Cool Metal Roofing

Source: National Institute of Building Sciences

By: Cool Metal Roofing Coalition

Introduction

Metal roofing has been available and utilized as a roofing material for centuries. Metal roofing is available in a wide variety of substrates, colors, textures, and profiles. Though diverse in appearance, metal roofing has many common attributes such as durability, recycled content, recyclability, fire resistance, low weight, and low life-cycle cost.

Depending upon the surface finish, cool metal roofing can provide enhanced energy efficiency with its solar reflectance and infrared emittance properties. In fact, the solar reflectance and infrared emittance of a metal roof can be engineered to meet the climate requirements of the building. Cool metal roofing can provide the desired high reflectance and low emittance in climates where heating loads prevail. Cool metal roofing can also provide the desired high reflectance and high emittance where cooling loads dominate. Cool metal roofing easily meets the requirements of the EPA's Energy Star® program. Cool metal roofing is also eligible for other cool roof rating programs such as the Cool Roof Rating Council.

Description

A. What is Metal Roofing?

Metal roofing is represented by a variety of metal-based roof coverings designed to provide buildings with protection from the elements; allow for positive drainage of water from the roof surface; and to keep contents and occupants dry and comfortable. Metal roofing products are available in a range of metals including steel, aluminum, copper, zinc, stainless steel, and titanium.

The predominant metal roofing substrate is metallic-coated steel sheet. The metallic coatings include zinc (galvanized), 55% aluminum-zinc alloy (Galvalume® sheet), 5% aluminum-zinc alloy (Galfan®), aluminum and lead-tin alloy (terne).

With its expected long life, metal roofing is a highly desirable and sustainable building component. Additionally, many of the metals used in roofing will have recycled content varying from 25% to 95%, often with much of that recycled content being in the post-consumer and pre-consumer categories. For more information on metal roofing, see WBDG Metal Roofing. See also WBDG Evaluating and Selecting Green Products.

B. What is Cool Metal Roofing?

Cool metal roofing is a family of sustainable, energy efficient roofing products comprised of unpainted metal, prepainted metal, and granular-coated metal. It is available in a wide variety of finishes, colors, textures, and profiles, for steep-slope and low-slope applications. Cool metal roofing products are part of an interdependent system of exterior roofing surfaces, substrates, underlayments, configurations, ventilation, and insulation.

With proper design, cool metal roofing systems save energy by reducing a building's cooling and/or heating load. Many metal roof systems are reflective, easily vented, and lend themselves well to insulated roof systems to help reduce heat gain into a building. Many products are also formed in ways that stop heat transfer through conduction by allowing only minimal contact between the metal and the underlying structure.

Mill-finish metal roof systems have very high solar reflectance, providing further reductions in heat gain. Metal roofs with oven-cured, pre-painted organic coatings that incorporate new "cool pigment" technology offer high total solar reflectance and high infrared emittance even with darker colors. Emissivity as high as 90% can be achieved for painted and granular-coated roofing. Such pre-painted metal roofing products meet the reflectance requirements of all major energy code initiatives. Finally, unlike many roofing materials, metal's low thermal mass will not store heat and thus radiate it into a building in the evening hours. Painted metal roofs retain 95% of their initial reflectance and emittance over time.

Cool Metal Roofing typically has a minimum recycled content of 25% and is 100% recyclable at the end of a long, useful life. Most metal roofs are credibly proven to last over 30 years with minimal maintenance.

For a glossary of roofing terms please see: Cool Metal Roofing Coalition.

C. Types of Metal Roofing

There are two basic classifications of metal roofing; structural and non-structural (also known as architectural). Structural metal roofing attaches directly to purlins or lathe boards and does not require any sort of solid support beneath it. Non-structural metal roofing requires a solid substrate beneath it, typically plywood, oriented strand board, or a metal roof deck. Metal roofing can also either be through-fastened (screwed directly to the purlins or substrate) or standing seam (using concealed clips to minimize the number of penetrations through the roof covering and to permit expansion and contraction).

