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October 21, 2004

To: Chris Scruton (CEC)
From: Steve Wiel
Subject: **Cool Roof Colored Materials:** Quarterly Progress Report for Third Quarter 2004
CC: Hashem Akbari, Paul Berdahl, Andre Desjarlais, Bill Miller, Ronnen Levinson

A summary of the status of Tasks and Deliverables as of September 30, 2004 is presented in Attachment 1.

OVERALL PROJECT STATUS

- Identifying and characterizing 83 infrared reflective pigments and have shared field data demonstrating the potential energy savings offered by cool roof color materials (CRCMs).
- Working with 12 companies – shingle and granule manufacturers, tile and tile coating manufacturers, metal and metal coating manufacturers, and pigment manufacturers.
- Produced CRCM prototype roofing products in shingles, tiles, tile coatings and metal panels.

HIGHLIGHTS FOR THE QUARTER

- The Public Interest Energy Research project “Cool Roof Color Materials” hosted its 5th Project Advisory Committee meeting at ORNL on September 9, 2004.
- We presented the paper “Cool colored materials for roofs” at the ACEEE Summer Study on Buildings in Asilomar, CA in August.
- The paper “Special Infrared Reflective Pigments Make a Dark Roof Reflect Almost Like a White Roof” was accepted by ASHRAE for final publication.
- We are testing the mixture model that we developed to be used in the coating formulation software.
- We developed a draft proposal for Task 2.6.4 to quantify the effect of solar reflectance on the useful life of roofing.

- Our test data acquired from the demonstration site in Fair Oaks, California show that the tile roof with cool pigments (0.41 solar reflectance) reduced the peak day heat flux by about 75% compared to the heat flow penetrating the ceiling of the house with standard production roof tile (0.08 solar reflectance).
- We are preparing to install cool shingles on two houses in Redding, CA.
- We continue to work with tile, granule, and shingle manufacturers to develop cooler products. One of the industrial partners shipped us several samples of newly-designed cool shingles.
- We completed Task 2.5.1.

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 industry partners and the project team met on the afternoon of September 8, 2004 and discussed technical issues and coordination related to planning and progress of project tasks in preparation for the PAC meeting the next day. The 5th PAC meeting was held at ORNL on September 9, 2004. LBNL and ORNL discussed the progress since the last PAC meeting on each of the project tasks.

2.4 Development of Cool Colored Coatings

2.4.1 Identify and Characterize Pigments with High Solar Reflectance
We prepared and measured the characteristics of a series of nonwhite paint mixtures to test the mixture model used in our software for design of high-reflectance coatings.

2.4.2 Develop a Computer Program for Optimal Design of Cool Coatings
To test the model with which we intend to predict the solar spectral reflectance of paint mixtures, we prepared binary (two-component), equal-volume mixtures of 15 nonwhite cool paints. This yielded 105 unique combinations, from which we selected 32 mixtures combinations whose appearances seemed well-suited for use on roofs. (More than 32 appeared suitable, but we limited the number of candidates to match our resources). We have prepared and characterized pigmented films of these 32 1:1 volumetric mixtures. If time permits, we will also prepare and characterize 1:4 and 4:1 mixtures of these 32 combinations.

We tested our volumetric mixture model for estimating the solar spectral reflectance of a paint mixture by comparing the Kubelka-Munk absorption and scattering coefficients of tints (mixture of colors with white) and nonwhite binary mixtures to those of their components. We found that a volumetric model (contributions proportional to volume fraction) typically well-estimates absorption by tints, and occasionally well-estimates absorption by nonwhite mixtures; estimates of scattering by tints and nonwhite mixtures are less effective. We are refining the mixture model with particular attention to prediction of scattering.

We have begun design of the coating formulation software for design of color-matching pigmented coatings with maximum solar reflectance.

We discussed design of the coating formulation software with our industrial partners at our September 9 PAC meeting. We continue to improve the mixture model on which our coating formulation software is based, and to develop the optimization algorithm.

