Cool Roof Requirements

California's Title 24 Energy Efficiency Standards for Nonresidential Buildings (2005)

Roofing Contractor Training

Cool Roof Training Collaborative

California Energy Commission, California Roofing Contractors, California Building Officials (CALBO), Pacific Gas & Electric Co., Southern California Edison, and Sempra Utilities

Brief Background - Title 24, Part 6
(California Building Energy Efficiency Standards)

- California energy standards began 1978
- Updated every 3 years
- Standards address:
  - Building Envelope: Insulation, windows, roofing
  - Lighting: Electric lighting allowances
  - HVAC: Equipment standards, duct leakage, etc.
- First **cool roofing** regulations took effect on October 1, 2005; amended for roof coatings September 11, 2006

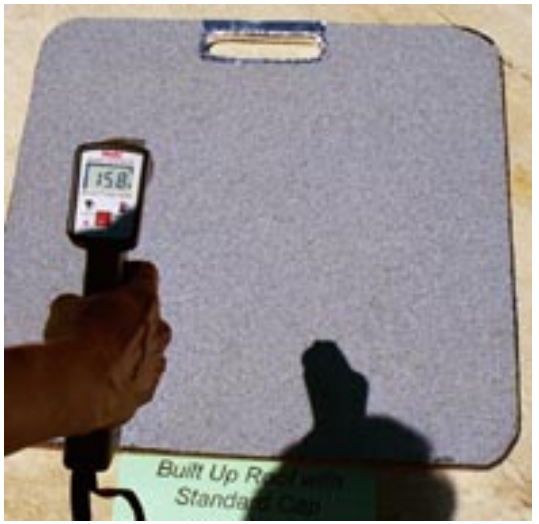
How Cool is a Cool Roof? (Part 1)

Sacramento, Noonish, July 12, 2000, 89ºF

EPDM single-ply
Surface 173°F

BUR topped with aggregate
159°F

BUR topped with capsheet
158 °F



Courtesy Dan Varvais

How Cool is a Cool Roof? (Part 2)

Sacramento, Noonish, July 12, 2000, 89ºF

Cool single-ply

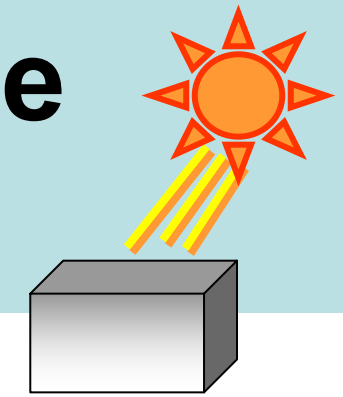
121°F

Cool coating over BUR

108°F

Courtesy Dan Varvais

Why Does Roof Surface Temperature Matter?



- Hotter roof drives heat into the building, increasing need for air conditioning
- Air conditioning is electricity-intensive
- Demand for electricity - -
  - stresses the statewide electric power grid (**possible power outages**)
  - costs building owners money

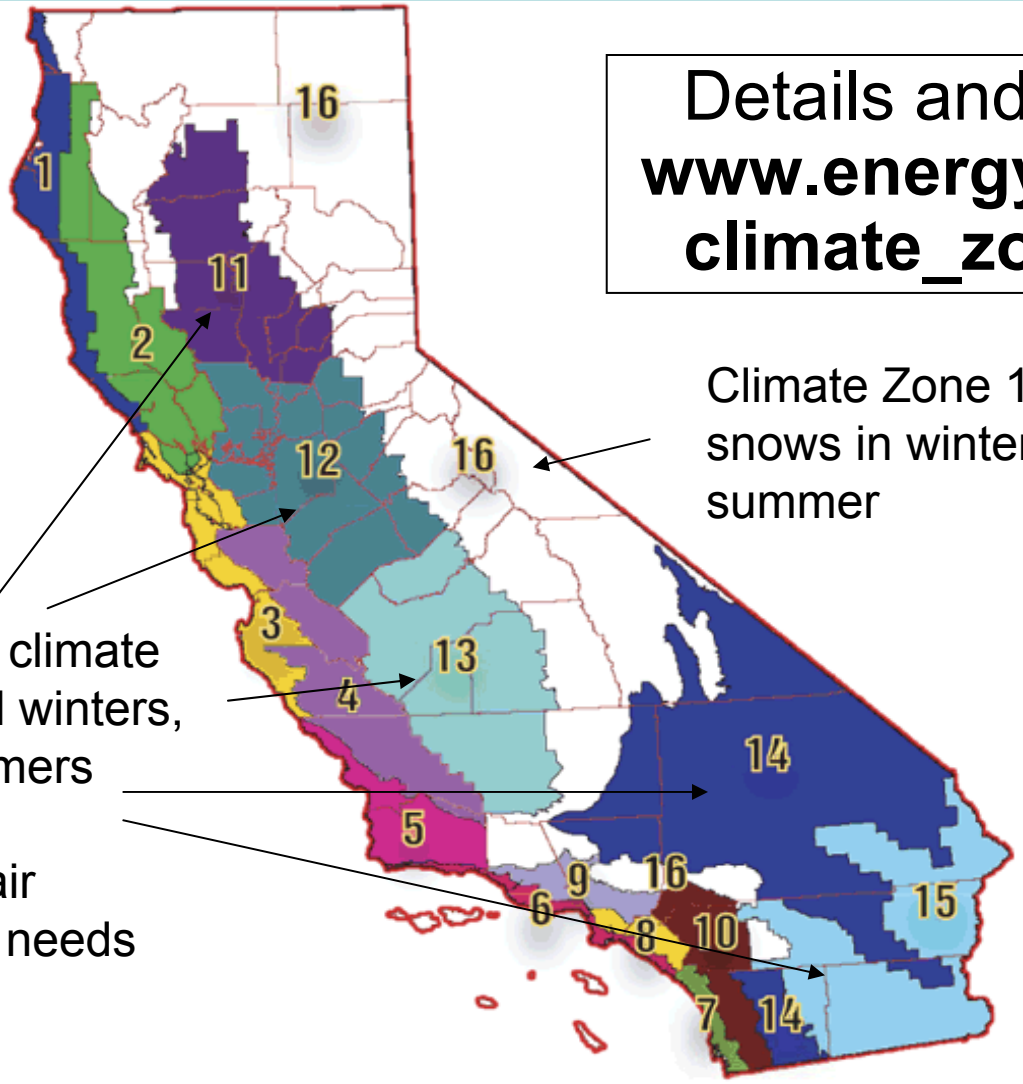
How Does Title 24 Energy Code Work?

Sets an energy budget for **NEW** buildings **AND** additions & alterations (includes **re-roofing**)

- Budget is in units of energy **NOT $$**: kBtu per square foot per year
- Budget varies by climate zone (16 climate zones in California)

California's 16 Climate Zones

Climate Zone 1, coastal, foggy, cool



Details and list of cities at **www.energy.ca.gov/maps/climate_zone_map.html**

Climate Zone 16 – mountains, snows in winter, less than 80°F in summer

Many inland climate zones – mild winters, hot dry summers (population increasing, air conditioning needs increasing)

Cool Roof Regulations Apply to <u>ALL</u> Climate Zones

How Does Title 24 Energy Code Work?
Meeting the Energy Budget

- Design the building or addition/alteration with appropriate energy efficiency features
- Submit documentation to building department with permit application
- Construct the building/addition/alteration with those features

Building Inspectors are the enforcers for Title 24 energy measures (not a perfect system, yet)

How Does Title 24 Energy Code Work? (cont'd)

For NEW construction, builders must show energy compliance by either - -

- Following Title 24 *prescriptive* requirements for building envelope, lighting & HVAC (our list of minimum requirements)

or

- Running computer simulation showing that building *performance* exceeds that of an identical building with the prescriptive measures – more flexible

How Does Title 24 Energy Code Work? (cont'd)

For reroofing, contractors must show energy compliance by either - -

- Following Title 24 *prescriptive* requirements for cool roofs

or

- Installing noncool roof plus roof insulation

Construction Team Roles

Team Member	Role
Owner	**P**rovide code-compliant building (even if permit is not required.)
Owner's Architect or Construction Manager	**P**roject coordination including building permits
Permitting Agency	**A**ssurance that all plans comply with the California Code of Regulations
Energy Consultant	**H**andle all Title 24 calculations and documentation
Roofing Products Manufacturers	**If providing a product to meet Title 24 standards, test with supervisory entity (CRRC) and affix CRRC label**
Roofing Contractor	**Comply with Title 24 standards. If permit is required, furnish documentation to Building Department**

California building standards are regulations required by law – permit or not.

What Are the Cool Roof Regulations? (part 1)

- **Cool roofs are <u>NOT</u> mandatory**
  - They are a part of the list or "prescription" of minimum levels of energy efficiency
  - These prescriptive energy measures help set the building's energy budget

What Are the Cool Roof Regulations? (part 2)

- **Cool roofs are NOT mandatory**

  Which means....

