California's Title 24 For Low-Slope Roofs

Building Energy Efficiency Standards

Updated March, 2020

(Supersedes March, 2017)

California's Title 24 for Low-Slope Roofs
Meeting the Code… Avoiding Hassles

About GAF
Founded in 1886, GAF has become North America's largest manufacturer of commercial and residential roofing. Our success in growing the company to nearly $3 billion in sales has been based on our unique philosophy of:

- Helping property owners & architects to make their best roofing choices
- Helping support distributors and roofing contractors build their businesses and avoid hassles

GAF is your best choice! For more information, visit www.gaf.com.

About Title 24
The California Energy Commission (CEC) was created in 1974 through the Warren-Alquist State Energy Resources Conservation and Development Act to construct and periodically modify energy efficiency standards for residential and non-residential buildings. In 1978, all building codes and standards were combined under one umbrella called Title 24 Building Standards Code and Part 6 of this standard code has the requirements for energy efficiency while Part 1 has the administrative requirements. For more information or to download a copy of Title 24, visit www.energy.ca.gov/title24/

Why Title 24 Now?
- California has over 35 million people and from 1960 to 1974 when the CEC was created, they saw their energy consumption rise over 50% per capita, which means that not only as their population was increasing, the amount of energy each person was using was also increasing dramatically.
- California's building efficiency standards (along with those for energy efficient appliances) have saved more than $56 billion in electricity and natural gas costs since 1978.
- The CEC's forecast data shows that 1/3 of the energy (natural gas and electricity) consumed in California is consumed by buildings.
- Strengthening the requirements of Title 24 has been a very key element in the state's climate change initiative.

Why Cool Roofs?
- Roof surface temperatures and attic temperatures can be reduced significantly.
- By lowering attic temperatures, air conditioning costs can be reduced by as much as 10-15% according to the Department of Energy's ENERGY STAR program.
- Reductions in air conditioning use help to reduce the "peak energy demand" on the power grid, reducing the need for new power plant construction.
- Cool roofs can reduce the effects of "Urban Heat Islands", where data shows that urban areas have higher ambient temperatures than surrounding rural areas because of their concentration of dark surfaces and the sparseness of vegetation (dark surfaces can be up to 70F hotter on a warm summer day than reflective, "cool" surfaces).

Do All Roofs Have "Cool Roof" Requirements in Title 24?

No. While Title 24 applies to all residential and non-residential buildings in the state, the specific requirements for roofs are dependent on geographic location, building use (residential, non-residential), type of construction (new construction, addition, or re-roofing), building type (low rise/high rise, low slope/high slope), etc. As this manual outlines, there are many instances where a "cool" roof is not required, and the CEC has been diligent in their requirements for "cool roofing" where it makes sense for property owners in the state.

When Did the 2019 Version of Title 24 Go Into Effect?

