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November 10, 2003

To: Chris Scruton (CEC)  
From: Steve Wiel  
Subject: **Cool Roof Colored Materials:** Monthly Progress Report for October 2003  
CC: Hashem Akbari, Paul Berdahl, Andre Desjarlais, Bill Miller, Ronnen Levinson

A summary of the status of Tasks and Deliverables as of October 31, 2003 is presented in Attachment 1.

## HIGHLIGHTS

- We characterized two prototype granules/shingles and two prototype tiles that partners had fabricated based on innovative coating designs suggested by LBNL. Using the results of these characterizations, LBNL has suggested new techniques for improving the reflectance of the undercoatings.
- We instrumented the first three demonstration houses.
- We strategized with our industrial partners on the development of initial prototype cool roofing materials. Several samples have been developed and measured.
- We visited MonierLifetile (manufacturing cement rooftiles) at Lathrop, CA.

## Tasks

- 1.1 Attend Kick-Off Meeting  
**This Task is completed.**
- 1.2 Describe Synergistic Projects  
**This Task is completed.**
- 2.1 Establish the Project Advisory Committee (PAC)  
**This Task is completed.** Peter Turnbull of PG&E and xxx of SCE were invited (and accepted) to join the PAC.
- 2.2 Software Standardization  
(No activity.)
- 2.3 PAC Meetings  
(No activity.)
- 2.4 Development of Cool Colored Coatings

#### 2.4.1 Identify and Characterize Pigments with High Solar Reflectance

We noted that some of our single-pigment films (e.g., titanium white, synthetic iron oxide black) had very low transmittance in parts of the solar spectrum, reducing the accuracy of our computed Kubekla-Munk scattering and absorption coefficients. Hence, we diluted these single-pigment paints with clear binder to prepare films with lower pigment volume concentration and higher transmittance. We also prepared diluted films of a pure carbon black pigment for the same purpose. (Our prior measurements on bone black should be similar, but bone black is a mixture of carbon black and other components of bone, especially calcium hydroxylapatite [Ca<sub>5</sub>(PO<sub>4</sub>)<sub>3</sub>OH].)

Several industrial partners are in the process of reviewing our draft paper on pigment characterization, which we hope to complete by the end of November.

#### 2.4.2 Develop a Computer Program for Optimal Design of Cool Coatings

(No activity.)

#### 2.4.3 Develop a Database of Cool-Colored Pigments

We continued discussing among ourselves and with our industrial partners methods to amend the database. We have contacted a few manufacturers for more data.

### 2.5 Development of Prototype Cool-Colored Roofing Materials

#### 2.5.1 Review of Roofing Materials Manufacturing Methods

On October 1, 2003, Berdahl, Levison, and Akbari visited the MonierLifetile plant at Lathrop, CA (near Modesto). A new section will be added to the "Roofing Materials Manufacturing Methods" report to cover cement tiles. We are still working to arrange a visit to a cedar shake roof-manufacturing plant.

#### 2.5.2 Design Innovative Methods for Application of Cool Coatings to Roofing Materials

We met (and held conference calls) with several of our industrial partners to plan production of prototype cool granules, shingles, and tiles. We agreed upon an iterative process in which LBNL suggests a coating design, receives a prototype fabricated by the industrial partner, and characterizes the spectral optical properties of the prototype. Our initial designs have focused on producing materials with a high reflectance white or metallic undercoat covered by a dark pigment with low near-infrared absorbance. We have received prototype granules and shingles from two partners, and prototype tiles from two partners. Based on characterizations of these early prototypes, LBNL has suggested techniques for improving the reflectance of the undercoatings.

#### 2.5.3 Accelerated Weathering Testing

(No activity.)

