in all different types, colors and materials
- Green insulation is simply environmentally friendly insulation, including products that reduce pollution, waste and environmental impacts, as well as saving energy and water.

Photo from Walls and Ceilings Magazine November 2004 issue

Whole Building Design

- Materials
- Systems and assemblies
  - Perspectives of:
    - Cost
    - Quality
    - Life cycle
    - Future flexibility
    - Efficiency
    - Environmental impact
    - Productivity
    - Creativity
- Goal: Create buildings that are responsive, responsible and defensible.



www.wbdg.org

To create a properly designed sustainable building envelope, a comprehensive perspective as opposed to the traditional segmented process of construction must be used. All building systems are interrelated and interdependent in the whole building approach. The design focuses on optimizing site potential, minimizing energy consumption, protecting and conserving water, and using environmentally preferable products. Such buildings consider geography, occupant needs, and energy loads, among others.

Fundamentals of Heat Flow or Heat Transfer

(Heat Loss and Heat Gain)

- Radiation
- Conduction
- Convection

Heat is transferred through 3 basic forms, radiation, conduction and convection. Heat always flows from a hot or warm substance to a cold medium, so geography and seasonal climate changes have a major effect on heat transfer within buildings, but insulation can reduce heat transfer either through convection or conduction. Reflective insulation is a combination of aluminum foil and airspaces to provide reflective cavities, which have low values of radiant energy emission (emittance). Ventilation and insulation are critical for controlling heat flow

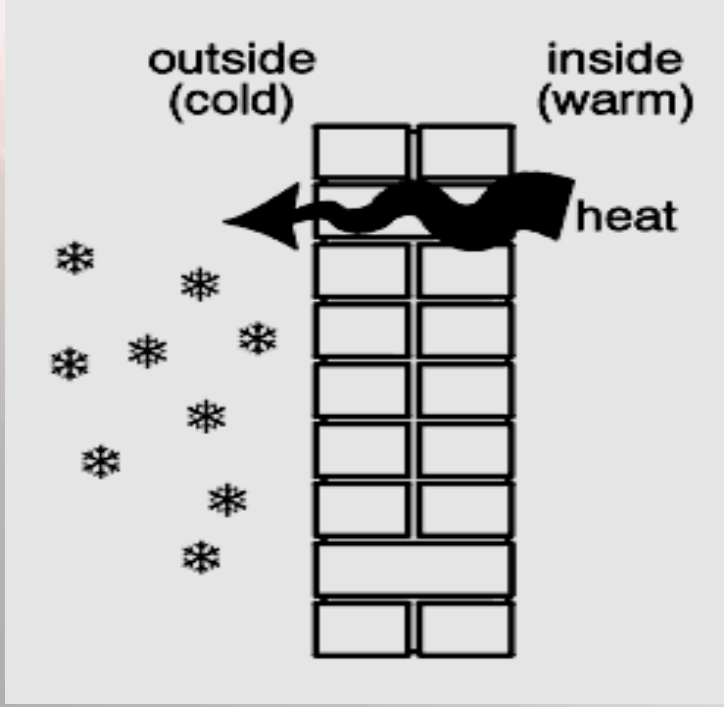
Radiant Heat

- Surface Absorption
- Surface Emittance
- Surface Reflectance

The physical properties of the surface(s) to absorb, emit or reflect radiant energy.

Unlike convection and conduction, radiation involves heat transfer through light waves, sometimes visible and sometimes not. The most effective way to ebb the flow of radiant energy is with a radiant barrier. Emittance and reflectance are key to how radiant insulation reduces heat transfer. Aluminum foil in attic radiant barriers reflects thermal radiation and emits very little heat. In other words, aluminum is a good heat reflector and a bad heat radiator. Aluminum foil in the attic reflects heat radiated by the roof while stopping downward heat transfer.

Conduction



Fourier's Law

Conduction happens as heat flows through a material following physical contact from a heat source. R- Value is a measure of a materials resistance to heat transfer by conductance.

Convection

- Convection loop
- Example of convection

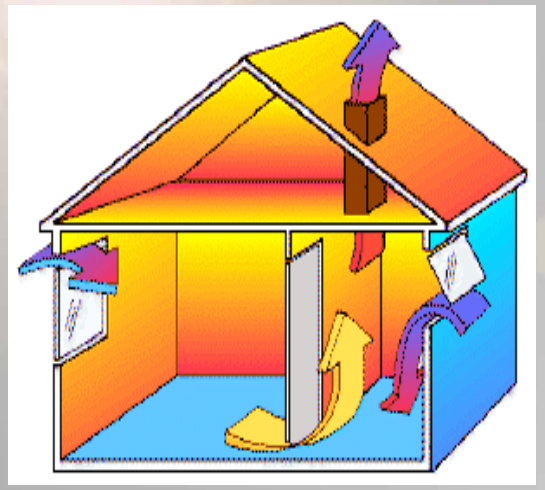
Convection is the circulation of hot or warm air. As the air heats up, it becomes less dense, and rises. Cool air is then forced down and warmed by the heat source in a continuous cycle, or convection loop. Convection can cause air leakage through seams, cracks, and other building penetrations. Forced convection is achieved with a fan or during wind. As heat flows from its source through the air, heat transfer in the air is accomplished by both radiation and convection, and not entirely by conduction. Overall, a temperature difference will exist between a heat source and the average air temperature.

