



COOL ROOF APPLICATION GOING DOWN IN THE WEST.

Cool Roofs

California Cool Roofs: A Snapshot of Installed Costs

by Phil Dregger, principal, Pacific Building Consultants

(Editor's Note: Phil Dregger is a registered engineer, registered roof consultant, fellow of the Roof Consultants Institute, and principal of Pacific Building Consultants, Inc., a DNG Group Company, in Concord, Calif., specializing in finding solutions to difficult building moisture problems. Dregger is a past director of the Roof Consultants Institute (RCI), a former faculty member of the

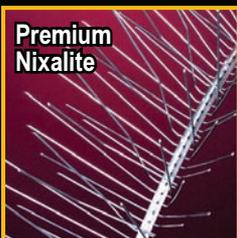


Roofing Industry Educational Institute, and serves as a consultant to the Asphalt Roofing Manufacturers Association (ARMA) on California Energy Code issues. Dregger may be reached at pdregger@dng-group.com.)



In October 1, 2005, the roof industry in California underwent a quantum change. Since that date, new and replacement roof coverings on certain low-sloped non-residential buildings were required to meet new stricter energy-efficiency standards. The new standards will undoubtedly save energy but at what cost to building owners? This article presents the results of a "snap shot" survey of five well-known California roofing

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The new standards require new and replacement roofs on certain non-residential buildings to meet minimum levels of energy efficiency. Generally speaking all non-residential buildings with roofs sloped less than 2:12 over conditioned spaces need to comply with the new requirements.

contractors regarding cost premiums associated with installing "cool" roofs as part of low-sloped membrane roof coverings.

The new energy-efficiency standards, referred to collectively as California Title 24, Part 6, are also known as the California Energy Code. The new standards require new and replacement roofs on certain non-residential buildings to meet minimum levels of energy efficiency. Generally speaking all non-residential buildings with roofs sloped less than 2:12 over conditioned spaces need to comply with the new requirements. However, compliance with the stricter requirements is optional if the building is: a hotel or motel; institutional "I" occupancy/use;

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Roofing Product	Cool Variety	Cost Premium (\$/ft ²)
ballasted BUR	use white gravel	up to 0.05
BUR with smooth asphalt coating	use cementitious or other white coatings	0.10 to 0.20
BUR with aluminum coating	use cementitious or other white coatings	0.10 to 0.20
single-ply membrane (EPDM, TPO, CSPE, PVC)	choose a white color	0.00 to 0.05
modified bitumen (SBS, APP)	use a white coating over the mineral surface	up to 0.05
metal roofing (both painted and unpainted)	use a white or cool color paint	0.00 to 0.05
roof coatings (dark color, asphalt base)	use a white or cool color coating	0.00 to 0.10
concrete tile	use a white or cool color	0.00 to 0.05
cement tile (unpainted)	use a white or cool color	0.05
red clay tile	use cool red tiles	0.10

cooled by evaporative cooler (swamp coolers) and not heated; a qualified historic structure; and, not intended for human occupancy (e.g., held less than 55°F or greater than 90°F).

Compliance Options

The 2005 Energy Code provides three compliance options for roofs – two “prescriptive” options and one “performance” option. Without going into detail, it is fair to say that for roof replacement projects, the most straightforward and simple compliance option is the first prescriptive option – apply a “cool roof.”

The other compliance options allow non-cool roofs to be installed as a sort of trade-off for increasing the energy efficiency of some other building component above base line levels (e.g. adding roof insulation). The second prescriptive option requires some relatively simple calculations to be performed showing that the proposed roof system with a non-cool membrane provides the same cooling energy efficiency as the standard “prescriptive” roof. The performance option requires a full-fledged computer analysis conducted by a certified energy consultant to show basically the same thing. Again, the most straightforward compliance option by far is to install a cool roof.

