

February 8, 2012

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 possible increased costs for a more reflective roof are cost effective compared to the energy saved over the assumed life of the roof. 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 (provide a link to this report)*.

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 low-sloped 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 was assumed. The size dynamics of this roof was identical that used by the Asphalt Roofing Manufacturers Association (ARMA) in their survey to the roofing industry for the 2008 Title 24 Standard development activity. The cost data obtained from the survey was then used with the energy analysis results for the assumed reference prototype building. The reference building used for this analysis is 16,900 square feet, and is the same reference prototype building used to develop the ASHRAE 90.1 Standards. Examples of survey instruments are provided in the *Reference Materials* section.

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Energy Savings Estimate

The energy savings estimate was determined using the methodology outlined in the Codes and Standards Enhancement (CASE) program. The building prototype model developed by the Department of Energy was used as the basis and inputs were modified to be in exact conformance with the 2008 Title 24 prescriptive requirements. The same process used to evaluate new measures is used to demonstrate that a building complies with the Standard. Internal load assumptions for the model match the office occupancy load assumptions that are specified in the Nonresidential ACM Manual. These load assumptions are fixed for the purpose of compliance calculations.

Time dependent valuation weighting factors are applied to electricity and gas use at each hour to determine energy use. Present value estimates in dollars are derived from savings over a 15-year life; the factors were developed by Energy and Environmental Economics and incorporate fuel escalation costs, generation mix and discount rates, among other factors.

The basic cost of roofing material, excluding distributor or contractor markups, is driven by the cost of materials 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 (Mod Bit), 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, Riverside, 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 could only be 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.

Methodology

The methodology for developing the survey and list of those polled is listed below.

Contractor Survey. Over 70 contractors were identified and targeted for the survey. The method used to generate the survey sample was as follows:

- From the National Roof Contractors Association online database, specify a metropolitan area (such as San Francisco), and search for contractors within a 50 mile radius.
- Add at least ten contractors from each region, unless less than 10 were available within the radius. The following areas were included: San Francisco, San Jose, Sacramento, Los Angeles, San Diego, Riverside, Fresno and Bakersfield.

This process could leave out contractors that are not near urban areas; however, the majority of new construction will take place in the surveyed areas. A true random sample might not provide a representative sample in different regions of the state.

The contractor survey form was developed in collaboration with ARMA. Reed Hitchcock of ARMA provided the survey form, and only minor revisions were made after AEC had John Goveia of Pacific Roof Consultants review the form. The form specified a sample roofing job with assumptions, and asked for installed costs for different roofing systems. Of the over 70 contractors identified, one-third of them agreed to look at the survey and tentatively agreed to fill out the form. Only three responses were received from the contractors, and one of these was by phone, using the same survey form and stating the same job assumptions. One of the three respondents from southern California actually pulled average costs of actual jobs from a database.

Phone Survey. Since the contractor data alone was insufficient to determine costs, a number of contractors were called by phone and asked a series of questions to gather costs for the same roofing systems. Again, the same approach was used to determine who to contact: a set of contractors from each of the regions of the state were identified above and called. The respondents (9) were from the following areas: Bay Area, Los Angeles, Sacramento, Fresno, Bakersfield.

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 roofing types, and not all contractors 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

Cost findings for all roof types are presented in Table 1. 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 2).

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/ft ²	Distributors
BUR	Mineral cap sheet	BUR to single ply	\$0.30/ft ²	Contractors/Distributors
Single Ply	TPO (60 mil)	Same	\$0.16/ft ²	Distributors
Single Ply	PVC (60 mil)	Same	\$0.15/ft ²	Distributors
Modified Bitumen	APP	Same	No data ¹	
Modified Bitumen	SBS	Same	\$0.25/ft ²	Contractors – Phone Survey
Roof Coatings	Unreinforced coating	Same	\$0.31/ft ²	Manufacturer Data

Note:

¹Data for Modified Bitumen APP was not obtainable due to the fact that not all contractors install the APP system. APP is a torch-applied (hot welded) membrane which requires the contractor to carry special liability insurance.

The net present value presented in the life-cycle cost summary below shows that a cool roof meeting the proposed aged reflectance requirement of 0.65 is cost effective. Table 2 shows the present value savings of each roof type. For simplicity, 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 0.65¹

Roof Type	Incremental Cost	PV Savings (High)	Net Present Value (High)	PV Savings (Low)	Net Present Value (Low)
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

¹Energy savings are estimated from the single-story office building prototype in the CASE report. The present value of savings is shown for the climate zone with the highest savings and the climate zone with the lowest savings only; savings for other climate zones fall in between the low and high values. Savings are adjusted lower from the earlier CASE report, which was based upon an aged reflectance of 0.67.

