Standard Test Method for
Field Determination of Water Penetration of Masonry Wall Surfaces[1]

This standard is issued under the fixed designation C 1601; 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 field determination of water penetration of a masonry wall surface under specific water flow rate and air pressure conditions. This test is intended for use on any masonry wall surface that can be properly instrumented and tested within the requirements of this standard.

1.2 This test method is not identical to and the results are not directly comparable with the laboratory standard Test Method E 514.

1.3 Surface penetration, as determined by this test method, is defined as the amount of water passing through the wall surface exposed to testing per unit time per unit area. This property is not directly comparable to overall water penetration and leakage, which are typically defined as the amount of water travelling completely through a masonry system.

1.4 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.

1.5 *This standard may involve hazardous materials, operations, or equipment. This standard does not purport to address all of the safety problems 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]

C 1232 Terminology of Masonry

E 514 Test Method for Water Penetration and Leakage Through Masonry

3. Terminology

3.1 For definitions of terms used in this test method, refer to Terminology C 1232.

4. Significance and Use

4.1 This non-destructive test method contains procedures and equipment requirements to quantitatively determine the surface penetration of water at a single location on a masonry wall. It is not designed to determine the overall water penetration and leakage of a masonry system.

4.2 Excessive water penetration of masonry may degrade masonry wall performance with respect to thermal conductivity, durability, efflorescence, staining, corrosion of embedded metal items, and water leakage.

4.3 This test may be used to evaluate masonry walls in-situ or for field mock-up testing. Common applications of this method have been comparison of water penetration rates of walls before and after repairs, and testing the efficacy of coatings. Alternative procedures are also provided to simulate the effect of local climatology on water penetration of masonry wall surfaces.

4.4 The outer surface of all masonry walls will experience water penetration when subjected to wind-driven rain. The resistance to water penetration is dependent on materials, workmanship, design, and maintenance. Some wall types accommodate large volumes of water penetration, without deleterious effects, through the presence of properly designed and installed drainage systems including flashing and weep holes. Use of this standard without consideration of the overall wall system may lead to incorrect conclusions regarding performance.

4.5 It is the intent of this standard that a sheet of water be developed and maintained on the wall surface during testing. In some cases, due to the surface texture of the masonry, the application of a coating, or other factors, a sheet of water will not consistently form. In those cases, results of this test method will likely be inaccurate.

4.6 This test method is similar to but distinct from the laboratory Test Method E 514. This field test method is designed to test in-situ walls. E 514 laboratory test method is designed to test laboratory wall specimens. This test method determines water penetration of the masonry at its surface. Test Method E 514 measures the water that has penetrated into and through the masonry specimen and is collected. Direct comparison of results from this test method and Test Method E 514 are inappropriate.

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[1] This test method is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.04 on Research.

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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.

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*A Summary of Changes section appears at the end of this standard.

5. Apparatus

5.1 *Test Chamber*—Use a test chamber similar to that shown in Fig. 1. Provide a rectangular opening with a minimum area of 12 ft² (1.08 m²) with a minimum dimension of 24 in. (0.6 m) for each side of the opening (Note 1). Seal the contact surface between the frame of the chamber and the test area to prevent loss of water and maintain air pressure. Cover the face of the chamber with a tough, transparent material capable of withstanding the test pressure (Note 2). Provide a ¾-in. (19-mm) diameter, corrosion-resistant, water spray pipe with a single line of 0.04-in. (1.0-mm) diameter holes spaced 1 in. (25 mm) apart, starting within 1 in. (25 mm) of each end (Note 3). Position the water spray pipe within the chamber so that the water impinges the wall perpendicular to the wall not more than 1.5 in. (40 mm) below the interior top of the test chamber.

Note 1—A size of 36 in. (0.9 m) wide and 48 in. (1.2 m) high is common.
Note 2—Transparent plastic sheets ³⁄₁₆ to ¼ inch (5 to 6 mm) thick have been shown to perform well. Plexiglas® and Lexan® are two products that have been used.
Note 3—Clean-outs at the end of the spray bar to facilitate cleaning the spray bar are common.

5.2 *Fixtures and Appurtenances to Chamber*—Fixtures and appurtenances to the chamber include an air line with manometer or pressure gauge able to read air pressure to within 0.50 lb/ft² (24 Pa), a water line with valves, a flow meter in the water supply line able to read flow within 0.02 gpm (4.5 L/h), and a water drain pipe at the bottom of the chamber. The water is stored in a calibrated reservoir with a minimum volume of 3 gal. (13 L), with graduations to allow readings within 0.015 gal (0.055 L) (Note 4). Pump water from the reservoir to the spray bar. Return water which drains from the bottom of the chamber directly to the reservoir.