2.4.3 Develop a Database of Cool-Colored Pigments

We added descriptions of 146 pigmented coatings to our database, including 32 mixtures of nonwhite paints, 57 1:4 tints (1 part color to 4 parts white), and 57 1:9 tints.

We shared the updated database with another industrial partner.

2.5 Development of Prototype Cool-Colored Roofing Materials

2.5.1 Review of Roofing Materials Manufacturing Methods

Task Completed. The revised paper was distributed to the Industry Partners at the September PAC meeting. We have sent the paper for LBNL publication. Western Roofing Magazine is also reviewing the paper for publication.

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

We used a Monte-Carlo (random-spot) technique to measure the solar reflectance of several prototype, blended cool shingle boards produced by an industrial partner. We also measured the thermal emittance of a series of cool metal roofing panels.

Ferro and the Cedar Shake Bureau are working together trying to make a reflective painted cedar shake that is both fade and fire resistant. Parametric testing with several different concentrations of pigment will be tried while applying fire retardants. Forintek's Fire Research group will check the fire resistance of the test shakes. (See Task 2.6.1 for more detail.)

We worked with shingle/granule manufacturing partners and Cedar Shake & Shingle Bureau for developing cool roofing materials.

2.5.3 Accelerated Weathering Testing

The currently available data from BASF on the small color shifts on aging are adequate for our purposes (e.g., see the draft paper for the THERM IX conference). We need to seek further comparable data from the pigment companies, and from the roofing materials manufacturers.

During the September PAC meeting, we discussed the Xenon-arc and field exposure data from BASF on the small color shifts for aging of metal roofing materials. Partners mentioned that they have accelerated weathering data and will share it with the project. Chris Gross of 3M Minerals and Ingo Joedicke of ISP Minerals offered to search for

shingle data, while Mark Ryan of Shepherd Color will look for clay and concrete tile data.

2.6 Field-Testing and Product Useful Life Testing

All four demonstration homes in Cavalli Hills are on-line. Elk's marketing director John McCaskill has helped us locate a pair of homes for demonstrating asphalt shingles with and without CRCMs. The homes have identical footprint and are being built in Redding, CA. Work continues on developing a cedar shake with cool colored pigments that appears weathered and highly reflective and that also meets Class B flame resistance for California building codes.

Initial validations of AtticSim are very promising; however, work continues to help explain differences observed around solar noon between predicted and measured values.

ORNL intern students traveled to all the weathering sites and collected reflectance and emittance measures for all the metal, clay and concrete tile samples. A few new concrete tile samples from Joe Riley were placed at the Corona site.

2.6.1 Building Energy-Use Measurements at California Demonstration Sites

All four demonstration homes in Cavalli Hills are on-line. The field data are collected daily by a dedicated PC at ORNL. The heat transfer across the ceiling of the two homes having concrete tile roofs with and without CRCMs are shown in Figure 1 for data collected on August 24, 04. The solar reflectance of the tile having the Cool Tile IR Coating™ was 0.41; tiles with the standard chocolate brown color had a

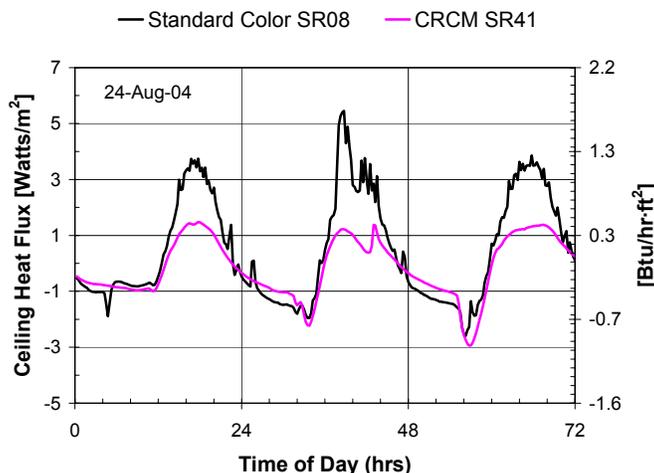


Figure 1. Ceiling heat flux measured for the two homes having concrete tile roofs with and without CRCMs.

