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Non-Residential Cool Roof Cost Summary

Purpose

This report identifies the potential cost increase associated with installing a cool roof with a higher aged solar reflectance on low sloped roofs of nonresidential buildings than is currently required by the 2008 Building Energy Efficiency Standards (Standards). The report identifies whether cost increases are cost effective compared to the energy saved over the assumed life of the building. The overall methodology for cost effectiveness and general reasoning for the analysis to support increases in the proposed solar reflectance for low sloped roofing materials has been laid out in the September 2011 CASE Report titled: *Nonresidential Cool Roof Reflectance*.

California Energy Commission (CEC) staff and its technical support team of Architectural Energy Corporation (AEC) have been working closely with representatives of the roofing industry to ensure that proposed reflectance values for roofing material are cost justified. To this end, this report responds to industry requests for further analysis to identify the cost impacts of the aged solar reflectance being proposed by staff for the 2013 Standards.

The September 2011 CASE report recommended increasing the required minimum aged solar reflectance from the current 2008 requirement of 0.55 to 0.67. In consideration of industry's concerns that this increase would still result in the restriction of materials available to the nonresidential market, staff has revised its 2013 proposal to a low sloped roof requirement of 0.65. This report provides the results of the cost analysis supporting staff's proposal for low sloped roofs.

Approach

The September 2011 CASE report estimated the potential statewide energy savings for the proposed increase in the aged solar reflectance over the 15 year projected life of a cool roof to be between $0.40/ft2 and $1.35/ft2, depending on the climate zone. Energy savings represent the dollar amount saved from the current reflectance value of 0.55 to a more highly reflective cool roof with an aged solar reflectance of 0.67.

To determine the incremental cost associated with a more highly reflective cool roof a combination of mail/email and telephone survey were used. The general makeup of questions for the survey instruments were developed in consultation with representatives of the roofing industry. To assist respondents in providing cost information a simple rectangular roof shape covering of 25,000 square feet which the Asphalt Roofing Manufactures Association used in there survey for the 2008 Title 24 Standard development was assumed. The data obtained from the survey was then used in the assumed DOE reference building of 16,900 square feet which was used to develop the ASHREA Standards. Examples of survey instruments are provided in the *Reference Material* section. The basic cost of roofing material, excluding distributor or contrctor markups, is driven by the materials cost and the cost to install it. In the nonresidential market there are four categories of roofing that are typically used and installation costs vary by the type of roofing called for: Built-up roofing (BUR), Modified bitumen (ModBit), Single Ply, and Field-Applied. Further discussion of roofing materials is provided in the *Determining Costs* section.

A variety of sources were contacted for cost information: manufacturer representatives, distributors and roofing contractors. The first order of approach was to contact those who install roofing products—contractors. When contractors could not provide cost information for a roofing material, distributors were contacted for

material cost information. When distributors could not provide cost information for a roofing material, manufacturers were contacted. Contractors were contacted in the San Francisco Bay Area, Sacramento, Los Angeles, San Diego, Fresno, and San Bernardino metropolitan areas. For some reflective roofing materials with higher reflectance values than current Standards, the contractors often didn't know of a price difference to distinguish a product with an aged reflectance of 0.65 from a product with aged reflectance of 0.55 (i.e., current Standards). For example, incremental costs for single ply systems were obtained from distributors. Costs include the roofing material with a higher reflectance value, a contractor mark-up.and any costs associated with installation if there was one. For field-applied coatings, manufacturer representatives were contacted for cost information.

Not all data sources and/or respondents had cost data readily available for all roofing types. For example, not all distributors handled materials from manufacturers in all categories, and not all contractors typically installed all roofing types. In addition, there seemed to be regional preferences to roofing material choice. Respondents in northern California, for example, more often relied upon BUR roofing materials than in southern California.

Summary of Findings

There are several choices of roofing materials used by designers and specifiers for nonresidential buildings, and in some cases it's somewhat unclear which roof type would be used when the choice is made to move to a more reflective roof. Nevertheless, findings from this cost analysis shows that the increase in incremental costs for all roofing types are lower than the estimated present value of energy savings for a cool roof meeting the proposed 2013 aged solar reflectance requirement of 0.65 for low sloped buildings in any California climate zone.

