Designation: E2268 – 04 (Reapproved 2016)

# Standard Test Method for Water Penetration of Exterior Windows, Skylights, and Doors by Rapid Pulsed Air Pressure Difference[1]

This standard is issued under the fixed designation E2268; 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 windows, skylights, and doors to water penetration when water is applied to the outdoor face and exposed edges simultaneously with a rapid pulsed air pressure at the outdoor face higher than the pressure at the indoor face.

1.2 This test method is applicable to windows, skylights, or doors alone. Those interested in testing curtain walls to rapid pulsed air pressure differences should use AAMA 501.1-94.

1.3 This test method addresses water penetration through a manufactured assembly. Water that penetrates the assembly, but does not result in a failure as defined herein, may have adverse effects on the performance of contained materials such as sealants and insulating or laminated glass. This test method does not address these issues.

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

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

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.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

2.2 *AAMA Standard:*[3]

AAMA 501.1-94 Standard Test Method for Exterior Windows, Curtain Walls and Doors for Water Penetration Using Dynamic Pressure

## 3. Terminology

3.1 *Definitions*—For definitions of general terms relating to building construction used in this test method, see Terminology E631.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *pulsed, v*—subjected to a transition from one level of differential air pressure to another and back within a prescribed time period.

3.2.2 *pulse generator, n*—test apparatus capable of producing rapid changes of air pressure between two prescribed levels within a specified time period (see Fig. 3).

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

3.2.4 *test pressure difference, n*—the specified difference in dynamic air pressure across the closed and locked or fixed specimen expressed as Pascals ($lbf/ft^2$).

3.2.5 *water penetration, n*—penetration of water beyond a plane parallel to the glazing intersecting the innermost projection of the test specimen, not including interior trim and hardware, under the specified conditions of air pressure difference across the specimen. For products with non-planar glazing surfaces (domes, vaults, pyramids, and so forth) the plane defining water penetration is the plane defined by the innermost edges of the unit frame.

## 4. Summary of Test Method

4.1 This test method consists of sealing the test specimen into or against one face of a test chamber and supplying air to or exhausting air from the chamber at a rapid cyclic rate across the specimen for the time specified, while spraying water onto the outdoor face of the specimen at the required rate and observing any water penetration.

[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.

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[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] Available from American Architectural Manufacturers Association (AAMA), 1827 Walden Office Square, Suite 550 Schaumburg, IL 60173-4268, http://www.aamanet.org.

## 5. Significance and Use

5.1 This test method is a standard procedure for determining the resistance to water penetration during rapid cyclic pulses of dynamic air pressure differences. The air-pressure differences acting across a building envelope vary greatly. These factors should be fully considered prior to specifying the test pressure difference to be used.

5.2 The median test pressure used in this test method is defined as the specified test pressure supplied by the user and related to the maximum positive building design pressure. This test method departs from the format of other ASTM water penetration resistance test methods based on a maximum test pressure related to a maximum positive building design pressure.

5.3 As the specified or median test pressure is increased, the maximum test pressure in this procedure is also increased to 1.5 times the specification median test pressure. This higher maximum test pressure may not be representative of actual building service conditions. For this reason the maximum recommended median test pressure is 480 Pa (10 psf), which corresponds to a maximum test pressure of 720 Pa (15 psf).

5.4 The pulsed pressure of this test method may act to pump water past dry seals and breather systems of units incorporating these features, thereby making the test method more severe than a static pressure test method. On the other hand, the low pressure portions of the pressure cycles of this test method may allow weep systems and drainage dams to dissipate water from units incorporating these features, thereby making the test method less severe than a static pressure test method.

NOTE 1—In applying the results of tests by this test method, note that the performance of a wall or its components, or both, may be a function of proper installation and adjustment. In service, the performance will also depend on the rigidity of supporting construction and on the resistance of components to deterioration by various causes, (vibration, thermal expansion and contraction, and so forth). It is difficult to accurately simulate the actual complex wetting conditions that can be encountered in service, with 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 test does not identify unobservable liquid water which may penetrate into the test specimen.

## 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* (Fig. 1)*:*

6.2.1 *Test Chamber*—A test chamber or box with an opening, a removable mounting panel, or one open side in which or against which the specimen is installed and sealed. At least one dynamic pressure tap shall be provided to measure the oscillating 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. A means of access into the chamber may be provided 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 maximum air pressure difference across the specimen. The system must provide fully reversible airflow at rapidly oscillating pressures for the required test period.