### 2.6 Field-Testing and Product Useful Life Testing

ORNL visited Cavalli Hills on October 27- 30, 2003 and instrumented three of four houses for monitoring the temperatures and the heat flow from attics having roofs with and without Cool Roof Color Materials (CRCMs). Mike Evans and the Sacramento Land & Home realator, Steve Burke, have pre-sold all 12 homes in the Cavalli Hills subdivision located in Fair Oaks, CA, and construction has just begun on the second set of six homes.

#### 2.6.1 Building Energy-Use Measurements at California Demonstration Sites

ORNL personnel installed temperature, relative humidity, pyranometer and heat flow instruments in the attics and roofs of three demonstration homes. Each house had a plastic electrical conduit run from the attic, down within the exterior wall and terminated adjacent the house's power panel. Interconnecting wires were pulled through the conduit, connected to the instruments and clearly labeled and documented for future hookup to the Campbell Scientific data loggers. ORNL personnel and Wim Bos of SMUD verified the sensor signals. Boss showed air temperature measures for some of the thermocouples to be within about 0.5°F of measurement made using a Fluke temperature indicator. The weather station and Campbell Scientific data loggers were not installed because stucco must first be applied to the exterior walls of the homes. Tentative plans are to complete all setups once Evans Construction has the fourth house in the dry, which should occur sometime in December or early January.

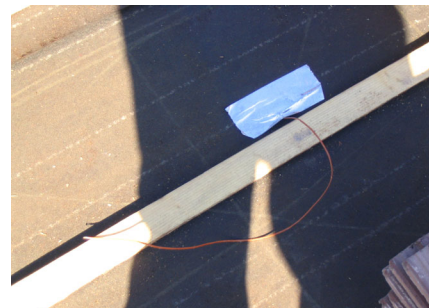
Dynamic Roofing has installed 30-lb felt paper, battens and has loaded both roofs of the A Style homes with Hanson's concrete tile (Fig. 1). The tiles have a dark brown color and are Hanson's low profile model H409 Hacienda concrete tile. A purchase order was let for Joe Riley of American Roof Tile Coatings to apply a topcoat finish to one of the two tile roofs. The topcoat contains CRCMs and will boost



the reflectance of the tile to almost 45%. **Fig. 1. The two A Style homes are loaded with Hanson's tile.**

Rinkydink Builders Inc. has also installed 30-lb felt paper on the C style home located between the two A style homes. Rinkydink will install the Country Manor Shake shingle having a walnut brown color with no CRCMs. The second C style house will be roofed with the Musket brown having the CRCMs. Once stucco is applied to the houses, the respective roofing crews will install the tile and metal roofs.

We plan to measure the surface temperature of the concrete tile and painted metal roof systems. W. Miller showed Dynamic Roofing and Rinkydink Builders the location of the thermocouples (Fig. 2) and asked them to give Wim Boss of SMUD advanced notice so he can quickly visit the site and assist the crews with the attachment of the thermocouples. Akbari and Miller discussed surface attachment techniques and agreed on an approach that will not disturb the thermal characteristics of the roof surface.



**Fig. 2. Tip of thermocouple wire to be threaded to the top of the upper tile.**

A special epoxy that is UV resistant will be used by Wim Boss to glue the thermocouple and about 1 inch of wire to the top of the brown colored tile. Afterward the attached thermocouple will be painted brown so the surface will have similar reflectance and emittance properties as the rest of the tile surface. The painted metal is very thin and the thermocouple will therefore be epoxy glued and taped to the underside of the metal shake by Bos while the roofers install the roof shakes.

While in Sacramento, W. Miller met with the real estate agent, Steve Burke, who is working with Evans Construction to sell the homes. All home sites are now sold. Miller requested the opportunity for Wim Bos (SMUD representative) and himself to meet each

of the four homeowners participating in our CRCM project so they would be comfortable when personnel visit to check instruments, do indoor blower door testing and make thermal scans of the exterior of their homes. Miller showed Burke the brochure prepared for Evans and handed him a signed Memorandum of Understanding. Burke was both agreeable and very excited about the project; he asked for and received additional copies of the brochure.