In summary, the proposed aged reflectance of 0.65 is cost effective in all climate zones and for all roofing types studied. When comparing the net present value of roof coatings (field-applied coatings) to those of single-ply, BUR and the modified bitumen (SBS), the present value of the energy savings for roof coatings only slightly outweigh the incremental costs. However, Table 2 only represents present value savings based on the highest and lowest savings from all climate zones. The net present value savings of the remaining 14 California climate zones falls between the high and low net present values indicated above. For low-sloped roofing types energy savings far outweigh the measure cost, resulting in large statewide energy savings.

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 top membrane.
 - Cap sheet— Surface top sheet of asphaltic based granular typically rolled across the surface of the roof.
 - Coated granules—Granular surface top coating typically spread across the top asphaltic layer.
- Modified bitumen (Mod Bit)—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; a self adhesive fully-adhered membrane
 - APP—Asphaltic material with non-woven polyester or glass fiber reinforcements, torch-applied (hot welded) membrane
- Single Ply—Pre-fabricated sheet of rubber polymers 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-adhered.
- TPO—Thermoset material combining plastic and rubber that is applied by mechanical attachment or is fully-adhered.
- Roof Coatings—Acrylic, urethane and silicone coatings which are field-applied to a variety of substrates. (Note: only unreinforced coatings were considered; those that do not include a layer of polyester fabric).

Contractor Costs

Cost information from contractors was 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: the San Francisco Bay area, the San Diego area, and the Sacramento area. Due to the limited response from 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 San Francisco Bay area, Los Angeles, San Diego, Fresno, and San Bernardino. The summary results, which incorporate the responses of both the phone survey and email survey, are shown in Table 3 below. Contractor cost results represent the average cost for the roof type with the specific aged solar reflectance. Detailed survey responses for each respondent to the phone survey and email survey are included in the *Reference Materials* 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	\$4.26	\$4.29	9 contractors; distributor costs for SR>=0.65
Modified Bitumen	APP	\$4.09	no response; not often used in CA.	5 contractors
Modified Bitumen	SBS	\$4.75	\$5.00	1 contractor for both
Single Ply	TPO	\$4.43	\$4.59	7 contractors
Single Ply	PVC	\$5.03	\$5.18	4 contractors
Field Applied Coating	Varies	\$1.65	\$1.96	4 contractors

Note: 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

Distributor Costs

Eleven (11) distributors were contacted throughout the state. These costs include a 30% contractor mark-up and are presented in Table 4 below.

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 cost information was provided by one manufacturer of roof coatings. The costs include material, labor and equipment costs to apply the required number of coats needed to meet proper roof installation. This

manufacturer provided costs of eight widely used coating products used in California. This cost information is shown in Table 5 below. Three products were excluded from the analysis; two of these incorporated polyester fabric in addition to the liquid coating and the third product was used for high tensile strength applications.