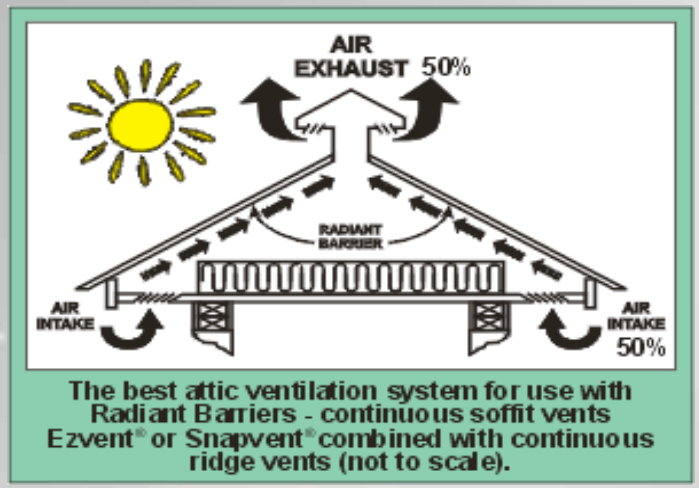
Energy Efficient Design

- Continuity of Barriers
- Designing for a Second Line of Defense
- Construction that Meets Intended Design

Reduced operating costs and energy efficiency are the most well-documented long-term benefits possible when sustainable project designs contain increased insulation. An environmentally sound building envelope includes continuous high performance air barriers installed properly, a defense against unexpected job site changes and must be constructed to meet the intended design. A third-party consultant hired by the owner is becoming part of the “whole” building strategy to ensure that building systems are designed, installed, functionally tested, and capable of being operated and maintained to the design intent and the owner's operational needs.

Building Envelope
Ventilation and Thermal Control

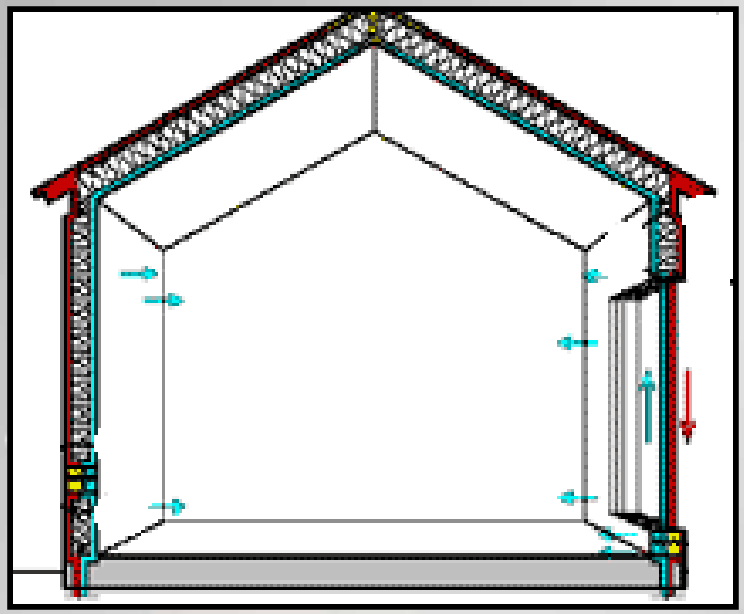




The best attic ventilation system for use with Radiant Barriers - continuous soffit vents Ezvent® or Snapvent® combined with continuous ridge vents (not to scale).

Building ventilation should be installed to maintain a lower the dew point temperature, and prevent elevated moisture levels during the heating season. A high dew point can create condensation on windows, within walls and at rooflines, which become sources for mold growth. Installing insulation for energy efficiency potentially reduces airflow, making ventilation necessary to avoid the collection of indoor air pollutants such as mold and mildew.

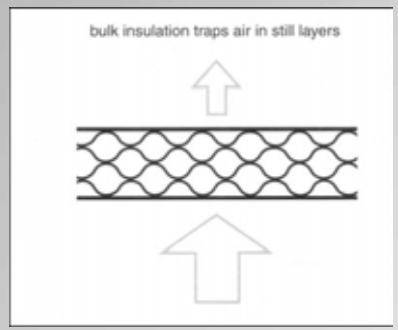
Building Envelope Insulation

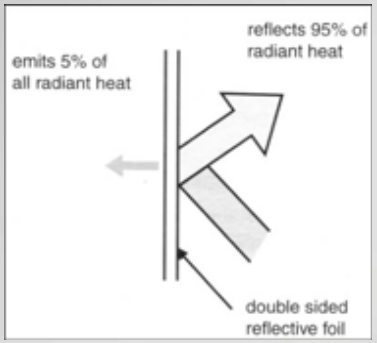


An important part of sustainability involves designing the building envelope for maximum environmental control of the conditioned space usually with barriers and insulation and interior finishes. This attempts to contain air leaks, coming in from outside, and slowing down the loss of the conditioned air, going out from inside. The weather and air barriers are also elements in a properly functioning building envelope. Efficient insulation does not have air moving through or around it, making it very important to seal any air leaks affecting the insulation performance.

Basic Forms of Thermal Insulation

- BATT/Bulk insulation
- BLOWN-IN loose-fill insulation
- FOAMED-IN-PLACE insulation
- RIGID BOARD insulation
- RADIANT INSULATION SYSTEMS





