
Chapter 8

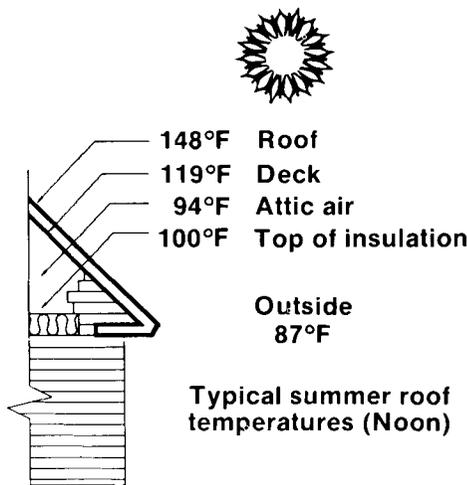
Energy-Efficient Roof, Ceilings and Attics

Recommendations	First Cost	% Potential Savings	
		Cooling	Heating
1. Seal potential air leakage sources in ceiling.	S	10	15
2. Use light-colored shingles and roofs.	N	5	—
3. Use continuous soffit vents at eaves and ridge vents at all peaks.	S	5	—
4. Insulate the attic thoroughly.	S	5-10	10
5. Use radiant barrier systems in attics.	S/M	8-12	8-12
Maximum Combined Total	M	25	25

Cost Codes: R = reduced
N = negligible
S = small (<\$0.25/ft² of floor area)
M = medium (>\$0.25 and <\$1.00/ft² of floor area)
H = high (>\$1.00/ft² of floor area)

Marketing Energy-Efficient Roofs, Ceilings and Attics

If it's hot outside, there's one very easy way to show your clients the importance of a cool roof. Ask them to go up to the attic of their current house for a couple of minutes. Just opening the door or hatch to their attic will probably do the job. The blast of hot air hitting their faces should quickly and powerfully show them how hot roofs and attics can get, and why something must be done to keep that heat from getting into their house. Your well-built, energy-efficient home will take on added value since you have done something to reduce the flow of heat from the attic downward into the house.



Typical summertime attic temperatures.

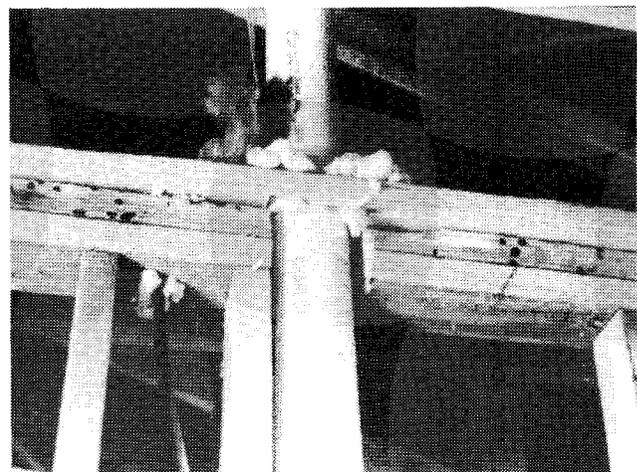
If the weather isn't hot, you can still explain this effect to your clients by showing them the above illustration of attic temperatures. The numbers are dramatic enough to do the selling job for you.

It is important to emphasize to your clients the major role roofs and attics play in heating Florida homes. Research shows that about 10-20% of the cooling load in homes in our state comes from heat conducted into the home through the ceiling, putting a major load on the air conditioner and greatly affecting the comfort level in the house. An additional 25% of the cooling load comes from heat and moisture infiltration, some of which enters the house through ceiling penetrations. The double whammy of higher air conditioning costs and an uncomfortable house poses a major problem to home owners, so you should not minimize the steps you have taken to keep their roof and attic cool.

You have five basic energy-conserving strategies to sell in your homes which can alleviate the problems

of a hot roof: well-sealed ceilings, proper roof materials, good ventilation, adequate insulation and attic radiant barriers. Your attention to these areas will help your buyers enjoy a comfortable home with affordable energy costs. They will feel and enjoy the benefits of these building strategies for many years.

