# NAVIGATING METAL ROOFING SYSTEM REFLECTIVITY SPECIFICATIONS

BY ROBERT ANDERSON

As green building continues to evolve from a "movement" to a widely accepted practice in both the low- and steep-slope roofing markets, demand for sustainable system design has grown along with it. For roof consultants and specification professionals, this upsurge is changing how they evaluate materials and design for energy efficiency.

In the 2008 Autodesk/AIA Green Index, an annual survey that measures how members of the American Institute of Architects are practicing sustainable design, 42% reported clients asking for green building elements in their projects. In addition, the survey shows that architects' clients have experienced a doubling in the market demand for green buildings since 2007. Interest in green building is being driven primarily by the desire for lower operating costs and reduced environmental impacts.

With more construction projects being aided by the American Economic Recovery and Reinvestment Act, much media attention has focused on solar roofing, geothermal technologies, and advances in vegetated roofing systems. However, for new construction as well as renovation projects, metal roofing products play a significant role in these environmentally conscious times.

Metal roofing's attributes include architectural appeal; variety of profiles, textures, and colors; flexibility; code compliance and resistance to wind, fire, and hail; and durability. Additionally, the range of highly reflective, highly emissive coatings and finishes available today has earned metal recognition as a "cool roofing" product.

Due to its high reflectivity, which can help save substantial energy costs by lowering building envelope cooling loads, metal roofing has proven to be a viable option for the commercial and residential markets. Yet as design professionals consider the various metal roofing options, there is confusion in interpreting some of today's architectural specifications. Determining the qualifications for metal roof reflectivity and understanding the differences among the various rating systems are key aspects to consider when specifying metal roofing products.

*Worker on top of a metal roof.*


*Dadeland Mall in Kendall, Florida.*

### Reflectivity Terms

When considering roof reflectivity, it is important to first understand some basic – yet often misunderstood or misused – terminology used to distinguish evaluation criteria. The U.S. Environmental Protection Agency (EPA) offers the following:

- **Solar Reflectance –** Solar reflectance is a measure of the ability of a surface material to reflect sunlight – including the visible, infrared, and ultraviolet wavelengths – on a scale of 0 to 1. Solar reflectance is also called "albedo."

  Light-colored materials generally have higher solar reflectance than dark-colored materials. Color, however, is not the most reliable indicator of reflectance, because visible light represents only 47% of the energy in the solar spectrum.
- **Thermal Emittance –** The thermal emittance of a material refers to its ability to release absorbed heat (via infrared radiation) to the surrounding atmosphere. Scientists use a number between 0 and 1, or 0% and 100%, to express emittance. Higher numbers indicate faster heat transfer.
- **Solar Reflectance Index (SRI) –** SRI is a value that incorporates both solar reflectance and thermal emittance in a single value to represent a material's temperature in the sun. SRI quantifies how hot a surface would get relative to standard black and standard white surfaces. It is calculated using equations based on previously measured values of solar reflectance and thermal emittance as laid out in the American Society for Testing and Materials (ASTM) Standard E1980, "Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces." The index ranges from 0 (black) to 100 (white).

  The Oak Ridge National Laboratory has an easy-to-use online SRI calculator available on its Web site at **www.ornl.gov/sci/roofs+walls/calculators/sreflect/index.htm**.
- **Urban Heat Island –** The term "heat island" describes built-up areas that are hotter than nearby rural areas. Heat islands can affect communities by not only increasing summertime peak energy demand and air conditioning costs, but also by contributing to air pollution and greenhouse gas emissions, heat-related illness and mortality, and

even water quality.

Because about half of the North American population lives in urban areas, roofing considerations can play an important role in alleviating the urban heat island effect. According to the Cool Metal Roofing Coalition, cool metal roofing is one way to mitigate the urban heat island effect. Roofs with higher reflectance have lower surface temperatures, which help reduce ambient air temperatures.

