

~~ANSI~~NFRC 202- 20230[E0A02]

Procedure for Determining
Translucent Fenestration Product
Visible Transmittance at Normal
Incidence

An American National Standard

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FOREWORD

The National Fenestration Rating Council, Incorporated (NFRC) has developed and operates a uniform rating system for energy and energy-related performance of fenestration products. The Rating System determines the U-factor, Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT) of a product, which are mandatory ratings for labeling NFRC certified products, are mandatory ratings for inclusion on label certificates, and are supplemented by procedures for voluntary ratings of products for Air Leakage (AL), and Condensation Resistance. Together, these rating procedures, as set forth in documents published by NFRC, are known as the NFRC Rating System.

The NFRC Rating System employs computer simulation and physical testing by NFRC-accredited laboratories to establish energy and related performance ratings for fenestration product types. The NFRC Rating System is reinforced by a certification program under which NFRC-licensed responsible parties claiming NFRC product certification shall label and certify fenestration products to indicate those energy and related performance ratings, provided the ratings are authorized for certification by an NFRC-licensed certification and Inspection Agency (IA).

The requirements of the rating, certification, and labeling program (Certification Program) are set forth in the most recent versions of the following as amended, updated, or interpreted from time to time:

- NFRC 700 Product Certification Program (PCP).
- NFRC 705 Component Modeling Approach (CMA), Product Certification Program (CMA-PCP).

Through the Certification Program and the most recent versions of its companion programs as amended, updated, or interpreted from time to time:

- The laboratory accreditation program (Accreditation Program), as set forth in the NFRC 701 Laboratory Accreditation Program (LAP).
- The IA licensing program (IA Program), as set forth in NFRC 702 Certification Agency Program (CAP).

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- The CMA Approved Calculation Entity (ACE) licensing program (ACE Program), as set forth in the NFRC 708 Calculation Entity Approval Program (CEAP).

NFRC intends to ensure the integrity and uniformity of NFRC ratings, certification, and labeling by ensuring that responsible parties, testing and simulation laboratories, and IAs adhere to strict NFRC requirements.

In order to participate in the Certification Program, a Manufacturer/Responsible Party shall rate a product whose energy and energy-related performance characteristics are to be certified in accordance with mandatory NFRC rating procedures. At present, a Manufacturer/Responsible Party may elect to rate products for U-factor, SHGC, VT, AL, Condensation Resistance, or any other procedure adopted by NFRC, and to include those ratings on the NFRC temporary label affixed to its products, or on the NFRC Label Certificate. U-factor, SHGC and VT, AL, and Condensation Resistance rating reports shall be obtained from a laboratory that has been accredited by NFRC in accordance with the requirements of the NFRC 701.

The rating shall then be reviewed by an IA which has been licensed by NFRC in accordance with the requirements of the NFRC 702. NFRC-licensed IAs also review label format and content, conduct in-plant inspections for quality assurance in accordance with the requirements of the NFRC 702, and issue a product Certification Authorization Report (CAR), or approve for issuance an NFRC Label Certificate for site-built or CMA products and attachment products. The IA is also responsible for the investigation of potential violations (prohibited activities) as set forth in the NFRC 707 Compliance and Monitoring Program (CAMP).

Ratings for products that are labeled with the NFRC Temporary and Permanent Label, or products that are listed on an NFRC Label Certificate in accordance with NFRC requirements, are considered to be NFRC-certified. NFRC maintains a Certified Products Directory (CPD), listing product lines and individual products selected by the manufacturer/responsible party for which certification authorization has been granted.

NFRC manages the Rating System and regulates the Product Certification Program (PCP), Laboratory Accreditation Program (LAP) and Certification Agency Program (CAP) in accordance with the NFRC 700 (PCP), the NFRC 701 (LAP), the NFRC 702 (CAP), the NFRC 705 (CMA-PCP), and the NFRC 708 (CEAP) procedures, and conducts compliance activities under all these programs as well as the NFRC 707 (CAMP). NFRC continues to develop the Rating System and each of the programs.

NFRC owns all rights in and to each of the NFRC 700, NFRC 701, NFRC 702, NFRC 705, NFRC 707, NFRC 708 and each procedure, which is a component of the Rating System, as well as each of its registration marks, trade names, and other intellectual property.

The structure of the NFRC program and relationships among participants are shown in Figure 1, Figure 2, and Figure 3. For additional information on the roles of the IAs and laboratories and operation of the IA Program and Accreditation Program, see the NFRC 700 (PCP), NFRC 701 (LAP), and NFRC 702 (CAP) respectively.

