Consumer Report:

5 Things You Must Know Before Buying Radiant Barrier

INDEX

I: How Do Radiant Barriers Really Work?

To help you to understand how a radiant barrier works, let me first start by explaining a little about heat transfer. When talking about radiant barriers, insulation, HVAC systems and energy efficiency, it is important that we recognize that all of these things are about controlling heat.

A: Understanding Heat Transfer

Heat transfer happens in homes and building in three distinct ways.

** Conductive heat transfer (conduction)*
** Convective heat transfer (convection)*
** Radiant heat transfer (thermal radiation)*

Conduction is the least efficient method of transferring heat, and in a kitchen analogy, that would be an equivalent of boiling water in a pot over a stove. The fire heats the pot and the pot transfers its heat to the water and the water eventually comes to a boil. The key point here is that conduction is the transfer of heat through direct physical contact.

Convection is more efficient than conduction, and in our kitchen analogy, convection would be the use of an oven to heat food. Convection heat transfer is the process by which heat is circulated in an area through the air and/or fluid. The key point here is that heat is transferred through air circulation.

Radiant heat otherwise known as thermal radiation is the most efficient type of heat transfer and the best example in our kitchen analogy would be the use of a microwave. Radiant heat is generated when heat from the movement of charged particles within atoms is converted to electromagnetic radiation. In a home or building, radiant heat refers to heat radiated from objects and materials, such as incandescent lights, concrete flooring and the sun. It is also important to note that radiant heat moves through the air without heating the air, instead it will heat the first surface that it touches, and this surface will then re-radiate that heat in the space making it feel warmer when you are in that space.

In general, heat transfer between the interior and exterior of a home or building is bad and decreases the efficiency of the heating and cooling system. There are some special conditions where heat transfer is used to increase the efficiency, such as traum walls, thermal masses, and other natural heating and cooling techniques. But for the most part, in a typical home or building which relies on mechanical means of heating and cooling, heat transfer is the enemy.

So, it makes sense to stop as much heat transfer as possible. This is why insulation is used in all structures. Insulation is great at reducing convective heat transfer, while also reducing some radiant and conductive heat transfer. However, the typical amount of insulation in a home or building (anything below R39) is simply not enough to stop the majority of radiant heat from infiltrating the structure.

B: How Radiant Barriers Stop the Heat

A **radiant barrier** is a material with a very low emissivity and high reflectivity giving it the ability to virtually stop the transfer of radiant heat or thermal conductivity. This allows the **radiant barrier** to reduce heat gain in the summer and heat loss in the winter, thus reducing the net heating and cooling needs of the structure.

There are two key values that determine the effectiveness of a **radiant barrier**, and those are its reflectivity (higher is better) and emissivity (lower is better) values.

The reflectivity value of a **radiant barrier** is pretty easy to understand, the higher the reflectivity value, the more light energy (heat) the **radiant barrier** is able to reflect. Reflectivity values are expressed as a percentage number (%), which basically describes how much light energy the surface will reflect.

The emissivity value is basically the ratio of heat energy radiated by a material to the heat energy radiated by a true black body at the same temperature. This may sound a bit confusing, so let's talk in layman's terms. Basically, if we were to take a pure black object (theoretical) which reflects no light energy and absorbs all light energy that touches it, it would have an emissivity value of one ($\varepsilon = 1$). Any real object, weather it is black or not would have an emissivity value of less than 1.

So, what this definition is really saying is that the darker an object is, the more light energy it will absorb and re-radiate. And subsequently, the lighter and more reflective a material is, the less light energy it will absorb and re-radiate.

