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To: Chris Scruton (CEC)
From: Steve Wiel
Subject: **Cool Roof Colored Materials**: Monthly Progress Report for February 2005
CC: Hashem Akbari, Paul Berdahl, Andre Desjarlais, Bill Miller, Ronnen Levinson

A summary of the status of Tasks and Deliverables as of February 28, 2005 is presented in Attachment 1. (Note the changes in the deliverables dates highlighted in yellow.)

HIGHLIGHTS

- We completed planning for the sixth Project Advisory Committee meeting to be held on March 3, 2005 at the Custom-Bilt facilities in Chino, CA.
- An article titled “Review of Residential Roofing Materials, Part I” appeared in Jan/Feb issue of *Western Roofing* magazine.

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.

2.2 Software Standardization
(No activity.)

2.3 PAC Meetings

We completed planning for the sixth Project Advisory Committee meeting to be held on March 3, 2005 at the Custom-Bilt facilities in Chino, CA. This PAC meeting will include presentations from seven industrial partners.

2.4 Development of Cool Colored Coatings

2.4.1 Identify and Characterize Pigments with High Solar Reflectance

Task Completed. Our two pigment papers are in press at Solar Energy Materials & Solar Cells; we have provided the final drafts of these papers to CEC.

2.4.2 Develop a Computer Program for Optimal Design of Cool Coatings

We continue to improve the mixture model on which our coating formulation software is based, and to develop the optimization algorithm. We plan to release an alpha version of the software in late March.

2.4.3 Develop a Database of Cool-Colored Pigments

Task Completed. We have submitted to the CEC an HTML version of our pigment database that augments measured and computed solar spectral radiative properties with images of pigmented coatings, performance data from manufacturers, and technical commentary derived from our pigment papers.

2.5 Development of Prototype Cool-Colored Roofing Materials

2.5.1 Review of Roofing Materials Manufacturing Methods

Task Completed. The first of a two-part review article appeared in Jan/Feb issue of *Western Roofing* magazine.

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

We continued working with manufacturers in developing cool shingle prototypes.

2.5.3 Accelerated Weathering Testing

An outline of a review article on accelerated weathering and bibliography is prepared. We plan to distribute the outline to our industrial partners at the PAC meeting on March 2, 2005; we will solicit comments from them and suggestions for additional references.

2.6 Field-Testing and Product Useful Life Testing

Work continues to document the benefits of cool colored roofing materials. We are working to establish the final pair of demonstration homes in Martinez, Calif. ORNL personnel will visit the weathering sites to collect reflectance and thermal emittance data and to pull roof samples for conducting chemical and microbial analysis of the surface contaminants.

2.6.1 Building Energy-Use Measurements at California Demonstration Sites

We continue to acquire and reduce field data weekly for the two pair of demonstration homes in Cavalli Hills. ORNL personnel are ready to install data loggers on the pair of demonstration homes built by Jerry Wagar of Ochoa and Shehan Inc., Redding Calif. John Goveia of Technical Roof Services, John McCaskil of the Elk Corp. and W. Miller discussed plans for the setup of the final pair of demonstration homes. Elk has an expensive high-end shingle that they want to demonstrate, and are willing to donate for field testing on the two homes located in Martenez, Calif. Goveia and an adjacent neighbor are willing to work with ORNL, LBNL and Elk and are in the process of obtaining bids for installing the shingles.

2.6.2 Materials Testing at Weathering Farms in California

Concrete, clay and painted metal samples continue to be exposed in six different climate zones in Calif. Solar reflectance and thermal emittance measures will be collected in March and some will be pulled for analyzing the elemental composition of contaminants and biomass.

2.6.3 Steep-slope Assembly Testing at ORNL

Solar reflectance measures were collected on the concrete and clay tile roof covers being exposed on the ESRA steep-slope attic assembly. After two years of weathering in East Tennessee's moderate and humid climate the tile covers show no noticeable loss of reflectance. The trend of solar reflectance with time varies from that observed at the

California weathering sites, with the exception of McArthur. The concrete samples exposed in California are soiled by the accumulation of airborne contaminants. Akbari, Berdahl and Rose (2002) believed that the deposition of carbon soot was the major contributor to the loss of solar reflectance. Samples will soon be pulled and surface contaminants checked for the elemental composition of the dust using an inductively coupled plasma spectrometer. We will also measure the concentrations of organic and elemental carbon contaminants contained in the dust. Carbon, especially elemental carbon, is the most significant light absorbing species embedded in atmospheric aerosols. If a surface is entirely covered with elemental carbon, the solar reflectance of the surface would be virtually zero.