Figure 1

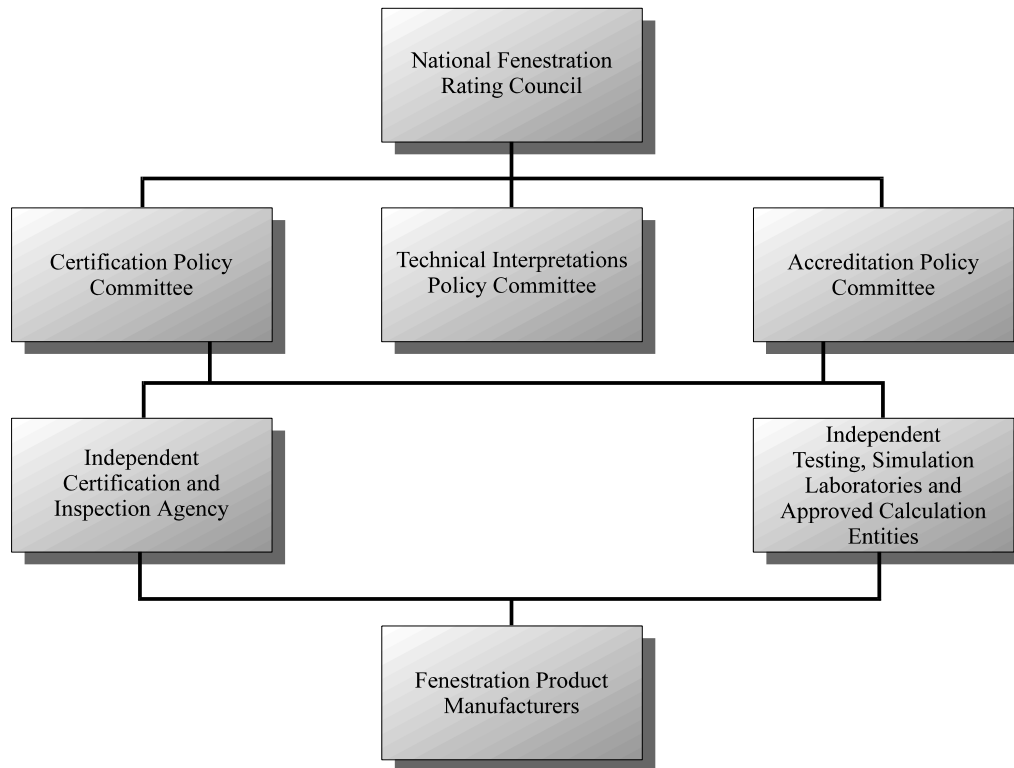


Figure 2

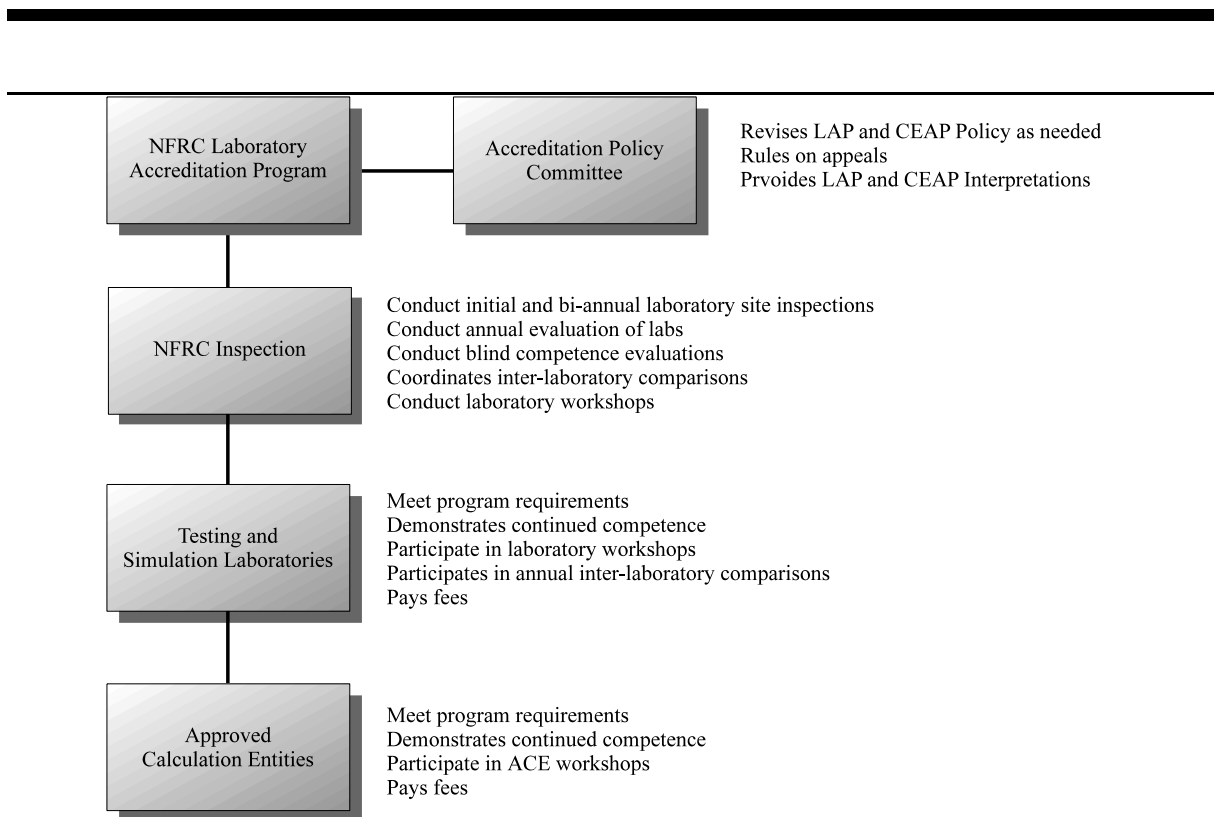
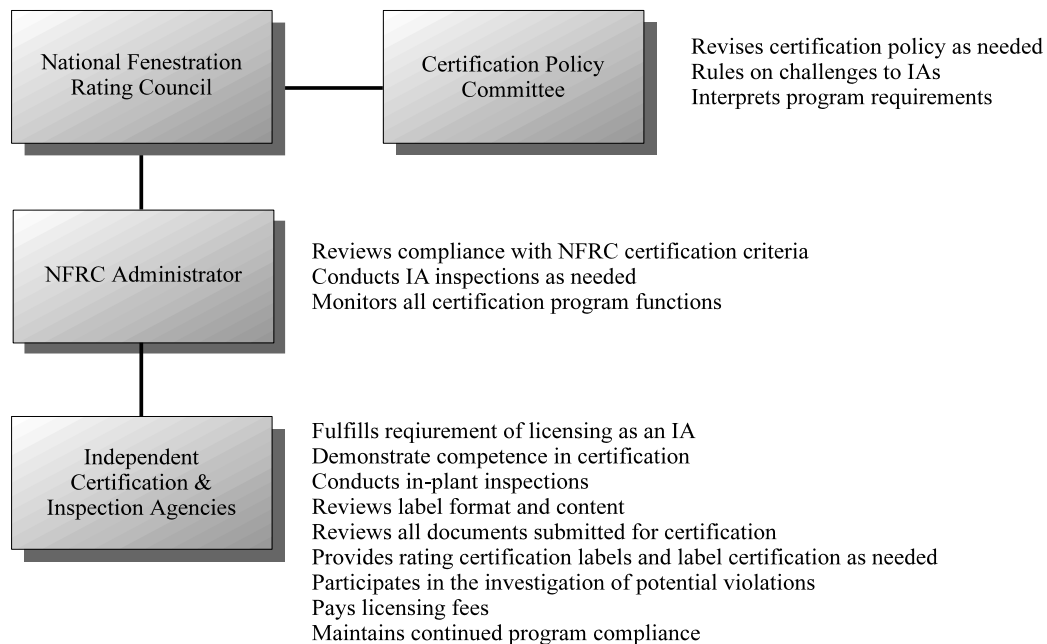


Figure 3



Questions on the use of this procedure should be addressed to:

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DISCLAIMER

NFRC certification is the authorized act of a Manufacturer/Responsible Party in: (a) labeling a fenestration or related attachment product with an NFRC Permanent Label and NFRC Temporary Label, or (b) generating a site built or CMA label certificate, either of which bears one or more energy performance ratings reported by NFRC-accredited simulation and testing laboratories and authorized for certification by an NFRC-licensed IA. Each of these participants acts independently to report, authorize certification, and certify the energy-related ratings of fenestration and related attachment products.

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NFRC program participants are required to indemnify NFRC from and against such liability.

This standard is maintained by the Continuous Maintenance Process.

Approval of ANSI / NFRC 202 as an American National Standard is maintained using the continuous maintenance process. Comments or proposals for revisions on any part of this standard may be submitted to National Fenestration Rating Council at any time. Written comments or proposals must be in writing and be submitted to the NFRC Accredited Standards Developer at standards@nfr.org.

Any written comments or proposals submitted to NFRC as provided above shall be submitted by NFRC to its consensus body for consideration within a reasonable timeframe not to exceed one year. The submitter will be notified by NFRC of the expected time frame for consideration of the proposal or comments. NFRC shall apply for reaffirmation of this standard regardless any comment or proposals every three years.



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1. PURPOSE

To specify a test method for translucent panels to determine the visible transmittance (VT_{cog}) at normal (perpendicular) incidence in accordance with ASTM E 972 and ASTM E 1084 (except where noted).