If you don't put on a cool roof, you must find energy savings elsewhere to meet the energy budget

- **When reroofing, this means**
  - **install a fully compliant cool roof OR**
  - **install a non-cool roof & roof insulation**
    - **ARMA has developed a calculator to determine insulation R-value needed (later in this presentation)**

What Are the Cool Roof Regulations? (part 3) – Building Types

- Current (2005) cool roof regulations apply when all of the following occur:
  - Nonresidential building
  - Conditioned building (air conditioned or heated or both)
  - Roofing is low slope (≤ 2:12)
- There are some exemptions:
  - Type "I" Occupancies: Health care facilities, prisons
  - Federal Buildings
- See California Energy Commission's "Blueprint" #83 for details – your handout or on Internet www.energy.ca.gov/efficiency/blueprint

Where Are Cool Roofs Optional?

- **Cool Roofs Are <u>Optional</u> (NOT prescriptive, NOT mandatory) for:**
  - Hotels and motels
  - ALL residential buildings (including high-rise apartments/condos)
  - Unconditioned buildings (see examples of partially conditioned or heated on later slide)
  - Refrigerated warehouses, other spaces held under 55°F, and spaces held over 90°F
  - Buildings cooled by evaporative coolers/swamp coolers and not heated
  - Roofs with slopes over 2:12

What Criteria Do the Energy Standards Set for Cool Roofs?

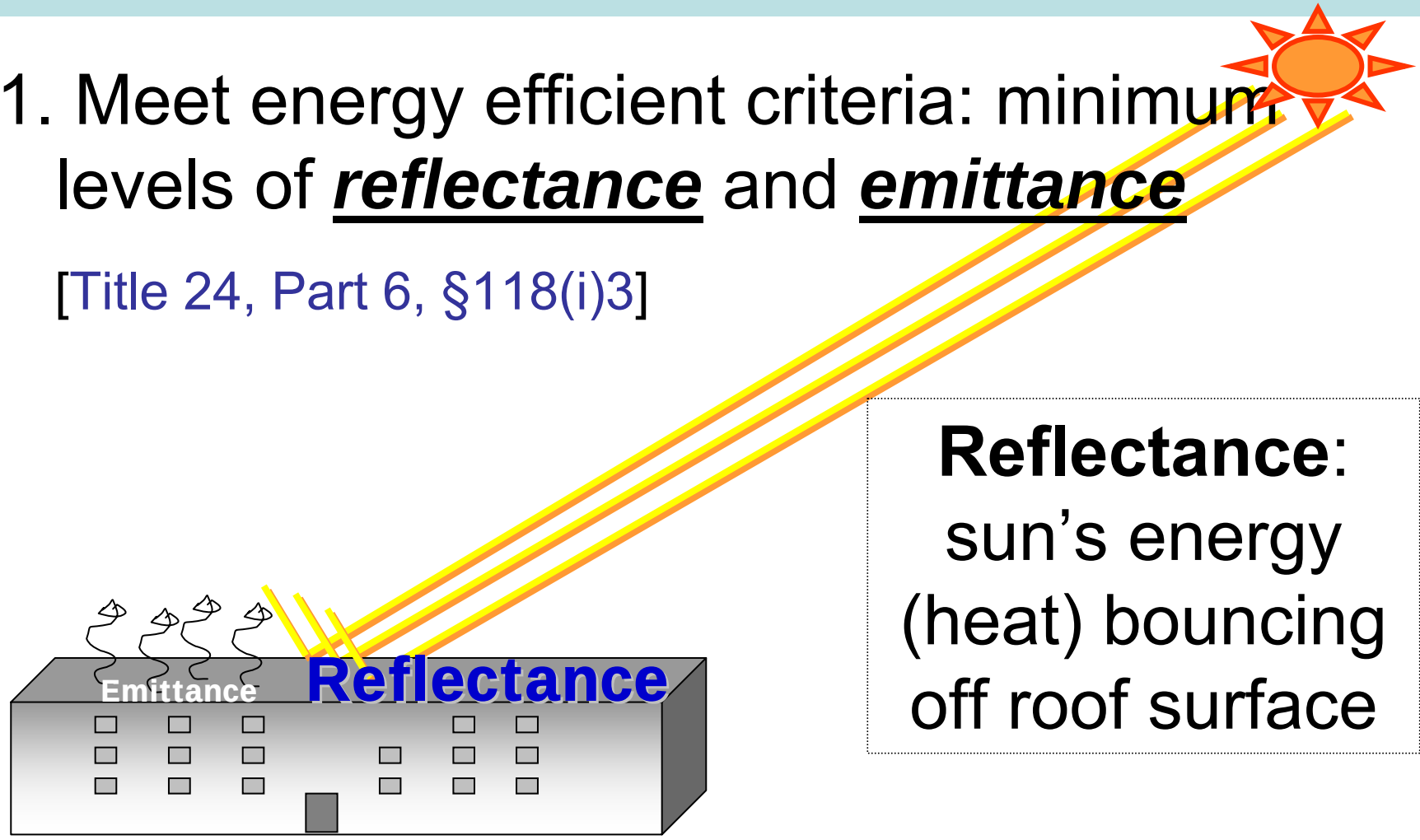
Roof materials must - -

1. Meet criteria for minimum levels of **reflectance and emittance**
2. Be **tested & rated** through an objective third party, the Cool Roof Rating Council (CRRC)
3. Be properly **labeled**
4. **Coatings liquid-applied** in the field must meet ASTM test requirements and be of proper coverage/dry mil thickness

Criteria 1: Reflectance & Emittance

1. Meet energy efficient criteria: minimum levels of ***reflectance*** and ***emittance***

   [Title 24, Part 6, §118(i)3]

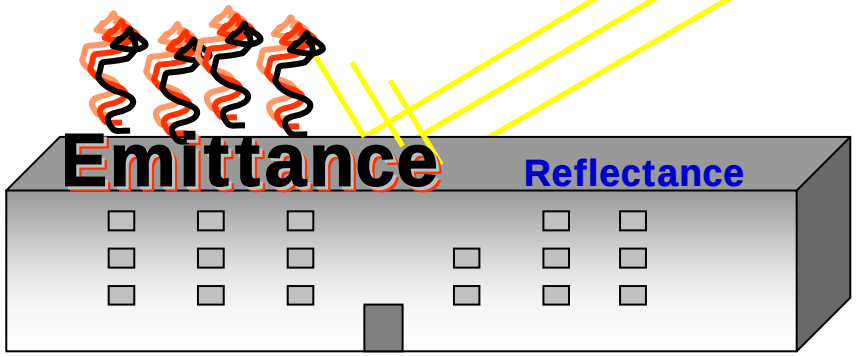


Reflectance: sun's energy (heat) bouncing off roof surface

Graphic provided courtesy of Johns Manville

What Is Emittance?

- Not ***ALL*** of sun's energy striking roof, bounces off; some is absorbed.
- Absorbed energy is given off – emitted – at different rates by different materials.
- "**Emittance"** is a measure of how quickly or efficiently the absorbed energy is given off.



Graphic provided courtesy of Johns Manville

Important: because heat emitted slowly has time to penetrate downward into the building; it is undesirable in most CA climate zones; it increases air conditioning

Prescriptive Requirements for Reflectance and Emittance

- Initial Reflectance at least 0.70
- Initial Emittance at least 0.75
- *Roof materials with values less than these can be used to meet the energy budget **but** –*
  - *you must find energy savings equivalence via insulation or other measures*

Examples of Reflectance and Emittance

White coating over BUR

Reflectance: .70 to .91

Emittance: .85 to .92

Black single-ply

Reflectance: .06 to .12

Emittance: .82 to .87

More Examples of Reflectance and Emittance

Aluminum Coatings

- Reflectance: .61 to .74
- Emittance: **.33 to .50**

Metals (metal coatings and uncoated metal roofs) are LOW emitters

Criteria 2: Third Party Rating of Roof Materials

- Materials are rated for reflectance and emittance through Cool Roof Rating Council Rated Products Directory, **www.coolroofs.org**

- Aged data (three-year data) are ignored for now. Reflectance degradation is assumed, with no washing of roofs.

Excerpt from CRRC Rated Product Directory (www.coolroofs.org)

- **CRRC Rated Products Directory is updated at least monthly**

TAKE NOTE!

- Not all CRRC-rated materials comply with the Title 24 prescriptive requirements
- You can use CRRC-rated materials that don't meet the prescriptive requirements, *but you must reach energy savings equivalence using insulation or other measures*
- Energy Star products **do not automatically** qualify. Use the CRRC Rated Products Directory.

