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

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

HIGHLIGHTS

- BASF and MCA delivered roof exposure samples to ORNL.
- Mike Evans Construction and SMUD signed the Memorandum of Understanding (MOU) contributing demonstration homes for Task 2.6.1.
- The project team visited two roofing factories in Southern California—Steelscape metal roll roofing in Rancho Cucamonga and MCA rooftile in Corona.

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
(No activity.)

2.4 Development of Cool Colored Coatings

2.4.1 Identify and Characterize Pigments with High Solar Reflectance
We modified an inexpensive tabletop roller mill to simultaneously roll four small (59 cc) jars, and equipped it with a 12-hour timer. The mill can now be used to prepare in a controlled, reproducible fashion small quantities of paint from dry pigment

powders, and also to mix prepared paints. We have begun to make paints from the 50 or so pigments provided by our industrial partners (Ferro, Shepherd), and to characterize the pigments from spectral measurements made on paint drawdowns.

While we succeeded in dispersing some of the dry pigments readily (the standard white being easy), other materials are proving more difficult and time consuming. We are consulting with the pigment manufacturers to improve our laboratory technique.

Intellectual property (IP) issues can hinder the free exchange of information between us and our industry partners. We signed one three-way non-disclosure agreement (NDA) to improve information flow and are working with the Tech Transfer and Patent departments at LBNL to arrange for the release of some internal LBNL information.

2.4.2 Develop a Computer Program for Optimal Design of Cool Coatings
See Task 2.4.1. No major progress in April.

2.4.3 Develop a Database of Cool-Colored Pigments
(No activity.)

2.5 Development of Prototype Cool-Colored Roofing Materials

2.5.1 Review of Roofing Materials Manufacturing Methods
On April 30, Berdahl, Levinson and Akbari visited the Steelscape metal roofing (in Rancho Cucamonga) and MCA rooftile (in Corona) plants in Southern California. The visit to Steelscape was arranged by Michelle Vondran from BASF, who accompanied us during the visit. Mr. Steve Perry, the plant manager at Steelscape, gave us a complete tour of the facilities. Steelscape has four major production lines: pickle line (cleaning of the hot band coil that arrives at the coating mill); cold reverse mill (reducing the thickness of the steel to specifications); metallic coating (production of steel rolls with zinc and aluminum metallic surface coatings); and paint line (painting the steel rolls). Of these four production lines, the paint line is that of direct interest to production of cool roofing materials. The painted metal rolls from Steelscape are used by other manufacturers to produce roofing materials. During the visit, we learned that it is feasible to produce novel cool-colored steel rolls through a two-layer coating approach (in some cases, the highly reflective metal surface under the colored coating would satisfy the condition of the reflective underlayer). It also appeared that the existing equipment for measuring the color of steel rolls may need to be expanded to afford capabilities for measuring reflectance in the near-infrared or solar spectra.

Our visit to MCA rooftile manufacturing plant was equally stimulating. We were hosted by Mr. Yoshihiro (Yoshi) Suzuki, the general manager of the plant. Yoshi gave us a complete tour of the facilities. The production of rooftiles at MCA plant goes through several basic stages: (1) preparation of the raw clay mix; (2) extrusion, cutting, and drying of clay tiles; (3) color-coating of the tiles; and (4) kiln-firing the raw dry clay tiles. MCA produces rooftiles in many different colors and has been a leader in application of cool-colored pigments on rooftiles. MCA also has a Devices & Services solar spectrum reflectometer for measuring the solar reflectance of products. We need to further investigate the applicability of the two-layer coating techniques to rooftiles.

We have started to prepare the draft final report for Task 2.5.1.

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

(No activity.)

2.5.3 Accelerated Weathering Testing

(No activity.)

2.6 Field-Testing and Product Useful Life Testing

The William Harrison Corporation continues building the exposure rack sets. BASF and MCA have made the roof exposure samples and Monier LifeTile has finally begun working with Shepherd to prepare the concrete tile samples. Data acquisition equipment is on order and instrumented panels are being built for the demonstration homes. University of Tennessee at Knoxville (UTK) is searching the literature for mixed convection flow visualization studies that are similar in flow behavior to that occurring under a batten and counter batten roof construction.