Structural metal roofing is broken down into low slope and steep slope categories. Low slope products are available for roof pitches from ¼:12 to 3:12 while steep slope products are designed for roof pitches greater than 3:12. Low slope structural metal roofing consists of interlocking

panels (standing seam) or overlapping panels (through-fastened), that run vertically on the roof surface. These products can have a painted, mill-finish, or clear acrylic finish. To ensure watertightness on roofs of less than 3:12 pitch, some standing seam products will require machine seaming during installation. These special machines are rolled along the panels to crimp the panel seams together.

Steep slope structural metal roofing is available in both vertical and horizontal profiles. The vertical panels include standing seam systems that are fastened to underlying purlins with hidden clips or fastening flanges. A wide variety of corrugated or tile facsimile metal roofs that are attached with exposed fasteners directly through the metal roofing panels are also available. These products overlap or interlock on their side and end laps for watertightness. Special seaming machines are typically not required.

Most non-structural metal roof panels are designed for roof pitches of 3:12 or greater. Rather than transmit loads through to purlins or lathe boards beneath them, non-structural systems transfer loads to the roof deck beneath them. Non-structural systems are available in a variety of styles including vertical standing seam, corrugated, and tile profiles as well as a wide variety of horizontal panels. The horizontal panels simulate the look of standard shingles, wood shake, slate, and tile. Most non-structural metal roofing will have a coating for aesthetics and durability. Coatings include various paint finishes as well as aggregate (stone) finishes.

D. Characteristics of Cool Metal Roofing

The benefits of metal roofing include:

- **Durability.** Metal roofing products are not subject to the degradation experienced by organic materials when they are exposed to the weather cycle. This provides metal roofing with a long life in terms of its ability to resist the elements and also to possess a low maintenance cost.
- **Low Weight.** Metal roof systems typically vary from 40 to 135 pounds per 100 square feet, making them among the lowest weight roofing products available. Low weight places fewer demands on a building's structure making metal roofing an excellent choice for retrofit projects. The light weight is also a benefit in locations prone to seismic activity.
- **Fire Resistance.** Many metal roof systems have been tested to meet Class A, B, and C fire ratings.
- **Aesthetics.** Due to its ability to accept coatings of various colors and patterns and its ability to be formed into a wide variety of functional profiles, cool metal roofing products

can be found to fit and enhance the aesthetic design of virtually any building. This gives architects extensive design flexibility.

- **Wind Resistance.** The interlocking or active fastening of most metal roofing panels allows them to pass very severe wind and uplift tests including ASTM E1592, UL 580, and UL 1897. Many products carry approval for use in Dade County, Florida.

E. Useful Life of Cool Metal Roofing

Metal roofing has a very long history, with roofs dating back to the 1800s still in service. The durability of cool metal roofing provides property owners with a very low "per year" cost option in roofing. Metal roofing products being manufactured today carry manufacturers' warranties lasting from 20 to 50 years. However, most products have been designed so that they can be refurbished on site for additional life once their original finish reaches its useful life. Metal roofing materials are 100% recyclable in the event that they are ever removed.

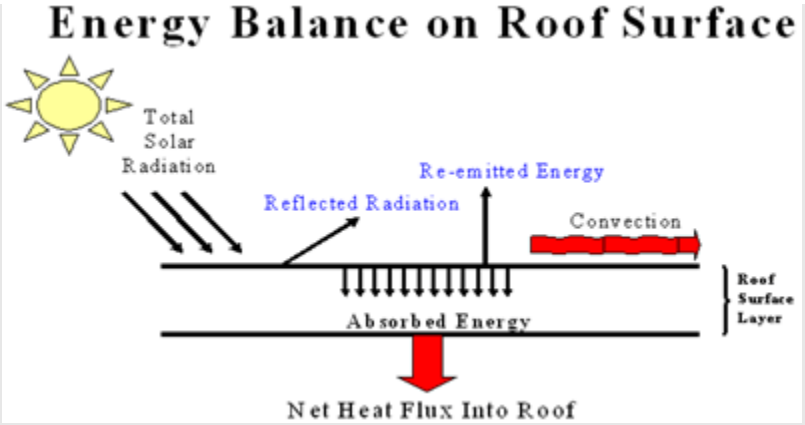
The high-quality, oven-cured paint systems used on pre-painted cool metal roofing are formulated to resist chalking and fading of their colors. In addition, these paint systems shed dirt and do not support the growth of algae or fungal matter.

