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INTERNATIONAL ROOFING EXPO GOES TO ORLANDO

MAXIMIZING COOL METAL ROOFS

HESS TOWER, HOUSTON

Cool Roof Reflections

Buildings Can Gain Many Benefits from Cool Metal Roofing

BY JESSICA CLARK ■ Whether for new construction or existing applications, cool roofs are one of the most adaptive energy-efficiency strategies you can incorporate into buildings. They are beneficial in a variety of climates and building types, can be combined with other environmental measures, and are available in virtually all product types, allowing for innovation and design creativity.

With thousands of color, texture, and profile options available, cool roofing is a particularly viable option for metal roofing. While cool roofs have been used as a passive cooling strategy around the world for thousands of years, new technologies constantly are being researched and developed.

Cool roofs have the potential to save 10 to 30 percent of a building's cooling energy and may provide additional environmental and health benefits. However, these can only be achieved if the roof is properly selected and installed. We will help decode the science and terminology of cool roofing for you. The guidelines and resources outlined here will help you design and specify the most efficient and effective cool roof.

CUSTOM-BILT METALS

What Makes a Cool Roof?

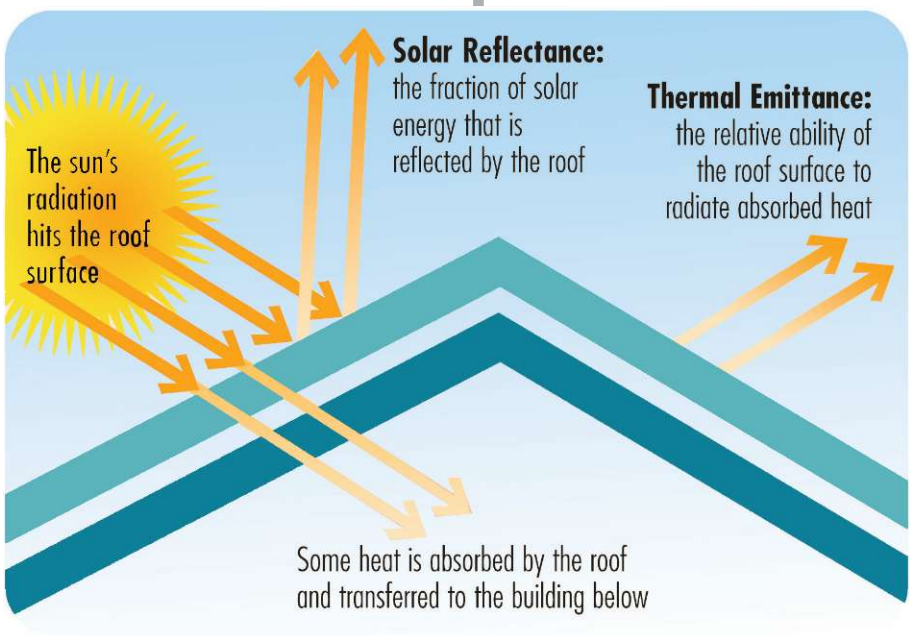
The most energy-efficient roof will reflect as much solar radiation as possible, while re-radiating as much absorbed heat as quickly as possible. The "coolness" of a roof is determined by two universal surface properties.

The fraction of solar energy that is reflected by a material is called the solar reflectance, and is reported as a value between zero and 1. The relative ability of a roof surface to reradiate any absorbed heat is called its thermal emittance, which also is reported as a value between zero and 1. Look for the highest possible values for both properties, though most materials, excluding bare shiny metals, will have a relatively high thermal emittance. (See Figure 1.)

Another metric often used is the solar reflectance index, or SRI. The SRI of a product is a calculation combining solar reflectance and thermal emittance into one simplified value that is typically between zero and 100, with poor products rating in the negatives, and the coolest products rating above 100.

The solar reflectance, thermal emittance, and SRI values are the key to choosing the most energy-efficient roofing material for a project. They also are important because many building codes and voluntary programs, such

▼ **FIGURE 1**: Solar reflectance and thermal emittance values are used to measure the effectiveness of a cool roof.



COOL ROOF RATING COUNCIL

How Much Energy Will Be Saved?