Table 1 – “Non-Cool” Roof Configurations

Built-Up Membranes – Wood Decks	
•	Insulation <u>below</u> deck (insulation costs NOT INCLUDED)
•	Nailed base, ply sheets adhered with hot asphalt, fire rated.
•	Base, 3 Type IV ply sheets, and aggregate.
•	Base, 2 Type IV ply sheets, and cap sheet.
•	Base, 3 Type IV ply sheets, and asphalt/aluminum emulsion.
Built-Up Membranes – Steel Decks	
•	Insulation <u>above</u> deck (insulation costs NOT INCLUDED)
•	Adhered with hot asphalt, fire rated.
•	3 Type IV ply sheets and aggregate.
•	3 Type IV ply sheets and cap sheet.
•	3 Type IV ply sheets and asphalt/aluminum emulsion.
Single Ply Membranes – Wood Decks	
•	Insulation <u>below</u> deck (insulation costs NOT INCLUDED)
•	45-60 mil, mechanically attached UNO, fire rated (include costs of required FR underlayments/thermal barriers).
•	EPDM loose laid w aggregate ballast.
•	EPDM fire rated membrane
•	White CPE, CSPE, PVC, or TPO (assume “cool”)
Single Ply Membranes – Steel Decks	
•	Insulation <u>above</u> deck (insulation costs NOT INCLUDED)
•	45-60 mil, mechanically attached UNO, fire rated (include costs of required FR underlayments/thermal barriers).
•	EPDM loose laid w aggregate ballast.
•	EPDM fire rated membrane
•	White CPE, CSPE, PVC, or TPO (assume “cool”)
Modified Bitumen Membranes – Wood Decks	
•	Insulation <u>below</u> deck (insulation costs NOT INCLUDED)
•	Nailed base, ply sheets adhered with hot asphalt, fire rated (include costs of required FR sheets/thermal barriers).
•	Base and 2 ply APP/SBS with aggregate ballast
•	Base and 2 ply SBS with granulated cap sheet
•	Base and 2 ply APP with granulated cap sheet
•	Base and 2 ply APP with unsurfaced FR sheet
•	Base and 2 ply APP with asphalt/aluminum emulsion
Modified Bitumen Membranes – Steel Decks	
•	Insulation <u>above</u> deck (insulation costs NOT INCLUDED)
•	Ply sheets adhered with hot asphalt, fire rated (include costs of required FR sheets/thermal barriers).
•	2 ply APP/SBS with aggregate ballast
•	2 ply SBS with granulated cap sheet
•	2 ply APP with granulated cap sheet
•	2 ply APP with unsurfaced FR sheet
•	2 ply APP with asphalt/aluminum emulsion

Cool Roofs Defined

As defined by the 2005 California Energy Code, a “cool” roof is a roof covering or surfacing that has been tested and labeled by the Cool Roof Rating Council (CRRC) as having an initial solar reflectance of at least 0.70 and an initial thermal emittance of at least 0.75. For more information, see www.coolroofs.org.

The new energy-efficiency requirements are designed to conserve

(Continued on Page 18)

TABLE 2 - BUILT-UP ROOF COSTS (AVERAGE OF 5)

NON-COOL ROOF OPTIONS		COOL ROOF OPTIONS		PREMIUM	
Roof Cover Type	Cost (\$/ft ²)	Roof Cover Type	Cost (\$/ft ²)	Cost (\$/ft ²)	Cost (%)
Built-Up Roof - Wood Deck	2.07-2.67	Built-Up Roof - Wood Deck	2.67-3.77	.37-1.10	15-46%
base, 3 plies, and aggregate	2.67	base, 3 plies, and aggregate + 200 mil "cool" cementitious coating (*5)	3.77	\$1.10	41%
base, 3 plies and cap	2.07	base, 3 plies and cap + "cool" acrylic coating	3.02	\$0.96	29%
		base, 3 plies and cap + 20 mil "cool" cementitious coating (*5)	2.67	\$0.60	29%
		base, 3 plies and cap w factory applied "cool" coating (*4)	3.01	\$0.94	46%
base, 3 plies, and asphalt emulsion + aluminum emulsion	2.50	base, 3 plies, and asphalt emulsion + "cool" acrylic coating	2.87	\$0.37	15%
Built-Up Roof - Steel Deck	2.15-2.61	Built-Up Roof - Steel Deck	2.75-3.71	.37-1.10	15-43%
3 plies and aggregate	2.61	3 plies and aggregate + 200 mil "cool" cementitious coating (*5)	3.71	\$1.10	42%
3 plies and cap	2.15	3 plies and cap + "cool" acrylic coating	3.06	\$0.91	43%
		3 plies and cap + 20 mil "cool" cementitious coating (*5)	2.75	\$0.60	28%
		3 plies and cap w factory applied "cool" coating (*4)	3.04	\$0.89	42%
3 plies and asphalt emulsion + aluminum emulsion	2.47	3 plies and asphalt emulsion + "cool" acrylic coating	2.84	\$0.37	15%

Cool Roofs

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energy, and specifically to reduce peak demand for electricity. Reducing peak demand for electricity is

often pointed to in discussions as the key factor in reducing the number of new power plants that need to be built as well as avoiding "rolling black outs" like California experienced in 2001.

