

California Energy Commission STAFF REPORT

FINAL EVALUATION REPORT

Compliance Option for the *Building Energy Efficiency Standards*

Default Cool Roof Performance Values for Low-Sloped Roofs
That Use Aggregate as the Surface Layer



CALIFORNIA
ENERGY COMMISSION

Edmund G. Brown Jr., Governor

APRIL 2013

CEC-400-2012-018-SF

CALIFORNIA ENERGY COMMISSION

David W. Ware
Payam Bozorgchami
Primary Authors

Gary Flamm
Supervisor

Eurlyne Geiszler
Office Manager
***High Performance Buildings and
Standards Development Office***

Dave Ashuckian
Deputy Director
***EFFICIENCY AND RENEWABLE ENERGY
DIVISION***

Robert P. Oglesby
Executive Director

DISCLAIMER

Staff members of the California Energy Commission prepared this report. As such, it does not necessarily represent the views of the Energy Commission, its employees, or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the Energy Commission nor has the Commission passed upon the accuracy or adequacy of the information in this report.

ABSTRACT

California's *Building Energy Efficiency Standards* require that roofing products meet specific "cool roof" properties to help reduce building cooling loads by reflecting and emitting energy from the sun. These properties reduce roof temperatures on hot sunny days, resulting in lower energy use by air-conditioning systems. These properties are called "aged solar reflectance and thermal emittance." Roofing products must be tested, certified, and labeled for their cool roof properties according to provisions of the Cool Roof Rating Council.

Aggregate is a roofing product type made up of stone or gravel material that is used as finish surface layers for low-sloped roofing on some nonresidential buildings. Sample roof assemblies are made up of aggregate materials, as the surface layer cannot be transported to certified testing facilities to determine their cool roof properties without damage to the aggregate surface layer. As a consequence, tests for cool roofs with these materials are worse performing than would be expected for roofs of this type.

Staff proposes that the California Energy Commission approve a compliance option that establishes a default aged solar reflectance and thermal emittance value to be used for roofs that use aggregate as the surface layer. The proposed default aged solar reflectance and thermal emittance values are based on on-site testing for the solar reflectance of aggregate installed on low-sloped roofs, and manufacturer's published values for the initial thermal emittance of aggregate.

The proposed default values for cool roof properties of aggregate materials will allow a realistic assessment of "cool roof performance" for low-sloped roofs that use aggregate as the surface layer when showing compliance with the standards. The proposed default values for cool roof properties are representative of long-term performance as determined through on-site testing and are higher than the default values currently allowed for compliance purposes for untested roofing products.

Keywords: California Energy Commission, cool roofs, low-sloped roofs, solar reflectance, thermal emittance, Lawrence Berkeley National Laboratory, Heat Island Group, *Building Energy Efficiency Standards*

Ware, David W., Bozorgchami, Payam, 2012. *Default Cool Roof Performance Values for Low-Sloped Roofs That Use Aggregate as the Surface Layer*. California Energy Commission, High Performance Buildings and Standards Development Office, CEC-400-2012-018-SF.

TABLE OF CONTENTS

ABSTRACT	i
TABLE OF CONTENTS.....	ii
1. Introduction	1
1.1. Compliance Options.....	1
2. Staff Evaluation.....	3
3. Proposed Default Solar Reflectance, Thermal Emittance, and Eligibility Criteria.....	7
4. Conclusion.....	8

1. Introduction

This report presents California Energy Commission staff's recommendation for approval of a default aged solar reflectance for low-sloped roofs that use aggregate as the surface layer. The recommended default aged solar reflectance is based on results from in-situ (positioned as normally constructed) testing and requires that aggregate material used for roofing have prior testing results for the product's initial solar reflectance and thermal emittance.

1.1. Compliance Options

Public Resources Code, Section 25402.1 (b) requires the California Energy Commission to establish a formal process for certification of compliance options of new products, materials, or calculation methods for showing compliance with Section 10-109 of the *Building Energy Efficiency Standards* allows for the introduction of designs, materials, or devices that cannot be adequately modeled in the currently approved alternative calculation methods or are not appropriately accounted for in the current approved compliance approaches.

