We held the sixth Project Advisory Committee meeting on March 3, 2005 at the Custom-Bilt facilities in Chino, CA. The PAC meeting included presentations from seven industrial partners. The minutes of the PAC meeting is attached.

On the afternoon of the March 2, 2005, the industry partners and the project team met to discuss technical details in developing and marketing cool colored roofing materials.

This was the last scheduled PAC meeting. This task is now completed.

2.4 Development of Cool Colored Coatings

2.4.1 Identify and Characterize Pigments with High Solar Reflectance
Task Completed

2.4.2 Develop a Computer Program for Optimal Design of Cool Coatings
We have created an alpha version of the coating formulation software that designs a topcoat matching a target visible reflectance spectrum and having high solar reflectance. Input parameters include

- the target visible spectral reflectance (400 - 700 nm @ 20-nm intervals);
- the type of the substrate (e.g., zincalume);
- components and thickness of the basecoat, if present (e.g., 25 microns of titanium dioxide white paint with a pigment volume concentration of 20%);
- the number of components to allow in the topcoat (e.g., 3);
- candidates for each of the components (e.g., component1=any blue; component2=one of three specific greens; component3=any yellow);
- types of pigments to exclude from consideration (e.g, pigments with strong NIR absorption);
- concentration levels to try for each component (e.g., 0, 1, 2, 3, 5, 10, 15, 20, 25, and 30%);
- the criterion to use for matching visible spectrum (e.g., root mean square difference not to exceed 0.03).

Graphical and text outputs detail the visible spectral reflectance and solar reflectance of coatings that closely match the target visible reflectance spectrum.

We are currently calibrating the software by comparing its predictions to the known compositions, visible spectral reflectance, and solar reflectance of mixtures prepared and characterized earlier in this project. We will share the calibrated software with our industrial partners in late April.

2.4.3 Develop a Database of Cool-Colored Pigments
Task Completed

2.5 Development of Prototypes of Cool-Colored Roofing Materials

2.5.1 Review of Roofing Materials Manufacturing Methods
Task Completed. The second of a two-part review article appeared in Mar/Apr issue of Western Roofing magazine.

2.5.2 Design Innovative Methods for Application of Cool Coatings to Roofing Materials
On March 1, 2005, Elk Corp. announced availability of cool-colored shingles for four products.

We continued working with manufacturers developing cool shingle prototypes. We received a new dark brown sample with a solar reflectance of 0.22.

2.5.3 Accelerated Weathering Testing
At the partner's meeting and the PAC meeting on March 2 and 3, 2005, we presented an outline of our proposed review article on accelerated weathering, together with a bibliography. The bibliography permitted us and our industrial partners to see which roofing subjects were only thinly documented. Subsequently, we received additional information on roof tiles (from MCA), and on A. Desjarlais' suggestion, located an outstanding reference on wood (Wood handbook-Wood as an engineering material, Forest Products Laboratory, Madison, Wisconsin (1999; available online.) Also, Ben Simkin of Arkema, Inc. is to provide materials on the weathering of PVDF roof coatings.

2.6 Field-Testing and Product Useful Life Testing
ORNL personnel visited the seven weathering sites and collected solar reflectance and thermal emittance data. Samples were pulled from each site and sent to ORNL for conducting elemental and microbial analysis of the surface contaminants.

Data loggers were installed on two demonstration homes in Redding CA. The Memorandum of Understanding (MOU) with Elk Group, Ochoa and Shehan Inc and ORNL was reviewed and approved by the Elk Group.

The Shepherd Color Company and 3M Mineral have agreed to conduct weatherometer accelerated testing of an assortment of cool-color roof products. Shepherd will conduct accelerated fluorescent light exposure while 3M Mineral will conduct Xenon-arc exposure testing.

2.6.1 Building Energy-Use Measurements at California Demonstration Sites
ORNL personnel installed data loggers on an external wall of each of the pair of demonstration homes built by Jerry Wagar of Ochoa and Shehan Inc., Redding Calif. Measurements of the roof and attic temperatures, the solar irradiance and the relative humidity in the attic and conditioned space were checked as part of commissioning the data loggers. Data for about one day were downloaded while at the Redding site as a final functionality check of the data acquisition system. Phone lines were connected to modems contained in the NEMA enclosures, and ORNL successfully downloaded data over the modem. ORNL is letting a work order with SBC Communications to maintain residential phone service during the two-year period of the demonstrations.

The legal department of the Elk Group approved the Memorandum of Understanding (MOU) and Elk's Product Brand Manager, John McCaskil, forwarded a signed copy for Jerry Wagar of Ochoa and Shehan Inc and ORNL to sign. Final copies of the document will be forwarded to all parties.

