



Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems¹

This standard is issued under the fixed designation E 1680; 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 resistance of exterior metal roof panel systems to air infiltration resulting from either positive or negative air pressure differences. The test method described is for tests with constant temperature and humidity across the specimen. This test method is a specialized adaptation of Test Method E 283.

1.2 This test method is applicable to any roof area. This test method is intended to measure only the air leakage associated with the field of the roof, including the panel side laps and structural connections; it does not include leakage at the openings or perimeter or any other details.

1.3 The proper use of this test method requires knowledge of the principles of air flow and pressure measurements.

1.4 The text of this test method references notes and footnotes excluding tables and figures, which provide explanatory material. These notes and footnotes shall not be considered to be requirements of the test method.

1.5 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *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.* For specific precautionary statements, see Section 7.

2. Referenced Documents

2.1 ASTM Standards:

E 283 Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors²

E 631 Terminology of Building Construction²

E 1592 Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference²

E 1646 Test Method for Water Penetration of Exterior Metal

Roof Panel Systems by Uniform Static Air Pressure Difference²

2.2 Other Standard:

AAMA 501 Methods of Test for Metal Curtain Walls³

3. Terminology

3.1 *Definitions*—For definitions of general terms relating to building construction used in this test method, see Terminology E 631.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *air leakage (Q)*—the volume of air flowing per unit of time through the assembled specimen under a test pressure difference, expressed in cubic feet per minute (cubic metres per second).

3.2.2 *extraneous air leakage (Q_L)*—the difference between the metered air flow (Q_m) and air leakage (Q); the leakage of the remainder of the test chamber.

3.2.3 *metered air flow (Q_m)*—the volume of air flowing per unit of time through the air flow metering system, expressed in cubic feet per minute (cubic metres per second).

3.2.4 *rate of air leakage*—the air leakage per unit of specimen area (A), expressed in cubic feet per minute per square foot (cubic metres per second per square metre).

3.2.5 *reference standard conditions*—dry air at a pressure of 29.92 in. Hg (101.3 kPa), temperature of 69.4°F (20.8°C), and air density of 0.075 lb/ft³ (1.2 kg/m³).

3.2.6 *specimen*—the entire assembled unit submitted for testing as described in Section 8.

3.2.7 *specimen area (A)*—the area determined by the overall dimensions of the test specimen expressed in square feet (square metres). The dimensions used to determine area shall not include exterior framework.

3.2.8 *test pressure difference*—the specified difference in static air pressure across the fixed specimen, expressed in pounds-force per square foot (pascals).

4. Summary of Test Method

4.1 The test procedure consists of sealing and fixing 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

¹ This test method is under the jurisdiction of ASTM Committee E-6 on Performance of Buildings and is the direct responsibility of Subcommittee E06.57 on Performance of Metal Roofing Systems.

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² *Annual Book of ASTM Standards*, Vol 04.11.

³ Available from Architectural Aluminum Manufacturers Association (AAMA), 35 East Wacker Dr., Chicago, IL 60601.

maintain the specified test pressure difference across the specimen, and measuring the resultant air flow through the specimen.

5. Significance and Use

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

NOTE 1—The air pressure differences acting across a building envelope vary greatly. The slope of the roof and other factors affecting air pressure differences and the implications of the resulting air leakage relative to the environment within buildings are discussed in the literature.^{4,5,6} These factors shall be considered fully when specifying the test pressure difference to be used.

NOTE 2—When applying the results of tests by this test method, note that the performance of a roof or its components, or both, may be a function of proper installation and adjustment. The performance in service will also depend on the rigidity of supporting construction, the presence of interior treatments, the roof slope, and the resistance of components to deterioration by various causes: corrosive atmospheres, aging, ice, vibration, thermal expansion, and contraction, etc. It is difficult to simulate the identical complex environmental conditions that can be encountered in service, including rapidly changing pressures due to wind gusting. Some designs are more sensitive than others to these environmental conditions.

