ENERGY STAR® Program Requirements for Roof Products

Partner Commitments

Commitment

The following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacturing of ENERGY STAR qualified roof products. The ENERGY STAR Partner must adhere to the following program requirements:

- comply with current ENERGY STAR Eligibility Criteria, defining the performance criteria that must be met for use of the ENERGY STAR certification mark on roof products and specifying the testing criteria for roof products. EPA may, at its discretion, conduct tests on products that are referred to as ENERGY STAR qualified. These products may be obtained on the open market, or voluntarily supplied by Partner at EPA's request;

- comply with current ENERGY STAR Logo Use Guidelines, describing how the ENERGY STAR labels and name may be used. Partner is responsible for adhering to these guidelines and for ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance;

- qualify at least one ENERGY STAR labeled roof product model within one year of activating the roof products portion of the agreement. When Partner qualifies the product, it must meet the specification (e.g., Tier 1 or 2) in effect at that time;

- provide clear and consistent labeling of ENERGY STAR qualified roof products. The ENERGY STAR label must be clearly displayed in product literature (i.e., user manuals, spec sheets, etc.) and on the manufacturer's Internet site where information about ENERGY STAR qualified models is displayed;

- through product literature, provide the following information to end users: 1) a description of the variables that influence the amount of energy savings that can be realized when an ENERGY STAR labeled roof product is installed on a home or building, 2) an acknowledgement that the solar reflectance of any roof products over time may increase or decrease, depending on the product make-up, due to aging and dirt and microbial accumulation, and 3) a description of the proper maintenance procedures required to maximize solar reflectance over the longest period of time possible (e.g., rinsing or power washing each spring or recoating every five years). Partners may continue to use the following statement (required under the old MOU) to meet this requirement: "When installed properly, this product will help reduce energy costs. Actual savings will vary based on geographic location and individual building characteristics. Consult your product manufacturer, roofing contractor, or call 1-888-STAR-YES (1-888-782-7937) for more information." Whenever the label is used on qualified products or packaging, this statement or one incorporating points 1-3 above must be in close proximity;

- provide to EPA, on an annual basis, an updated list of ENERGY STAR qualifying roof product models. Once the Partner submits its first list of ENERGY STAR labeled roof product models, the Partner will be listed as an ENERGY STAR Partner. Partner must provide annual updates in order to remain on the list of participating product manufacturers;

- for each qualifying roof product model, provide to EPA test data to certify that the product has met the required performance characteristics. This data may be in the form of a testing report, either from the Partner or a third party. EPA will only add models to its product list after reviewing and approving the product test results;

- provide to EPA, on an annual basis, unit shipment data or other market indicators to assist in determining the market penetration of ENERGY STAR. Specifically, Partner must submit the total number of ENERGY STAR qualified roof products shipped (in units by model) or an equivalent measurement as agreed to in advance by EPA and Partner. Partner is also encouraged to provide ENERGY STAR qualified unit shipment data segmented by meaningful product characteristics (e.g., capacity, size, speed, or other as relevant), total unit shipments for each model in its product line, and percent of total unit shipments that qualify as ENERGY STAR. The data for each calendar year should be submitted to EPA, preferably in electronic format, no later than the following March and may be provided directly from the Partner or through a third party. The data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner;

- notify EPA of a change in the designated responsible party or contacts for roof products within 30 days.

Performance for Special Distinction

In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures and should keep EPA informed on the progress of these efforts:

- consider energy efficiency improvements in company facilities and pursue the ENERGY STAR label for buildings;

- purchase ENERGY STAR labeled products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR labeled product information to employees for use when purchasing products for their homes;

- ensure the power management feature is enabled on all ENERGY STAR qualified monitors in use in company facilities, particularly upon installation and after service is performed;

- provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR labeled product models;

- feature the ENERGY STAR label(s) on Partner Web site and in other promotional materials. If information concerning ENERGY STAR is provided on the Partner Web site as specified by the ENERGY STAR Web Linking Policy (this document can be found in the Partner Resources section on the ENERGY STAR Web site at www.energystar.gov), EPA may provide links where appropriate to the Partner Web site;

- provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, communicate, and/or promote Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR web pages, etc. The plan may be as simple as providing a list of planned activities or planned milestones that Partner would like EPA to be aware of. For example, activities may include: (1) increase the availability of ENERGY STAR labeled products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrate the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) provide information to users (via the Web site and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products, and (4) build awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event;

- provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and its message.