### Reflectivity Standards

As outlined in ASTM E1980, solar reflectance and thermal emittance are important factors affecting surface and near-surface ambient air temperature. Surfaces with low solar reflectance absorb a high fraction of the incoming solar energy. Fractions of this absorbed energy are conducted into the ground and buildings, convected to air (leading to higher air temperatures), and radiated to the sky.

For equivalent conditions, the lower the emissivity of a surface, the higher its steady-state temperature. Surfaces with low emissivity cannot effectively radiate to the sky and, therefore, get hot. Determination of solar reflectance and thermal emittance, and subsequent calculation of the relative temperature of the surfaces (using the SRI) may aid design professionals in choosing the most energy-efficient materials.

### Cool Roof Considerations

Today, there are three primary rating systems that define what constitutes a cool roof for applications on low- (a slope of 2:12 or less) and steep-sloped surfaces (a slope greater than 2:12): EnergyStar®, Leadership in Energy and Environmental Design (LEED®), and the State of California's Energy Efficiency Code (also known as Title 24).

EnergyStar® is a joint program of the EPA and the U.S. Department of Energy, created to reduce costs and protect the environment through energy-efficient products and practices. What began in 1992 as a voluntary labeling program to identify and promote energy-efficient products to reduce greenhouse gas emissions now encompasses more than 50 product categories. In particular, the EnergyStar® label now covers products for commercial and residential buildings, including roofing products.

According to EnergyStar® program requirements for roof products, standing seam roofs can be used with slopes as low as 1/4:12. Steel (and, sometimes, aluminum coils and sheets) is commonly used to fabricate metal roof panels. Steel requires a corrosion-resistant metal coating, typically zinc (galvanized) or an alloy of zinc-aluminum. Metallic-coated steels may also be painted to provide additional barrier protection as well as color. This paint finish imparts much of the reflectivity and emissivity that make metal panels "cool."

When designing with energy-efficient roof products, EnergyStar® specifications outline minimum values for initial solar reflectance (ISR) as well as maintenance of solar reflectance, which refers to the reflectivity value three years after installation under normal conditions.

In order to achieve EnergyStar® eligibility, qualifying products must achieve a minimum ISR greater than or equal to 0.65 (low slope) or 0.25 (steep slope). Additionally, they must have three-year weathered reflectivity greater than or equal to 0.50 (low slope) or 0.15 (steep slope). A quick review of EnergyStar®'s product list[1] shows dozens of metal roofing manufacturers, each with a multitude of light- and dark-colored products with an ISR typically ranging all the way from 0.25 to 0.80. The list also validates that the reflectivity values of metal roofing suffer very little degradation after three years of aging.

The LEED® Green Building Rating System was developed by the U.S. Green Building Council as a third-party certification program and is the nationally accepted benchmark for the design, construction, and operation of high-performance green buildings. With a goal of promoting sustainable, integrated, whole-building design practices, several LEED® rating systems exist for new construction and major renovations of both residential and commercial building projects. To earn LEED® certification, designers may make material choices or design choices that garner one or more LEED® points.

| Roof Type | Slope | SRI |
|---|---|---|
| Low-sloped roof | ≤ 2:12 | 78 |
| Steep-sloped roof | > 2:12 | 29 |

*Table 1*

Unlike the EnergyStar® criteria, the LEED® rating system for roofing focuses on the SRI. For example, in the newly released LEED® 2009 for New Construction, to earn one LEED® point under Sustainable Site Credit 7.2 – which is intended to reduce the heat island effect of roofing systems – one of the following requirements must be met:

1. Use roofing materials with a solar reflectance index equal to or greater than the values in *Table 1*[2] below for a minimum of 75% of the roof surface. Roofing materials having a lower SRI value may be used if the weighted rooftop SRI average meets the following criteria (See *Formula 1.*)
2. Install a vegetated roof that covers at least 50% of the roof area.
3. Install high albedo and vegetated roofing surfaces that, in combination, meet the same SRI criteria as Option 1. Roofing materials having a lower SRI value may be used if the weighted rooftop SRI average meets the following criteria (See *Formula 2.*)

Several metal roofing materials will meet the steep-slope SRI requirement of *Formula 1* below. For low-slope metal roofing systems, there might be fewer color and finish options, but metal roofing can meet this requirement, too.