Explain to prospective home buyers that the unwanted flow of air and moisture from the attic into a house — called air infiltration — is a major cooling load in Florida homes. Point out that much of the problem is caused by air leaking into the house from openings for electrical lines, plumbing penetrations, and other building components which go between the attic and living area below. Describe how well-sealed *your* homes are, and how your crew pays special attention to these sources of air leakage.



Let a photo show the attention you have paid to sealing plumbing and wiring penetrations in the top plate.

Be sure to emphasize that your crew's attention to such hard-to-reach places as ducts and dampers, pipes, and other sources of infiltration may save the home owner considerable expense later on, since many of the areas needing sealing are inaccessible once the home is built.

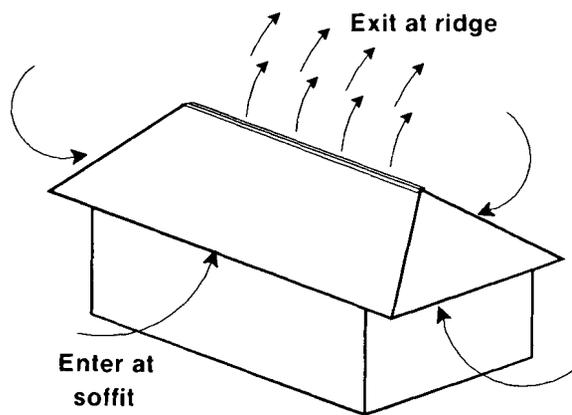
Some builders leave two pieces of asphalt shingle — one black and one white — outside their office window for a simple demonstration of the effects of shingle colors. Try doing this, then take prospective clients outside on a sunny afternoon to this "test area" and ask them to pick up or at least put their hands above each piece. The darker colored shingle



A white tile roof reflects most of the sun's heat.

will be very hot to hold, and will clearly be much hotter than the lighter colored piece. Your clients will see how important shingle color is to the temperature of their roof.

Emphasize to clients how effective vents are at increasing ventilation in their home's attic. If you have installed soffit and ridge vents, explain that these create better attic air flow than gable vents.



Attic air flow is best with continuous soffit and ridge vents.

Many potential buyers will ask you about the insulation in your homes. Media advertising, news articles and other promotional messages over the past few years have convinced home owners that insulation is a major factor in a home's energy use.

Adequate insulation slows the flow of heat through the attic and ceiling, allowing the occupants of the house to maintain comfortable temperatures throughout the year with minimum energy cost.

Inform the home buyer that the best time to install insulation is during construction, since many parts of the attic will be difficult to reach with insulation once the home is completed.

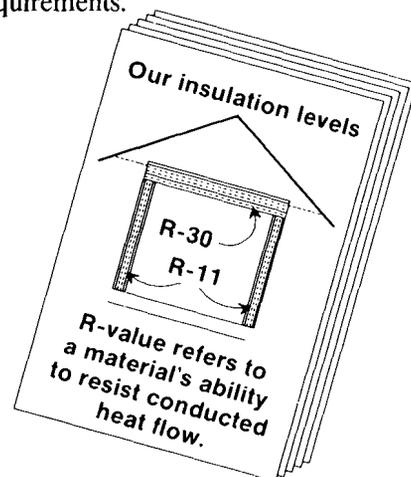
It is important that you anticipate your clients' interest in insulation, and present them with enough information to convince them that your homes are well-built with adequate levels of insulation.

The Federal Trade Commission requires that builders disclose R values to buyers. You can show them the energy code forms to disclose the information.

In Florida, ceiling insulation with an R-value between 19 and 30 is generally recommended (R-19 is the minimum under Florida's Energy Efficiency Code). R-19 is equivalent to about 6 inches of fiberglass batts, 8.5 inches of blown fiberglass, or 6 inches of blown cellulose. R-30, or R-19 plus a radiant barrier, is suggested for good energy conservation.

Explain R-value to customers this way: R-value refers to an insulation's ability to resist the flow of heat from one side of it through to the other. The higher the R-value, the more effective the insulation. Note, though, that each added amount of insulation is not as cost-effective as the previous amount.