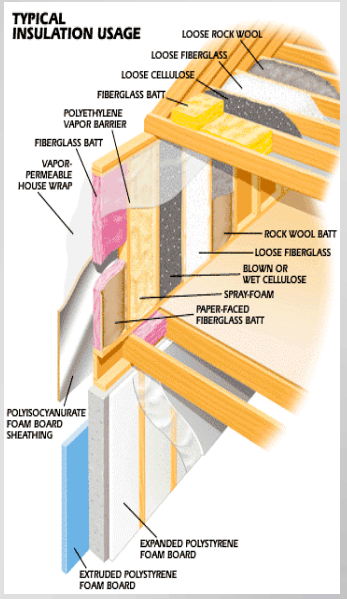


illustration by George Retseck

Popular Mechanics magazine

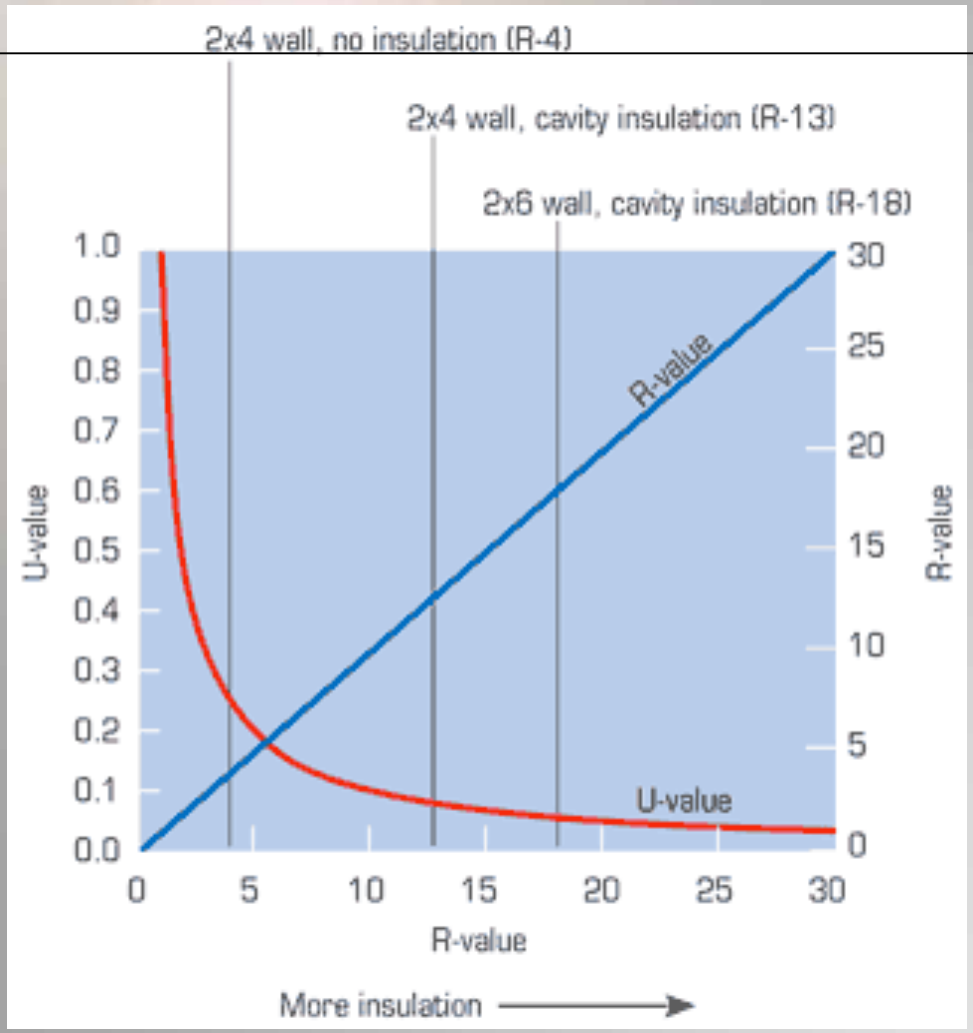
Thermal Insulation includes: blankets in batts or rolls of fiberglass rock wool made in part from sand or rock: blown-in loose fill of loose fibers or fiber pellets spread into building cavities; foamed into place polyurethane foam to seal cavities and stop convection and infiltration; rigid insulation of fibrous materials or plastic foams press or extruded into rigid boar forms; and reflective insulation fabricated from aluminum foils with a variety of backings including kraft paper, plastic film and polyethylene bubbles.

Insulation Ratings:

R - Value

U - Value

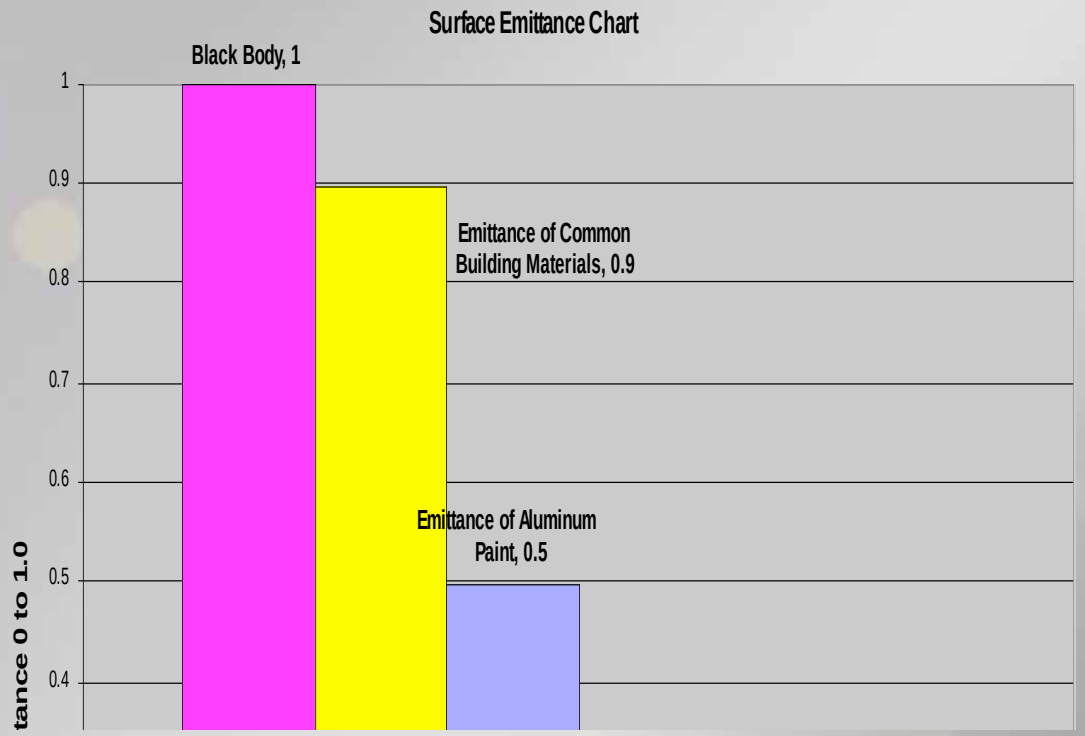
E - Value



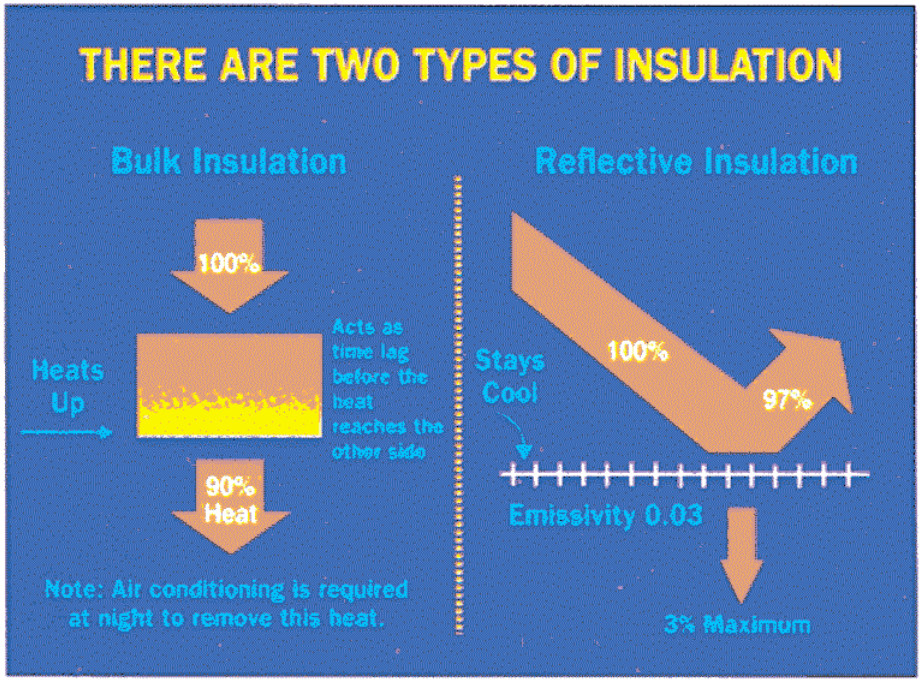
Insulation is rated by its thermal resistance, which indicates its resistance to the flow of the undesirable hot or cold temperature. R-Value is one measure, which records resistance to heat flow, and rises as the insulation increases in effectiveness. U-value is the inverse of R and is known as thermal conductance. While high R-values sound attractive, the real effect of insulation—the U-value—diminishes with each additional inch of insulation. Lastly, E - Value is the amount of radiant energy absorbed by a surface and emitted or re-radiated thru the opposite side. The lower the E-value, the more the insulation will continue to protect a building from radiant energy transfer.

E -VALUES and Radiant Insulation Solutions

Reflective insulation is a combination of aluminum foil and air spaces that provide reflective cavities with low radiant energy emission (E-Value). These cavities may have low emittance surfaces (foil) or encapsulated air spaces within the layers of foil such as the bubble pack product. Often reflective insulation is expected to perform at a similar R-Value as thermal insulation, but R-value is just a measure of heat transfer by conduction. Reflective insulation stops up to 97 % of heat transferred through radiation.



Features and Advantages



- Superior thermal performance
- Reflects 97% of radiant heat
- Ideal solution for retrofit
- Reduces sound transmission
- Lightweight, safe for easy installation
- Increased occupant comfort
- Compliant with building codes
- Environmentally friendly

ASTM Standards

ASTM-American Society of Testing Materials

C16 is the Group that that sets the standards for insulation products and includes experts from all of the insulation types

ASTM C1158 Standard Practice for Installation and Use of Radiant Barrier Systems (RBS) in Building Construction

ASTM C727 Standard Practice for Installation and Use for Reflective Insulation in Building Construction

ASTM C1224 Standard Specification for Reflective Insulation in Building Applications

ASTM C1313 Standard Specification for Sheet Radiant Barriers for Building Construction Applications

These standards should be included in Part 2.

C1224-99 Standard Specification for Reflective Insulation for Building Applications

1.1 This specification covers the general requirements and physical properties of reflective insulations for use in building applications. These insulation materials consist of one or more low emittance surfaces, such as metallic foil or metallic deposits, unmounted or mounted on substrates. Reflective insulations derive their thermal performance from surfaces with an emittance of 0.1 or less, facing enclosed air spaces.

C1313-00 Standard Specification for Sheet Radiant Barriers for Building Construction Applications

1.1 This specification covers the general physical property requirements of radiant barrier materials for use in building construction. The scope is specifically limited to requirements for radiant barrier sheet materials that consist of at least one surface having a far-infrared emittance of 0.1 or less, such as metallic foils or metallic deposits mounted or unmounted on substrates.