reflectance of 0.08. The higher reflectance roof reduced the peak day heat flux by about 75% of the heat flow penetrating the ceiling of the house with standard production roof tile (Fig. 1). Integrating the flux over the sunlit hours for the three-day period shows the reduction in roof heat to be about 21% of that measured for the standard brown tile. The

reduction in ceiling heat flux is a direct result of the reduction in heat penetrating the roof. Heat flux transducers embedded in the west facing roofs of both homes show that the roof with Cool Tile IR Coating™ had significantly less heat penetrating the roof as compared to the roof with standard color tile. The greatest differences occur around solar noon, which may prove very beneficial for peak load reductions for the electric utilities.

The two homes with painted metal roofs show even more dramatic reductions. The ridges of both homes are oriented east-west, and the sun's irradiance is almost normal to these south-facing roofs around solar noon. Data shows that the heat flux is reduced almost 10 Btus per hr per square foot yielding about a 40% reduction in heat flux because of the difference in reflectance of the two south-facing roof systems.

A pair of existing homes located in Martinez CA is also available for demonstrating cedar shake roofs with and without CRCMs. The homeowners donating use of their homes are John Goveia of Technical Roof Services and his neighbor. Goveia sent ORNL and FERRO samples of new and weathered Class B, Western Red Cedar shakes. The weathered shakes from Goveia's existing roof have 16 years of CA exposure.

Solar reflectance of the weathered shake is about 0.35, while the solar reflectance of the new shake is about 0.65 (Fig. 2). The weathered



Figure 2. Picture of a 16 year old western cedar shake roof and a sample of a new cedar shake (Goveia residence).

shake has a silvery-gray color, which Goveia states "the residents of CA prefer." FERRO Corporation painted several new cedar shakes received from the Cedar Shake Bureau with an acrylic latex coating containing CRCMs¹. Reflectance of the unpainted half of each of the shakes is surprisingly high (Fig. 3). As example, the solar reflectance of the unpainted portion of one shake (bottom left in Fig. 3) is 53% while the painted portion is 59%. The shakes in general have a naturally occurring high solar reflectance which after several years drops to about 35% (see Fig. 2 showing solar reflectance for Goveia's shake roof). Therefore, the advantage for adding CRCM coatings to shake roofing addresses more the improved reliability of the shake to fade resistance and even more importantly to the homeowner the potential improvement in fire resistance. Steve Harris of the Cedar Shake Bureau and Ken Loye of Ferro are working to test whether adding the CRCMs will increase the fire resistance of the shake. Ferro has shipped complex inorganic pigments to Harris to test adding the pigments during the addition of fire retardants. The process places cedar shakes in a small vacuum chamber, and pressurizes the ingredients to about 100 psi for two hours. The work is being performed by Paul Morris at the University of British Columbia. Morris will add the color pigments in different concentration levels to determine the concentration needed to produce

¹ FERRO Corp. used Nickel-Antimony-Titanium and Chromium-Antimony-Titanium pigments in the composition of the acrylic latex paint applied to the cedar shakes.

satisfactory color coating of the shakes. Harris will then have the painted shakes tested by the Forintek's Fire Research group, an International Accreditation Service, to determine the effects of the color pigments on the fire resistance of the cedar shakes.