#### 2.6.2 Materials Testing at Weathering Farms in California

ORNL received concrete tile samples from the Shepherd Color Company, which they made for MonierLife Tile.

#### 2.6.3 Steep-slope Assembly Testing at ORNL

ORNL requested and received from MonierLifetile, Hanson, MCA and Eagle about 1-1/2 squares of tiles for placement on the ESRA. The previous metal roofs and plywood deck were removed from the existing steep-slope assembly and 5/8-in OSB attached with a 30-lb felt paper cover. Jerry Vandewater, Dave Faulkner and Rick Olson will setup the tile systems with support from Desjarlais and Miller.

#### 2.6.4 Product Useful Life Testing (No activity.)

#### 2.7 Technology transfer and market plan

##### 2.7.1 Technology Transfer (No activity.)

##### 2.7.2 Market Plan (No activity.)

##### 2.7.3 Title 24 Code Revisions (No activity.)

### **Management Issues**

- None.

Attachment 1

**Project Tasks and Schedules (Approved on May 16, 2002)**

Task	Task Title and Deliverables	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 10/31/2003
1	<b>Preliminary Activities</b>					
1.1	Attend Kick Off Meeting <i>Deliverables:</i> <ul style="list-style-type: none"> <li>Written documentation of meeting agreements and all pertinent information (<b>Completed</b>)</li> <li>Initial schedule for the Project Advisory Committee meetings (<b>Completed</b>)</li> <li>Initial schedule for the Critical Project Reviews (<b>Completed</b>)</li> </ul>	5/16/02	5/16/02	6/1/02	6/10/02	100%
1.2	Describe Synergistic Projects <i>Deliverables:</i> <ul style="list-style-type: none"> <li>A list of relevant on-going projects at LBNL and ORNL (<b>Completed</b>)</li> </ul>	5/1/02	2/1/02	5/1/02	5/1/02	100%
1.3	Identify Required Permits	N/A		N/A		
1.4	Obtain Required Permits	N/A		N/A		
1.5	Prepare Production Readiness Plan	N/A		N/A		
2	<b>Technical Tasks</b>					
2.1	Establish the project advisory committee <i>Deliverables:</i> <ul style="list-style-type: none"> <li>Proposed Initial PAC Organization Membership List (<b>Completed</b>)</li> <li>Final Initial PAC Organization Membership List</li> <li>PAC Meeting Schedule (<b>Completed</b>)</li> <li>Letters of Acceptance</li> </ul>	6/1/02	5/17/02	9/1/02		100%
2.2	Software standardization <i>Deliverables:</i> <ul style="list-style-type: none"> <li>When applicable, all reports will include additional file formats that will be necessary to transfer deliverables to the CEC</li> <li>When applicable, all reports will include lists of the computer platforms, operating systems and software required to review upcoming software deliverables</li> </ul>	N/A		N/A		

