Designation: C1199 – 14

Standard Test Method for Measuring the Steady-State Thermal Transmittance of Fenestration Systems Using Hot Box Methods[1]

This standard is issued under the fixed designation C1199; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers requirements and guidelines and specifies calibration procedures required for the measurement of the steady-state thermal transmittance of fenestration systems installed vertically in the test chamber. This test method specifies the necessary measurements to be made using measurement systems conforming to Test Method C1363 for determination of fenestration system thermal transmittance.

NOTE 1—This test method allows the testing of projecting fenestration products (that is, garden windows, skylights, and roof windows) installed vertically in a surround panel. Current research on skylights, roof windows, and projecting products hopefully will provide additional information that can be added to the next version of this test method so that skylight and roof windows can be tested horizontally or at some angle typical of a sloping roof.

1.2 This test method refers to the thermal transmittance, U of a fenestration system installed vertically in the absence of solar radiation and air leakage effects.

NOTE 2—The methods described in this document may also be adapted for use in determining the thermal transmittance of sections of building wall, and roof and floor assemblies containing thermal anomalies, which are smaller than the hot box metering area.

1.3 This test method describes how to determine the thermal transmittance, U_S of a fenestration product (also called test specimen) at well-defined environmental conditions. The thermal transmittance is also a reported test result from Test Method C1363. If only the thermal transmittance is reported using this test method, the test report must also include a detailed description of the environmental conditions in the thermal chamber during the test as outlined in 10.1.14.

1.4 For rating purposes, this test method also describes how to calculate a standardized thermal transmittance, U_{ST}, which can be used to compare test results from laboratories with vastly different thermal chamber configurations, and facilitates the comparison to results from computer programs that use standard heat transfer coefficients to determine the thermal transmittance of fenestration products. Although this test method specifies two methods of calculating the standardized thermal transmittance, only the standardized thermal transmittance result from one method is reported for each test. One standardized thermal transmittance calculation procedure is the Calibration Transfer Standard (CTS) Method and another is the Area Weighting (AW) Method (see Section 9 for further descriptions of these two methods). The Area Weighting method requires that the surface temperatures on both sides of the test specimen be directly measured as specified in Practice E1423 in order to determine the surface heat transfer coefficients on the fenestration product during the test. The CTS Method does not use the measured surface temperatures on the test specimen and instead utilizes the calculation of equivalent surface temperatures from calibration data to determine the test specimen surface heat transfer coefficients. The AW shall be used whenever the thermal transmittance, U_S, is greater than 3.4 W/(m^2·K) [0.6 Btu/(hr·ft^2·°F)], or when the ratio of test specimen projected surface area to wetted (that is, total heat transfer or developed) surface area on either side of the test specimen is less than 0.80. Otherwise the CTS Method shall be used to standardize the thermal transmittance results.

1.5 A discussion of the terminology and underlying assumptions for measuring the thermal transmittance are included.

1.6 The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for information purposes only.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C168 Terminology Relating to Thermal Insulation

[1] This test method is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.30 on Thermal Measurement.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
C1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions
C1114 Test Method for Steady-State Thermal Transmission Properties by Means of the Thin-Heater Apparatus
C1363 Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
E283 Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
E631 Terminology of Building Constructions
E783 Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
E1423 Practice for Determining Steady State Thermal Transmittance of Fenestration Systems

2.2 *ISO Standards:*

ISO 8990 Thermal Insulation-Determination of Steady-State Thermal Transmission Properties—Calibrated and Guarded Hot Box[3]
ISO12567–1 Thermal Insulation—Thermal Performance of Windows and Doors—Determination of Thermal Transmittance by Hot Box Method—Part 1 Complete Windows and Doors[3]
ISO12567–2 Thermal Insulation—Determination of Thermal Transmittance by Hot Box Method—Part 2: Roof Windows and Other Projecting Windows[3]