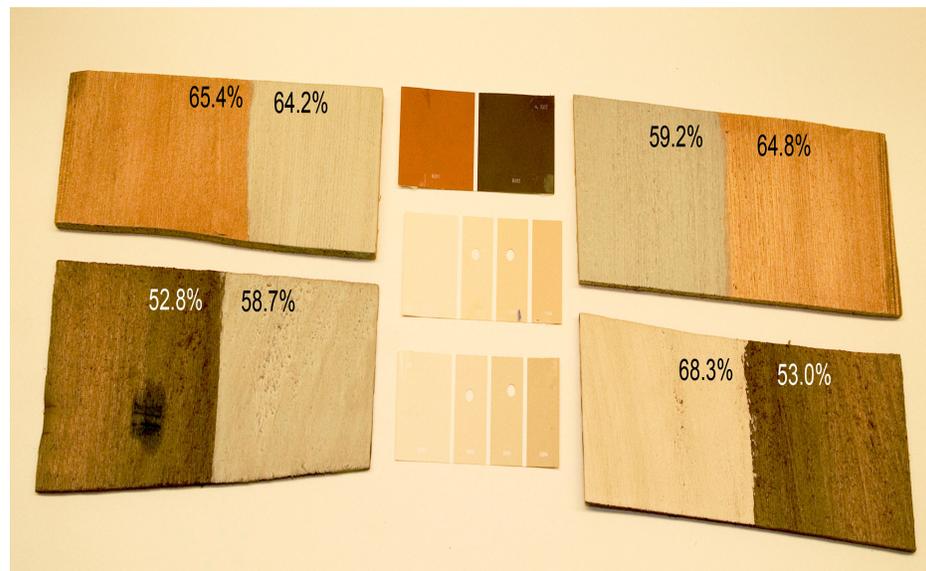


Figure 3. Picture of a new shakes prepared for testing, having half of each of the four shakes painted with CRCMs while the other half is unpainted. (Goveia provided the color samples shown in Fig 2 and 3).

After the negotiations failed with Daues of Mercy Housing, Elk's marketing director John McCaskill and Lou Hahn worked through their marketing contacts and located a residential site in Redding CA for demonstrating asphalt shingles with and without CRCMs. Jerry Wagar of Ochoa and Shehan Inc. is building several new homes in Redding, CA and a pair having identical footprint of 1600 square feet are available for demonstrating CRCM roofs. Instrumented sandwich panels made of oriented strand board (OSB) were received by Wagar, and ORNL personnel are awaiting Wagar's notice to come and instrument the two homes for monitoring performance of the roof systems.

Wim Boss of SMUD continues to check and trouble shoot the power instrumentation at the Cavalli Hills demonstration homes because our most recent field data showed no power use for the air-conditioners in three of the four homes. Boss discovered that some of the transducers being used in the field are different from those originally designated for measuring air-conditioning power. Replacement of the revenue meter and the power transducer for the air-conditioner corrected the measurement issues for House 1 at 4979 Mariah Place.

2.6.2 Materials Testing at Weathering Farms in California

ORNL personnel visited the exposure sites in late July, made reflectance and emittance measurements and installed additional concrete tile samples prepared by American Roof Tile Coatings. The crisp and clear alpine climate of McArthur continues to show the lowest loss of reflectance, and the data shows that the roof slope does affect the loss of reflectance for the lighter color samples. However, the trends for darker color CRCM samples are not as consistent as those for the lighter samples. In fact, reflectance increased slightly for all exposure slopes in El Centro for the brick red painted metal. In Colton, there is observed a loss of reflectance with exception of the samples with

standard pigments. In the alpine climate of McArthur, it appears the samples lost reflectance and then regained reflectance possibly due to washing by precipitation. Variation in airborne particulate matter between the different sites is affecting the trends for the change in reflectance. However, the changes in reflectance are small and just within the accuracy of the Device & Services reflectometer. For Colton and El Centro, the standard pigmented red brick color increased reflectance from 0.20 to 0.25, a 0.05 increase. LBNL and ORNL showed the reflectometer as compared to the LBNL spectrometer to be within an average accuracy of about 0.02 reflectance points.

