ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY

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April 17, 2005

To: Chris Scruton (CEC)

From: Steve Wiel

Subject: **Cool Roof Colored Materials**: Quarterly Progress Report for First Quarter 2005

CC: Hashem Akbari, Paul Berdahl, Andre Desjarlais, Nancy Jenkins, Bill Miller, Ronnen Levinson

A summary of the status of Tasks and Deliverables as of March 31, 2005 is presented in Attachment 1.

HIGHLIGHTS

- The sixth Project Advisory Committee meeting was held on March 3, 2005 at the Custom-Bilt facilities in Chino, California.
- An alpha version of the coating formulation software was developed.
- The pair of demonstration homes showcasing asphalt shingles with and without cool roof color materials (CRCMs) is online acquiring data in Redding, California.
- We prepared an article titled "Cooling down the house: Residential roofing products soon will boast *cool* surfaces" that appeared in the March issue of *Professional Roofing* magazine.
- We prepared a two-part article titled "Review of Residential Roofing Materials" that the January/February and March/April issues of *Western Roofing* magazine.
- BASF testing of cool pigments applied to painted metals and exposed to almost 10,000 hours of fluorescent UV light showed a slightly higher retention in gloss and improved fade resistance as compared to standard pigments of the same color.
- Plans are implemented for conducting fluorescent and Xenon-arc accelerated weathering tests on painted metal, clay tile, concrete tile and asphalt shingles already under natural sunlight exposure testing in California.

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 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 are attached.

On the afternoon of the March 2, 2005, the industrial 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. 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 continued to improve the mixture model on which our coating formulation software is based, and to develop the optimization algorithm. 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. We 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. We prepared a two-part article titled "Review of Residential Roofing Materials" that appeared in the January/February and March/April issues 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 the availability of cool-colored shingles for four colors.

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

2.5.3 Accelerated Weathering Testing

We continued to collect references and perform literature searches on the topics of accelerated weathering and weathering mechanisms of roofing materials. An outline of a review article on accelerated weathering and bibliography was prepared. At the partners' meeting on March 2 and the PAC meeting on March 3, we presented the outline of our proposed review article, 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 measured the solar reflectance and thermal emittance of exposed samples. Several samples were pulled from each site and sent back to ORNL for elemental and microbial analyses of the surface contaminants.

The two demonstration homes in Redding California are online acquiring data, and the homeowners are scheduled to occupy the residences in May. 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 will conduct weatherometer accelerated testing on 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

Asphalt Shingle Demonstrations: ORNL personnel completed the setup of the pair of demonstration homes in Redding Calif. that showcase asphalt shingles with and without CRCMs (Fig. 1). Elk Corp. donated their new Weatherwood shingle having infrared reflective pigments (Fig. 1 left photo) and their standard off-the-shelf Weatherwood shingle (Fig. 1 right photo) for demonstrating the benefits of CRCMs applied to asphalt shingle roofs. The homeowners will move into the homes in early May.

Figure 1. The pair of homes in Redding, CA demonstrating Elk's Weatherwood shingle having solar reflectance of 0.25 (left photo) and the conventional Weatherwood shingle having solar reflectance of 0.09 (right photo).

Field data for the Redding homes were reviewed on site to check the functionality of all instrument measurements made by the data loggers. Phone lines were then connected to the modem of each data logger, and data was successfully downloaded on site and also at ORNL. A work order was placed with SBC Communications to maintain a secondary phone line for each residence 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 to Jerry Wagar of Ochoa and Shehan Inc. Wagar has signed the document and will forward it back to ORNL, who will distribute final copies to LBNL, Elk and Ochoa and Shehan Inc.

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, the Brown Castle Winslow, 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 will work with ORNL, LBNL and Elk and are in the process of obtaining bids for installing the shingles.

Painted Metal and Concrete Demonstrations: Coding in Excel visual basic was programmed to read and write weeks of field data for making direct comparisons of the pairs of homes having concrete tile and painted metal roofs with and without cool colored coatings. All four homes have been online since August 04, and two of the houses (4979 and 4983 Mariah Place) have almost acquired a full year of data. Results are promising and continue to show the positive benefits of the reflective pigments. As example, coating the concrete tile roof with a 0.41 reflective layer produced an averaged 18.6% reduction in the heat transferred across the west facing tile roof. Similarly, a 36% drop in heat transferred across the metal roof was measured during the month of Sept., 04.