Criteria 3: Product Must Be Labeled

Manufacturer obtains labeling rights only <u>through license agreement w/CRRC.</u> SAMPLE LABEL:

CRRC
COOL ROOF
RATING COUNCIL ®

	Initial	Weathered
Solar Reflectance	0.82	Pending
Thermal Emittance	0.89	Pending

Rated Product ID Number	XXXXX
Licensed Seller ID Number	XXXXX
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.

Criteria 4: Liquid Coatings (2006 Changes)

New requirements effective Sept. 11, 2006:

- Apply all coatings at thickness or coverage recommended by manufacturer for each surface type
- Meet Table 118-C or ASTM C836, D3468, D6083, and/or D6694 as appropriate
- Cement-based coatings to meet ASTM D822 AND C1583 and D5870
- Adds ASTM D522, Test B, to Table 118-C as alternative to elongation & tensile testing at 0°F

Specifics for Nonresidential Reroofing

- Prescriptive (not mandatory)
- If >50% or >2,000 sf of low-sloped roof, whichever is less, is being replaced, recovered, or recoated, cool roof regulations kick in [§ 149(b)1B] (***SEE next slide)***
  - **Install a cool roof that meets prescriptive OR**
  - **Install a roof that does not meet prescriptive plus install roof insulation**
    - ❖ This is how a garden roof or BIPV* roof can be installed when re-roofing

*BIPV = Building-integrated photovoltaics (solar electric pv modules become the roof)

Reroofing Example 1 - 50% or 2,000 Square Feet (Whichever Is Less)

Example 1

- **Total Roof Area = 44 sqs.**
- **Reroofing 21 squares**.

This is less than 50% but more than 2,000 sq.ft., so **cool roof requirements apply.**

Reroofing Example 2 - 50% or 2,000 Square Feet (Whichever Is Less)

Example 2

- **Total Roof Area = 37 sqs.**
- **Reroofing 19 sqs.**

This is less than 2,000 sf but over 50%, so **cool roof requirements apply.**

Reroofing Example 3 - 50% or 2,000 Square Feet (Whichever Is Less)

Example 3

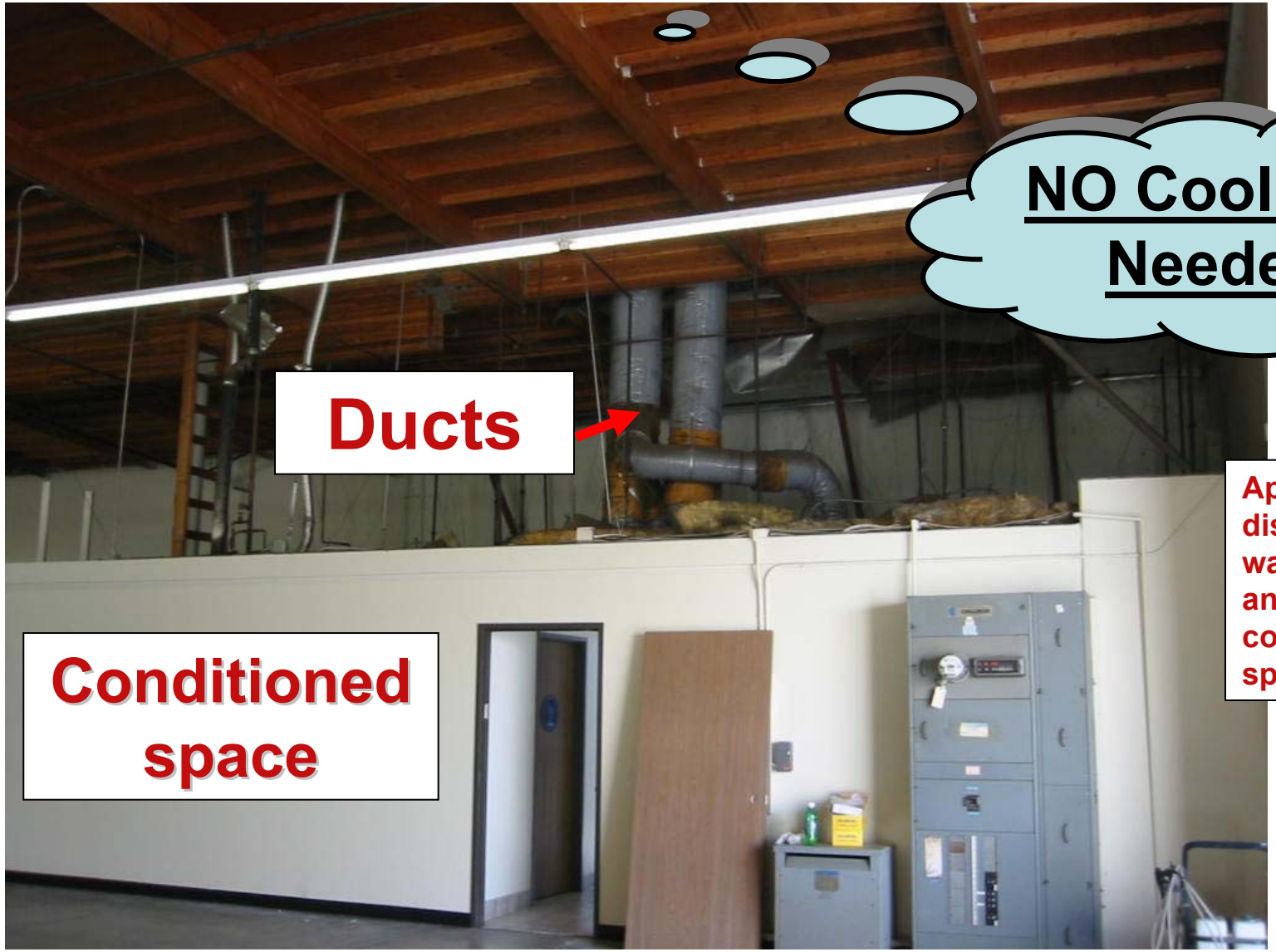
- **Total Roof Area = 33 sqs.**
- **Reroofing 16 sqs.**

Reroofing less than 50% and less than 20 squares, so cool roof is not required.

Reroofing Example 4 – Unconditioned Warehouse Containing Office

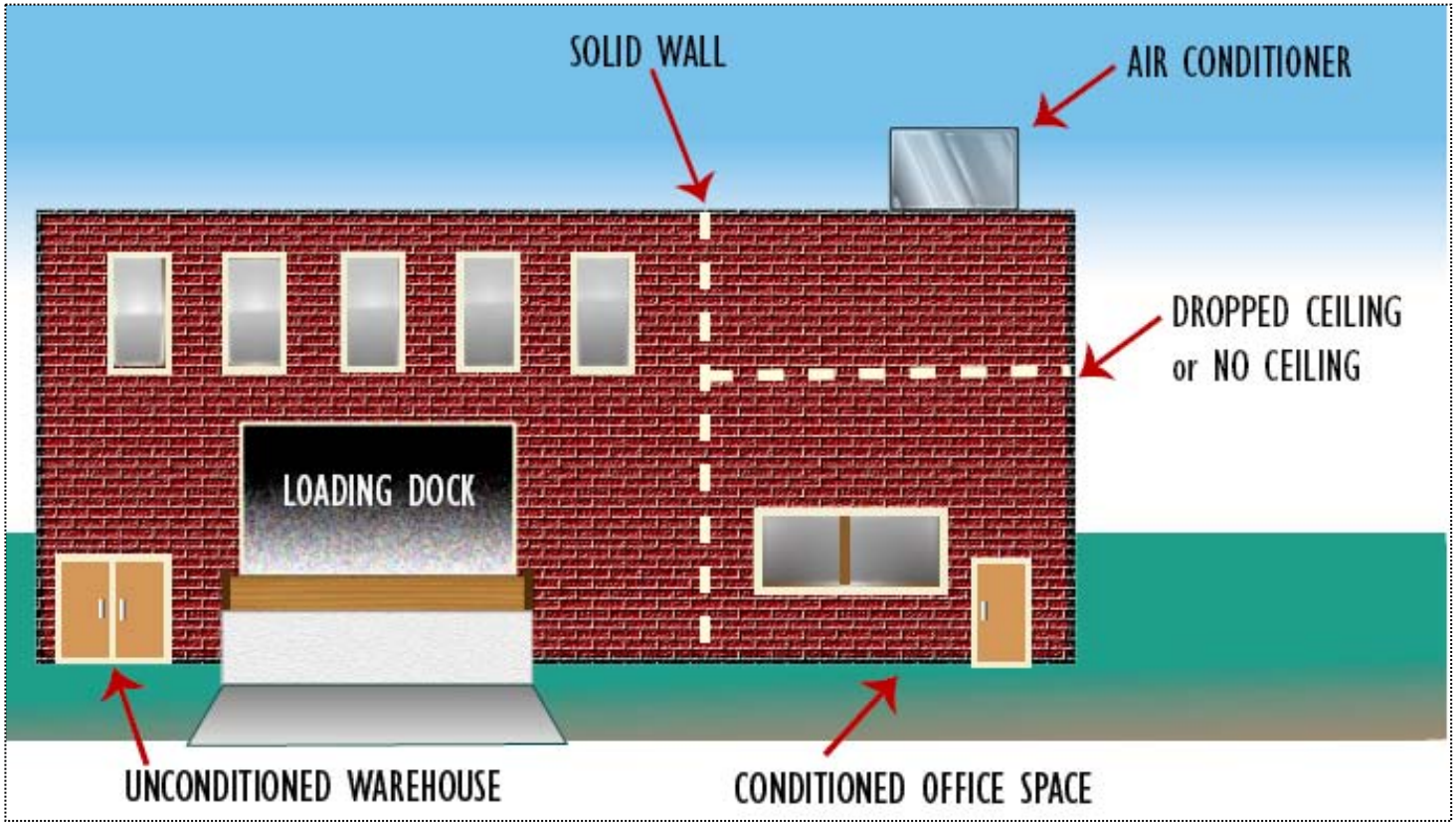
- **Unconditioned Warehouse Containing Conditioned Office Space**
  - **Cool Roof Regulations Apply? Consider two cases…**