Table 1 – Low Sloped Cool Roof Incremental Cost Data (Aged Reflectance of 0.65)

Roof Type	Exposed Roof Material (Typical)	Exposed Roof Material to Meet 0.65 Solar Reflectance	Incremental Cost	Source(s)
BUR	Mineral cap sheet	Same	$0.03/ft2	Distributors
BUR	Mineral cap sheet	BUR to single ply	$0.30/ft2	Contractors/Distributors
Single Ply	TPO (60 mil)	Same	$0.16/ft2	Distributors
Single Ply	PVC (60 mil)	Same	$0.15/ft2	Distributors
Modified Bitumen	APP	Same	No data—not used in CA	
Modified Bitumen	SBS	Same	$0.25/ft2	Contractors – Phone Survey
Roof Coatings	See manufacture coating cost	Same	$0.31/ft2	Manufacturer Data

The life-cycle cost summary below shows a positive net present value for a cool roof meeting the proposed aged reflectance requirement of 0.65. Table 2 shows the present value savings of each roof types represented by the climate zone with the highest and lowest energy savings are represented in this table. The life-cycle cost results show that the proposed aged reflectance of 0.65 is cost effective for all low sloped roof types in all California climate zones.

Table 2 – Life-Cycle Cost Summary, Aged Reflectance of 0.65[1]

Roof Type	Incremental Cost	PV Savings High	Net Present Value	PV Savings Low	Net Present Value
BUR	$0.03/ft2	$0.86/ft2	$0.83/ft2	$0.33/ft2	$0.30/ft2
BUR to Single Ply, TPO	$0.30/ft2	$0.86/ft2	$0.56/ft2	$0.33/ft2	$0.03/ft2
Single Ply, TPO	$0.16/ft2	$0.86/ft2	$0.70/ft2	$0.33/ft2	$0.17/ft2
Single Ply, PVC	$0.15/ft2	$0.86/ft2	$0.71/ft2	$0.33/ft2	$0.18/ft2
Modified Bitumen, SBS	$0.25/ft2	$0.86/ft2	$0.61/ft2	$0.33/ft2	$0.08/ft2
Roof Coatings	$0.31/ft2	$0.86/ft2	$0.55/ft2	$0.33/ft2	$0.02/ft2

[1]Original analysis…include building type?

Determining Costs

The following roofing types were examined for low sloped roofs of nonresidential buildings:
Built-up roofing (BUR): BUR roofing employs several overlaid layers of water resistant material with an exposed membrane.

- Cap sheet --- An asphaltic based granular surface top sheet typically rolled across the surface of the roof.
- Coated granules –A granular surface top coating typically spread across the top asphaltic layer.
- Modified bitumen (ModBit)---A bitumen (asphalt or tar) modified with plastic and layered with reinforcing materials then topped with a surfacing material.
    - SBS --- asphaltic material with non-woven polyester or glass fiber reinforcements, self adhesive fully-adhered membrane
    - APP --- asphaltic material with non-woven polyester or glass fiber reinforcements, torch-applied (hot welded) membrane
- Single Ply--- is a pre-fabricated sheet of rubber polymers which is laid down in a single layer over a roof. There are two main types of single-ply materials: single-ply thermoset and single-ply thermoplastic.
    - PVC --- Thermoplastic membrane that is applied by mechanical attachment or is fully self adhered.
    - TPO --A thermoset material combining plastic and rubber that is applied by mechanical attachment or is fully self adhered.
- Roof Coatings--- Acrylic, urethane and silicone coatings which are field applied to a variety of substrates. (Only unreinforced coatings were considered; those that do not include a layer of polyester fabric).

Contractor Costs

Cost information from contractors were obtained by email and phone survey. An email survey was sent to 70 roofing contractors and efforts were made to ensure response. However, only three responses were received, one from the Bay Area, one from the San Diego area, and the third for the Sacramento area.

