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October 9, 2003

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

A summary of the status of Tasks and Deliverables as of September 30, 2003 is presented in Attachment 1.

## HIGHLIGHTS

- The third project advisory committee (PAC) meeting was held at LBNL on September 11, 2003.
- We presented our draft paper characterizing 83 single-pigment paints to our industrial partners and Project Advisory Committee at meetings held on September 10 and 11, respectively.
- We shared a preliminary version of our pigment property database with our industrial partners.
- American Roof Tile and US Tile are planning to place concrete and clay roof tiles with cool colored coatings for weathering at the seven CA exposure sites.

## 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

The third PAC meeting was held on September 11. The project team met with the industrial partners prior to the PAC meeting on the afternoon of September 10. The

agenda for the PAC meeting, the minutes of the meeting, the list of attendants, and the presentation material for the PAC meeting is available at the project web site ([CoolColors.LBL.gov](http://CoolColors.LBL.gov)).

## 2.4 Development of Cool Colored Coatings

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

We presented our draft paper characterizing 83 single-pigment paints to our industrial partners and Project Advisory Committee at meetings held on September 10 and 11. We will incorporate their feedback in the final version of the paper, 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 have shared a preliminary version of our pigment property database with our industrial partners. Its current form is a ZIP archive of tab-delimited text files, one file per single-pigment paint. Each file details the measured and computed solar spectral optical properties of a pigment, such as film reflectance, film transmittance, film absorbance, scattering coefficient, and absorption coefficient.

## 2.5 Development of Prototype Cool-Colored Roofing Materials

### 2.5.1 Review of Roofing Materials Manufacturing Methods

The “Roofing Materials Manufacturing Methods” report was presented at the PAC meeting. The representatives from cement roof tile and cedar shake roof manufacturers requested that the report be expanded to include these roofing materials. We are arranging visits to cement roof tile and cedar shake roof-manufacturing plants and will expand the current draft report.

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

We continued our discussions regarding the application to the two-layered technique and novel cool pigments with a few of our industrial partners. We expect to receive novel samples of roofing granules and at least two types of coated roof tiles in the near future.

### 2.5.3 Accelerated Weathering Testing (No activity.)

## 2.6 Field-Testing and Product Useful Life Testing

Shepherd Color Company made concrete tile samples with cool colored pigments for MonierLife Tile. American Roof Tile and US Tile want to expose concrete and clay samples at the seven field sites. Mike Evans has three homes partially constructed and has selected Hanson’s Hacienda tile (H 409) for the two ‘A’ style homes. ORNL personnel will install the data acquisition systems on each house the last week of October. A brochure was developed to help Evans explain to potential homeowners the benefits of cool colored pigments and the special tests ORNL will perform at no cost to them to check the thermal performance of their residences (see Attachment 2).

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

Miller and Scruton visited the demonstration homes at Cavalli Hills, Sacramento following the September 11, 2003 Project Advisory Committee meeting. Mike Evans of Evans Construction (second from right in the background, Fig. 1) met with Willem Boss and David Bisbee of SMUD (first and third from right, Fig. 1), with the CEC project manager Chris Scruton (fourth from right, Fig. 1) and with W. Miller of ORNL. The second floor of the homes were under construction at the time of our visit; however, as of this writing three of the four demonstration homes are partially constructed with 5/8" oriented strand board (OSB) nailed to the roof rafters. Evans stated that his construction crew would cut the instrumented (OSB) sandwich panels supplied by ORNL into the three roofs. These OSB instrument panels contain heat flux transducers and thermometry for measuring the heat flow and temperatures of the roof.



Fig. 1. ORNL, SMUD and the CEC with Evans Const.

Hanson Roof Tile is donating their low-profile Hacienda tiles for the two 'A' style homes in Cavilli Hills. The tiles are a model H409 having standard brown color pigments. Lou Zumpano of Hanson placed the order and will ship material to Evans who has contracted Dynamic Roofing to install the concrete tile. ORNL will pay for the tile installation. Once installed, Joe Riley of American Roof Tile will apply four topcoats to one of the two tile roofs. The topcoat contains cool colored pigments and will boost the reflectance of the tile to almost 45%. Riley developed the technique through funding from California's Energy Innovation Small Grants program. The technique applies enough of Ferro Corp.'s cool colored pigments to develop about a 6-mil thick painted surface that is highly reflective and opaque to infrared radiation. Ken Loye of Ferro Corp. had developed a slurry coat application; however, Loye agreed that the topcoat application developed by American Roof Tile is the most expedient process for getting the job done. Hanson and American Roof Tile will provide Evans a ten-year warranty on the coating. The labor and material for installing the topcoats will be covered by ORNL.

Custom-Bilt Metals will supply Evans with the "Country Manor Shake" with and without cool colored pigments. Painted metal shakes will be installed on the two 'C' style homes adjacent the two 'A' style homes covered with Hanson's concrete tile. ORNL will pay for the installation of the painted metal roofs. Evans Construction has one 'C' style home ready for roof placement, while ground breaking for the second 'C' style home will occur in October 03.

Willem Boss and W. Miller developed a common data acquisition system (DAS) for measuring performance of the insulated concrete form (ICF) wall, cool-colored roofs and HVAC. All DAS equipment has been calibrated and checked for proper operation and will be shipped to Evans. ORNL personnel are scheduled to run instrument wiring the last week of October. Evans Construction prefers minimal intrusions from DAS and monitoring equipment. He wants potential homebuyers to be enthusiastic about their new home, and not dissatisfied with unsightly DAS equipment. Therefore ORNL has requested



Fig. 2. Campbell Scientific CR23X data logger for demo home.