2.6.2 Materials Testing at Weathering Farms in California
ORNL personnel collected solar reflectance and thermal emittance measures for the concrete, clay, painted metal and stone coated metal samples being exposed at seven different exposure sites in Calif. Some painted metal and concrete samples were pulled from each rack for conducting elemental and microbial analysis of the surface contaminants. ORNL's Environmental Science Division (ESD) will check the elemental

composition of the dust from the samples using an inductively coupled plasma spectrometer (ICP); the elements include Ca, K, Al, Fe, Pb, Zn, Mg, and Mn. These elements are selected because of their predominance in the ambient air. We also plan to do analysis for carbon and sulfur using a total carbon and sulfur analyzer. The Biomarker Analysis Center at the University of Tennessee will conduct an Ester-linked Phospholipid Fatty Acid (PLFA) analysis to determine the microbial community structure on the samples exposed in California. The surface composition and morphology studies will help identify the drivers affecting the change in reflectance of the roof samples.

2.6.3 Steep-slope Assembly Testing at ORNL

Work continued to validate AtticSim against field data for the direct nailed asphalt shingle being tested on the steep-slope assembly at ORNL. A check was made of the ventilation air change rate modeled within the attic cavity, which is presently configured with the ridge vent partially closed. The roof was modeled as a shed type roof and tested with ridge and soffitt venting and with only soffitt venting. The results (+ AtticSim) show that soffitt and ridge venting resulted in too much air exchange within the attic cavity because AtticSim under predicted the attic air temperature measured at center of the cavity (——— Center Cavity). The code was then run using measured temperatures for the roof and ceiling boundary conditions to eliminate the confounding variable of weather and enable a check of the attic's radiosity exchange and the air exchange rate. Soffitt venting (ridge modeled as nearly shut) yielded reasonable results (o AtticSim – BC) as seen in Figure 1. The results show that a slight adjustment of AtticSim's ventilation algorithm yielded accurate attic air temperatures and ventilation rates. Ochoa and Shehan Inc provided the floor plans of the demonstration homes, which will be used to generate input data files for predicting the thermal performance of the two direct nailed roofs under demonstration in Redding, CA.

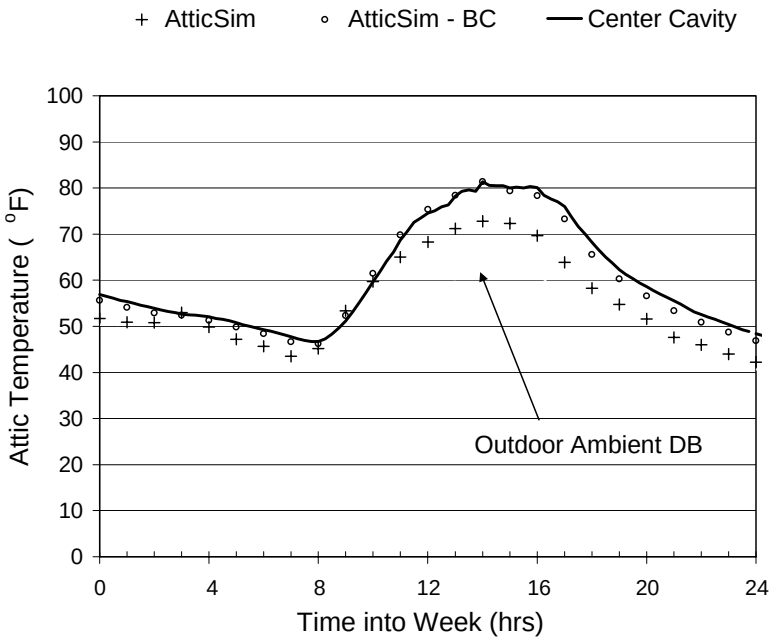

Figure 1. Validation of AtticSim against field measures of the attic air temperature gleaned from the ESRA steep-slope roof assembly.

2.6.4 Product Useful Life Testing

For our review article on weathering of roofing, we proceeded as listed above (2.5.3) with an outline and bibliography. Also, we have learned that weathering of minerals is a subject treated in geology textbooks, so we intend to incorporate some information on weathering, soiling, and biological growth to the extent that it is relevant to weathering of roofing materials. As far as soot accumulation is concerned, we found some new data on soot accumulation on calcium carbonate deposits in caves. This work supports our earlier observations that much of the reflectance change of white roofing is due to soot. The carbon analysis of the field samples being exposed at the weathering sites will also help substantiate these earlier observations.

The Shepherd Color Company and 3M Mineral have agreed to provide weatherometer time for accelerated testing of an assortment of cool-color roof products. Shepherd will conduct accelerated fluorescent light exposure while 3M Mineral will conduct Xenon-arc exposure testing. Exposure testing will include samples with and without cool-pigmented colors. Painted metal samples, clay tile samples, concrete tiles with American Rooftile coating and three different cool prototype shingles are slated for testing. The painted metal, clay tile and concrete tile with coatings are already under natural exposure testing at the seven California weathering sites. Plans are to expose about 12 samples with and without cool-pigments to judge fade resistance under about 5000 hours of accelerated testing starting in April. Shepherd and 3M will measure total color change, gloss retention and solar reflectance at 1000 hour increments over the course of about 5000 hours of exposure. The data will be reported in an October 05 CEC milestone for the weathering of cool-pigmented roof products.

2.7 Technology transfer and market plan

2.7.1 Technology Transfer

An article titled “Review of Residential Roofing Materials, Part II” appeared in Mar/Apr issue of Western Roofing magazine.