2. SCOPE

2.1 Products and Effects Covered

Flat or domed, diffusing products which cannot be measured in a spectrophotometer and cannot be simulated using computer tools due to complex internal structure or thickness. Examples of such products include, but are not limited to:

2.1.1 Translucent fiberglass or multicell plastic sandwich panels with or without internal grids;

2.1.2 Translucent multicell profile plastic panels with or without internal grids;

2.1.3 Translucent multicell plastic panels with or without internal grids;

2.1.4 Glass panels with translucent insulation insert material with or without internal grids between the glass;

2.1.5 Translucent channel reinforcing profile glass with or without translucent insulation insert material between the glass.

2.1.6 Plastic domed skylights with or without internal flat or multicell panels

2.1.7 Prismatic materials (i.e. dome, flat sheet)

Note: Products containing linear structural members (e.g. grids, muntins) and/or frames may be rated in accordance with procedures specified in ANSI/NFRC 200, based on the center-of-glazing measurements, performed in accordance with this procedure, to calculate the effects of such members and frames. The effects of internal grids are determined for certification by assuming (as specified by NFRC) that they are opaque and by performing an area-weighted average of the transmittances of the translucent and opaque areas.

2.2 Products and Effects Not Covered

The following products and effects are not covered:

- 2.2.1 Fenestration products with shading systems, either between the glazing or added to the indoor or outdoor side of the fenestration;
- 2.2.2 Tubular daylighting devices, etc.; (See NFRC 203 for the VT procedure)
- 2.2.3 Fenestration systems with printing on glass such as frit patterns;
- 2.2.4 Fenestration systems with structural members different from perpendicular and rectilinear in nature;
- 2.2.5 Corrugated or patterned glass, glass blocks, etc.

2.3 Sample Requirements

Visible transmittance (VT_{cog}) measurements of the translucent products shall be determined using ASTM E972 and ASTM E1084.

- 2.3.1 Flat panel sample size shall be 1000 mm by 1000 mm (39" x 39") or the closest deviations as determined using ANSI/NFRC 100 Section 4.6.1. The sample should be constructed without any internal structural members except at the perimeter (frame), which structural members shall be located outside the 500mm x 500mm aperture of the testing apparatus as specified in ASTM E1084.
- 2.3.2 Dome product – size 1220 mm x 1220 mm (48" x 48") (to match SHGC NFRC 201 sample)
- 2.3.3 Rise of the dome – Test the standard rise for the dome sample. If SHGC testing per NFRC 201 then the rise and, where applicable, spacing of the dome shall be the same in the VT test.
- 2.3.4 If the product cannot be made large enough to cover the standard size above due to its modular sizes, the specimen shall be constructed to the closest deviations as determined using ANSI/NFRC 100 Section 4.6.1 by joining one or more modular panels. Note: Modular components of the panel should be rigidly fastened in a manner that affects the optical properties of the sample minimally, such as with a thin layer of super glue or equivalent.
- 2.3.5 If multiple product lines have different surface characteristics, or different textures such as cell size of a multicell polycarbonate panel or other glazing materials, each product, consisting of layers

with different surface will be treated as a separate individual product and each product must be separately tested. Each product shall be tested in the exterior/interior orientation intended for installation. If multiple product lines have different color or tints in the panel skin, each different surface will be treated as a separate individual product and each must be separately tested.

2.3.6 If multiple product lines have different internal insulation each different insulation type and density will be treated as a different product and each must be separately tested.

2.3.7 Grouping of domes within a product line shall be permitted to reduce the number of tests. If this approach is used, the lowest rise shall be used as the group leader to represent the total fenestration VT for all individual products within that group. This grouping shall not be used to group individual products from different product lines into one product line.

3. DEFINITIONS

Definitions and terms are in accordance with terminology in ASTM E972, ASTM E1084, ASTM C168, ASTM E631, ASTM E772 and ASTM E1175 unless otherwise defined in this document.

Diffuse:

Property of the transmitting material where emerging rays are transmitted nearly uniformly in all directions.

Illumination:

In this document only the portion of solar radiant energy from 380 to 760 nm is of interest.

Photometer:

An instrument for measuring luminous intensity, luminous flux or illuminance.

Photopic Response:

The spectral response of the average human eye when fully adapted to daylight conditions.

Solar Heat Gain Coefficient (SHGC):

The ratio of the solar heat gain entering the space through the fenestration product to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and that portion of the absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

Specular:

Property of the transmitting material where emerging rays are transmitted in the direction of incidence.

Visible Transmittance (VT):

The ratio of visible radiation entering the space through the fenestration product to the incident visible radiation, determined as the spectral transmittance of the total fenestration system, weighted by the photopic response of the eye and integrated into a single dimensionless value. Weighted by a standard solar spectrum.