The compliance options process enables new or additional products, materials, designs, or procedures to be used to demonstrate compliance for newly constructed buildings and additions and alterations to existing buildings. The compliance options process encourages market innovation and allows the Energy Commission to respond to changes in building design, construction, installation, and enforcement.

1.2. Purpose of Compliance Option for Aggregate Roofing Materials

For compliance with the standards, the term "cool roof" refers to a roofing product with high solar reflectance and thermal emittance (radiative) properties. These cool roof properties help reduce building cooling loads by reflecting and emitting energy from the sun, reducing roof temperatures on hot, sunny days, resulting in lower energy use by air conditioning systems. Both solar reflectance and thermal emittance are measured from 0 to 1: the higher the value, the "cooler" the roof. There are numerous roofing materials in a wide range of colors that have relatively good cool roof properties. The standards stipulate that all roofing products shall meet minimum solar reflectance and thermal emittance values for showing compliance with the standards.

The standards specify radiative properties that represent minimum "cool roof performance" qualities of roofing products:

- Solar reflectance—the fraction of solar energy that is reflected by the roof surface.
- Thermal emittance—the fraction of thermal energy that is emitted from the roof surface.

The standards provide two methods of demonstrating compliance: prescriptive method and performance method. With the prescriptive method of compliance, every measure listed in nonresidential Tables 143-A and B and residential Table 151-C, Component Package D of the *2008 Building Energy Efficiency Standards* must be met or exceeded for the building to be in compliance. With the performance method, the minimum value for solar reflectance and thermal emittance specified in these tables becomes the baseline cool roof performance threshold.

The standards require that to gain compliance credit for “cool roof performance,” roofing products must be tested and certified by the Cool Roof Rating Council (CRRC). The CRRC’s procedures require that sample roof assemblies for all roofing products must first be tested in a prescribed manner to determine the product’s “initial” solar reflectance and thermal emittance. Then the assemblies must be tested again over a three-year period to establish the product’s “aged” solar reflectance. Alternative calculation methods currently approved by the Energy Commission must use CRRC-tested performance values to describe their cool roof properties or assume poor performing default assumptions when showing compliance with the standards.

One roofing type used on low-sloped roofs of some nonresidential buildings is aggregate material made of crushed stone or gravel. There are two basic types of aggregate materials used for the surface layer in these applications: stone or gravel ranging in size of $\frac{3}{4}$ -inch or smaller. The material is spread across the surface of a moisture-resistant membrane and acts as the finished layer of a “built-up roof.” The weight of a “ballasted roof,” made up of larger stone or gravel material ranging in size of $2\frac{1}{2}$ to $\frac{3}{4}$ inches, is used to hold down the underlying moisture-resistant membrane.

Several manufacturers that provide rock-, stone-, or gravel-type materials for roof assemblies that use aggregate as the surface layer have noted that samples for testing cannot be transported to certified testing facilities as specified by CRRC procedures for evaluation of their cool roof properties without damage to the aggregate surface layer. This leads to test results for this material’s cool roof properties that are worse than the performance that would be expected of actual roofs of this type that are installed on buildings.

This compliance option would allow a default aged solar reflectance and thermal emittance for low-sloped roofs that use aggregate as the surface layer. This allowance requires the manufacturer of the aggregate material to have prior testing results for the product’s initial solar reflectance and thermal emittance.