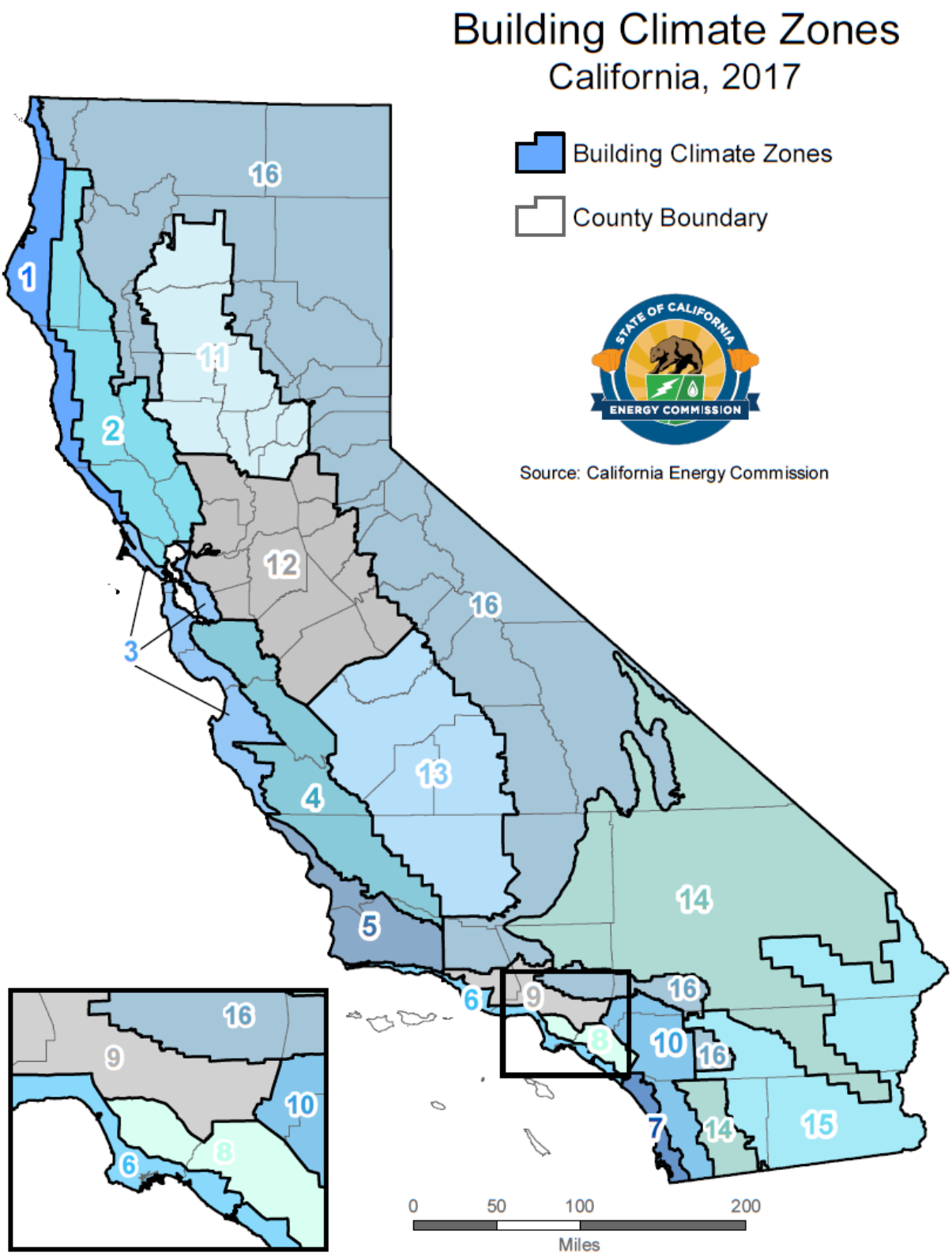
California's Building Energy Efficiency Standards are updated on an approximately three-year cycle. The 2019 Standards improves upon the 2016 Standards for new construction of, and additions and alterations to, residential and nonresidential buildings. The 2019 Standards went into effect on January 1, 2020.

Glossary of Cool Roofing Terms

Term	Explanation
CRRC	**Cool Roof Rating Council** The CRRC does not set requirements for solar reflectance (reflectivity) or thermal emittance; instead, they set the requirements for how to measure these properties and how to label products that have been measured. They also provide independent certification of a product's reflectance and emittance.
ENERGY STAR	ENERGY STAR is a joint federal program of the U.S. Environmental Protection Agency and the U.S. Department of Energy that provides choices for energy efficient products and practices. Note: The ENERGY STAR certified roof products program will be sunsetted on June 1, 2022.
Low Slope	Slopes up to and including 2:12
Solar Reflectance	The part of solar energy that is reflected by a surface, expressed as a percentage, e.g. a material with a 0.25 solar reflectance reflects 25% of solar energy. In Title 24, the term "aged reflectance" is used and refers to the reflectance of a material after 3 years of aging in the field.
SRI	**Solar Reflectance Index** SRI combines reflectivity and emittance to measure a roof's overall ability to reject solar heat. The calculation of this index is defined by ASTM E 1980-01 and is based on a mathematical formula that includes values for solar absorptance, solar flux, thermal emissivity, and various other coefficients. Title 24 provides SRI alternatives to the solar reflectance and thermal emittance requirements.
Steep Slope	Slopes greater than 2:12
Thermal Emittance	The relative ability of a material to release absorbed heat gained from solar energy.

