Designation: ~~E283 – 04 (Reapproved 2012)~~ E283/E283M – 19

Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen[1]

This standard is issued under the fixed designation ~~E283;~~E283/E283M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers a standard laboratory procedure for determining the air leakage rates of exterior windows, skylights, curtain walls, and doors under specified differential pressure conditions across the specimen. The test method described is for tests with constant temperature and humidity across the specimen. Persons interested in performing air leakage tests on units exposed to various temperature differences across the specimen should reference Test Method E1424.

1.2 This laboratory procedure is applicable to exterior windows, skylights, curtain walls, and doors and is intended to measure only such leakage associated with the assembly and not the installation. The test method can be adapted for the latter purpose.

NOTE 1—Performing tests ~~at non-ambient~~under uncontrolled conditions or with a temperature differential across the specimen may affect the air leakage rate. This is not addressed by this test method.

1.3 This test method is intended for laboratory use. Persons interested in performing field air leakage tests on installed units should reference Test Method E783.

1.4 Persons interested in evaluating air permeance of building materials should reference Test Method E2178.

1.5 Persons interested in determining air leakage of air barrier assemblies should reference Test Method E2357.

1.6 Persons using this procedure should be knowledgeable in the areas of fluid mechanics, instrumentation practices, and shall have a general understanding of fenestration products and components.

1.7 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values ~~given~~stated in ~~parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.~~each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.8 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statement, see Section 7.

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

E783 Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors

E1424 Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure and Temperature Differences Across the Specimen

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.51 on Performance of Windows, Doors, Skylights and Curtain Walls.

Current edition approved ~~April 1, 2012~~Aug. 1, 2019. Published ~~May 2012~~September 2019. Originally approved in 1965. Last previous edition approved in ~~2004~~2012 as ~~E283 – 2004.~~E283–04(2012). DOI: ~~10.1520/E0283-04R12.~~10.1520/E0283_E0283M–19.

[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.

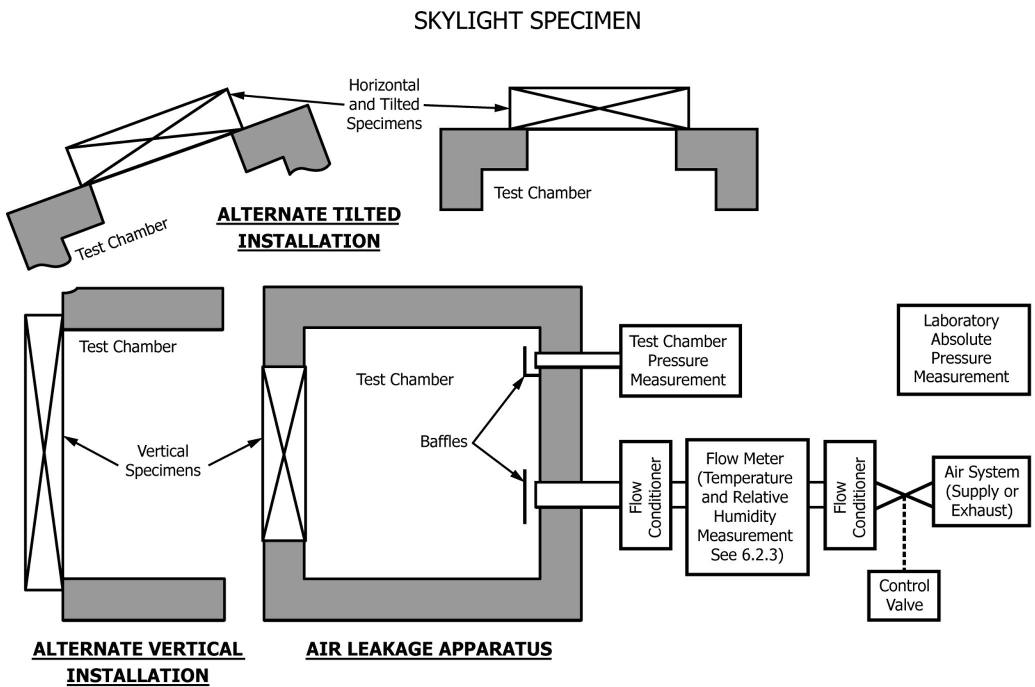

FIG. 1 General Arrangement of the Air Leakage Apparatus

E2178 Test Method for Air Permeance of Building Materials
E2357 Test Method for Determining Air Leakage Rate of Air Barrier Assemblies
2.2 *ISO Standard:*[3]
ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories

3. Terminology

3.1 *Definitions*—Terms used in this ~~standard~~ test method are defined in Terminology E631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *air leakage rate (q_A or q_l), L/(s·m²) ~~(ft)~~ [ft³/min·ft²~~)~~], or L/(s·m) ~~(ft~~[ft³~~/min·ft) —~~/min·ft]*—the air leakage per unit of specimen area (A) or per unit length of operable crack perimeter (l).

3.2.2 *extraneous air leakage (Q_e), m³/s ~~(ft~~[ft³~~/min)—~~/min]*—the volume of air flowing per unit of time through the test chamber and test apparatus, exclusive of the air flowing through the test specimen, under a test pressure difference and test temperature difference, converted to standard conditions.

3.2.2.1 *Discussion*—

Extraneous leakage is the sum of all leakage other than that intended to be measured by the test.

3.2.3 *skylight*—for the purposes of this test method, skylights include roof windows, sloped glazing, tubular daylighting devices (TDDs), and units skylights.

3.2.4 *specimen*—the entire assembled unit submitted for test as described in Section 7.

3.2.5 *specimen air leakage (Q_s), L/s ~~(ft~~[ft³~~/min)—~~/min]*—the volume of air flowing per unit of time through the specimen under a test pressure difference and test temperature difference, converted to standard conditions.

3.2.6 *specimen area (A), m² ~~(ft~~[ft²~~)—~~]*—the area determined by the overall dimensions of the frame that fits into the rough opening.

3.2.7 *standard ~~test~~ conditions*—in this test method, dry air at:

~~Pressure—101.3 kPa (29.92 in. Hg)~~
~~Temperature—20.8°C (69.4°F)~~
~~Air Density—1.202 kg/m³ (0.075 lbm/ft³)~~

[3] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.

Pressure—101.3 kPa [29.92 in. Hg]
Temperature—20.8 °C [69.4 °F]
Air Density—1.202 kg/m³ [0.075 lbm/ft³]

3.2.8 *test pressure differences, Pa ~~(lbf/ft[lbf/ft²) —]~~*—the specified differential static air pressure across the specimen.

3.2.9 *total air flow (Q_t), L/s ~~(ft[ft³/min) —/min]~~*—the volume of air flowing per unit of time through the test chamber and test apparatus, inclusive of the air flowing through the test specimen, under a test pressure difference and test temperature difference, converted to standard conditions.

3.2.10 *unit length of operable crack perimeter (l), m ~~(ft)—[ft]~~*—the sum of all perimeters of operable ventilators, sash, or doors contained in the test specimen, based on the overall dimensions of such parts. Where two such operable parts meet the two adjacent lengths of perimeter shall be counted as only one length.

4. Summary of Test Method

4.1 The test consists of sealing a test specimen into or against one face of an air chamber, supplying air to or exhausting air from the chamber at the rate required to maintain the specified test pressure difference across the specimen, and measuring the resultant air flow through the specimen. Measurements of the resultant air flow are adjusted to standard conditions.

5. Significance and Use

5.1 This test method is a standard procedure for determining the air leakage characteristics under specified air pressure differences at ambient conditions.

NOTE 2—The air pressure differences acting across a building envelope vary greatly. The factors affecting air pressure differences and the implications or the resulting air leakage relative to the environment within buildings are discussed in the literature.[4-6] These factors should be fully considered in specifying the test pressure differences to be used.