2. Staff Evaluation

2.1. Review of Aggregate Roofing Materials

The *California Building Code* (CBC) describes aggregate used as surfacing for roof coverings as crushed stone, crushed slag, or water-worn gravel.¹ Stone, aggregate, and gravel materials are often used as the finish layer for built-up roofs. They are used on flat or “low-sloped” roofs, most often seen in commercial building construction. Crushed aggregate and gravel, used as surfacing on low-sloped roofs, is typically between ¼ to ¾ inches and spread across the roof surface.² This differs from stone and larger aggregate used on ballasted roofs, which use larger stones (typically 1 ½ to 2 ½ inches) and concrete pavers to provide sufficient weight to hold down single-ply roofing membranes without mechanical fastening. Typically, aggregate roofing materials are spread across the top of a water-resistant membrane installed on the roof. In some cases, the water-resistant membrane may be liquid asphalt or another sealant installed through “hot mopping.” In this case, the aggregate becomes embedded in the asphalt, and a light overlay of loose aggregate is applied across the roof surface to provide longevity to the installed roof system. For example, it’s not uncommon to see aggregate used on rooftops of schools and hospitals. The color of the aggregate depends on the stone from which it is quarried. Aggregate that is to be used as roof surfaces is crushed to specified sizes and may be placed in a furnace to remove moisture and to dry-finish any applied coatings.

Specifications for stone and aggregate roofing materials are based on a size classification defined by ASTM International: ASTM D448, *Standard Classification for Sizes of Aggregate for Road and Bridge Construction* and ASTM C136, *Standard Method for Sieve Analysis of Fine and Coarse Aggregates*. Rock and aggregate are dropped through different sieves to determine their size. Size No. 4 is typical of ballasted roofs, whereas aggregate and gravel, which is smaller, is typically size No. 6 and No. 7. The *California Building Code* references these standards for roofs that use aggregate as the surface layer and for ballasted roofs. In the case of built-up roofs, the CBC further defines size and quality by reference to ASTM D1863, *Standard Specification for Mineral Aggregate Used on Built-Up Roofs*. Construction documents will specify the aggregate or rock size when these roof types are used.

2.2. Review of Cool Roof Rating Council Procedures

To qualify for energy credit when showing compliance with the *Building Energy Efficiency Standards*, Section 118(i) requires roofing products to be tested, certified, and labeled

1 2010 *California Building Code*, Title 24, Part 2, Volume 1 of 2, Section 1502.1.

2 ASTM C136, *Standard Method for Sieve Analysis of Fine and Coarse Aggregates*; ASTM D1863, *Standard Specification for Mineral Aggregate Use on Built-Up Roofs*.

according to procedures of the CRRC. To receive a product rating by the CRRC, the manufacturer or company that sells the finished product must:

1. Become licensed with the CRRC.
2. Send product samples to a CRRC-accredited independent laboratory for testing to determine the product's initial solar reflectance and thermal emittance based on the product's performance qualities for coating type, membrane thickness, and color.
3. Send the same finished laboratory testing samples to an approved CRRC test farm to complete the three-year weathering test to determine the product's aged solar reflectance.

The CRRC's Rated Products Directory includes 11 product types, including but not limited to sheet goods (single-ply roofing products), shingles and tiles (asphalt, concrete, clay or metal), metal roofing panels, and factory- and field-applied coatings. The size and other characteristics of samples to be sent to CRRC testing facilities for performance testing depend on the type of roofing product. In all cases, the company requesting the product rating is responsible for the cost of testing and for ensuring product samples arrive at test facilities in a condition representative of the finished product.

For each "Standard Roof Product" to be tested, manufacturers must prepare a total of nine samples randomly selected from two batches representing the finished roofing product. Upon completed testing for the initial solar reflectance and thermal emittance, three of the product samples are then shipped by the testing laboratory to each of the three approved CRRC test farms for completion of three-year aged exposure testing.³ The three roof exposure testing farms are regionally located across the country, representing hot-humid, cold-temperate, and hot-dry climate zone conditions.

The CRRC's test method requires product test samples for aggregate roofing to be at least 4 meters on each side (about 13 ft. on each side, or about 172 sq. ft.). A typical built-up roof test sample with embedded aggregate including a light overcoat weighs roughly 130 lbs. or more per sample. A test sample for a ballasted roof could weigh two to three times this amount. The sheer size and overall weight of the CRRC-required three samples that must be sent to three facilities across the country demand that each sample is mechanically loaded and unloaded from each freight truck. It is unlikely that the samples will arrive at test facilities without dislodging aggregate and exposing the substrate below. In this condition the sample will not be representative of the finished product as installed on actual roofs. As a consequence, manufacturers that provide aggregate as a cool roof covering for low-sloped roofs have difficulty in establishing realistic product performance ratings for their aged solar reflectance following CRRC procedures.