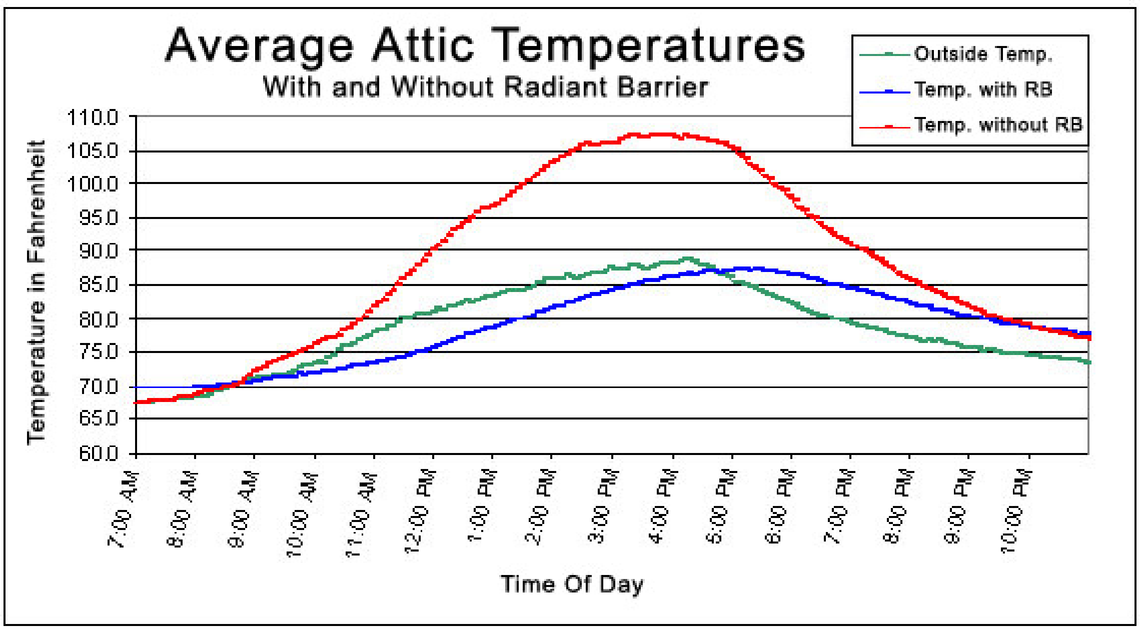
Radiant barriers, even though they have little or no "insulation" properties can effectively block most of the heat coming in or leaving a structure. This is because radiant heat is the most efficient type of heat transfer, and stopping radiant heat transfer is the most effective way to decreasing your heating and cooling needs. In the summer, less radiant heat entering your attic makes your AC system run more efficiently, and in the winter, less heat energy being lost through the roof makes your heater more efficient.

II: What Type of Savings Can I Expect

Many individuals want a hard number or percentage of estimated savings from a radiant barrier. Unfortunately, it is virtually impossible to predict, because there are so many different factors which contribute to its effectiveness or ineffectiveness. However, according to studies done by the U.S. Department Of Energy, it is generally accepted that installing radiant barrier in the attic will reduce heat gain through the ceiling by 40%, typically leading up to a 17% reduction on heating and cooling costs.

While this 17% figure holds true for many climates using a typical installation, it will vary from place to place. Many independent studies and radiant barrier users have tested their results and reported energy savings varying from as low as 12% up to as high as 39%.

The graph below shows the attic temperature difference between two similar attics spaces, one with a radiant barrier installed and the other without. As you can see, the attic with the radiant barrier (blue) stayed much cooler throughout the day.



This report is not meant to give hard figures, rather it is meant to give the potential radiant barrier user/installer the proper information to make the most informed decision possible. With that being said, the section below will list and describe some of the main factors which will affect the performance of a radiant barrier installation.

Main Factors Determining Radiant Barrier Effectiveness:

- *Attic Ductwork* – If ductwork or air handlers are located in the attic, the temperature of the attic area will affect the efficiency of the HVAC system. Using a **radiant barrier** to control attic temperatures will increase the HVAC system's efficiency, thus reducing energy costs.
- *Existing Insulation* – If existing attic insulation is less than a R39, a **radiant barrier** installation will help to stop excess radiant heat. Homes with a R39 or higher ceiling-insulation, and have no ductwork in the attic will not achieve much energy savings from a **radiant barrier** installation.
- *Cold Climates* – In climates where the majority of annual energy usage goes towards heating the structure, a **radiant barrier** on the floor of the attic, above the insulation and ductwork will provide substantial energy savings.
- *Hot Climates* – In climates where the majority of annual energy usage goes towards cooling the structure, a **radiant barrier** stapled to the bottom of the roof rafters will provide maximum energy savings.
- *Mild Climates* – In more mild climates where neither heating nor cooling is used much, a **radiant barrier** installation will not create massive energy savings. However, the **radiant barrier** will increase the overall comfort of the structure while providing small to moderate energy savings.

