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December 08, 2003

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

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

HIGHLIGHTS

- Task 2.4.2 “Develop a Computer Program for Optimal Design of Cool Coatings” was started on November 1, 2003.
- On November 24 and 25, Berdahl and Akbari traveled to Ennis Texas and met with 3M and Elk R&D staff (at Elk Head Quarter) to assess their recent progress in developing cool colored shingles.
- The Roof Tile Institute and its affiliates installed six types of concrete and clay tiles on the steep-slope attic assembly at ORNL.
- We are working to establish a second demonstration site for parallel testing of standard and cool asphalt shingles. Evans has sold all twelve homes in Cavalli Hills, and will not provide two additional homes with shingles because the homeowners prefer tile or metal shake roofs.
- We continue working with our industrial partners on the development of initial prototype cool roofing materials. Several more samples have been developed and measured.

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 Greg Ander of SCE were invited to join the PAC and accepted the invitations.

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 revised our pigment characterization draft paper to (a) better account for measurement errors, including those stemming from the limitations of our spectrometer's integrating sphere; and (b) elaborate on some of the physical features (e.g., absorptance spectra) observed in the pigments. We expect to finalize the paper in December.

2.4.2 Develop a Computer Program for Optimal Design of Cool Coatings

We have started this task by assembling various algorithms developed under Task 2.4.1.

2.4.3 Develop a Database of Cool-Colored Pigments

We forwarded data to our partners and responded to partners' questions and comments.

2.5 Development of Prototype Cool-Colored Roofing Materials

2.5.1 Review of Roofing Materials Manufacturing Methods

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 continue to work with tile, granule, and shingle manufacturers to develop cooler products, focusing this month on developing cool glazes for clay tiles. Since the optical properties of a glaze change when fired in a kiln (peak temperature of about 1050 °C), glaze samples must be fired prior to characterization. This presents a challenge, because the clear substrates (e.g., quartz) than can survive such high temperatures have lower coefficients of thermal expansion than do the glazes, which would make the glaze or substrate crack during firing. Hence, we intend to characterize each glaze by measuring the solar spectral reflectance of a series of white tiles coated with glazes containing increasing concentrations of pigments (e.g., 0.5%, 1%, 2%, 4%, and 6%). We have received such "concentration ladder" tiles for about 20 Ferro ceramic colors, and will measure their reflectance in December.

On November 24 and 25, Berdahl and Akbari traveled to Ennis Texas and met with 3M and Elk R&D staff (at Elk Head Quarter). During the meeting, 3M and Elk updated the LBNL project team on their recent progress for development of cool colored shingles.

2.5.3 Accelerated Weathering Testing

(No activity.)

2.6 Field-Testing and Product Useful Life Testing

The Roof Tile Institute (RTI) and its affiliate members installed clay and concrete tile on the steep-slope attic assembly on the Envelope Systems Research Apparatus. Efforts are in progress to establish a second demonstration site for testing asphalt shingles with and without colored cool pigments.

2.6.1 Building Energy-Use Measurements at California Demonstration Sites

Last month we reported that Evans Construction and the Sacramento Land & Home realtor, Steve Burke, sold all 12 homes in the Cavalli Hills subdivision. Original plans called for six homes to be built next year, but because of unexpected demand Evans accelerated his building and will complete all twelve homes for occupancy by March 04 (Figure 1). Our project calls for demonstrating six homes. Two C style homes in Cavalli Hills have metal roofs with and without Cool Roofing Colored Materials (CRCMs); two A style houses have tile roofs. However, Evans will not provide two additional homes in Cavalli Hills with asphalt shingle roofs. Evans is looking for other sites to support our initiative; however, ORNL has made contacts through SMUD, Steve Burke and the Economic Resource Council of Grass Valley to develop a second demonstration site for testing homes with asphalt shingles.

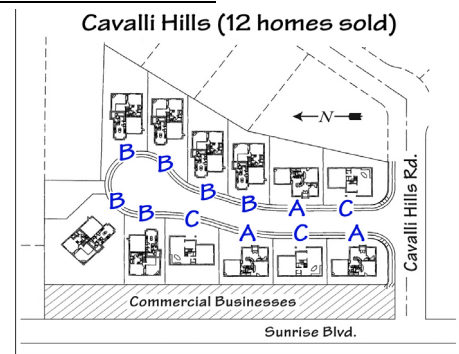


Figure 1. Footprint of A, B and C style homes built by Evans Construction.

Dynamic Roofing installed what is termed an 80% lay of the Hanson concrete tile on the two A Style homes. They will install trim tile to complete the job after other crews have applied stucco to the insulated concrete form walls of the homes. The concrete tiles are the model H409 Hacienda low profile with dark brown color. Joe Reilly of American Roof Tile Coatings has prepared coatings with CRCMs and is ready to apply a topcoat finish to one of the two installed tile roofs. The CRCM topcoat will boost the reflectance of the tile from about 25% to almost 45%.

The weather station and Campbell Scientific data loggers will be installed after stucco is 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 Evans estimates will occur in early January, 04.

