



Designation: E 1423 – 99

Standard Practice for Determining Steady State Thermal Transmittance of Fenestration Systems¹

This standard is issued under the fixed designation E 1423; 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 practice covers standard test specimen sizes and test conditions as well as the calculation and presentation of the thermal transmittance and conductance data measured in accordance with Test Method C 1199. The standard sizes and conditions are to be used for fenestration product comparison purposes. The specifier may choose other sizes and conditions for product development or research purposes.

1.2 This practice deals with the determination of the thermal properties of a fenestration system installed vertically in the absence of solar heat gain and air leakage effects.

NOTE 1—To determine air leakage effects of fenestration systems, Test Method E 283 or E 1424 should be referenced.

1.3 This practice specifies the procedure for determining the standardized thermal transmittance of a fenestration test specimen using specified values of the room-side and weather-side surface heat transfer coefficients, h_h and h_c , respectively.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other.

1.5 *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:

C 168 Terminology Relating to Thermal Insulating Materials²

C 1199 Test Method for Measuring the Steady State Thermal Transmittance of Fenestration Systems Using Hot Box Methods²

C 1363 Test Method for Thermal Performance of Building

Assemblies by Means of a Hot Box Apparatus²

E 283 Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen³

E 631 Terminology of Building Constructions³

E 783 Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors³

E 1424 Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure and Temperature Differences Across the Specimen³

3. Terminology

3.1 *Definitions*—Definitions and terms are in accordance with Terminology E 631 and C 168, from which the following have been selected and modified to apply specifically to fenestration systems. See Fig. 1 and Fig. 2 for variable identification. (For further information on definitions and procedures, see Appendix X1 or Test Method C 1199.)

3.1.1 *surface heat transfer coefficient, 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. Subscripts are used to differentiate between room-side (1 or r) and weather-side (2 or c) surface heat transfer coefficients (see Fig. 1 and Fig. 2).

3.1.2 *test specimen thermal transmittance U_s* (sometimes called *overall coefficient of heat transfer*)—the heat transfer in unit time through unit area of a test specimen and its boundary air films, induced by unit temperature difference between the environments on each side.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *overall thermal resistance, R_s* —the temperature difference between the environments on the two sides of a body or assembly when a unit heat flow per unit time per unit area is established through the body or assembly under steady-state conditions. It is defined as follows:

$$R_s = \frac{1}{U_s} \quad (1)$$

¹ This guide is under the jurisdiction of ASTM Committee E-6 on Performance of Buildings and is the direct responsibility of Subcommittee E06.51 on Component Performance of Windows, Curtain Walls, and Doors.

Current edition approved Oct. 10, 1999. Published March 2000. Originally published as E 1423 – 91. Last previous edition E 1423 – 91.

² Annual Book of ASTM Standards, Vol 04.06.

³ Annual Book of ASTM Standards, Vol 04.11.

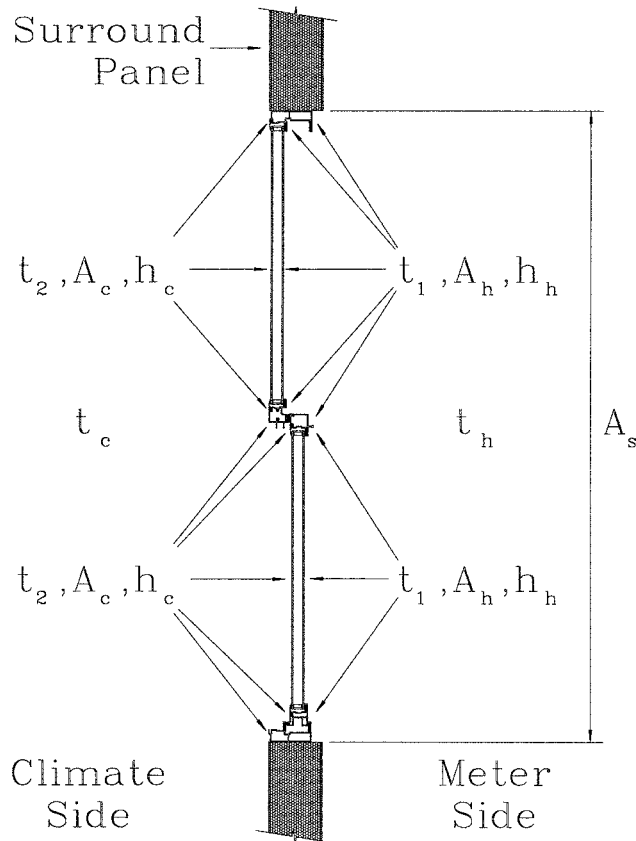


FIG. 1 Window Mounted Flush with Climate Side of Surround Panel

where:

R_S = overall thermal resistance of specimen (air to air under test conditions), $m^2 \cdot K/W$ ($ft^2 \cdot hr \cdot ^\circ F/Btu$).