³ Cool Roof Rating Council, Product Rating Program, CRRC-1.

2.3. Results of On-Site Testing of Aggregate Roofing Materials

In the spring of 2012, the Heat Island Group at Lawrence Berkeley National Laboratory (LBNL) measured the in-situ (in its original place) solar reflectance of roofs covered with aggregate, which had been installed for periods ranging from 1 to 20 years. Measurements were taken at four sites in the Los Angeles basin on March 26-28, 2012. This study sought to determine the solar reflectance of limestone aggregate, sold by A-1 Grit Company as 3/8" Natural White Rock (aka "white marble"), and the extent to which the solar reflectance diminishes over time. The study was conducted following ASTM Standard E1918-06, *Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field*. The measured solar reflectance ranged from about 0.48 to 0.52. Even though measurements were taken of aggregate quarried from different sites and at different times, and roof solar reflectance measurements were in different environments within the greater Los Angeles basin, measurements indicate that the aggregate retains a solar reflectance of about 0.50 over a 20-year period.⁴

2.4. Public Review of Testing Results and Staff's Draft Compliance Option for Aggregate Roofing Materials

Based on results from the LBNL on-site testing, staff completed a draft compliance options report and solicited public review and comment.⁵

On December 18, 2012, Energy Commission staff held a public webinar to present the proposal of cool roof properties for aggregate roofing materials, represented by a default aged solar reflectance and thermal emittance value. Staff's presentation and the discussion from the approximate 20 webinar participants focused primarily on the results of in-situ testing by the Heat Island Group at LBNL. There was no public opposition expressed to establishing default cool roof properties for aggregate roofing material when tied to proposed specific eligibility criteria. However, two recommendations were suggested:

1. LBNL representatives noted that the proposed draft default values for aged solar reflectance should be set at the actual value represented by the results of on-site testing. Whereas staff's original proposed default values were based on the average

⁴ See full report: Pablo, Melvin Pomerantz, Ronnen Levinson (Lawrence Berkeley National Laboratory). 2012. *Solar Reflectance of Roofs Covered with Mineral Aggregate Surfacing Material*. (<http://www.energy.ca.gov/2012publications/CEC-500-2012-083/CEC-500-2012-083.pdf>).

⁵ See *Draft Evaluation Report: Proposed Compliance Option for Low-Sloped Roofs That Use Aggregate as the Surface Layer*, California Energy Commission, December 2012. (<http://www.energy.ca.gov/2012publications/CEC-400-2012-018/CEC-400-2012-018-SD.pdf>)

aged solar reflectance from all on-site testing, LBNL suggested a more defensible value would be the tested aged solar reflectance from the aggregate roofing surface of the oldest building. This value would best represent the cool roof performance qualities for aggregate material over the long term. Staff agrees. Staff's original proposed aged solar reflectance of 0.50 has been modified to 0.48.

LBNL representatives also requested that staff's proposed initial solar reflectance be modified downward from 0.55 to 0.50, as this too better represented the results from their on-site testing. Staff agrees, and this change has been made.

2. In a letter to the docket (Docket No. 12-BTSD-07) dated December 28, 2012, representatives of the EPDM Roofing Association recommended that:
 - The proposed compliance option should be wider in scope to encompass larger stone and aggregate material typical of ballasted roof surfaces (1 ½ - 2 ½ inches).
 - An allowance should be made for mass type roof coverings with a weight of 10 pounds per square foot (psf.) or more.