Berdahl, P., Akbari, H., and Rose, L.S. 2002. "Aging of reflective roofs: soot deposition," *Applied Optics*, April 2002 Vol. 41, No. 12, 2355-2360.

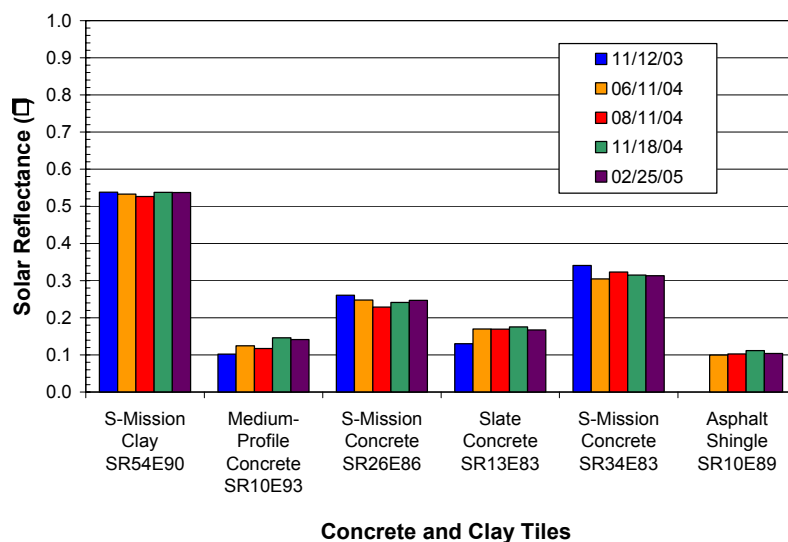


Figure 1. Solar reflectance measures acquired for the tile roof covers being exposed on the steep-slope attic assemblies at ORNL.

2.6.4 Product Useful Life Testing

An outline of a review article on the weathering of roofing, with bibliography, is prepared. We plan to distribute the outline to our industrial partners at the PAC meeting on March 2, 2005; we will solicit comments from them and suggestions for additional references.

A granule manufacturer forwarded some data for roofing granules applied on an asphalt-coated panel and exposed to natural weathering at a south Florida exposure site. Table 1 lists the pigment, months of exposure, the initial granule color and the total color change after exposure. The results again show the cool pigments outperform the conventional pigments. The ΔE for the Ferro pigments is roughly half that measured for the standard production pigments, which indicates the cool colored coatings have improved retention of color over the 2 to 4 years of exposure testing.

Table 1: Granules exposed to natural sunlight in south Florida and painted with and without cool colored coatings.

Pigment	Exposure (months)	Initial Color of Asphalt-Coated Panel			Color Change after Exposure ΔE
		L	a	b	
Carbon Black	18	22.0	0.4	-0.2	2.4
Black Iron Oxide	42.5	22.9	2.7	3.6	1.6
Ferro V-778	58	26.0	2.1	2.6	0.8
Ferro O-1765B	23.5	22.7	1.5	0.7	0.9

2.7 Technology transfer and market plan

2.7.1 Technology Transfer

We prepared an article for the *National Roofing Magazine*.

The paper “Experimental Analysis of the Natural Convection Effects Observed within the Closed Cavity of Tile Roofs,” was finalized for publication at the upcoming Roof Consultants Institute’s “Cool Roof” symposium to be held May 12 - 13, 2005 in Atlanta, GA.

An article titled “Review of Residential Roofing Materials, Part I” appeared in Jan/Feb issue of *Western Roofing* magazine.

2.7.2 Market Plan

(No activity.)

2.7.3 Title 24 Code Revisions

Akbari continues working with PG&E and the Energy Commission to develop a plan for code change proposal for sloped-roof residential buildings.

Management Issues

None.