An article titled “Cooling down the house: Residential roofing products soon will boast cool surfaces” appeared in Mar issue of Professional Roofing magazine.

W. Miller met, while traveling to the various weathering sites, with Tony and Joe Chiovare of Custom-Bilt Metals, Bob Scichili formerly of BASF and with building construction manager Walt Ferguson. Mr. Ferguson is building 26 new homes in a residential subdivision in southern CA. The homes are high-end residences and will be roofed with painted metal shingles from Custom-Bilt Metals. Custom-Bilt and Miller posed the opportunity of establishing a large-scale demonstration at the site. A white paper was provided outlining a plan to measure whole house power of all the homes and establishing a pair of homes with similar instrument measures made at Fair Oaks and at Redding. Mr. Ferguson was very open to the opportunity and is willing to work with the “Cool Team” provided funding is available from the CEC and or the DOE.

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.

Correction to Monthly Progress Reports

An error was found in the % completion of Task XII(C) in the previously issued monthly progress reports. The correct % completion for Task XII(C) is 94 % (34/36).

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 3/31/2005
1	Preliminary Activities					
1.1	Attend Kick Off Meeting Deliverables: x Written documentation of meeting agreements and all pertinent information (Completed) x Initial schedule for the Project Advisory Committee meetings (Completed) x 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: x 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: x Proposed Initial PAC Organization Membership List (Completed) x Finalize Initial PAC Organization Membership List (Completed) x PAC Meeting Schedule (Completed) x Letters of Acceptance (Completed)	6/1/02	5/17/02	9/1/02		100%
2.2	Software standardization Deliverables: x When applicable, all reports will include additional file formats that will be necessary to transfer deliverables to the CEC x 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 3/31/2005
2.3	PAC meetings (Completed) Deliverables: x Draft PAC meeting agenda(s) with back-up materials for agenda items x Final PAC meeting agenda(s) with back-up materials for agenda items x Schedule of Critical Project Reviews Draft PAC Meeting Summaries x Final PAC Meeting Summaries	9/1/02	6/1/02	6/1/05		100% (6/6)
2.4	Development of cool colored coatings					
2.4.1	Identify and Characterize Pigments with High Solar Reflectance Deliverables: x Pigment Characterization Data Report (Completed)	6/1/02	6/1/02	12/1/04 → 12/31/04		~ 99%
2.4.2	Develop a Computer Program for Optimal Design of Cool Coatings Deliverables: x Computer Program	11/1/03	11/1/03	12/1/04 → 5/1/05		~ 93%
2.4.3	Develop a Database of Cool-Colored Pigments Deliverables: x 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	Review of Roofing Materials Manufacturing Methods Deliverables: x Methods of Fabrication and Coloring Report (Completed)	6/1/02	6/1/02	6/1/03		~ 99%
2.5.2	Design Innovative Methods for Application of Cool Coatings to Roofing Materials Deliverables: x Summary Coating Report x Prototype Performance Report	6/1/02	6/1/02	12/1/04 → 5/1/05		~ 97%
2.5.3	Accelerated Weathering Testing Deliverables: x Accelerated Weathering Testing Report	11/1/02	10/1/02	6/1/05→ 10/1/05		~ 50%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 3/31/2005
2.6	Field-testing and product useful life testing					
2.6.1	Building Energy-Use Measurements at California Demonstration Sites Deliverables: x Demonstration Site Test Plan (Completed) x Test Site Report	6/1/02	9/1/02	10/1/05 → 10/1/06		87%
2.6.2	Materials Testing at Weathering Farms in California Deliverables: x Weathering Studies Report	6/1/02	10/1/02	10/1/05 → 10/1/06		75%
2.6.3	Steep-slope Assembly Testing at ORNL Deliverables: x Whole-Building Energy Model Validation x Presentation at the Pacific Coast Builders Conference x Steep Slope Assembly Test Report	6/1/02	10/1/02	10/1/05		80%
2.6.4	Product Useful Life Testing Deliverables: x Solar Reflectance Test Report	5/1/04	5/1/04	6/1/05 → 10/1/05		55%
2.7	Technology transfer and market plan					
2.7.1	Technology Transfer Deliverables: x Publication of results in industry magazines and refereed journal articles x 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		~ 95%
2.7.2	Market Plan Deliverables: x Market Plan(s)	5/1/05		6/1/05		
2.7.3	Title 24 Code Revisions Deliverables: x Document coordination with Cool Roofs Rating Council in monthly progress reports x Title 24 Database	6/1/02	5/16/02	6/1/05		~ 70%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 3/31/2005
VII	Critical Project Review(s) Deliverables: x Minutes of the CPR meeting					
XII (C)	Monthly Progress Reports Deliverables: x Monthly Progress Reports	6/1/02	6/1/02	6/1/05		94% (34/36)
XII (D)	Final Report Deliverables: x Final Report Outline x Final Report	3/1/05→ 3/31/06		10/1/05 → 10/1/06		
	Final Meeting Deliverables: x Minutes of the final meeting	10/15/05		10/31/05		