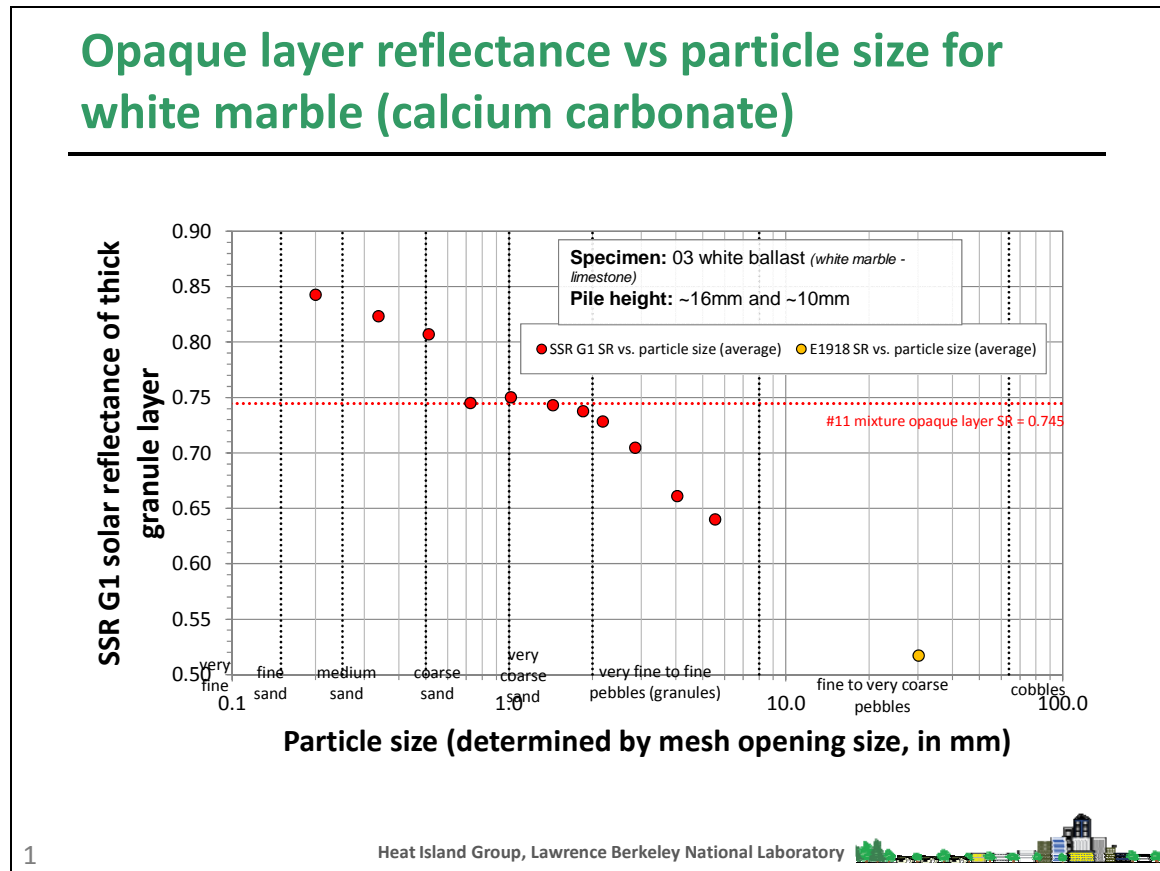
An e-mail response from staff was sent January 11, 2013, to the EPDM Roofing Association representative responding to these suggestions (Log #69107 to the docket). Staff noted in this response its acceptance of recommendations to widen the scope of allowed aggregate material sizes to be allowed a default solar reflectance. After all, ballasted roofing systems that use larger rock and gravel have equal difficulty in meeting CRRC testing protocols for sending representative finish samples to weathering test farms as those for built-up roofs with smaller aggregate. Additionally, one could assume that rock of equal quality and color should exhibit similar reflectivity regardless of size. To verify the applicability of expanding the allowed default solar reflectance to larger aggregate material, staff indicated the need for concurrence by LBNL based on results of other research it has conducted.

