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Radiant Barriers: A Question & Answer Primer

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Radiant barriers:
A question & answer primer

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Introduction

Attic radiant barriers made of aluminum foil are becoming a popular way for homeowners to save energy and money in Southern states. They are increasing in popularity for two reasons. First, tests by the Florida Solar Energy Center and other groups show that they work. Second, manufacturers are improving the quality of radiant barrier materials.

To most homeowners, attic radiant barriers are a new energy conservation concept; many of them have questions about how radiant barriers work and how to use them. This Energy Note answers some of the most commonly asked questions. It also recommends ways to install radiant barriers in existing attics and new homes.

Q: What is a radiant barrier?

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). Figure 1 illustrates a radiant barrier installed in an attic.

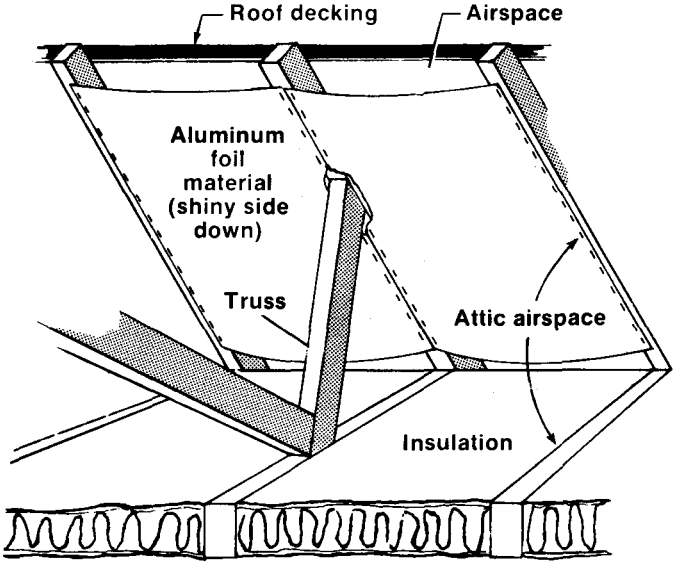


Figure 1. An installed radiant barrier.

Q: What are the benefits of radiant barriers in attics?

In hot climates, benefits of attic radiant barriers include both dollar savings and increased comfort.

Without a radiant barrier, your roof radiates solar-generated heat to the insulation below it. The insulation absorbs the heat and gradually transfers it to the material it touches — principally, the ceiling. This heat transfer makes your air conditioner run longer and consume more electricity.

An aluminum foil radiant barrier blocks 95 percent of the heat radiated down by the roof so it can't reach the insulation.

In summer, when your roof gets very hot, a radiant barrier cuts air-conditioning costs by blocking a sizable portion of the downward heat gain into the building.

In the warm spring and fall, radiant barriers may save even more energy and cooling dollars by increasing your personal comfort. During these milder seasons, outdoor air temperatures are comfortable much of the time. Yet solar energy still heats up your roof, insulation, attic air and ceiling to temperatures that can make you uncomfortably warm. An attic radiant barrier stops almost all of this downward heat transfer so that you can stay comfortable without air conditioning during mild weather.

You may also find that radiant barriers can expand the use of space in your home. For instance, uninsulated, unconditioned spaces such as garages, porches and workrooms can be more comfortable with radiant barriers. And because radiant barriers keep attics cooler, the space is more usable for storage.

One final benefit: a cooler attic transfers less heat into air conditioner ducts, so the cooling system operates more efficiently.

Q: How do radiant barriers "block" heat transfer?

Aluminum foil — the operative material in attic radiant barriers — has two physical properties of interest here. First, it reflects thermal radiation very well. Second, it emits (gives off) very little heat. In other words, aluminum is a good heat reflector and a bad heat radiator.

Your grandmother probably made use of these properties through "kitchen physics." She covered the Thanksgiving turkey with a loose "tent" of aluminum foil before she put it in the oven. The foil reflected the

oven's thermal radiation, so the meat cooked as evenly on top as on the bottom. She removed the foil briefly to let the skin brown, but when she took the bird from the oven, she "tented" it with foil again. Since aluminum doesn't emit much heat, the turkey stayed hot until the rest of the meal was ready.