Case 1. Conditioned Space's Walls Don't Go All the Way to Warehouse Roof



Applies for any distance between warehouse roof and 'lid' of conditioned space

Case 2 – Walls of Conditioned Space Reach Warehouse Roof



Cool Roof requirements apply

OVER THE CONDITIONED SPACE(S) ONLY

not over the entire warehouse roof

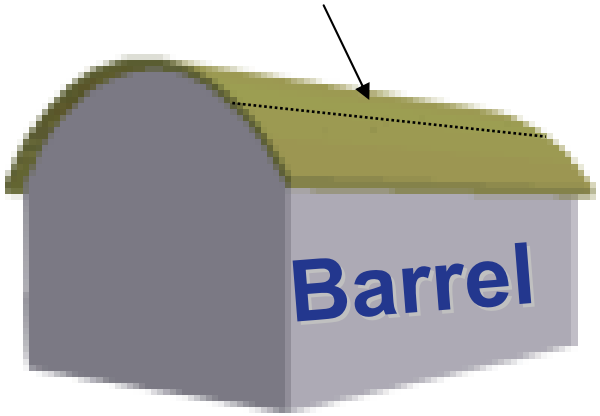
New Construction: "Partly" Cool Roofs

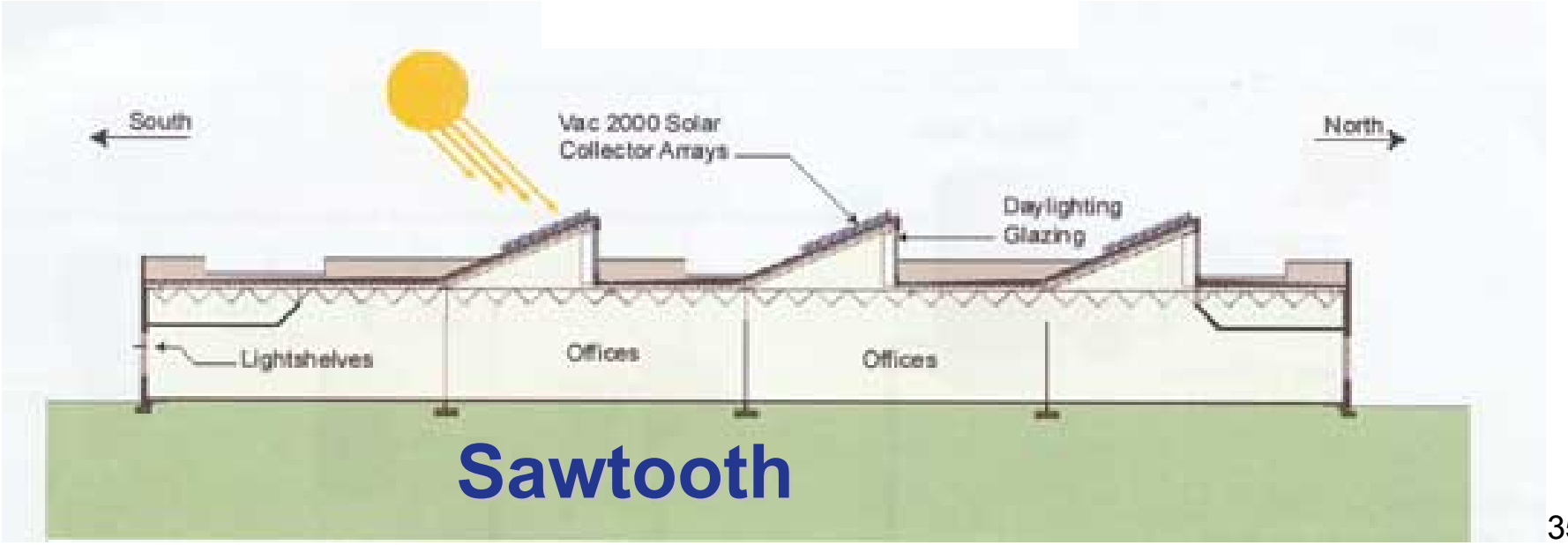
- **Roofing materials not meeting the prescriptive requirements for 0.70 reflectance and 0.75 emittance can get "partial" energy credit**
  - Must use approved computer software to model the building's energy performance

    OR
  - Must use prescriptive "overall envelope approach" (allows trade-offs among components of the building envelope) – ARMA calculator to determine R-value if use roof insulation

Other Roof Situations – Barrel, Sawtooth

Roof slope area ≤ 2:12 must meet Title 24



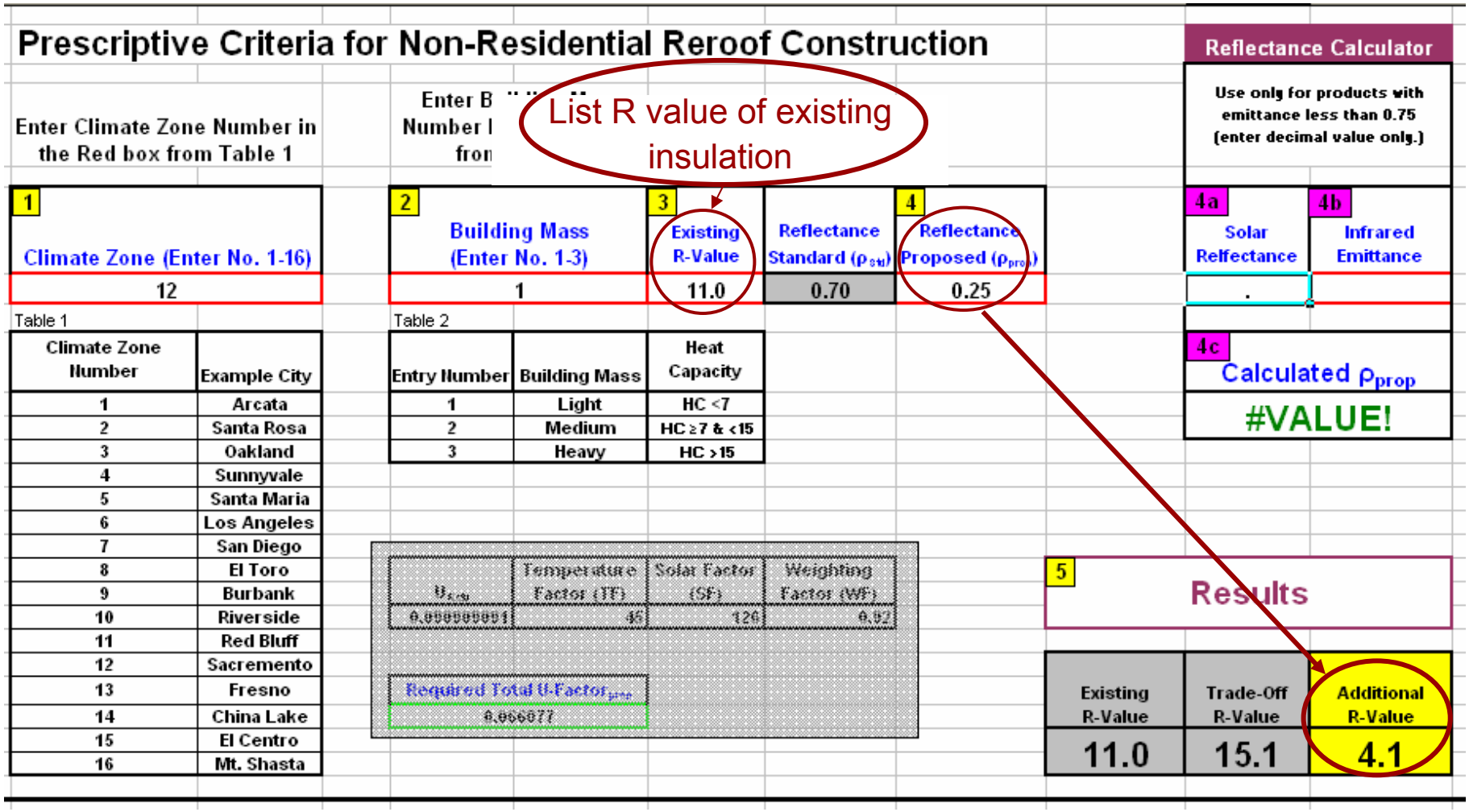


Other Roof Situations - **Mixed Use Buildings**

- **Mixed Residential and Nonresidential Occupancies.** Any nonresidential conditioned space with a low-sloped roof must observe the cool roof regulations, even if mixed in with residential, except:
  - **Minor Occupancy**. If an occupancy type occupies less than 10% of the total conditioned floor area, then it may optionally be treated as if it were of the major occupancy.