California's 16 Climate Zones

California has very distinct and differing climates which have been broken into 16 different "climate zones". These zones recognize that different climates have different energy demands and costs. The following map shows the 16 climate zones for the state:



Complying With Title 24

There are 3 different ways to comply with the requirements for energy efficiency in Title 24

Prescriptive Approach

This is the simplest approach to meeting the requirements of Title 24, particularly for re-roofing because it defaults to installing a "cool roof" or other options (for re-roofing only). When the "cool roof" is installed, the prescribed requirements are met.

Overall Envelope Approach

This approach allows non-cool roofing to be installed if enough attic insulation is installed. While this trade-off makes sense, it must be accompanied by documentation that the amount of insulation used was adequate and meets the energy performance requirements for the building.

Performance Approach

The approach to meeting Title 24 requires detailed calculations using CEC software where the energy efficiency of the entire building is calculated and compared to a prescribed energy "budget". Using this method allows for trade-offs between different building envelope components and provides flexibility for designers; however, it is very difficult to comply with the standard when only making alterations to an existing building. Typically, an energy consultant is used when this approach is taken for compliance.

Understanding How Title 24 Classifies Buildings

In addition to knowing where the building is located so you can know what is required, you need to know how Title 24 classifies "buildings".

"Low Rise Residential"… describes:

- All single family homes of any number of stories
- All duplexes of any number of stories
- All multi-family buildings up to 3 stories in height
- Garden apartments and other housing types up to 3 stories in height

"Nonresidential"… describes:

- Offices, retail and wholesale stores
- Grocery stores, restaurants, theaters
- Hotels and motels
- Industrial work buildings
- Commercial or industrial storage units
- Schools and churches
- Apartment and multi-family buildings with four or more stories
- Long-term care facilities
- Dormitories
- Private garages, carports, sheds and agricultural buildings

"High Rise Residential"… describes:

- All multi-family residential buildings with 4 or more habitable stories
- Garden apartments and other housing types with 4 or more habitable stories

For more information on building classifications, please refer to the actual Title 24, Part 6 standard.

Minimum Performance Requirements for Liquid Applied Roof Coatings on Low-Sloped Roofs

Table 110.8-C

Physical Property	ASTM Test Procedure	Requirement
Initial percent elongation (break)	D2370	Minimum 200% 73ºF (23ºC)
Initial percent elongation (break) OR Initial Flexibility	D2370 D522, Test B	Minimum 60% 0ºF (-18ºC) Minimum pass 1" mandrel 0ºF (-18ºC)
Initial tensile strength (max stress)	D2370	Minimum 100 psi (1.38 Mpa) 73ºF (23ºC)
Initial tensile strength (max stress) OR Initial Flexibility	D2370 D522, Test B	Minimum 200 psi (2.76 Mpa) 0ºF (-18ºC) Minimum pass 1" mandrel 0ºF (-18ºC)
Final percent elongation (break) after accelerated weathering 1000 h	D2370	Minimum 100% 73ºF (23ºC)
Final percent elongation (break) after accelerated weathering 1000 h OR Flexibility after accelerated weathering 1000 h	D2370	Minimum 40% 0ºF (-18ºC) Minimum pass 1" mandrel 0ºF (-18ºC)
Permeance	D1653	Maximum 50 perms
Accelerated weathering 1000 h	D4798	No cracking or checking*
*Any cracking or checking visible to the eye fails the test procedure		

Liquid applied roof coatings applied to low-sloped roofs in the field as the top surface of a roof covering shall:

A. Be applied across the entire roof surface to meet the dry mil thickness or coverage recommended by the coating manufacturer[1], taking into consideration the substrate the substrate is applied, and

B. Meet the minimum performance requirements listed above or the minimum performance requirements of ASTM C836, D3468, D6083, or D6694, whichever are appropriate to the coating material.