Cooking a turkey is a simple analogy, but the same principles of physics apply to an attic radiant barrier. Aluminum foil across the attic airspace reflects heat radiated by the roof. Even if the radiant barrier material has only one aluminum foil side and that side faces down, it still stops downward heat transfer because the foil will not emit — it will not radiate the roof's heat to the insulation below it.

Q: How much can radiant barriers save?

Since everyone's home and lifestyle are different, we can't precisely calculate your personal savings from attic radiant barriers. However, it's reasonable to expect that an attic radiant barrier can save 8-12 percent of your annual cooling costs in the Southeast.

Savings from an attic radiant barrier depend on the amount of heat the roof and attic contribute to your home's cooling load. ("Cooling load" is the total amount of heat your air conditioner must remove to maintain comfortable indoor temperatures.) In general, the more energy efficient the rest of your home is, the larger the percentage of energy you save from an attic radiant barrier because the roof and attic make up a larger portion of the cooling load.

Figure 2 shows a breakdown of cooling loads in a typical 1500-square-foot Central Florida home. The roof accounts for 15 percent of the total cooling load. In this house, an attic radiant barrier could save 8 percent on the annual air-conditioning costs.

Although not as significant, heating savings may also accrue from the use of radiant barriers.

Q: Are claims of greater savings untrue?

As in most cases, claims for radiant barriers that ***sound*** too good to be true ***are*** too good to be true. If your roof accounts for less than 20 percent of your cooling load, then an attic radiant barrier can't possibly save more than 20 percent on your bills.

Claims of greater savings may simply be the results of misunderstanding. For instance, FSEC has measured and reported that radiant barriers can reduce

