

The benefit of a high reflectance surface is obvious: while dark surfaces absorb the sun’s energy (visible light, invisible infrared, and ultraviolet radiation) and become hot, light-colored surfaces reflect solar energy and stay cooler. However, high emittance is also important. Emittance refers to the ability of heat to escape from a surface once it is absorbed. Surfaces with low emittance (usually shiny metallic surfaces) contribute to the transmission of heat into the roof components under the roof surface. The heat can increase the building’s air conditioning load resulting in increased air conditioning load and less comfort for the occupants. High-emitting roof surfaces give off absorbed heat relatively quickly through the path of least resistance- upward (and out of the building).

Rating and Labeling

Roofing products that are used for compliance with the standards (prescriptive and performance approaches) are required to be tested and labeled by the Cool Roof Rating Council (CRRC) per §10-113 and that liquid applied products meet minimum standards for performance and durability per §118(i)4. The CRRC is the supervisory entity responsible for certifying cool roof products. The CRRC test procedure is documented in CRRC-1, the CRRC Product Rating Program Manual. This test procedure includes tests for both solar reflectance and thermal emittance.

The roofing products manufacturer must have its roofing product tested for solar reflectance and thermal emittance, and be labeled according to CRRC procedures. Figure 3-1 provides an example of an approved CRRC product label.


		<u>Initial</u>	<u>Weathered</u>
	Solar Reflectance	0.00	Pending
	Thermal Emittance	0.00	Pending
	Rated Product ID Number	-----	
Licensed Seller ID Number	-----		
Classification	Production Line		
<p>Cool Roof Rating Council ratings are determined for a fixed set of conditions, and may not be appropriate for determining seasonal energy performance. The actual effect of solar reflectance and thermal emittance on building performance may vary.</p> <p>Manufacturer of product stipulates that these ratings were determined in accordance with the applicable Cool Roof Rating Council procedures.</p>			

Figure 3-1- CRRC Product label and information

The residential roofing product requirement in the prescriptive package is as follows. For steep-sloped applications in climate zones 10-15, for roofing products that have a density of less than 5 pounds per square foot (generally, asphalt shingle and metal products) there is a three year aged solar reflectance requirement of 0.20 and a (three year aged or new) thermal emittance

requirement of 0.75, or a minimum solar reflectance index (SRI) of 16. For roofing products with a density of 5 pounds per square feet or more (generally include concrete, clay tiles, slate and possibly some synthetic roof coverings), in climate zones 1-16, there is a minimum aged solar reflectance of 0.15 and thermal emittance of 0.75, or a minimum SRI of 10.

For low-sloped roofing applications, in climate zones 13 and 15, there is a minimum aged solar reflectance of 0.55 and thermal emittance of 0.75, or a minimum SRI of 64.

There are two exceptions to meeting the roofing products requirements in the prescriptive package:

1. The roof area with building integrated photovoltaic panels and building integrated solar thermal panels are exempt from the minimum requirements for aged solar reflectance and thermal emittance or SRI per Exception 1 to §151(f)12.
2. If roof constructions that have thermal mass over the roof membrane with a weight of at least 25 lb/ft² are exempt from the minimum requirements for aged solar reflectance and thermal emittance or SRI under Exception 2 to §151(f)12

If the aged value for the reflectance is not available in the CRRC's Rated Product Directory then the equation below can be used until the aged rated value for the reflectance is posted in the directory.

Aged Reflectance_{calculated}=(0.2+0.7[ρ_{initial} – 0.2])

Where ρ_{initial} = Initial Reflectance listed in the CRRC Rated Product Directory.

Solar Reflectance Index (SRI) is a new concept in the 2008 Standards; in lieu of meeting a thermal resistance and solar reflectance requirement, compliance can be shown by meeting a minimum SRI. The temperature of a surface depends on the surface's reflectance and emittance, as well as solar radiation. The SRI measures the relative steady-state surface temperature of a surface with respect to the standard white (SRI=100) and standard black (SRI=0) under the standard solar and ambient condition. A calculator was produced by the staff at Lawrence Berkeley National Laboratory which calculates the SRI by designating the solar reflectance and thermal emittance of the desired roofing material. Calculations shall be based on moderate wind velocity of 2-6 meters per second. To calculate the SRI the 3-year aged value of the roofing product must be used. By using the SRI calculator a cool roof may comply with an emittance lower than 0.85 as long as the aged reflectance is higher. Also, SRI can be obtained by trading off a lower aged solar reflectance with a higher thermal emittance.

