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Date: January 23, 2013

HEMISPHERICAL SPECTRAL REFLECTANCE and TOTAL EMITTANCE TEST REPORT

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1.0 INTRODUCTION

This report presents results of spectral reflectance and total emittance measurements on the following six roofing products coded:

GRANULAR MODIFIED UNCOATED
POLAROOF RAC OVER GRANULATED MODIFIED
POLAROOF RAC WITHOUT REINFORED FABRIC
POLAROOF RAC WITH ROOFAB
POLAROOF RAC WITH POLAFAB
POLAROOF RAC OVER SMOOTH MODIFIED

2.0 TEST METHODS AND PROCEDURES

Reflectance

Hemispherical spectral reflectance measurements were performed in accordance with ASTM Standard Test Method E903. The measurements were performed with a PerkinElmer Lambda 950 Spectrophotometer utilizing an integrating sphere (Fig A1.3 of E903). Total reflectance measurements were obtained in the solar spectrum from 2500nm to 300nm at an incident angle of 8°. The measurements employ a detector-baffled, wall-mounted integrating sphere that precludes the necessity of employing a reference standard except to define the instrument's 100% line. The measurements are properly denoted as being 'hemispherical spectral reflectance'.

Total Solar ρ reflectance was obtained by integrating the spectral data against Air Mass 1.5 (ASTM G159) direct solar spectrum utilizing 105 weighted ordinates. All spectral data are submitted herewith in the original.

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2.0 TEST METHODS AND PROCEDURES (cont'd)

Emittance

Near-normal infrared reflectance measurements were performed in accordance with ASTM E408, Method A. A Gier Dunkle Instruments Infrared Reflectometer Model DB 100 was utilized for the measurements.

Inside the detector portion are two semi-cylindrical cavities. One of the cavities is heated by an electrical heater and the other stabilizes at approximately room temperature. Thus, the two cavities are maintained at different temperatures. As the cavities rotate, the sample is alternately irradiated at 13 Hz. A vacuum thermocouple views the sample through an optical system that focuses through slits in the ends of the cavities. The detector receives energy emitted by the sample and energy reflected by the sample. Only the reflected energy contains an alternating component as the sample is alternately irradiated by the hot and cold cavities. An amplifier is synchronized with the cavity rotation to pass only the desired alternating signal, which is then rectified and filtered. The zero and gain are set with standards of known emittance. The calibration is rechecked at several intervals during the measurement. The Gier Dunkle Infrared Reflectometer is calibrated using high and low emittance standards. The standards were calibrated at and obtained from the National Physical Laboratory in England. The emittance value for the glass standard equals 0.89. The emittance value for the mirror standard equals 0.01.

Near-normal emittance for the client's specimens was calculated from Kirchhoff's Relationship where:

$$\rho + \alpha + \tau = 1, \alpha = \varepsilon$$

Since these specimens are opaque and have no τ in the far IR, the preceding equation reduces to:

$$\rho + \varepsilon = 1 \text{ and } 1 - \rho = \varepsilon$$

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2.0 TEST METHODS AND PROCEDURES (cont'd)

SRI

The Solar Reflectance Index is calculated from ASTM E1980. The procedure defines a Solar Reflectance Index (SRI) that measures the relative "steady-state surface temperature" of a surface with respect to the standard white (SRI=100) and the standard black (SRI=0) under the standard solar and ambient conditions. The program used for the calculations was provided by Lawrence Berkeley Laboratory in California.

3.0 OBSERVATIONS, DEVIATIONS, AND WAIVERS

All measurements were performed on the uncoded side of the specimens.

The values reported for emittance represent the average of at least four measurements.

With all test methods, there typically is a level of uncertainty for the test data due to the acceptable operating tolerances of the instrumentation and variation caused by the test method. The estimated tolerances are expected to be less than plus or minus 2% for most materials tested to ASTM E903.

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4.0 RESULTS

Reflectance and SRI:

Specimen Code	% Solar Reflectance	SRI
GRANULAR MODIFIED UNCOATED	9.1	7
POLAROOF RAC OVER GRANULATED MODIFIED	55.0	51
POLAROOF RAC WITHOUT REINFORED FABRIC	53.2	50
POLAROOF RAC WITH ROOFAB	52.2	49
POLAROOF RAC WITH POLAFAB	49.1	43
POLAROOF RAC OVER SMOOTH MODIFIED	59.7	55

Emittance:

Specimen Code	Far IR Reflectance (ρ) Measured	Near Normal Total Emittance (ε) Calculated
GRANULAR MODIFIED UNCOATED	.06	.94
POLAROOF RAC OVER GRANULATED MODIFIED	.49	.51
POLAROOF RAC WITHOUT REINFORED FABRIC	.44	.56
POLAROOF RAC WITH ROOFAB	.44	.56
POLAROOF RAC WITH POLAFAB	.45	.55
POLAROOF RAC OVER SMOOTH MODIFIED	.59	.41