2.6.1 Building Energy-Use Measurements at California Demonstration Sites

Mike Evans Construction and SMUD have signed and returned the Memorandum of Understanding (MOU) that establishes their willingness to coordinate work through ORNL for the setup and maintenance of data acquisition systems and instruments to be installed in the demonstration homes. LBNL was sent a copy of the signed MOU.

The decking of the demonstration homes will be 5/8-in OSB. Typically 15/32-in OSB is used with batten construction for supporting concrete tile roofs. However, the 5/8-in OSB was selected because it is of sufficient thickness for obtaining accurate measures of heat flow from a 0.15-in thick heat flux transducer that will be embedded in the OSB. A 2-ft-square section of 5/8-in OSB was placed in a heat flux apparatus to determine the thermal conductivity of the material. Top temperature of the board was set at 45, 75, 100 and 120°F, which are typical temperatures observed by Parker, Sonne and Sherwin (2002) for roof decks covered by concrete tile. Results revealed that the thermal conductivity of OSB increases linearly with temperature (Fig. 1). A thinner ¼-in OSB board was also tested and found to have thermal conductance within ± 0.5% of the measures obtained for the thicker 5/8-in board (Fig. 1). The thinner board can therefore be used as a cover plate to hold the heat flux transducer in place. Shunting of heat flow will not occur because the two OSB boards have very close thermal conductivities. Shunting due to the differences in thermal conductance of the HFT and the OSB will be corrected by calibrating the instrumented 4-ft by 4-ft test panels using ASTM C518 (ASTM 1998). The thinner board will be on the underside of the deck to provide access if maintenance and or sensor replacement is required.

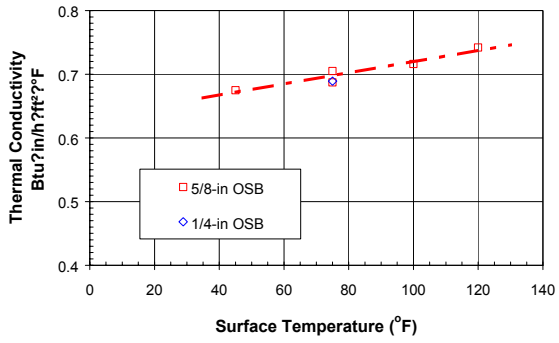

Figure 1. Thermal conductivity measures made for OSB.

Parker, D.S., Sonne, J. K., Sherwin, J. R. 2002. "Comparative Evaluation of the Impact of Roofing Systems on Residential Cooling Energy Demand in Florida," in ACEEE Summer Study on Energy Efficiency in Buildings, proceedings of American Council for an Energy Efficient Economy, Asilomar Conference Center in Pacific Grove, CA., Aug. 2002.

ASTM. 1998. Designation C518-98: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus. American Society for Testing and Materials, West Conshohocken, PA.

2.6.2 Materials Testing at Weathering Farms in California

MCA clay tile samples were delivered to ORNL. Jerry Vandewater sent Monier LifeTile's cement mixture to Shepherd Color Company for blending the CRCM into the concrete tiles. Tom Steger of Shepherd volunteered technician support to help Monier make the 3.5-in square samples for the exposure sites. BASF has made the metal samples and the materials are in shipment to ORNL.

The William Harrison Corporation continues building the exposure rack sets. Shipment of the assemblies to the respective participating roofing manufacturers, Custom-Bilt, Steelscape, BASF, MCA and ELK is scheduled for the first week of June. The participating manufacturers will install the exposure rack sets at their facilities. ORNL personnel will install the two sets shipped to the California Irrigation Management Information System (CIMIS) sites located in Shasta and Imperial counties.

