Designation: E 1646 – 95

An American National Standard

Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference[1]

This standard is issued under the fixed designation E 1646; 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 water penetration when water is applied to the outdoor face simultaneously with a static air pressure at the outdoor face higher than the pressure at the indoor face, that is, positive pressure. This test method is a specialized adaption of Test Method E 331.

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

1.3 This test method is limited to specimens in which the side seams and attachments are clearly visible and in which the source of leakage is readily determined. Composite systems in which the source cannot be readily determined are outside the scope of this test method.

1.4 The proper use of this test method requires a knowledge of the principles of pressure and flow measurement.

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 and may be approximate.

1.6 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 as requirements of the test method.

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.* For specific hazard statements, see 7.1.

2. Referenced Documents

2.1 *ASTM Standards:*

E 331 Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference[2]

E 631 Terminology of Building Constructions[2]

E 1680 Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems[2]

E 1592 Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference[2]

2.2 *Other Standard:*

AAMA 501 Methods of Test for Metal Curtain Walls[3]

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 *Descriptions of Terms Specific to This Standard:*

3.2.1 *specimen*—the entire assembled unit submitted for test as described in Section 8.

3.2.2 *test pressure difference*—the specified difference in static air pressure across the assembled and fixed specimen expressed as pounds-force per square foot (newtons per square metre (pascals)).

3.2.3 *water leakage*—penetration of water onto the exposed inside surface of the test specimen under specified conditions of air pressure difference across the specimen during a 15-min test period. Water penetration at or around end dams or side rails is not leakage; end dams and side rails are installed to cause and control ponding over the panels and to support the panels. They are not part of the roof.

4. Summary of Test Method

4.1 This test method consists of sealing and fixing the test specimen into or against one face of a test chamber, supplying air to or exhausting air from the chamber at the rate required to maintain the test pressure difference across the specimen, while

[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 Roof 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.

spraying water onto the outdoor face of the specimen at the required rate and observing any water leakage.

5. Significance and Use

5.1 This test method is a standard procedure for determining the resistance to water penetration under uniform positive static air pressure differences, and simulates wind driven rain imposed on sidelaps and rain that is free to drain while building a water head as it flows. The slope of the roof is significant. These factors shall be fully considered prior to specifying the test pressure difference.

NOTE 1—In applying the results of tests by this method, note that the performance of a roof or its components, or both, may be a function of proper installation and adjustment. In service, the performance also depends on the rigidity of supporting construction, roof slope, and on the resistance of components to deterioration by various causes: corrosive atmosphere, aging, ice, vibration, thermal expansion and contraction, etc. It is difficult to simulate the identical complex wetting conditions that can be encountered in service, including large wind-blown water drops, increasing water drop impact pressures with increasing wind velocity, and lateral or upward moving air and water. Some designs are more sensitive than others to this upward moving water.

NOTE 2—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 method's guidelines. Practical considerations suggest that every combination of panel thickness, span, and design load need not be tested in order to substantiate product performance.

NOTE 3—This test method shall not, by itself, be relied upon to form conclusions about overall water penetration 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 this test method and generate significant data by isolating specific details and measuring leakage.

6. Apparatus

6.1 The description of apparatus in this section 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 test 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. Chamber design shall not allow run-off from the test chamber to drain onto the test specimen. At least one static pressure tap shall be provided to measure the chamber pressure and shall be so located that the reading is unaffected by the velocity of the air supply to or from the chamber. The air supply opening into the chamber shall be arranged so that the 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.

NOTE 4—Uniform ponding is essential to this test method—refer to 5.1. For this reason the specimen slope must be horizontal, and the overflow devices described in 8.3 are required to control ponding. Chamber run-off that drains onto the specimen is not allowed so that the accuracy and uniformity of the metered flow rate described in 6.2.4 is not compromised.

6.2.2 *Air System*—A controllable blower, compressed air supply, exhaust system, or reversible blower designed to provide the required maximum air-pressure difference across the specimen. The system must provide essentially constant airflow at a fixed pressure for the required test period and be capable of maintaining positive and negative pressures.

6.2.3 *Pressure-Measuring Apparatus*—A device to measure the test pressure difference within a tolerance of ±2 %. The device must measure positive and negative pressures.

6.2.4 *Water-Spray System*—The water-spray system shall deliver water uniformly against the exterior surface of the test specimen at a minimum rate of 5.0 U.S. gal/ft^2 per h or 8 in./h (3.4 L/m^2 per min).

6.2.4.1 The water-spray system shall have nozzles spaced on a uniform grid, located at a uniform distance approximately 12 in. (0.3 m) above the test specimen, and be adjustable to provide the specified quantity of water in such a manner as to wet the test specimen uniformly and to wet those areas vulnerable to water leakage. The spray must be directed at all overlapping side seams with the stream centerline approximately 20° off vertical (see Fig. 1). If additional nozzles are required to provide uniformity of water spray at the edge of the test specimen, they shall be equally spaced around the entire spray grid.