F. Economics of Cool Metal Roofing

The long life and low maintenance of metal roofing, combined with the savings from energy efficiency, give it a very attractive life-cycle cost.

Application

Cool metal roofing is used for reducing cooling/heating loads on new construction and on retrofit roofing applications in the commercial, industrial, architectural, institutional, and residential construction markets. Depending on the choice of finishes and colors, this family of roofing products has solar reflectance and infrared emittance properties conducive to lowering cooling and heating energy usage, lowering peak energy demand in buildings, and mitigating the urban heat island effect.



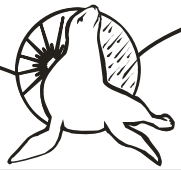
Cool metal roofing products are included in the EPA's Energy Star Roof Products Directory. The EPA estimates that reflective roofs can save up to 40% cooling energy on homes and buildings. Cool metal roofing is also listed extensively in the Cool Roof Rating Council Product Directory. Florida Power and Light (FPL) has also recognized the sustainable energy-efficiency of metal roofing in a cooperative program involving Florida Solar Energy Center and Habitat for Humanity. FPL found that a painted metal roof could save a homeowner about 23% annually in cooling costs compared to a dark colored traditional shingle roof. (Florida Power and Light, February 5, 2001 press release)

Low Slope

Cool metal roofs as large as 1 million square feet are common in industrial and commercial construction. Weathertight standing seam roof systems are designed with special clips and fastener systems to allow for thermal expansion and contraction.

Retrofit

Leaky flat non-metallic roofs can be replaced with sloped metal roofs by adding an engineered lightweight secondary structural system to the existing building. Metal roofing can also be used for steep slope retrofit roofing projects. In many cases it can be applied directly over worn out asphalt shingles eliminating the need to landfill the old roofing materials.



Relevant Codes and Standards

Federal Mandate

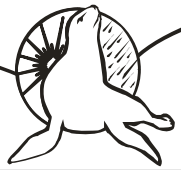
- Energy Policy Act of 2005 (PDF 1.9 MB, 550 pgs)
- Energy Independence and Security Act of 2007 (PDF 738 KB, 310 pgs)
- American Recovery and Reinvestment Act of 2009 (PDF 1.1 MB, 407 pgs)

The following relevant codes and standards have been divided into three categories:

- **Building Codes and Regulations** that invoke energy standards that include cool roofs;
- **Energy Standards** that have minimum properties associated with cool roof designations; and
- **Rating Programs** for independent certification and labeling of roof products.

Building Codes and Regulations

- *ASHRAE 189.1-2009 Standard for the Design of High Performance, Green Buildings*—A minimum of 75% of the entire roof surface shall be covered with products that comply with one or more of the following: a. have a minimum initial SRI of 78 for a low-sloped roof (a slope less than or equal to 2:12) and a minimum initial SRI of 29 for a steep-sloped roof (a slope of more than 2:12). b. comply with the criteria for USEPA's ENERGY STAR® Program Requirements for Roof Products—Eligibility Criteria. Certain allowances and exceptions may apply.
- *California Title 24 Energy Efficiency Standards for Residential and Nonresidential Buildings (2008)*—The cool roof performance criteria is based on a roof product's thermal emittance and 3-year aged reflectance. A solar reflectance index (SRI) criteria is included as an alternate, but is to be based on the 3-year aged reflectance. A cool roof on nonresidential buildings is defined as one with a 3-year aged solar reflectance of at least 0.55 and an infrared emittance of at least 0.75 (or minimum SRI of 64) in climate zones 2 through 15 for low slopes (2:12 or less). For steep slope (greater than 2:12) nonresidential, a cool roof is defined in climate zones 2 through 16 as one with a 3-year aged solar reflectance of at least 0.20 and an infrared emittance of at least 0.75 (or minimum SRI of 16) where the roofing product has a density of less than 5 pounds per square foot. A cool roof on residential buildings is defined as one with a 3-year aged solar reflectance of at least 0.20 and an infrared emittance of at least 0.75 (or minimum SRI of 16) in climate zones 10 through 15 for steep slope applications (greater than 2:12) and where the roofing product has a density less than 5 pounds per square foot. Low slope residential roofs (2:12 or less) only have a prescriptive cool roof requirement in climate zones 13 and 15 and that is the same requirement as for nonresidential There is also an allowance for a cool roof that has a very high reflectance, but a