The amount of energy saved by installing a cool roof will depend on several site-specific factors. Although they can only calculate estimated savings, online cool-roof savings calculators are the best way to get a general idea of whether a cool roof is a good option for your project (see the Resources table on p. 26). Depending on a project's budget, climate, or site constraints, it may benefit from other energy-efficiency measures such as increased insulation or, for existing buildings, envelope weatherization. Following are some factors to consider when specifying a new roof:

Life-cycle Cost Assessment: Will a cool roof be cost-effective over its lifetime? The DOE estimates a cost premium of zero to more than $1.00 per square foot for cool over standard metal roofing. Several utility companies also offer rebates to help offset additional costs. Cool roofing decreases cooling energy by 10 to 30 percent and may also help increase the lifespan of a roof system by decreasing thermal flux. Generally, cool roofs are most effective on buildings in hot climates where air conditioning is used excessively. Consult online cool-roof calculators to help determine if a cool roof will be cost-effective for your project in your climate.

Code Requirements: Always check if local or state building and energy codes require a cool roof. If you are pursuing voluntary green-building certification, you often can receive credits for cool roofing. Each code or voluntary program sets minimum solar reflectance, thermal emittance, and SRI values for cool roofing. There is no universal standard for a cool roof.

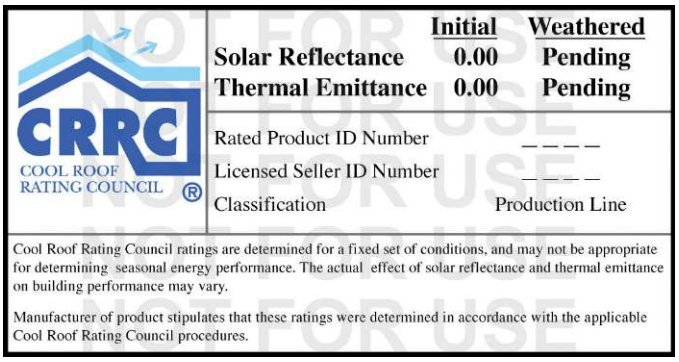
Retrofits: For building retrofits, what is the condition of the existing roof? Does it just need recoating? If so, you may be able to recoat with a cool- or light-colored product. Depending on the condition of the existing roof, you also may be able to save labor and material expenses by installing a metal roof over an existing asphalt shingle roof.

Comprehensive design: Cool roofing complements additional green-building strategies, such as PV panels and water harvesting. Studies have shown that harvested water quality rates well when collected on metal roofing. A cool roof may also allow for smaller air-conditioning units. Conversely, if your design already includes more-than-adequate insulation or a pitched roof with an attic, cool roofing may not be as effective at cooling the living spaces below.

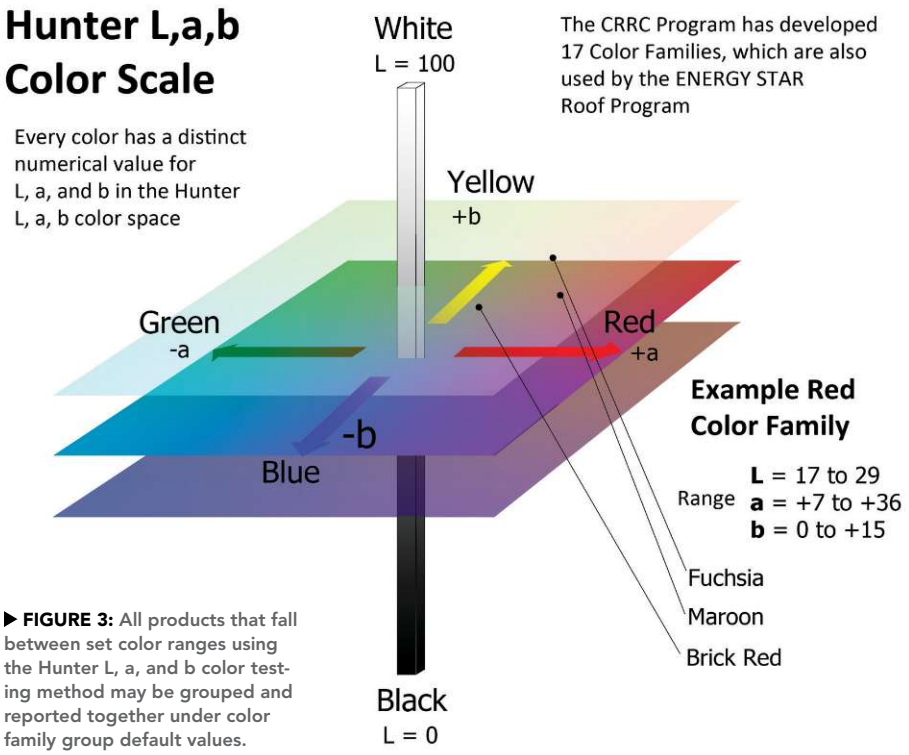
Design restrictions: Are there neighborhood building associations, and do they enforce restrictions on cool- and light-colored roofs? If it is a renovation project, do you need to match the new addition to the existing roof?

