

FEATURES AND BENEFITS OF COOL ROOFS: THE COOL ROOF RATING COUNCIL PROGRAM

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INTRODUCTION

Green buildings incorporate many strategies to reduce energy use and environmental impacts and improve occupant health. Cool roofs are one important green building strategy because of the immense positive benefit they can provide. Cool roofs are not a new phenomenon, but they are essential to the construction and maintenance of energy efficient buildings, and new cool roof technologies give architects more options for both material type and color.

What is a cool roof?

Generally speaking, cool roofs are highly reflective and emissive. In other words, they reflect sunlight and reradiate absorbed heat as light energy back to the atmosphere, rather than transferring absorbed heat to the building below.

Traditional dark roofs do not reflect light and emit heat as well as cool roofs do; heat is easily absorbed by the roof and penetrates through to the building interior, increasing cooling costs. In contrast, cool roofs can reduce cooling load during hot summer months and equate to substantial annual energy and cost savings.

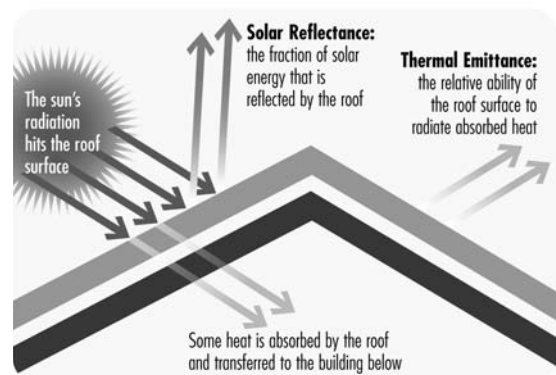
Take the following analogy as a parallel comparison between cool and non-cool roofs: imagine two people wearing T-shirts on a hot day; one is wearing white and the other is wearing black. As many people know from direct experience, a black T-shirt worn on a hot summer day is not the most comfortable choice because the black fabric absorbs the sun's rays and heats the skin beneath it. In contrast, a white T-shirt will keep an individual substantially cooler because it reflects more sunlight, and absorbs less heat. Cool roofs, like the white T-shirt, keep the internal temperature of the building cooler.

However, one important difference between the cool roof and the white T-shirt parallel is that a cool roof need not be *white*. According to the U.S. Environmental Protection Agency, 90% of roofs in the U.S. are dark colored.¹ Perhaps this is in part due to aesthetic preferences, but attractiveness need not be

sacrificed when there is such an abundance of color choices available. The newest trend in the cool roofing market involves the use of “cool color” products, which use dark-colored pigments that are highly reflective in the near-infrared (non-visible) portion of the solar spectrum. With “cool color” technologies, there are now cool roofs that come in green, red, blue, and almost any color imaginable.

Beyond the issue of color choice, cool roof product types have exploded in recent years, as well. Whether looking for shingles, tiles, modified bitumen, field-applied coatings, or single-ply membranes, there is a “cool” version available that will meet everyone's aesthetic and energy saving needs.

A cool roof is defined by two properties: Solar Reflectance and Thermal Emittance.



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Three examples of CRRC-related roofing products: a white field-applied coating, a standing seam metal roof, and a barrel tile (from left to right). Photos courtesy of: HydroStop, Custom-Bilt Metals, and MCA Superior Clay Roof Tile.



How do you measure a cool roof?

Roofing materials have two important physical properties that determine how “cool” they are: solar reflectance (the fraction of solar energy that is reflected by the roof) and thermal emittance (the relative ability of the roof surface to radiate absorbed heat). Both properties are measured as a fraction or percent, and the higher the value, the “cooler” the roof. At this point, there is no universally accepted definition for a cool roof in terms of reflectance and emittance. Minimum requirements are set by organizations that maintain building codes and voluntary green building programs, and can vary from one to the next. These two properties help determine how cool the surface temperature of the roof stays when it is exposed to the sun.