Insulation Tradeoff Calculator

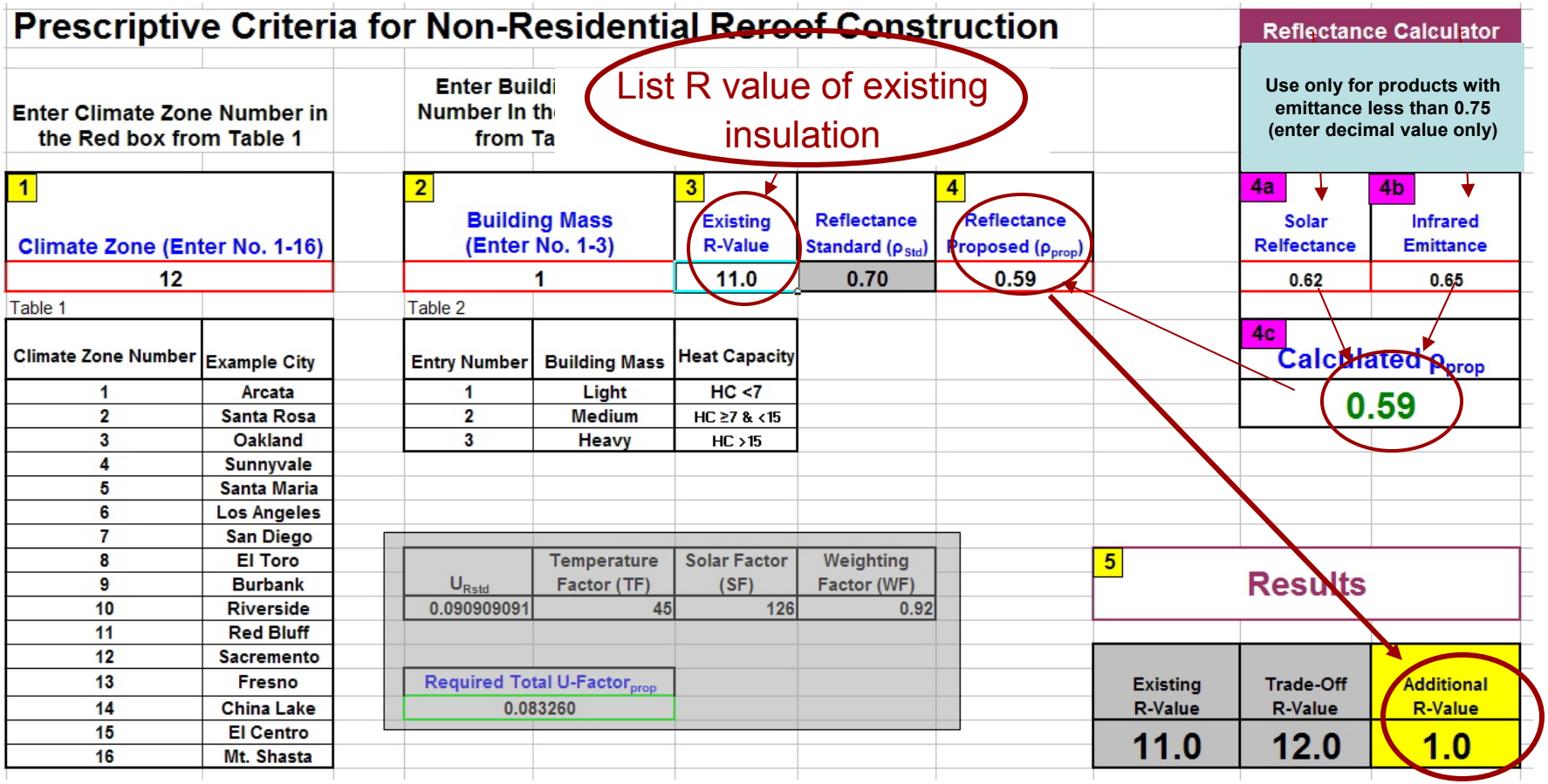
Example #1 - CRRC listed, complies with Emittance NOT Reflectance



www.asphaltroofing.org/title24_reroof.html

Insulation Tradeoff Calculator - Example #2

CRRC listed - does NOT comply with Emittance or Reflectance



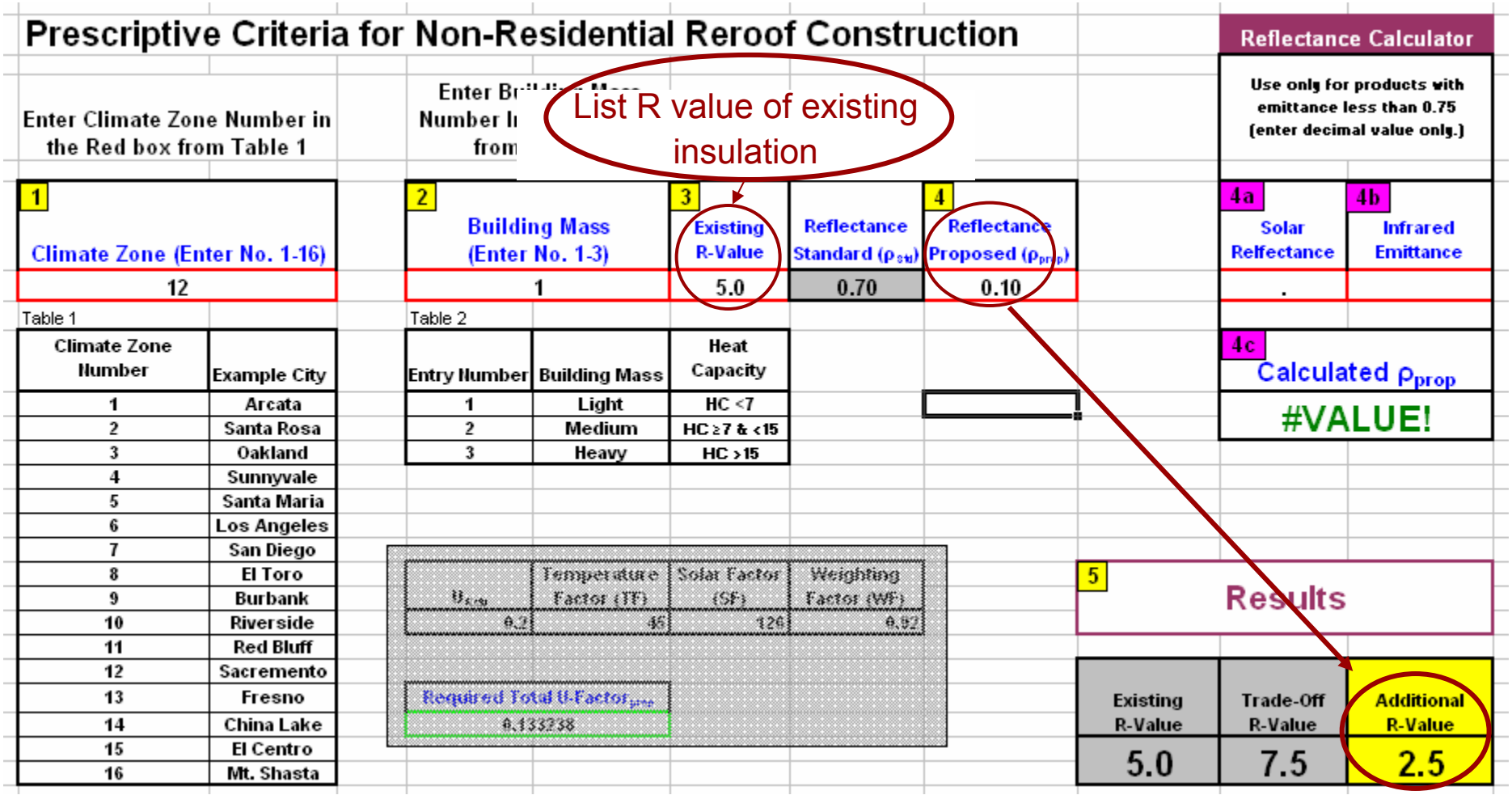
www.asphaltroofing.org/title24_reroof.html

Roof Materials
Not CRRC Tested and Rated

- Materials not tested & rated through CRRC are assigned a default value for reflectance – it is LOW, only 0.10
- You can use materials not rated by CRRC but you must meet the energy budget under the Title 24 Energy Standards' performance compliance method.