However, staff also noted in its January 11, 2013, response that evidence suggested by the EPDM Roofing Association for a weight of 10 psf. as equivalent to the thermal effects of an aged solar reflectance of 0.55, is not clearly supported by either the letter's referenced Oakridge National Laboratory (ORNL) study or within the analysis of an earlier letter submitted to the Energy Commission on March 4, 2011, by this same industry representative. For this issue, staff believes it would be most beneficial to the industry's interests to develop a separate "fact sheet" for the 2013 *Standards* that describe the equivalent energy tradeoff allowed for roofing types based on their weight.

It was subsequently learned that LBNL's Heat Island Group studied solar reflectance versus aggregate particle size. Results of this research indicate that the aged solar reflectance of large aggregate (3/8 inch – 2 inches) is actually somewhat different than its smaller counterpart. The cool roof properties of larger aggregate, while similar to smaller aggregate, tends to decline over time. In fact, the initial solar reflectance of this material is somewhat lower than aggregate of the same type but smaller size (see Figure

1). The reasons for this are twofold: the effects of soiling and weathering over time and the translucency of the larger aggregate are greater than for smaller material. As a consequence, larger stone and gravel material tends to exhibit somewhat lower reflectance values than smaller material of the same quality.

Figure 1: Opaque Layer Reflectance vs. Particle Size for White Marble



Source: Heat Island Group, Lawrence Berkeley National Laboratory

3. Proposed Default Solar Reflectance, Thermal Emittance, and Eligibility Criteria

Staff proposes that a default aged solar reflectance and thermal emittance be used for aggregate roofing materials installed on low-sloped roofs for showing compliance with the *Building Energy Efficiency Standards*. Use of the default aged cool roof properties requires that the aggregate material have prior testing for the product's initial solar reflectance and thermal emittance. The proposed default values and eligibility criteria will enable manufacturers to use cool roof properties that are more representative of the performance of aggregate installed on actual roofs for showing compliance with the standards, rather than being required to use default values that are substantially worse than in-situ measured performance.

Based on the findings of the LBNL studies discussed above, staff proposes that aggregate used as the surface layer of low-sloped roofs shall have the default cool roof properties for the aggregate sizes listed in Table 1 provided all eligibility criteria are met.

Eligibility criteria for aggregate used as the surface layer of low-sloped roofs:

1. Aggregate shall have a tested initial solar reflectance that meets or exceeds 0.50 for Built-Up Roofs and 0.45 for Ballasted Roofs using the ASTM E1918 test procedure conducted by an independent laboratory meeting the requirement of Section 10-113(d)4 of the *Building Energy Efficiency Standards*;
2. Aggregate shall have a label on bags or containers of the aggregate material stating (a) the material's tested initial solar reflectance conforming to ASTM D1863, and (b) the material's size conforming to ASTM D448.

Table 1: Default Solar Reflectance and Thermal Emittance for Aggregate Materials Based on Size

Aggregate Size	Required Tested Initial Solar Reflectance	Default Aged Solar Reflectance	Default Thermal Emittance ⁵
Built-Up Roofs Size 6-8 conforming to ASTM D448 and ASTM D1863	0.50	0.48	0.85
Ballasted Roofs Size 2-4 conforming to ASTM D448	0.45	0.40	0.85

4. Conclusion

Staff proposes that a default aged solar reflectance and thermal emittance value be allowed for showing compliance with the *Building Energy Efficiency Standards* for low-sloped roofs using aggregate as the surface layer, when the aggregate meets specific eligibility criteria. The proposed default aged solar reflectance and thermal emittance values will provide realistic cool roof properties for aggregate materials used commonly on built-up and ballasted roofing systems. Allowing the use of these default “aged” values is consistent with the compliance options process prescribed by Public Resources Code, Section 25402.1 (b) and Section 10-109 of the *Building Energy Efficiency Standards*, which allows for the introduction of designs, materials, or devices that cannot be adequately modeled in the currently approved alternative calculation methods or are not appropriately accounted for in the currently approved compliance approaches.

The proposed default aged solar reflectance and thermal emittance values will help provide manufacturers of aggregate materials who have taken necessary steps to test for their product’s initial solar reflectance from using substantially lower cool roof property values for the prescriptive and performance compliance methods than evidence suggests of these materials when actually installed. Staff’s proposed default aged solar reflectances for aggregate used as the surface layer of low-sloped roofs will provide cool roof indices more representative of this roofing system’s actual long-term performance.