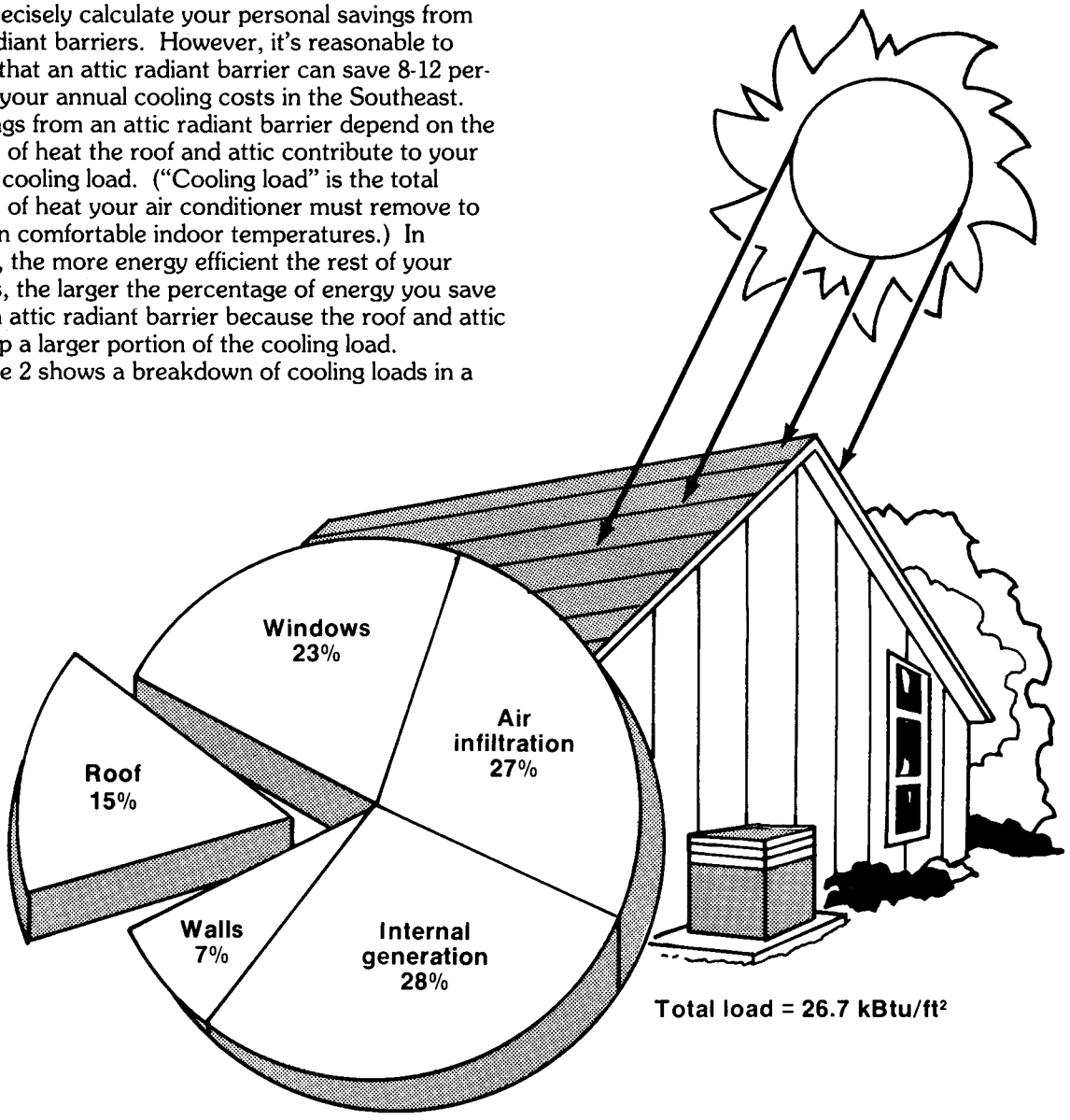


Figure 2. Annual air conditioning load sources for a typical 1500 ft² Central Florida home.

heat gain through R-19 insulated ceilings by over 40 percent. If the ceiling portion of the total cooling load is 20 percent, that's a reduction of 40 percent of 20 percent, which amounts to 8 percent savings on the total cooling load.

If all the facts and figures tend to confuse you, just remember that an attic radiant barrier can save about 8-12 percent on your air-conditioning costs in the Southeast. Any Sunbelt homeowner knows that an 8-12 percent saving on air-conditioning bills can be significant.

Q: What kinds of radiant barrier materials are available?

There are many types of radiant barrier materials on the market, and more are being developed as radiant barriers become more widely used. Five generic types are most common:

- Single-sided foil (one foil side) with another material backing such as kraft paper or polypropylene. Some products are further strengthened by fiber webbing sandwiched between foil and backing. The strength of the backing material is important since unreinforced foil tears very easily.
- Double-sided foil with reinforcement between the foil layers. Reinforcement may be cardboard, kraft paper, mylar or fiber webbing.
- Foil-faced insulation. The insulating material may be polyisocyanurate, polyethelene "air-bubble" packing or other materials that impede heat conduction.
- Multilayered foil systems. When fully extended and installed so that the foil layers do not touch, these products also form insulating airspaces.

Some of these products may have R-values, which may be claimed only if the product was tested according to Federal Trade Commission regulations for insulation.

Although it is not by definition a radiant barrier, there is a low-emissivity paint available that can be applied directly to the underside of the roof decking.

Q: Which material is best?

While the Florida Solar Energy Center strongly recommends radiant barrier systems in attics, it doesn't endorse any particular brand of radiant barrier material. However, we suggest that you look for a few common-sense characteristics:

- Emissivity (the lower the better)
- Fire rating (as required by building codes)
- Ease of handling
- Strength of reinforcement
- Width appropriate for installation
- Low cost.

Q: What does a radiant barrier cost?

Costs for an attic radiant barrier depend on several factors, including the following:

- Whether purchase includes installation (which increases cost)
- Amount purchased (greater quantities can cost less per square foot)
- Manufacturing method and type of reinforcement
- Presence of other insulation materials
- Marketing methods
- Aspects of supply and demand.

One other condition greatly affects the cost of a radiant barrier system to the homeowner — the individual's knowledge and willingness to do some comparison shopping. A few phone calls and a little research can save you money on most purchases. Radiant barriers are no exception.

Informal surveys show a wide range of material costs ($0.07-$1.00/square foot) and installation costs ($0.10-$1.00/square foot). The increases costs appear to be due more to marketing practices than to any inherent difference in thermal performance.

In some cases, radiant barriers are included in a package of energy-saving features sold to homeowners. When considering a "package deal," you may want to ask for an itemized list that includes material and installation costs for all measures included. Then shop around to see what each item would cost if you purchased them individually. You may see considerable savings. And you may decide that you want to install the items yourself, including the radiant barrier.

