

California Cool Roofing

CODE REQUIREMENTS

By Alan E. Burnett, PE

In 2000 and 2001, California's energy crisis came to a head when the state suffered from rolling blackouts. In response, Title 24, Part VI of the California Code of Regulations (which provides energy efficiency standards for buildings) included a cool roof prescriptive requirement in October 2005. The purpose of this revision was to reduce building energy consumption and mitigate the rolling blackouts. These changes have minimally affected some roof systems and resulted in modifications to other systems.

Definitions of Terms

- **California Energy Commission (CEC):** Primary state agency responsible for energy policy and planning.
- **Cool Roof:** A roof with high reflectivity and emissivity that improves the energy efficiency of a building. Title 24 defines a cool roof as having a minimum reflectance of 0.70 and a minimum emittance of 0.75.
- **Cool Roof Ratings Council (CRRC):** The only organization recognized for testing and certification of roof surfacing products for Title 24 compliance.
- **Emissivity (E):** A measure of the amount of heat that a roof material can emit back into the atmosphere. It is the ratio of radiant heat flux emitted by a black body at the same temperature (expressed in decimal form with 1.0 being the highest).

- **Energy Star:** A voluntary labeling program developed by the U.S. Environmental Protection Agency that identifies energy-efficient products.
- **Reflectance (R):** The amount of sunlight that is reflected off the roof surface. It is the ratio of reflected light to incident light (expressed in decimal form, with 1.0 being the highest).
- **Title 24:** Part VI of the California Code of Regulations that sets energy design and construction standards for residential and non-residential buildings. This is part of the state building code.

How a Cool Roof Works

Sunlight striking a roof is either reflected or absorbed into the roof membrane. The absorbed sunlight will heat the roof assembly. This heat will either be transferred back to the atmosphere by convection or radiation (i.e., emittance) or flow downward through the roof assembly and into the building interior.

or. A cool roof reflects more light and emits more heat back to the atmosphere than a conventional roof (Figures 1 and 2). This results in less heat transferred into the building interior and reduced cooling needs.

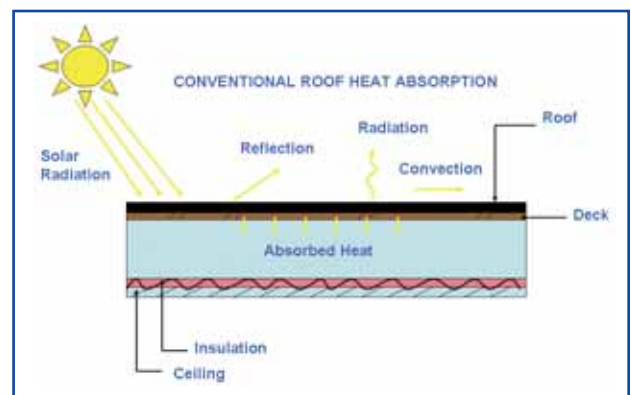


Figure 1

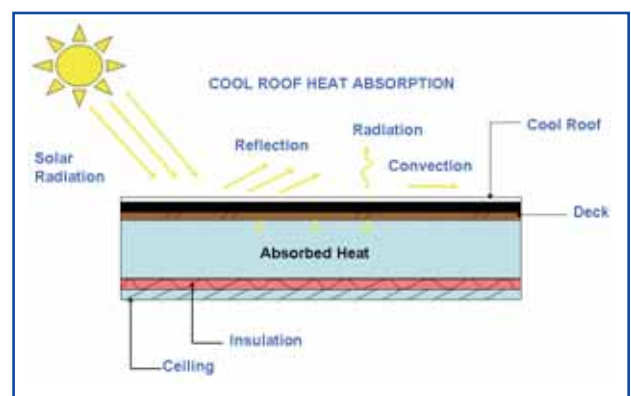


Figure 2

Figures 1 and 2 – Conventional and cool roof heat absorption.

the roof, since this equipment can be removed in the future, leaving it exposed to the sun. Photovoltaics integrated into the roof material are typically a dark color and do not satisfy the reflectance requirement. For these roofs, the same procedures as for green roofs are followed.³

Roof Coatings

Some systems (e.g., built-up roofs) need coatings to enhance the reflectance and/or emittance to qualify as a cool roof. Title 24 requires that the coating have a minimum dry thickness of 20 mils. In addition to the reflectance and emittance testing, coatings must satisfy ASTM weathering, elongation, and flexibility requirements.