It is important to note that a cool roof only refers to the properties of the surface material of a roof. Therefore, insulation, while also important in reducing heat transfer to the building, is not included in the definition of a cool roof. The combination of a cool roof *and* insulation, however, can be an excellent way to increase a building’s efficiency.

Now that we know why cool roofs are important, the question is: Where can one obtain trustworthy, accurate data on products to determine how “cool” they really are? Enter the Cool Roof Rating Council.

WHAT IS THE COOL ROOF RATING COUNCIL?

The Cool Roof Rating Council (CRRC) was established in 1998 as an independent, non-profit rating entity that measures roofing product surfaces for radiative properties. Through the CRRC,

roofing product manufacturers and sellers can have their products measured for radiative property data through one of our Accredited Independent Testing Laboratories (AITL), and listed on the CRRC’s online Rated Products Directory at www.coolroofs.org.

In addition to implementing and communicating fair, accurate, and credible energy performance ratings for roof surfaces, the mission of the CRRC is to support research into energy-related radiative properties of roofing surfaces and to provide education and objective information to parties interested in understanding and comparing various roofing options. The CRRC provides third-party verification of radiative property data on roofing products, an important tool for individuals looking for the right roof.

As green building takes center stage among building owners, code bodies, architects, and manufacturers alike, so does the need for verification of the products’ “greenness.” Individuals seeking to verify product ratings might include architects and specifiers, property owners, building code bodies, energy service providers, and community planners. Each of these groups needs to have reliable data to satisfy a code requirement, obtain a cool roof credit, federal tax credit, or rebate incentive. A building owner might want to verify that a certain product meets a code requirement, an architect might be looking to obtain a point for a LEED (Leadership in Energy Efficiency Design) credit, or a utility company might need accurate information to implement a rebate program.

The CRRC is made up of two separate and distinct groups: Licensees and Members. Licensees are those companies that rate roofing products or

product components. The CRRC's diverse membership consists of any parties that are interested in the organization. Members can vote on certain matters related to the organization, join a committee, or run for a position on the CRRC Board of Directors. Membership is completely separate from the CRRC Product Rating Program, and includes roofing manufacturers, suppliers, and distributors, as well as roofing contractors, consultants, architects, non-profit groups, government agencies, educational institutions, air quality boards, code bodies, energy service companies, and other interested parties. (<http://www.coolroofs.org/crrcmembers.html>)

HOW DOES THE PRODUCT RATING PROGRAM WORK?

The CRRC's Product Rating Program allows roofing manufacturers to label various roof surface products with initial and aged radiative property values, and to have these products listed on the Rated Products Directory. (<http://www.coolroofs.org/products/search.php>)

Independent Testing and Verification

As was mentioned earlier, testing of product samples is performed at one of the CRRC's five Accredited Independent Testing Laboratories (AITL). The CRRC tests roofing products, not roof installations. As such, all testing is conducted on small samples of the roofing material. Currently, the CRRC accepts ASTM test methods E1918, C1549, and E903 for solar reflectance, as well as CRRC-1 Test Method #1, a modification of C1549. Thermal emittance is tested using ASTM C1371. The CRRC also implemented a new requirement in 2007 that requires thickness testing for field-applied coating samples upon initial product rating to ensure that products are tested at the manufacturer's recommended application.

The CRRC's Product Rating Program also maintains a random testing program through which a certain percentage of rated products are randomly selected each year to undergo retesting. Product samples for random testing are obtained from the marketplace from distributors and contractors carrying the product, or they are collected at the site of manufacturing. Product retesting ensures that products sold in the marketplace reflect their rated values.

Initial and Aged Ratings

Once initial testing is performed, the product samples are forwarded to a test farm location in each of three different climate zones. Samples are placed at each site to weather for three years. The idea is to simulate how products age and change in performance over time, as affected by soot, algae growth, and any other natural weather conditions across the country. After three years, the samples are removed and retested, unwashed, for radiative property values. Once this is performed, the aged values are added to the online directory, and directory users can see how a product performs over a three-year period.