Although not included as prescriptive equivalents for new construction, §152(b)1H contains acceptable cool roof alternatives to the prescriptive requirements for alterations. These alterations can also be utilized in the design and construction of a new roof system to improve the thermal performance by reducing the cooling energy load placed on the building. Examples of these practices that can be utilized in new construction and that a contractor or designer could consider include: (Note: some of the following measures may result in an additional compliance credit if incorporated into the building.)

- a. Insulation with a thermal resistance of at least 0.85 hr·ft²·°F/Btu or at least a 3/4 inch air-space is added to the roof deck over an attic; or
- b. Existing ducts in the attic are insulated and sealed according to §151(f)10; or
- c. In climate zones 10, 12 and 13, with 1 ft² of free ventilation area of attic ventilation for every 150 ft² of attic floor area, and where at least 30 percent of the free ventilation area is within two feet vertical distance of the roof ridge; or
- d. Buildings with additional ceiling insulation annexes of the Prescriptive package requirement for the climate zone; or
- e. Buildings with a radiant barrier in the attic meeting the requirements of §151(f)2; or
- f. Buildings that have no ducts in the attic; or
- g. In climate zones 10, 11, 13 and 14, R-3 or greater roof deck insulation above vented attic.

The prescriptive requirements call for a cool roof in both low-slope and steep-slope applications for residential buildings. A low-slope roof is defined as a surface with a pitch less than or equal to 2:12 (9.5 degrees from the horizontal) while a steep-slope roof is a surface with a pitch greater than 2:12 (9.5 degrees from the horizontal). The prescriptive requirements for cool roofs under the new 2008 Standards are now climate zone dependent and the aged reflectance and emittance criteria depend on the type of roofing material being used.

Solar Reflectance Index (SRI) is a new concept with in the 2008 Standards. The temperature of a surface depends on the surface's reflectance and emittance, as well as solar radiation. The SRI measures the relative steady-state surface temperature of a surface with respect to the standard white (SRI=100) and standard black (SRI=0) under the standard solar and ambient condition. A calculator was produced by the staff at Lawrence Berkeley National Laboratory which calculates the SRI by designating the Solar Reflectance and Thermal emittance of the desired roofing material. SRI calculations shall be based on moderate wind velocity of 2-6 meters per second. To calculate the SRI the 3-year aged value of the roofing product must be used. By using the SRI calculator a cool roof may comply with an emittance lower than 0.85 as long as the aged reflectance is higher.

A qualifying cool roof must have an aged reflectance and emittance greater than or equal to that provided. Also to be a cool roof the roofing material must be listed in the CRRC's Rated Product Directory (see <http://www.coolroofs.org>). For a newly constructed Low-Rise Residential buildings with steep-slope roofs in Climate Zones 1-16 with a density of 5 lbs/ft² or more, is required to have an aged reflectance of 0.15 and aged emittance of 0.75, or a SRI equivalence of 10. In Climate Zones 10-15, low density roofs, weighing less than 5 lbs/ft², is required to have an aged reflectance of 0.20 and aged emittance of 0.75, or a SRI equivalence of 16.

However, if the aged value for the reflectance is not available in the CRRC's Rated Product Directory then the equation below can be used until the aged rated value for the reflectance is posted in the directory.

$$\text{Aged Reflectance}_{\text{calculated}} = (0.2 + 0.7[\rho_{\text{initial}} - 0.2])$$

Where ρ_{initial} = Initial Reflectance listed in the CRRC Rated Product Directory.

In addition to the questions and answers below about cool roofs, the 2008 Nonresidential Manual contains more cool roof information (including different questions and answers) in Section 3.4.

Example 3-14

Question

Is a cool roof required in new residential construction or in residential alterations or additions?

Answer

Yes, for the 2008 Title 24 Standards cool roof is required when using the prescriptive package in new residential construction, additions or alterations. Cool roof now applies to both low-slope and steep-slope residential roofs. Also, the cool roof requirement is different per climate zone and per the type of product being used (product weighing less than 5 lbs/ft² or 5 lbs/ft² or

more). If one wishes not to install a cool roof then they must meet the title 24 Standards using the performance method where tradeoffs can be done.

Example 3-15

Question

I am a salesperson and represent some roofing products, and many of them are on the EPA's Energy Star list for cool roofing materials. Is this sufficient to meet Title 24 Standards?