Q: My material has only one foil side; should the foil face the roof?

No. In attics, single-sided radiant barrier material should be installed with the foil side facing down. This may run counter to our intuitive feel for "how things work," but it does work, and work well.

To understand how it works, remember the two properties of aluminum foil from our Thanksgiving turkey analogy; foil reflects radiant energy very well but does not radiate heat well. It does not emit heat to the cooler surfaces around it.

If you install a single-sided radiant barrier with the foil side facing up, the aluminum will (for a time) reflect the thermal energy radiated by the hot roof.

If you install a single-sided radiant barrier with the foil side facing down, the aluminum simply will not radiate the heat it gains from the roof to the cooler insulation it faces.

At first, a single-sided radiant barrier will work equally well with the foil facing up or down. But over time, dust may accumulate on the surface of foil facing up. The dust will reduce the radiant barrier effect by allowing the foil to absorb rather than reflect thermal radiation. However, a radiant barrier with the foil side facing down will not collect dust on the foil and will continue to stop radiant heat transfer from the hot roof to the insulation over the life of the installation.

Even if you use a double-sided radiant barrier material, it is best to install it at the rafter level so that the bottom side faces the attic airspace and will not collect dust.

Q: How should I install a radiant barrier in my attic?

The most effective way to install a radiant barrier in an existing attic is simply to staple the foil material to the underside of the top chord of the roof trusses or to the underside of the roof decking. See Figure 3 for an illustration.

It is not very easy to work in any attic, even one with a steep pitch. And always keep in mind that a misstep could be disastrous, since most attic "floors" are not floors at all, but rather 2x4s holding ceiling drywall topped by conventional insulation. So you should consider safety first; take every precaution listed in Figure 4.

Take care to avoid compressing existing insulation in the attic.

Tools and materials needed to install a radiant barrier include the following:

- Enough radiant barrier material to cover the underside of the roof
- Measuring tape and flashlight
- Heavy-duty scissors or utility knife
- Staple guns and heavy-duty staples
- Two movable support surfaces such as 3x2-foot sheets of one-inch plywood or three-foot lengths of 1x12 board.

Perhaps your most important aid will be a partner. Working in pairs in the attic makes the work go faster. Even more important, it adds to safety.

Begin by measuring the length of the attic roof from peak to soffit. Then, return to a stable, ground-or floor-level surface to measure and cut the radiant barrier material to size. The material usually comes in rolls of 50 to several hundred feet; it's easiest to cut and reroll all the lengths you'll need before returning to the attic.

At one end of the attic, place the plywood or 1x12 as a stable surface across two of the attic truss members. Try to minimize compression of existing insulation. Provide one surface at the peak and one at the soffit end so that both installers can work together.

Safety reminder: Be extremely careful at the sides of your support surface. If you step on an edge, the surface can tilt and drop you through the ceiling drywall below.