A licensee does *not* have to wait three years to rate that product with the CRRC—a CRRC rating may be obtained as soon as initial testing is performed. When the product is rated by the CRRC, the product is listed on the CRRC's online Rated Products Directory and the licensee can use the CRRC Product Label on the product's packaging. The aged values will be listed as "pending" until the three-year weathering exposure is complete.

CRRC Product Directory

The Rated Products Directory is designed to be user-friendly, and has several search categories. Depending on the specifications the user has, he or she may search by product type, manufacturer, brand/model, slope, and minimum initial or aged solar reflectance and thermal emittance. Search results can also be sorted alphabetically or numerically by each of these category headings.

Beyond the CRRC, the only other cool roof rating program in the United States is ENERGY STAR[®]'s Reflective Roof Program, which is complementary to the CRRC's Program. The ENERGY STAR label is widely recognized by consumers as an indication of energy-efficiency, whereas the CRRC's program is targeted toward the specifier and architect rather than home owners. Manufacturers can choose to rate their products with ENERGY STAR as long as they meet ENERGY STAR's minimum specifications. The ENERGY STAR program accepts manufacturer provided data as well as CRRC ratings. In order to obtain an ENERGY STAR rating, a manufacturer must have three-year data; however, unlike the CRRC, testing can be performed in the field on existing roof installations.

On the CRRC Rated Products Directory search page users can search the directory by a number of different criteria, including product type, manufacturer, and radiative properties to find a product that meets their needs.

The CRRC Rated Products Directory Search Results page displays the manufacturer information along with the initial and aged solar reflectance and thermal emittance. Users can sort the results by any of the column headers.

CRRC Prod. ID	Manufacturer Information (sorted +)	Brand	Model	Product Type	Solar Reflect.			Therm Emitt.			Slope Application
					init	1 yr	3 yr	init	1 yr	3 yr	
0020-0001	A&S Building Systems Walter Merishon (865-426-2141)	A&S Building Systems	Structural Roof Panels	Dynapron Cool Roof Reflective White	Metal	0.70	pending	0.88	pending	Low/Steep	
0020-0002	A&S Building Systems Walter Merishon (865-426-2141)	A&S Building Systems	Structural Roof Panels	Weather X Cool Roof Solar White	Metal	0.70	pending	0.85	pending	Low/Steep	
0020-0003	A&S Building Systems Walter Merishon (865-426-2141)	A&S Building Systems	Structural Roof Panels	Fluropon Cool Roof Bone White	Metal	0.70	pending	0.04	pending	Low/Steep	
0892-0001	Ace Coating Company Inc. Den Heilbrunn (819-697-3300)	Alpha 8	905	Field-Applied Coating		0.84	pending	0.79	pending	Low	
0728-0002	Advanced Coating Systems, Inc.	Enerav Seal Coatings	Acu-Shield - Ceramic	Field-Applied Coatings		0.86	pending	0.89	pending	Steep	

WHAT IS THE CRRC'S ROLE IN GREEN BUILDING?

Green buildings aim to increase efficiency and reduce negative impacts on human health and the environment. Cool roofs are an important element of green building, as they can save energy, reduce Urban Heat Island Effect, decrease roof maintenance, waste and costs, and help projects comply with green building programs and standards.

Energy Savings

Because a cool roof reflects and emits the sun's heat back to the sky instead of transferring it to the building below, cool roofs achieve lower surface temperatures that reduce heat conduction into the building and reduce the building's cooling load during hot summer months. A study conducted by Lawrence Berkeley National Laboratory and the Davis Energy Group in California found that installing a cool roof reduced the daily peak roof surface temperature of each building, and could reduce energy use expended to operate cooling equipment up to 52%. Using the measured data and calibrated simulations, researchers further estimated savings for similar buildings with cool roof retrofits, within all 16 California climate zones, would have an average peak demand savings of about 3.9 to 6.6 Watts/square meter.²

In many climate zones worldwide, cool roofs can significantly reduce the energy use of a building's cooling loads. There is some concern as to whether cool roofs will increase heating costs in winter months, and though slight increases in heating costs

may occur, the increase is usually outweighed by the cooling energy savings achieved during summer months. During cold, winter months, the sun is low in the sky, the weather tends to be overcast, and snow often covers the roof, usually making the heat gain through the roof during the winter almost negligible in all but the most northern climate zones in the U.S. As mentioned earlier, a combination of a cool roof *and* insulation can be an excellent way to increase a building's efficiency and can work extremely well for buildings located in cooler climate regions.