4. REFERENCED DOCUMENTS

4.1 NFRC Standards

ANSI/NFRC 200, *Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence*

NFRC 300, *Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems*

4.2 ASTM Standards

ASTM E972, *Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight*

ASTM E1084, *Standard Test Method for Solar Transmittance (Terrestrial) of Sheet Materials Using Sunlight*

Note: For additional test standards related to this NFRC test standard, see those listed in ASTM E 972 and E 1084.

5. SIGNIFICANCE AND USE

5.1 This test method details the calibration and testing procedure, and necessary instrumentation, required to measure the visible light transmittance of non-specular or diffuse fenestration glazing.

5.2 Glazed apertures in buildings are generally utilized for the controlled admission of both light and solar radiant heat energy into the structure.

The bulk of the solar radiant energy entering a building in this manner possesses wavelengths that lie from 300 to 2500 nm. Only the portion from 380 to 760 nm is visible radiation. In daylighting applications, it is therefore important to distinguish the radiant (solar radiant energy) transmittance of constructions or materials from their luminous (light) transmittance.

- 5.3** This test method is useful for determining the solar luminous transmittance of optically inhomogeneous, materials or constructions, or non-planar, but otherwise optically homogeneous. This test method provides a means of measuring solar luminous transmittance under fixed conditions of incidence and detection.
- 5.4** The spectral distributions of both the direct and diffuse solar irradiation, as well as the directional distributions of both at the earth's surface, generally vary with location, season and time of day. Although these variations are typically not significant when testing the visible light transmittance of clear or tinted and uncoated glazing systems at normal incidence, they can influence the measured results if the test specimen has complex spectral or directional optical characteristics. For these reasons, the visible transmittance of these types of products measured at an outdoor laboratory may vary from the results measured at another outdoor laboratory in a different location or under different conditions. At this time, there is no way to account for these discrepancies which are deemed to have small impact, and as such, are deemed to be acceptable.

6. CALIBRATION

- 6.1** The photometric measurement system, as referenced in ASTM E 972, shall be calibrated annually.
- 6.2** Photometric Sensor Calibration. Since the test involves the calculation of ratios of measurements made with the photometric sensor, there is no requirement regarding its absolute calibration. Instead, the linearity specification stated in 7.1.1.A below shall be met and verified by yearly recalibration, using any one of the following three methods:
 - 6.2.1** Return the sensor to the manufacturer for a recalibration, to include a statement of linearity of response, with a calibration certificate being supplied following the recalibration.
 - 6.2.2** Place the sensor facing the direct sun on a clear day and take readings of its output electrical current, voltage or illuminance readings, both uncovered and covered by neutral density filters

(less than 2% spectral variation in the transmittance over the spectral range from 390 to 750 nm) having known visible transmittances ($\pm 1\%$) ranging from 80% down to 1% in 10 steps, then plot the output signals versus filter transmittance (100% for the uncovered case), fit the data points to a straight line and measure the departures of the data points from the straight line at each transmittance level.

6.2.3 Replace the neutral density filters by some other means of reducing the solar flux on the sensor by a precise fractional value while providing uniform illumination of all parts of the sensor.

6.3 The photometric measurement system, as referenced in ASTM E 972 shall have its calibration validated for overall accuracy at the time of measurement, using a thin, homogeneous diffusing sheet whose spectral transmittance over the visible range was previously measured in a spectrophotometer and the VT_{cog} value of the sheet calculated from those measurements. The calibration confirmation measured VT_{cog} shall not depart more than 5% from the VT_{cog} as measured in the spectrophotometer.

7. APPARATUS AND INSTRUMENTATION

7.1 The required test apparatus is outlined in ASTM E 1084 and E 972.

7.1.1 Photometric Sensor Specifications

Since the test involves the calculation of ratios of measurements made with the photometric sensor, there is no need for its electrical output signal to be converted to illuminance units. However, the following additional specifications for the purchase of a suitable photometric sensor shall be met:

- A. Linearity of output signal with respect to incident radiant flux: Maximum deviation of 1% over a dynamic range of 1000 to 1.
- B. Stability in output linearity: $< \pm 2\%$ change over a 1-year period.
- C. Response Time: less than 10 ms.
- D. Temperature Dependence: $\pm 0.15\%$ per °C maximum.
- E. Cosine Correction: Angular response shall be, as required in E 972, "The response of the photometer to uniform, collimated incident radiation at an angle θ of incidence, divided by its response at normal incidence ($\theta = 0^\circ$), shall

depart from the cosine of θ by no more than $(\theta \div 18) \%$, with θ in deg.”

- F. Tilt: No error induced from orientation.
- G. Operating Temperature: -20 to 65 °C.
- H. Relative Humidity: 0 to 100%.
- I. Detector: High stability silicon photovoltaic detector.
- J. Spectral response as required in ASTM E 972, “The response of the photometer at wavelength λ , divided by its response at 555 nm (5550 Å), shall depart from the spectral luminous efficiency of the standard human observer at wavelength λ by no more than 2% for all wavelengths from 390 to 750 nm. Photometer response shall be essentially zero outside this range.”