III: How, When and Where to Install Radiant Barrier

A radiant barrier installation can be a very daunting task. But with a little know how and the proper tools, any handy man (or woman) can definitely do the job. A radiant barrier installation is best done when the outside temperature is mild so as to minimize installer discomfort. Spring or fall are the best seasons to install radiant barrier, however if you must install radiant barrier during summer or winter months, early mornings and evenings are the best times to work, as the attic is cooler.

There are a variety of different installation procedures and locations, which depend on a number of different factors. Below, we will address all of the most common factors and their subsequent installation applications.

A: Perforated or Non-perforated

The type of radiant barrier you choose will depend on your local climate and humidity. You will find that radiant barriers come in two main flavors, perforated or non-perforated (aka: vapor barrier). It is very important to understand when, where and if a non-perforated (vapor barrier) radiant barrier is needed.

A vapor barrier or vapor retardant is a material which does not allow water vapor to pass through it. A non-perforated radiant barrier is a vapor retardant (vapor barrier) and if used, it will not allow water vapor to pass through. While this may seem like a desirable feature, if used incorrectly the radiant barrier may actually cause condensation.

In certain conditions, one side of the radiant barrier may be warm, while the other side may be cold which could cause water to condense on the cold side of the radiant barrier. Once the water condenses, it will naturally flow downward due to gravity, then drip and pool at the bottom of the radiant barrier sheet. This dripping and pooling could cause a variety of different problems, from mold and rot to rust and deterioration. These are all undesirable and will end up costing thousands to fix, so please choose your material wisely.

The most obvious solution is to use a perforated radiant barrier! A perforated radiant barrier will allow water vapor to pass through it, eliminating the risk of condensation issues. If you are not sure weather a perforated or non-perforated radiant barrier is needed, you're better off playing it safe and going with a perforated radiant barrier.

If you still want to use a non-perforated radiant barrier (vapor barrier), the graphic below will show you where it should be installed. In northern states, a vapor barrier will want to be installed on the interior (warm side) of the insulation.

In southern states, the vapor barrier if installed (We **DO NOT** recommend it) will want to be installed on the exterior (warm side) of the insulation. The small band, north of the southern states is simply too humid to use a vapor barrier and you are asking for trouble if you insist on installing one.

B: Required Installation Tools:

Regardless of the installation location, one common factor is the required tools for the job. Below we have listed the most common tools that any individual will need for a typical **radiant barrier** installation job.

Required Tools	Safety Tools	Optional Tools
Staple Gun	Safety Glasses	Ladder
Utility Knife/Box Cutter	Dust Mask	Shop Light
Measuring Tape	Gloves	Dowel w/ Nail Point

C: Where to Install Radiant Barrier

Radiant barriers can be installed and used in a variety of ways. This report is not meant to be an installation guide, and will only cover the two most common, tried and true installation scenarios. These two installation methods have been tested over time and have ample data to support the 17% average energy savings.

Attic – Bottom of Roof Rafters

As mentioned above, maximum energy savings can be achieved in hot climates when the **radiant barrier** sheets are stapled to the bottom of the roof rafters as shown in the images below.

This installation is considered to be the best method in hot climates where cooling is far more prominent than heating. This type of installation will keep the entire attic space much cooler compared to a non **radiant barrier** insulated attic, and will effectively block radiant heat from striking air handlers and ductwork in the attic. Also, any attic air which happens to leak into the return side of the ductwork will be cooler, causing less stress on the cooling equipment, increasing its efficiency and lengthening its life.

Although this installation method is the most efficient, it is also the most challenging and requires the most work and time to install. However, once complete, this is a virtually maintenance free installation method, requiring no cleaning because it is not generally affected by dust.

Attic – Over Insulation & Ductwork

In cooler climates **radiant barrier** can simply be draped over the attic floor covering the existing insulation and ductwork. This method is the most common and easiest way of installing **radiant barrier** in an existing attic. The location of the **radiant barrier** in this installation primarily reduced heat loss through the ceiling in colder climates, although it will also reduce radiant heat gain through the ceiling in the summer.

IV: Radiant Barrier Myths... Busted

A: Radiant Barrier Paint vs. Roll Radiant Barriers

Many radiant barrier paint manufacturers will have you believe that radiant barrier paint is an equal or superior product to roll type radiant barriers. This could not be further from the truth. In fact, radiant barrier paint is technically not even a real radiant barrier, because its reflectance is only 75%.