Ongoing care: A roof's solar reflectance and thermal emittance are affected by accumulated microbiological growth and soiling. The energy performance of a roof is dependent on the maintenance of solar reflectance. According to the DOE, cleaning a roof per the manufacturer's recommendations can restore it to 90 percent of its original solar reflectance.

Recyclability and environmental impact: Project environmental goals or green-building certification ambitions may lead you to consider the recycled content, end-of-life recyclability, and toxicity of materials specified.



▶ **FIGURE 2:** The Cool Roof Rating Council's label appears on the packaging of roofing products. CRRC established one of the main third-party rating programs for cool roofs.



▶ **FIGURE 3:** All products that fall between set color ranges using the Hunter L, a, and b color testing method may be grouped and reported together under color family group default values.

as the U.S. Green Building Council's LEED rating system, require that new or retrofit projects include cool roofing with minimum solar reflectance, thermal emittance, and SRI values.

Roofing-product manufacturers work with accredited laboratories and rating systems to measure and report these values to the public. Most manufacturers will have their products tested for initial values. Many also will have their samples sent to a test farm where they will be installed on racks outdoors for three years before being testing for aged values in order to get a better sense of how the product will perform over its lifetime. The initial and aged solar reflectance, thermal emittance, and SRI can often be found on manufacturers' websites or product spec sheets, although the most reliable source is a third-party rating system.

Cool Roof Rating Programs

The two main nationwide roof-product rating systems are the Oakland, Calif.–based Cool Roof Rating Council's (CRRC) Product Rating Program and the Roof Products Program from Energy Star, a joint effort of the U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy (DOE). The CRRC's is strictly a rating program, listing the solar reflectance, thermal emittance, and SRI values of products on its free online Rated Products Directory. The CRRC's label, with the same information, also appears on roofing product packaging. (See Figure 2.)

The Energy Star program sets minimum solar-reflectance values that the EPA deems

Resources for Designers and Contractors

Cool Roof Savings Calculators

Small- to medium-sized flat roofs ..... www.ornl.gov/sci/roofs+walls/facts/CoolCalcEnergy.htm
Residential and commercial facilities ..... www.roofcalc.com

Cool Roof Selection Guidance

DOE Guidelines for Selecting Cool Roofs www1.eere.energy.gov/femp/pdfs/coolroofguide.pdf
CRRC: Cool Roofs for Hot Projects ..... continuingeducation.construction.com/article.php?L=68&C=790

List of Codes and Voluntary Green Building Programs with Cool Roof Requirements and/or Credits

Cool Roof Rating Council (CRRC) Code List ..... coolroofs.org/codes_and_programs.html

Green Building Programs

USGBC's LEED Program ..... www.usgbc.org
Green Globes ..... www.greenglobes.com

List of Rebates

Database of State Incentives for Renewables and Efficiency (DSIRE) ..... www.dsireusa.org
CRRC Rebate List ..... coolroofs.org/codes_and_programs.html#rebate

Product Rating Programs

EPA's Energy Star Qualified Roof List ..... www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=RO
CRRC Product Rating Program ..... coolroofs.org/products/search.php

One of the most environmentally promising benefits of cool roofs is their ability to help mitigate the urban heat-island effect, a phenomenon that increases urban temperatures over their surrounding rural areas due to a concentration of dark, manmade materials that readily absorb and store solar energy for prolonged periods of time.