Note: *Qualifying coatings include elastomeric coatings and white acrylic coatings*

EXCEPTION 1: Aluminum-pigmented asphalt roof coatings shall meet the requirements of ASTM D2824 or ASTM D6848 and be installed as specified by ASTM D3805.

EXCEPTION 2: Cement-based roof coatings shall contain a minimum of 20 percent cement and shall meet requirements of ASTM C1583, ASTM D822, and ASTM D5870.

Note: *Requirements do not apply to industrial coatings that are factory-applied, such as metal roof panels.*

[1]GAF recommends a minimum of 20 mil DFT per ASTM D6083 for United Coatings systems and 40 mil DFT for HydroStop® systems. If a coating is applied to an existing GAF NDL roof with the intent of satisfying the requirements of Title 24, GAF's guarantee does not cover the coating, which remains a maintenance item that may need periodic review and re-application.

Mandatory Requirements[1] for Solar Ready Buildings

High-rise Multi-family Buildings, Hotel/Motel Occupancies, and Nonresidential Buildings shall comply with the requirements of Section 110.10(a) through 110.10(d).

(b). Solar Zone.

1. Minimum Area. The solar zone shall be located on the roof or overhang of the building or on the roof or overhang of another structure located within 250 feet (75 meters) of the building or on covered parking installed with the building project and have a total area no less than 15 percent of the total roof area of the building excluding any skylight area.

EXCEPTION 1: Buildings with a permanently installed solar electric system having a nameplate direct current (DC) power rating, measured under Standard Test Conditions, of no less than one watt per square foot of roof area.

EXCEPTION 2: Buildings with a permanently installed domestic solar water heating system complying with Section 150.1(c)8Ciii.

EXCEPTION 3: Buildings with designated solar zone area that is no less than 50 percent of the potential solar zone area. The potential solar zone area is the total area of any low-sloped roofs where the annual solar access is 70 percent or greater and any steep-sloped roofs oriented between 90 degrees and 300 degrees of true north where the annual solar access is equal or greater than 70 percent. Solar access is the ratio of solar insolation including shade to the solar insolation without shade. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of annual solar access.

EXCEPTION 4: Multi-family buildings meeting the following conditions: The solar zone, interconnection pathway, and documentation requirements do not apply when compliant thermostats and other energy efficiency features are installed during construction. Refer to Section 110.10(b)1 Exception 4 for further requirements.

EXCEPTION 5: Buildings where the roof is designed and approved to be used for vehicular traffic or parking, or for a heliport.

2. Orientation. All sections of the solar zone located on steep-sloped roofs shall be oriented between 110 degrees and 270 degrees of true north.

3. Shading.

A. No obstructions, including but not limited to, vents, chimneys, architectural features, and roof mounted equipment, shall be located in the same solar zone.

B. Any obstruction, located on the roof or any other part of the building that projects above the solar zone shall be located at least twice the distance, measure in the horizontal plane, of the height difference between the highest point of the obstruction and the horizontal projection of the nearest point of the solar zone, measured in the vertical plane.

EXCEPTION 1: Any obstruction located on the roof or any other part of the building that is oriented north of all points of the solar zone.

4. Structural Design Loads[2] on Construction Documents.

a. For areas of the roof designated as solar zone, the structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents.