Attachment 1

Project Tasks and Schedules (Approved on May 16, 2002; Revised schedules approved November 2004)

Task	Task Title and Deliverables	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 2/28/2005
1	Preliminary Activities					
1.1	Attend Kick Off Meeting <i>Deliverables:</i> <ul style="list-style-type: none"> Written documentation of meeting agreements and all pertinent information (Completed) Initial schedule for the Project Advisory Committee meetings (Completed) Initial schedule for the Critical Project Reviews (Completed) 	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"> A list of relevant on-going projects at LBNL and ORNL (Completed) 	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	Technical Tasks					
2.1	Establish the project advisory committee <i>Deliverables:</i> <ul style="list-style-type: none"> Proposed Initial PAC Organization Membership List (Completed) Final Initial PAC Organization Membership List PAC Meeting Schedule (Completed) Letters of Acceptance 	6/1/02	5/17/02	9/1/02		100%
2.2	Software standardization <i>Deliverables:</i> <ul style="list-style-type: none"> When applicable, all reports will include additional file formats that will be necessary to transfer deliverables to the CEC When applicable, all reports will include lists of the computer platforms, operating systems and software required to review upcoming software deliverables 	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 2/28/2005
2.3	<p>PAC meetings <i>Deliverables:</i></p> <ul style="list-style-type: none"> • Draft PAC meeting agenda(s) with back-up materials for agenda items • Final PAC meeting agenda(s) with back-up materials for agenda items • Schedule of Critical Project Reviews Draft PAC Meeting Summaries • Final PAC Meeting Summaries 	9/1/02	6/1/02	6/1/05		83% (5/6)
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"> • Pigment Characterization Data Report (Completed) 	6/1/02	6/1/02	12/1/04 → 12/31/04		~99%
2.4.2	<p>Develop a Computer Program for Optimal Design of Cool Coatings <i>Deliverables:</i></p> <ul style="list-style-type: none"> • Computer Program 	11/1/03	11/1/03	12/1/04 → 5/1/05		~93%
2.4.3	<p>Develop a Database of Cool-Colored Pigments <i>Deliverables:</i></p> <ul style="list-style-type: none"> • Electronic-format Pigment Database (Completed) 	6/1/03	7/1/03	6/1/05 → 12/31/04		~99%
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"> • Methods of Fabrication and Coloring Report (Completed) 	6/1/02	6/1/02	6/1/03		~99%
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"> • Summary Coating Report • Prototype Performance Report 	6/1/02	6/1/02	12/1/04 → 5/1/05		~95%
2.5.3	<p>Accelerated Weathering Testing <i>Deliverables:</i></p> <ul style="list-style-type: none"> • Accelerated Weathering_Testing_Report 	11/1/02	10/1/02	6/1/05 → 10/1/05		~40%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 2/28/2005
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"> Demonstration Site Test Plan Test Site Report 	6/1/02	9/1/02	10/1/05 → 10/1/06		85%
2.6.2	Materials Testing at Weathering Farms in California <i>Deliverables:</i> <ul style="list-style-type: none"> Weathering Studies Report 	6/1/02	10/1/02	10/1/05 → 10/1/06		70%
2.6.3	Steep-slope Assembly Testing at ORNL <i>Deliverables:</i> <ul style="list-style-type: none"> Whole-Building Energy Model Validation Presentation at the Pacific Coast Builders Conference Steep Slope Assembly Test Report 	6/1/02	10/1/02	10/1/05		75%
2.6.4	Product Useful Life Testing <i>Deliverables:</i> <ul style="list-style-type: none"> Solar Reflectance Test Report 	5/1/04	5/1/04	6/1/05 → 10/1/05		45%
2.7	Technology transfer and market plan					
2.7.1	Technology Transfer <i>Deliverables:</i> <ul style="list-style-type: none"> Publication of results in industry magazines and refereed journal articles Participation in buildings products exhibition, such as the PCBC Brochure summarizing research results and characterizing the benefits of cool colored roofing materials 	6/1/03	6/1/02	6/1/05		~ 90%
2.7.2	Market Plan <i>Deliverables:</i> <ul style="list-style-type: none"> Market Plan(s) 	5/1/05		6/1/05		
2.7.3	Title 24 Code Revisions <i>Deliverables:</i> <ul style="list-style-type: none"> Document coordination with Cool Roofs Rating Council in monthly progress reports Title 24 Database 	6/1/02	5/16/02	6/1/05		~ 50%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 2/28/2005
VII	Critical Project Review(s) <i>Deliverables:</i> <ul style="list-style-type: none"> Minutes of the CPR meeting 					
XII (C)	Monthly Progress Reports <i>Deliverables:</i> <ul style="list-style-type: none"> Monthly Progress Reports 	6/1/02	6/1/02	6/1/05		83% (30/36)
XII (D)	Final Report <i>Deliverables:</i> <ul style="list-style-type: none"> Final Report Outline Final Report 	3/1/05 → 3/31/05		10/1/05 → 10/1/06		
	Final Meeting <i>Deliverables:</i> <ul style="list-style-type: none"> Minutes of the CPR meeting 	10/15/05		10/31/05		