2.6.3 Steep-slope Assembly Testing at ORNL

Field data show that the S-Shaped mission tiles have the lowest heat flux penetrating the attic due to their higher solar reflectance and also due to the venting occurring in the air gap made by the tile with the roof deck (Figure 4). The slate tile and the shingle roofs have about the same solar reflectance (0.13 vs 0.10); however, the heat flux penetrating the slate roof was half that entering the asphalt shingle roof at solar noon on August 24 because of the thermal buoyancy effects occurring in the air gap. The batten-counter batten arrangement places the tile about 1.5-in (38 mm) off the roof deck, which allows air currents induced by temperature gradients to traverse up the roof from the soffit to the ridge. These convective currents in the laminar boundary layer are apparently dissipating heat through the gaps formed by overlapping tiles.

It is also interesting to compare the performance of the MCA S-mission clay tile to the Eagle concrete S-mission tile. The MCA clay tile with CRCMs has a solar reflectance of 0.54 while the Eagle is from standard production and has solar reflectance of about 0.34. The MCA clay tile was direct nailed to the roof. The Eagle tile was placed on a batten system about 0.75-in (19 mm) above the deck. Yet despite the batten construction the Eagle tile had a higher heat flow penetrating the roof as compared to the MCA clay tile (Fig. 4). Hence the results tend to show that solar reflectance of the tile has a more dominant effect on the thermal performance of the roof; however, the venting does provide benefit as seen by comparing the slate roof on a batten-counter-batten system and the direct nailed shingle roof.

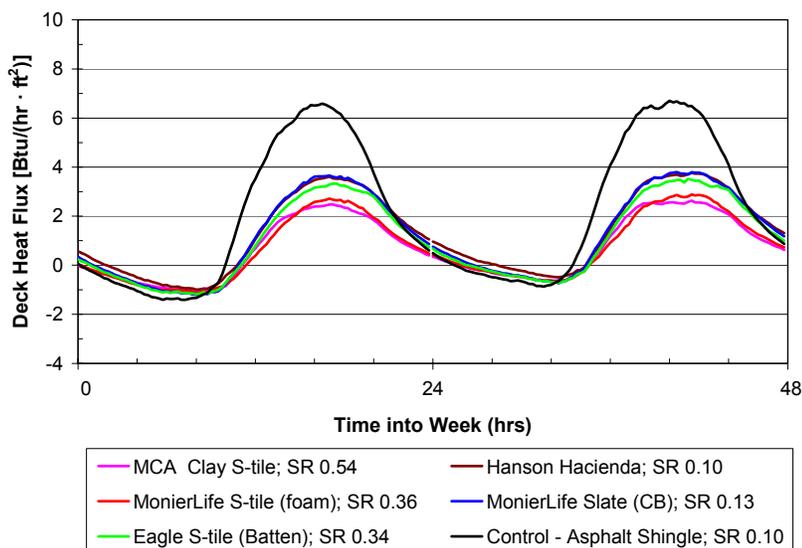


Figure 4. Heat flux penetrating the roof deck of the clay, concrete and asphalt shingle roof systems being field tested on the Envelope Systems Research Apparatus (ESRA).

Inputs to the AtticSim computer code were developed that describe the geometry and the thermal and moisture characteristics for the ESRA attic test lane having a roof with direct nailed asphalt shingles. Conduction heat transfer through the south-facing roof deck was modeled by developing conduction transfer functions for the six surfaces of the attic. The transfer functions predict the time-dependent one-dimensional conduction transfer at the interior and exterior surfaces and couples the results with radiation and convection heat transfer within the attic enclosure to predict the heat flux penetrating into the conditioned space.