Two of the four homes in Cavalli Hills were purchased by speculative buyers who immediately attempted to resale the homes. Unfortunately, the speculators did not operate the air-conditioners of these homes last summer, and a third resident also opted to not air-condition their residence. W. Miller contacted each resident and made arrangements to pay their respective electric bills during the months May through September 05 provided each homeowner runs their air-conditioner with the thermostat set at 72ºF (see Appendix A.1 for a sample letter). All residents agreed to participate – amazing! Also ORNL and the Sacramento Municipal Utility District (SMUD) visited Cavalli Hills and checked the transducers measuring whole house, air-conditioner and compressor cycling rate. SMUD technician, Brian Sanders, used a portable load source and checked the calibration constants for the transducers measuring air-conditioner power. Field data downloaded the following week proved all power instruments were operable. Therefore problems with occupancy habits and instrumentation are corrected and we await summer data for quantifying the electrical energy savings for the concrete and metal roofs with CRCMs.

Table 1. The percentage drop in the heat flow measured across the south facing painted metal roofs and the west facing concrete tile roofs with cool colored coatings.

Week starting	Pair of Homes with and without cool colored roofs	
	Concrete tile roofs (% drop in $Q_{west\ roof}$)	Painted Metal Roofs (% drop in $Q_{south\ roof}$)
Sep. 3, 04	20.6	35.5
Sep. 10, 04	15.4	35.9
Sep. 17, 04	23.9	38.0
Sep. 24, 04	14.6	34.4
Average	**18.63**	**36.0**

Percentage is based on the reduction in roof heat transfer during the sunlit hours for a roof with cool colored roofs as compared to one without cool colored roofs.

Cedar Shake Testing: Anthony Galo of Galchem Chemical Inc attempted to mix FERRO's inorganic pigments into the fire retardants added to cedar shakes. Results were not satisfactory. Galo observed the complex inorganic pigments to precipitate out of the fire retardant solution before he could pressurize and force the ingredients into the wood. Further testing showed the pigments to be aggressive precipitants, causing some of the fire retardant ingredients to also precipitate out of the solution. The pigments appear to have a strong ionic potential for certain compounds in the fire retardant, which puts in question long term leaching effects of the pigments on the treated shake, even if the pigments are applied as a paint coating. Galo believes that the differences in expansion and contraction of the wood and paint with cool-colored materials would have deleterious effects on the cedar shakes because the pigments may leach the retardants out of the cedar wood, especially when one considers that the ingredients were forced under hydrostatics into the wood and will by natural hydraulics tend to diffuse back out of the cedar.

The phenol resins in cedar gives the shake excellent weather ability upwards of almost 50 years. The porous internal structure of the wood strongly scatters light and even after

16 years of west coast weathering, cedar shakes have a solar reflectance of about 0.35 (see Aug., 04 report). Therefore, the economy of scale, and the incompatibility of the pigments with code approved fire retardants deters us from further pursuit of adapting complex inorganic color pigments to cedar shakes.

2.6.2 Materials Testing at Weathering Farms in California

ORNL personnel measured the solar reflectance and thermal emittance of the concrete, clay, painted metal and granule coated metal samples being exposed at the 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. The Environmental Science Division of ORNL 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 drop in reflectance of the roof samples.

Solar reflectance measurements were also collected on the concrete and clay tile roofs 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 (Fig. 2). The trend of solar reflectance with time varies from that observed at the California weathering sites. The concrete samples exposed in California are soiled by the accumulation of airborne contaminants. Akbari, Berdahl and Rose (2002) believe the deposition of carbon soot is the major contributor to the loss of solar reflectance. We intend to incorporate the soiling and biological growth results in our review article (2.5.3). We have also found some new data on soot accumulation on calcium carbonate

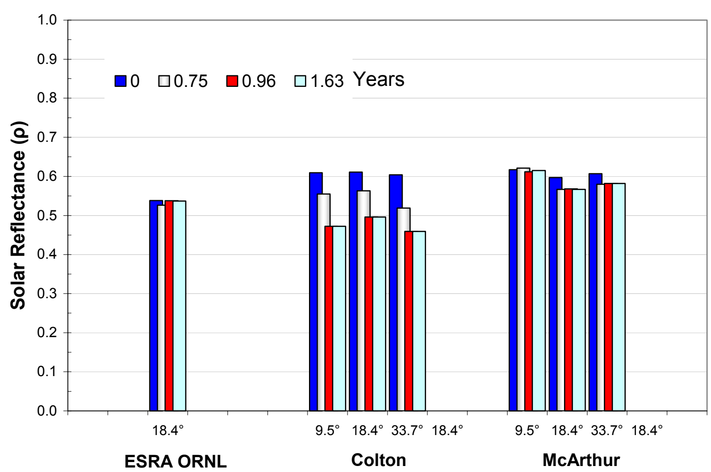

Figure 2. Solar reflectance of clay tile exposed at ORNL and at CA weathering sites.

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.

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

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 (Fig. 3). 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 3. 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.