3.2.2 *standardized thermal transmittance, U_{ST}* —the heat transfer in unit time through unit area of a specimen (using standardized surface heat transfer coefficients) induced by unit temperature difference between the environments on each side.

3.2.3 *surround panel* (sometimes called the *mask*, *mask wall*, or *homogeneous wall*)—a homogeneous wall in which the test specimen is mounted.

3.2.4 *test specimen*—the fenestration system or product being tested.

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

A_c total heat transfer surface area of test specimen on weather side, m^2

A_h total heat transfer surface area of test specimen on room side, m^2

A_s projected area of test specimen, (same as open area in surround panel), m^2

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

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

R_S overall thermal resistance of test specimen (air to air under test conditions), $m^2 \cdot K/W$

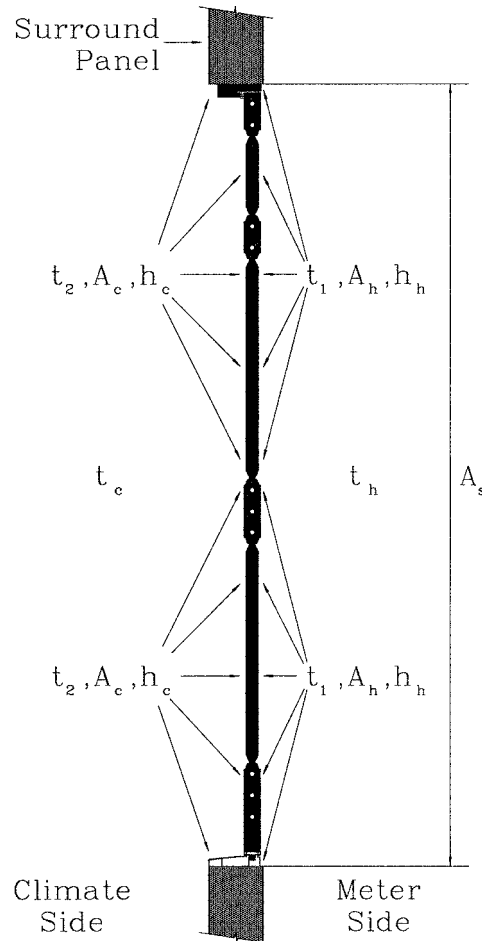


FIG. 2 Door Mounted Flush with Climate Side of Surround Panel

t_c average temperature of weather side air, $^\circ C$

t_h average temperature of room side air, $^\circ C$

t_1 average temperature of test specimen, room side surface, K or $^\circ C$

t_2 average temperature of test specimen, weather side surface, K or $^\circ C$

U_S thermal transmittance of test specimen (air to air under test conditions), $W/(m^2 \cdot K)$

U_{ST} standardized thermal transmittance of test specimen, $W/(m^2 \cdot K)$

4. Significance and Use

4.1 This practice details the test specimen sizes and test conditions, namely, the room-side and weather-side air temperatures, and the air velocities on both sides of the test specimen, when testing fenestration products in accordance with Test Method C 1199.

4.2 The thermal transmittance and conductance of a specimen are affected by its size and three-dimensional geometry. Tests should therefore be conducted using the specimen sizes recommended in 5.1. Should the specimen size differ from those given in 5.1, the actual size shall be reported in the test report.

4.3 Many factors can affect the thermal performance of a fenestration system, including deflections of seals during

units. Care should be exercised to maintain the original physical condition of the fenestration system and to install it in the surround panel to simulate actual installation.

4.4 The thermal transmittance and conductance results obtained do not reflect performances expected from field installations since they do not account for solar radiation and air leakage effects. The thermal transmittance and conductance results are taken from specified laboratory conditions and should be used only for fenestration product comparisons and as input to thermal performance analyses that also include solar and air leakage effects.

5. Test Specimen

5.1 *Specimen Sizes*—The specimen sizes given in [Table 1](#) for different types of fenestration systems shall be used when testing fenestration products where the results will be used for product comparison purposes. All dimensions given are $\pm 5\%$ or ± 100 mm (4 in.), whichever is less.

6. Test Conditions

6.1 *General*—A single set of test conditions does not necessarily define the thermal characteristics of a fenestration system. However, a single set of test conditions is specified to permit comparison of the thermal transmittance of different fenestration products. Thermal transmittance values obtained under this set of test conditions have been shown to be valid for the range of weather conditions typical of the North American climate [weather-side temperatures between 43 and -30°C (110 and -22°F) and wind speeds up to 6.7 m/s (15 mph)].