According to the Department of Energy (DOE), a product classified as a "radiant barrier" must have a high reflectance of al least 90% and a low emittance of 10% or less. Not only that, but the EPA wont even classify radiant barrier paint as insulation. On the other hand, roll type radiant barriers, meeting certain criteria can in fact be classified as insulation under the EPA, qualifying them as ENERGY STAR products. Furthermore, some of these radiant barrier paints contain ceramic, which has a higher emittance than the existing sheathing, thus making the attic even hatter than before.

B: Radiant Barrier & Shingle Roofs

Another common myth about radiant barriers is that they will reflect radiant heat into the back of the existing roof shingles, degrade the life of the shingles and void their warranties. While radiant heat from the sun will in fact be reflected back into the opposite direction and cause heat exchange from the underside of the roof, its affect on the shingles is negligible.

According to countless studies from as early as 1989, sponsored by the U.S. Department of Energy and the Reflective Insulation Manufactures Association, a common conclusion has been met:

> "When properly installed, the use of radiant barriers with proper venting should not cause any damage to the roofing materials and will not void the warranty, since shingle warranties cover defects in manufacturing, not installation."

The fact is shingles are designed for hot temperatures that range from 160 to 190 degrees. The only measurable increase in temperature on shingles from a radiant barrier installation was between 2 and 5 degrees Fahrenheit on a hot summer day. This small rise is negligible and will not void any roofing warranties.

V: Not All Radiant Barriers Are Made the Same

As with most products, radiant barriers come in a variety of different shapes, sizes, styles and qualities. The following is a comprehensive list of all of the different things to look for in a radiant barrier, followed by a professional take on each:

1. *Single Sided or Double Sided*
2. *Code Compliance (ASTM*
3. *Longevity (Manufacturing Process)*
4. *Strength to Weight Ratio*
5. *Roll Widths*
6. *Oxidation/Corrosion Protection*
7. *Local or Imported*

Single Sided or Double Sided

We highly recommend against purchasing a single sided radiant barrier. These single sided radiant barriers are inferior products when compared to a good double sided radiant barrier. This is because a double sided radiant barrier will protect against dust deposits. If a single sided radiant barrier is installed facing up, then naturally dust will accumulate on the radiant barrier thus reducing the reflectivity in those areas. Some tests have shown that dust accumulation can reduce the effective reflectivity of a single sided radiant barrier by up to 50%. The same cannot be said for double sided radiant barriers as the opposite side of the radiant barrier can remain dust free and still offer the same reflective and emissive properties.

Code Compliance (ASTM E84-10)

In the United States most states and/or local municipalities have adopted the most recent 2012 International Building Code (IBC) and International Residential Code (IRC) from the International Code Council (ICC). These new codes, combined with the new fire testing requirements, changed the entire radiant barrier industry overnight. The new codes stipulate that radiant barriers applied in buildings and houses must be Class A/Class 1 fire rated, per the new ASTM E84-10 testing requirements which uses the ASTM E2599 mounting method. In layman terms, the new way of holding the radiant barrier during the E84 burn test (horizontally) caused almost all of the aluminum & polyethylene scrim based radiant barriers on the market to fail. This bread the metallization and VaporPhase deposition manufacturing processes which we will cover later. In order to meet all current codes, you must have a product that is Class A/Class 1 rated per the new ASTM E84-10(2010 or later) testing method. A simple glance at the specification page or document provided by the manufacturer should let you know which test was used to achieve the rating.

Longevity (Manufacturing Process)

As mentioned above, the changes in the testing mounting methods led to many new types of manufacturing processes for radiant barriers. The most notable process that has come as a result of the new ASMT testing methods is the Vapor Phase thin film encapsulation process. This manufacturing process runs the reinforced woven polyethylene scrim through a low temperature vacuum chamber full of nano-sized aluminum particles which deposit directly on the fabric truly making the aluminum one with the scrim. The result is a lighter, stronger product with more longevity than other processes. Another manufacturing process which meets the new ASMT test uses a heat roller welding process to sandwich a polyethylene scrim between two layers of metalized Mylar. This results is a process that heats the polyethylene past the melting point of the aluminum, resulting in a brittle scrim liner susceptible to tearing.