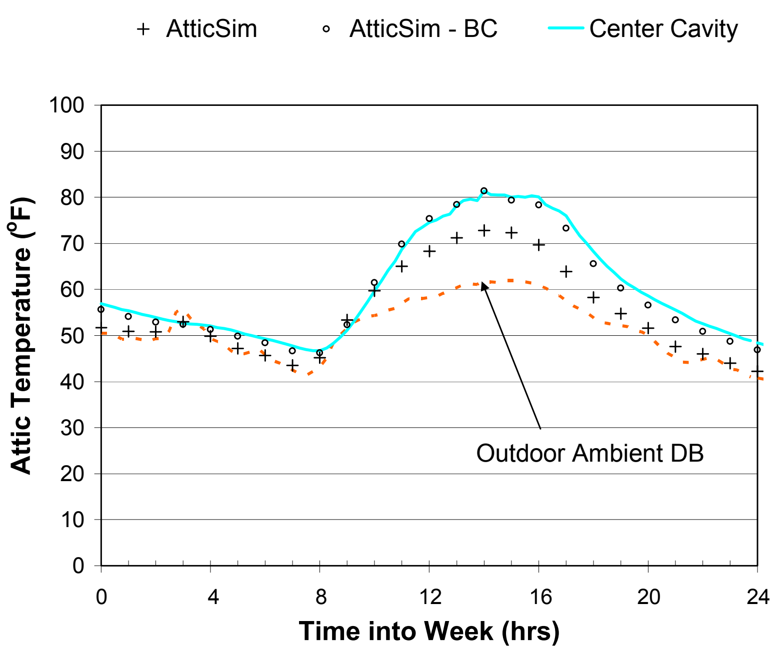

Figure 3. Validation of AtticSim against field measures of the attic air temperature gleaned from the ESRA steep-slope roof assembly.

2.6.4 Product Useful Life Testing

Masstones with and without CRCMs and of the same color were applied to polyvinylidene fluoride (PVDF) galvanized steel samples and exposed to UV irradiance to observe differences in fading and gloss retention. Samples were exposed to upwards of 10,000 hours of fluorescent UV light using a UVB-313 lamp that emits significantly more irradiance below 300 nm than does sunlight. The sample color, hours of exposure and the value of the total color change and the present reduction in gloss are shown in Figure 4. The total color difference (ΔE) is described in ASTM D 2244-02 (ASTM 2002), and is used by the paint industry to numerically identify variability in color over periods of time

The results show that pigment stability and discoloration resistance of the cool pigments are as good as those commercially available (Fig. 4). The fade resistance of the cool colored blue and yellow masstones is much improved over the respective standard color. Blue, especially a blue tint, is well known to fade; however, the cool colored masstone blue shows excellent fade resistance. The retention of gloss from the original color is also shown to verify performance of the larger sized cool pigments as compared to standard production pigments. A higher gloss paint is often preferred because it provides a homeowner greater wear and therefore reduced maintenance costs. The gloss retention findings are very important because, the larger the particle, the greater is its effect on film smoothness, which affects the scattering of light. The larger the size of a pigment particle the greater is the drop in gloss of a paint finish; however, the cool pigments actually show a slightly higher retention in gloss as compared to their counterparts and they therefore again perform as well as if not better than present production painted metals.

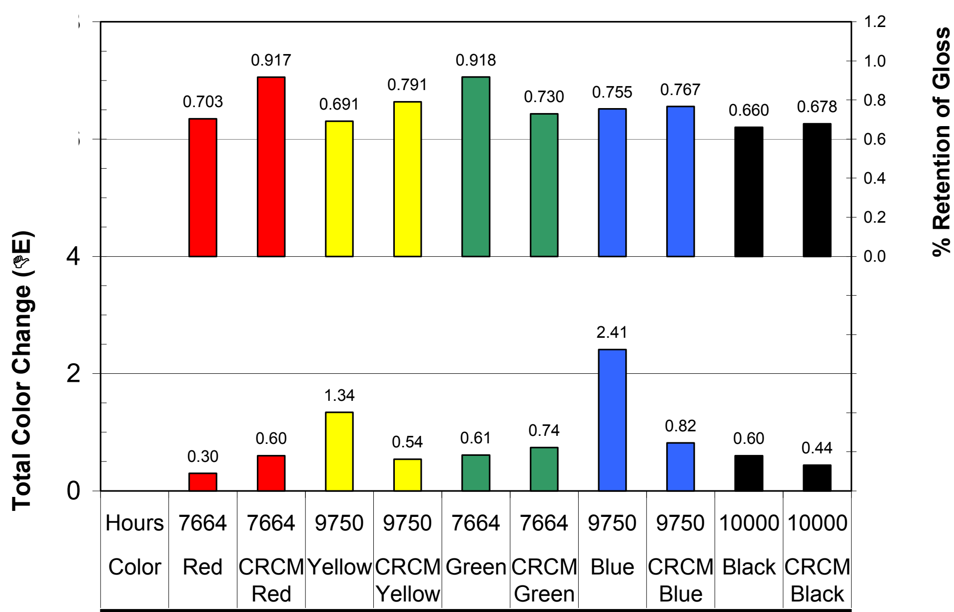

Figure 4. The total color change and the retention of gloss for masstones tested under fluorescent UV light using ASTM G154 protocol. (Data courtesy of BASF).