7.2 The test apparatus shall be supplied with a means to adjust its orientation to face within 5 degrees of the center of the sun.

8. TEST PROCEDURE

The VT_{cog} measurement shall be performed using ASTM E 1084 and ASTM E 972 as follows:

- 8.1** Altitude and azimuth angles of a perpendicular line in the center of the test sample shall be verified to be within 5 degrees of facing the center of the direct beam sun. (The test specimen shall be tested at normal incidence, plus or minus 5 degrees from the sun.)
- 8.2** An 'exposed' reading is taken with the sample removed to determine the amount of incident flux from the sun. The result is a voltage or current reading ($V_{exposed}$) output from a photometer meeting the requirements set forth in Section 6 above.
- 8.3** The sample is then placed over the test apparatus aperture ('covered' position) with the photometer sensor 250 mm (10") from each edge of the specimen. While leaving the test aperture covered, a reading ($V_{covered}$) is taken. The sample then is moved a set distance (see Note below) towards the opposite corner of the sample and an additional reading is made. This process is repeated with additional steps until the photometer sensor is 250 mm (10") from the opposite edge of the sample, as described in detail in Section 8.4 through 8.8 below. This movement of the sample across the test aperture is intended to produce an area-weighted

average value of the transmittance in a systematic way relative to the aperture. Care should be taken so that no light escapes between the test sample and the edge of the aperture. Black foam tape can be adhered to the flush face of the aperture in contact with the test specimen where appropriate, to achieve this requirement. (See figures A3 and A3.1)

NOTE: The set distance of each measurement should be determined by calculating the distance between the starting point of the test specimen (250mm (10") in the horizontal and vertical direction from the corner) and the final reading (250mm (10") in the horizontal and vertical direction from the opposite corner). This distance is then divided by ten to determine the set distance of each movement to produce an area-weighted average of the test specimen. For 1000mm x 1000mm samples (standard flat panel size), the step distance is 70.7mm and for 1220mm x 1220mm samples (standard dome product size) the step distance is 101.8mm. For non-standard sizes calculate the specific step size for the non-standard product.

- 8.4** After six readings, the test specimen will be centered over the photometric sensor. The test specimen is removed and an 'exposed' reading is taken while the altitude and azimuth angles are verified to be within 5 degrees of the center of the sun. If the full sun reading varies by more than 5% between each 'exposed' measurement, then testing shall be delayed until weather conditions allow less than a 5% variance in full sun readings. This is to insure that the full sun reading has not changed in the time taken to perform the 'covered' measurements.
- 8.5** The sample is then replaced, centered over the aperture, at the same location from which it was removed, and moved a set distance in the same direction as before. A seventh reading is taken and then the sample is again moved the set distance. Four more readings are taken in this manner so that a total of eleven readings have been made of the transmitted flux through the sample.
- 8.6** After the final set of five readings has been completed, another exposed reading is taken while the altitude and azimuth are verified to be within 5 degrees of the center of the sun. Eleven readings is the minimum required. Additional readings are encouraged for spatially inhomogeneous materials in order better to achieve an accurate spatially averaged visible transmittance.
- 8.7** Each covered sample reading must be paired with the exposed reference reading closest to it in time, for the purpose of calculating the ratio of that sample reading to the nearest exposed reading.
- 8.8** The uncertainty of the readings shall be calculated with the standard formula for calculating the standard deviation from the mean, and if below

a 5% variance from the mean of the readings, testing can stop. If it is above 5%, eleven additional readings must be taken in the manner above, however, starting from the opposite bottom corner of the test specimen. If the cause of variance greater than 5% is thought to be due to changes in solar incident irradiance due to atmospheric conditions, then the test should be postponed until more stable atmospheric conditions prevail, at which time the testing must be restarted. If the cause of the out-of-limit readings is thought to be a result of inhomogeneities other than linear opaque framing or support structures, or shape then this procedure cannot be used on that sample.

The VT_{cog} value for the product is computed as the average of the ratio between the covered $V_{covered}$ and exposed $V_{exposed}$ readings.