Radiant Insulation Architectural 3 Part Specifications

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Reflective Insulation Company, Anywhere Street, State 55555. Phone number, Fax, Web site

2.2 RADIANT BARRIER

A. Multi-Layer Radiant Barrier

B. Description:
   1. Inside Layer: 1.4 mil metalized PVC.
   2. Outside Layer: 0.000285 inch aluminum foil laminated with fire-retardant adhesive to 30 pound natural kraft paper. Reinforced with tri-directional fiberglass and polyester scrim.
   3. Reflective Air Space: Layers expand when installed to form reflective air space.

C. Compliance:
   1. ASTM C 1158.
   2. Federal Specification HH-I-1252B.
   3. SBCCI Report 94101.
   4. Metro-Dade Report 99-0122.04.

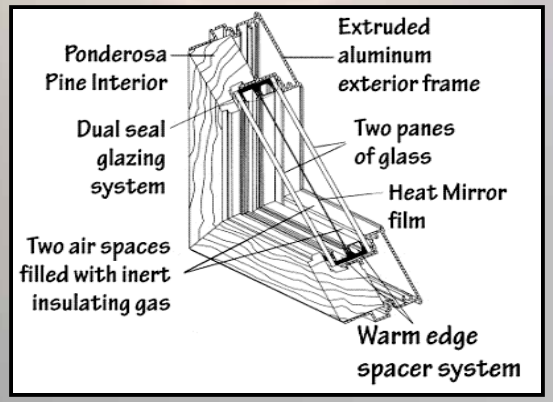
D. Testing:
   1. Water Vapor Permeance, ASTM E 96: 0.052.
   2. Flammability, ASTM E 84:
      a. Flame Spread Rating: 15.
      b. Smoke Developed Rating: 45.
      c. NFPA Classification: Class A.
   3. Thermal Emittance, ASTM C 1371:
      a. First Layer, MET PVC: 0.05.
      b. Second Layer, Foil Laminate: 0.03.
   4. Corrosivity, 5 Days, ASTM D 3310: No change.
   5. Adhesive Performance:
      a. Bleeding: None.
      b. Delamination: None.
      c. Pliability: None.
   6. Mold and Mildew, ASTM C 1338: Pass.

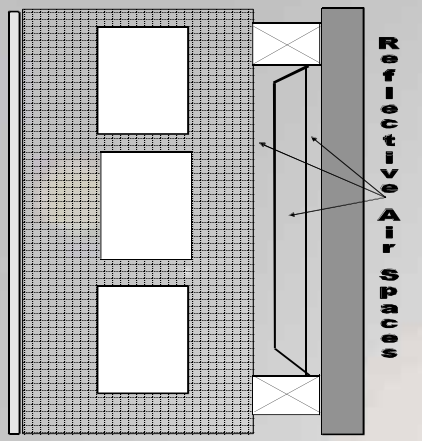
Understanding Reflective Insulation and Radiant Barriers

- **Reflective Insulation - defined as having one or more reflective air spaces in a CLOSED cavity**
- **Radiant Barriers - defined as facing an open airspace**
  - **typically installed in open attics that allow ventilation**
- **Reflective Insulation HAS R-values**
- **Radiant Barriers DO NOT have R-values**

Low-e Windows – Reflective Insulation System

The thermal resistance of a reflective insulation is dependent on the size and the number of reflective air spaces.





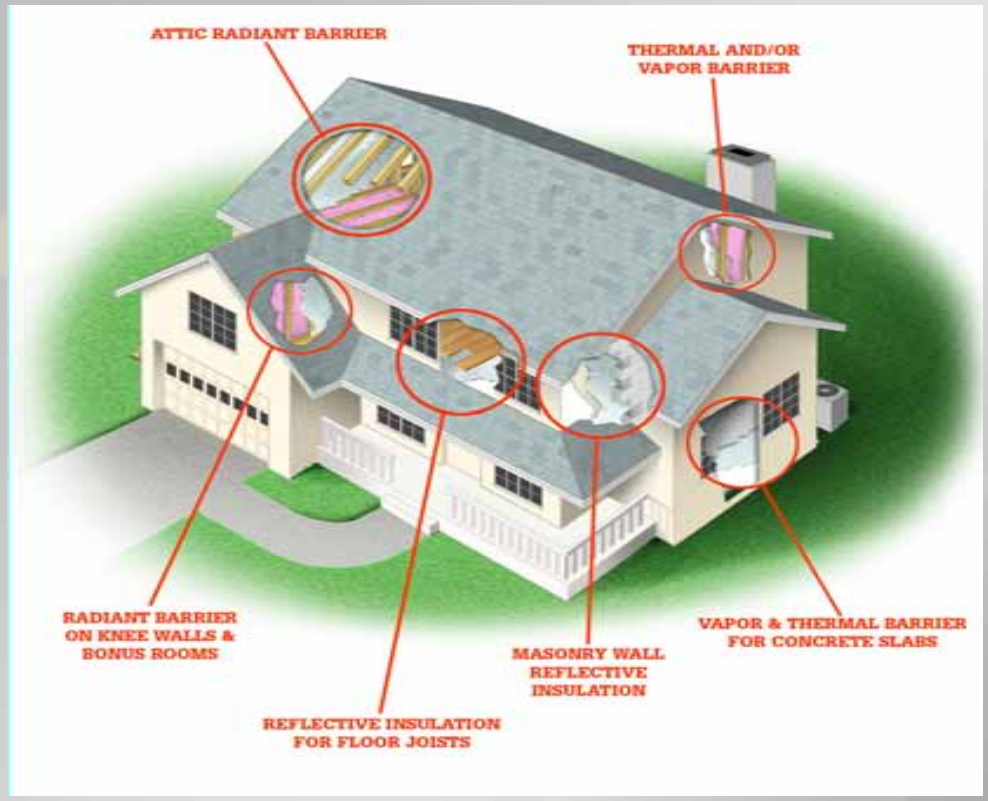
The thermal resistance of a reflective insulation is dependent on the size and the number of reflective air spaces.