To help your clients better understand what R-value means to them, prepare a simple hand-out sheet with a brief definition of R-value (similar to the one above), along with a drawing of your house showing the wall and attic R-values. This will be especially impressive if any of the numbers exceed the minimum requirements.

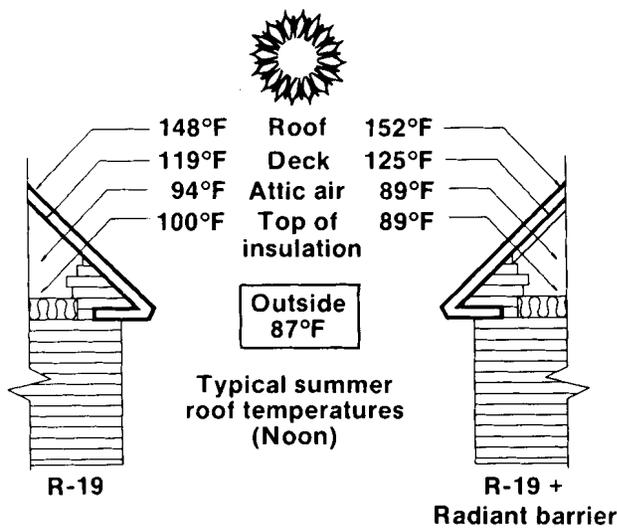


Prepare a hand-out sheet showing R-value of insulation levels in your home.

Point out the benefits of buying a house with a radiant barrier already installed. Retrofitting these systems can be very difficult since attics usually have limited space, and stapling the materials onto the trusses can be an uncomfortable and, in some cases, even impossible task.

Emphasize to your clients that heat transferring (radiating) downward from a hot roof causes the home's air conditioner to run longer and use more electricity. A radiant barrier system (aluminum foil facing the attic air space), however, will stop most of this radiant heat transfer — and, when combined with good soffit and ridge vents, can reduce the heat flow at the ceiling by about 40%. Look at the next illustration and notice how much lower the attic temperatures are with a radiant barrier system.

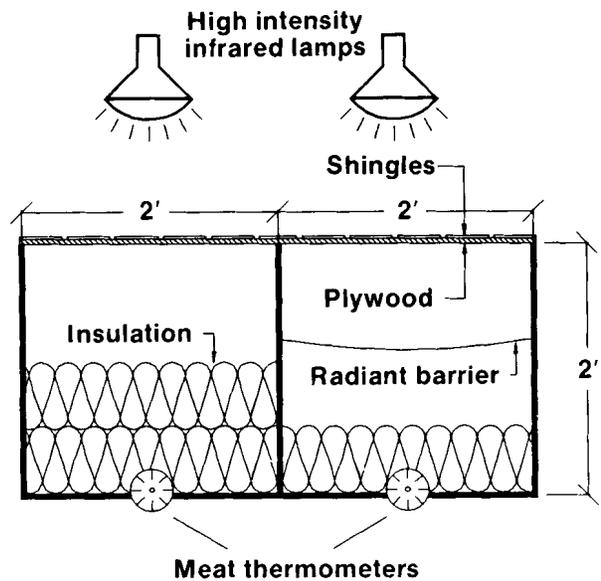
Since these systems keep attic temperatures much lower, the ductwork, plumbing and other materials in the attic may have longer life spans. Cooler ducts also make the cooling system in the home operate more efficiently. The combined effect may even result in a smaller-sized air conditioner.



Comparison of temperatures in attics with and without a radiant barrier.

It is reasonable to expect an attic radiant barrier to save the home owner 8% to 12% on annual space conditioning costs. Actual savings will depend on the amount of heat the roof and attic contribute to the home's total cooling load.

