Radiant Barrier System

Introduction

A radiant barrier system (RBS) is comprised of a sheet of aluminum foil placed next to an airspace. Together, they block the transfer of radiant heat from a heat-radiating surface to a heat-absorbing surface.

In a hot climate, an RBS, properly installed beneath a roof (either stapled to the bottom of the roof rafters as in Fig. 1 or purchased already laminated to the underside of the roof decking as in Fig. 2), blocks up to 95% of the heat transfer from the roof to the attic insulation, resulting in a cooler living space. Walls facing direct sun can also be constructed with an RBS.

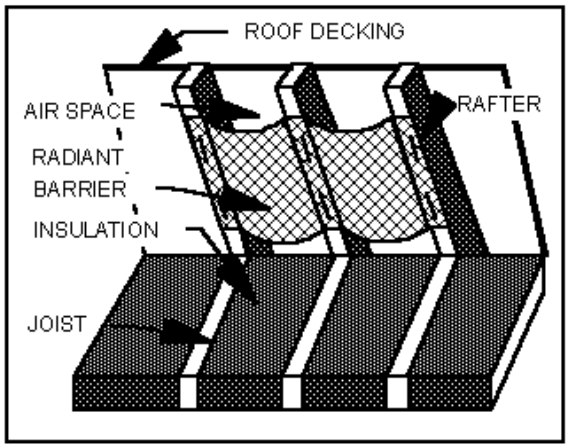

Fig 1: Radiant barrier foil stapled to bottom of rafters (courtesy of Oak Ridge National Laboratory)

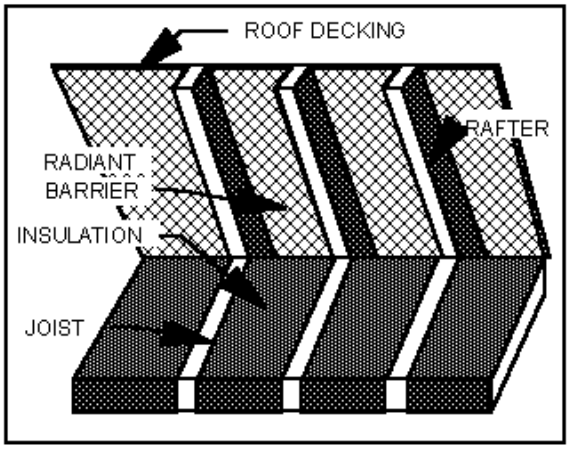

Fig 2: Radiant barrier laminated to roof decking (courtesy of Oak Ridge National Laboratory)

Green Building Benefits

Energy Savings and Improved Comfort

An RBS is installed primarily to improve comfort and reduce energy bills for mechanical cooling in a hot climate. During a hot day outside temperatures may be 100 degrees, but in the attic temperatures can get between 130-160 degrees. This overpowers the ceiling insulation and heats up the rooms below in two ways. First, the 130-160 degree air moves by convection through the insulation to the rooms below. Second, the hot shingles and roof decking store and emit radiant heat through the attic and insulation to the rooms below. Radiant heat is what you feel near a fire or a hot surface. An RBS can block up to 95% of the radiant heat as well as lower the attic temperatures to within 5-10 degrees above the outdoor temperature. An RBS helps in spring and fall, too, when roof temperatures get very hot on sunny days, even though outside air temperature is moderate. In winter, no energy penalty is paid, since most upward heat movement occurs by convection and because the radiant barrier will reflect some heat back down.

If the HVAC ductwork is located in the attic (the worst possible location, but a common one), benefits from an RBS will be substantially increased, since duct insulation is only R-8 at best. An RBS protects the air in the duct from getting too warm on its travel through the attic. An added benefit is the cooler attic itself, which is a better storage space than a hot attic—stored items won't degrade as easily.

An RBS is a low-cost way to achieve these benefits, since the product is inexpensive, the labor required to install it is low-skill, and the product keeps passively working forever without ever needing maintenance.

Savings on energy bills will vary, depending on occupant lifestyle, how hot the climate is, roof type and color, amount of insulation in the attic, whether ductwork is located in the attic, the level and quality of attic ventilation, how much the home is shaded, how well the system is installed, and other factors.

Studies show that typical savings are about 8-12% of annual cooling costs. A very small heating savings may be realized, as well.

How Radiant Barrier Systems Work

You may wonder how a thin piece of aluminum foil can be so effective in blocking heat. It works well because it is a good heat reflector and a bad heat radiator. Think of your Thanksgiving turkey: when you take it out of the oven and cover it loosely with foil, it stays hot—the foil reflects heat back to the turkey but does not emit much heat out to the cooler surfaces around it.