For samples without internal grids or structures:

$$VT_{cog} = \frac{\sum_{i=1}^N \frac{v_{covered}(i)}{v_{exposed}(i)}}{N} \quad \text{Equation 8-1}$$

Where, N is the total number of paired readings

9. REPORTING

- 9.1 Results to be reported in accordance with ASTM E1084;
- 9.2 Additional reporting item is the total VT_{cog} results obtained in Equation 8-1 of this document.
- 9.3 Drawings to be included as part of the report as follows:
 - A. A drawing showing important details and dimensions
 - B. Photographs
 - C. Cross-sectional views

10. REFERENCES

- A. CIE “Colorimetry Technical Report.” 15:2004 (3rd Edition). International Commission on Illumination (CIE), Vienna, Austria. www.cie.co.at.
- B. ASTM E 972: Standard Test Method for Solar Photometric Transmittance of Sheet Materials Using Sunlight, American Society for Testing and Materials, West Conshohocken, PA., Volume 04.11.
- C. ASTM E 1084: Standard Test Method for Solar Transmittance (Terrestrial) of Sheet Materials Using Sunlight, American Society for Testing and Materials, West Conshohocken, PA., Volume 04.11.
- D. ANSI/NFRC 200-2017: Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence, National Fenestration Rating Council, Greenbelt, MD. www.nfrc.org.
- E. NFRC 300-2017: Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems, 2010, National Fenestration Rating Council, Greenbelt, MD. www.nfrc.org.

11. APPENDIX A: TEST APPARATUS AND MEASUREMENT PROFILE



Figure A1: Photo of the test aperture. The center sensor is the photometric sensor. The other two sensors should be disregarded and removed from the apparatus for this test procedure.



Figure A2: Photo of test apparatus with a generic test specimen centered over the aperture in the 'covered' position.

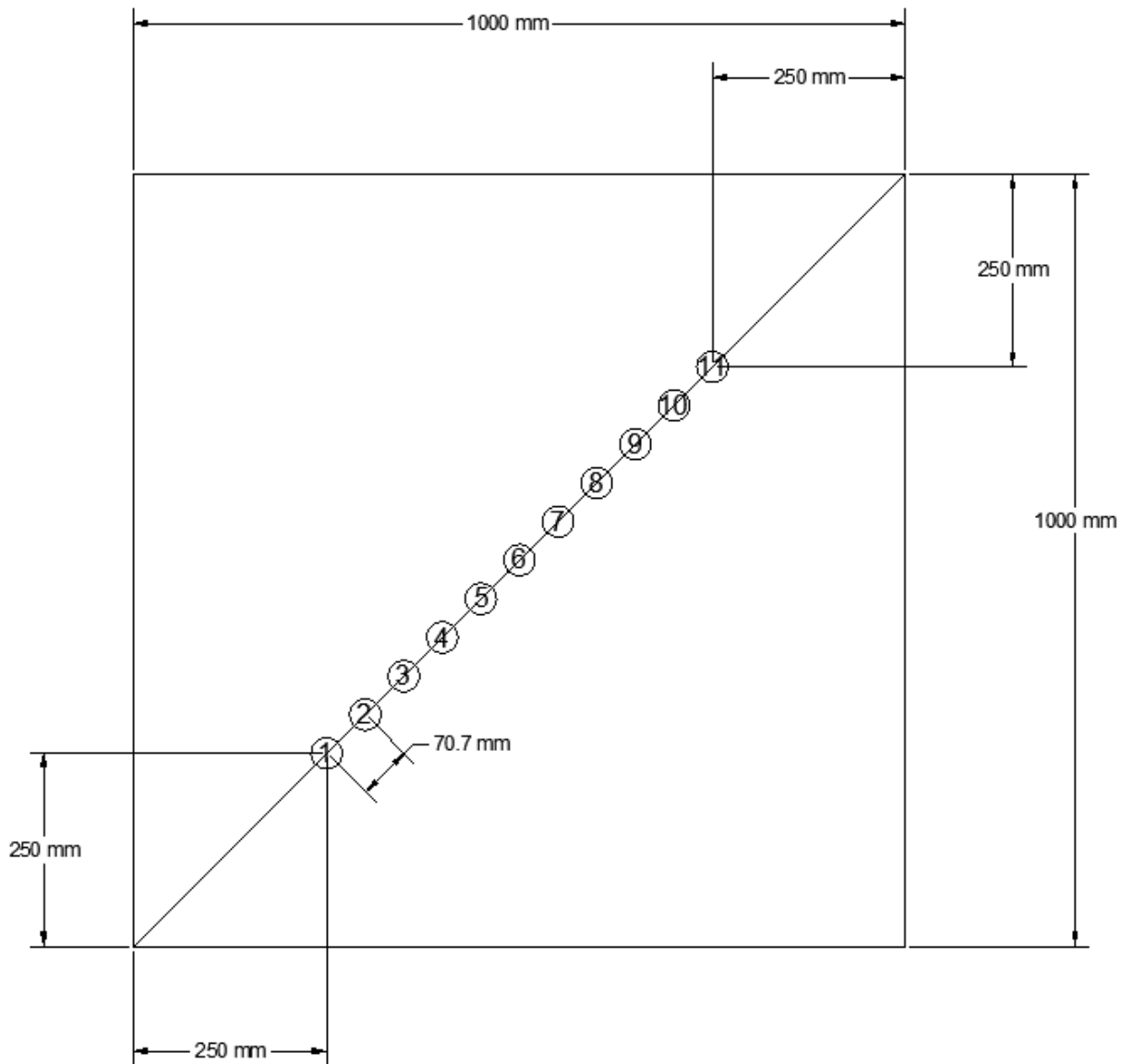


Figure A3: Reading Locations – Flat panel at standard 1000mm x 1000mm size.