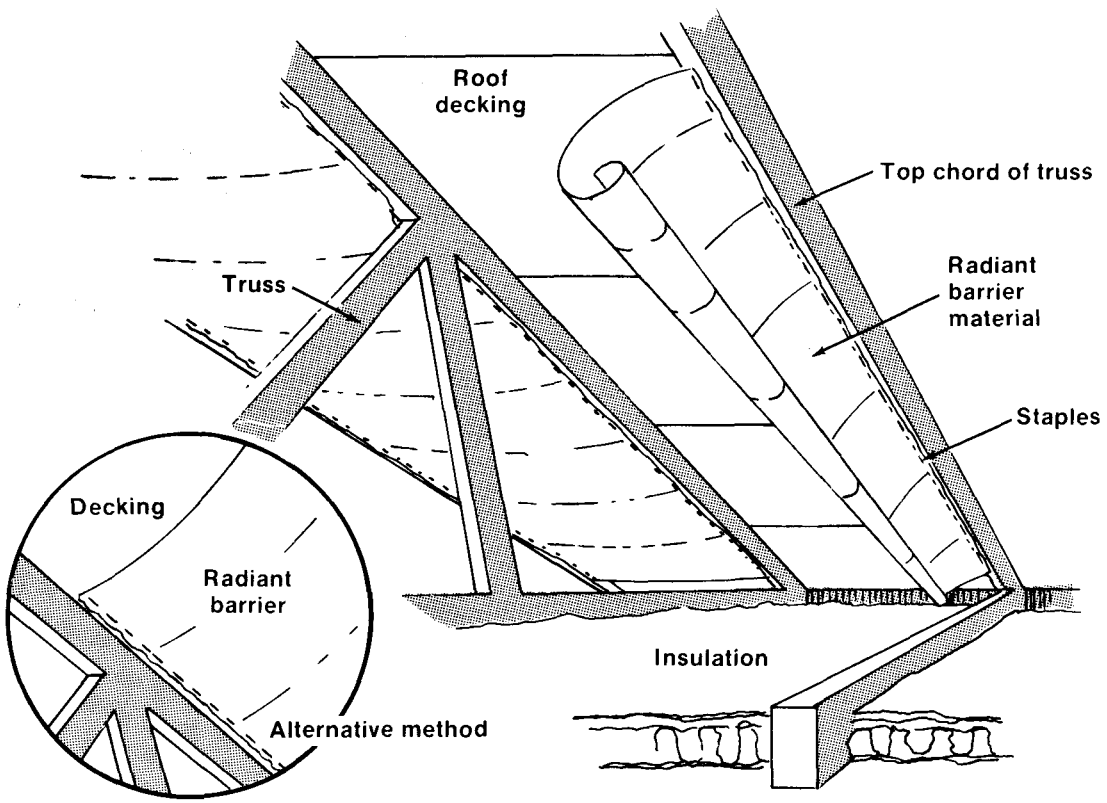
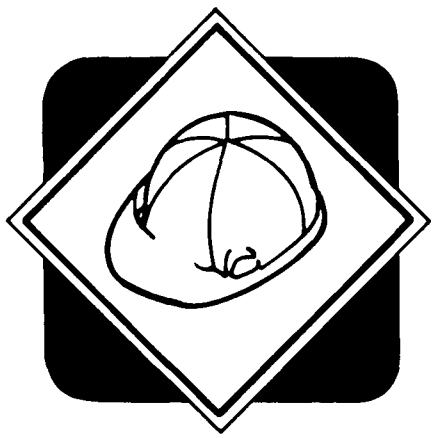


Figure 3. Locations for radiant barrier materials.

Safety tips for installing an attic radiant barrier system

- If you use a ladder for access to the attic, make sure it is stable and tall enough for easy entry and exit.
- Work in the attic only when temperatures are reasonable. Attic daytime temperatures can rise far above 100°F during much of the year in the Sunbelt. Install your radiant barrier system early in the morning, or wait until cool weather sets in.
- Work with a partner. Not only does it make the job go faster, it also means that you'll have aid should a problem occur.
- Watch where you walk and use a movable support surface. Step only on the attic trusses or rafters and your working surface. *Never* step on the attic insulation or the ceiling drywall below it.



- Step and stand only on the center of your movable working surface. Don't step on the edge; it can cause the surface to tip.
- Watch your head. In most attics, roofing nails penetrate through the underside of the roof. If you bump your head, it can cause a serious cut or puncture. If your skin is punctured by a nail, an up-to-date tetanus vaccination is a must. Avoid potential problems by wearing a hard hat.
- Be especially careful around electrical wiring, particularly around junction boxes and older wiring. Never staple through or over electrical wiring.
- Make sure that the attic space is well ventilated and well lighted. Bring in fans and extra work lights if necessary.
- If your attic has blown-in insulation, direct fans upward, away from the insulation material.
- Avoid exposure to mineral fiber insulation. Wear goggles, long pants, a long-sleeved shirt, and a particle mask or kerchief over your nose and mouth. Wear gloves if you are particularly sensitive to fiberglass.
- Wear a tool belt or utility apron to carry staples, staple gun, scissors, measuring tape, etc.
- Take frequent breaks, and pace yourself. It's better to get the job done over a longer period than to risk an accident due to fatigue or to end up with a poor-quality installation.

Figure 4.