A multi-layer reflective insulation installed in a building assembly will perform in the same manner as a multi-pane Low-e window. The additional panes trap air or a gas to increase the resistance to heat flow. The low-e is a coating on the window that reduces radiant heat transfer across the airspace. Low-E stands for low emittance.

Applications

Radiant Insulation Solution Applications in Residential Applications

Reflective insulation materials are designed for installation between, over, or under framing members and as a result, are applicable to walls, floors, and ceilings and crawl spaces. Applications for reflective insulation extend to many commercial, agricultural and industrial uses, such as panelized wood roofs, pre-engineered buildings, and pole barns. Applications can include: new or existing residential and manufactured housing, water heater covers, cold storage units, poultry, and livestock buildings, equipment sheds, pipe insulation and recreational vehicles.

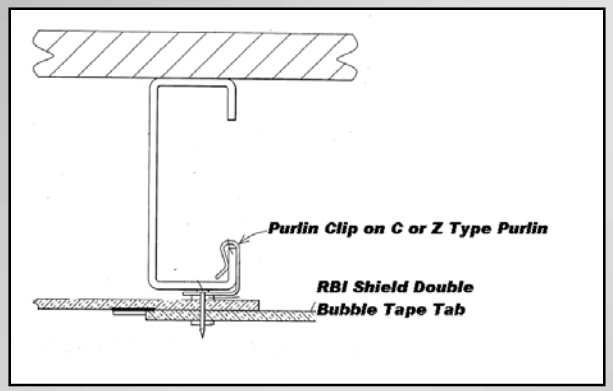


Reflective Insulation Applications

- **Floors – crawl spaces**
- **Walls – block or frame**
- **Ceilings – metal or post frame**
- **R-value is dependent on the thickness of the cavity, the heat flow direction (up-down-horizontal), and the number of reflective air spaces.**
- **A reflective insulation can also function as a vapor retarder – a Hi-Perm or perforated version allows vapor transfer and should be used in <u>Hot Humid Climates</u>.**

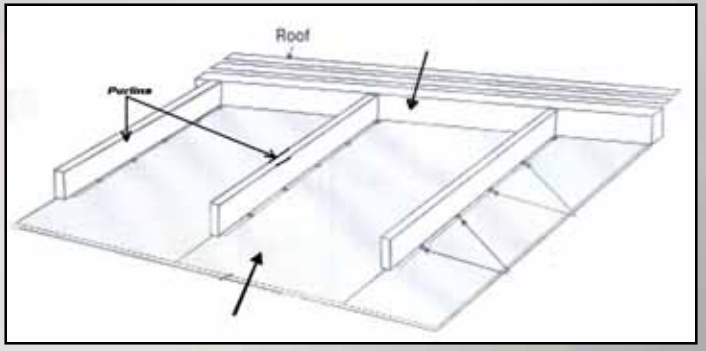
Reflective insulation is typically installed between floor joists, wall studs or roof rafters. If a single reflective surface is used alone facing an open area, it is considered to be a radiant barrier. Radiant barriers come in many forms for different applications; single-sided foils backed by a supportive material such as kraft paper or polypropylene; foil-faced roof sheathings such as foil-laminated OSB; double-sided foils with a reinforcing material between the layers such as polyethylene bubble-pack; foil-faced insulation (reflective insulation); multi-layered foils; and radiant barrier chips.

Metal Buildings



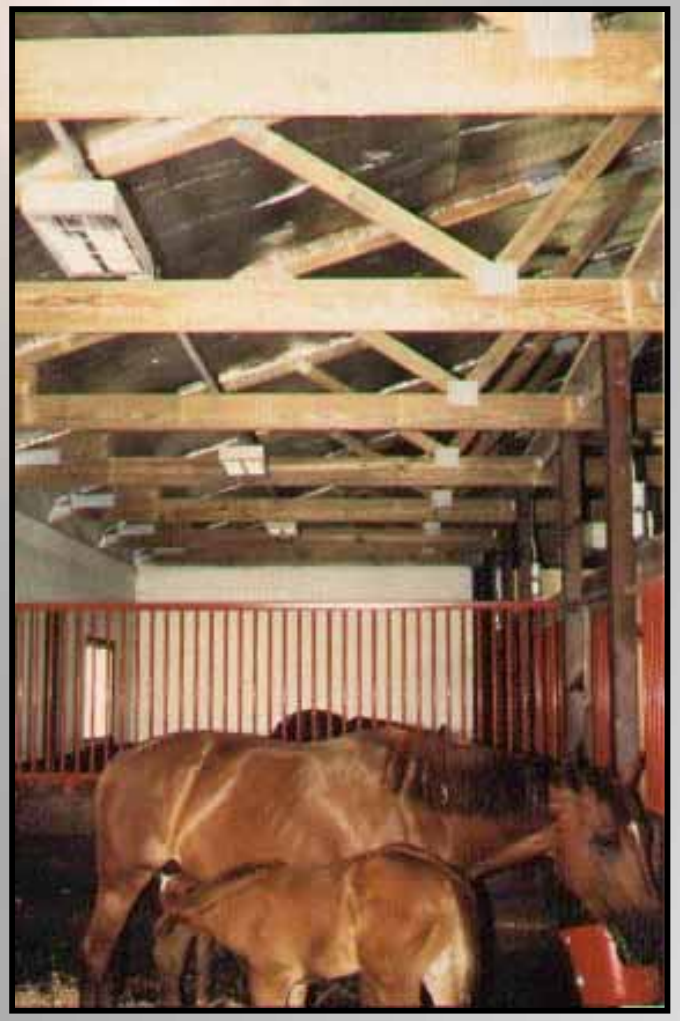
Can be back-filled with mass insulation

Radiant insulation solutions throughout its sustainable life will not emit fumes, particles or other toxins that could degenerate the air quality of otherwise harm the environment within the buildings where they were installed.



