When the Going Gets Rough: The Impact of Substrate Texture on Solar Reflectance Ratings

Jeffrey Steuben, Executive Director
Cool Roof Rating Council
Overview

• CRRC Mission
• Why Cool Roofs?
• CRRC Rating Process
• RCMA Study & Results
• RRCI Study & Results
• CRRC Response
• Next Steps
CRRC Mission

- Ratings
- Research
- Education
CRRC Mission

By pursuing this mission, the CRRC will become the recognized informational resource for:

- Reducing the urban heat island effect
- Increasing building energy efficiency
- Improving occupant comfort
- Mitigating the effects of global warming
Why Cool Roofs?

The urban fabric is composed of MANY DARK SURFACES

- Pavements: 39%
- Vegetation: 29%
- Roofs: 19%
- Other: 14%

Aerial view of Sacramento, CA

Image and graph courtesy of LBNL Heat Island Group
Why Cool Roofs?

Sketch of an Urban Heat-Island Profile

- Late Afternoon Temperature

- Rural, Commercial, Urban Residential, Suburban Residential, Downtown, Park, Rural Farmland

2014 Roof Coatings Manufacturers Association International Roof Coatings Conference
Why Cool Roofs?
Defining a “Cool” Roof

Solar Reflectance: the fraction of solar energy that is reflected by the roof

Thermal Emittance: the relative ability of the roof surface to radiate absorbed heat

The sun’s radiation hits the roof surface

Some heat is absorbed by the roof and transferred to the building below
Manufacturers send samples to a test lab for initial testing.

3-Year aging at three test farm locations.

Aged testing at a test lab.
Product Aging

- Ohio: cool/temperate
- Arizona: hot/dry
- Florida: hot/humid
## CRRC Rated Product Label

<table>
<thead>
<tr>
<th></th>
<th>Initial</th>
<th>Weathered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Reflectance</td>
<td>0.00</td>
<td>Pending</td>
</tr>
<tr>
<td>Thermal Emittance</td>
<td>0.00</td>
<td>Pending</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Product ID Number</td>
<td>__ __ __</td>
</tr>
<tr>
<td>Licensed Seller ID Number</td>
<td>__ __ __</td>
</tr>
<tr>
<td>Classification</td>
<td>Production Line</td>
</tr>
</tbody>
</table>

Cool Roof Rating Council ratings are determined for a fixed set of conditions, and may not be suitable for determining seasonal energy performance. The actual effect of solar reflectance and emittance on building performance may vary.

Manufacturer of product stipulates that these ratings were determined in accordance with the Cool Roof Rating Council procedures.
Acknowledgments

• Roof Coating Manufacturers Association (RCMA)
• Reflective Roof Coatings Institute (RRCI)
• Andre Desjarlais, Oakridge National Laboratory
• Frank Klink, 3M
• Jim Leonard, E.R. Systems
• Momentum Technologies, Inc.
• Don Portfolio, Gardner-Gibson
• PRI Construction Materials Technologies
• Q-Lab Weathering Services
History Lesson: 2006-2007

- CRRC Board discusses best way to rate coatings
- Standard aluminum panel selected
- Commission studies to measure impact of substrate
RCMA Study
RCMA Study Objectives

• 11 different coatings on smooth and rough substrates

Initial Ratings  →  3-year exposure  →  Aged Ratings

22 Comparisons of Smooth and Rough
RCMA Coatings

• Acrylic Elastomeric (AC)
• Styrene Acrylic Elastomeric (SA)
• SEBS (Solvent Borne) Elastomeric (SEBS)
• Aluminum (Solvent Borne) Rubberized (AR)
• Aluminum (Solvent Borne) Fibrated (AF)
• Aluminum (Solvent Borne) Non-Fibrated Coatings (ALNF)
Results: Initial Ratings

Initial Solar Reflectance
Coatings on Smooth vs. Rough Substrates

Solar Reflectance

Coating

Smooth
Rough

2014 Roof Coatings Manufacturers Association
International Roof Coatings Conference
Results: Aged Ratings

Aged Solar Reflectance
Coatings on Smooth vs. Rough Substrates

Solar Reflectance

Coating

Smooth
Rough

AC-1 AC-2 SA-1 SA-2 SEBS-1 SEBS-2 ALR-1 ALR-2 AL-1 ALNF-1 ALNF-2
## Results: Data Table

<table>
<thead>
<tr>
<th>Coating</th>
<th>Initial Smooth</th>
<th>Initial Rough</th>
<th>Aged Smooth</th>
<th>Aged Rough</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC-1</td>
<td>0.88</td>
<td>0.71</td>
<td>0.69</td>
<td>0.64</td>
</tr>
<tr>
<td>AC-2</td>
<td>0.85</td>
<td>0.71</td>
<td>0.68</td>
<td>0.64</td>
</tr>
<tr>
<td>SA-1</td>
<td>0.9</td>
<td>0.68</td>
<td>0.73</td>
<td>0.66</td>
</tr>
<tr>
<td>SA-2</td>
<td>0.77</td>
<td>0.67</td>
<td>0.65</td>
<td>0.58</td>
</tr>
<tr>
<td>SEBS-1</td>
<td>0.73</td>
<td>0.73</td>
<td>0.72</td>
<td>0.68</td>
</tr>
<tr>
<td>SEBS-2</td>
<td>0.78</td>
<td>0.74</td>
<td>0.75</td>
<td>0.7</td>
</tr>
<tr>
<td>ALR-1</td>
<td>0.63</td>
<td>0.56</td>
<td>0.61</td>
<td>0.52</td>
</tr>
<tr>
<td>ALR-2</td>
<td>0.65</td>
<td>0.56</td>
<td>0.58</td>
<td>0.5</td>
</tr>
<tr>
<td>AL-1</td>
<td>0.5</td>
<td>0.42</td>
<td>0.41</td>
<td>0.33</td>
</tr>
<tr>
<td>ALNF-1</td>
<td>0.65</td>
<td>0.51</td>
<td>0.52</td>
<td>0.45</td>
</tr>
<tr>
<td>ALNF-2</td>
<td>0.66</td>
<td>0.51</td>
<td>0.58</td>
<td>0.45</td>
</tr>
</tbody>
</table>
Results: Difference (measured)