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

NOTE 3—The specimen construction discussed in 1.2 and required in 8.1 isolates a source of leakage. The rate of air leakage measured during the test method has units of cubic feet per minute per square foot (litres per second per square metre). Openings and details such as end laps or roof curbs are excluded since leakage is measured more appropriately in cubic feet per minute per foot (litres per second per metre) at these conditions. The test specimen area is relatively small; the inclusion of details will give unrealistic import to the detail's presence when compared to actual roof constructions. This test method shall not be relied on singularly to form conclusions about overall air leakage through metal roofs. A roof contains many details. Although prescribed modifications are outside the scope of this test method, an experienced testing engineer is able to use the principles presented in the test method and to generate significant data by isolating specific details and measuring leakage.

Additional leakage sources are introduced if details are included. If total leakage is then measured, the results will generally be conservative relative to tests without details. To minimize the number of tests, the specifier may allow details such as end laps when qualitative or general quantitative results are desired and the isolation of sources is not required for performance. Only one panel end lap shall be allowed. The user shall be aware of the bias when comparing alternate systems if end laps are included.

NOTE 4—This is a test procedure. It is the responsibility of the specifying agency to determine the specimen construction, size, and test pressures after considering the test methods' guidelines. Practical considerations suggest that every combination of panel thickness, span, and design load need not be tested in order to substantiate product performance.

⁴ *ASHRAE Handbook of Fundamentals*, American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc., 1972, Chapter 25.

⁵ *Fluid Meters—Their Theory and Application*, 5th edition, 1959.

⁶ *ASME—Power Test Code*, 2nd edition, 1956, Part 5, Chapter 4, "Flow Measurements."

6. Apparatus

6.1 This description of the apparatus is general in nature, and any arrangement of equipment capable of performing the test procedure within the allowable tolerances is permitted.

6.2 *Major Components* (see Fig. 1).

6.2.1 *Test Chamber*—A well-sealed chamber or box with either an opening, a removable mounting panel, or one open face in which or against which the specimen is installed and sealed. The specimen shall be installed horizontally. At least one static pressure tap shall be provided to measure the chamber pressure. All pressure taps shall be located so that the reading is unaffected by the air supply either to or from the chamber. The air supply opening into the chamber shall be arranged so that air does not impinge directly on the test specimen with any significant velocity. When required, a means of access shall be provided into the chamber to facilitate adjustments and observations after the specimen has been installed.

6.2.2 *Air System*—A controllable blower, compressed air supply, exhaust system, or reversible blower designed to provide the required air flow at the specified test pressure difference. The system shall provide constant air flow at a fixed pressure for the period required to obtain readings of air flow and pressure difference, and it shall be capable of maintaining positive and negative pressures.

6.2.3 *Pressure Measuring Apparatus*—A device for measuring the test pressure difference within a tolerance of $\pm 2\%$, or ± 0.01 in. (± 2.5 Pa), of water column, whichever is greater. The device must measure positive and negative pressures.

6.2.4 *Air-Flow Metering System*—A device to measure the air flow within the limitations of error prescribed in 6.3. (The publications listed in Footnotes 5 and 6^{5,6} present background information on fluid metering practices.)

6.3 The air flow through the test specimen shall be determined with an error not greater than $\pm 5\%$ when this flow equals or exceeds $2\text{ ft}^3/\text{min}$ (0.94 L/s) or $\pm 10\%$ when the air flow is below $2\text{ ft}^3/\text{min}$ but more than $\frac{1}{2}\text{ ft}^3/\text{min}$ (0.24 L/s).

NOTE 5—A greater percentage of error will usually be acceptable at lower flows. Special flow-measuring techniques are necessary if higher precision is required. The accuracy of the specimen leakage flow measurement is affected by the accuracy of the flowmeter and amount of extraneous leakage of the apparatus (see Annex A1 of Test Method E 283).