Cost Premiums

A question often not directly addressed as part of these discussions is what impact the new standards will have on the installed costs of roof systems in California. In other

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TABLE 3 - SINGLE PLY ROOF COSTS (AVERAGE OF 5)

NON-COOL ROOF OPTIONS		COOL ROOF OPTIONS		PREMIUM	
Roof Cover Type	Cost (\$/ft ²)	Roof Cover Type	Cost (\$/ft ²)	Cost (\$/ft ²)	Cost (%)
Single Ply - Wood Deck	3.05-3.85	Single Ply - Wood Deck	3.18-3.90	.00-.85	0-28%
EPDM loose laid w aggregate ballast (*2)	3.85	EPDM w "cool" ballast - None Available	NA		
EPDM "FR" membrane	3.05	EPDM w "cool" acrylic coating	3.90	\$0.85	28%
		White EPDM	3.25	\$0.20	7%
White CPE, CSPE, PVC or TPO	3.18	White CPE, CSPE, PVC or TPO	3.18	\$0.00	0%
Single Ply - Steel Deck	3.12-3.79	Single Ply - Steel Deck	3.42-3.85	.00-.73	0-24%
EPDM loose laid w aggregate ballast (*2)	3.79	EPDM w "cool" ballast - None Available	NA		
EPDM "FR" membrane	3.12	EPDM w "cool" acrylic coating	3.85	\$0.73	24%
		White EPDM	3.42	\$0.30	10%
White CPE, CSPE, PVC or TPO	3.28	White CPE, CSPE, PVC or TPO	3.28	\$0.00	0%

words, how much of a cost premium will a building owner in California likely have to pay to comply with the new requirements if the compliance option selected is to install a "cool" roof?

It is interesting to note that the new prescriptive cool roof requirements were included in the 2005 California Energy Code in part based on projected cost premiums associated with cool roofs.

As part of the process that led to including prescriptive cool roof requirements in the 2005 California Energy Code, a report entitled, *Inclusion of Cool Roofs in Nonresidential Title* (Continued on Page 20)

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Cool Roofs

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24 Prescriptive Requirements, Revised August 2002, was submitted by Pacific Gas and Electric. The report concluded, among other things, that the maximum cost premiums for cool roofs was \$0.20 per square foot or less and included the table shown on page 17.

We asked five well known, non-residential roofing contractors, representing both union and non-union operations, from across the State of California to provide us estimates of the installed costs for several low-sloped roof membrane systems both as "non-cool" installations and as "cool" installations. Two contractors were selected from the San Francisco Bay Area and one each from Sacramento, Fresno, and Los Angeles. Single-ply roofing

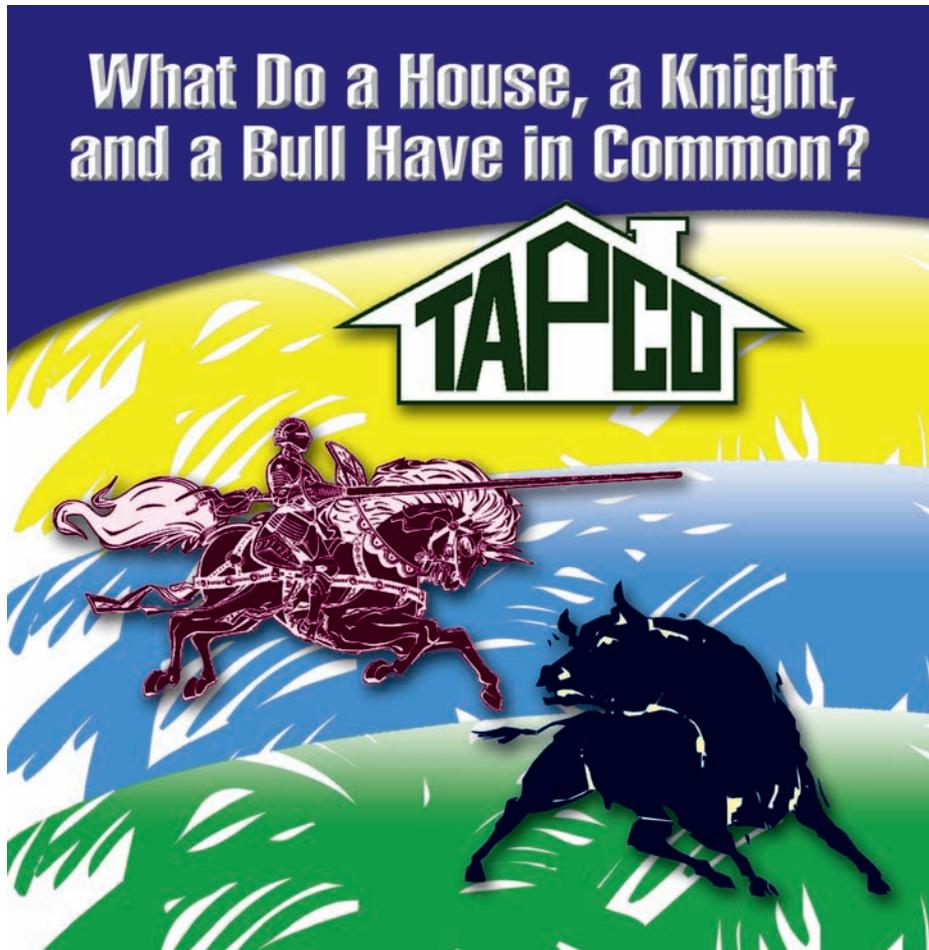
cost information from DC Taylor Company and built-up roofing and modified bitumen roofing cost infor-