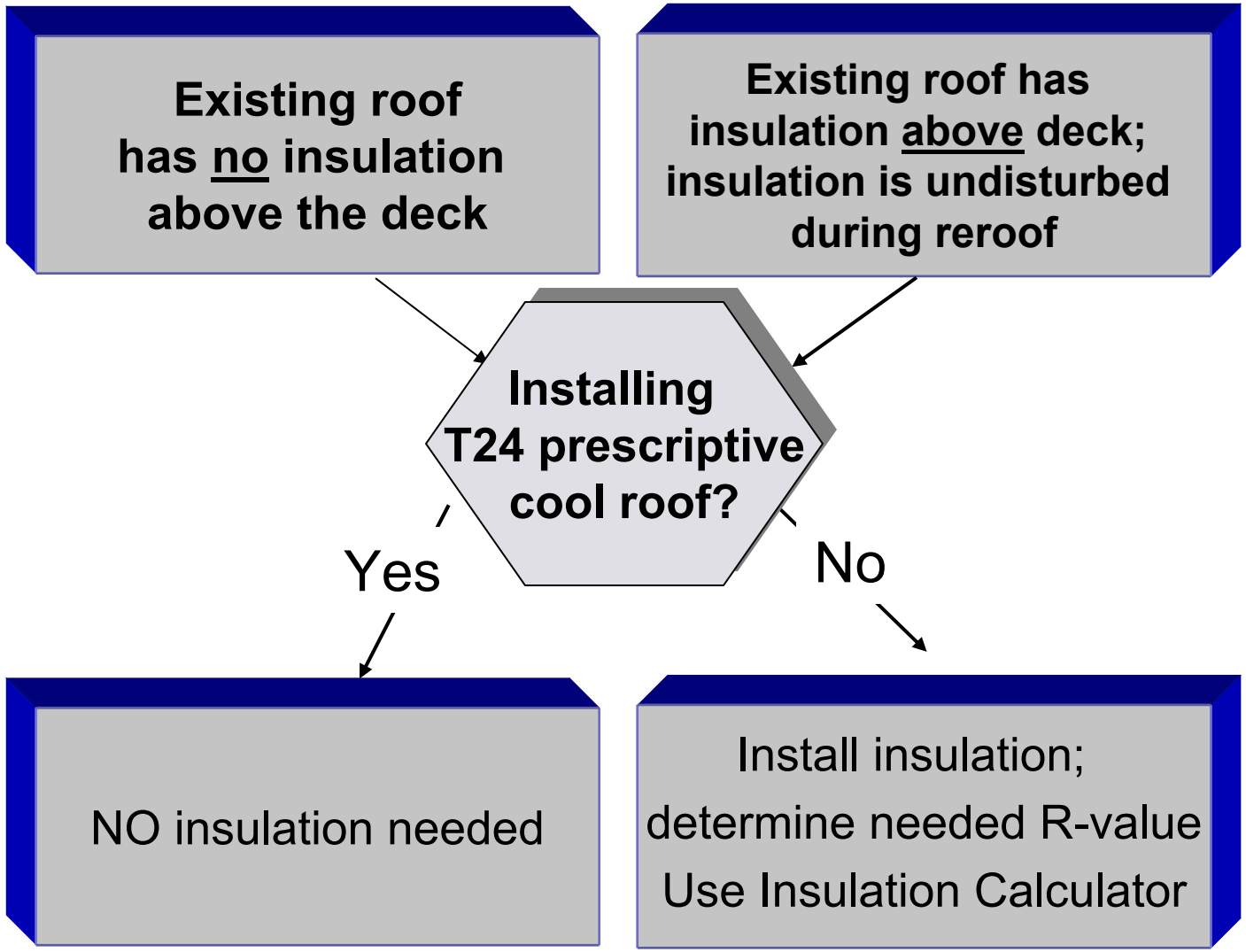
Insulation Tradeoff Calculator

Example #3 – NOT CRRC listed – Product defaults to 0.10

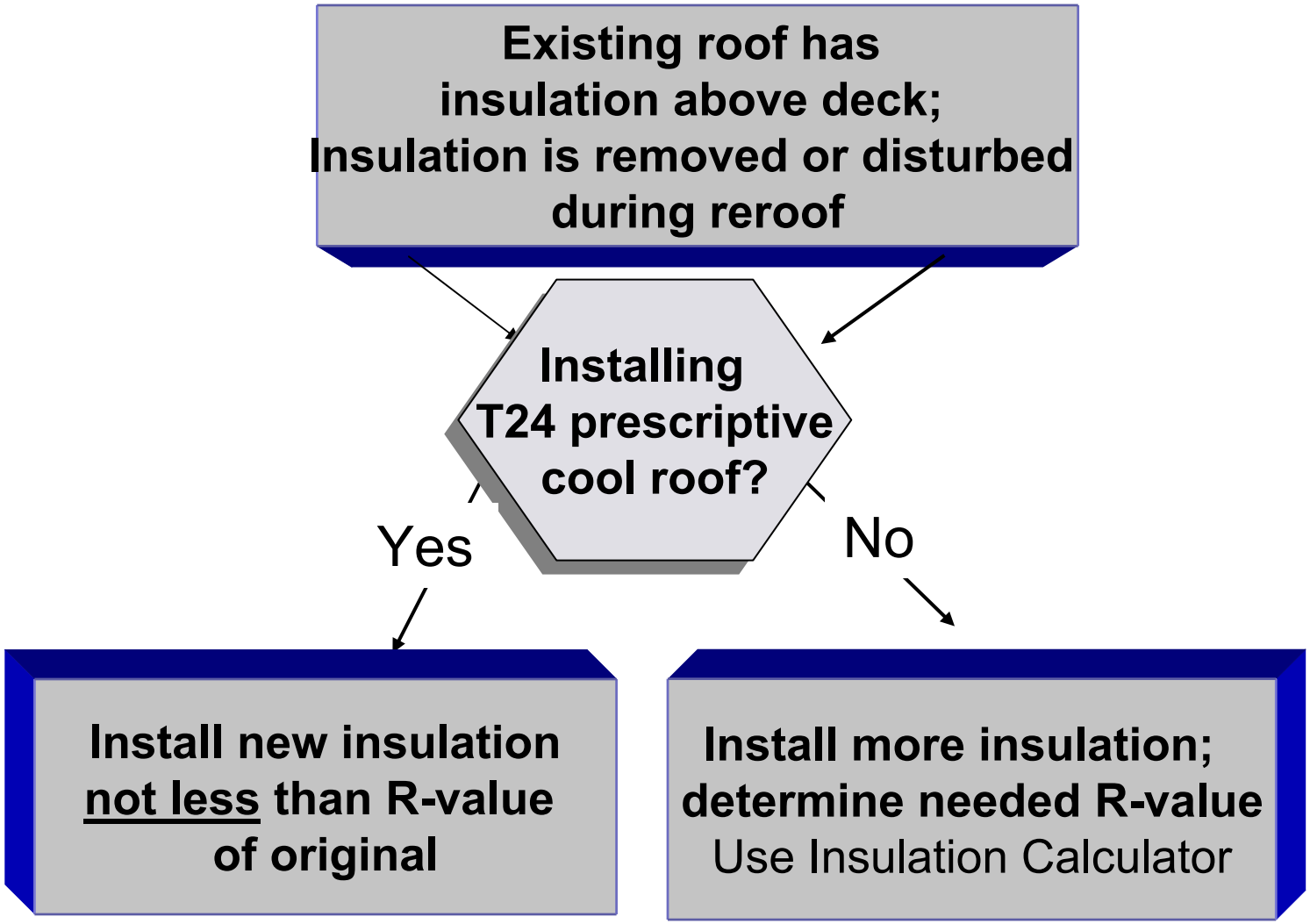


www.asphaltroofing.org/title24_reroof.html

Reroofing & Roof Insulation Guidelines Case Study 1



Reroofing & Roof Insulation Guidelines Case Study 2



Ways to Comply (Cool Roof Options)

Roofs come as…	Cool Option #1	Cool Option #2	'Partly' Cool or Noncool roofs
BUR (Including Smooth, Gravel or Cap)	**Select <u>manufactured product</u> meeting 0.70 Reflectance 0.75 Emittance (see CRRC rated product directory)**	**Over non-compliant or non-rated system: Select <u>Coating</u> from CRRC list that meets 0.70 Reflectance 0.75 Emittance and meets physical property requirements**	**May or may not be CRRC listed. Use Prescriptive Overall Envelope (tradeoff) Approach Or Computer Software (Performance) Method**
Modified Bitumen			
Single Ply			
Coated Metal (nonmetal coat)			
Spray Foam			
Uncoated Metal or metallic coating	**N/A**		

A Word on Fire Ratings

- Title 24 Energy Standards only address energy savings, not other code requirements.
- Architect, Contractor, Consultant etc. is still required to:
  - Meet requirements of the Energy Standards

    AND
  - Select system that meets code-required fire ratings

T24 Forms for Reroofing to Accompany Permit Application

At time of design for reroofing include *Certificate of Compliance* on drawings.