7. Hazards

7.1 **Warning**—Glass breakage and specimen failure do not normally occur at the small pressure differences applied in this test. Larger or excessive pressure differences occur during preload or 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.

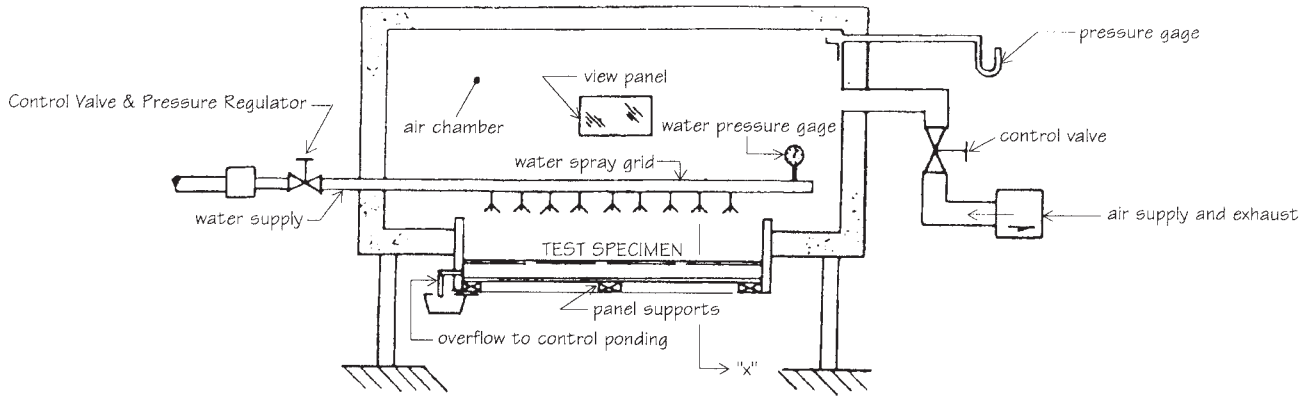
8. Test Specimen

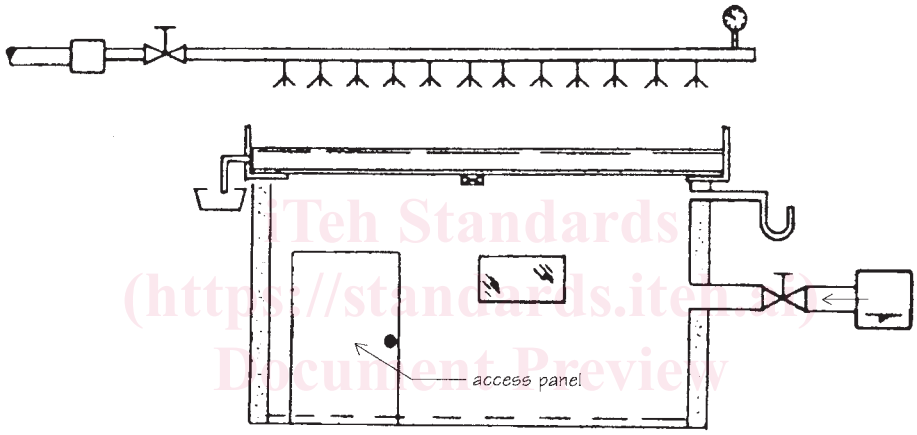
8.1 Roof test specimens shall be of sufficient size to determine the performance of all typical parts of the roof system. For roofs constructed with prefabricated or preformed units or panels, the specimen width shall be equivalent to or greater than the width of three typical units plus the side rail supporting elements at each edge. The specimen shall contain at least three assembled side lap seams; this allows partial width units. The specimen width shall be sufficient to provide loading on at least one typical unit (see Fig. 1). 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. One panel end lap is optional but shall not be used if the test will be run in tandem with Test Method E 1680. However, one end lap is allowed if the specifying authority adopts the option at Test Method E 1680.

NOTE 5—The unbalanced span criterion more closely simulates multispan panel deflection curvature. This works the panel sidelap while minimizing 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 used on actual buildings.

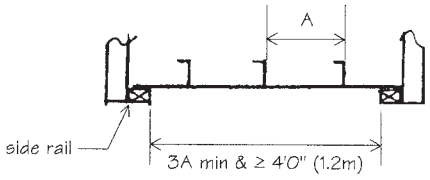
8.1.2 Condition of structural support shall be simulated as accurately as possible. If the roof system accommodates thermal expansion parallel to the panel, this detail must be





Alternate

Alternate preferred if dynamic test will be performed on same specimen. When a negative pressure system is used to create positive pressure on the specimen, the water-spray grid shall be located outside the chamber.



A = side seam spacing. Requires 4 overflow devices

section "x"

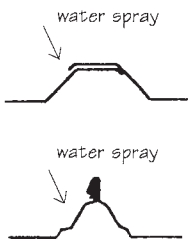


FIG. 1 General Arrangement of Water Leakage Apparatus Positive Chamber System