Notes:

1. *For further Solar Ready Building requirements, refer to Section 110.10(C) through 110.10(d).*
2. *Section 110.10(b)4 does not require the inclusion of any collateral load for future solar energy systems.*

Insulation Requirements for Roof Alterations

Table 141.0-C

	Nonresidential		High-rise Residential and Guest Rooms of Hotel/Motel Buildings	
Climate Zone	**Continuous Insulation R- value**	**U-factor**	**Continuous Insulation R- value**	**U-factor**
1	**R-8**	**0.082**	**R-14**	**0.055**
2	**R-14**	**0.055**	**R-14**	**0.055**
3-9	**R-8**	**0.082**	**R-14**	**0.055**
10-16	**R-14**	**0.055**	**R-14**	**0.055**

EXCEPTION 1: The existing roof is insulated with at least R-7 insulation.
EXCEPTION 2: If mechanical equipment is located on the roof and it will not be disconnected and lifted as part of the roof replacement, insulation added may be limited to the maximum insulation thickness that will allow a height of 8 inches (203 mm) from the roof membrane surface to the top of the base flashing.
EXCEPTION 3: If adding the required insulation will reduce the base flashing height to less than 8 inches (203 mm) at penthouse or parapet walls, the insulation added may be limited to the maximum insulation thickness that will allow a height of 8 inches (203 mm) from the roof membrane surface to the top of the base flashing. These conditions must be met:

A. The penthouse or parapet walls are finished with an exterior cladding material other than the roof covering membrane material; and
B. The penthouse or parapet walls have exterior cladding that must be removed to install the new roof covering membrane to maintain the flashing height of 8 inches (203 mm); and
C. For nonresidential buildings, the ratio of the replaced roof area to the linear dimension of the affected penthouse or parapet walls shall be less than 25 square feet per linear foot for Climate Zones 2 and 10 through 16, and less the 100 square feet per linear foot for Climate Zones 1 and 3 through 9.
D. For high-rise residential buildings, hotels or motels, the ratio of the replaced roof area to the linear dimension of affected penthouse or parapet walls shall be less than 25 square feet per linear foot for all Climate Zones.
E. Tapered insulation may be used which has a thermal resistance less than that prescribed in the Table 141.0-C at the drains and other low points, provided that the thickness of insulation is increased at the high points of the roof so that the average thermal resistance equals or exceeds the value that is specified in Table 141.0-C.

Prescriptive Envelope Requirements

Nonresidential (including relocatable public schools)

Type of Construction	Climate Zones	Minimum Requirements
New Construction	**1-16** **(See map on page 3)**	**Install Cool Roofing:** **1. Aged Reflectance: ≥0.63** **Thermal Emittance: ≥0.75** **Or** **2. Aged SRI ≥75**
Re-roofing*	**1-16** **(See map on page 3)**	**Install Cool Roofing:** **1. Aged Reflectance: ≥0.63** **Thermal Emittance: ≥0.75** **Or** **2. Aged SRI ≥75**

**Re-roofing requirements must be met when more than 50% of the roof is recovered or replaced or the roof area is greater than 20 squares (2,000 sq.ft.)*

EXCEPTION 1: Roof area covered by building-integrated photovoltaic panels and building-integrated solar thermal panels is not required to meet cool roof requirements.
EXCEPTION 2: Roof constructions that have thermal mass over the roof membrane with a weight of at least 25 lb/ft^2 are exempt from the requirements.
EXCEPTION 3: Wood framed roof assemblies in climate zones 3 and 5 are exempt if the roof assembly has a U-factor of .034 or lower.

When an aged solar reflectance less than 0.63, roof/ceiling insulation tradeoffs are available. By increasing the insulation level of a roof, a roofing product with a lower reflectance than the prescriptive requirements can be used to meet the cool roof requirements. The appropriate U-factor can be determined from Table 3-5 for nonresidential buildings based on roof type, climate zone and aged reflectance of at least 0.25.

Note: *1. Air barriers requirements apply to nonresidential buildings, but not relocatable public school buildings and cannot be traded off in the performance approach.*
*2. There are **no** alternatives to using a cool roofing product for re-roofing.*

Prescriptive Envelope Requirements

High-Rise Residential & Hotels/Motels Buildings

Type of Construction	Climate Zones	Minimum Requirements
New Construction	**9-11 & 13-15** **(See map on page 3)**	**Install Cool Roofing:** **1. Aged Reflectance: ≥0.55** **Thermal Emittance: ≥0.75** **Or** **2. Aged SRI ≥64**
Re-roofing*	**9-11 & 13-15** **(See map on page 3)**	**Install Cool Roofing:** **1. Aged Reflectance: ≥0.55** **Thermal Emittance: ≥0.75** **Or** **2. Aged SRI ≥64**