California's 2008 Energy Efficiency Code (Title 24), which takes effect on August 1, 2009, defines a cool roof as a roof covering or surfacing that has been tested and labeled by the Cool Roof Rating Council

$$\frac{\text{Area roof meeting minimum SRI}}{\text{Total roof area}} \times \frac{\text{SRI of installed roof}}{\text{Required SRI}} \geq 75\%$$

*Formula 1*

$$\frac{\text{Area roof meeting minimum SRI}}{0.75} + \frac{\text{Area of Vegetated Roof}}{0.5} \geq \text{Total Roof Area}$$

*Formula 2*

*Metal roofing's attributes include architectural appeal; variety of profiles, textures, and colors; flexibility; code compliance; durability; and resistance to wind, fire, and hail.*

(CRRC) as having an aged solar reflectance and thermal emittance in accordance with its published guidelines. The published guidelines[3] – *Prescriptive Criteria for Roofing Product for Nonresidential Buildings* – vary depending on the climate zone, roof slope, building type, and weight (thermal mass) of the roofing material. This represents a change from the 2005 Title 24 Energy Code, where only initial values were used, and they required an initial solar reflectance of 0.70 and an initial thermal emittance of at least 0.75 on low-sloped roofs.

Although metal roofing is very strong and durable, it will almost always fall in the "less than 5 lb/ft²" category. Therefore, on steep-sloped nonresidential buildings in all California climate zones (except zone #1), the threshold for aged reflectance will be 0.20, and the threshold for thermal emittance will be 0.75 (an SRI of 16). The standard is more demanding for low-sloped products and for products of a greater weight.

CRRC, which is an independent, nonprofit organization that develops methods for evaluating and labeling the solar reflectance and thermal emittance of roofing products and maintains a third-party rating system, does not approve products. Rather, CRRC is an accreditation agency and a "listing clearinghouse" for laboratories that conduct reflectivity testing. Title 24 only recognizes values that are listed on the CRRC's directory, while EnergyStar® and LEED® accept any data, even from nonaccredited resources.

## Cool Metal Roofs

Because they are made with high recycled content, are completely recyclable, and offer a great combination of high reflectivity and high thermal emissivity, metal roofs are well suited to a wide range of low- and steep-slope cool roofing applications. Understanding the nuances of cool roofing and, particularly, roof reflectivity criteria among the three primary rating systems, is a key component to evaluating and specifying the eco-friendly, energy-efficient roofing systems that building owners, facility managers, and consumers seek today. In addition to the many resources outlined above, work closely with roofing systems manufacturers to help determine which cool roof products will best meet clients' needs.

## References


1. *Roof Product List*, U.S. EPA EnergyStar®, January 2, 2009. (www.energystar.gov/ia/products/prod_lists/roofs_prod_list.pdf )
2. *LEED® 2009 for New Construction and Major Renovations Rating System*, U.S. Green Building Council, November 2008.
3. "2008 Building Energy Efficiency Standards," Sec. 3.4.2, Roofing Products Prescriptive Requirements, *Nonresidential Compliance Manual*, California Energy Commission, December 30, 2008.



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Firestone Building Products entered the architectural metal market in July of 2005, and Robert Anderson became the company's first metal product manager in April of 2006. He previously held the position of estimating manager at Firestone Metal Products in Minnesota, the manufacturer of UNA-CLAD® metal wall and roofing systems. Anderson joined Copper Sales, Inc. as an estimator in 2000, and he became the estimating manager the following year. Anderson has a bachelor of science degree in finance from Northern Illinois University. He is a member of ASTM and the Metal Construction Association, where he currently serves as the Statistics Committee chair.