Urban Heat Island Reduction

In cities, energy savings associated with the use of cool roofs can be even more significant where Urban Heat Island Effect can increase temperatures by 2–10 degrees Fahrenheit as compared to nearby rural areas.³ Urban Heat Island Effect refers to metropolitan areas that have higher temperatures than their surroundings largely due to the concentration of heat absorbing construction materials. These elevated temperatures can impact communities by increasing peak energy demand, air conditioning costs, air pollution levels and smog formation, and heat-related illnesses. Cool roofs can help reduce the negative effects of heat islands by reflecting the heat back to the atmosphere.

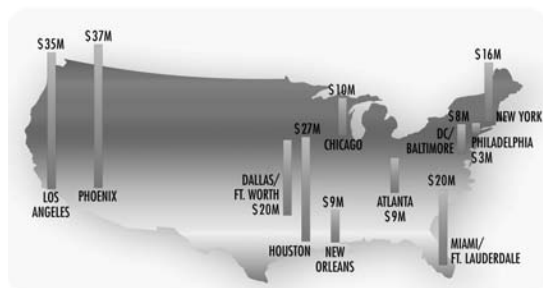
Reduced Roof Maintenance

Research has shown that cool roofs can extend the lifespan of a roof. Extreme daily cycles of ultraviolet (UV) radiation, infrared (IR) radiation, and moisture penetration tend to wear out materials. Cool roofing systems slow down the rate of degradation by reflecting the UV and IR radiation, and in turn keeping the roof at a more constant temperature. Extending roof life helps cut maintenance costs and reduces the creation of unnecessary waste.

Recycled and Non-Toxic Materials

Another important aspect of green building includes use of products that are fashioned from recycled and/or non-toxic materials. Many manufacturers have integrated additional environmental benefits into their cool roof product formulations. For instance, metal products and some synthetic shakes are manufactured with recycled content. Moreover, some products are designed to be fully recycled

Nationwide implementation of cool roofs could mean an annual savings of \$1 billion in cooling costs, according to a study by Lawrence Berkeley Laboratory's Heat Island Group. Values shown reflect 1997 energy prices.



at the end of their useful life. Recycling materials means fewer new resources are necessary, which can reduce energy consumption and pressure on overflowing landfills.

Green Seal is an independent, non-profit organization dedicated to safeguarding the environment and transforming the marketplace by promoting the manufacture, purchase, and use of environmentally responsible products and services through a certification program. Green Seal is currently revising their Paint Standard, which establishes environmental requirements for paints and coatings to ensure products that are less toxic on the environment and on human health. The proposed updates include requirements for solar reflective coatings, which mandate minimum requirements for initial and aged solar reflectance and thermal emittance. Once this standard takes effect, any reflective coating product with a Green Seal label will have to both meet the minimum radiative property values and Green Seal's requirements for less-toxic materials.

Green Building Programs

Several national green building programs recognize the myriad of benefits of cool roofing as a strategy for creating more sustainable buildings. These include the U.S. Green Building Council (USGBC) Leadership in Energy Efficient Design (LEED®) program, the Green Building Initiative's Green Globes program, and the draft version of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Green Building Standard.

USGBC LEED. The LEED rating system is a voluntary certification program for several different types of buildings, and is a nationally accepted benchmark for the design, construction, and operation of high-performance green buildings. LEED for New Construction and Major Renovations (LEED-NC) Version 2.2 has a cool roof credit under Sustainable Sites Credit 7.2 Heat Island Effect: Roof. LEED-NC awards a point for roofs with a Solar Reflectance Index (SRI) value greater than or equal to 78 for low-slope roofs, and 29 for steep-slope roofs. The SRI is calculated using solar reflectance and thermal emittance. A few online calculators, including one provided by the USGBC, can calculate the

SRI, by having the user input the solar reflectance and thermal emittance values. The LEED program references the CRRC as a source for product ratings, though CRRC-rating is not currently required to obtain the cool roof credit.