**Project Tasks and Schedules (contd.)**

Task	Task Title and Deliverables	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 10/31/2003
2.3	<p>PAC meetings <i>Deliverables:</i></p> <ul style="list-style-type: none"> <li>Draft PAC meeting agenda(s) with back-up materials for agenda items</li> <li>Final PAC meeting agenda(s) with back-up materials for agenda items</li> <li>Schedule of Critical Project Reviews</li> <li>Draft PAC Meeting Summaries</li> <li>Final PAC Meeting Summaries</li> </ul>	9/1/02	6/1/02	6/1/05		50% (3/6)
2.4	Development of cool colored coatings					
2.4.1	<p>Identify and Characterize Pigments with High Solar Reflectance <i>Deliverables:</i></p> <ul style="list-style-type: none"> <li>Pigment Characterization Data Report</li> </ul>	6/1/02	6/1/02	12/1/04		~60%
2.4.2	<p>Develop a Computer Program for Optimal Design of Cool Coatings <i>Deliverables:</i></p> <ul style="list-style-type: none"> <li>Computer Program</li> </ul>	11/1/03		12/1/04		
2.4.3	<p>Develop a Database of Cool-Colored Pigments <i>Deliverables:</i></p> <ul style="list-style-type: none"> <li>Electronic-format Pigment Database</li> </ul>	6/1/03	7/1/03	6/1/05		~10%
2.5	Development of prototype cool-colored roofing materials					
2.5.1	<p>Review of Roofing Materials Manufacturing Methods <i>Deliverables:</i></p> <ul style="list-style-type: none"> <li>Methods of Fabrication and Coloring Report</li> </ul>	6/1/02	6/1/02	6/1/03		~95%
2.5.2	<p>Design Innovative Methods for Application of Cool Coatings to Roofing Materials <i>Deliverables:</i></p> <ul style="list-style-type: none"> <li>Summary Coating Report</li> <li>Prototype Performance Report</li> </ul>	6/1/02	6/1/02	12/1/04		~13%
2.5.3	<p>Accelerated Weathering Testing <i>Deliverables:</i></p> <ul style="list-style-type: none"> <li>Accelerated Weathering Testing Report</li> </ul>	11/1/02	10/1/02	6/1/05		<5%

**Project Tasks and Schedules (contd.)**

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 10/31/2003
2.6	Field-testing and product useful life testing					
2.6.1	Building Energy-Use Measurements at California Demonstration Sites <i>Deliverables:</i> <ul style="list-style-type: none"> <li>• Demonstration Site Test Plan</li> <li>• Test Site Report</li> </ul>	6/1/02	9/1/02	10/1/05		33%
2.6.2	Materials Testing at Weathering Farms in California <i>Deliverables:</i> <ul style="list-style-type: none"> <li>• Weathering Studies Report</li> </ul>	6/1/02	10/1/02	10/1/05		35%
2.6.3	Step-slope Assembly Testing at ORNL <i>Deliverables:</i> <ul style="list-style-type: none"> <li>• Whole-Building Energy Model Validation Presentation at the Pacific Coast Builders Conference</li> <li>• Steep Slope Assembly Test Report</li> </ul>	6/1/02	10/1/02	10/1/05		20%
2.6.4	Product Useful Life Testing <i>Deliverables:</i> <ul style="list-style-type: none"> <li>• Solar Reflectance Test Report</li> </ul>	5/1/04		6/1/05		
2.7	Technology transfer and market plan					
2.7.1	Technology Transfer <i>Deliverables:</i> <ul style="list-style-type: none"> <li>• Publication of results in industry magazines and refereed journal articles</li> <li>• Participation in buildings products exhibition, such as the PCBC Brochure summarizing research results and characterizing the benefits of cool colored roofing materials</li> </ul>	6/1/03	6/1/02	6/1/05		~5%
2.7.2	Market Plan <i>Deliverables:</i> <ul style="list-style-type: none"> <li>• Market Plan(s)</li> </ul>	5/1/05		6/1/05		
2.7.3	Title 24 Code Revisions <i>Deliverables:</i> <ul style="list-style-type: none"> <li>• Document coordination with Cool Roofs Rating Council in monthly progress reports</li> <li>• Title 24 Database</li> </ul>	6/1/02	5/16/02	6/1/05		~5%

**Project Tasks and Schedules (contd.)**

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 10/31/2003
VII	Critical Project Review(s) <i>Deliverables:</i> • Minutes of the CPR meeting					
XII (C)	Monthly Progress Reports <i>Deliverables:</i> • Monthly Progress Reports	6/1/02	6/1/02	6/1/05		44% (17/36)
XII (D)	Final Report <i>Deliverables:</i> • Final Report Outline • Final Report	3/1/05		10/1/05		
	Final Meeting <i>Deliverables:</i> • Minutes of the CPR meeting	10/15/05		10/31/05		