Due to the limited response to the emailed surveys, AEC telephoned a number of contractors throughout the state to help provide survey cost data. Nine responses were received from different regions of the state, including the Bay Area, Los Angeles, San Diego, Fresno and San Bernardino. The summary results are shown in the table 3 below. Contractor cost results represent the highest cost for the roof type with the specific aged solar reflectance. Detailed survey responses are included in the *Reference section.*

Table 3 - Contractor Cost (material + installation)

Roof Type	Exposed Roof Material (Typical)	2008 T24 (SR=0.55)	Proposed 2013 T24 (SR>=0.65)	Source
BUR	Cap sheet	$4.53	$4.56	7 contractors
Modified Bitumen	APP	$4.11	no response not readily used in CA.	4 contractors
Modified Bitumen	SBS	$4.75	$5.00	1 contractor
Single Ply	TPO	$4.67	$4.83	6 contractors
Single Ply	PVC	$5.40	$5.55	3 contractors
Field Applied Coating	Varies	$1.65	$1.96	4 contractors

Cost premium to go from a dark BUR (not code compliant) to a 2008 Title 24 compliant BUR with cool cap sheet: $0.82/ft2 ($3.71/ft2 average installed cost for dark mineral cap sheet for BUR)

Email Survey Conclusions

Two survey responses to the email survey were received: one from a Bay Area contractor and a second from a San Diego area contractor. The detailed responses are provided in the Reference section at the end of this report. A summary of the results is provided below.

The following conclusions can be gathered from the survey responses:

1. The incremental cost of a T24-2008 compliant BUR is estimated at $0.54/ft2.
2. Incremental costs for reflective coated granules for BUR are $0.68/ft2, but in discussions with several contractors, no one goes with this option.
3. The incremental cost of a single ply roof over a T24 compliant built-up roof is as high as $0.30/ft2, but in some cases a single-ply roof is less expensive than a comparable BUR.
4. Recoat price varies from $1.50/ft2 to $1.65/ft2.
5. There is no appreciable price difference between T24-2008 compliant top ply for single ply roofs top plies that would meet the proposed 2013 Standard.
6. Southern California contractor quote is for private sector jobs only; public sector jobs carry additional cost. Also, if metal and lead flashings are provided by the roof contractor and not another sub, this could add 5% to the cost.

Distributor Costs

11 distributors were contacted throughout the state. These costs include a 30% contractor mark-up.

Table 4 – Distributor Cost Summary (material-includes contractor markup)

Roof Type	Exposed Roof Material (Typical)	Dark (SR<0.55)	T24 (SR=0.55)	Proposed (SR>=0.65)	Notes

BUR	Cap sheet	$1.50	$1.94	$1.97	
Modified Bitumen	APP	$1.80	$1.90	n/a	
Modified Bitumen	SBS	n/a	$1.68	n/a	
Single Ply	PVC	$1.18	$1.18	$1.33	60 mil
Single Ply	TPO	$0.96	$0.96	$1.12	60 mil

Manufacturer Coating Cost Data

Additional information was provided a manufacturer for roof coatings. The costs include material and labor costs to apply the required number of coats needed to meet proper roof installation. Costs of the five widely used coating products used in California are shown in table 5 below.