Clip & Pin Snaps on Purlin and secures insulation with locking washer

Agricultural Applications



Buildings for:

Livestock
Poultry
Hatcheries
Horses
Dairies
Hogs
Nurseries

Reduced Radiation keeps animals more comfortable

Radiant Barriers

A radiant barrier system specifies that the reflective material face an open air space. The idea is that a radiant barrier facing an enclosed air space is a “reflective insulation” with a measurable R-value. A radiant barrier is a layer of aluminum foil placed in an airspace to block radiant heat transfer between a heat-radiating surface, such as a hot roof, and a heat-absorbing surface, such as conventional attic insulation, mechanical equipment, or ducts. The products are categories as aluminum foil laminates or aluminized plastic films.

Radiant Barrier in vented or non-vented attic application

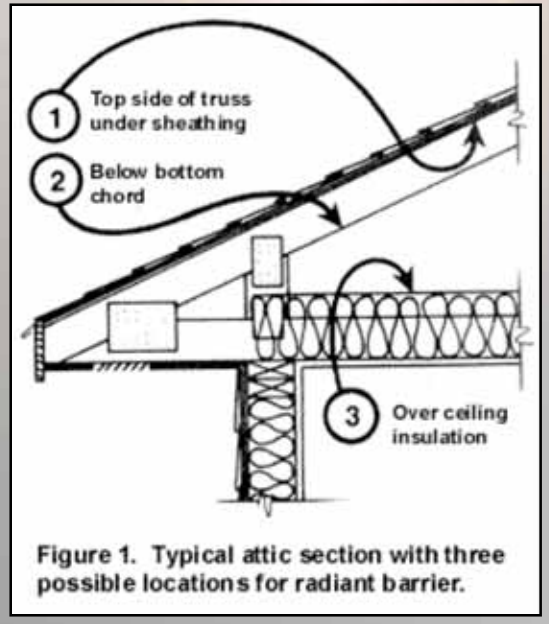
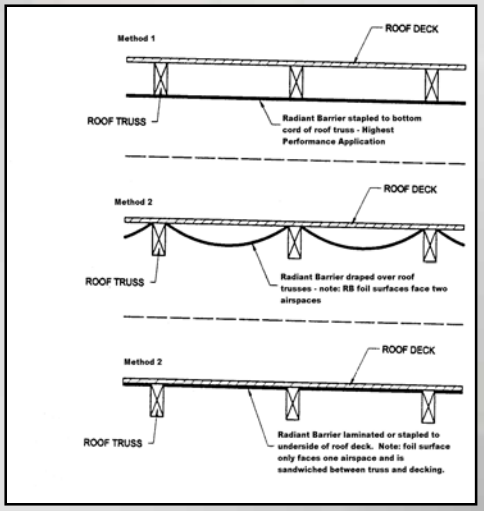


Figure 1. Typical attic section with three possible locations for radiant barrier.

Typical attic section with two locations for an attic radiant barrier

The air change in a perfectly built and vented attic (code 1:300 ratio) results in an average air change rate of 3 to 6 ach. results in an average air change rate of 3 to 6 ach. At this attic air change rate there is approximately a 2 to 3 percent reduction in heat transfer to the conditioned space through the vented attic as compared to an unvented attic insulated to the same level. This assumes an airtight ceiling and no ductwork in the attic and certainly not leaky ductwork in the attic.



Ceiling Insulation

Radiant Barriers in the attic reflect heat and perform best when ventilated. Local code will be the ultimate deciding factor on how to proceed. The rationale for venting attics in the South is to "flush" heat. The dominant heat transfer mechanism in an attic is radiation. Venting attics will not "flush" radiation.

Radiant Barriers – Bonus Rooms

A number of new initiatives have been developed within the arena of sustainability. These include the U.S. Green Building Council's LEED Rating System, ASHRAE 2000, a new sustainability standards from ASTM, as well as a host of non-government green standards such as Energy Star, The Cool Roofs Initiative, Greenguard and others. These are terms that should be synonymous with Radiant Insulation Solutions as an energy efficient, environmentally friendly material that is compatible with most building envelope systems.

Reduces the surface temperature of the insulation and assures proper alignment of wall mass insulation with the air barrier (holds the insulation against the inside surface of the drywall).

Overall Benefits of Radiant Barriers

- Low emittance surfaces reduce radiant heat transfer up to 97%
- Reduces Attic Temperatures up to 30 degrees F
- Improves air conditioning duct performance up to 50%
- Improves comfort in unconditioned areas like garages and lanais
- Reduces the radiant surface temperatures of the ceilings and walls
- Saves energy & improves comfort

Unlike conventional insulation, reflective insulation has very low emittance values “E-values” (typically 0.03 compared to 0.90 for most insulation) and that significantly reduces heat transfer by radiation. By comparison, most building materials, including fiberglass, foam and cellulose have "E" values in excess of 0.70. Reflective insulation typically has "E" values of 0.03, which is better. In addition, reflective insulation does not absorb or retain heat and usually has a lower moisture transfer and absorption rates. The environmental benefits include limited fiberglass, foam or ground paper and therefore it does not irritate the skin, eyes, or throat, or contain out-gassing compounds. Compaction or moisture absorption in common mass insulations is not an issue with reflective insulation.