Strength to Weight Ratio

Many manufacturers will make the argument that the more a radiant barrier weighs the better it is, but that is not necessarily true. It's the ratio of the thickness and weight to the actual tensile strength that sets one radiant barrier apart from another. When looking at all of these values, the higher the tensile strength is, the better, and if the tensile strength is high and the weight/thickness is low, then you have a very strong and efficient product. Strong and lightweight qualities will be much appreciated as you fumble around in the attic getting it installed.

Please be advised, not all tensile strength tests are equal! The old method of testing strength was the ASTM D-828 test which was made to test paper and was discontinued in 2009. The most used test for tensile strength of radiant barriers is now the ASTM D2261 Tongue Tear Strength test, in which an incision is cut into the radiant barrier and a machine tries to tear it by pulling perpendicular to the plane. While this test works on most new radiant barriers, mainly due to the brittleness of the polyethylene scrim, it will not work on radiant barriers manufactured using the Vapor Phase process mentioned earlier. This is mainly due to the elasticity of the polyethylene scrim because it was never heated to the high temperatures of the other manufacturing processes. When this is the case the ASTM D4533 Trapezoid Tear test must be employed, in which the machine tries to tear the radiant barrier by pulling in the direction of the tear in the same plane.

With all of this being said, if you go with a cheap, flimsy and weak material, you will pay the price during installation and will be cursed with continuous and frequent maintenance issues. Weak radiant barrier is notorious for not holding a staple, ripping and tearing, which are all undesirable properties when installing a radiant barrier. When comparing tensile strengths of different radiant barriers be cognizant of the testing methods used and do not just look at the numbers, as they are all different and you may be comparing apples to oranges.

Roll Widths

The industry standard width of radiant barrier rolls are 48” and 24”, which makes perfect sense when looking at standard construction methods and stud spacing. Typical stud spacing in walls and roofs is 16” or 24” On Center (O.C.), thus the 48” and 24” rolls generally work just fine. However, some manufacturers are offering different roll sizes to account for the inevitable imperfections at the job sites. When using a 48” roll on roof rafters spaced at 24” O.C. the installer is often left trying to staple the edge of the radiant barrier to the center of a rafter that was spaced at 24.5” instead of 24”. So the move to a 51” and 25.5” roll by some manufacturers is a smart move in this author’s opinion. The wider rolls allow the installer to have a little extra where he needs it and allows for a better and more secure staple connection.

Oxidation/Corrosion Protection

Because 99.9% of all radiant barriers are made of aluminum in one form or another, that makes them susceptible to oxidation over time. Therefore as a consumer you should make sure that the **radiant barrier** you are researching meets the bare minimum for corrosion resistance. This comes in the form of yet another ASTM test procedure, the ASTM D3310 Corrosion Resistance test, which is essentially a 7 day steam bath at which point a corrosion rating of 1 (better) to 5 (badly) is given to the resultant **radiant barrier**. Better **radiant barrier** manufacturers will offer some sort of oxidation protectant coating to ensure a long life of their products, and this will be evident in the result of the ASTM D3310 test in which no number result will be given and instead it will state that there was no loss of aluminum as a result of the test.

Local or Imported

This may not be a big deal to some individuals, but then again it may be a huge deal to others, but is the product made in the USA or is it a cheap import? There is a good reason that many manufactures source out their processes overseas… it’s cheaper. The labor is cheaper, the raw material is cheaper and the laws regarding life safety and welfare are much more relaxed, if not nonexistent in many of the manufacturing facilities overseas. The question then becomes, do you want to support a foreign economy which exploits their workers and environment in order to save a few bucks, or do you want to support your own economy?

The better **radiant barrier** products such as **Ra-flect™** (http://www.raflect.com), from Neutral Existence LLC, have the best of all of the qualities mentioned above. They use a proprietary Vapor Phase thin film encapsulation process to deposit aluminum nanoparticles directly to their high strength woven polyethylene scrim. This advanced deposition process, finished with a proprietary protective coating allows them to achieve a corrosion resistant, light weight, and virtually tear-proof **radiant barrier**. Best of all, **Ra-flect™ Radiant Barrier** is manufactured right here is the USA!