2.3 *Other Standards:*

NFRC 100 –2004 Procedure for Determining Fenestration Product Thermal U-factors[4]
NFRC 102 –2004 Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems[4]
NFRC 200 –2004 Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence[4]
BS874 Part 3, Section 3.1, 1987, British Standard Methods for Determining Thermal Insulation Properties, (Part 3, Tests for Thermal Transmittance and Conductance, Section 3.1) Guarded Hot Box Method[5]
BS874 Part 3, Section 3.2, 1990, British Standard Methods for Determining Thermal Insulation Properties, Part 3, Tests for Thermal Transmittance and Conductance, Section 3.2 Calibrated Hot Box Method[5]
ASHRAE Handbook-Fundamentals 2009[6]

3. Terminology

3.1 *Definitions*—Definitions and terms are in accordance with definitions in Terminologies E631 and C168, from which the following have been selected and modified to apply to fenestration systems. See Fig. 1 for temperature locations.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *apparent thermal conductance*—A thermal conductance assigned to a material that exhibits thermal transmission by several modes of heat transfer resulting in property variation with specimen thickness, or surface emittance.

3.2.2 *calibration transfer standard, n*—an insulation board with a known measured thermal conductance that is faced with glazing, and instrumented with temperature sensors either between the glazing and the insulation board core or on the exterior surface of the glazing, which is used to calibrate the surface resistances and the surround panel (see Annex A1 for design guidelines for Calibration Transfer Standards).

3.2.3 *projecting products, n*—a non-planar product where the glazing projects outward past the cold side surround panel surface plane (that is, skylights, garden windows).

3.2.4 *standardized thermal transmittance, n*—U_{ST}, the heat transmission in unit time through unit area of a test specimen and standardized boundary air films, induced by unit temperature difference between the environments on each side.

3.2.5 *surface heat transfer coefficient, n*—*h*, (sometimes called *surface conductance* or *film coefficient.*) the time rate of heat flow from a unit area of a surface to its surroundings, induced by a unit temperature difference between the surface and the environment.

3.2.6 *surround panel (*sometimes called the *mask, mask wall,* or *homogeneous wall), n*—a homogeneous panel with an opening where the Calibration Transfer Standard or the test specimen is installed. When there is no test specimen aperture, or the opening is filled with the same thickness of surround panel assembly, it is called a characterization panel. (see 5.1.1.1, and Annex A11 of Test Method C1363 for a description of surround panels and characterization panels.)

3.2.7 *test specimen, n*—the fenestration system or product being tested.

3.2.8 *thermal transmittance, n*—U_S (sometimes called the overall coefficient of heat transfer) the heat transfer in unit time

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[4] Available from National Fenestration Rating Council, 6305 Ivy Lane, Suite 140, Greenbelt, MD 20770.
[5] Available from British Standards Institute (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., http://www.bsi-global.com.
[6] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.