⁵ See Appendix A: Pablo, Melvin Pomerantz, Ronnen Levinson (Lawrence Berkeley National Laboratory). 2012. *Solar Reflectance of Roofs Covered with Mineral Aggregate Surfacing Material*. (<http://www.energy.ca.gov/2012publications/CEC-500-2012-083/CEC-500-2012-083.pdf>).

Energy - Docket Optical System

From: Ware, David@Energy
Sent: Tuesday, May 07, 2013 10:17 AM
To: Energy - Docket Optical System
Subject: FW: Docket 12-BTSD-07: Compliance Option for Low-Sloped Roofs the Use Aggregate
Attachments: FinalEvalReportCEC-400-2012-018-SF.pdf

Categories: Ready to Docket

Please docket this email and the attachment into: [Docket 12-BTSD-07: Compliance Option for Low-Sloped Roofs the Use Aggregate](#). Thanks.

David W. Ware
California Energy Commission
1516 Ninth Street, MS 37
Sacramento, CA 95814
916-654-4168
david.ware@energy.ca.gov

From: Tom Hutchinson [<mailto:hutch@hutchinsondesigngroup.com>]
Sent: Tuesday, May 07, 2013 4:19 AM
To: Ware, David@Energy
Subject: RE: Docket 12-BTSD-07: Compliance Option for Low-Sloped Roofs the Use Aggregate

Morning David,

Thank you for this opportunity to review your proposed cool roof default ballast cool roof reflectance. For the purpose of defining the use of reflective aggregate I think you have improved the default by having BUR and Single ply ballasted roofs separated out. You might want to add a colon after the word 'Roofs' though.

While reflection is one way to defer heat gain and shift cooling loads there are other options such as insulation, which at what I understand approximately R24, roof color has no impact. Additionally traditional ballast (ASTM No.4) for single plies, is self-cleaning, fire proof and maintains a stable reflectance in the mid 20's but also accepts some heat and stores it, thus also mitigating heat gain and shifts cooling loads to later in the afternoon. I would encourage the CEC that if they wish to truly become transparent and sustainable in their energy conservation efforts that they look to the insulation and traditional ballast options, both of which may be less costly than an manufactured, tumble stone.

I appreciate the opportunity to converse with you and appreciate you openness to my views. Should you ever wish to visit large or small ballasted roofs, some designed to have

a service life of over 50 years, here in the Chicago area, or wish to set testing data loggers, etc. within them please let me know.

Sincerely, Tom

From: Ware, David@Energy [<mailto:David.Ware@energy.ca.gov>]
Sent: Wednesday, March 20, 2013 10:39 AM
To: Thomas Hutchinson (hutch@hutchinsondesigngroup.com)
Subject: FW: Docket 12-BTSD-07: Compliance Option for Low-Sloped Roofs the Use Aggregate

Tom:
I had a few errors in what I sent yesterday and have made those corrections below. I look forward to your comments.
Thanks.

DAVE

David W. Ware
California Energy Commission
1516 Ninth Street, MS 37
Sacramento, CA 95814
916-654-4168
david.ware@energy.ca.gov

From: Ware, David@Energy
Sent: Tuesday, March 19, 2013 2:29 PM
To: Thomas Hutchinson (hutch@hutchinsondesigngroup.com)
Subject: Docket 12-BTSD-07: Compliance Option for Low-Sloped Roofs the Use Aggregate

Tom:
We have modified our original proposed default cool roof solar reflectances and I would appreciate your feedback on this proposal. I believe we're more accurately reflecting how aggregate material is specified for construction purposes. We hope to move this forward for approval at the April 10th business meeting.

Your review and comment would be most helpful. Thanks.

Aggregate used as the surface layer of low-sloped roofs shall have the default cool roof properties for the aggregate sizes listed in Table 1 provided all eligibility criteria are met.