With your partner, unroll one length of the radiant barrier material from soffit to peak. Leaving one or two inches of free space at the roof peak, staple one corner of the material to the underside of the top chord of the first roof truss. Continue stapling the edge of the radiant barrier material down the truss at 6 to 12-inch intervals, stopping 2 to 3 inches from the ceiling insulation. Next, staple the other edge of the material to the underside of the adjacent roof truss. Continue the process at adjoining trusses until the underside of the roof is no longer visible except for a one- or two-inch strip at the roof peak.

As an alternative, you may staple the radiant barrier material to the underside of the roof decking, adjacent to the top chord of the truss. The weight of the material will allow it to drape naturally between trusses.

Q: Does the radiant barrier have to be airtight in order to work?

No; you're installing a barrier against radiated not convected heat, so you need not cut off air motion. In fact, ventilation from soffit to peak improves radiant barrier system performance.

Small tears and holes will not significantly lessen the performance of the radiant barrier, so don't worry if you must cut and patch around obstructions such as vent stacks and truss supports.

Q: Can't I just roll the material out on top of the insulation?

It's not recommended to place the material directly on top of insulation. In this type of installation, dust will accumulate on the foil surface facing the roof. In time, the dust will negate the radiant barrier effect. In addition, problems could develop with moisture condensation.

Q: Will foil-faced batt insulation work as a radiant barrier?

While some conventional batt-type insulations have an aluminum foil backing, it's probably not a good idea to simply flip your insulation over to use it as a radiant barrier. Not only will you encounter the eventual dust problem, you may also encounter a fire hazard in the glue that bonds the foil to the batt.