lower emittance. While cool roofs are not mandatory, the equivalent energy savings of a cool roof in terms of other trade offs with building envelope components, A/C or lighting must be provided where a cool roof is prescriptively required. Title 24 also requires cool roof properties to be verified through CRRC ratings (described below), or low default values for reflectance and emittance must be substituted in energy calculations.

- *International Building Code (2009)*, Section 1301.1.1—Buildings shall be designed and constructed in accordance with the International Energy Conservation Code.
- *International Energy Conservation Code (2009)*, Section 501.1—Commercial buildings shall meet the requirements of ASHRAE 90.1, or meet the requirements of Chapter 5 (which does not address cool roof requirements). Cool roofs are not addressed for residential buildings.
- *International Green Construction Code Public Version 1.0.*—Model code focuses on new and existing commercial buildings addressing green building design and performance. Not less than 75 percent of the roof surfaces of buildings located in climate zones 1 through 3 shall be in compliance with the minimum aged solar reflectance and thermal emittance values, in accordance with CRRC-1, or the minimum aged solar reflectance index (SRI) value as provided in Table 404.3.1 for roof slope less than 2:12 or for roof slope 2:12 or greater, respectively.
- *National Fire Protection Association (NFPA) 5000 Building Construction and Safety Code (2009)*, Section 51.2—All commercial buildings, except storage and industrial occupancies, shall meet the requirements of ASHRAE 90.1. Cool roofs are not addressed for residential buildings.

Energy Standards

- *ANSI/ASHRAE/IESNA Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings (2007)*, Section 5.5.1.1—Less roof insulation is required in climate zones 1 through 3 where the roof meets the cool roof requirements (note that ASHRAE refers to a cool roof as a high albedo roof). A separate table (5.5.3.1) is provided for the required U Factor ASHRAE 90.1 defines a cool roof as having a minimum solar reflectance of 0.70 and a minimum infrared emittance of 0.75, or alternately a minimum solar reflective index (SRI) of 82. Reflectance is measured using ASTM E903, C1549, or E1918. Emittance is measured using ASTM C1371, or E408. SRI is measured using ASTM E1980.

Rating Programs

- Cool Roof Rating Council (CRRC) Product Rating Program—The CRRC administers a rating program under which manufacturers can label various roof surface products with radiative property

values. Tests must be carried out in CRRC accredited laboratories. Solar reflectance is measured using ASTM E903, E1918, or C1549. Emittance is measured using ASTM C1371 or E408.

- Environmental Protection Agency (EPA) Energy Star Program Requirements for Roof Products—This federal program designates roof products that comply with the EPA requirements to assist consumers in making informed decisions with respect to energy conservation. The guidelines for energy star designation are different for low slope (2:12 or less) and steep slope roofs. The EPA Energy Star guidelines include initial solar reflectance (>0.25 for steep slope and >0.65 for low slope), weathered solar reflectance (>0.15 for steep slope and >0.50 for low slope, after three years of normal exposure) and a comparable warranty to non-reflective roof products.
- U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design Green Building Rating System® (LEED)—The LEED® rating system is a national consensus-based program to accelerate the development and implementation of green building practices. The program awards "points" for different green building design measures, including cool roofs. LEED is designed for rating new and existing commercial, institutional, and high-rise residential buildings. To qualify as cool, LEED requires roofing materials for a minimum of 75% of the roof surface to have a solar reflectance index (SRI) equal to or greater than 78 for low-sloped roof (≥ 2:12) and 29 for steep-sloped roof (> 2:12). Other provisions are made for cool roofing materials covering more than 75% of the roof surface and vegetated roof surfaces.