2.6.2 Materials Testing at Weathering Farms in California

All samples are installed at weathering farms.

2.6.3 Steep-slope Assembly Testing at ORNL

Richard Olson of the Roof Tile Institute (RTI), David Faulkner of Polyfoam Products, Danny Cornwell, consultant to the western states roofing contractors association, Philip Dregger and John Goveia both of Technical Roof Services and Jerry Vandewater of MonierLife Tile installed clay and concrete tile on the steep-slope attic assembly on Nov 15, 03. The type of tile, manufacturer of the tile, the application used to fasten the tile and surface coverage per test lane are listed below.

Lane	Type of Tile	Manufacturer	Application	Weight	Roof Surface
1	Clay "S"	MCA	Direct Deck	850 lbs	48" by 17'
2	Concrete Medium	Hanson	Direct Deck	675 lbs	48" by 17'
3	Concrete Medium	MonierLife Tile	Direct Deck w/foam	628 lbs	48" by 17'
4	Concrete Flat	MonierLife Tile	Counter Batten	700 lbs	48" by 17'
5	Concrete "S"	Eagle	Batten	640 lbs	57 1/2" by 17'
6	Asphalt Shingle	Proprietary	Direct Deck	50 lbs	54 1/2" by 17'

Parapets made from treated 2' by 4' lumber and channel flashing were installed between the lanes of clay and concrete tile to eliminate any airflow from underneath the tile to another test lane. All tiles whether direct nailed or installed on battens have a shallow

channel for venting heat away from the roof deck. ORNL will measure the temperatures and heat flows just underneath the tile for direct nailed, batten and counter-batten tile systems and will compare the results to a top-of-the-line asphalt shingle.

ORNL recently learned that the Lafarge Roofing Technical Center has developed and validated a computer code that predicts condensation, temperature and heat flow within the air channel seen in batten and counter-batten roof construction. Lafarge wants to validate the code against field data acquired in the U.S, and has submitted a budget to the Lafarge Roofing Corp. for working with ORNL. Hence, a white paper was forwarded to the Lafarge Center to begin negotiating collaborative work. It makes good sense to work together and validate the Lafarge code against field data acquired at the demonstration sites and the fully instrumented attic test stand. Once validated, we would use the code to develop correlations for the heat transfer occurring in direct nailed, batten and counter-batten constructions and implement the correlations in AtticSim for determining the cost of energy savings for vented roofs in different climates.

2.6.4 Product Useful Life Testing
(No activity.)

2.7 Technology transfer and market plan

2.7.1 Technology Transfer

The project team submitted abstracts to ACEEE 2004 and to THERM IX.

2.7.2 Market Plan
(No activity.)

2.7.3 Title 24 Code Revisions

Revisions to Title 24 were approved by CEC on November 5, 2003. The new revisions would make cool roofs a prescriptive requirement for low-sloped non-residential buildings. The new standards will be in effect on January 1, 2004.

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 11/30/2003
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 11/30/2003
2.3	PAC meetings <i>Deliverables:</i> <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		50% (3/6)
2.4	Development of cool colored coatings					
2.4.1	Identify and Characterize Pigments with High Solar Reflectance <i>Deliverables:</i> <ul style="list-style-type: none"> Pigment Characterization Data Report 	6/1/02	6/1/02	12/1/04		~65%
2.4.2	Develop a Computer Program for Optimal Design of Cool Coatings <i>Deliverables:</i> <ul style="list-style-type: none"> Computer Program 	11/1/03	11/1/03	12/1/04		<2%
2.4.3	Develop a Database of Cool-Colored Pigments <i>Deliverables:</i> <ul style="list-style-type: none"> Electronic-format Pigment Database 	6/1/03	7/1/03	6/1/05		~10%
2.5	Development of prototype cool-colored roofing materials					
2.5.1	Review of Roofing Materials Manufacturing Methods <i>Deliverables:</i> <ul style="list-style-type: none"> Methods of Fabrication and Coloring Report 	6/1/02	6/1/02	6/1/03		~95%
2.5.2	Design Innovative Methods for Application of Cool Coatings to Roofing Materials <i>Deliverables:</i> <ul style="list-style-type: none"> Summary Coating Report Prototype Performance Report 	6/1/02	6/1/02	12/1/04		~20%
2.5.3	Accelerated Weathering Testing <i>Deliverables:</i> <ul style="list-style-type: none"> Accelerated Weathering Testing Report 	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 11/30/2003
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"> • Demonstration Site Test Plan • Test Site Report 	6/1/02	9/1/02	10/1/05		35%
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		35%
2.6.3	Step-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		25%
2.6.4	Product Useful Life Testing <i>Deliverables:</i> <ul style="list-style-type: none"> • Solar Reflectance Test Report 	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"> • 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		~5%
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		~5%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 11/30/2003
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		50% (18/36)
XII (D)	Final Report <i>Deliverables:</i> <ul style="list-style-type: none"> • Final Report Outline • Final Report 	3/1/05		10/1/05		
	Final Meeting <i>Deliverables:</i> <ul style="list-style-type: none"> • Minutes of the CPR meeting 	10/15/05		10/31/05		