There is a dramatic and effective way to demonstrate radiant barriers to prospective home buyers. Take some plywood and a couple of 2x4s and build a large box about 4 feet wide, 2 feet deep and 2 feet high. Leave the top and front open, and divide the box into two equal compartments. Put a 6-inch layer of insulation on the floor of each compartment. Add 6 more inches of insulation in one compartment, and put a radiant barrier above the insulation in the other one. Put plywood and a shingle roof on the box. Place a sunlamp or other high-intensity bulb a good distance above each compartment. Put a piece of transparent material, such as clear acrylic, on the open side. Drill a hole in the front of each compartment, one inch from the bottom, and insert a meat thermometer into the insulation. After the lamps have been on a few minutes, your clients will see how much cooler the insulation stays under the radiant barrier.

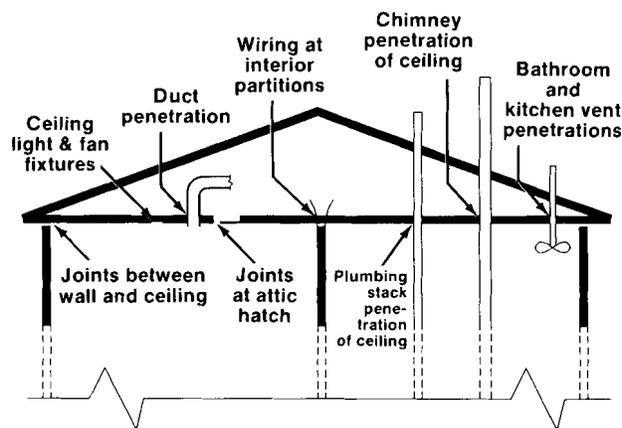


A radiant barrier demonstration box can be a dramatic sales tool.

Product Selection and Installation for Energy-Efficient Roofs, Ceilings and Attics

1. Air-tight ceilings

Prevent air infiltration from attics by paying close attention to areas around ceiling lights and fan fixtures, water lines, switches, outlets, attic access doors and whole-house fans. Seal the wall top plates around wiring and plumbing with noncombustible materials. Check carefully for leaks around bath and kitchen vent fans and chimney penetrations. During the day the attic becomes a source of very high temperatures and moisture, and much of this unwanted air can penetrate through these openings into the house.



Major locations of air leakage between conditioned area and attic.

2. Roof materials

Tests at FSEC and other research centers have shown that both the color and the type of roof material affect energy consumption and home comfort.

The solar absorptance of a surface is the extent to which that surface will convert solar radiation to heat. A surface with a rating of 1 will convert all the solar radiation; a surface rated at 0 will convert none of it. Roofs typically range from 0.35 for clean white tile (absorbing only about 35% of the solar radiation) to 0.95 for black shingles (converting about 95% of the radiation to heat). Choose light-colored surfaces whenever possible, because their lower solar absorptance will help keep heat out of the house.

Also, materials with more exposed surface area — such as tiles, shakes and pebbles — will be cooler than asphalt shingles.

Effective Solar Absorptance of Common Roof Surfaces

Surface	Solar Absorptance
Dark asphalt shingles	.85 - .95
Medium asphalt shingles	.80 - .85
Light asphalt shingles	.70 - .75
Dark pebbles built-up roof	.80 - .90
Medium pebbles built-up roof	.60 - .80
Light pebbles built-up roof	.50 - .60
Dark roof tiles	.80 - .90
Medium roof tiles	.70 - .80
Light roof tiles	.35 - .50
Old cedar shakes	.80 - .80
New cedar shakes	.65 - .75

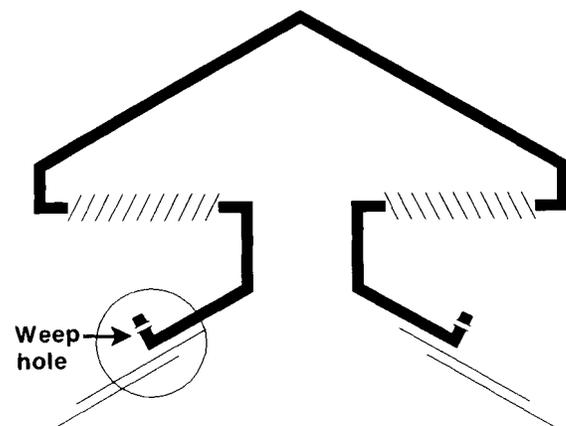
Note: Dark colors: black and dark primary color combinations

Medium colors: pastels to warm primary color combinations

Light colors: white or off white.