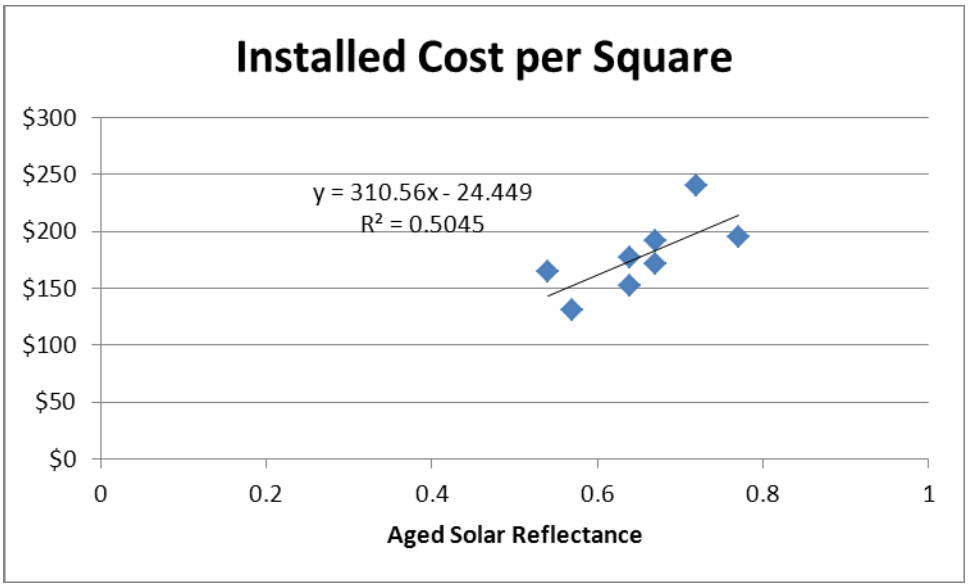
Table 5 – Roof Coating Cost Data

	Cost ($/gal)		SR		TE		Coverage (mils)	Mat'l Cost ($)	Coats	Labor	Installed Cost
	Avg	SBV	Initial	3 yr	Initial	3 yr	Mod'ty	Typ'l $/sqr	Mod'ty	Avg $/sqr	Typ'l $/sqr
D-6083 Acrylic	14.50	0.54	0.83	*0.67*	0.91	*0.90*	40	$67	3	105	$172
D-6083 HT	17.50	0.52	0.82	0.72	0.89	0.90	50	$105	4	135	$240
D-6694 Silicone Coating	30.67	0.80	0.86	0.64	0.87	0.88	20	$48	2	105	$153
Acrylic for Asphalt	14.33	0.60	0.81	0.54	0.89	0.89	40	$60	3	105	$165
D-6083 Acrylic for Single Ply's	14.50	0.54	0.83	*0.67*	0.91	*0.90*	40	$67	4	125	$192

Notes:
Price is the typical price per gallon of coating. SBV is the solid fraction by volume. SR is solar reflectance and TE is thermal emittance. The material cost is the typical material cost per roofing square (100 ft2) based on the number of coats required to achieve the recommended dry finished thickness (DFT).

Manufacture information indicated that there are several coating materials use to achieve a cool roof, all with different costs. A linear regression of all cost for all coatings was used to establish a signal incremental cost for roof coatings materials, which is presented in figure 1 below.

Figure 1: Cost of Roof Coatings



The average change in cost to achieve an aged solar reflectance of 0.65 is $31 per square ($0.31/ft^2).

Findings

The cost data was obtained from several sources: roof contractors, distributors and a manufacturer through different regions of the state. The following incremental costs are shown in table 1 above. Information provided by these sources indicates that the installation cost for a cool roof material is the same regards of the solar reflectance value for the roof type. In addition there does not seem to be a change in the maintenance schedule that often accompanies the installation of a roof type used for low sloped roofs.

The incremental costs for all roofing types are lower than the estimated present value of energy savings for the cool roof. The 2013 low sloped cool roof solar reflectance of 0.65 represent an approximate ????? percent better than the 2008 Standard.

Reference Materials

Phone Survey – Detailed Costs

The table below shows detail survey results from the phone survey. Nine contractors in different regions of the state were interviewed. In many cases, the contractors did not have cost estimates for all of the roofing types; for example, some do not work with the torch-applied modified bitumen. Also, most were not able to distinguish any price difference between single ply products that barely meet 2008 Title 24 code and those that would meet the code proposal of an aged reflectance of 0.65. The contractors said that the price difference would only be the material price difference.