As per sections 8.4 and 8.5, Start at Position #1, taking a reading at positions #1 through #6. After reading #6 (center of specimen), the test specimen is removed for an “exposed” sunlight reading. Continue taking readings #7 through #11

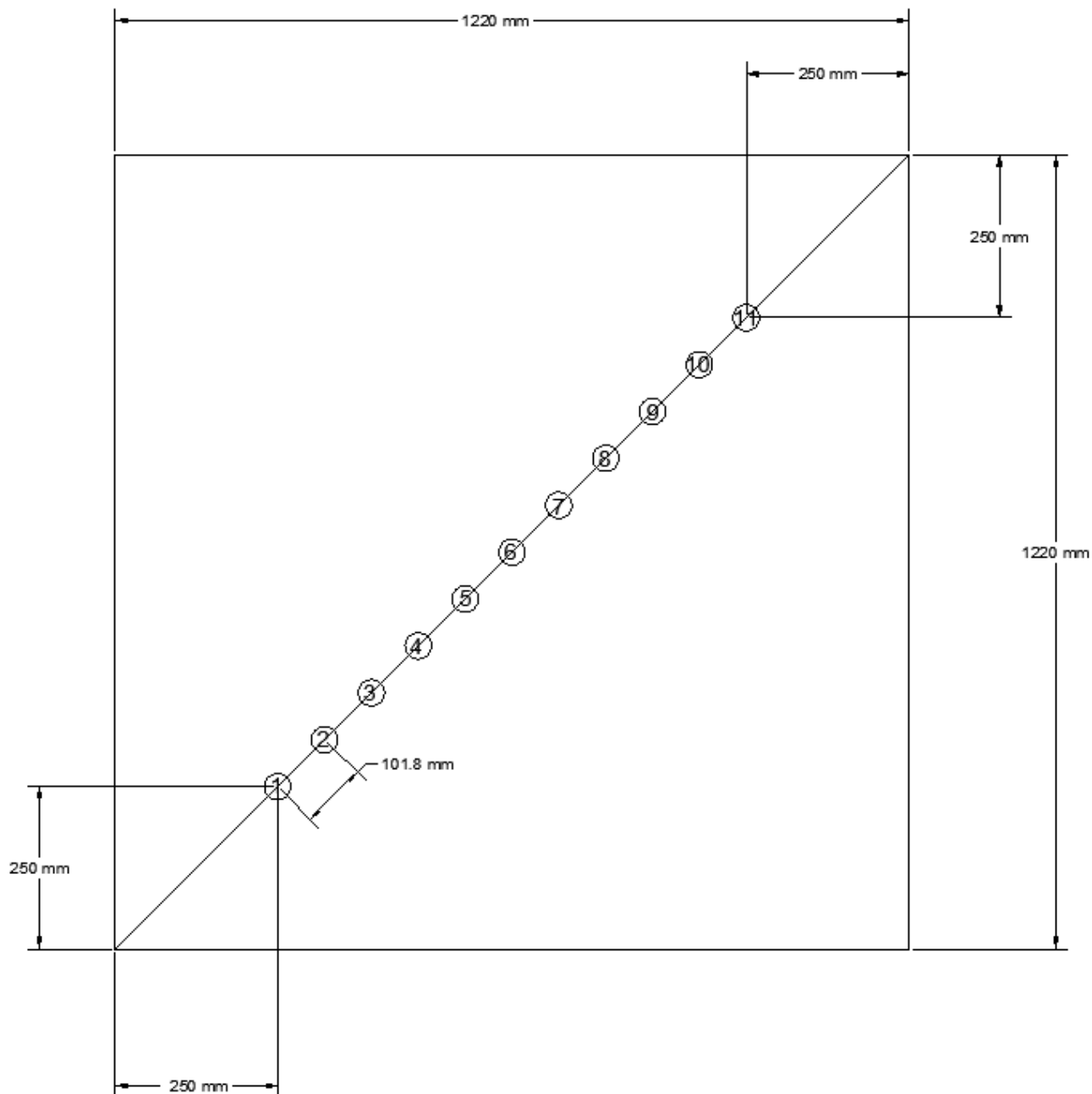


Figure A3.1: Reading Locations – Dome product at standard 1220mm x 1220mm size

As per sections 8.4 and 8.5, Start at Position #1, taking a reading at positions #1 through #6. After reading #6 (center of specimen), the test specimen is removed for an “exposed” sunlight reading. Continue taking readings #7 through #11