3. Attic ventilation

We recommend the use of continuous soffit and ridge vents whenever possible. You will need at least one square foot of free vent area for each 150 square feet of ceiling to meet building codes. Be sure that vents are sized to provide an equal open area for both inlets and exits. Cut felt paper clear of ridge vents to assure the maximum opening. Use a



A ridge vent of this type is effective in resisting wind-driven water from backing up into openings. Weep hole is present in end flange.

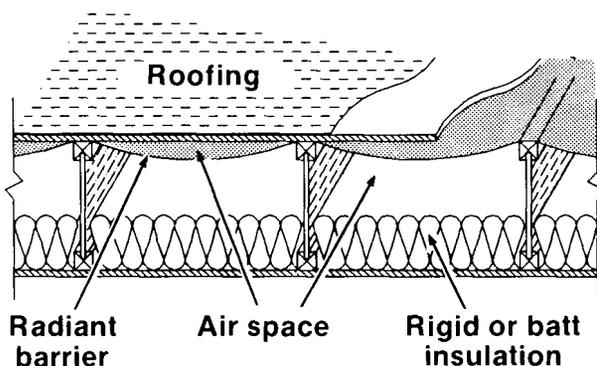
continuous baffle at eaves to prevent insulation from blocking air flow.

There are ridge vent products that can be shingled or tiled over. Such ridge vents make it possible to have a roof of uniform appearance.

If you're building homes with vaulted or cathedral ceilings, use an appropriate truss system to obtain an airspace and thereby reduce heat gain. If you are using a single-assembly roof (no attic space), you will have to find some other means to provide an airspace between the roof decking and the insulation. The use of 2x12s or plywood-webbed I-beams for framing allows room for the airspace, insulation and a radiant barrier (if used) without blocking airflow.

Avoid the use of wind turbines in new construction. Although they may have a place in retrofit applications, they are not as reliable as other new construction venting methods (gable or ridge vents with soffit vents).

Power ventilators are not necessary. Natural ventilation can achieve similar attic heat-flow reduction without the cost of running power ventilators.



Use plywood-webbed I-beams to assure air space for ventilation and radiant barriers (if used) in cathedral roofs.

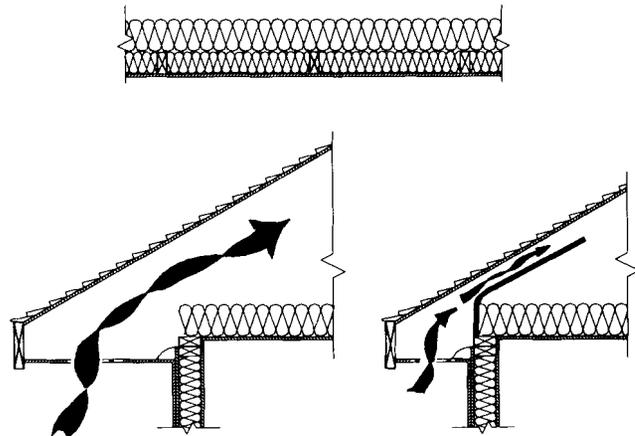
4. Insulation

Insulation comes in blankets (rolls made of glass fiber or rock wool), batts (pre-cut blankets in standard sizes), rock wool or fiberglass (loose insulation requiring blown-in installation), cellulose fiber (recycled paper particles treated with chemicals and blown-in or sprayed), foam-in-place (liquid foamed plastic), phenolics, or rigid foam (sheets or boards of

foamed plastic such as polyurethane or polystyrene). When choosing the insulation for your job, consider such factors as cost, quality, special characteristics (e.g., odor, treatment for insects, etc.), and insulating capability (R-value). Chapter 6 contains a table that compares the insulating materials frequently used in new home construction.

The goal of any installation is to have a continuous layer of insulation without gaps, cracks or air bypasses. Among the points that require special attention:

- The insulation at the edge of the ceiling must not be allowed to contact the roof decking and block airflow from the soffit vents. When installing ceiling insulating materials, use baffles to prevent blocking the vents.
- Batts or blankets must butt tightly against framing or other batts and blankets. Cover the bottom chord of the truss so that heat will not easily transfer through the wood.