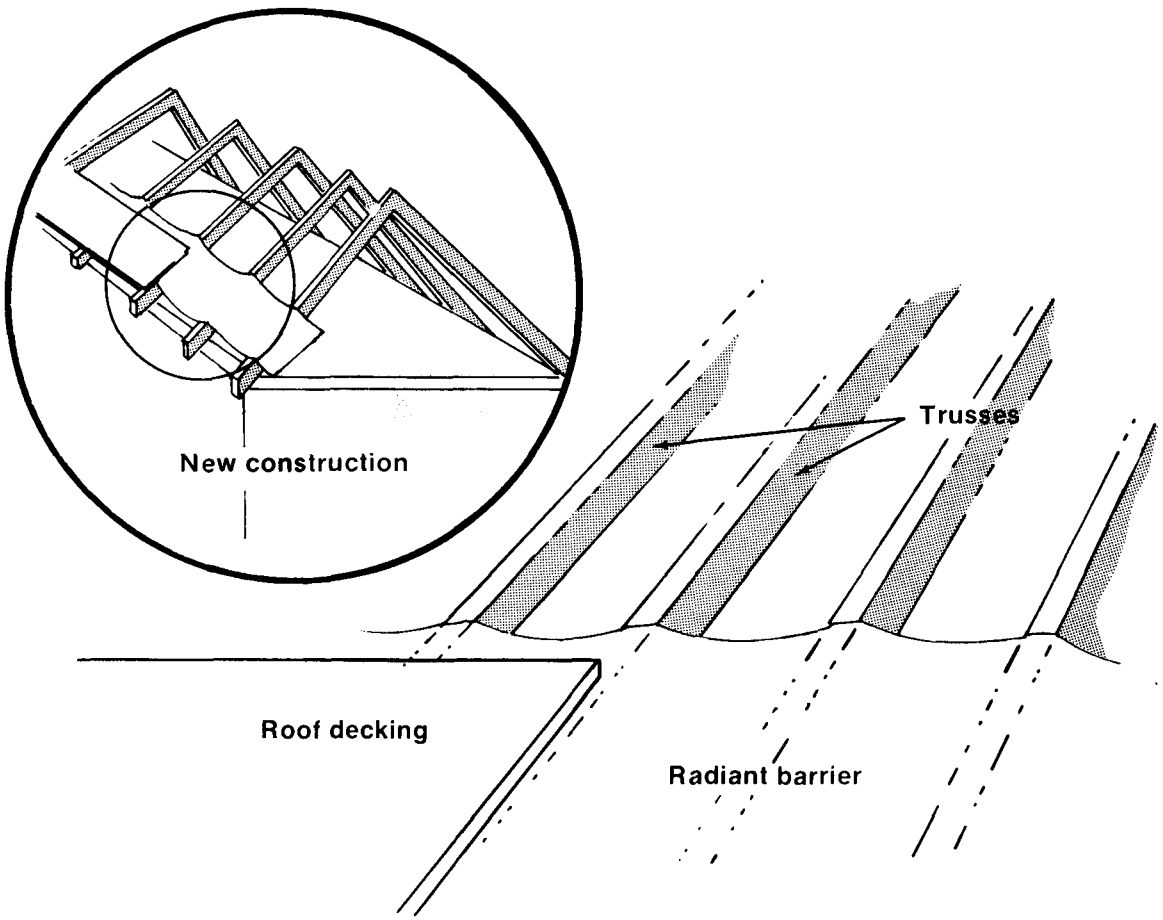


Figure 5. Radiant barrier installation in new construction.

At least one batt insulation manufacturer has introduced a product with a foil face that is bonded to the insulation with a fire-retardant glue. This product meets fire codes, but it still has the potential for dust problems.

Q: Will heat build up in the roof and damage my shingles?

It's extremely unlikely. The Florida Solar Energy Center has measured the temperatures of roof shingles above attic radiant barriers on hot, sunny summer days. Depending on the color of the shingles, their peak temperatures are only 2-5°F higher than the temperature of shingles under the same conditions without a radiant barrier.

Roofing materials are manufactured to withstand the high temperatures to which they are frequently exposed. A 2-5°F increase in peak temperatures that normally reach 160-190°F should have no adverse affect.

Q: What about my shingle warranty?

Shingle warranties should not be subject to cancellation by the manufacturer on the basis of radiant barrier installation. However, it may be wise to review the warranty to be sure that work of this nature will not void it. You may want to inquire directly of the manufacturer. Any changes in warranty should be substantiated in writing.

Q: Can I just roll the material out on the roof before reshingling?

This will not provide a radiant barrier. Remember, to be a radiant barrier, the aluminum foil must be installed ***facing an airspace.*** If there is no airspace, the foil acts as a conductor and quickly passes heat by conduction from a hot surface to a cooler one.

Q: What's the easiest installation method in new construction?

Builders usually find it easiest to install a radiant barrier in new construction prior to putting down the roof decking. At this point, rolls of radiant barrier material can be unrolled horizontally across the top of the trusses from one end of the roof to the other (see Figure 5). The first length should be installed at the soffit end; the next length should overlap the first. The radiant barrier material can be temporarily tacked or

stapled to the top of the trusses until the decking is applied. It's easiest to apply a section of both radiant barrier material and decking at a time so that the installation crew has a stable working surface on the roof.

Installers should ensure that the radiant barrier material drapes two or three inches below deck level between the trusses. The resulting air channels provide ventilation between the radiant barrier and the hot roof deck, which removes heat from roof materials.

Wind can be a problem when working with lengths of flexible foil material. Some ingenious builders solve the problem by using an easily constructed installation rack (see Figure 6).

The rack serves three important functions:

1) It holds plywood-sized lengths of the radiant barrier material in place, even in the wind.
2) It makes it easier to unroll and fasten the radiant barrier material.
3) It ensures an even radiant barrier material drape between the trusses.

Note: When installing a single-sided radiant barrier material, remember to face the foil side down toward the attic floor/insulation.

Q: What else can I do to decrease heat gain through my attic?

While a radiant barrier is one effective way of reducing heat gain through attics, it's not the only one. Other options include:

- Continuous peak and soffit or gable vents (which also improve radiant barrier system performance)
- Light-colored shingles
- Additional conventional insulation.

If you shop carefully, you will probably find that attic radiant barriers are one of the least costly and yet most effective of the attic conservation measures for Southern climates.

Q: When will I see a payback from an attic radiant barrier?

Computer studies conducted in the development of the Florida Model Energy Code indicate that a typical attic radiant barrier installed in a Florida home will offer a six to seven year simple payback and a 15% to 19% return on investment.