ENERGY STAR® Program Requirements for Roof Products

Eligibility Criteria

Below is the product specification (Version 1.1) for ENERGY STAR qualified roof products. A product must meet all of the identified criteria if it is to be labeled as ENERGY STAR by its manufacturer.

1) Definitions: Below is a brief description of roof products and other terms as relevant to ENERGY STAR.

   A. Roof surface: The uppermost part of the roof system that is in direct contact with solar radiation.

   B. Low-Slope Roofs: Surfaces with a slope of 2:12 inches or less.[1]

   C. Steep-Slope Roofs: Surfaces with a slope greater than 2:12 inches.

   D. Low-Slope Roof Products: Products that are typically installed on low-slope surfaces such as single-ply membranes, built-up-roofs (BUR), modified bitumen, spray polyurethane foam, roof coatings, and standing-seam profiled metal. Some products that are typically installed on low-slope roofs may also be installed on steep-slope roofs (e.g., single-ply membranes and roof coatings). For the purposes of this specification, the roof product will constitute the uppermost surface of the building structure.

   E. Steep-Slope Roof Products: Products that are typically installed on steep-slope surfaces such as composite shingles, clay, concrete, or fiber-cement tile, slate, shakes, architectural profiled metal and individual metal roof components. Some products that are typically installed on low-slope roofs may also be installed on steep-slope roofs (e.g., single-ply membranes and roof coatings). For the purposes of this specification, the roof product will constitute the upper most surface of the building structure.

   F. Roof Coating: A material typically applied in the liquid state to the roof surface at the time of construction or at a later time as a retrofit measure. Roof coatings may be bituminous, polymeric, or polymer modified. Bituminous roof coatings are formulated using bitumen. Polymeric roof coatings are formulated using a variety of synthetic resins such as acrylic, neoprene, styrene butadiene, urethane, polyvinyl acetate, and others. Polymer modified roof coatings are manufactured by combining a portion of the polymeric technology with bitumen technology.

   G. Built-Up-Roof (BUR): Traditional hot asphalt or coal tar built-up roofing membrane assembly consists of alternating layers of felts, fabrics, or mats saturated with bitumen during manufacture, assembled in place, and adhered with applied layers of hot bitumen. Surfacing for the hot BUR can be aggregate embedded in hot asphalt; mineral-surface cap sheets; modified bitumen cap sheets; or smooth-surface applications or coatings.[2]

   H. Single-Ply Membrane: Flexible manufactured sheet of compounded synthetic materials. Single-ply membranes include EPDM (ethylene, propylene, diene monomer), Neoprene (chloroprene rubber), PVC (polyvinyl chloride polymers), CSPE (chlorosulfonated polyethylene, also known as Hypalon), CPE (chloronated polyethylene), PIB (polyisobutylene), NBP (nitrite alloy membranes compounded from butadiene-acrylonitrile copolymers), TPO (thermoplastic polyolefin), and others.

   I. Modified Bitumen: Roll roofing products consisting of asphalt, reinforcing layers, and in some cases, surfacing. During manufacture, a polymer (APP, or atactic polypropylene, and SBS, or styrene butadiene styrene, are the most common) is added to the bitumen while heating, which

[1] As defined in proposed ASTM Standard E 1918-97.
[2] National Roofing Contractors Association Commercial Low-Slope Roofing Materials Guide 1998.