Insulation should extend over the top ceiling joints and ventilation should be provided at the eaves with extended trusses or baffles.

- Cut batts or blankets to fit at framing joints to avoid buckling and gaps.
- Avoid using recessed light fixtures if possible. If you must use them, choose ones with insulated covers. For fire safety, do not cover standard recessed light with insulation.
- Insulate and weatherstrip the attic access panel.

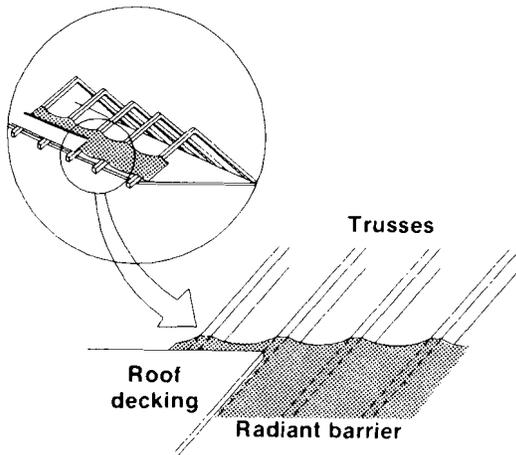
It is essential that insulation be properly installed. Follow the manufacturer's instruction to achieve the desired thermal performance. An R-11 fiberglass batt will perform at less than R-7 if compressed to

half the designated thickness. Insulation that is blown or poured into an attic will not perform to its stated standards unless it is evenly applied to the proper depth and density. You can check the depth by placing markings on the truss webs. You can also check the quantity by counting the number of bags the installer used.

In addition, gaps that are often found around wiring, piping and other openings can seriously impair the overall performance of the insulation. Inspect thoroughly and fill any gaps with insulation.

5. Attic radiant barriers

FSEC tests have shown that the effects of radiant barrier systems are effective in stopping heat transfer between a hot roof and conventional attic insulation. However, it is important to have soffit and ridge vents before even considering a radiant barrier system. Radiant barriers perform far better with good ventilation from soffit and ridge vents.



A radiant barrier can be draped over the trusses with the foil facing down.

Selection. There are many types of radiant barrier material on the market. Select the type which fits best with your needs.

The identified generic types that are in use are:

- single-sided foil with another material backing, such as kraft paper or polypropylene
- double-sided foil with reinforcement between the foil layers
- foil-faced insulation with a special material to impede heat conduction (such as polyisocyanurate or polyethylene)
- multilayered foil systems which form enclosed, insulating airspaces.

When choosing the best type for your construction needs, be sure to take into account the emissivity of the material — the lower, the better. A maximum of 0.06 is permitted in the energy code. A fire rating of Class A is required by Florida building codes. Also consider ease of handling, strength of reinforcement, appropriate width, and cost. Radiant barriers should be considered a supplement to conventional insulation, not a replacement. Most builders have found fiber-reinforced, single-sided-foil radiant barrier products economical and durable in attics. When choosing foil products, remember that low emissivity is a characteristic of the foil surface. Avoid products which are not labeled as radiant barriers. Even though some building materials may include aluminum foil or appear reflective, the surface may be treated in a way that would make them ineffective.

Most foil-backed insulations are not fire rated to exposure to an airspace and cannot be used as a radiant barrier. However, one batt insulation product has a radiant barrier attached.

There is also a low-emissivity paint that can be applied directly to the under side of the roof decking. This paint does not qualify as a radiant barrier under the energy code because it has a emissivity of 0.23. However, it does reduce the heat flow across the attic into the house and is an appropriate product for many applications.

Installation. Installation of radiant barriers is fairly easy during new construction. In some localities, you can hire subcontractors specializing in such installation. It can be a sideline for a carpenter, roofer, or other skilled worker. If you decide to install the systems yourself, we recommend using a team of two workers. After some experience, they should be able to install 500 to 1000 square feet of material per hour in new construction.