6.2.3 *Pressure Measuring Apparatus*—A device to measure the test pressure difference within a tolerance of ±2 % or ±5 Pa (±0.02 in. of water column), whichever is greater.

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 3.4 L/(m$^2$·min) [5.0 U.S. gal/(ft$^2$·h)].

6.2.4.1 The water-spray system shall have nozzles spaced on a uniform grid, located at a uniform distance from the test specimen, and shall be adjustable to provide the specified quantity of water in such a manner as to wet all of the test specimen uniformly and to wet those areas vulnerable to water penetration. 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 will not normally occur at the small pressure differences applied in this test. Excessive pressure differences may occur, however, 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. Sampling, Test Specimens, and Test Units

8.1 Test specimens shall be of sufficient size to determine the performance of all typical parts of the fenestration system.

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

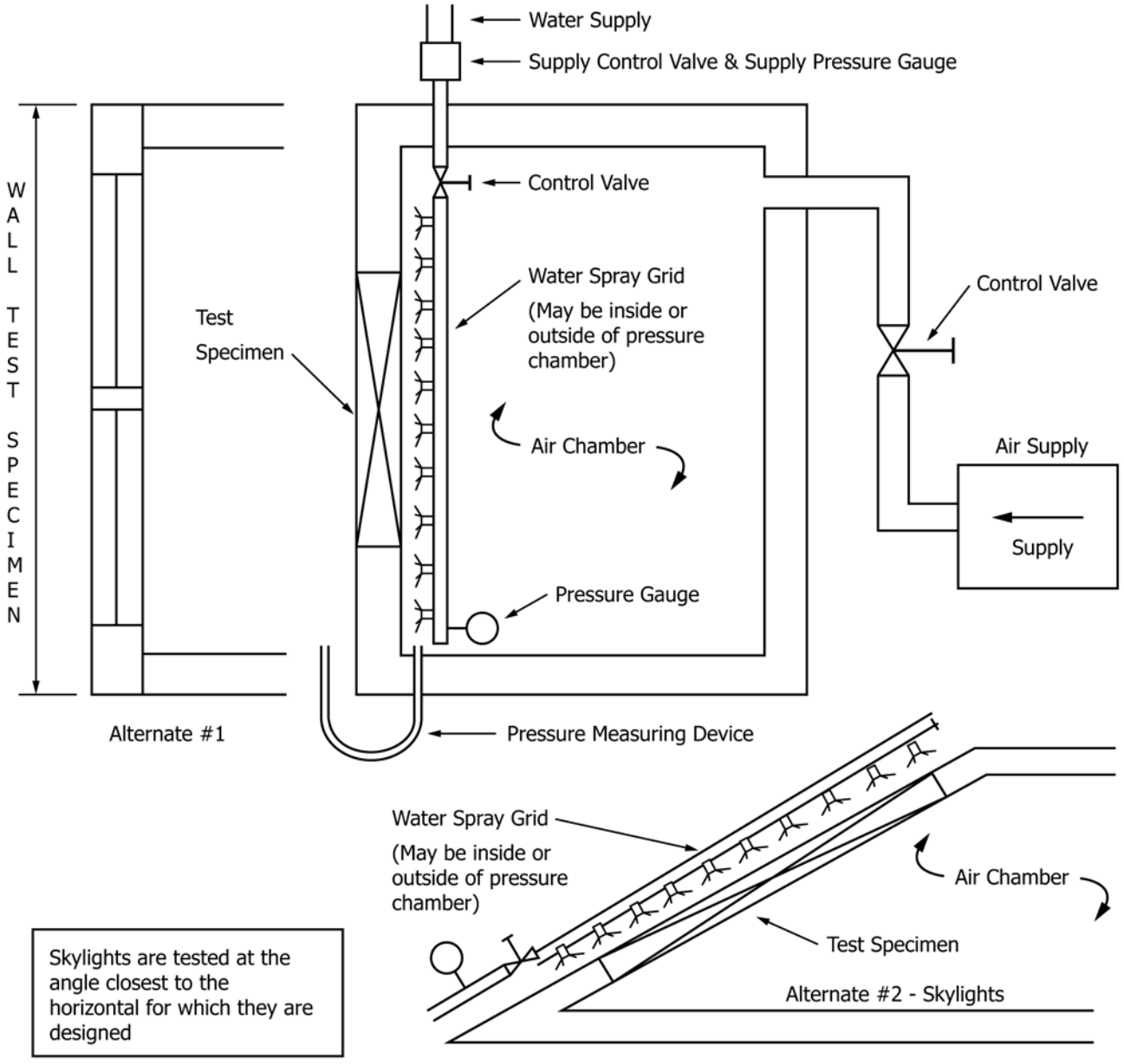
8.2 Window, skylight, door, or other component test specimens shall consist of the entire assembled unit, including frame and anchorage as supplied by the manufacturer for installation in the building.

