Designation: E1105 – 15

Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference[1]

This standard is issued under the fixed designation E1105; 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 installed exterior windows, curtain walls, skylights, and doors to water penetration when water is applied to the outdoor face and exposed edges simultaneously with a static air pressure at the outdoor face higher than the pressure at the indoor face.

1.2 This test method is applicable to any curtain-wall area or to windows, skylights, or doors alone. It is intended primarily for determining the resistance to water penetration through such assemblies for compliance with specified performance criteria, but it may also be used to determine the resistance to penetration through the joints between the assemblies and the adjacent construction. Other procedures may be appropriate to identify sources of leakage.

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 inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI 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.* For specific hazard statements, see 7.1.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E331 Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

E547 Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference

E631 Terminology of Building Constructions

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 *specimen, n*—the entire assembled unit submitted for test as installed in the exterior wall of a building.

3.2.1.1 *Discussion*—The test specimen consists of the major components of the assembly, including all joints, cracks, or openings between such components and any panning, receptors, extenders, sills, mullions, or other parts or components used for assembling any installation. The joints between assemblies and the openings into which they are mounted (masonry openings, for example) are not part of the test specimen. However, these joints may be tested by this procedure.

3.2.2 *test pressure difference, n*—the specified difference in static air pressure across the closed and locked or fixed specimen expressed in lbf/ft^2 (pascals).

3.2.3 *water penetration, n*—penetration of water beyond a plane parallel to the glazing (the vertical plane) 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-planer surfaces (domes, vaults, pyramids, etc.) the plane

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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.

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 a chamber to the interior or exterior face of specimen to be tested, supplying air to a chamber mounted on the exterior or exhausting air from a chamber mounted on the interior, at the rate required to maintain the test pressure difference across the specimen while spraying water onto the outdoor face of the specimen at the required rate and observing any water penetration.

5. Significance and Use

5.1 This test method is a standard procedure for determining the resistance to water penetration under uniform or cyclic static air pressure differences of installed exterior windows, skylights, curtain walls, and doors. The air-pressure differences acting across a building envelope vary greatly. These factors should be considered fully prior to specifying the test pressure difference to be used.

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 simulate the identical 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 method does not identify unobservable liquid water which may penetrate into the test specimen.

5.2 Laboratory tests are designed to give an indication of the performance of an assembly. Field performance may vary from laboratory performance since the supporting structure for the test specimen, methods of mounting, and sealing in the laboratory can only simulate the actual conditions that will exist in the building. Shipping, handling, installation, acts of subsequent trades, aging, and other environmental conditions all may have an adverse effect upon the performance of the installed product. This field test procedure provides a means for determining the performance of a product once installed in the building.

5.3 The field test may be made at the time the window, skylight, curtain-wall, or door assemblies are initially installed and before the interior of the building is finished. At this time, it is generally easier to check the interior surfaces of the assemblies for water penetration and to identify the points of penetration. The major advantage of testing when assemblies are initially installed is that errors in fabrication or installation can be readily discovered and corrections made before the entire wall with its component assemblies is completed at which time the expense of corrective work may be increased many times.

5.4 The field test may also be made after the building is completed and in service to determine whether or not reported leakage problems are due to the failure of the installed assemblies to resist water penetration at the specified static air pressure difference. Generally it is possible to conduct tests on window, skylight, and door assemblies without too much difficulty, and to identify sources of leakage. A curtain-wall assembly, on the other hand, may not be accessible from the inside without the removal of interior finished walls and ceilings. Even with removal of interior walls and ceilings, it may not be possible to observe curtain-wall surfaces behind spandrel beams. The feasibility of conducting a meaningful static air pressure difference water penetration test on an in-service building must be carefully evaluated before being specified.

5.5 Weather conditions can affect the static air pressure difference measurements. If wind gusting causes pressure fluctuation to exceed ±10 % from the specified test pressure, the test should not be conducted.

