Designation: E2357 – 24

Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies[1]

This standard is issued under the fixed designation E2357; 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 the determination of the air leakage rate of air barrier assemblies that are used in building enclosures. This procedure measures the air leakage of a representative air barrier assembly before and after exposure to specific conditioning cycles and then assigns a rating dependent upon the results. Although this is a laboratory procedure, the method may also be applied to site mockups.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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]

E283 Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

E330/E330M Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference

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, Skylights, Curtain Walls, and Doors Under Specified Pressure and Temperature Differences Across the Specimen

E1677 Specification for Air Barrier (AB) Material or Assemblies for Low-Rise Framed Building Walls

E2178 Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of general terms related to building construction used in this test method, refer to Terminology E631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *air barrier*—a designated "plane" of reduced air flow between different environments.

3.2.2 *air barrier accessory*—a transitional component of the air barrier that provides continuity.

3.2.3 *air barrier assembly*—the air barrier materials and accessories that provide a continuous designated plane to the movement of air through portions of building enclosure assemblies.

3.2.4 *air barrier material*—a primary element that provides a continuous barrier to the movement of air.

3.2.5 *air barrier system*—a combination of air barrier assemblies installed to provide a continuous barrier to the movement of air through building enclosures.

3.2.6 *air leakage rate*—the quantitative measure of air passage through a set surface area of an assembly within a given time period under a pressure differential between the two sides of the assembly.

3.2.7 *building enclosure*—a system of building components and materials designed and installed in such a manner as to provide a barrier between different environments, including dissimilar interior environments.

3.2.8 *continuity*—an uninterrupted succession of air barrier materials, accessories, and assemblies.

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.41 on Air Leakage and Ventilation Performance.

Current edition approved Jan. 1, 2024. Published February 2024. Originally approved in 2005. Last previous edition approved in 2023 as E2357 – 23a. DOI: 10.1520/E2357-24.

[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.

3.2.9 *durability*—the ability of a building component to perform its required functions over a period of time within the environment to which it is exposed.

3.2.10 *negative pressure*—air pressure on one side of a building enclosure lower than on the other side.

3.2.11 *positive pressure*—air pressure on one side of a building enclosure higher than on the other side.

4. Summary of Test Method

4.1 This test method establishes a specimen preparation protocol with which an air barrier assembly may be evaluated. A test specimen is constructed and tested in separate pressures. Up to three specimens are constructed, each additionally representing different field conditions. Specimen 3 is optional and may be combined with Specimen 2. By applying air pressure differentials across the specimens in stages, the air barrier and system components may be evaluated as to their specific air leakage.

5. Significance and Use

5.1 This method is intended to simulate the performance of various air barrier materials/accessories when combined into an assembly. Based upon the results of the measurements, this procedure then assigns an air leakage rating for the air barrier assembly.

5.2 This method does not purport to establish all criteria necessary for consideration in the selection of an air barrier assembly. The results are intended to be used for comparison purposes and may not represent the field installed performance of the air barrier assembly when installed as part of an air barrier system in a building. However, the results of these tests may be useful in determining the appropriate use of a specified air barrier system assembly.

5.3 This method does not purport to establish all criteria necessary for air barrier systems of all construction types. Test Method E2178 provides an air permeance test method for testing of some air barrier materials. Specification E1677 provides a specification for air barrier systems for low-rise framed building walls.

6. Sampling

6.1 For each air barrier assembly, up to three specimens shall be tested as described in Annex A1. The proponent may elect not to prepare and test specimen three or combine the details of Specimen 3 with Specimen 2.

7. Test Apparatus

7.1 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.

7.2 *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.

7.2.1 *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 and cyclic loads at the specified test pressure difference for a time period sufficient to obtain readings of air flow.

7.2.2 *Pressure Measuring Apparatus*—A device to measure the differential test pressures to ±2 % of setpoint or ±2.5 Pa, whichever is greater.

7.2.3 *Air Flow Metering System*—A device to measure the air flow into the test chamber or through the test specimen.

7.3 This test method is intended for laboratory use. Persons interested in performing field air leakage tests on air barrier assemblies should reference Test Method E783.

8. Sample Preparation

8.1 *Air Leakage and Structural Performance Tests:*

8.1.1 As the air barrier assembly is site-assembled, the specimens tested shall be representative of the site assembly. Therefore the test specimens shall be fabricated as prescribed by the proponent in providing for the specimen construction required herein.

8.2 *Air Leakage and Structural Performance Test Specimens:*

8.2.1 This test method specifies a minimum of (2) specimens for testing. Annex A2 describes the requirements of the test specimens. To meet these requirements, one specimen shall be an opaque wall (Fig. A1.1) and one specimen shall have penetrations, terminations and connections as outlined in Annex A2, Fig. A1.2. The test specimens are to be conditioned prior to being submitted to the structural performance qualification test program and subsequently, to the air leakage rate procedure. Photographs are to be taken of original test specimens including joining details.

8.3 *Conditioning for Tests:*

8.3.1 Unless otherwise stated, the specimens shall be tested "as received." No modifications to the proponents' assembly instructions are permitted.

8.3.2 If the evaluation of the aged performance of the air barrier assemblies is desired by the proponent, the specimens may be conditioned prior to testing by exposure, ultraviolet radiation or thermal cycling, or both.

9. Test Procedure

9.1 *Air Leakage:*

9.1.1 The air leakage rate shall be measured at each of the air pressure differences across the test specimen in accordance with Test Method E283.