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

NOTE 3—It should be recognized, especially with windows, that performance is likely to be a function of size and geometry. Therefore, select specimens covering the range of sizes to be used in a building. In general, the largest size of a particular design, type, construction, and configuration to be used should be tested.

## 9. Calibration and Standardization

9.1 The ability of the test apparatus to meet the requirements of 6.2.4 shall be checked by using a catch box, the open face of which shall be located at the position of the face of the test specimen. The calibration device is illustrated in Fig. 2. The catch box shall be designed to receive only water impinging on the plane of the test specimen face and to exclude all run-off water from above. The box shall be 610 mm (24 in.) square, divided into four areas each 305 mm (12 in.) square. Use a cover approximately 760 mm (30 in.) square to prevent water from entering the calibration box before and after the timed observation interval. The water impinging on each area




NOTE 1—For a negative pressure system, the water-spray grid would be located outside the chamber and the air supply would be replaced by an air-exhaust system.

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

shall be captured separately. A spray that provides at least 1.26 L⁄min (20 gal/h) total for the four areas and not less than 0.25 L⁄min (4 gal/h) nor more than 0.63 L/min (10 gal/h) in any one square shall be acceptable.

9.1.1 The water-spray system shall be calibrated at both upper corners and at the quarter point of the horizontal center line (of the spray system). If a number of identical, contiguous, modular spray systems are used, only one module need be calibrated. The system shall be calibrated with the catch boxes at a distance within 50 mm (2 in.) of the test specimen location from the nozzle. The reference point for location of the spray system from the specimen shall be measured from the exterior glazing surface of the specimen farthest from the spray system nozzles. The water spray rack shall be installed parallel to the plane of the specimen. Recalibrate at intervals of not more than 6 months.

9.1.2 The device used to control pressure cycling shall be calibrated to apply pressure pulses in a modified sinusoidal pattern with a frequency of one complete cycle every 2 s, ±10 % (see Fig. 3).

## 10. Information Required

10.1 The median test-pressure difference or differences at which water penetration is to be determined, unless otherwise specified, shall be 140 Pa (2.86 lbf/ft$^2$) and the upper and lower test pressure differences shall be equal to ±50 % (150 % and