However, working with radiant barriers is new to Florida builders, and it is important that they follow a few basic guidelines.

In particular, **installers must allow an airspace next to the foil side of the material.** The airspace is essential for the radiant barrier effect.

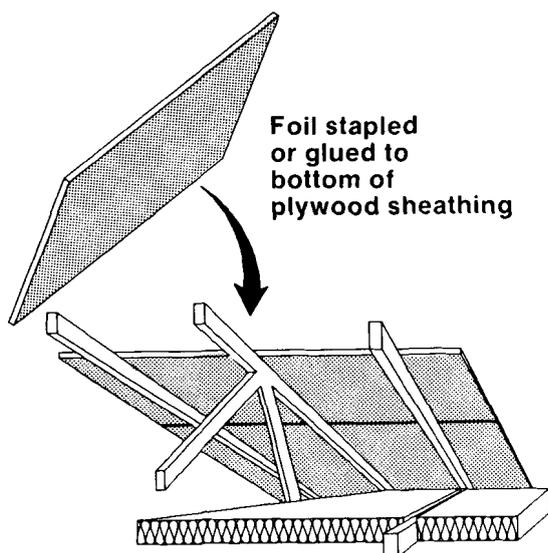
Face the foil side down to ensure that dust won't collect on the low-emissivity surface and degrade the system's performance. **Leave a 3- to 6-inch gap near the peak for hot attic air to exit the ridge vent.**

There are four locations where radiant barriers could

be installed:

- glued or stapled to the underside of the plywood roof sheathing, foil side facing down
- draped from the roof rafters underneath the plywood, foil side facing down
- stapled from the bottom of the roof rafters, foil side facing down
- placed on top of the insulation, foil side facing up.

Although attaching a radiant barrier to roof sheathing is the simplest and least costly method, the location does not conform to the model energy code (because of the lack of data when the code was issued). However, recent experiments indicate this location is as good as others.

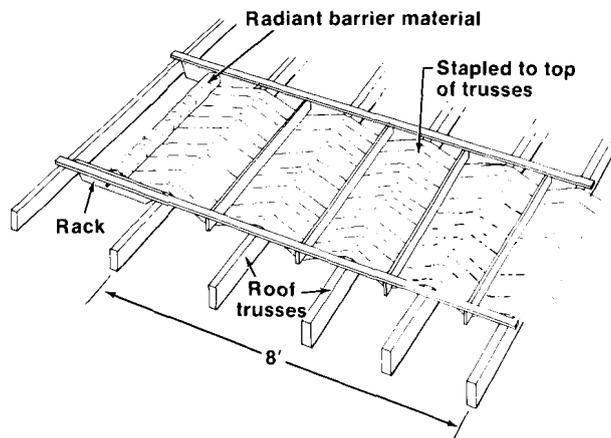


Attaching the radiant barrier directly to the sheathing can reduce installation costs.

Builders usually find that draping the radiant barrier before putting down the decking is made easier by the use of an installation rack (see drawing). With it, foil can be unrolled horizontally across the top of the trusses from one end of the roof to the other. The first length should be installed at the soffit end; each successive length should overlap the preceding one.

The rack serves three important functions:

- It holds plywood-sized lengths of foil in place, even in the wind.
- It makes it easier to unroll and fasten the material.
- It ensures an even drape of the foil between the trusses.



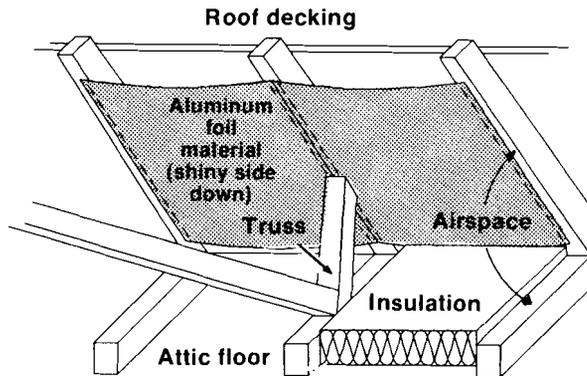
An easily-built radiant barrier installation rack.