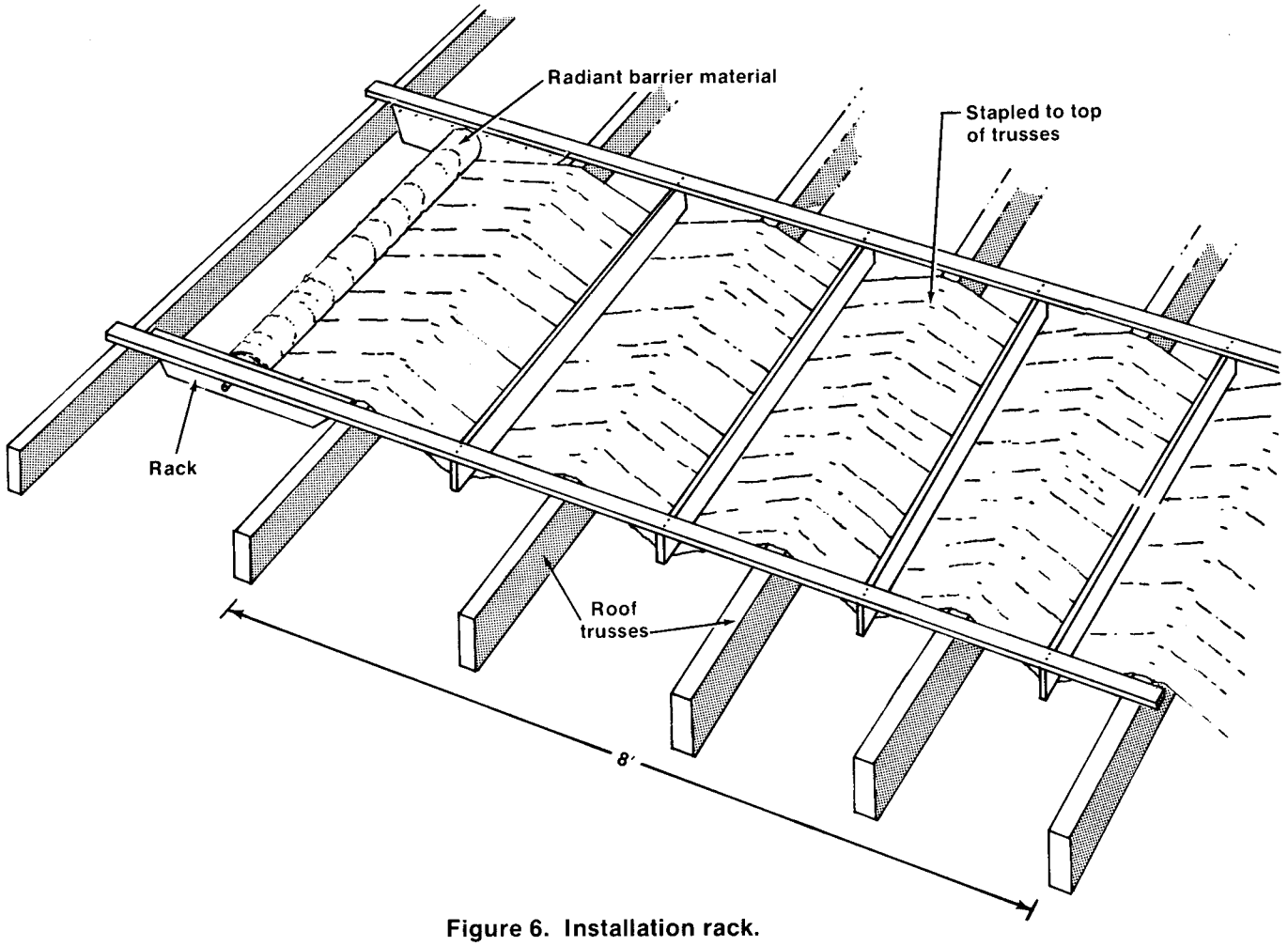


Figure 6. Installation rack.

Conclusion

Attic radiant barriers are an inexpensive but effective way for Sunbelt homeowners to save energy and money. While they are not a new concept, radiant barriers have only recently been proved effective for energy conservation.

Manufacturers are continuing to improve radiant barrier materials, which are becoming widely available throughout the southern states.

A radiant barrier may be installed in an existing attic or during construction of a new home. Both are relatively easy procedures.

Acknowledgment

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