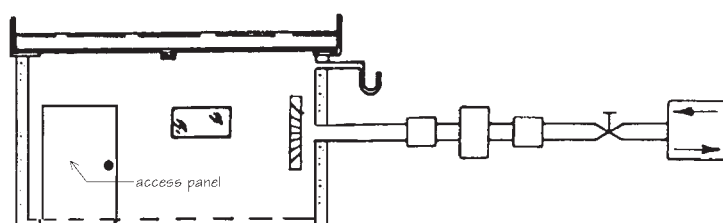
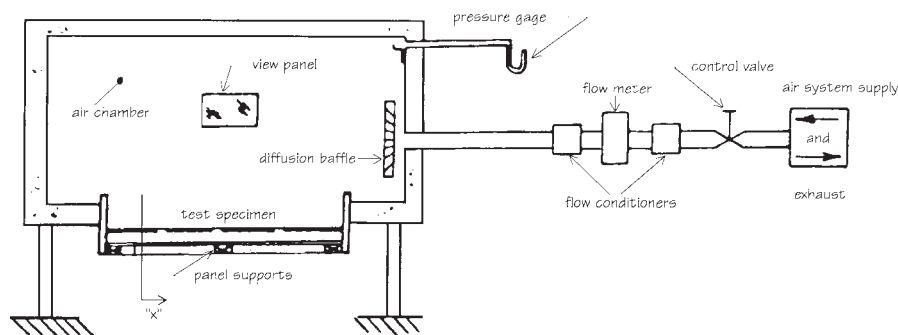
7. Safety Precautions

7.1 Glass breakage and specimen failure will not normally occur at the small pressure differences applied in this test procedure. Larger or excessive pressure differences occur during preload, due to error in operation, or when the apparatus is used for other purposes such as structural testing; therefore exercise adequate precautions to protect personnel.

8. Test Specimen

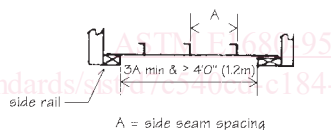
8.1 The roof specimen shall be of sufficient size to determine the performance of all typical parts of the roof system. For roofs constructed with prefabricated or preformed units or panels, the specimen width shall be equivalent to or greater than the width of three typical units plus the side rail supporting elements at each edge. The specimen shall contain at least three assembled side lap seams; this allows partial

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Alternate

Alternate preferred if dynamic test will be performed on same specimen.



section "x"

FIG. 1 General Arrangement of Air Leakage Apparatus

width units. The specimen width shall be sufficient to provide loading on at least one typical unit (see Fig. 1). When partial width units are used at the specimen sides, the maximum portion to be used in calculating the specimen area shall be one half of the unit. The specimen shall be of sufficient length to develop a multispan condition unless the panel is used only in single-span applications. If two spans are used, they shall be unequal, with the shorter being 75 % of the longer. Building perimeter details need not and interior details, other than typical side seams, shall not be included (see Note 3 for commentary and exceptions). The specimen perimeter shall be well sealed.

NOTE 6—The unbalanced span criterion more closely simulates multi-span panel deflection curvature. This works the panel sidelap while minimizing the specimen length.

8.1.1 All parts of the roof test specimen shall be full size, using the same materials, details, and methods of construction and anchorage as those on actual buildings.

8.1.2 The condition of structural support shall be simulated as accurately as possible. If the roof accommodates thermal expansion parallel to the panel length, this detail must be included in the test specimen, and the interior support must be able to slide parallel to the panel or its attachment, or both.

8.2 If insulation is an optional component of the roof system, it shall not be included in the test specimen.

8.3 If only one specimen is to be tested, the selection shall be determined by the specifying authority.

NOTE 7—Air leakage is likely to be a function of size, geometry, and stiffness. Therefore, select specimens covering the range of sizes to be used in a building. In general, the largest size and least stiff of a particular design, type, construction, and configuration shall be tested (see Note 3 for related commentary).

9. Calibration

9.1 Calibration shall be accomplished by mounting a plywood or similar rigid blank to the test chamber in place of a test