Answer

No. Energy Star has different requirements for reflectance and NO requirements for emittance. The Cool Roof Rating Council (<http://www.coolroofs.org>) is the only entity currently recognized by the Energy Commission to determine what qualifies as a cool roof under Title 24.

Example 3-16

Question

Example 3-17

Question

How does a product get CRRC cool roof certification?

Answer

Any party wishing to have a product or products certified by CRRC should contact CRRC to get started - call toll-free (866) 465-2523 from inside the US or (510) 485-7176, or email info@coolroofs.org. CRRC staff will walk interested parties through the procedures. In addition, CRRC publishes the procedures in "CRRC-1 Program Manual," available for free on <http://www.coolroofs.org> or by calling CRRC. However, working with CRRC staff is strongly recommended.

Example 3-18

Question

I've heard the words reflectivity, reflectance, emissivity, and emittance? Can you explain?

Answer

"Reflectivity" and "reflectance" denote the same thing, but the Standards use only "reflectance" to avoid confusion. "Emissivity" and "emittance" denote the same thing, and again the Standards use only "emittance."

Example 3-19

Question

I understand reflectance, but what is emittance?

Answer

Even a material that reflects the sun's energy will still absorb some of that energy as heat; there are no perfectly reflecting materials being used for roofing. That absorbed heat undergoes a physical change (an increase in wavelength, for readers who remember physics) and is given off – emitted – to the environment in varying amounts by various materials and surface types. This emittance is given a unitless value between 0 and 1, and this value represents a comparison (ratio) between what a given material or surface emits and what a perfect blackbody emitter (again, recall physics) would emit at the same temperature.

§150(c) if the building can show compliance using performance compliance and modeling R-11.

Roofing Products


All roofing products must meet the mandatory requirements of §10-113 and §118(i), and the prescriptive requirements of §152(b)1H. Roofing products with high solar reflectance and thermal emittance are referred to as “cool roof”, which refers to an outer layer or exterior surface of a roof. As the term implies, the temperature of a cool roof is lower on hot sunny days than for a conventional roof, reducing cooling loads and the energy required to provide air conditioning.

The benefit of a high reflectance is obvious: while dark surfaces absorb the sun’s energy (visible light, invisible infrared, and ultraviolet radiation) and become hot, light-colored surfaces reflect solar energy and stay cooler. However, high emittance is also important. Emittance refers to the ability of heat to escape from a surface once it is absorbed. Surfaces with low emittance (usually shiny metallic surfaces) contribute to the transmission of heat into the roof components under the roof surface. The heat can increase the building’s air conditioning load resulting in increased air conditioning load and less comfort for the occupants. High-emitting roof surfaces give off absorbed heat relatively quickly through the path of least resistance- upward (and out of the building).

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The roofing products manufacturer must have its roofing product tested for solar reflectance and thermal emittance, and be labeled according to CRRC procedures. Figure 8-1 provides an example of an approved CRRC product label

	Solar Reflectance	<u>Initial</u> 0.00	<u>Weathered</u> Pending
	Thermal Emittance	0.00	Pending
	Rated Product ID Number	-----	
	Licensed Seller ID Number	-----	
Classification	Production Line		
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<small>Manufacturer of product stipulates that these ratings were determined in accordance with the applicable Cool Roof Rating Council procedures.</small>			

Example 8-17**Question**

I am considering doing a reroof on my home. When will I be required to put on a cool roof?

Answer

Cool roof requirements are triggered when either more than 50 percent of the roof area or more than 1,000 ft², whichever is less is replaced. If one of the exceptions below applies then cool roof requirements are not triggered:

Buildings with no ducts in the attic; or

If the building with a radiant barrier in the attic meeting the requirements of section 152(f)2 of the Title 24 standards Part 6; or

Buildings with at least R-30 ceiling insulation; or If in climate Zones 10, 11, 13, and 14, R-3 or greater roof deck insulation above vented attic; or

If existing ducts in the attic are insulated and sealed according to section 151(f)10 of the title 24 standards part 6; or

Insulation with a thermal resistance of at least 0.85hrft²°F/Btu or at least ¾ inch air-space is added to the rook deck over an attic; or

In climate zones, 10, 12, and 13, with 1ft² of free ventilation area of attic ventilation for every 150 ft² of attic floor area, and where at least 30 percent of the free ventilation area is within two feet vertical distance of the roof ridge; or

If the building can show compliance using performance approach.

Example 8-18**Question**

I am building a 450 ft² addition on my house; do I have to meet cool roof requirements in the prescriptive package?