GREEN Initiatives

for Radiant Insulation Solutions

- USGBC LEED™ Rating System
- ASHRAE 2000
- ENERGY STAR

A number of new initiatives have been developed within the arena of sustainability. These include the U.S. Green Building Council's LEED Rating System, ASHRAE 2000 (which is a new sustainability standards from ASTM), as well as a host of non-government green standards such as Energy Star, The Cool Roofs Initiative, GreenGuard and others.

For Radiant Insulation Solutions

Radiant Insulation Solutions may contribute to point toward LEED certification of a project under the rating system's section covering "Energy and Atmosphere" which has a prerequisite of 2 Minimum Energy Performance. One credit is available for demonstrating optimized energy performance. Radiant insulation also can gain potential points under "Materials and Resources" for building reuse when durability assures continuous performance; "Construction Waste Management" if the material can be separated into paper and foil, and "Recycled Content" because the insulation is made of recycled paper and foil. Further points can be achieved under "Local/Regional Materials" and "Innovative & design Process". It is best to consult a LEED-accredited professional to assist in the scoring process or gain accredited from the USGBC. Reflective Insulation can also gain points for projects involving new construction, existing buildings, or retail or commercial interiors.

LEED
LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

Energy and Atmosphere

- Prerequisite 2 - Minimum Energy Performance
- Credit 1. Optimize Energy Performance

Materials and Resources

- Building reuse
- Construction waste management
- Recycled Content
- Local/Regional Materials

Innovative & design Process

–LEED Accredited Professional

CONTINUING EDUCATION AIA

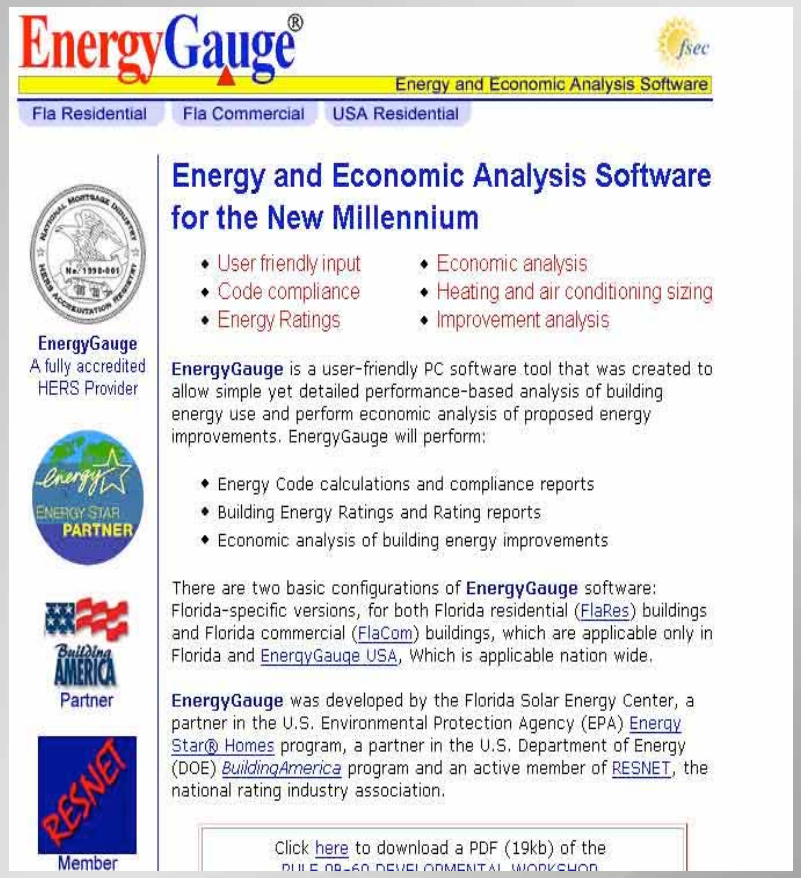
In Review

- Building Envelope Science
- Low Emittance or High Reflectivity is key
- Meets many sustainable design criteria
- Helps in meeting new ASHRAE standards
- Proven return on investment

The reflective advantages to radiant insulation make it an ideal green product. It can make batt insulation in the attic floor work more efficiently. There are many applications and types of foil insulating products to meet specific project needs. In niche markets, radiant insulation can be retrofitted on metal building, which is ideal for the US Green Building Council's new LEED for Existing Buildings rating system. However, the greatest benefits are energy efficiency and comfort for calculable returns on invest through energy modeling.

Energy Modeling with Radiant Insulation Solutions

Energy modeling tools can assist with the complexities of determining which products and assemblies to consider. It is best to perform an energy model prior to writing the specifications because the writer can then include the proper products. Other benefits to modeling include: saving on operating expenses, and building a more green and sustainable building. Also, ensure energy modeling is in the design schedule. The Florida Solar Energy Commission's energy calculator is an ideal modeling tool for the climate in the Southeastern United States and it runs over the DOE's program.



Helpful Web Sites

- Fi-Foil - www.fifoil.com
- RIMA - www.rima.net
- FSEC - www.fsec.ucf.edu
- EPA - www.epa.gov
- Energy Star - www.energystar.gov
- US Green Building Council
  www.usgbc.org
- Oak Ridge Laboratories - www.ornl.gov
- US Dept of Energy -
  www.eere.energy.gov/AB/
- Building America - www.buildingamerica.gov
- Sustainable Building Industry Council - www.psic.org
- Florida Green Building Coalition -http://floridagreenbuilding.org

ASTM E-2129 & LEED™ Rating Points

FI-FOIL COMPANY
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GREEN Reflective Insulation and Radiant Barriers

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the CEU test and
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Building Green with Radiant Insulation Solutions

Presented By:

Jan Buehler, CSI