mation from Bigham-Taylor Roofing were combined to represent "one" contractor. The contractors surveyed were: Steve Duchene, Bigham-Taylor Roofing (BUR and MB only); Mark Wilson, D7 Roofing Services; Bo Meyersieck, DC Taylor Company (single-ply only); Rick Boyce, Eberhard; Marty Dunham, Enterprise Roofing Service; and Gary Graham, Graham Prewett.

Cost estimates were requested for various predefined configurations of the three most common low-sloped membrane roof coverings installed in California over both wood (combustible) and steel (non-combustible) decks. Table 1 lists the basic "non-cool" roof configurations.

Both steel and wood decks were considered since California has at least as many non-residential buildings with wood decks as it has non-residential buildings with steel decks. Roof membranes over wood decks were also considered separately since single-ply roof membranes, when installed over wood decks (insulation below the deck) require additional protective layers (e.g., gypsum board) to achieve at least a Class B fire rating. The roof systems are assumed to be insulated, but we asked the con-

NON-COOL ROOF OPTIONS		COOL ROOF OPTIONS		PREMIUM	
Roof Cover Type	Cost (\$/ft ²)	Roof Cover Type	Cost (\$/ft ²)	Cost (\$/ft ²)	Cost (%)
Modified Bitumen - Wood Deck	3.03-4.88	Modified Bitumen - Wood Deck	4.19-5.41	.53-1.12	11-26%
MB w aggregate ballast (*2)	3.03	MB w "cool" ballast - None Available	NA		
w SBS granulated cap sheet	3.59	w "cool" Factory surfaced SBS granulated cap sheet (*4)	4.48	\$0.89	25%
		w SBS granulated cap sheet + "cool" acrylic elastomeric coating	4.37	\$0.79	22%
		w SBS granulated cap sheet + 20 mil "cool" cementitious coating (*5)	4.19	\$0.60	17%
w APP granulated cap sheet	4.20	w "cool" Factory surfaced APP granulated cap sheet (*4)	5.25	\$1.05	25%
		w APP granulated cap sheet + "cool" acrylic elastomeric coating	5.03	\$0.83	20%
w unsurfaced APP FR sheet	4.25	unsurfaced APP w asphalt emulsion + "cool" acrylic coating	5.38	\$1.12	26%
		w "cool" Factory surfaced APP sheet (*4)	5.22	\$0.97	23%
APP w asphalt emulsion + aluminum emulsion	4.88	APP w asphalt emulsion + "cool" acrylic coating	5.41	\$0.53	11%
Modified Bitumen - Steel Deck	3.31-4.79	Modified Bitumen - Steel Deck	4.15-5.36	.57-1.24	12-31%
MB w aggregate ballast (*2)	4.13	MB w "cool" ballast - None Available	NA		
w SBS granulated cap sheet	3.55	w "cool" Factory surfaced SBS granulated cap sheet (*4)	4.39	\$0.84	24%
		w SBS granulated cap sheet + "cool" acrylic elastomeric coating	4.58	\$1.03	29%
		w SBS granulated cap sheet + 20 mil "cool" cementitious coating (*5)	4.15	\$0.60	17%
w APP granulated cap sheet	3.98	w "cool" Factory surfaced APP granulated cap sheet (*4)	4.89		
		w APP granulated cap sheet + "cool" acrylic elastomeric coating	4.81	\$0.83	21%
w unsurfaced APP FR sheet	4.04	unsurfaced APP w asphalt emulsion + "cool" acrylic coating	5.07	\$1.03	25%
		w "cool" Factory surfaced APP sheet (*4)	5.28	\$1.24	31%
APP w asphalt emulsion + aluminum emulsion	4.79	APP w asphalt emulsion + "cool" acrylic coating	5.36	\$0.57	12%