Table 7 - Contractor Phone Survey Individual Survey Results

	Oakland #1	Oakland #2	Los Angeles	Van Nuys	Fresno	San Bernardino	San Diego County	Fresno (prevailing wages)	Liver-more
BUR, dark cap sheet	$5.00	$3.00	$1.67	$3.10	$5.75	$2.25 to $2.50	$5.00	$3.50 to $4.50	n/a
BUR, T24 cap sheet	$6.25	$3.65	$2.27	$3.80	$6.25	$3.50	$6.00	n/a – uses coating for extra $1/ft2	n/a
SPR, 60 mil, TPO, 0.55	$7.50	n/a	$3.25	n/a	$4.00	n/a	$6.00	$3.50 to $4.50	$3.50
SPR, 60 mil, PVC, 0.55	n/a	n/a	n/a	n/a	$5.50	n/a		$4.00 to $5.00	$3.70
SPR, 60 mil, TPO, 0.65	$7.50	n/a	Don't know	n/a	Don't know	n/a		Same price, only material price difference	Depends on product
SPR, 60 mil, PVC, 0.65	n/a	n/a	Don't know	n/a	Don't know	n/a		Same price, only material price difference	Depends on product
Mod Bit, SBS**	$8.50	n/a	$2.47	$3.10	$9.00 for cold applied	n/a		$5.00 to $6.00	$4.75
Mod Bit, SBS 0.65	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	$5.00
Mod Bit, APP	n/a	n/a	$2.27	$2.65	$5.50	n/a	$5.00 ($6 coated)	$10.00*	n/a
Metal roof, Coating	n/a	$1.60-$1.80	$1.13	$1.90	$2.50	n/a			n/a
Recoat	$2.50	$1.00	$1.00	$1.25	$1.50 to $1.75	$2.00 to $2.50	$2.00	$1.60	n/a

* Excluded high number from survey average, since it was much higher than the other estimates.

** Used Livermore estimate when looking at price differential between SBS that meets 2008 Title 24 and SBS that meets the proposed level. Other cost estimates for modified bitumen SBS were for reflectance levels that just meet code (0.55 aged).

Email Survey Results

Raw Cost Data

The following data is from a southern California contractor. This data is actually a compilation of price data from recent projects. All costs are installed costs in $/ft^2.

Table 8 – San Diego County Contractor Email Survey Results

	System	Standard	T24-2008 compliant	Difference	2013 Cost	Difference 2013 Prop
1	BUR, Aggregate	$3.65	$4.33	$0.68	n/a	
2	BUR, Cap Sheet	$2.89	$3.42	$0.53	n/a	
3	Mod Bit SBS	$5.57	$6.10	$0.53		
4	Mod Bit APP	$4.52	$5.05	$0.53		
5	Single Ply 60 mil, TPO	$3.24	$3.24	$0.00	$3.24	-$0.18
	Single Ply 60 mil, PVC	$3.47	$3.47	$0.00	$3.47	$0.05
	Alterations					
1	Recoat	$1.65	$1.65	None		
2	Reroof, BUR aggregate	$4.26	$4.94	$0.68		
	Reroof, BUR cap sheet	$3.50	$4.03	$0.53		
	Reroof, Mod Bit SBS	$6.18	$6.71	$0.53		
	Reroof, Mod Bit APP	$5.13	$5.66	$0.53		
	Reroof, Single Ply 60 mil	$3.85	$3.85	$0.00		-$0.18

The following data is from a northern California (Bay Area) contractor. A slightly different survey was given, focusing on re-roofing costs, so some of the information provided in the more detailed survey is not available.

Table 9 – Concord, CA (East Bay, Northern California) Contractor Email Survey Results

	System	Standard	T24-2008 compliant	Difference	Difference 2013 Prop
1	BUR, Aggregate	n/a			
2	BUR, Cap Sheet	$2.66	$3.20	$0.54	
3	Mod Bit SBS	n/a	n/a		
4	Mod Bit APP	n/a	n/a		
5	Single Ply 60 mil, TPO	$3.50	$3.50	$0.00	
	Single Ply 60 mil, PVC				
	Alterations				
1	Recoat	$1.50	$1.50	none	
2	Reroof, BUR aggregate	n/a			
	Reroof, BUR cap sheet	$3.41	$3.95	$0.54	
	Reroof, Mod Bit SBS				
	Reroof, Mod Bit APP				
	Reroof, Single Ply 60 mil	$4.24	$4.24	$0.00	$0.29