Evans to install a 1½-in PVC pipe into the exterior foam of the ICF wall. The pipe will run from the attic to about 3-ft above ground level and will be used as a conduit for running instrument wires from the attic to the DAS. Evans plans to finish the exterior walls with stucco and therefore the 1½-in PVC pipe will be hidden; it is being embedded in the wall.

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

Shepherd Color Company has made the concrete tile samples for MonierLife Tile and will ship them to ORNL for placement in the seven CA exposure sites. Joe Riley of the American Roof Tile Company and Brad Heath of US Tile both expressed interest in participating in the weathering study of cool colored pigments. American Roof Tile and US Tile are making samples, which ORNL will also place in the seven field sites.

#### 2.6.3 Steep-slope Assembly Testing at ORNL (No activity)

#### 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**

- Drs Tammy Elkins and Bill Herron from DuPont Central Research and Development visited LBNL and discussed development and marketing of cool-colored roofing materials.

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 09/30/2003
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 09/30/2003
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		~ 55%
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		~ 7%
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		~ 10%
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 09/30/2003
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		30%
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		14%
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%

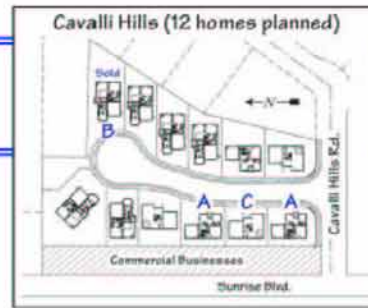
**Project Tasks and Schedules (contd.)**

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 09/30/2003
VII	Critical Project Review(s) <i>Deliverables:</i> <ul style="list-style-type: none"> <li>Minutes of the CPR meeting</li> </ul>					
XII (C)	Monthly Progress Reports <i>Deliverables:</i> <ul style="list-style-type: none"> <li>Monthly Progress Reports</li> </ul>	6/1/02	6/1/02	6/1/05		44% (16/36)
XII (D)	Final Report <i>Deliverables:</i> <ul style="list-style-type: none"> <li>Final Report Outline</li> <li>Final Report</li> </ul>	3/1/05		10/1/05		
	Final Meeting <i>Deliverables:</i> <ul style="list-style-type: none"> <li>Minutes of the CPR meeting</li> </ul>	10/15/05		10/31/05		



## Mike Evans Building Energy Efficient Homes For You

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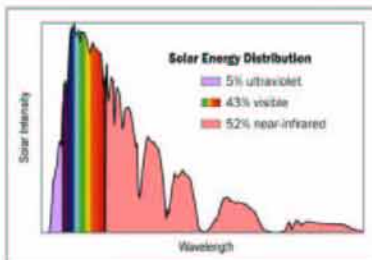


### COOL ROOF COLOR MATERIALS (CRCMs)

Most painted roofs today have a reflectance of about 10-20%, but special paint made using Cool Roof Color Materials can give you a much higher reflectance of almost 60%. A roof covered by this special paint absorbs less solar energy and can save nearly 20% of your air conditioning costs.

FERRO Corp. and the Shepherd Color Company developed the Cool Roof Color Materials to look dark in color even though they reflect most of the sun's energy.

How can these dark roofs reflect as much or more energy than a white roof? The sun's radiation consists of



ultraviolet, visible, and infrared energy. Our eyes can only see the visible region. The visible light that is reflected from an object determines the color of that object. White roofs reflect most of the visible light (which mixes together to look white to our eyes), but over half of the sun's energy is contained in the infrared region, which isn't visible

to our eyes. Because we can't see this energy, we can reflect it away from the roof without changing the roof's color.

### Advantages of Cool Roof Color Materials

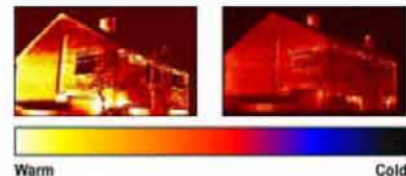
- Better fade resistance than standard colors
- Reflect more sunlight and stay cooler
- Lower utility bill for cooling the house
- Architectural appeal

### Insulated Concrete Form Walls

Oak Ridge National Laboratory and the Florida Solar Research Center independently proved that insulated concrete form wall construction reduces seasonal cooling energy. These walls save energy in two ways. First they have a higher thermal resistance (R-value) than many other types of walls. Second, they tend to store energy, so that regular day and night temperature swings can help cool the house in summer and warm the house in winter.

### Special Testing

The Sacramento Municipal Utility District is working with Evans Construction because they want to collect thermal performance data for insulated concrete form walls in Sacramento. The California Energy commission and two national laboratories, Oak Ridge National Lab and Lawrence Berkeley National Lab, are interested in knowing the performance of the Cool Roof Color Materials. So it makes good sense to work together in



one project. Oak Ridge will make thermal scans of the roofs and walls. In these scans, cold surfaces show as black while the hottest surfaces are orange, red or white in color. The house with ICF walls on the right show lower wall temperatures than the frame construction house on the left, and therefore has lower heat losses.

Air leakage affects the thermal performance of a home, and can account for 30% or more of your home's utility bill. Oak Ridge will conduct blower door and duct testing to determine the natural infiltration rate of the house and duct system. Uncontrolled air leakage can result in high fuel bills and moisture damage.