Quality Assurance

Title 24 has a quality assurance requirement that all roof surfacing products be tested, rated, and certified by the Cool Roof Rating Council (CRRC). The initial reflectance and emittance test data must be printed on the label of the product. If a product not tested by CRRC is specified, a default reflectance value of 0.10 must be used.

Cool Roof Rating Council (CRRC)

The CRRC, a non-profit organization founded in 1998, develops methods to evaluate and label solar reflectance and emittance of roofing materials in an accurate



Photo 1 – Typical Title 24-compliant single-ply roof.

manner. One of the CRRC's main functions is to administer the product-rating program required by Title 24. This program tests the reflectance and emissivity of roof surfacing products such as coatings, mineral-surfaced cap sheets, single-ply membranes, metal panels, shingles, and tiles. Each product tested is given a unique CRRC Identification Number. The CRRC tests the initial and 3-year aged reflectance and the emittance. The aged reflectance testing is currently in progress and no results are available. CRRC-certified laboratories perform the testing.

Test results are listed in the product rating directory on the CRRC Web page. This directory, a database presently containing over 700 products, lists the CRRC

Identification Number, manufacturer information, product name and type, steep- or low-slope application, initial reflectance, and emissivity. Aged reflectance is stated as pending. The directory can be sorted by one or more variables, such as roof type, manufacturer, and steep- or low-slope applications. This database provides product test results and does not state if a product complies with Title 24. It is the designer's choice to make that determination. It is similar to the ENERGYSTAR® product summary and is a good information source.

[EDITOR'S NOTE: For more information on the CRRC, see "Cool Roofing and the Cool Roof Rating Council: The Evolution of a Rating System," on page 5 of this issue.]



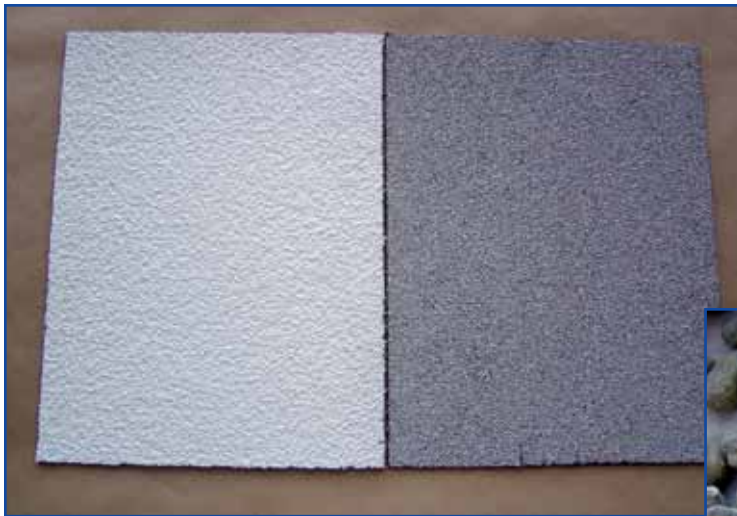


Photo 2 – Title 24-compliant coated (left) and conventional, mineral-surfaced cap sheet (right).

Photo 3 – Conventional (left) and Title 24-compliant aggregate (right).



Title 24 and Roof Systems

The new Title 24 requirement has minimal impact on some roof systems and requires modifications for other systems. Three roof systems most commonly used in California are discussed below.

Metal Roofs

Metal has been minimally affected by the change, since most applications are for steep slopes. If installed on low-slope, the color pallet is limited. Advances in cool pigment paint technology have provided a wider color pallet than single-ply or built-up systems.