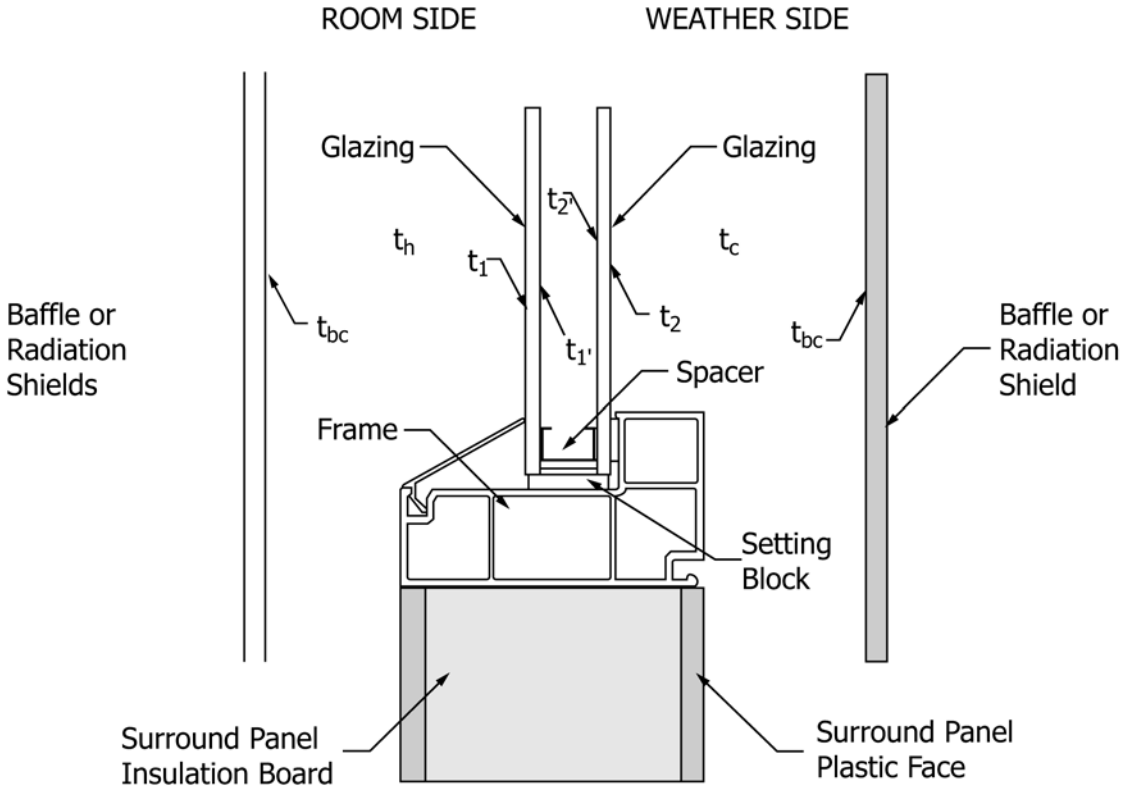

FIG. 1 Schematic Representation of Various Temperatures for Fenestration Systems

through unit area of a test specimen and its boundary air films, induced by unit temperature difference between the environments on each side.

3.3 *Symbols*—The symbols, terms, and units used in this test method are as follows:

A_h = total heat transfer (or developed) surface area of test specimen on room side, m^2,

A_c = total heat transfer (or developed) surface area of test specimen on weather side, m^2,

A_{b1} = area of room side baffle and all other surfaces in view of the test specimen, m^2,

A_{b2} = area of weather side baffle and all other surfaces in view of the test specimen, m^2,

A_S = projected area of test specimen (same as test specimen aperture in surround panel), m^2,

A_{sp} = projected area of surround panel (does not include test specimen aperture in surround panel), m^2,

α = absorptance of surface,

C_g = apparent thermal conductance of glass or acceptable transparent plastic facing on calibration transfer standard, $W/(m^2 \cdot K)$,

C_{sp} = apparent thermal conductance of surround panel (surface to surface), $W/(m^2 \cdot K)$, determined by means of Practice C1045 used with either Test Method C177, Test Method C518 or Test Method C1114,

$C_{ts[core]}$ = apparent thermal conductance of calibration transfer standard core, $W/(m^2 \cdot K)$, determined by means of and Practice C1045 used with either Test Method C177, Test Method C518 or Test Method C1114

$C_{ts[assembly]}$ = apparent thermal conductance of calibration transfer standard assembly, $W/(m^2 \cdot K)$, determined by means of Practice C1045 used with either Test Method C177 and Test Method C518 or Test Method C1114.

ε = total hemispherical emittance of surface,

h_{STh} = standardized surface heat transfer coefficient, room side, $(W/m^2 \cdot K)$,

h_{STc} = standardized surface heat transfer coefficient, weather side, $(W/m^2 \cdot K)$,

h_h = surface heat transfer coefficient, room side, $W/(m^2 \cdot K)$,

h_c = surface heat transfer coefficient, weather side, $W/(m^2 \cdot K)$,

K_c = convection coefficient, $W/(m^2 \cdot K^{1.25})$,

L = length of heat flow path, m,

Q = time rate of heat flow through the total surround panel/test specimen system, W,

Q_c = time rate of convective heat flow from test specimen surface, W,

Q_{fl} = time rate of flanking loss heat flow around surround panel, W,