"modifies," or changes, its properties.[3]

J. Metal Roof Panel: Metal roofing systems are divided into two categories, architectural and structural. Architectural metal roofs usually require a slope of at least 3:12. Structural metal roofs can be used on roofs with slopes as low as 1/4:12. Steel and aluminum sheets are commonly used to fabricate metal roof panels. Steel requires a corrosion resistant metal coating such as zinc, aluminum, alloys of zinc-aluminum, or tin. Metallic coated steel includes galvanized steel, aluminized steel, zinc-aluminum-coated steel and terne-coated steel. Metallic coated steels are also painted to provide additional corrosion protection, as well as color.

K. Metal Roof Component: Metal roof product designed to resemble a traditional steep-slope residential product such as shingle, tile, shake, or slate.

L. Spray Polyurethane Foam Roof System: A fully adhered system that consists of a rigid closed-cell sprayed-in-place polyurethane foam insulation and a protective roof coating. Typical coatings include acrylic, silicon, or urethane elastomers.

M. Composite Shingle: Composed of a base material, either organic felt or glass fiber mat; asphalt; and surfacing material, generally in the form of mineral granules.[4]

N. Roof Tile: May be composed of clay, concrete, fiber-cement, or synthetic materials. A variety of tile profiles, styles, finishes, and colors are available.

O. Solar Spectrum: Radiation originating from the sun, including ultraviolet, visible, and near-infrared radiation. Approximately 99 percent of solar energy lies between wavelengths of 0.3 to 3.5 micrometers (Fm).

P. Solar Flux: The direct and diffuse radiation from the sun received at ground level over the solar spectrum expressed in watts per square meter.

Q. Solar Reflectance: The fraction of solar flux reflected by a surface expressed as a percent or within the range of 0.00 and 1.00.

2) Qualifying Products: Any roof product as defined in Section 1 above, is eligible for the ENERGY STAR label.

3) Energy-Efficiency Specifications for Qualifying Products: Only those products listed in Section 2 that meet the criteria below (Tables 1 and 2) may qualify as ENERGY STAR. **For roof products that may be applied to either low-slope or steep-slope roofs, such as roof coatings and single-ply membranes, Table 1 contains the applicable ENERGY STAR specifications.**

[3] National Roofing Contractors Association Commercial Low-Slope Roofing Materials Guide 1998.
[4] Ibid.

Table 1 – Specifications for Low-Slope Roof Products	
Characteristic	**Performance Specification**
Energy Efficiency	
Initial Solar Reflectance	Greater than or equal to 0.65
Maintenance of Solar Reflectance	Greater than or equal to 0.50 three years after installation under normal conditions.
Reliability	
Manufacturer warranty for defects in materials and manufacturing	Each company's warranty for reflective roof products must be equal in all material respects to the product warranty offered by the same company for comparable non-reflective roof products. A company that sells only reflective roof products must offer a warranty that is equal in all material respects to the standard industry warranty for comparable non-reflective roof products.

Table 2 – Specifications for Steep-Slope Roof Products	
Characteristic	**Performance Specification**
Energy Efficiency	
Initial Solar Reflectance	Greater than or equal to 0.25
Maintenance of Solar Reflectance	Greater than or equal to 0.15 three years after installation under normal conditions.
Reliability	
Manufacturer warranty for defects in materials and manufacturing	Each company's roof product warranty for reflective roof products must be equal in all material respects to the product warranty offered by the same company for comparable non-reflective roof membrane products. A company that sells only reflective roof products must offer a warranty that is equal in all material respects to the standard industry warranty for comparable non-reflective roof products.

4) Test Criteria: Manufacturers are required to perform tests and self-certify those product models that meet the ENERGY STAR guidelines. Partner agrees to follow EPA Test Methods as outlined below.

   Initial Solar Reflectance
   Product shall be tested using ASTM E 903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmission of Materials Using Integrating Spheres. Products need only be tested for solar reflectance (values for solar absorptance and transmission need not be obtained). Manufacturers will submit a 3" X 3" flat sample of each product to a laboratory that has the appropriate equipment. The manufacturer shall request that the test be performed using a black background for the sample. Where appropriate, the sample shall be prepared according to manufacturer recommendation for thickness used in the field.