First efforts to validate the AtticSim model against the direct nailed shingle roof assembly showed excellent agreement to the measured ceiling heat flux penetrating the ceiling of the attic assembly (Fig. 5). However, AtticSim tended at solar noon to under predict the roof's surface temperature and the heat flux penetrating the roof. It also under predicted the attic air temperature. To better check AtticSim, we have installed a pyranometer on the roof to measure rather than calculate the global irradiance normal to the roof. AtticSim uses routines gleaned from DOE2.1e that take the global irradiance and the direct beam irradiance on a horizontal surface and calculate the irradiance normal to the sloped roof. The direct measure of irradiance will enable us to check the solar calculations especially around solar noon where the code under predicts the field data. We are also looking at the ventilation predictions to better understand the magnitude of their effect on the heat transfer analysis, and will attempt to use a tracer gas technique with sulfur-hexafluoride to estimate the air exchange rate in the test attic.

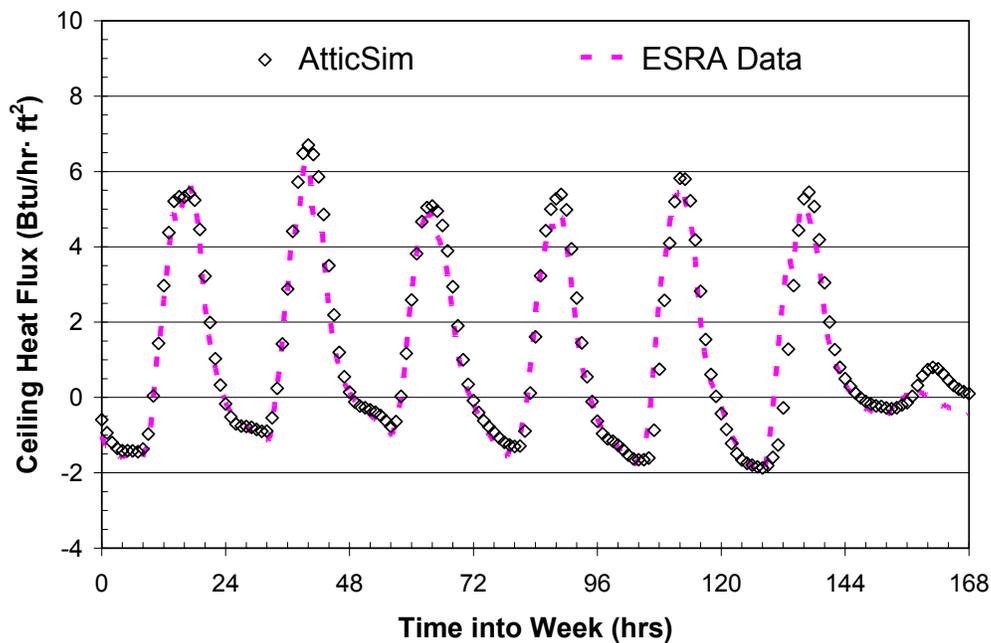


Figure 5. AtticSim validation of the heat flux penetrating the roof deck of the standard production asphalt shingle roof system being field tested on the Envelope Systems Research Apparatus (ESRA).

2.6.4 Product Useful Life Testing

We have been analyzing published data, and consulting with industry experts, on the subject of whether cooler asphalt shingles will last longer than conventional shingles. One reason this is a difficult topic is that there is no industry consensus on how to measure asphalt shingle degradation and lifetime. A typical failure mechanism is that the shingles begin to crack under stress. In many cases, stress due to wind is a factor. The cracking is associated with gradual hardening and increased brittleness over time. The brittleness is associated both with oxidation of the asphalt and with the out-diffusion of low molecular weight (plasticizer-like) components. Another failure mechanism is the loss of the granule surfacing, followed by rapid UV-induced degradation.

One idea was to evaluate shingle degradation using the 3M industry standard abrasion test (granule loss due to steel brush abrasion). However, other tests of mechanical properties, particularly bending stiffness, may be more appropriate. One test involves cooling the shingle to about 30°F and measuring the force and displacement as it is bent to failure. Another option would be non-destructive measurement of stiffness.