2.6.3 Steep-slope Assembly Testing at ORNL

Last month computational fluid dynamic simulations were run to better understand the flow occurring within a batten constructed roof deck. The simulations were made for an open channel; however, both metal and tile roof manufacturers recommend the sealing the vent gap terminating at the ridge vent to prevent moisture damage from incoming rain. The Roof Tile Institute and the metal roofing consortiums have conducted wind uplift studies to measure the porosity of the roof cover. In fact the roof is designed porous to alleviate the underside air pressure and minimize uplift. Efforts are being made to acquire information on the flow coefficients measured from wind uplift testing. The data is extremely important for accounting for the dynamic behavior of the airflow occurring from the roof deck through gaps in the tile and back into the wind stream.

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

Akbari and CEC had several e-mail exchange discussing and fine-tuning the details of the code language for application of reflective low-sloped on non-residential buildings.

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 04/30/2003
1	**Preliminary Activities**					
1.1	Attend Kick Off Meeting *Deliverables:* • 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 *Deliverables:* • 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 *Deliverables:* • 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 *Deliverables:* • 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 04/30/2003
2.3	PAC meetings *Deliverables:* • Draft PAC meeting agenda(s) with back-up materials for agenda itemsFinal PAC meeting agenda(s) with back-up materials for agenda items Schedule of Critical Project ReviewsDraft PAC Meeting Summaries • Final PAC Meeting Summaries	9/1/02	6/1/02	6/1/05		33% (2/6)
2.4	Development of cool colored coatings					
2.4.1	Identify and Characterize Pigments with High Solar Reflectance *Deliverables:* • Pigment Characterization Data Report	6/1/02	6/1/02	12/1/04		~ 35%
2.4.2	Develop a Computer Program for Optimal Design of Cool Coatings *Deliverables:* • Computer Program	11/1/03		12/1/04		
2.4.3	Develop a Database of Cool-Colored Pigments *Deliverables:* • Electronic-format Pigment Database	6/1/03		6/1/05		
2.5	Development of prototype cool-colored roofing materials					
2.5.1	Review of Roofing Materials Manufacturing Methods *Deliverables:* • Methods of Fabrication and Coloring Report	6/1/02	6/1/02	6/1/03		~ 65%
2.5.2	Design Innovative Methods for Application of Cool Coatings to Roofing Materials *Deliverables:* • Summary Coating Report • Prototype Performance Report	6/1/02	6/1/02	12/1/04		< 5%
2.5.3	Accelerated Weathering Testing *Deliverables:* • Accelerated Weathering Testing Report	11/1/02	10/1/02	6/1/05		< 3%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 04/30/2003
2.6	Field-testing and product useful life testing					
2.6.1	Building Energy-Use Measurements at California Demonstration Sites *Deliverables:* • Demonstration Site Test Plan • Test Site Report	6/1/02	9/1/02	10/1/05		8%
2.6.2	Materials Testing at Weathering Farms in California *Deliverables:* • Weathering Studies Report	6/1/02	10/1/02	10/1/05		17%
2.6.3	Steep-slope Assembly Testing at ORNL *Deliverables:* • Whole-Building Energy Model Validation Presentation at the Pacific Coast Builders ConferenceSteep Slope Assembly Test Report	6/1/02	10/1/02	10/1/05		14%
2.6.4	Product Useful Life Testing *Deliverables:* • Solar Reflectance Test Report	5/1/04		6/1/05		
2.7	Technology transfer and market plan					
2.7.1	Technology Transfer *Deliverables:* • 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		~ 3%
2.7.2	Market Plan *Deliverables:* • Market Plan(s)	5/1/05		6/1/05		
2.7.3	Title 24 Code Revisions *Deliverables:* • 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 04/30/2003
VII	Critical Project Review(s) *Deliverables:* • Minutes of the CPR meeting					
XII (C)	Monthly Progress Reports *Deliverables:* • Monthly Progress Reports	6/1/02	6/1/02	6/1/05		30% (11/36)
XII (D)	Final Report *Deliverables:* • Final Report Outline • Final Report	3/1/05		10/1/05		
	Final Meeting *Deliverables:* • Minutes of the CPR meeting	10/15/05		10/31/05		