5.2 Rates of air leakage are sometimes used for comparison purposes. Such comparisons may not be valid unless the components being tested and compared are of essentially the same size, configuration, and design.

6. Apparatus

6.1 The description of the apparatus in this section is general in nature. Any suitable arrangement of equipment capable of maintaining the required test tolerances is permitted. (See Fig. 1.)

6.2 *Test Chamber*—A well sealed box, wall, or other apparatus into or against which the specimen is mounted and secured for testing. An air supply shall be provided to allow a positive or negative pressure differential to be applied across the specimen without significant extraneous losses. The chamber shall be capable of withstanding the differential test pressures that may be encountered in this procedure. At least one static air pressure tap shall be provided on each side of the specimen to measure the test pressure differences. The pressure tap shall be located in an area of the chamber in which pressure readings will not be affected by any supply air. The air supply opening to the chamber shall be located in an area in which it does not directly impinge upon the test specimen.

6.2.1 *Supply Air System*—A controllable blower, exhaust fan, or reversible blower designed to provide the required air flow at the specified test pressure difference. The system should provide essentially constant air flow at the specified test pressure difference for a time period sufficient to obtain readings of air flow. The inlet into the chamber (sealed box) shall be located or be shielded with a baffle so that the air flow is not directed upon the test specimen.

6.2.2 *Pressure Measuring Apparatus*—A device to measure the differential test pressures to ±2 % of ~~setpoint~~ set point or ±2.5 Pa ~~(±0.01~~[±0.01 in. of water ~~column);~~column], whichever is greater.

6.2.3 *Air Flow Metering System*—A device to measure the air flow ~~into~~ to ±5 % into/out of the test chamber or through the test specimen. Typically air flow is measured using a mass flow meter or volumetric flow meter. Methods to adjust volumetric flow meter measurements to standard conditions are included in Section 12.

6.2.4 *Air Temperature Measurement Apparatus*—A device to measure the temperature of the air to ±0.5 K at the flow meter. This device may be built-in or integral to the flow meter.

6.2.5 *Absolute Pressure Measurement Apparatus*—A device to measure the absolute pressure to ±2 % within the laboratory.

[4] ~~Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329, http://www.ashrae.org.~~*ASHRAE Handbook of Fundamentals*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), Atlanta, GA, 2013.

[5] *Fluid Meters—Their Theory and Application*, 5th Edition, American Society of Mechanical Engineers (ASME), New York, NY, 1959.

[6] ~~Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.~~*Power Test Code*, 2nd Edition, Part 5, Chapter 4 Flow Measurements, American Society of Mechanical Engineers (ASME), New York, NY, 1956.

6.2.6 *Relative Humidity Measurement Apparatus*—A device to measure the relative humidity of the air to ±2 % RH at the flow meter or at a location where no change in the moisture content can occur between the flow meter and the relative humidity sensor. This device may be built-in or integral to the flow meter.

7. Hazards

7.1 **Precaution**—Glass —Glazing infill breakage may occur at the test pressure differences applied in this test. Adequate precautions should be taken to protect personnel.

8. Test Specimen

8.1 The test specimen for a wall shall be of sufficient size to determine the required performance of all typical parts of the wall system. For curtain walls walls, sloped glazing, or walls constructed with prefabricated units, units or components, the specimen width shall be not less than two typical units plus the connections and supporting elements at both sides, and sufficient to provide full loading on at least one typical vertical joint or framing member, or both. The height shall be not less than the full building story height or the height of the unit, whichever is greater, and shall include at least on full horizontal joint, accommodating vertical expansion, such joint being at or near the bottom of the specimen, as well as all connections at top and bottom of the units.

8.1.1 For curtain wall specimens, the height shall be not less than the full building story height or the height of the unit, whichever is greater, and shall include at least one full horizontal joint, accommodating vertical expansion, such joint being at or near the bottom of the specimen, as well as all connections at top and bottom of the units. All parts of the wall test specimen shall be full size using the same materials, details, and methods of construction and anchorage as used on the actual building.