Role of the airspace: Space is the operative word when we're talking about radiant heat. *Radiant* heat moves in straight lines through a space from hotter objects to any cooler object it can "see." We are not talking about *convective* heat, which moves in air. Nor do we mean the *conduction* of heat, which would occur if there were no space and the radiant barrier were touching the insulation.

E-value and R-value: Insulation effectiveness is measured by R-value (resistance of a material to the conductance of heat): the higher the number the better. Radiant barrier effectiveness is measured by E-value, an emissivity rating (ability of a material to emit heat): the lower the number the better (0.05 or less on a scale of 0.0 to 1.0).

Aluminum foil does not have insulative value. Advertising claims of R-value are most likely false (unless it is attached to an insulation or constructed in multiple layers with airspaces). Both insulation and radiant barrier, properly installed, do function to reduce heat flow--they simply do it by different means. Together, they form two lines of defense: one at the roof deck and one at the ceiling.

Selection and Installation

Products: Radiant barrier is available in a number of forms, the most common being reinforced single or double-sided foil. The foil can be perforated, so as not to act as a vapor barrier.

Radiant barrier/insulation combinations are probably not worth the expense. If a home needs more insulation, it is usually cheaper to install it separately from the radiant barrier.

Roof decking manufactured with radiant barrier factory-glued to it is recommended for new construction.

Radiant-barrier paint can be used for retrofits in attics in which foil radiant barrier would be too difficult to install. Its emissivity rating is typically higher than foil (0.22-0.49), but it will still help cool the attic.

Placement: Roof radiant barrier should be installed at the top of the attic, shiny surface facing down toward the lower air space. It should not be placed on the floor of the attic because it will get dusty in this location and cease to be effective. Placement of the radiant barrier at the roof may increase roof temperature by 2-5 degrees, but this is not enough to cause roofing to degrade in any way.

In new construction, it is easiest to use roof decking with the radiant barrier already glued to the underside, since no additional labor is required and since it blocks the radiant heat from ever entering the attic space (as in Fig.1).

If the ceiling is vaulted, it can be tricky to get the necessary airspace (1" minimum) between the radiant barrier and the insulation installed between the rafters. Parallel cord or scissor trusses solve this problem as they make the attic cathedral cavity larger.

If a radiant barrier wall is constructed, the shiny side of the radiant barrier faces outward to an airspace behind the siding. An airspace can be formed by nailing 1x4 boards, spaced as needed, to the structural wall. Proper installation of brick and stone veneer provides an airspace.

In retrofits, the radiant barrier should be draped from rafter to rafter and stapled to their underside (As in Fig.2). A handy homeowner can do this job. Note that a radiant barrier does not need to be installed as a continuous gap-free system as insulation does, but more coverage does offer more protection. Radiant barrier will help cool the house wherever you put it. If you can't get to all the corners of the attic, don't worry.

For installation, choose a cool day and wear protective clothing, including a dust mask to protect against insulation fibers and particles. A heavy-duty scissors or utility knife should be adequate to cut the radiant barrier. Use a slap-hammer stapler, not a manual compression staple gun, or your hand will wear out quickly. Place boards or pieces of plywood across the ceiling joists to walk on, in order to prevent yourself from accidentally stepping through the ceiling.

Attic ventilation: Radiant barrier effectiveness is increased by good attic ventilation. Continuous soffit and ridge vents provide the most effective ventilation system, since outside air can enter the attic under the entire soffit, evenly bathe the entire underside of the roof deck, and exhaust fully out of the highest part of

the attic (Fig. 3). This system is dependent only on physics, not wind or electricity.

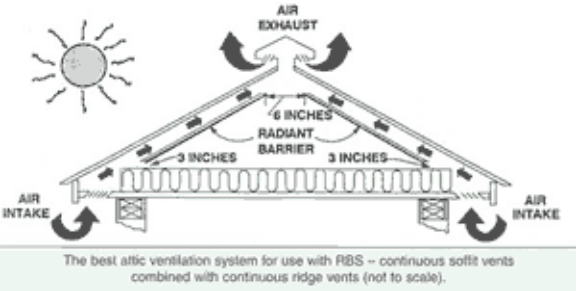

Fig 3: Attic ventilation above the radiant barrier (courtesy of Austin Energy)

Operation and Maintenance

Properly installed radiant barrier needs no maintenance. Once it's in place, it keeps working for the occupants for the life of the home.

Bay Area Suppliers

Radiant barrier products are available from almost every retail hardware outlet.

- Search the **Materials Database** from Bay Area Build It Green to find local suppliers and services: www.build-green.org

For More Information

- **Oak Ridge National Laboratory:** (www.ornl.gov/sci/roofs+walls/radiant/rb_02.html) This is a lengthy radiant barrier fact sheet showing the results of detailed field testing in numerous cities and various climates.
- For more information about Green Building, visit our website at: www.greenaffordablehousing.org or call Bruce Mast at 510-271-4785.