   Partner may also employ a reflectometer such as the one produced by Devices and Services Company. Partner shall follow the procedures outlined in Devices & Services Company Solar Spectrum Reflectometer, Version 5.0 (provided by Oak Ridge National Laboratory) which is found on page 8 of these Program Requirements.

   If manufacturer has performed the test for initial solar reflectance on a particular product since 1996, the product need not be retested. The manufacturer must have a record of the test results on file and must submit these results to EPA. Particularly with regard to roof coatings, if Partner has changed a fundamental element of product formulation such as the base latex, Partner must retest for the solar reflectance of the product both initial and after three years on a roof (see next section). In addition, to ensure other product formulation changes will not affect the solar reflectance of the product, Partner shall certify that the product formulation or recipe has not changed since the solar reflectance testing was performed.

Maintenance of Solar Reflectance

Partner shall identify three existing roofs on which the same product was installed a minimum of three years prior. At least one of these existing roofs must be located within a major metropolitan area such as Atlanta, Boston, Chicago, Dallas, Houston, Los Angeles, Miami, Minneapolis, New York, Philadelphia, San Francisco, St. Louis, Washington D.C., etc. The roof product need not have been installed at the same time on the three buildings; however, the roofs must each be at least three years old. Roofs that are chosen may be cleaned according to proper maintenance procedures as recommended by the manufacturer before tests are performed.

For low-slope roof products and coatings, Partner shall use either ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field or the Solar Spectrum Reflectometer Test outlined in Devices & Services Company Solar Spectrum Reflectometer, Version 5.0, to test the solar reflectance of the roof product as installed and weathered for three years. Partner shall divide the roof into at least 10 equal sections. Measurements shall be performed in the center of each area. At least three repetitions shall be made of each measurement. Partner shall take the average of all solar reflectance values obtained from the roof to determine if the solar reflectance of the roof product as installed and weathered for three years is greater than or equal to the stated threshold value (0.50). If Partner is employing ASTM E1918, the test must be performed on a clear day (no clouds) between 10:00 AM and 2:00 PM when the sun is high in the sky and there can be no obstruction in the field of view.

To measure the solar reflectance of steep-slope roofs as installed and weathered for three years, Partner shall employ a reflectometer such as the one produced by Devices and Services and shall follow the procedures outlined in Devices & Services Company Solar Spectrum Reflectometer, Version 5.0. Partner shall divide the roof into at least 10 equal sections. Measurements shall be performed in the center of each area. At least three repetitions shall be made of each measurement. Partner shall take the average of all solar reflectance values obtained from the roof to determine if the solar reflectance of the roof product as installed and weathered for three years is greater than or equal to the stated threshold value (0.15 for products that can only be applied on steep-slope roofs; 0.50 for products that can be applied to either low-slope or steep-slope roofs).

Alternatively, Partner may test for solar reflectance of the product after three years by taking samples from the existing roofs as identified above, and having those samples tested according to ASTM E 903 as described above. Subsequently, the Partner is responsible for ensuring that the roof from which samples were taken is properly repaired so as to resume watertight integrity.

5) Effective Date: The date that manufacturers may begin to qualify products as ENERGY STAR will be defined as the *effective date* of the agreement. The ENERGY STAR Roof Products (Version 1.1) specification is effective immediately.

6) Future Specification Revisions: ENERGY STAR reserves the right to change the specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through industry discussions.

OAK RIDGE NATIONAL LABORATORY
Managed by Lockheed Martin Energy Research Corporation
For The U.S. Department of Energy

P.O. Box 2008
Oak Ridge, TN 37831-6070

BUILDINGS TECHNOLOGY CENTER
Energy Division, Building 3147
PHONE: (865) 574-5206
FAX: (865) 574-5227

Contact: T.W. Petrie, Research Engineer

DEVICES & SERVICES COMPANY SOLAR SPECTRUM REFLECTOMETER, VERSION 5.0

1. Instrument

1.1 The Devices & Services Company Solar Spectrum Reflectometer, Version 5.0 is designed to provide a measurement of solar reflectance for laboratory and field samples of flat, first-surface reflectors. Accessories and techniques are suggested in the operator's manual for curved and second-surface reflectors.