A third contractor in the Sacramento area discussed prices over the phone, but did not fill out the entire survey. He provided the following estimates:

1. Tear off and replace BUR with BUR and cool cap sheet – $4.00/ft2
2. Tear off and replace BUR with single ply, 60 mils - $3.50/ft2
3. Tear off and replace mod bit roof and add reflective coating (aged 0.63) - $6.00/ft2
4. Coatings run about $1.50/ft2 installed
5. All single ply products run about the same price

Email Survey

Nonresidential Low-Sloped Roof Cost Survey

Thank you for completing the survey. If a particular job scenario does not apply to your company you may leave it blank. For questions for comments contact John Arent at jarent@archenergy.com or call 415-970-6513.

Please respond to the questions below in the yellow boxes.
You may leave a question blank or write "N/A" if it is not applicable to your business.

Price Survey Location (City):

_____

	Installed Price ($/sf)	**Recoat Price** ($/sf)

A. Built Up Roof Coverings

Baseline System 1 - Built up roof membrane with conventional gravel aggregate surfacing over a wood deck.

Highly Reflective Options		
1. Reflective Aggregate		
2. Field-Applied Reflective Coating	*(provided by others)*	*(provided by other)*

Baseline System 2 - Built up roof membrane with conventional mineral surfaced cap sheet over a wood deck.

Highly Reflective Options		
1. Reflective Top Ply		
2. Field-Applied Reflective Coating		

B. Modified Bitumen Roof Coverings

Baseline System 3 - Conventional mineral surfaced 2-ply SBS modified bitumen membrane over a wood deck.

Highly Reflective Options		
1. Reflective Top Ply		
2. Field-Applied Reflective Coating		

Baseline System 4 - Conventional smooth surfaced 2-ply APP modified bitumen membrane over a wood deck.

Highly Reflective Options		
1. Reflective Top Ply		
2. Field-Applied Reflective Coating		

C. Single Ply Roofs

Baseline System 5 - Single Ply Roof with minimum 60 mil membrane

Indicate roof type: **TPO** or **PVC**	TPO or PVC	
1. CRRC Aged Reflectance of 0.55		
2. CRRC Aged Reflectance of 0.67		

General Procedures when contacting **Commercial Building** roofing contractors and distributors:

Candidate Roof Contractor –

Thank you for agreeing to participate in our cost survey for low-sloped roofs. We are looking to gather accurate cost information to support the development and revisions of the Title 24 efficiency standards for 2013.

The purpose of this request is to gather information on:

1. New construction installed costs, for different roof types
2. Installed costs for re-roofing on existing buildings
    a. Re-roof installed costs (tear off)
    b. Re-coating costs for cool roof membrane

The attached spreadsheet includes five baseline roof systems; two built up roof (BUR) and two modified bitumen (MB) roof system and a single-ply roof, and indicates 2 options to make the baseline roof coverings more highly reflective. For surface properties of the proposed highly reflective roof systems see NOTES below.

Baseline Systems, Reflective Options, and Recoating:

A. Built Up Roof Coverings

1. Baseline System 1 - Built up roof membrane with conventional gravel aggregate surfacing over a wood deck. Class B or better fire-rated system.
    a. Reflective Aggregate Option – Omit conventional gravel aggregate. Install instead a reflective aggregate adhered with an adhesive.
    b. Field-Applied Reflective Coating Option – Remove the loose aggregate, install conventional gravel aggregate in coat of asphalt.. Then coat embedded gravel aggregate with reflective cementitious coating.
2. Baseline System 2 - Built up roof membrane with conventional mineral surfaced cap sheet over a wood deck. Class B or better fire-rated system.
    a. Reflective Top Ply Option– Omit conventional mineral surfaced cap sheet. Install instead a cap sheet with a factory-applied highly reflective surface (with or without mineral granules) .

b. Field-Applied Coating Option – Maintain conventional mineral surfaced cap sheet. Field-apply a highly reflective elastomeric coating system.