Eligibility criteria for aggregate used as the surface layer of low-sloped roofs:

1. Aggregate shall have a tested initial solar reflectance that meets or exceeds 0.50 for Built-Up Roofs and 0.45 for Ballasted Roofs using the ASTM E1918 test procedure conducted by an independent laboratory meeting the requirement of Section 10-113(d)4 of the *Building Energy Efficiency Standards*,

2. Aggregate shall have a label on bags or containers of the aggregate material stating: (a) the material's tested initial solar reflectance conforming to ASTM D1863, and (b) the material's size conforming to ASTM D448.

Table 1: Default Solar Reflectance and Thermal Emittance for Aggregate Materials Based on Size:

Aggregate Size	Required Tested Initial Solar Reflectance	Default Aged Solar Reflectance	Default Thermal Emittance
Built-Up Roofs Size 62- 84 conforming to ASTM D448 and ASTM D1863	0.50	0.48	0.85
Ballasted Roofs Size 2-4 conforming to ASTM D448	0.45	0.40	0.85

David W. Ware
California Energy Commission
1516 Ninth Street, MS 37
Sacramento, CA 95814
916-654-4168
david.ware@energy.ca.gov

From: Ware, David@Energy
Sent: Wednesday, March 13, 2013 10:14 AM
To: Thomas Hutchinson (hutch@hutchinsondesigngroup.com)
Subject: Docket 12-BTSD-07: Compliance Option for Low-Sloped Roofs the Use Aggregate

March 13, 2013

Thomas W. Hutchinson
Hutchinson Design Group, Ltd.
232 E. Main Street
Barrington, IL 60010

RE: DOCKET 12-BTSD-07

Dear Mr. Hutchinson:

Tom—

This note responds to issues discussed in my email to you dated January 11th. You have suggested that our proposed compliance option for aggregate material include larger rock sizes, similar in size to that used for ballasted roofs, and that the compliance option account for the material's overall weight as a surrogate for the effectiveness of solar reflectance based on the thermal benefits of the heavier roof. We've been working towards completion of our proposed compliance option and have had several discussions with LBNL for recommendations of the aged solar reflectance of larger rock sizes based on their research results. Based on those discussions we are proposing to finalize our compliance option for aggregate material and are expanding it to include larger aggregate. Note, this compliance option proposal does not include roofing material weight. My January 11th email explained reasons for not including equivalent energy tradeoffs for varying roof types based on weight. However, we support the future development of a factsheet that is focused on these effects as stated in my previous email.

Please review our proposed modifications to the default aged solar reflectance for aggregate materials shown below. I'd like us to follow-up with a telephone conversation regarding this proposal.

Thanks.

1. Aggregate used as the surface layer of low-sloped roofs shall have the default cool roof properties listed in Table 1 provided all eligibility criteria listed in 2 below are met:

Table 1: Default Solar Reflectance and Thermal Emittance for Aggregate Materials

Aggregate Size	Required Tested Initial Solar Reflectance	Default Aged Solar Reflectance	Default Thermal Emittance
Passes No. 4 Sieve and Retained by No. 8 Sieve conforming to ASTM D448	0.50	0.48	0.85
Passes No. 4 Sieve and Retained by No. 5 Sieve conforming to ASTM D448	0.45	0.40	0.85

2. Eligibility criteria for aggregate used as the surface layer of low-sloped roofs:
 - Conforms to material standard ASTM D1863,
 - Has a tested initial solar reflectance that meets or exceeds 0.50 or 0.45 respectively using the ASTM E1918 test procedure conducted by an independent laboratory meeting the requirement of Section 10-113(d)4 of the *Building Energy Efficiency Standards*,
 - Has a label on bags or containers of aggregate stating the tested initial solar reflectance, that the materials conform to ASTM D1863 and ASTM D448, and the sieve size used for determining aggregate size.

David W. Ware
California Energy Commission
1516 Ninth Street, MS 37
Sacramento, CA 95814
916-654-4168
david.ware@energy.ca.gov