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tractors to not include costs associated with the insulation. Insulation costs were not included since the insulation in both the non-cool and cool roof configurations is assumed to be the same and we were focusing on cool roof cost premiums.

For each basic roof membrane configuration, costs were requested for both a "non-cool" and a "cool" roof option. In general, cool options for bituminous roof membranes included utilizing special cool factory-coated cap sheets in lieu of a conventional mineral surfaced cap sheet or included applying cool coatings in the field. Single-ply roof systems utilizing white, single-ply roof membranes were assumed to be inherently "cool," not requiring a change to go from "non-cool" to "cool." We did not specify which generic type of single-ply roof membrane to consider only that the same type of membrane is considered in both the non-cool and cool configurations.

Cost Estimating Assumptions

The same table of roof systems and the same set of instructions were sent to each contractor. The following are excerpts from correspondence requesting the cost information.

"Thank you for agreeing to provide some typical roof system installation cost information. The attached spreadsheet indicates the form of the needed cost information and the various different roof systems we are interested in. Provide cost information for as many of the indicated roof systems as you have bidding experience. Assume new roof installations, located within a 25 mile radius of the contractor's operations, typical commercial buildings (e.g. strip mall drug store), a simple rectangular roof shape covering 25,000 square foot, no parapets, ¼:12 slope, bowl style drains and overflows, several self-contained roof top units, a manufacturer ten year warranted system but do not include the cost of the warranty in the roof system cost information. Assume insulation is installed as indicated but do not include costs associated with the insulation in your roof system costs. Include typical related sheet metal costs."

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Cool Roofs

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Selected Definitions & Other Comments

■ “Cool” refers to CRRC listed and labeled materials meeting the minimum values of 0.70 reflectance and 0.75 emittance.

■ “Fire Rated” means the system has been tested and qualifies for a Class B or better external fire rating (ASTM E108). Include costs directly related to obtaining fire rated systems (e.g. FR products, thermal barriers over wood decks below single-ply membranes).

■ Information may be limited regarding the availability and costs of some indicated products (e.g., “cool” factory coated fiberglass cap sheets or “cool” coated smooth APP sheets). Provide cost estimates for labor and/or materials you are able to obtain.”

Obviously, some non-residential building roofs cover more than 25,000 square feet and some cover less. Some non-residential building roofs have parapet walls and some do not. However, differences such these have little or no impact on the incremental cost differences of installing non-cool or cool roofs. The objective was to obtain cost premium information based on consistent sets of project assumptions.

It should be noted that we obtained costs associated with applications of a white cementitious coating from one specialty contractor, Craig Lease, Heat Shield Roof Coatings, Stockton, Calif., and added these costs to the costs we received from the five roof contractors.

Findings

The expected average cool roof cost premiums vary by roof system and by configuration.

- Built-Up Roofs - \$0.37 to \$1.10
- Single-Ply Roofs - \$0.00 to \$0.85
- Modified Bitumen Roofs - \$0.53 to \$1.24

Tables 2, 3, and 4 indicate the average installed cost for each roof system configuration and the “cool roof” cost premium associated with these average costs. Table 2 includes costs for built-up roof configurations. Table 3 includes costs for single-ply roof configurations. Table 4 includes costs associated with modified bitumen roof systems.

Table 5 is a summary of the ranges

of roof system costs and cost premiums by general roof system type and by location. The ranges of cost “premiums” relate to configuration-to-configuration comparisons and, therefore, do not necessarily track with the range of installed costs for that system type.

Although the data is limited to five contractors in four major metropolitan areas, it is clear from this snapshot that there are significant cost premiums associated with making adjustments to non-cool roofs so they qualify as “cool.”