- Form ENV-1 part 1 & 2

- At time of submission for permit include:
  - Form ENV-2 part 1 & 2 - Material Compliance OR
  - ENV-3 part 5 – Overall Envelope Method

- See Nonresidential Compliance Manual Appendix A for details
  www. energy.ca.gov/title24/2005standards/ nonresidential_manual.html

NOTES:

- Check with building dept for requirements

- T24 FORMS ARE BEING UPDATED AND SIMPLIFIED

ENVELOPE COMPONENT METHOD (Part 2 of 2) ENV-2-C

PROJECT NAME	DATE

COOL ROOFS - LOW-SLOPED - See Section 3.4 in the NRM and §118(i)3 and §143(a)1 in the Energy Standards for further description about exterior roofs and mandatory requirements for Cool Roofs.

✓ **CHECK APPLICABLE BOXES**

■ **Option 1 - Tested - Initial Thermal Emittance ≥ 0.75 and Intial Solar Reflectance ≥ 0.70**

Proposed emittance and reflectance must be ≥ the standard when tested with CRRC-1	Proposed	Standard	
1. Enter proposed initial thermal emittance, $\varepsilon_{initial}$	0.86	≥ 0.75	If proposed ≥ to the Standard then it complies.
2. Enter the proposed initial solar reflectance, $\rho_{initial}$	0.70	≥ 0.70	If proposed ≥ to the Standard then it complies.

3. When applying **Liquid Field Applied Coatings,** the coating must be applied with a minimum dry mil thickness of 20 mils across the entire roof surface and meet minimum performance requirements listed in §118(i)3 and Table 118-C. Select the applicable coating:

☐ Aluminum-Pigmented Asphalt Roof Coating ☐ Cement-Based Roof Coating ☐ Other _____

☐ **Option 2 - CRRC-1 Tested - Initial Thermal Emittance < 0.75**

Proposed initial thermal emittance < 0.75 when tested with CRRC-1.	Proposed	Standard	
1. Enter proposed initial thermal emittance, $\varepsilon_{initial}$		< 0.75	Go to line 2. Insert $\varepsilon_{initial}$ value in calculation.
2. Enter the initial solar reflectance, $\rho_{initial}$		$0.70 + [0.34 \times (0.75 - \varepsilon_{initial})]$	**Standard** $\rho_{initial}$ =

3. To apply **Liquid Field Applied Coatings,** the coating must be applied with a minimum dry mil thickness of 20 mils across the entire roof surface and meet minimum performance requirements listed in §118(i)3 and Table 118-C. Select the applicable coating:

☐ Aluminum-Pigmented Asphalt Roof Coating ☐ Cement-Based Roof Coating ☐ Other _____

✓ ☒ **CRRC-1 Label Attached to Submittal**
(Note if no CRRC-1 label is available, this compliance method can not be used).

ENVELOPE COMPONENT METHOD (Part 2 of 2) ENV-2-C

PROJECT NAME	DATE

COOL ROOFS - LOW-SLOPED - See Section 3.4 in the NRM and §118(i)3 and §143(a)1 in the Energy Standards for further description about exterior roofs and mandatory requirements for Cool Roofs.

✓ **CHECK APPLICABLE BOXES**

☐ **Option 1 - Tested - Initial Thermal Emittance ≥ 0.75 and Initial Solar Reflectance ≥ 0.70**

Proposed emittance and reflectance must be ≥ the standard when tested with CRRC-1.	**Proposed**	**Standard**	
1. Enter proposed initial thermal emittance, $\varepsilon_{initial}$		≥ 0.75	If proposed ≥ to the Standard then it complies.
2. Enter the proposed initial solar reflectance, $\rho_{initial}$		≥ 0.70	If proposed ≥ to the Standard then it complies.

3. When applying **Liquid Field Applied Coatings,** the coating must be applied with a minimum dry mil thickness of 20 mils across the entire roof surface and meet minimum performance requirements listed in §118(i)3 and Table 118-C. Select the applicable coating:

■ Aluminum-Pigmented Asphalt Roof Coating ☐ Cement-Based Roof Coating ☐ Other _____

☐ **Option 2 - CRRC-1 Tested - Initial Thermal Emittance < 0.75**

Proposed initial thermal emittance < 0.75 when tested with CRRC-1.	**Proposed**	**Standard**	
1. Enter proposed initial thermal emittance, $\varepsilon_{initial}$	0.40	< 0.75	Go to line 2. Insert $\varepsilon_{initial}$ value in calculation.
2. Enter the initial solar reflectance, $\rho_{initial}$		0.70 + [0.34 X (0.75 - $\varepsilon_{initial}$)]	**Standard** $\rho_{initial}$ = 0.82

3. To apply **Liquid Field Applied Coatings,** the coating must be applied with a minimum dry mil thickness of 20 mils across the entire roof surface and meet minimum performance requirements listed in §118(i)3 and Table 118-C. Select the applicable coating:

☐ Aluminum-Pigmented Asphalt Roof Coating ☐ Cement-Based Roof Coating ☐ Other _____

✓ ☒ **CRRC-1 Label Attached to Submittal**
(Note if no CRRC-1 label is available, this compliance method can not be used).

Example 3: CRRC Rated Product with Successful Insulation Trade-Off to Gain Compliance

OVERALL ENVELOPE METHOD (Part 5 of 7) ENV-3-C

PROJECT NAME | DATE

ROOF ABSORPTANCE CALCULATION: Use this table to determine the value of the absorptance for the proposed design, α_{prop}

CHECK APPLICABLE BOXES				
Case 1 - Proposed	YES		NO	
1. CRRC-1 Certified?	X	Go to 2.		Go to 8.
2. Is the thermal emittance ≥ 0.75?		Go to 3.	X	Go to 5.
3. Enter the initial reflectance ρ_{Init} value	$\rho_{Ri,prop}$ =		Go to 4. Insert value in calculation.	
4. Calculate $\alpha_{prop} = 0.94-0.7\rho_{Ri,prop}$	α_{prop} =		Enter calculated value in Column F below.	
Case 2 - CRRC-1 Tested				
5.Enter initial reflectance & emittance values from CRRC-1	ρ_{Init} = .68	ε_{Init} = .40	Go to 6. Insert values in calculation	
6. Calculate $\rho_{Ri,prop} = -0.448 + 1.121\ \rho_{Init} + 0.524\ \varepsilon_{Init}$	$\rho_{Ri,prop}$ =		Go to 7. Insert value in calculation	
7. Calculate $\alpha_{prop} = 0.94-0.7\rho_{Ri,prop}$	α_{prop} = .58		Enter calculated value in Column F below.	
Case 3 - Not CRRC-1 Tested	YES		NO	
8. Is the roof a nonresidential low-sloped? (2:12 or less)		Go to 9.		Go to 10.
9. Use the default values for absorptance, α_{prop}	α_{prop} = 0.87		Enter default value in Column F below.	
10. Use the default values for absorptance, α_{prop}	α_{prop} = 0.73		Enter default value in Column F below.	
Standard absorptance values α_{std} for Column J are either				
For nonresidential low-sloped roofs	α_{std} = 0.45		Enter standard value in Column F below.	
For nonresidential high-sloped roofs	α_{std} = 0.73		Enter standard value in Column F below.	

