AFRC Complex Glazing Test Standard

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Standard Outdoor Test Method for Measuring Solar and Visible Reflectance and Transmittance of Large-Structure Complex Glazing Materials

1. Scope

This test method covers the outdoor measurement of solar and visible reflectance and transmittance of large-structure complex skylight glazing materials with a repeating structure of 2mm or greater. Overall sample size may be as small as one metre in diameter. Solar measurements are made with a pyranometer and visible measurements are made with a photometer. The source radiation is solar and the test material must be planar. For reflectance and transmittance, the test method is intended for use when the angle between the solar beam and the normal to the glazing surface is less than 8^{o}, i.e. the incidence of the solar beam is near-normal.

2. Referenced Documents

2.1 ASTM Standards:

E1918 – 06 *Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.*
E972 – 96 (Reapproved 2007) *Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight*.
E1084 – 86 (Reapproved 2009) *Standard Test Method for Solar Transmittance (Terrestrial) of Sheet Materials Using Sunlight*.

2.2 Other publications:

Ronnen Levinson, Hashem Akbari and Paul Berdahl, *Measuring solar reflectance—Part II: Review of practical methods.* Solar Energy **84** (2010) 1745-1759.
Hashem Akbari, Ronnen Levinson and Stephanie Stern, *Procedure for measuring the solar reflectance of flat or curved roofing assemblies*. Solar Energy **82** (2008) 648–655.

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3. Terminology

3.1 Definitions:

3.1.1 *large-structure complex glazing material*—material with a surface structure and/or internal structure having a period of 2mm or more.
3.1.2 *pyranometer*—an instrument used to measure the total solar radiant energy incident upon a surface per unit time and unit surface area.
3.1.3 *photometer*—an instrument used to measure the total visible radiant energy incident upon a surface per unit time and unit surface area.
3.1.4 *solar energy*—the radiant energy originating from the sun. Approximately 99 % of solar energy lies between wavelengths of 0.30 to 3.50 µm.
3.1.5 *solar flux*—for these measurements, the direct and diffuse radiation from the sun received at sea level over the solar spectrum, expressed in watts per square metre.
3.1.6 *visible flux*—for these measurements, the direct and diffuse radiation from the sun received at sea level in the visible spectrum, expressed in watts per square metre.
3.1.7 *solar reflectance*—the fraction of solar flux reflected by a material surface.
3.1.8 *solar transmittance*—the fraction of solar flux transmitted by a material.
3.1.9 *visible reflectance—the fraction of visible flux reflected by a material surface.*
3.1.10 *visible transmittance—the fraction of visible flux transmitted by a material.*

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *solar spectrum*—the solar spectrum at sea level extending from wavelength 0.30 to 3.50µm.
3.2.2 *visible spectrum*—that part of the solar spectrum at sea level extending from wavelength 0.38 to 0.78µm.

4. Summary of Test Method

4.1 **Reflectance.** A pyranometer (for solar wavelengths) or a photometer (for visible wavelengths) is used to measure incoming and reflected solar radiation for a glazing material. The reflectance is the ratio of the reflected radiation to incoming radiation. The beam angle between the incident solar radiation and the sample surface normal must not exceed 8^{o}.
4.2 **Transmittance.** A pyranometer (for solar wavelengths) or a photometer (for visible wavelengths) is used to measure incoming and transmitted solar radiation for a glazing material. The transmittance is the ratio of the transmitted radiation to incoming radiation. The beam angle between the incident solar radiation and the sample surface normal must not exceed 8^{o}.

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5. Significance and Use

5.1 Reflectance and transmittance are essential optical properties of glazing materials. This test method allows these parameters to be measured for large-area, complex glazing materials. The method is suitable for any glazing material that has surface or internal structure on a scale larger than 2mm. The need arises because of the unsuitability of a conventional spectrophotometer for the task. Such an instrument, routinely used by optical laboratories for specular glazings or fine-structure woven fabric samples, has a measurement beam of order 5mm x 9mm in cross-sectional size. This renders the instrument unsuitable for measuring the transmittance and reflectance of large-structure materials, since results will vary noticeably depending on what part of the structure the measurement beam intersects.

5.2 This test method overcomes the above limitation by using broadband solar radiation and by measuring transmitted or reflected radiation that has been collected and averaged over many periods of the sample structure. Sample size is governed by the angular field of view of the pyranometer used for measurement of reflectance or transmittance combined with the distance it stands off from the sample. An indicative sample size is 0.5 to 1m in diameter . It is determined finally by the mask size used for reflectance as in Section 2.2, or for the transmittance aperture. The lower limit on sample size is acceptable accuracy, as defined by the same size mask used on multiple samples of one type or on different areas of the same sample. A trade-off is that, since the method employs broadband radiation it is unable to resolve spectral information on a wavelength-by-wavelength basis in the way a spectrophotometer can. However the method will yield the test sample's visible and total solar properties (over 0.38-0.78µm and 0.30-2.50µm, respectively).

6. Apparatus and Procedure

6.1 The sensors, read-out instruments, instrumental setup, analysis and reporting shall follow References 2.1 and 2.2 above.

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