1.2 The instrument consists of three parts: a measurement head; a control and readout module; and, up to 7.6 m (25 ft) of connecting cable. The control and readout module contains a keypad to select the various options for operation. An opening in the measurement head is placed directly against a flat sample. Up, down or sideways orientation is permitted. The sample is illuminated diffusely with a tungsten halogen lamp for two seconds out of a ten second measurement cycle. Reflected light is measured at an angle of 20° from the incident angle with four separate detectors. Each detector is equipped with color filters to tailor its response to a range of wavelengths in the solar spectrum.

1.3 Software in the instrument combines the outputs of the four detectors in appropriate proportions to approximate the response over the solar spectrum for incident solar radiation through air mass 0, 1, 1.5 or 2. The solar reflectance for the desired air mass is selectable by pressing and holding a key on the instrument's keypad until the desired air mass cycles to the display. The solar reflectances measured by the four individual detectors are also available with this key on the keypad. The output is updated every ten seconds and will continue to be the solar reflectance for the last selection until a new selection is made. The output of the instrument is the selected solar reflectance as a fraction between 0 and 1. The resolution of the digital readout is 0.001.

2. Test Samples and Sampling Area

2.1 The opening on the measurement head is 2.5 cm (1 in.) in diameter. Reflectances can be obtained for this area on a sample within 30 seconds by placing the measurement head over the desired area and allowing at least three cycles to check that a stable reading has been obtained. Several areas should be sampled to obtain data from which an average over the desired sample area can be calculated. The values for each area are best recorded manually on a data sheet with notes about the location and appearance of the sampling area.

3. Operating Procedures

3.1 The instrument requires 110 volt AC power but can be used outdoors if conditions are dry. Before power is applied and the instrument is turned on, either end of the cable must be connected to the socket on the measurement head. The other end must be connected to the socket on the readout and control module. The instrument powers up ready to measure total solar reflectance through air mass 2. Normal operation is to obtain solar reflectance over the total solar spectrum through air mass 2. Normal operating procedure requires a warm up period of about 30 minutes. The instrument can be left on for extended periods of time with a cover over the measurement head opening.

3.2 At the end of the warm up period, zero and gain should be checked and adjusted if necessary. A zero reflectance, blackbody cavity and various high reflectance standard samples are provided to check zero and gain. If the blackbody cavity covers the opening of the measurement head and a non-zero reading is noted, the calibration/zero key should be depressed. The instrument detects the presence of the zero reflectance cavity and resets the output reflectance to zero.

3.3 The gain or calibration adjustment requires that the reflectance of a known standard be coded into the instrument. Three standards provided with the instrument are preprogrammed into the memory. Five additional standards can be programmed by the user. A selection key on the keypad allows the user to select which of eight standards will be used. If the desired standard covers the opening of the measurement head and its reflectance is not noted on the display, the calibration/zero key should be depressed. When a calibration standard is over the measurement head opening and the calibration/zero key is depressed, the instrument automatically detects that a high reflectance object is in place and resets the output reflectance to the selected standard's preset value.

3.4 Zero is very stable but is conveniently checked by using the blackbody cavity as a way to cap the measurement head between samples. Gain is fairly stable but checking the gain should be done once every 30 minutes after warm-up and the gain or calibration adjustment procedure of paragraph 3.3 repeated if necessary.