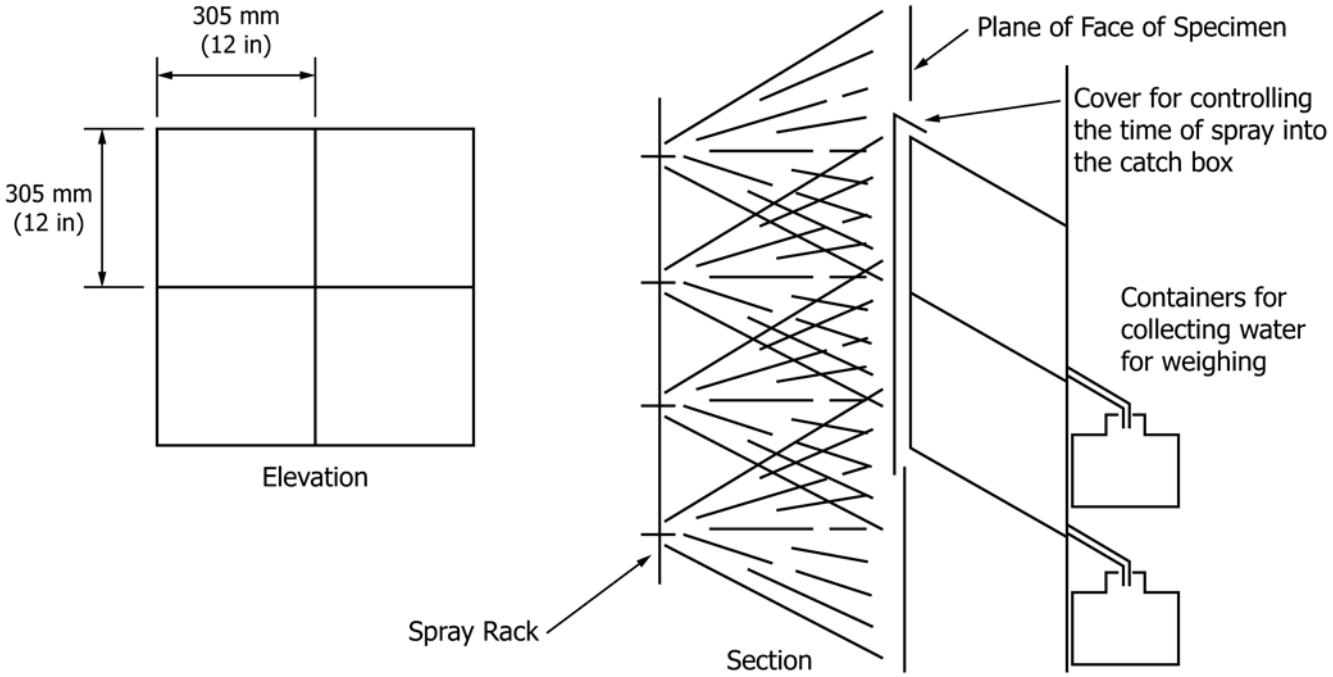
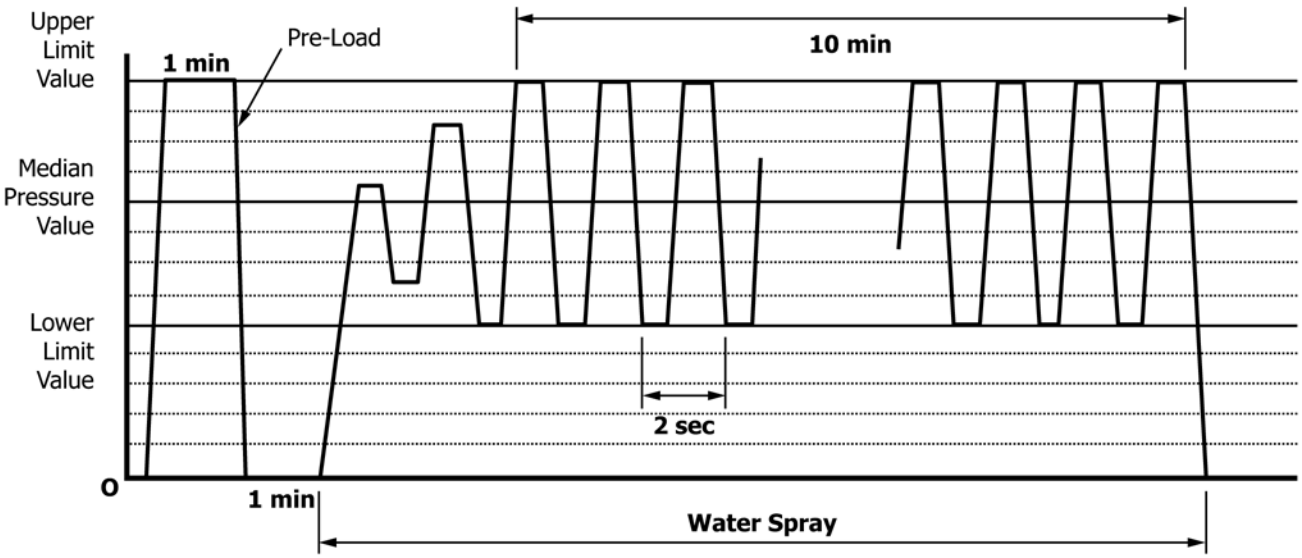



**FIG. 2 Catch Box for Calibrating Water-Spray**




NOTE 1—The operational check is performed between the pre-load and the cycle test. The pre-load pressure shall be increased and decreased at a rate of 10 Pa/s (0.20 psf/s) ± 2 Pa/s (0.04 psf/s). The rate of pressure application during cycling shall be consistent with maintenance of a 2 s pulse duration. The median pressure value is the test pressure differential. The upper and lower limit values are equal to 150 % and 50 %, respectively, of the median test pressure differential across the specimen.