Table 5 – Roof Coating Cost Data

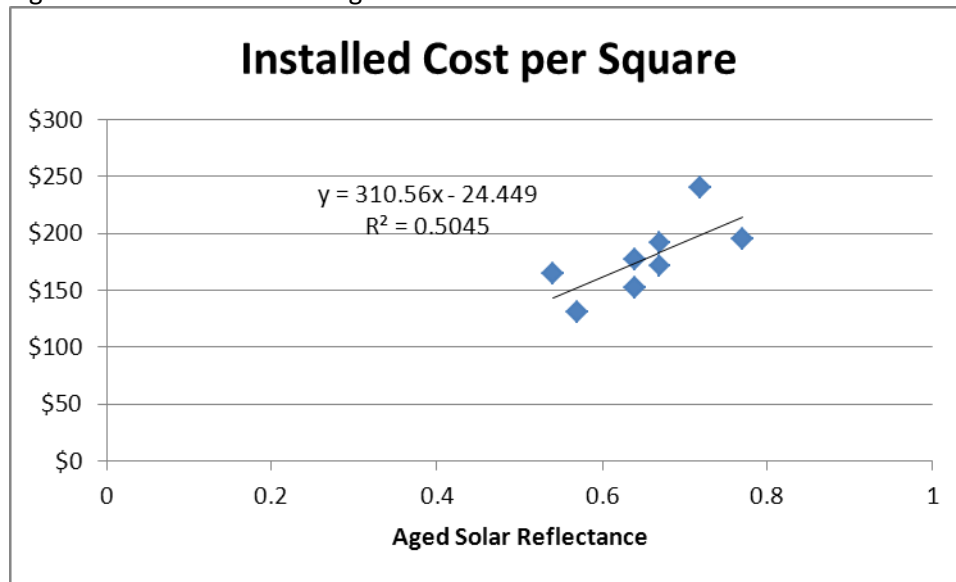
	Cost (\$/gal)	SR		TE		Coverage (mils)	Mat'l Cost (\$)	Coats	Labor	Installed Cost
	Avg	Initial	3 yr	Initial	3 yr	Mod'ty	Typ'l \$/sqr	Mod'ty	Avg \$/sqr	Typ'l \$/sqr
D-6083 Acrylic	14.50	0.83	0.67	0.91	0.90	40	\$67	3	\$105	\$172
D-6083 HT	17.50	0.82	0.72	0.89	0.90	50	\$105	4	\$135	\$240
Styrene Acrylic	\$12	80	57	91	88	30	\$46	2	\$85	\$131
Fluoropolymer	\$100	87	77	89	68	4.0	\$50	4	\$145	\$195
D-6694 Silicone Coating	30.67	0.86	0.64	0.87	0.88	20	\$48	2	\$105	\$153
Acrylic for Asphalt	14.33	0.81	0.54	0.89	0.89	40	\$60	3	\$105	\$165
Ceramic	\$16	84	64	89	87	40	\$73	3	\$105	\$178
D-6083 Acrylic for Single Ply's	14.50	0.83	0.67	0.91	0.90	40	\$67	4	\$125	\$192

Note:

Cost (\$/gal) is the typical price per gallon of coating. 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).

Information from this manufacturer indicates there are several coating materials used to achieve a cool roof, all with different costs. To depict a single cost for all roof coating materials a linear regression was established of total installed cost against aged reflectance for all coatings. The regression results were used to establish a signal incremental cost for roof coating materials. The regression analysis is presented in Figure 1 below. Results of this analysis shows that the average change in cost to achieve an aged solar reflectance of 0.65 for roof coatings is \$31 per square (\$0.31/ft²).

Figure 1: Cost of Roof Coatings



Findings

The cost data was obtained from several sources: roof contractors, distributors and one manufacturer representing different regions of the state. The incremental costs are shown in Table 1 above. Information provided by these sources indicates that the material cost represents the primary cost increase attributed to a more reflective roof. Installation costs are the same regardless 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.

Reference Materials

Phone Survey – Detailed Costs

Table 7 below shows detailed phone survey results. Nine contractors in different regions of the state were interviewed. In many cases, the contractors did not have cost estimates for all of 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 meet the 2008 Title 24 solar reflectance of 0.55 and those that would meet the 2013 code proposal of an aged solar reflectance of 0.65. Contractors indicated that any price difference would only be for the material. The results from the email survey were compiled with the phone survey results below to determine average installed costs.

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)	Livermore
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/ft ²	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. All costs are installed costs in \$/ft².

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 Alterations	\$3.47	\$3.47	\$0.00	\$3.47	\$0.05
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 (San Francisco bay area) contractor.

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. 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

Example of 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)
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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	<div style="background-color: yellow; width: 100%; height: 20px;"></div>	<div style="background-color: yellow; width: 100%; height: 20px;"></div>
2. Field-Applied Reflective Coating	<i>(provided by others)</i>	<i>(provided by other)</i>

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

Highly Reflective Options

1. Reflective Top Ply	<div style="background-color: yellow; width: 100%; height: 20px;"></div>	<div style="background-color: yellow; width: 100%; height: 20px;"></div>
2. Field-Applied Reflective Coating	<div style="background-color: yellow; width: 100%; height: 20px;"></div>	<div style="background-color: yellow; width: 100%; height: 20px;"></div>

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	<div style="background-color: yellow; width: 100%; height: 20px;"></div>	<div style="background-color: yellow; width: 100%; height: 20px;"></div>
2. Field-Applied Reflective Coating	<div style="background-color: yellow; width: 100%; height: 20px;"></div>	<div style="background-color: yellow; width: 100%; height: 20px;"></div>

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

Highly Reflective Options

1. Reflective Top Ply	<div style="background-color: yellow; width: 100%; height: 20px;"></div>	<div style="background-color: yellow; width: 100%; height: 20px;"></div>
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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 CRR (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 CRR Web site “coolroofs.org” for Rated Products Directory.
- “Reflective” refers to CRR (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 CRR 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.

Example of Phone Survey Questions

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