TABLE 5 - ROOF SYSTEM COST RANGE BY LOCALE

NON-COOL ROOF OPTIONS		COOL ROOF OPTIONS		PREMIUM	
Roof Cover Type	Cost (\$/ft ²)	Roof Cover Type	Cost (\$/ft ²)	Cost (\$/ft ²)	Cost (%)
Built-Up Roof - Wood Deck	1.50-2.84	Built-Up Roof - Wood Deck	1.88-4.79	.17-1.95	9-69%
Fresno	2.25-2.77	Fresno	2.87-3.87	.28-1.10	11-40%
Los Angeles	2.84-3.20	Los Angeles	3.44-4.79	.49-1.95	16-69%
Sacramento	1.50-2.32	Sacramento	1.88-3.23	.17-1.10	9-65%
SF Bay (1)	1.86-2.52	SF Bay (1)	2.37-3.62	.30-1.10	12-44%
SF Bay (2)	2.07-2.73	Bay (2)	2.67-3.83	.60-1.10	24-50%
Built-Up Roof - Steel Deck	1.50-3.40	Built-Up Roof - Steel Deck	2.07-4.60	.17-1.60	9-57%
Fresno	2.38-2.72	Fresno	2.98-3.72	.28-1.10	10-42%
Los Angeles	3.01-3.40	Los Angeles	3.50-4.60	.49-1.60	16-53%
Sacramento	1.50-2.32	Sacramento	2.07-3.42	.17-1.10	9-57%
SF Bay (1)	1.93-2.24	SF Bay (1)	2.25-3.21	.30-1.10	13-52%
SF Bay (2)	1.92-2.58	SF Bay (2)	2.52-3.68	.60-1.10	26-54%
Single Ply - Wood Deck	1.98-5.24	Single Ply - Wood Deck	1.98-5.60	.00-1.07	0-35%
Fresno	2.24-3.05	Fresno	2.24-3.87	.00-1.00	0-35%
Los Angeles	4.11-4.70	Los Angeles	4.53-5.60	.00-1.07	0-24%
Sacramento	1.98-3.24	Sacramento	1.98-2.99	.00-.77	0-35%
SF Bay (1)	2.66-5.24	SF Bay (1)	2.91-3.65	.00-.59	0-22%
SF Bay (2)	2.98-3.61	SF Bay (2)	3.31-3.79	.00-.81	0-27%
Single Ply - Steel Deck	1.56-5.24	Single Ply - Steel Deck	1.56-5.25	.00-1.05	0-41%
Fresno	2.28-3.08	Fresno	2.28-3.94	.00-1.00	0-34%
Los Angeles	4.20-4.35	Los Angeles	4.20-5.25	.00-1.05	0-25%
Sacramento	1.56-2.82	Sacramento	1.56-2.54	.00-.74	0-41%
SF Bay (1)	2.66-5.24	SF Bay (1)	2.91-3.65	.00-.59	0-22%
SF Bay (2)	3.52-4.58	SF Bay (2)	4.29-4.80	.00-.80	0-20%
Mod. Bit. - Wood Deck	2.92-6.20	Mod. Bit. - Wood Deck	3.58-6.58	.15-1.32	4-29%
Fresno	3.23-4.43	Fresno	3.83-4.72	.29-1.05	7-29%
Los Angeles	4.39-6.20	Los Angeles	4.99-7.5	.60-1.60	14-33%
Sacramento	2.92-3.85	Sacramento	3.58-4.13	.15-.92	4-29%
SF Bay (1)	3.46-5.81	SF Bay (1)	4.05-6.58	.42-1.32	7-26%
SF Bay (2)	3.61-4.31	SF Bay (2)	4.21-5.1	.49-1.12	12-28%
Mod. Bit. - Steel Deck	2.66-6.40	Mod. Bit. - Steel Deck	3.26-7.35	.15-1.73	4-44%
Fresno	2.66-3.78	Fresno	3.26-4.06	.28-.98	7-32%
Los Angeles	4.55-6.40	Los Angeles	5.20-7.35	.60-1.70	12-37%
Sacramento	3.11-4.04	Sacramento	3.76-4.32	.15-.91	4-27%
SF Bay (1)	3.56-5.88	SF Bay (1)	4.16-6.15	.42-1.48	7-33%
SF Bay (2)	3.55-4.25	SF Bay (2)	4.15-5.65	.60-1.73	17-44%