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 2005 CEC milestone for the weathering of cool-pigmented roof products.

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 2 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 2: 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**

American Society for Testing and Materials (ASTM). 2002. Designation G 154-04: Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials. West Conshohocken, Pa.: American Society for Testing and Materials.

American Society for Testing and Materials (ASTM). 2002. Designation D2244-02: Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates. West Conshohocken, Pa.: American Society for Testing and Materials.

2.7 Technology transfer and market plan

2.7.1 Technology Transfer

We prepared a two-part article titled "Review of Residential Roofing Materials" that appeared in the January/February and March/April issues of *Western Roofing* magazine.

We prepared an article titled "Cooling down the house: Residential roofing products soon will boast *cool* surfaces" that appeared in the March issue of *Professional 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.

The paper "Aging and Weathering of Cool Roofing Membranes" was finalized for publication at the upcoming Roof Consultants Institute's "Cool Roof" symposium to be held May 12 - 13, 2005 in Atlanta, GA.

The paper "Solar Spectral Optical Properties of Pigments" was finalized for publication at the upcoming Roof Consultants Institute's "Cool Roof" symposium to be held May 12 - 13, 2005 in Atlanta, GA.

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 agreed to participate with the "Cool Team" provided funding is available from the CEC and 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.

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:* • 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**) • Finalize Initial PAC Organization Membership List (**Completed**) • PAC Meeting Schedule (**Completed)** • Letters of Acceptance (**Completed)**	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 3/31/2005
2.3	PAC meetings (**Completed)** *Deliverables:* • 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		100% (6/6)
2.4	Development of cool colored coatings					
2.4.1	Identify and Characterize Pigments with High Solar Reflectance *Deliverables:* • 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:* • 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:* • 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:* • 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:* • Summary Coating Report • Prototype Performance Report	6/1/02	6/1/02	12/1/04 → 5/1/05		~ 97%
2.5.3	Accelerated Weathering Testing *Deliverables:* • 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:* • Demonstration Site Test Plan (**Completed)** • 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:* • 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:* • 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		80%
2.6.4	Product Useful Life Testing *Deliverables:* • 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:* • 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		~ 95%
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 CRRC in monthly progress reports • 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:* • Minutes of the CPR meeting					
XII (C)	Monthly Progress Reports *Deliverables:* • Monthly Progress Reports	6/1/02	6/1/02	6/1/05		94% (34/36)
XII (D)	Final Report *Deliverables:* • Final Report Outline • Final Report	3/1/05 → 3/31/06		10/1/05 → 10/1/06		
	Final Meeting *Deliverables:* • Minutes of the final meeting	10/15/05		10/31/05		

Appendix A.1

OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

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April 9, 2005

Mr. John Zaichkin
4987 Mariah Place
Fair Oaks, CA 95628

John:

Payment of Summer Utility Bills (May through September, 2005)

Thank you again for the opportunity to talk with you on Wednesday April 7, 2005. The Building Envelope Group (BEP) of the Oak Ridge National Laboratory (ORNL) is working on a Public Interest Energy Research project for the California Energy Commission (CEC) that involves your residence at 4987 Mariah Place. I shall pay the electric bill for the months May, June, July, August and September provided you simply leave the air-conditioner on with the thermostat set at 72°F (22°C). Thank you for offering to participate in the Cool Reflective Roof project sponsored by the CEC.

To receive payment for your electrical bill simply fill out the attached form (similar to the one I handed you on April 7) and attach a copy of your electric bill. Please understand that you pay the electric bill to the local utility (SMUD) to avoid any late charges. I will then reimburse you (pay you) once I receive the attached form and a copy of the electric bill. Please understand that I will not pay late charges for tardiness in paying a bill that is your responsibility.

Again I thank you for the opportunity to meet and talk with you. If the summer data shows positive benefits, then I will make the same offer to pay the electric bill for the months of May, June, July, August and September 2006.

Sincerely,

William A. Miller

William A. Miller, Ph.D.
Building Envelope Group

WAM:tkw

Enclosures: As noted.