**FIG. 3 Pressure Application for Pre-load and Pressure Cycles**

50 %, respectively) of the median test pressure difference unless otherwise specified.

10.2 Unless otherwise specified, failure criteria of this test method shall be defined as water penetration in accordance with 3.2.5. Failure also occurs whenever water penetrates through the perimeter frame of the test specimen. Water contained within drained flashing, gutters, and sills is not considered failure.

10.3 The periods of time during which the specimen is to be subjected to pressure difference(s) shall be specified.

10.3.1 In no case shall there be fewer than three hundred test cycles.

10.3.2 In no case shall the total time of pressure application be less than 10 min.

10.4 If this test method is to be used at other than ambient temperatures, such temperature conditions shall be specified.

## 11. Procedure

11.1 Remove any sealing material or construction that is not normally a part of the assembly as installed in or on a building. Fit the specimen into or against the chamber opening with the outdoor side of the specimen facing both the high pressure side of the chamber and the water spray, and in such a manner that no joints or openings are obstructed. Skylight specimens shall be tested at the minimum angle from the horizontal for which they are designed to be installed. Seal the outer perimeter of the specimen to the chamber and seal at no other points.

NOTE 4—Non-hardening mastic compounds or pressure-sensitive tape can be used effectively to seal the test specimen to the chamber opening, to seal the access door to the chamber, and to achieve air-tightness in the construction of the chamber. These materials can be used to seal a separate mounting panel to the chamber. Rubber gaskets with clamping devices may also be used for this purpose provided that the gasket is highly flexible and has a small contact edge.

11.2 Without disturbing the seal between the specimen and the test chamber, adjust all operable units, included in the test specimen, so that their operation conforms to the specification requirements. Adjust all hardware for maximum tightness without interfering with their operation.

11.3 Submit each operable unit to five cycles of opening, closing, and locking prior to testing.

11.4 Before starting the cyclic portion of the test procedure, apply a pressure differential across the specimen equal to the upper limit of the test sequence for a period of 1 min. The pre-load pressure shall be increased and decreased at a rate of 10 Pa/s (0.20 psf/s) ± 2 Pa/s (0.04 psf/s).

11.5 Adjust the water spray to the specified rate.

11.6 Apply the air pressure difference during cycling at a rate consistent with maintaining a 2 s pulse duration (see Fig. 3).

11.7 While maintaining the water spray, cycle the applied pressure between the upper and lower pressure limits for a period of at least 10 min.

11.8 At the conclusion of the required number of cycles (see 10.3.1) remove the air pressure difference and stop the water spray.

11.9 Observe and record the points of water penetration, if any.

## 12. Report

12.1 Report the following information:

12.1.1 Date of test and date of report.

12.1.2 Identification of the specimen (manufacturer, source of supply, dimensions, model, type, materials, and other pertinent information).

12.1.3 Detailed drawings of the specimen that provide a description of the physical characteristics including dimensioned section profiles, sash or door dimensions and arrangement, framing location, panel arrangement, installation and spacing of anchorage, weatherstripping, locking arrangement, hardware, sealants, glazing details, angle from the horizontal for skylights, complete description of weeps (if any), and any other pertinent construction details. Any modifications made on the specimen to obtain the reported values shall be noted on the drawings.

12.1.4 For window, skylight, and door components, a description of the locking and operating mechanism.

12.1.5 Identification of glass thickness and type, and method of glazing.

12.1.6 Type or types of weatherstrip.

12.1.7 A statement or tabulation of pressure difference or differences applied across the specimen and temperature during the test, number and duration of pressure difference applications, and water application rates during the test.

12.1.8 A record of all points of water penetration on the indoor face of the test specimen, and of water penetration as defined in 3.2.5.

12.1.9 When the tests are made to check the conformity of the specimen to a particular specification, an identification or description of that specification shall be included.

12.1.10 A statement that the test or tests were conducted in accordance with this test method, or a complete description of any deviations from this test method.

12.2 If several identical specimens of a component are tested, the results for all specimens shall be reported, each specimen being properly identified, particularly with respect to distinguishing features or differing adjustments. A separate drawing for each specimen shall not be required if all differences between them are noted on the drawings provided.

## 13. Precision and Bias

13.1 No statement is made either on the precision or bias of this test method for measuring water penetration since the result merely states whether there is conformance to the criteria specified for success.

## 14. Keywords

14.1 doors; skylights; water penetration; windows