6.2 *Test Conditions for U-Values for Comparison Purposes*—The test specimen shall be tested in accordance with Test Method [C 1199](#). For comparison purposes, the following set of conditions shall be used (see [Fig. 1](#)):

$$t_h = 21 \pm 1^{\circ}\text{C} (70 \pm 2^{\circ}\text{F}) \quad (2)$$

$$t_c = -18 \pm 1^{\circ}\text{C} (0 \pm 2^{\circ}\text{F}) \quad (3)$$

6.2.1 *Room Side (Natural Convection)*—The air velocity should be less than 0.3 m/s (60 ft/min). For comparison purposes, the standard surface heat transfer coefficient measured on the room side of each calibration transfer standard (CTS) during calibration shall be:

$$h_c = 7.0 \text{ W}/(\text{m}^2\cdot\text{K}) + 10\% (1.2 \text{ Btu}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F}) + 10\%) \quad (4)$$

$$[\text{allowed CTS calibration range of } 7.0 \text{ to } 7.7 \text{ W}/(\text{m}^2\cdot\text{K}) \\ (1.2 \text{ to } 1.3 \text{ Btu}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F}))]$$

Since this is the natural convection lower limit of the indoor side overall surface heat transfer coefficient, a + 10 % variation in this value is allowed to accommodate some forced convection due to small room side air circulation fans that provide a more uniform flow distribution on the indoor side of the CTS.

NOTE 2—Using the 1997 American Society for Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Fundamentals Handbook (1)⁴, Fenestration Chapter 29, Table 3, the indoor side of the overall combined natural convection, radiation heat transfer coefficient for a

1.22-m (4-ft) high, 13-mm (0.5-in.) wide cavity, double glazed, low emittance glazing unit is $6.98 \text{ W}/(\text{m}^2\cdot\text{K})$ ($1.23 \text{ Btu}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F})$). For a 1.22-m (4-ft) high, 12.7-mm (0.5-in.) thick high density expanded polystyrene (EPS) foam core CTS with two 4-mm (0.16-in.) glass faces, the indoor side calculated overall combined natural convection, radiation heat transfer coefficient is $7.02 \text{ W}/(\text{m}^2\cdot\text{K})$ ($1.24 \text{ Btu}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F})$), using the same methods and equations that were used to obtain the ASHRAE Chapter 27, Table 3 results. Rounding off these two results gives a nominal standardized surface heat transfer coefficient of $7.0 \text{ W}/(\text{m}^2\cdot\text{K})$ ($1.23 \text{ Btu}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F})$), which is the lower limit for natural convection for this size of CTS.

6.2.2 *Weather-side*—For comparison purposes, the standard surface heat transfer coefficient measured on the weather side of each CTS shall be (perpendicular or parallel):

$$h_c = 29.0 \text{ W}/(\text{m}^2\cdot\text{K}) - 10\% (5.1 \text{ Btu}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F}) - 10\%) \quad (5)$$

$$[\text{allowed CTS calibration range of } 26.0 \text{ to } 29.0 \text{ W}/(\text{m}^2\cdot\text{K}) \\ (4.6 \text{ to } 5.1 \text{ Btu}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F}))]$$

NOTE 3—Again, referring to the 1997 ASHRAE Fundamentals Handbook (1), Fenestration Chapter 29, the recommended design value for the weather side overall combined forced convection, radiation heat transfer coefficient for a nominal 24 km/h (15 mph) wind speed is $h_c = 29.0 \text{ W}/(\text{m}^2\cdot\text{K})$ ($5.1 \text{ Btu}/(\text{hr}\cdot\text{ft}^2\cdot^{\circ}\text{F})$).

7. Test Specimen Installation and Instrumentation

7.1 Test Specimen Installation:

7.1.1 *Surround Panel*—A surround panel shall be provided for installation of the test specimen similar to that shown in [Fig. 1](#) (see the description in Test Method [C 1199](#)).

7.1.2 *Test Specimen*—The fenestration system to be tested shall be installed in the surround panel as shown in [Figs. 1 and 2](#) for windows and doors. That is, the complete assembly, including all frame elements and operating hardware, shall be in place during the test. Accessory interior or exterior devices, such as trim or insect screens, shall be removed before testing. The test specimen shall be mounted so that it is centered in the metering area of the surround panel, and the frame on the cold side of the fenestration product shall be flush with the weather side of the surround panel. The specimen shall be fixed securely in a plane parallel to the surround panel surfaces, suitable for any wind loads experienced during testing. The installation shall also allow space to accommodate all sash or operating members, or both. If the fenestration system does not fill the opening in the surround panel completely, the space between the surround panel and the fenestration system shall be filled with material of similar thermal conductance to that of the surround panel. Perimeter joints between the specimen and the surround panel shall be sealed on both sides of the wall. In no case shall the tape or caulk cover more than 13 mm (0.50 in.) of the test specimen frame or edge.

7.1.3 *Air Leakage*—All potential air leakage sites on the test specimen, on the surround panel, and at the interface between the surround panel and the test specimen must be sealed with nonmetallic tape or caulking, or both, as close to the primary seal as possible to minimize or eliminate air leakage between the room side and weather side chambers. The thermal performance can be affected by the method and placement of the test specimen air seal. Therefore, the test specimen is to be sealed at the primary seal of the test specimen with tape, caulking, or other material of similar surface emissivity to that of the

⁴ Available from American Society of Heating, Refrigeration, and Air-Conditioning Engineers, 1791 Tullie Circle N.E., Atlanta, GA 30329.