4. Calculations

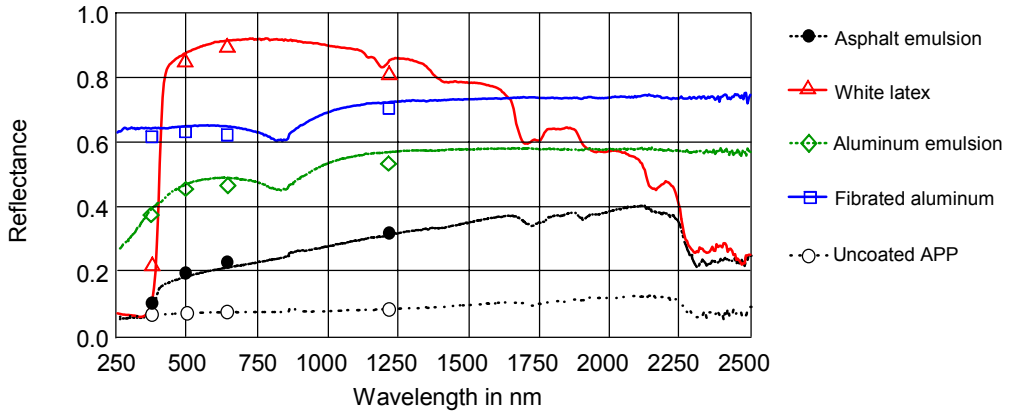
4.1 With a set of reflectance values available for the desired areas of a sample, the arithmetic average of the values is most conveniently found with a calculator or in a spreadsheet. A calculator or spreadsheet allows the standard deviation to be found for the average. The standard deviation indicates the scatter about the average. Typical scatter from different locations that appear equally bright on the same sample is $\pm$0.003 to $\pm$0.01.

5. Precision and Bias

5.1 Drift of no more than $\pm$0.003 from the calibration value is typical during 30 minutes of operation after warm-up and setting of the gain. Therefore the instrument's precision is $\pm$0.003 but the precision of the average of several measurements is usually governed by the variability of reflectances from area to area on a sample.

5.2 In a collaborative effort to document the bias of the Devices & Services (D&S) Solar Spectrum Reflectometer, Oak Ridge National Laboratory (ORNL) and Lawrence Berkeley National Laboratory (LBNL) compared solar spectrum reflectances of five samples including an uncoated modified bitumen and pieces of the modified bitumen coated with an asphalt emulsion, an aluminum emulsion, a fibrated aluminum and a white latex coating. These samples covered the range from poorly reflecting to highly reflecting surfaces typical for uncoated and coated low-slope roofs. LBNL measured the spectrum of reflectances from 250 to 2500 nanometers as well as the solar spectrum average for the samples using a Perkin-Elmer Lambda 9 Spectrophotometer. ORNL measured the air mass 2 solar spectrum reflectance with the D&S instrument before and after the samples were at LBNL. ORNL also recorded the output of the four individual detectors of the D&S instrument and assigned these values to the wavelength at which each detector was most sensitive.

5.3 The figure shows the continuous lines from the LBNL spectral scans and symbols from the ORNL readings with the four detectors of the D&S instrument. The individual detectors are able to provide some spectral resolution but not enough to detect differences in behavior of the test surfaces at the long wavelengths.



5.4 The table shows total solar spectrum reflectances for all the samples in the collaborative effort. The average was taken of the ORNL readings before and after the LBNL solar average was determined from the spectra for each sample. The LBNL measurements were made according to ASTM Designation: E 903-96 "Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres." ASTM E 903 states that the precision of the method (as indicated by the repeatability of measurements by the method) is typically ±0.005. Bias is not able to be specified because it depends on the individual apparatus and care with which the measurement is done. For this collaborative effort, the LBNL measurements are accepted as the true measure of the reflectance of each sample. The difference between the ORNL and LBNL averages is given for each sample in the last column of the table. The average difference of +0.003 is within the expected drift of the D&S instrument during 30 minutes of operation after warm-up. The difference of +0.02 for the white latex and -0.02 for the aluminum emulsion is interpreted to mean that ±0.02 is a conservative estimate of the bias in the measurement of the solar reflectance of an individual sample with the Devices and Services Company Solar Spectrum Reflectometer, Version 5.0.

Sample description	ORNL before	LBNL Solar Avg.	ORNL after	Difference
Asphalt emulsion	0.259	0.2394	0.246	+0.013
White latex	0.844	0.8224	0.842	+0.021
Aluminum emulsion	0.472	0.4930	0.478	-0.018
Fibrated aluminum	0.659	0.6574	0.650	-0.003
Uncoated APP	0.077	0.0757	0.076	+0.001
			AVERAGE:	**+0.003**