5.6 Generally it is more convenient to use an interior mounted pressure chamber from which air is exhausted to obtain a lower pressure on the interior surface of the specimen. A calibrated rack of nozzles is then used to spray water at the proper rate on the exterior surface. Under circumstances where it is desirable to use an exterior-mounted pressure chamber, the spray rack must be located in the pressure chamber and air supplied to maintain a higher pressure on the exterior surface. Exterior chambers are difficult to attach readily and seal to exterior surfaces.

5.7 Even though the equipment requirements are similar, this procedure is *not* intended to measure air infiltration because of the difficulty of isolating the component air leakage from the extraneous leakage through weep holes, mullion joints, trim, or other surrounding materials.

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 procedures within allowable tolerances is permitted.

6.2 *Major Components* (Fig. 1):

6.2.1 *Test Chamber*—A test chamber or box made of plywood, plastic, or other suitable material and sealed against the test specimen. Test chambers mounted on the interior must be made so that interior surfaces and joints of the specimen can be easily observed for water penetration during the test. No part of the testing chamber shall come in contact with or restrict any point where water penetration may occur. At least one static air pressure tap shall be provided to measure the chamber air pressure versus the ambient (interior-exterior) air pressure and shall be so located that the reading is unaffected by exterior impinging wind, or by the velocity of air supply to or from the chamber. The air supply opening into or exhaust from the chamber shall be arranged so that 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 chamber has been installed.

6.2.2 *Air System*—A controllable blower, compressed air supply exhaust system, or reversible blower designed to supply the required maximum air pressure difference across the