"cool." So although their online qualified product list provides only initial and aged solar reflectance and initial thermal-emittance values, all products on that list meet their minimum set values.

Metal roofing is unique in that it is highly customizable, with dozens of profiles and thousands of colors. It is implausible to test and age thousands of products, so the CRRC has developed the Color Family Program for factory-coated metal products. All products that fall between set color ranges using the Hunter L, a, and b color testing method (see Figure 3) may be grouped and reported together under specific color family group default values. This is important to know when searching for the CRRC Product ID to report to city building-permit departments and for LEED credits.

Why Choose A Cool Roof?

When chosen and installed properly, cool roofs provide a range of benefits. One of the most environmentally promising benefits of cool roofs is their ability to help mitigate the urban heat-island effect, a phenomenon that increases urban temperatures over surrounding rural areas due to a concentration of dark, manmade materials that readily absorb and store solar energy for prolonged periods of time. Cool roofs help improve urban conditions by the following:

- Immediately reflecting solar radiation back into the atmosphere before it can be absorbed and degraded to heat.
- Indirectly reducing the use of air conditioning by lowering ambient air temperature.
- Improving grid stability by increasing peak energy savings at the hottest times of the year.
- Improving air quality and reducing heat- and smog-related illnesses such as asthma and heat stroke by lowering the ambient temperature.

In a 2010 report, "Global Cooling: Policies to Cool the World and Offset Global

Warming from CO_2 Using Reflective Roofs and Pavements," the Lawrence Berkeley National Laboratory in Berkeley, Calif., speculated that worldwide implementation of reflected roofing in urban areas can produce a global cooling effect equivalent to offsetting 24 gigatons of CO_2 over a 20-year use of those roofs. That is equivalent to taking 300 million cars off the road and amounts to $600 billion in energy savings.

But a study published in September by Stanford University in Palo Alto, Calif., found that the urban heat-island effect may not play as large of a role in climate change as previously thought. There will no doubt be scientific research on both sides of the urban heat-island equation in the coming years, but there are many immediate, building-scale benefits owners and designers can expect by specifying a cool roof. These include the following:

- Improved occupant comfort because of lower building temperatures directly below the roof, especially on unconditioned spaces such as warehouses and attics.
- Energy savings from reduced cooling energy loads.
- Longer air-conditioning unit life due to decreased use.
- Increased roof durability due to reduced thermal flux.

Cool roofs often complement other green-building strategies such as solar photovoltaic panels. In fact, cool roofs can actually increase the efficiency of PV panels by maintaining a cooler, more optimal performance temperature underneath rooftop photovoltaic arrays. Cool metal roofing also is ideal for water-harvesting projects. In a study completed in January 2011 by the Cockrell School of Engineering at the University of Texas at Austin, researchers found that metal roofing produced one of the highest levels of harvested water quality for indoor use.

Metal-roofing manufacturers long ago developed cool-colored coatings with light-reflecting pigments that increase solar reflectance by reflecting light in the near infrared spectrum, which is where half of the sun's energy resides. These cool color products are more reflective than their standard counterparts, with a reflectance of, for example, 0.4 versus 0.09. There may be a slight price premium on these products, so designers may also choose to use a lighter-colored standard product. New technologies are continually emerging, such as directionally reflective products. These stepped metal panels have a white or light-colored coating on the horizontal surfaces and a colored surface on the vertical surfaces. The roof appears white from the sun's angle above and colored from the street level. Again, the energy efficiency of a roof depends on its solar reflectance and thermal emittance, not merely by its labeling as a cool product.

While studies have shown that cool roofs may be beneficial in most climates, the ultimate success of a cool roof is based on several factors, including life-cycle cost analysis, project location, budget, projected savings, and maintenance. With these parameters in mind, you will be on your way to your coolest design yet. :M

Jessica Clark, LEED AP, is the marketing liaison for the Cool Roof Rating Council, headquartered in Oakland, Calif. Visit www.coolroofs.org.