The radiant barrier material should be tacked or stapled to the top of the trusses until the decking is applied. A hammer stapler is very handy. It's easiest to apply one section of foil and decking at a time so that the installation crew has a stable working surface on the roof.

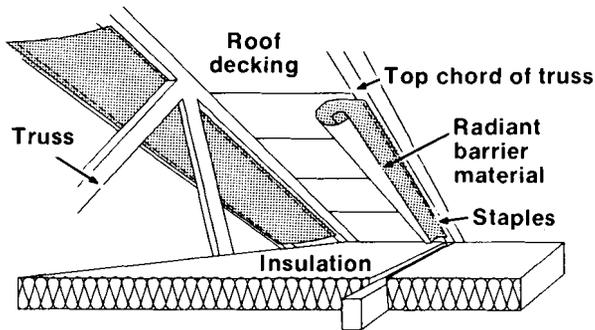
An alternative method is to install the material on the roof rafters after the roof sheathing has been installed. Some builders prefer this method since the sheathing reduces the wind force and the need for close coordination between the barrier and sheathing installers. Begin the job by measuring the distance from roof peak to the soffits along the roof rafters. This often can be done by counting the number of 4-foot plywood widths on the roof. Mark that distance, minus 4 inches for airflow, before attempting to install. Scrap wood can be used as markers. Roll out the radiant barrier material and cut it to the desired length. Install the piece. If the cut is a little too long, cut off the excess. If the size is correct, proceed to roll and cut pieces of the same size for that roof section.

One person can now get up on the ceiling joists near the peak with pre-cut rolls. A second worker stays on a ladder near the soffit. The material is first stapled at opposite ends of the same rafter and then stretched across the space and stapled to the other rafter or roof truss. **Be generous with staples.** Follow the same procedure for other roof sections.

Laying a radiant barrier on top of insulation is not recommended. Although initially it will be fully



A radiant barrier can also be installed by stapling it to the bottom of the trusses.



The foil is stapled at opposite ends of the same rafter and then stretched to the other rafter.

effective, dust may accumulate and degrade performance. Further, the first time a contractor or home owner walks in the attic the foil may rip.

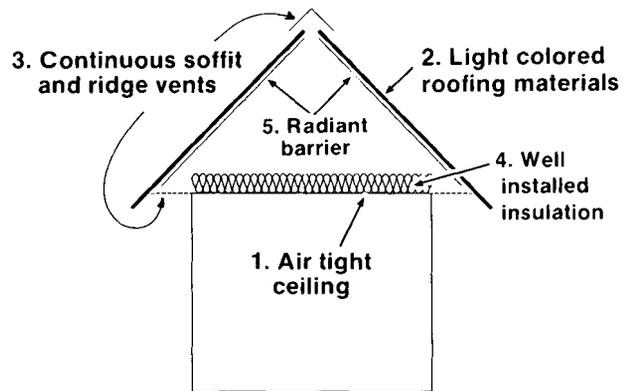
Two more points on radiant barrier systems:

- Only one low-emissivity surface is required for the radiant barrier system to be effective. Little is gained with two radiant barriers or double-sided foil.

- If installation is difficult in places and you leave small gaps, this will not significantly reduce the effectiveness of the system. The more of the attic you can do, the better, but whatever can be done will be beneficial.

Summary

There are five effective strategies to making the roof/attic/ceiling more energy efficient, as shown in the drawing below. Use these strategies whenever you can. Together, these strategies should reduce heat flow to the house from the roof by 50-70% over minimum required practices.



There are five energy-efficient roof/attic/ceiling strategies.

For further information

“White Roofs vs. Black: Which Save Me Energy?” Dan Backenstow, *Roofing, Siding and Insulation*, August 1987.

“Attic Ventilation,” Henry Spies, *Progressive Builder*, August 1987.

“Finding the Flaws in Superinsulation,” Gary Nelson, *New England Builder*, August 1984.

“Radiant Barriers: A Question and Answer Primer,” Ingrid Melody, FSEC-EN-15-87.