8.1.2 Conditions of structural support shall be simulated as accurately as possible.

8.2 The test specimen for a window, skylight, door, or other component shall consist of the entire assembled unit, including product frame and anchorage type and location as supplied by the manufacturer for installation in the building. If only one specimen is to be tested the selection shall be determined by the specifying authority.

NOTE 3—The air leakage rate is likely to be a function of size and geometry of the specimen.

9. CalibrationValidation

9.1 CalibrationValidation shall be performed by mounting a plywood or similar ridge blankrigid panel to the test chamber in place of a test specimen, using the same mounting procedures as used for standard specimens. The blankpanel shall be 19 ± 3 mm ([¾ ± ⅛ in.) thick with a 150-mm (6-in.) diameter hole(s) over which NIST traceable orifice plates shall be mounted. The blank in.] thick. The edge of the aperture supporting the orifice plate shall not be less than 50 mm [2 in.] from the nearest edge of the aperture in the orifice plate. The overall dimension of the orifice plates shall sufficiently overlap the supporting aperture to enable adequate sealing. The panel shall be attached to a minimum 140 mm (5 [5½ in.)in.] deep (nominal[nominal 2 × 6)by 6] pine test frame (buck) with dimensions 1220 mm wide by 1830 mm high (4[4 ft wide by 6 ft high).high]. The test frame and blankpanel shall be sealed at all joints.

9.2 Each NIST traceable orifice plate shall be constructed of 3 mm ([⅛ in.)in.] thick stainless steel having an outside diameter of 200 mm (8 in.) dimension sufficient to cover the aperture of the panel as specified in 9.1, and interior square edge diameters of 25.40 mm (1.000 in.), 38.10 mm (1.500 in.), and 50.80 mm (2.000 in.).the orifices are 6.35 mm [0.250 in.], 12.70 mm [0.500 in.], 25.40 mm [1.000 in.], 38.10 mm [1.500 in.], 50.80 mm [2.000 in.], and 63.50 mm [2.500 in.] as needed. The dimensions of the orifice plate shall be National Institute of Standards and Technology (NIST) traceable or verified by an ISO/IEC 17025 accredited calibration laboratory.

9.3 Fasten the orifice plate to the blank,panel, centered over a 150-mm (6-inch) diameter hole. the panel aperture. Seal the hole in the orifice plate with a suitable adhesive tape so that an extraneous reading on the air flow system can be obtained. Measure the amount of such leakage with the orifice plate sealed, at the air pressure difference to be appliedas referenced in 10.1.2during calibration. . After determining the extraneous leakage, remove the adhesive tape from the hole in the orifice plate and repeat the process to determine the total measured flow. The measured air flows shall be corrected to standard conditions (see Section 12.)

9.4 CalibrationValidation of the air leakage test equipment shall consist of determining the flow through the air flow system to be calibratedvalidated using all applicable orifice plate sizes for the design range of the flow metering apparatus. The orifice plate to be used for each of the followingcorresponding air flow ranges is indicated in Table 1. When needed, additional orifice plate sizes may be used to adequately cover the air flow system measuring range outside of Table 1 nominal flow ranges. It is also allowed to use other means of validation for the air leakage equipment given that it can be demonstrated that the alternative method yields accuracy of validation equal to or exceeding that of the orifice plate method. For ranges of nominal flow between 3.47 L/s [7.36 ft^3/min] to 21.33 L/s [45.20 ft^3/min], the use of the corresponding orifice plates referenced in Table 1 is mandatory.

NOTE 3—Three A minimum of three orifice plates are used to allow the air flow measuring equipment to be used for a variety of specimen sizes and chamber/wall setups.

NOTE 4—At test pressure other than 75 Pa (1.57 psf),[1.57 psf], the laboratory shall calibratevalidate the airflow measuring equipment with the applicable orifice plates and record the measurements at the specified pressure(s). Using pressures greater than 75 Pa (1.57 psf)[1.57 psf] may not permit