LEED for Existing Buildings (LEED-EB) Version 2.0 awards a point for a cool roof under Sustainable Sites Credit 6.2, Heat Island Reduction: Roof. To receive a LEED-EB point, the roofing material must be ENERGY STAR compliant and must be rated with a minimum thermal emittance of 0.90.

LEED for Neighborhood Development (LEED-ND) currently is in its pilot phase and scheduled to be launched in 2009. LEED-ND awards a point for a cool roof under Green Construction and Technology Credit 10, Heat Island Reduction. A roofing material that covers a minimum of 75 percent of the roof surface of all buildings within the project and maintains an SRI value greater than or equal to 78 for low-slope roofs and 29 or greater for steep-slope roofs will receive a LEED point.

Green Globes. Green Globes is another green building rating system that allocates points for cool roofs. Originally developed in Canada, The Green Building Initiative brought the Green Globes system to the United States as well. The Green Globes V.1 Rating System is a questionnaire-based green building rating system that allots up to 1000 points for all of the different categories. The "site" category assigns up to 10 points for projects that use "cool" roof surfacing. Like the LEED program, the credit is also based on SRI calculation, and requires a minimum value of 78 for low-slope roofs and 29 for steep-slope roofs. The higher the percentage of cool roofing material on the roof covered, the more points awarded.

ASHRAE/USGBC/IESNA Proposed Standard

189.1P. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), the U.S. Green Building Council, and the Illuminating Engineers Society of North America (IESNA) have co-sponsored the development of Proposed Standard 189.1P, a standard for high-performance green building. The standard will address environmental responsibility, resource efficiency, occupant comfort and well-being, and community sensitivity,

while helping to provide a baseline for green building practices. In the proposed draft language, if a cool roof is used, it must have a minimum initial SRI of 78 for low-sloped roofs and 29 for steep-sloped roofs, or it must comply with the U.S. EPA's ENERGY STAR Reflective Roof Program Requirements. Moreover, "the values for solar reflectance and thermal emittance shall be determined by a laboratory accredited by a nationally recognized accreditation organization such as the Cool Roof Rating Council CRRC-1 Product Rating Program and shall be labeled and certified by the manufacturer." The standard is currently in the 45-day public review language and will take effect in 2009.

CONCLUSION

The CRRC is the only entity that provides credible, independent, third-party tested data for the reflectance and emittance of roof products. The CRRC's Rated Products Directory is an invaluable online resource for designers, architects, and builders, especially as more and more building codes and programs require energy-efficient roofing products measured by third-party rating entities. Cool roof-

ing is an effective approach to energy-efficient roofing in new buildings and renovation projects. The CRRC is continually striving to increase awareness of this effective strategy, by attending green building tradeshow and increasing architect and consultant membership to help guide the direction of the CRRC. Green building professionals should reference the CRRC online Rated Products Directory and consider using a cool roof for their green building projects.

NOTES

1. "Heat Island Effect: Cool Roofs." United States Environmental Protection Agency. 2007. October 2007. <http://www.epa.gov/heatisld/strategies/coolroofs.html>. March 27, 2008.
2. Akbari, Hashem. Levinson, Ronnen. Rainer, Leo. "Monitoring the energy-use effects of cool roofs on California commercial buildings." *Energy and Buildings*. Volume 37, Issue 10. October 2005.
3. United States Environmental Protection Agency. "Heat Island Effect." January 22, 2008. <http://www.epa.gov/hiri/index.html>. March 7, 2008.
4. Kirn, W. et al. "The effects of Acrylic Maintenance Coatings on Reducing Weathering Deterioration of Asphaltic Roofing Materials." *Roofing Research and Standards Development*. Vol. 3. 1994.