B. Modified Bitumen Roof Coverings

1. Baseline System 3 - Conventional mineral surfaced 2-ply SBS modified bitumen membrane over a wood deck.
   a. Reflective Top Ply Option – Omit conventional MB top ply. Install instead a MB top ply with a factory-applied highly reflective surface (with or without mineral granules).
   b. Field-Applied Coating Option – Field-apply a highly reflective elastomeric coating system to either a conventional mineral surfaced MB top ply or to a smooth MB top ply.

2. Baseline System 4 - Conventional smooth surfaced 2-ply APP modified bitumen membrane over a wood deck.
   a. Reflective Top Ply Option – Omit conventional smooth surfaced MB top ply. Install instead a MB top ply with a factory-applied highly reflective surface.
   b. Field-Applied Coating Option – Field-apply a highly reflective elastomeric coating system to conventional mineral surfaced MB top ply.

C. Single-ply roofing system – a single ply roof with a minimum 60 mil thickness membrane.
Indicate whether a TPO or PVC membrane is used by noting the choice on the survey.

Assume the project involves replacing an existing roof on a typical commercial building (e.g. strip mall drug store) within 50 mile radius of the contractor's operations, a simple rectangular roof shape covering 25,000 square foot, no parapets, 1/4:12 slope, bowl style drains and overflows, several self-contained roof top units, eligible for a manufacturer 10 year warranted system but DO NOT include the price of a warranty in the roof system price information.

Provide installed, price-to-the-owner type information (e.g., include labor, materials, overhead, and profit) including additional labor, if any, typically required to “touch up” highly reflective applications. Apply values that in your opinion are typical for the area indicated.

Notes:

- “Highly Reflective” refers to CRRC (Cool Roof Rating Council) listed and labeled materials meeting the minimum 3-year aged solar reflectance of 0.65 and aged solar reflectance of 0.75, respectively. See CRRC Web site “coolroofs.org” for Rated Products Directory.
- “Reflective” refers to CRRC (Cool Roof Rating Council) listed and labeled materials meeting the Title 24 requirement of minimum 3-year aged reflectance of 0.55 and aged thermal emittance of 0.75, respectively. See CRRC Web site “coolroofs.org” for Rated Products Directory.
- “Class B Fire Rated" means the system, including the highly reflective option, has been tested and qualifies for a Class B external fire rating or better (ASTM E108), or additional fire rated membrane. Include additional prices, if any, associated with obtaining fire rated systems (e.g., only tested products, installed at recommended minimum mill thicknesses and combinations, etc.).
- Unreinforced Recoating/Renewal - The “highly reflective” options are anticipated to require recoating and/or renewal of reflective surfacing after about 7 or 8 years of service. Include prices associated with preparing a 7 to 8 year BUR or MB roof (e.g., cleaning) and applying a highly reflective coating today (not 7 to 8 years from now) at today’s costs and pricing.

Phone Survey

Assumptions: for the sample project assume a medium size, 15,000 ft2 retail (low-rise) building, several rooftop units, no parapet wall, bowl style drains and a class B or better fire rating.

Similar roof type descriptions from the email survey were used in the phone survey.

For NEW CONSTRUCTION, provide installed cost estimates for each of the following roof systems:

1. BUR, dark mineral surfaced cap sheet (does not meet Title 24-2008 reflectance requirements)
2. BUR, T24 cool cap sheet: meets 2008 Title 24 reflectance requirements (aged reflectance of 0.55)
3. Single Ply Roof, 60 mil, TPO, aged reflectance of 0.55
4. Single Ply Roof, 60 mil, TPO, aged reflectance of 0.65
5. Single Ply Roof, 60 mil, PVC, aged reflectance of 0.55
6. Single Ply Roof, 60 mil, PVC, aged reflectance of 0.65
7. Modified bitumen, fully adhered (SBS), 0.55
8. Modified bitumen, fully adhered (SBS), 0.65
9. Modified bitumen, APP (torch-applied), 0.55
10. Modified bitumen, APP (torch-applied), 0.65

For existing construction, what is the cost to recoat:

11. Recoat, unreinforced coating