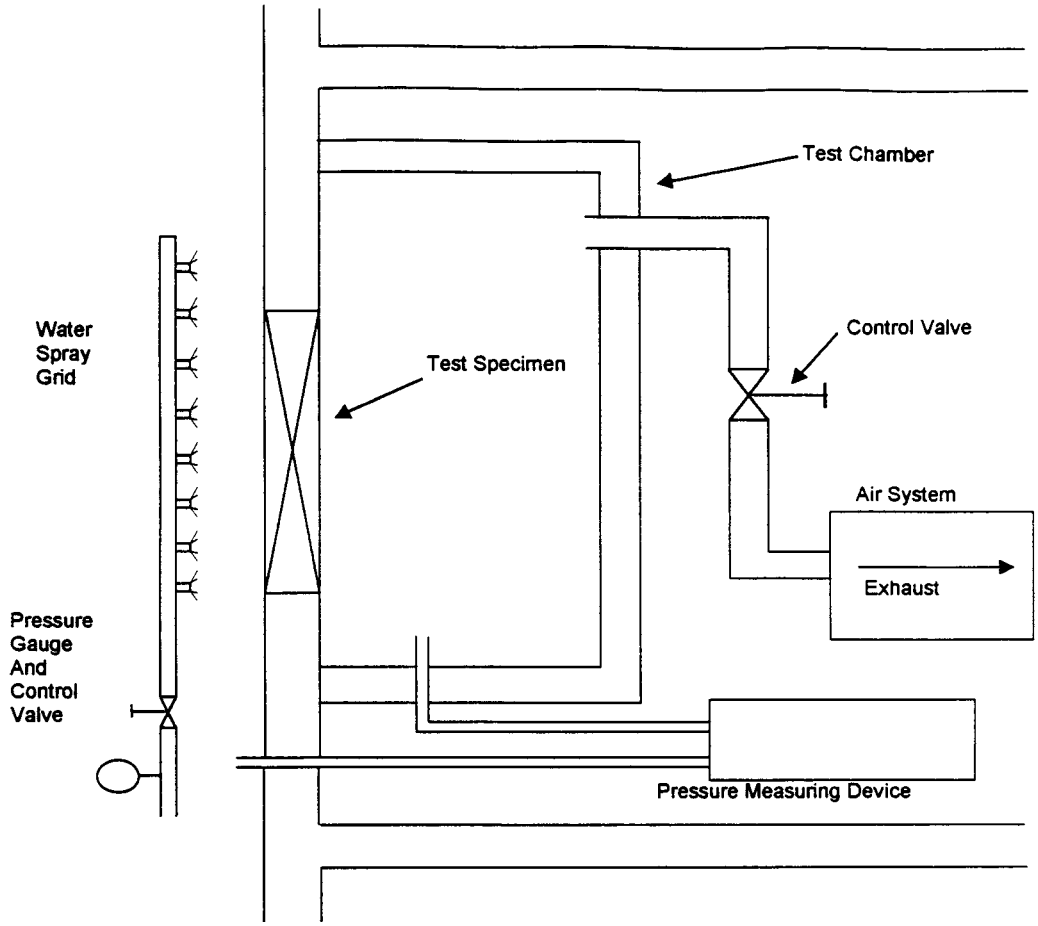

FIG. 1 General Arrangement of Water Penetration Test Apparatus

specimen. The system must provide essentially constant air flow at a fixed pressure 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 ±0.01 in. (±2.5 Pa 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 5.0 U.S. gal/ft^2·h (3.4 L/m^2·min).

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.

6.2.4.2 The intake water line to the nozzle grid shall be equipped with a pressure gage and pressure adjusting valve. For field testing, the water pressure shall be adjusted to the same pressure at which the water spray system was calibrated.

7. Hazards

7.1 **Warning—**Glass breakage will not normally occur at the small pressure differences applied in this test method. Excessive pressure differences may occur, however, due to error in operation or gusting wind, therefore, exercise adequate precautions to protect personnel.

7.2 Take whatever additional precautions are necessary to protect persons from water spray, falling objects (which may include tools), the spray system, or even the exterior test chamber.

8. Examination of Test Specimens

8.1 Select and identify the test specimen in accordance with the procedures established in Section 10.

8.2 Conduct a detailed visual examination of the test specimen and the construction adjacent to the test specimen. Record all pertinent observations.

8.3 If the intent is to test an operable window, skylight, or door, the unit should be checked for proper installation by opening, closing, and locking the unit five times prior to testing, with no further attention other than the initial adjustment.

NOTE 3—The purpose of this examination is to record the physical condition of the test specimen and adjacent construction at the time of testing. Examples of pertinent observations to be recorded include; any damage or deterioration observed, missing or broken components, miss-adjustment or weatherstrip or other components, cleanliness of the test specimen, out-of-square installations, and so forth.

9. Calibration

9.1 The ability of the test apparatus to meet the applicable requirements 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 24 in. (610 mm) square, divided into four areas each 12 in. (305 mm) square. Use a cover approximately 30 in. (760 mm) square to prevent water from entering the calibration box before and after the timed observation interval. The water impinging on each area shall be captured separately. A spray that provides at least 20-gal/h (1.26-L/min) total for the four areas and not less than 4 gal/h (0.25 L/min) nor more than 10 gal/h (0.63 L/min) 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 ±2 in. (51 mm) 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. Recalibrate at intervals necessary in the judgment of the testing agency but not more than six months.

9.1.2 When the calibration is made, record the water pressure on the intake water line to the nozzle grid. When a field test is made, make sure to adjust the water pressure on the intake line to the pressure recorded when the grid was calibrated.

10. Information Required

10.1 The specifying authority shall supply the following information or provide guidance relative to its specification.

NOTE 4—Although the specifying authority is responsible for establishing test specimen sampling, selection, and identification procedures, such procedures or modifications to said unit should be mutually agreed upon by all parties involved prior to testing.

10.1.1 Test specimen sampling, selection, adjustment, and identification.

10.1.2 Test pressure difference(s) to be applied during the test.

10.1.3 Whether uniform or cyclic air pressure difference tests, or both, shall be used. Duration and number of cycles if cyclic test is used.

10.2 Unless otherwise specified, failure criteria of this test method shall be defined as water penetration in accordance with 3.2.3. 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.