** Re-roofing requirements must be met when more than 50% of the roof is recovered or replaced or the roof area is greater than 20 squares (2,000 sq.ft.)*

EXCEPTION 1: Roof area covered by building-integrated photovoltaic panels and building-integrated solar thermal panels is not required to meet cool roof requirements.
EXCEPTION 2: Roof constructions that have thermal mass over the roof membrane with a weight of at least 25 lb/ft^2 are exempt from the requirements.
EXCEPTION 3: Wood framed roof assemblies in climate zones 3 and 5 are exempt if the roof assembly has a U-factor of .034 or lower.

When an aged solar reflectance less than 0.63, roof/ceiling insulation tradeoffs are available. By increasing the insulation level of a roof, a roofing product with a lower reflectance than the prescriptive requirements can be used to meet the cool roof requirements. The appropriate U-factor can be determined from Table 3-5 for nonresidential buildings based on roof type, climate zone and aged reflectance of at least 0.25.

Note: *1. There are **no** alternatives to using a cool roofing product for re-roofing.*

Prescriptive Envelope Requirements

Low-Rise Residential (typical single family home)

Type of Construction	Climate Zones	Minimum Requirements
New Construction	**13 & 15** **(See map on page 3)**	**Install Cool Roofing:** **1. Aged Reflectance: ≥0.63** **Thermal Emittance: ≥0.75** **Or** **2. Aged SRI ≥75**
Re-roofing*	**13 &15** **(See map on page 3)**	**Install Cool Roofing (or see alternatives below):** **1. Aged Reflectance: ≥0.63** **Thermal Emittance: ≥0.75** **Or** **2. Aged SRI ≥0.75**

** Re-roofing requirements must be met when more than 50% of the roof is recovered or replaced or the roof area is greater than 10 squares (1,000 sq.ft.)*

EXCEPTION 1: Roof area with building-integrated photovoltaic panels or building-integrated solar thermal panels.
EXCEPTION 2: Roof constructions that have a weight of at least 25 lb/ft².

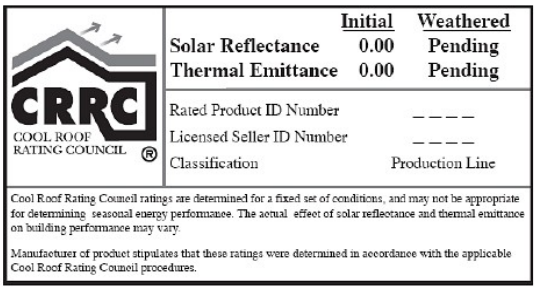
There is the performance approach where the prescriptive cool roof requirements can be traded off. For more on the performance approach, see Section 3.6 and Chapter 8 in Residential Compliance Manual of the 2019 Building Energy Efficiency Standards.

GAF Eligible Products

Product	Aged Reflectivity (≥0.63)	Initial Emissivity (≥0.75)	Aged SRI* (Title 24) (≥75)
Single-Ply Membranes			
EverGuard® TPO FB Ultra (white)	0.68	0.90	**83**
EverGuard® TPO (white)	0.68	0.90	**83**
EverGuard® Freedom™ TPO (white)	0.68	0.90	**83**
EverGuard® Energy Tan TPO	0.66	0.89	**80**
EverGuard® Energy Gray TPO	0.67	0.87	**81**
EverGuard Extreme® TPO (white)	0.72	0.84	**87**
EverGuard Extreme® TPO FB Ultra (white)	0.72	0.84	**87**
EverGuard® PVC Smooth (white)	0.76	0.87	**94**
EverGuard® PVC (white)	0.81	0.88	**101**
EverGuard® PVC Fleeceback (white)	0.81	0.88	**101**
EverGuard® PVC KEE	0.82	0.88	**103**
EverGuard® PVC KEE Fleeceback	0.82	0.88	**103**
Modified Bitumen Membranes			
Ruberoid® EnergyCap™ Torch Plus Granule FR	0.64	0.90	77
Coatings			
Topcoat® Membrane (white)	0.69	0.90	**84**
United Coatings™ Diathon® Roof Coating (white)	0.71	0.92	**88**
United Coatings™ Roof Mate™ Top Coat (white)	0.71	0.92	**88**
United Coatings™ Unisil II Silicone Roof Coating (white)	0.73	0.90	**90**
United Coatings™ Unisil HS II Silicone Roof Coating (white)	0.73	0.90	**90**
United Coatings™ Roof Mate™ TCM Coating (white)	0.69	0.90	**84**
HydroStop® PremiumCoat® Finish Coat (white)	0.73	0.90	**90**
HydroStop® PremiumCoat® Finish Coat (cotton)	0.67	0.90	**82**