9.1.2 *Air Leakage Test Conditions*—The air leakage rate of the specimens, for both positive and negative cases, shall be determined with a minimum of seven (7) measurements conducted across the sample in accordance with Test Method

E283. The seven (7) measurements shall be as follows: 25 Pa, 50 Pa, 75 Pa, 100 Pa, 150 Pa, 250 Pa, and 300 Pa.

9.1.3 *Results*—The air leakage results for each test series shall be curve fit using a least squares procedure to establish the relationship between pressure difference and leakage. See 11.4 for the data fitting requirements.

9.2 *Wind Pressure Conditioning:*

9.2.1 After the initial leakage testing, the specimen shall be exposed to the pressure loading in Table 1. The loading schedule for application of positive and negative pressure shall be as outlined by the graph presented in Annex A3 at the maximum values contained in Table 1 for sustained loads, cyclic loads, and gust loads.

9.2.2 *Observations to be Reported*—After each loading stage (sustained, cyclic, or gust loading), the air barrier assembly shall be inspected by the testing agency for signs of fracture, delamination, loosening of fasteners, and so forth. The air barrier assembly shall not demonstrate any change in structure, which would affect the integrity of the assembly. Photographs are to be taken of any failures.

9.3 *Post Conditioning Air Permeance:*

9.3.1 The air leakage test of 9.1 shall be repeated after the conditioning listed in 9.2. The post conditioning permeance values shall be used to establish the system rate. (See Section 10.)

9.4 *Deflection Measurements:*

9.4.1 Maximum deflections of the air barrier material and the test specimen shall be recorded at the wind pressures as outlined in Table 2 for both positive and negative pressures. The measurements shall be taken after the post conditioning leakage tests of 9.3.

10. Calculation

10.1 *Establishing Air Leakage Rate:*

10.1.1 The determination of the air leakage rate for the assembly shall be based on the results of tests of the wall assemblies as shown in Annex A1. The referenced air leakage rate for each wall assembly shall be the higher data point value leakage rate at 75 Pa for the exfiltration and infiltration cases.

TABLE 2 Wind Pressure Loading

NOTE 1—The wind pressure loads specified in Table 2 are not intended to represent conditions for a specific building; rather they are intended to provide a uniform comparison basis. The wind pressure loads are based on the assumption that the air barrier will take the full wind load and include a safety factor. Although in theory and in some applications (such as a pressure equalized rain-screen wall) a single air barrier layer may be exposed to the full pressure load, in many common applications the air barrier layer is subjected to a much smaller load (as low as 30 % of the total load) because of partial wind load being absorbed by other wall layers.

For geographical areas where wind design value is	Record maximum deflection(s) after completion of wind pressure loading at following load[A]
Q_{10} < 0.40 kPa	$D_{0.40}$ at 960 Pa
Q_{10} > 0.40 kPa	$D_{0.60}$ at 1440 Pa

[A] The wind pressure loading shall be maintained for a minimum of 10 s and the maximum deflection, at any point on the specimen, from the supporting member of the air barrier assembly shall be determined for both positive and negative pressures.

10.1.1.1 The reference base air leakage rate at 75 Pa determined for Specimen 1, the Opaque Wall, shall be the system air leakage rating assigned to the assembly provided that the air leakage at 75 Pa obtained for Specimen 2 is no more than 10 % greater than the reference base air leakage for Specimen 1. The air leakage rate of the specimen to be reported, for both positive and negative cases, shall be the air leakage rate of the specimen after it has been subjected to the structural loading schedule in accordance with 9.2. If the regression line does not go through point of origin, explain the assembly behavior during the test.

11. Report

11.1 Report the following information:

11.1.1 *General*—Testing agency, date and time of test, and date of report.

11.1.2 *Sample Description*—Proponent, product manufacturer, product type, related materials, and other pertinent information; description of the test frame, equipment used, penetrations made, conditioning, manufacturer's installation guidelines, material qualities; specimen area.

TABLE 1 Sustained Loads, Cyclic Loads and Gust Loads

NOTE 1—The wind loads specified in Table 1 are not intended to represent conditions for a specific building; rather they are intended to provide a uniform basis for comparison purposes. The wind loads are based on the assumption that the air barrier will take the full wind load and that the air barrier would see two severe storms in the first 15 years in service, The Q10 design values of 400/600 Pa for sustained wind conditions originates from values in the National Building Code of Canada for window design. Design values for window glass area were used because windows are part of both exterior envelope and the air barrier, and must take the full wind load on the building. The user may consult the applicable building code and corresponding ASCE/SEI 7 volume for guidance on wind speeds for the area where a specific building is or will be located.

For geographical areas where pressure design value is	Specimens as in accordance with Appendix X1 for wood frame, metal or masonry	P_1, P'_1 sustained for 1 h[A] (Pa)	P_2, P'_2 2000 cycles[B] (Pa)	P_3, P'_3 gust wind (Pa)
Q_{10} < 0.20 kPa	Specimen 1, 2, 3	400	530	800
Q_{10} > 0.20 kPa	Specimen 1, 2, 3	600	800	1200

[A] Specimens shall be conditioned for a minimum of 24 h at laboratory conditions prior to loading.

[B] The 2000 cycles can be applied in either four stages of 500 cycles per stage or two stages of 1000 cycles per state, with pressure direction reversal occurring between stages.

See Annex A3 for reference to P_1, P'_1, P_2, P'_2, P_3 and P'_3.