At our September PAC meeting, we presented a straw-man proposal for an experiment in which asphalt shingles would be artificially aged at 50, 65, and 80 °C (both oven aging and uv + water spray + heat). The stiffness at 0 °C would be monitored as a function of time, and the results would be used to determine how the elevation of temperature affects the results.

There were two criticisms of this proposal. The first is that understanding of how stiffness changes over time addresses only one aspect of durability; durability is multi-dimensional. The other criticism of the proposal is that it is very close to what industry has already done, and so little new information would be obtained. (The proposal was a follow-up to some excellent papers by the CertainTeed group.) After the PAC meeting, we are analyzing four options. These include

- (1) Focus on literature review and discussions with industrial partners, and summarize what we learn in a review paper. (Whichever option we choose, we are very interested in locating all relevant publications, and in receiving any industry data that can be placed in the public domain.)
- (2) Perform some sort of modified experiment. (This option would require concurrence by our industrial partners, which is unlikely unless we come up with a better experimental design.)
- (3) Perform some sort of analysis of old shingles exposed at weathering farms. Are the white shingles in better shape than the black ones? What sort of tests need to be done?
- (4) Perform some mechanical and/or rheological tests on the new, cooler, asphalt shingles to be demonstrated on the pair of demonstration homes in Redding CA. The manufacturer would pull a shingle from each home about twice a year for a full two years. If successful, these tests would confirm that these new shingles perform in a consistent manner with existing standard shingles. Testing can include tear strength, tensile strength, tensile elongation, and bending stiffness.

Currently our plan is that for LBNL to focus on option (1) above and conclude work on the task by May, 2005. ORNL would focus on option (4) and complete mechanical tests in the future, under a no-cost extension.

2.7 Technology transfer and market plan

2.7.1 Technology Transfer

We sent a copy of the “Manufacturing Report” to Western Roofing Magazine for possible publication.

On August 25, 04, Akbari presented the paper “Cool colored materials for roofs” at the ACEEE conference in Asilomar, CA.

The paper “*Special Infrared Reflective Pigments Make a Dark Roof Reflect Almost Like a White Roof*” was submitted to ASHRAE for final publication.

2.7.2 Market Plan (No activity.)

2.7.3 Title 24 Code Revisions (No activity.)

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 09/30/2004
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 09/30/2004
2.3	<p>PAC meetings <i>Deliverables:</i></p> <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		83% (5/6)
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"> • Pigment Characterization Data Report 	6/1/02	6/1/02	12/1/04		~97%
2.4.2	<p>Develop a Computer Program for Optimal Design of Cool Coatings <i>Deliverables:</i></p> <ul style="list-style-type: none"> • Computer Program 	11/1/03	11/1/03	12/1/04		~65%
2.4.3	<p>Develop a Database of Cool-Colored Pigments <i>Deliverables:</i></p> <ul style="list-style-type: none"> • Electronic-format Pigment Database 	6/1/03	7/1/03	6/1/05		~65%
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"> • Methods of Fabrication and Coloring Report 	6/1/02	6/1/02	6/1/03		~99%
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"> • Summary Coating Report • Prototype Performance Report 	6/1/02	6/1/02	12/1/04		~90%
2.5.3	<p>Accelerated Weathering Testing <i>Deliverables:</i></p> <ul style="list-style-type: none"> • Accelerated Weathering Testing Report 	11/1/02	10/1/02	6/1/05		~18%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 09/30/2004
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		80%
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	10/1/06		70%
2.6.3	Steep-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		65%
2.6.4	Product Useful Life Testing <i>Deliverables:</i> <ul style="list-style-type: none"> • Solar Reflectance Test Report 	5/1/04	5/1/04	6/1/05		12%
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		~55%
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		~10%

Project Tasks and Schedules (contd.)

Task	Task Title	Plan Start Date	Actual Start Date	Plan Finish Date	Actual Finish Date	% Completion as of 09/30/2004
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		72% (26/36)
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		