11. Preparation of Test Apparatus

11.1 Fit the test chamber to the perimeter of the test specimen to cover the entire assembly through which a check for water penetration is to be made. Provide suitable support for the test chamber so that it does not contact or restrict any point where water leakage may occur. Seal all joints between the test specimen perimeter and the test chamber. Seal any openings between the test chamber and any air supply or exhaust ducts, pressure taps, or other measuring devices.

11.2 Establish a means for measuring the air pressure difference across the test specimen which takes into account the difference that may exist between the static pressure in the interior of the building and the static pressure on the exterior. In the case of an interior mounted test chamber, it may be possible simply to open a window in a room to balance the pressure. A pressure tap to the exterior for a pressure measuring device on an interior-mounted chamber or a pressure tap to the

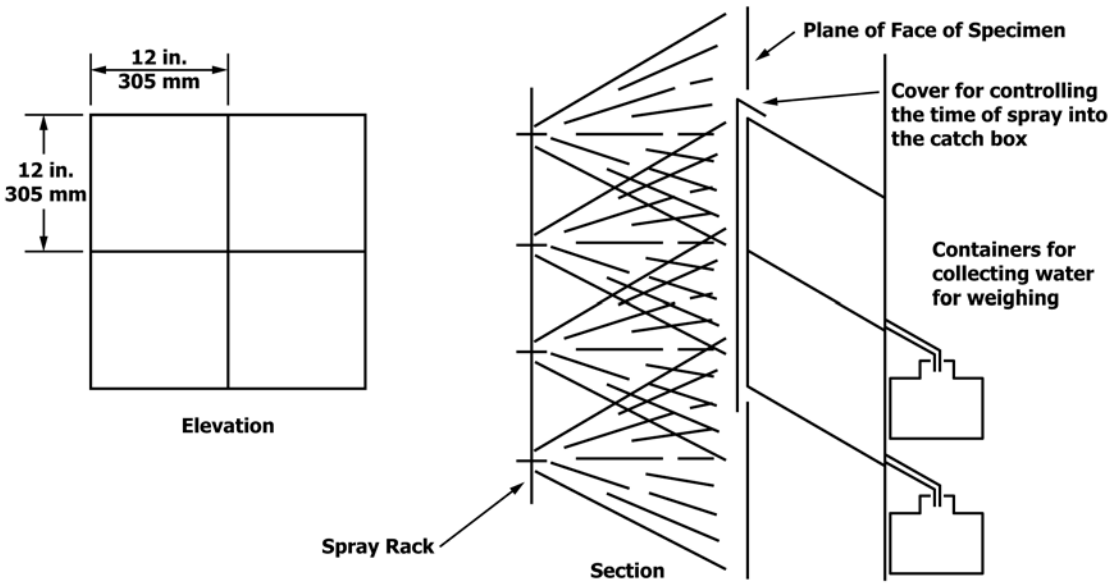

FIG. 2 Catch Box for Calibrating Water-Spray System

interior for an exterior-mounted test chamber would properly account for any difference.

12. Procedure

12.1 *Procedure A*—Test under uniform static air pressure difference as follows:

12.1.1 Adjust the valve on the water-spray system so that the intake water is being delivered at the calibrated pressure, as described in Section 9.

12.1.2 Apply the specified static air pressure difference within 15 s and maintain this pressure, along with the specified rate of water spray, for 15 min.

12.1.3 Observe and note points of water penetration, if any, that occur during the test.

12.1.4 Remove the air pressure difference and stop the water spray. Carefully inspect the test specimen for any additional evidence of water penetration and note any such evidence for the report.

12.2 *Procedure B*—Test under cyclic static air pressure difference as follows:

12.2.1 Adjust the valve on the water-spray system so that the intake water is being delivered at the calibrated pressure, as described in Section 9.

12.2.2 Apply the specified static air pressure difference across the test specimen promptly and maintain this pressure, along with the specified rate of water spray, for the period of time stipulated by the specification or the specifier. Unless otherwise specified, the duration of the pressure cycle shall be 5 min.

