Cool Roof Rating Council
ASTM Methods

Program Background

ENERGY STAR is a United States Environmental Protection Agency voluntary program to broadly promote both energy efficiency and conservation in new and existing construction by setting performance standards for appliances, building products, and building systems [1]. The Cool Roof Rating Council develops methods and labeling criteria for solar reflectance and radiative properties specifically for roofing products and shares this information to all stakeholders [2]. For example, the US State of California's Energy Commission developed Title 24, an energy standard dictating performance criteria utilizing CRRC product listings. ENERGY STAR provides performance guidance for initial and three year aged solar reflectance. CRRC listings are more expansive, detailing the product's initial, aged, and laboratory aged solar reflectance and emissivity. CRRC has an agreement with accredited exposure farms where roofing products are aged for three years after which time the average solar reflectance and emissivity from these sites are measured and listed with CRRC. ASTM test methods are used to measure all solar and radiative properties.

Test Method Background

ASTM C1549 is the standard test method for solar reflectance [3]. A Devices and Services Solar Reflectometer is used to measure the total reflectance of incident solar radiation between 380nm and 1220nm. This incident solar radiation covers the visible, UV and Near IR wavelengths. ASTM C1371 is the standard test method for emittance [4]. Again, a Devices and Services produced emissometer measures the radiative heat transfer of a roofing product. More precisely, emissivity is the percent of thermal radiation being emitted from a material as compared to a fully thermal absorbing black body. ASTM E1980 is the standard practice for calculating solar reflectance index, SRI [5]. SRI is a calculated value based on solar reflectance, emissivity, and heat transfer coefficient of convection based on estimates of roof wind speed [Equation 1]. ASTM D7897 is a predictive laboratory test for the solar and thermal properties for three years of exterior exposure on roofing products [6]. This three day accelerated testing procedure within ASTM D7897 has been demonstrated to correlate to three years of exterior exposure across multiple roofing products and technologies [7]. ASTM D7897 consists of three steps, the initial UV conditioning of the roofing panel, spray depositing a specific mass of a codified dirt solution onto the roof panel, and finally weathering the panel under UV for 24h. The dirt solution used in ASTM D7897 was developed following the analysis of dirt collected from the three CRRC exposure sites representative of three distinct climates and chemistries; desert (dust), tropical (organic material), and temperate (a combination of dust, salt, and soot). ASTM D7897 averages the dirt composition from the three regions to create the dirt solution used for the test method. The results from ASTM D7897 testing can be listed with CRRC or used on a CRRC label as an interim demonstration of aged solar and thermal performance while the three year exterior exposure is in progress. ASTM D7897 is also known as the CRRC Rapid Ratings test due to the speed and association with CRRC labeling.

Wilcote Performance Results

Wilcote W118 Infra-Red Coating -Sandstone Beige was tested by an independent certification laboratory for initial solar reflectance and emissivity, per respective ASTM protocols. The certification laboratory conducted ASTM D7897 and again measured the solar reflectance and emissivity of *Wilcote W118 Infra-Red Coating -Sandstone Beige* after the predictive weathering test. The results are discussed below.

Wilcote W118 Infra-Red Coating -Sandstone Beige has an initial solar reflectance of 68% per ASTM C1549 meeting ENERGY STAR requirements with an initial solar reflectance greater than 65%.

Wilcote W118 Infra-Red Coating -Sandstone Beige has an initial emissivity of 91% per ASTM C1371. The initial solar reflective index is calculated to be between 82.9 and 83.2 per ASTM E1980, depending theoretical wind speeds.

Following the predictive laboratory aging of ASTM D7897, *Wilcote W118 Infra-Red Coating -Sandstone Beige* has a predictive aged solar reflectance of 67% and a predictive aged emissivity of 90% as measured by the independent certification laboratory. The predictive aged solar reflective index is between 81.2 and 81.7 depending theoretical wind speeds, per ASTM E1980.

The Rapid Rating ASTM D7897 performance of *Wilcote W118 Infra-Red Coating -Sandstone Beige* meets the 50% minimum three year solar reflectance of ENERGY STAR. The US State of California's Energy Commission, Title 24 Section 140.3 adapts CRRC listings and sets a stringent performance minimum following 3 years of exterior aging of 63% solar reflectance, 75% emissivity, or a SRI of 75 for nonresidential low slope roofs. *Wilcote W118 Infra-Red Coating -Sandstone Beige* meets the California Title 24 performance following ASTM D7897 conditioning.

Wilcote W118 Infra-Red Coating -Sandstone Beige	Solar Reflectance ASTM C1549	Emissivity ASTM C1371	SRI_{Low} ASTM E1980	SRI_{Medium} ASTM E1980	SRI_{High} ASTM E1980
Initial Readings	0.68	0.91	82.91	83.05	83.16
CRRC Rapid Ratings: Three year Accelerated Aged ASTM D7897	0.67	0.90	81.21	81.46	81.66
ENERGY STAR (Solar Reflectivity)	0.65 (Initial) 0.50 (Aged)				
California Energy Commission Title 24	0.63 (Aged)	0.75 (Aged)	75	75	75

1. https://www.energystar.gov/about
2. http://www.coolroofs.org/about-crrc/overview
3. ASTM C1549; Standard test method for solar reflectance near ambient temperature using a portable solar reflectometer
4. ASTM C1371; Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers
5. ASTM E1980; Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces
6. ASTM D7897; Laboratory Soiling and Weathering of Roofing Materials to Simulate Effects of Natural Exposure on Solar Reflectance and Thermal Emittance
7. M. Sleiman et al. Solar Energy Materials & Solar Cells 122 (2014) 271–281

Equation 1.

$$SRI = 123.97 - 141.35\chi + 9.655\chi^2$$

$$\chi = \frac{(\alpha - 0.029\varepsilon)(8.797 + h_c)}{(9.5205\varepsilon + h_c)}$$

$$h_c = 12.4\frac{W}{m^2 C^\circ}$$

- α = 1- SRI
- Ɛ = emissivity
- h_c = heat transfer coefficient of convection and estimate roof wind speed
- SRI_{Low}= Wind speed 0-2 m/s; h_c = 5
- SRI_{Medium} = Wind speed 2-6 m/s; h_c = 12.4
- SRI_{High} = Wind speed 6-10 m/s; h_c = 30