*Aged SRI is based on Aged Reflectivity and Initial Emissivity per Title 24 requirements

Common Questions & Answers…To Avoid Hassles

Question	Avoiding Hassles
Are there labeling requirements to meet Title 24?	• **Yes! If you are going to meet the prescriptive requirements and use a cool roofing product,** it must not only meet the requirements of Title 24, but **it must have a CRRC label** that shows its solar reflectance and emittance.  CRRC COOL ROOF RATING COUNCIL Initial / Weathered Solar Reflectance 0.00 Pending Thermal Emittance 0.00 Pending Rated Product ID Number ____ Licensed Seller ID Number ____ Classification Production Line 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. Manufacturer of product stipulates that these ratings were determined in accordance with the applicable Cool Roof Rating Council procedures.
We've heard a lot about tax credits/exemptions… does installing cool roofing that meets Title 24 qualify for a tax credit?	• **Not necessarily!** A tax deduction is available to owners or designers of commercial buildings that save at least 50% of the heating and cooling energy as compared to ASHRAE Standard 90.1-2007 (or 90.1-2001 for buildings or systems placed in service before January 1, 2018). The deduction is available for buildings placed in service after December 31, 2017 through December 31, 2020. • **For further information click here.**
If a product has an Energy Star rating mark, can it be used in California?	• ***Maybe…*** but if you have to use "cool roofing" to meet Title 24, then the product you use **must also have a CRRC label**.
If the CRRC label only has "as manufactured" values, can it be used under Title 24?	• **Yes!** Because Title 24 allows for a "calculation" of the 3 year aged value.
If a zone is not listed in the Prescriptive Requirements Tables, what do I have to do?	• **You do NOT have to use a cool roofing product to be in compliance with Title 24.** If a zone is not listed, there is not a requirement for cool roofing in that geographic area.

Question	Avoiding Hassles
Who will enforce Title 24? Is there a permitting process?	• **Enforcement to the Energy Efficiency Standards rests with your local building code official(s)…** typically a city or county building code department. If you are in an area that will require "cool roofing", you should contact the building code office in your city or county (whichever is applicable) and make sure that you understand what will be required to pull a building permit. California law requires building permits for both new construction and alterations and renovations, and your local office may adopt a "Certificate of Compliance" that will be used to verify compliance to Title 24.

Want to Learn More?

GAF Technical Support Services… can provide detail and answer questions on project specific conditions.

Contact Telephone… 1-800-766-3411.

For more information… about GAF's commitment to sustainability and our full line of energy saving products, click here.

Helpful Links…

www.gaf.com	**GAF**
www.energy.ca.gov/title24/	**California's Title 24 Home Page**
Title24@energy.ca.gov	**California's Title 24 E-mail Hotline**
www.coolroofs.org	**Cool Roof Rating Council's Home Page**
http://gaf.ecoscorecard.com	**GAF's ecoScorecard**
www.coolroofs.org	**Cool Roof Rating Council (CRRC)**
www.DSIREusa.org	**State Incentives for Renewables & Efficiency**
http://cool.gaf.com	**Cool Roof Energy Savings Tool (CREST)**