12.2.3 While maintaining the water spray, reduce the air pressure difference to zero for a period of not less than 1 min.

12.2.4 Repeat the preceding two steps for the specified number of cycles. In no case, however, shall the total time of pressure application be less than 15 min.

12.2.5 Observe and note points of water penetration, if any, which occur during the test.

12.2.6 At the conclusion of the required number of cycles, remove the air pressure difference and stop the water spray. Carefully inspect the test specimen for any additional evidence of water penetration and note any such evidence for the report.

12.3 Measure and record the barometric pressure and temperature of the air near the exposed surface of the test specimen, and of the air near the air intake or exhaust of the air system. Measure and record the speed and direction of the air movement (wind) at or near the exposed surface of the test specimen. Take such measurements immediately prior to or during the test.

13. Report

13.1 Report the following information:

13.1.1 *General*—Testing agency, requester of test, date and time of test, date of report, identification, and location of building.

13.1.2 *Test Specimen Description*—Manufacturer, model, operation type, dimensions, materials, etc.; identification and location of the test specimen(s) within the building; physical condition of the test specimen, description of any modifications made to test specimen; age of the test specimen, if known, etc.

13.1.3 *Detailed Drawings*—If available, detailed drawings of the specimen that provide a description of the physical characteristics, skylight sash or door dimensions and arrangement, framing location, panel arrangement, installation and spacing of anchorage, weatherstripping, locking arrangement, hardware, sealants, glazing details, and any other pertinent construction details. Any modifications made on the specimen to obtain the reported shall be noted.

13.1.4 *Sampling Procedures*—If applicable, describe or list the procedures established.

13.1.5 *Test Parameters*—List the specified static air pressure difference used in the test and the rate of water-spray application if different from that specified in Section 6. If cyclic test was used, list the number and duration of pressure difference applications. Describe the location of the test chamber, whether mounted on the interior of the building or the exterior; describe the method used to take into account the difference in the static air pressure. If test was made to check the conformity of the specimen to a particular specification, identify or describe that specification.

13.1.6 *Test Conditions*—List pertinent atmospheric conditions such as pressures and temperatures and list exterior wind speed and direction as measured and recorded during the test.

13.1.7 *Test Results*—Record all water penetration as described in Section 12.

13.1.8 *Compliance Statement*—Include a statement that the tests were conducted in accordance with this test method or a complete description of any deviations from this test method.

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

14. Precision and Bias

14.1 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.

15. Keywords

15.1 curtain walls; doors; skylights; water penetration; windows

APPENDIX

(Nonmandatory Information)

X1. SPRAY RACK RATE

X1.1 The defined spray rate of the Test Method E1105 water-spray system is a minimum of 5.0 U.S. gal/ft^2·h (3.4 L/m^2·min). The spray rate is the same as that specified in Test Methods E331 and E547, the laboratory tests for fenestration water penetration. Test Method E331 was first published in 1967 and, along with Test Method E547, has consistently defined the spray rate as a minimum of 5.0 U.S. gal/ft^2·h (3.4 L/m^2·min).

X1.2 Some users of Test Method E1105 have converted the spray rate to an inches-per-hour measurement in an attempt to correlate the spray rate to service conditions. Although a spray rack used at the specified spray rate has proven to replicate certain actual rain events, defining the water-spray system as a replicator of a specific rain event is misleading. As stated in 6.2.4.1, the purpose of the water-spray system is to wet the specimen uniformly for the purpose of evaluating water resistance. There is no evidence that the developers of Test Methods E1105, E331, and E547, intended to reproduce or simulate any given rain event. In-service fenestration products may receive more or less water than a Test Method E1105 water-spray system delivers, depending on surrounding architectural features, building height, building corner effects, and other factors.

X1.3 The Test Method E1105 test procedure offers an effective method to evaluate the water penetration resistance of fenestration products through a consistent and repeatable process.