Solar Reflectance Substrate Difference (Smooth - Rough)

Coating

- AC-1
- AC-2
- SA-1
- SA-2
- SEBS-1
- SEBS-2
- ALR-1
- ALR-2
- AL-1
- ALNF-1
- ALNF-2

Initial
Aged
Results: Difference (percent)

Solar Reflectance Percent Difference
\((S-R)/S\)

- AC-1
- AC-2
- SA-1
- SA-2
- SEBS-1
- SEBS-2
- ALR-1
- ALR-2
- AL-1
- ALNF-1
- ALNF-2

Coating

Initial
Aged

2014 Roof Coatings Manufacturers Association
International Roof Coatings Conference
RCMA Study Conclusions

• 21 of 22 comparisons show smooth substrate performs higher than rough substrate
• 1 of 22 showed no difference
• Average 15% higher performance for initial ratings
• Average 12% higher performance for aged ratings

12-15% boost
RRCI Study
RRCI Study Objectives

• Evaluate coatings on a wider range of substrates

3-year exposure

Initial Ratings
6-mo. Ratings
1-year Ratings
2 year Ratings
3 year Aged Ratings

55 data points
RRCI Study Materials

Smooth substrates:
• Aluminum
• CRS (Cold rolled steel)
• APP Smooth
• Asphalitic emulsion
• EPDM
• PVC
• SPF (Spray Polyurethane Foam)

Rough Substrates:
• APP Granulated
• SBS Granulated black
• SBS Granulated green
• SBS Granulated white
Results: A Lot Going On

Solar Reflectance of All Substrates
(Zoomed for detail)

- Aluminum
- CRS (cold rolled steel)
- APP granulated
- APP smooth
- Asphaltic Emulsion
- EPDM
- PVC
- SBS granulated black
- SBS granulated green
- SBS granulated white
- SPF (spray polyurethane foam)
Results: Smooth and Rough

Solar Reflectance of Smooth and Rough Substrates
(Zoomed for detail)

Solar Reflectance

Initial 6 mo 1 year 2 year 3 year

Aluminum
APP granulated
SBS granulated black

2014 Roof Coatings Manufacturers Association
International Roof Coatings Conference
### Results: Data Table

<table>
<thead>
<tr>
<th>Substrate type</th>
<th>Solar Reflectance Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.83</td>
</tr>
<tr>
<td>CRS (cold rolled steel)</td>
<td>0.80</td>
</tr>
<tr>
<td>APP granulated</td>
<td>0.78</td>
</tr>
<tr>
<td>APP smooth</td>
<td>0.82</td>
</tr>
<tr>
<td>Asphalitic Emulsion</td>
<td>0.83</td>
</tr>
<tr>
<td>EPDM</td>
<td>0.83</td>
</tr>
<tr>
<td>PVC</td>
<td>0.85</td>
</tr>
<tr>
<td>SBS granulated black</td>
<td>0.81</td>
</tr>
<tr>
<td>SBS granulated green</td>
<td>0.81</td>
</tr>
<tr>
<td>SBS granulated white</td>
<td>0.81</td>
</tr>
<tr>
<td>SPF (spray polyurethane foam)</td>
<td>0.84</td>
</tr>
</tbody>
</table>
## Results: Difference

<table>
<thead>
<tr>
<th></th>
<th>Difference</th>
<th>Percent Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alum. - APP</td>
<td>Alum. - SBS</td>
</tr>
<tr>
<td>Initial</td>
<td>0.06</td>
<td>0.02</td>
</tr>
<tr>
<td>6 mo</td>
<td>0.04</td>
<td>0.07</td>
</tr>
<tr>
<td>1 year</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>2 year</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>3 year</td>
<td>0.07</td>
<td>0.11</td>
</tr>
</tbody>
</table>
RRCI Study Conclusions

- 10 of 10 data points show smooth aluminium substrate performs higher than rough substrate
- Average 5% higher performance for initial ratings
- Average 12% higher performance for aged ratings

5-12% boost
And Then What?
CRRC Board Decision

- March 2013 – Technical Committee unanimously moves to recommend testing of coatings on smooth and rough substrates
- April 2013 – Board unanimously approves dual ratings for coating products
- Pending implementation details
Technical Approach

- Apply 20-40 mils adhesive to standard panel
- Apply granules to rejection
- Let dry
- Apply coating for testing
Next Steps

- CRRC to conduct round robin testing of rough substrates
- Modify procedure if necessary
- Communicate testing requirements and timeline to coating manufacturers
QUESTIONS?
Contact Information

Jeffrey Steuben
Executive Director
Cool Roof Rating Council
510.482.4420 x288
jeff@coolroofs.org