OVERALL HEAT GAIN FROM RADIATION — OPAQUE SURFACES

A	B	C	D	E	F	G	H	I	J	K
	PROPOSED						STANDARD			
ASSEMBLY NAME (e.g. Roof-1)	AREA	SOLAR FACTOR	WEIGHT FACTOR	U-FACTOR	Absorp α	HEAT GAIN (B×C×D×E×F)	AREA (Adjusted)	U-FACTOR	Absorp α	HEAT GAIN (C×D×H×I×J)
Roof-1	2000	126	0.84	.025	87	4604.04	2000	.057	45	4858.06

Example 3: CRRC Rated Product with Successful Insulation Trade-Off to Gain Compliance

OVERALL HEAT GAIN FROM RADIATION — OPAQUE SURFACES

A	B	C	D	E	F	G	H	I	J	K
			Proposed					Standard		
ASSEMBLY NAME (e.g. Roof-1)	AREA	SOLAR FACTOR	WEIGHT FACTOR	U-FACTOR	Absorp α	HEAT GAIN (B×C×D×E×F)	AREA (Adjusted)	U-FACTOR	Absorp α	HEAT GAIN (C×D×H×I×J)
Roof-1	2000	126	0.84	.037	.58	4542.65	2000	.051	.45	4858.06
						4542.65				4858.06
						SUBTOTAL				SUBTOTAL

Subtotals are entered under "Subtotal" in COLUMNS I and M of ENV-3-C, Part 6 of 7.

Example 4: No Insulation Added to non-CRRC Rated Roof Does Not Comply

OVERALL ENVELOPE METHOD (Part 5 of 7) ENV-3-C

PROJECT NAME | DATE

ROOF ABSORPTANCE CALCULATION: Use this table to determine the value of the absorptance for the proposed design, α_{prop}

CHECK APPLICABLE BOXES

Case 1 - Proposed	YES	NO
1. CRRC-1 Certified?	☐ Go to 2.	☐ Go to 8.
2. Is the thermal emittance ≥ 0.75?	☐ Go to 3.	☐ Go to 5.
3. Enter the initial reflectance ρ_{init} value	$\rho_{Ri,prop}$ =	Go to 4. Insert value in calculation.
4. Calculate $\alpha_{prop} = 0.94-0.7\rho_{Ri,prop}$	α_{prop} =	Enter calculated value in Column F below.

Case 2 - CRRC-1 Tested			
5.Enter initial reflectance & emittance values from CRRC-1	ρ_{init} =	ε_{init} =	Go to 6. Insert values in calculation
6. Calculate $\rho_{Ri,prop} = -0.448 + 1.121\ \rho_{init} + 0.524\ \varepsilon_{init}$	$\rho_{Ri,prop}$ =		Go to 7. Insert value in calculation
7. Calculate $\alpha_{prop} = 0.94-0.7\rho_{Ri,prop}$	α_{prop} =		Enter calculated value in Column F below.

Case 3 - Not CRRC-1 Tested	YES	NO
8. Is the roof a nonresidential low-sloped? (2:12 or less)	X Go to 9.	☐ Go to 10.
9. Use the default values for absorptance, α_{prop}	α_{prop} = 0.87	Enter default value in Column F below.
10. Use the default values for absorptance, α_{prop}	α_{prop} = 0.73	Enter default value in Column F below.

Standard absorptance values α_{std} for Column J are either

For nonresidential low-sloped roofs	α_{std} = 0.45	Enter standard value in Column F below.
For nonresidential high-sloped roofs	α_{std} = 0.73	Enter standard value in Column F below.

OVERALL HEAT GAIN FROM RADIATION OPAQUE SURFACES

A	B	C	D	E	F	G	H	I	J	K
	PROPOSED						STANDARD			
ASSEMBLY NAME (e.g. Roof-1)	AREA	SOLAR FACTOR	WEIGHT FACTOR	U-FACTOR	Absorp α	HEAT GAIN (B×C×D×E×F)	AREA (Adjusted)	U-FACTOR	Absorp α	HEAT GAIN (C×D×H×I×J)
Roof-1	2000	126	0.84	.037	87	6813.97	2000	.057	45	4858.06

Example 4: Insulation Added to non-CRRC Rated Roof to Gain Compliance

OVERALL HEAT GAIN FROM RADIATION — OPAQUE SURFACES

A	B	C	D	E	F	G	H	I	J	K
			Proposed					Standard		
ASSEMBLY NAME (e.g. Roof-1)	AREA	SOLAR FACTOR	WEIGHT FACTOR	U-FACTOR	Absorp α	HEAT GAIN (B×C×D×E×F)	AREA (Adjusted)	U-FACTOR	Absorp α	HEAT GAIN (C×D×H×I×J)
Roof-1	2000	126	0.84	.037	.87	6813.97	2000	.057	.45	4858.06
						6813.97 SUBTOTAL	Subtotals are entered under "Subtotal" in COLUMNS I and M of ENV-3-C, Part 6 of 7.			4858.06 SUBTOTAL

Example 5: More Insulation Added to non-CRRC Rated Roof to Gain Compliance

OVERALL ENVELOPE METHOD (Part 5 of 7) ENV-3-C

PROJECT NAME | DATE

ROOF ABSORPTANCE CALCULATION: Use this table to determine the value of the absorptance for the proposed design, α_{prop}

CHECK APPLICABLE BOXES

Case 1 - Proposed	YES	NO	
1. CRRC-1 Certified?			Go to 2. / Go to 8.
2. Is the thermal emittance ≥ 0.75?			Go to 3. / Go to 5.
3. Enter the initial reflectance ρ_{init} value	ρ_{RLprop} =		Go to 4. Insert value in calculation.
4. Calculate $\alpha_{prop} = 0.94-0.7\rho_{RLprop}$	α_{prop} =		Enter calculated value in Column F below.
Case 2 - CRRC-1 Tested			
5.Enter initial reflectance & emittance values from CRRC-1	ρ_{init} =	ε_{init} =	Go to 6. Insert values in calculation
6. Calculate $\rho_{RLprop} = -0.448 + 1.121\ \rho_{init} + 0.524\ \varepsilon_{init}$	ρ_{RLprop} =		Go to 7. Insert value in calculation
7. Calculate $\alpha_{prop} = 0.94-0.7\rho_{RLprop}$	α_{prop} =		Enter calculated value in Column F below.
Case 3 - Not CRRC-1 Tested	YES	NO	
8. Is the roof a nonresidential low-sloped? (2:12 or less)	X Go to 9.		Go to 10.
9. Use the default values for absorptance, α_{prop}	α_{prop} = 0.87		Enter default value in Column F below.
10. Use the default values for absorptance, α_{prop}	α_{prop} = 0.73		Enter default value in Column F below.
Standard absorptance values α_{std} for Column J are either			
For nonresidential low-sloped roofs	α_{std} = 0.45		Enter standard value in Column F below.
For nonresidential high-sloped roofs	α_{std} = 0.73		Enter standard value in Column F below.

OVERALL HEAT GAIN FROM RADIATION PASSED OPAQUE SURFACES

A	B	C	D	E	F	G	H	I	J	K
	PROPOSED						STANDARD			
ASSEMBLY NAME (e.g. Roof-1)	AREA	SOLAR FACTOR	WEIGHT FACTOR	U-FACTOR	Absorp α	HEAT GAIN (B×C×D×E×F)	AREA (Adjusted)	U-FACTOR	Absorp α	HEAT GAIN (C×D×H×I×J)
Roof-1	2000	126	0.84	.025	87	4604.04	2000	.057	45	4858.06

Example 5: More insulation added to non-CRRC Rated Roof to Gain Compliance (cont'd)

OVERALL HEAT GAIN FROM RADIATION — OPAQUE SURFACES

A	B	C	D	E	F	G	H	I	J	K
			Proposed					Standard		
ASSEMBLY NAME (e.g. Roof-1)	AREA	SOLAR FACTOR	WEIGHT FACTOR	U-FACTOR	Absorp α	HEAT GAIN (B×C×D×E×F)	AREA (Adjusted)	U-FACTOR	Absorp α	HEAT GAIN (C×D×H×I×J)
Roof-1	2000	126	0.84	.025	.87	4604.04	2000	.057	.45	4858.06
						4604.04 SUBTOTAL	Subtotals are entered under "Subtotal" in COLUMNS I and M of ENV-3-C, Part 6 of 7.			4858.06 SUBTOTAL

Resources

- **Title 24 Energy Hotline**
  - 800-772-3300 (within CA)
  - 916-654-5106 (outside CA)
  - title24@energy.state.ca.us
- **Title 24 Website**
  - Title 24 Energy Standards and support documents - **www.energy.ca.gov/title24**
- **Energy Commission Cool Roof Website** under construction
  - **www.energy.ca.gov/title24/coolroofs/**
- ***Blueprint*, Energy Commission Newsletter on T24 Questions and Answers**
  - **www.energy.ca.gov/efficiency/blueprint**

More Resources

- **Free Title 24 Energy Information Videos**
  - www.energyvideos.com
- **Trade-off Calculator**
  - www.asphaltroofing.org/title24_reroof.html
- **Cool Roof Rating Council**
  - www.coolroofs.org; 866-465-252
- **Calif. Assoc. of Building Energy Consultants**
  - www.cabec.org; 866-360-4002
- **Approved Title 24 Nonresidential Compliance Software**
  - EnergyPro: www.energysoft.com
  - Perform 2005: call or email Title 24 Hotline

THANK YOU!!

QUESTIONS?