Single-ply Roofs

There has been minimal impact on design and installation of single-ply sys-

tems, except for the color limitation. Presently, white-colored membranes satisfy cool roof requirements (Photo 1).

Built-up Roofs

Built-up roofing has been most affected by the Title 24 change. The commonly-used, conventional, gray-colored, mineral-surfaced cap sheet or aggregate does not satisfy the Title 24 reflectance requirement of 0.70. Non-compliance results in changing to a coated cap sheet or changing the type of aggregate (Photos 2 and 3).

A white-colored surface is required to obtain a 0.70 reflectance. This is achieved by applying a white, elastomeric, acrylic coating on the top of the cap sheet. This coating can be either factory-applied or applied in the field by the roofing contractor and must satisfy the Title 24 20-mil thickness requirement. Both options result in increased installation costs and additional maintenance.

A factory-applied, coated cap sheet typically requires less installation time since the coating is pre-applied. Touch-ups are needed at asphalt bleed-out on cap sheet laps and on damaged or marked areas of the coating. The amount of touch-up is dependent upon the quality of the roof installation crew and the amount of roof-related construction activity on the completed roof.

Careless installation can result in



Photo 4 – Factory-coated cap sheet with field-applied touch-ups in progress. Note asphalt bleed-out at laps in left side of photo.

extensive asphalt marking. Damaged coating results in reduced reflectance. Touch-up repairs will be visible (Photo 4) and can affect aesthetics. Factory-coated cap sheets are approximately \$0.50 per square foot more expensive than conventional cap sheets. The cost of touch-ups is dependent upon labor and materials to repair the damaged area. Designers should include an allowance for touch-ups in the bid documents to mitigate change orders, particularly if other trades damage the coating after the roofing contractor has completed its work.

Field-applied coatings are applied after all roof-related construction (e.g., HVAC) is completed and are less susceptible to damage by other trades. The conventional mineral-surfaced cap sheet is cleaned and primed, and two coats of the coating are applied (Photo 5). This option is more costly than factory-applied (\$1.00 to \$1.50 per square foot), but provides a more uniform appearance.

Both cap sheet options will result in additional maintenance to ensure long-term reflectance. The roof will typically need to be recoated every five to seven years, resulting in two coatings over a 20-year lifespan.

Currently, a crushed white marble aggregate set in white adhesive is the only product that has been tested to comply with the Title 24 reflectance requirement. The white adhesive will not darken the aggregate with a coating of asphalt from the flood coat and will provide a uniform white color (i.e., no reduced reflectance). It is more costly than the conventional aggregate.

Title 24 and the Owner

Owners should be informed of the following items during the design phase:

- The Title 24 Cool Roof requirements and compliance options should be explained.



Photo 5 – Field-applied coating on a mineral-surfaced cap sheet.

- The new roof will need maintenance to maintain its reflectance.
- A coated or built-up roof will cost more to install and maintain.
- The new roof will be noticeably brighter than the previous one, resulting in potential aesthetic complaints if the roof is visible from ground level or from above.

Summary

- Title 24, part of the California State Building Code, now has a cool roof prescription requirement for non-residential, low-slope roofs. The intent is to reduce building energy consumption.
- A cool roof is required unless the designer performs calculations showing that the building envelope or building satisfies the building energy budget.
- The new requirement has resulted in increased installation and main-

tenance costs for built-up and coated roof systems. 

FOOTNOTES

- 1 Blueprint No. 83, California Energy Commission, December 2005.
- 2 www.energy.ca.gov/title24/2005standards/2005_computer_prog_list.html.
- 3 Blueprint No. 83, California Energy Commission, page 6, December 2005.

INFORMATION SOURCES

- 2005 Building Energy Efficiency Standards.
- 2005 Non-residential Compliance Manual.
- California Energy Commission, www.energy.ca.gov/title24/index.html.
- Cool Roof Rating Council, www.coolroofs.org.

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