Answer

Yes, if using prescriptive compliance the roof must meet the cool roof requirements of Package D for the type of roof slope and density. To avoid the cool roof requirements requirement you can use the performance approach and tradeoff against other energy efficiency features of the addition alone or the existing building use the existing + addition + alteration approach.

TABLE 151-B COMPONENT PACKAGE C

Climate Zone	1, 16	3	4	5	6	7	8, 9	10	2, 11-13	14	15
BUILDING ENVELOPE											
Insulation minimums ¹											
Ceiling	R49	R38	R38	R38	R38	R38	R38	R49	R49	R49	R49
Wood-frame walls	R29	R25	R25	R25	R21	R21	R21	R25	R29	R29	R29
“Heavy mass” walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
“Light mass” walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Below-grade walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Slab floor perimeter	R7	R7	R7	R7	R7	R7	R7	R7	R7	R7	R7
Raised floors	R30	R30	R30	R30	R21	R21	R21	R30	R30	R30	R21
Concrete raised floors	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radiant Barrier	NR	NR	REQ	NR	NR	NR	REQ	REQ	REQ	REQ	REQ
Roofing Products	See TABLE 151-C, COMPONENT PACKAGE D										
FENESTRATION											
Maximum U-factor ²	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Maximum Solar Heat Gain Coefficient (SHGC) ³	NR	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Maximum total area	14%	14%	14%	16%	14%	14%	14%	16%	16%	14%	16%
Maximum West facing area	NR	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%
THERMAL MASS⁴	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
SPACE-HEATING⁵											
Electric-resistant allowed	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
If gas, AFUE =	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
If heat pump, HSPF ⁶ =	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
SPACE-COOLING											
SEER =	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN
If split system, Refrigerant charge measurement or charge indicator display	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ
Central Forced Air Handler:	See TABLE 151-C, COMPONENT PACKAGE D										
DUCTS											
Duct sealing	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Duct Insulation	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8
WATER-HEATING	System shall meet Section 151(f)8 or Section 151(b)1 ⁷										

TABLE 151-C COMPONENT PACKAGE D

			Climate Zone																
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
Insulation minimums ¹	Ceilings		R38	R30	R30	R30	R30	R30	R30	R30	R30	R30	R38	R38	R38	R38	R38	R38	
	Walls	Wood-frame walls	R21	R13	R13	R13	R13	R13	R13	R13	R13	R13	R13	R19	R19	R19	R21	R21	R21
		Heavy mass walls	(R4.7 6)	(R2.4 4)	(R2.4 4)	(R2.4 4)	(R2.4 4)	(R2.4 4)	(R2.4 4)	(R2.4 4)	(R2.4 4)	(R2.4 4)	(R2.4 4)	(R4.7 6)	(R4.7 6)	(R4.7 6)	(R4.7 6)	(R4.7 6)	(R4.7 6)
		Light mass walls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Below-grade walls	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R0	R13
	Floors	Slab floor perim.	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	R7
		Raised floors	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19	R19
Concrete raised floors		R8	R8	R0	R0	R0	R0	R0	R0	R0	R0	R0	R8	R4	R8	R8	R4	R8	
Radiant Barrier			NR	REQ	NR	REQ	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR	
Roofing Products	Low-sloped	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.55	NR	0.55	NR	
		Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	NR	0.75	NR	
	Steep Sloped (less than 5 lb/ft ²)	Aged Solar Reflectance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.20	0.20	0.20	0.20	0.20	0.20	NR
		Thermal Emittance	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.75	0.75	0.75	0.75	0.75	0.75	NR
	Steep Sloped (5 lb/ft ² or more)	Aged Solar Reflectance	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
		Thermal Emittance	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Fenestration	Maximum U-factor ²		0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
	Maximum Solar Heat Gain Coefficient (SHGC) ³		NR	0.40	NR	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.35	NR	
	Maximum Total Area		20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Maximum West Facing Area		NR	5%	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	NR
THERMAL MASS ⁴			NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
SPACE-HEATING ^{5, 10}	Electric-resistant allowed		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	
	If gas, AFUE =		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	
	If heat pump, HSPF ⁶ =		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	
SPACE-COOLING	SEER =		MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	MIN	
	If split system, Refrigerant charge measurement or charge indicator display		NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR	
Central Forced Air Handlers	Cooling Airflow and Watt Draw		NR	NR	NR	NR	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	NR	
	Central Fan Integrated Ventilation System Watt Draw		REQ	REQ	REQ ²	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	
DUCTS	Duct sealing		REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	