Note 4—Use of a cylindrical reservoir having dimensions of approximately 4 to 8 inches (100 to 200 mm) in diameter by 5 ft. (1.5 m) or taller is common.

5.3 Other equipment includes devices for handling and mounting the chamber and measuring time, water quantities, and ambient temperature.

6. Hazards

6.1 The use of this test method requires careful design of both air chamber and support of the wall system to avoid possible injury due to equipment or masonry failure. Assure that the chamber and its attachment to the wall are adequate for the applied pressures during testing.

6.2 Water penetration resulting from this test can cause saturation of adjacent materials and leakage into occupied spaces of the buildings. Take into consideration the effects of potential water infiltration and leakage.

7. Procedure

7.1 *Mounting Chamber*—Attach the test chamber with mechanical fasteners using sufficient pressure to form an air- and water-resistant seal (Note 5).

Note 5—Use of a gasket or sealant at the contact surface is common.
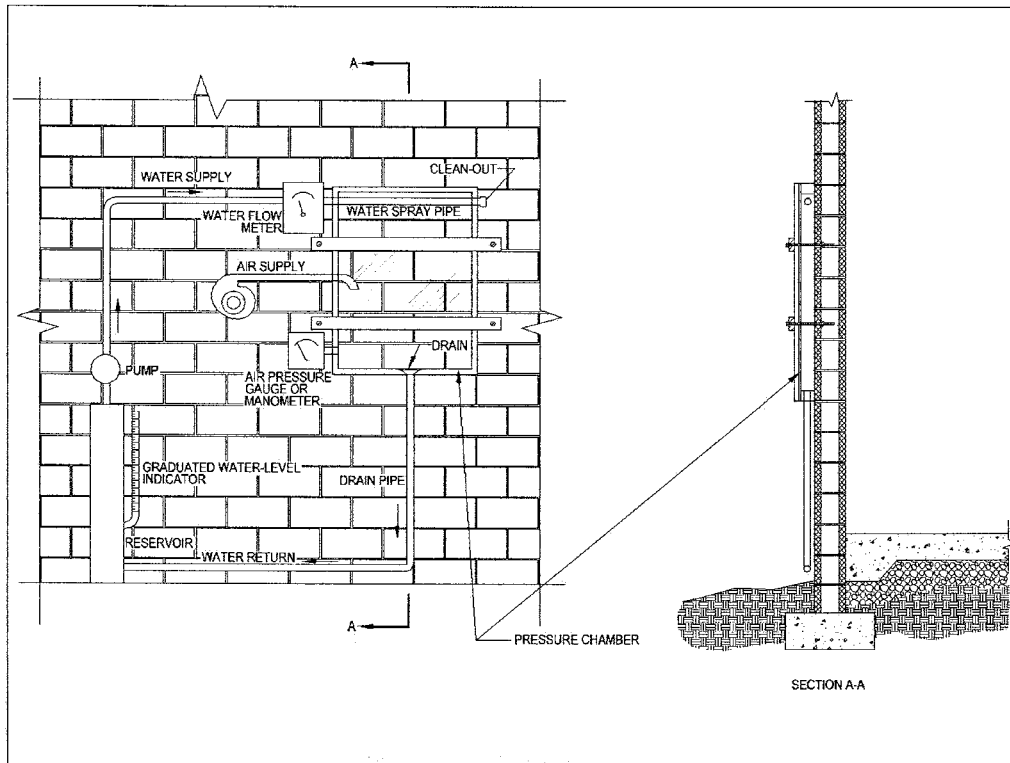

FIG. 1 Water Surface Penetration Test System

7.2 *Sealing*—If needed, apply a perimeter sealant between the chamber and wall surface to ensure that leakage does not occur at the interface. Allow the sealant to cure sufficiently to ensure adequate bond and water resistance.

7.3 *Application of Air Pressure and Water Flow*—Adjust the water flow rate to 3.4 gal/ft^2/h (138 L/m^2/h) times the area of the chamber opening. Simultaneously, increase the air pressure within the chamber to 10 lb/ft^2 (500 Pa). Check for leakage from the perimeter of the chamber. If leakage occurs, stop the test, reseal, and re-start the procedure.

7.3.1 During the test, note the flow pattern of the water over the masonry surface. If a complete sheet of water is observed, report it as "sheet flow". If the water runs down the surface in patterned or random riveted streams or in any other manner that leaves portions of the wall surface un-wetted, report it as "incomplete sheet flow" and document the pattern of flow with sketches drawn to scale. Monitor the water flow pattern during the testing and report any changes.

NOTE 6—It is the intent of this standard that a sheet of water be developed and maintained on the wall surface during testing. In some cases, due to the surface texture of the masonry, the application of a coating, or other factors, a sheet of water will not consistently form. In those cases, results of this test method will likely be inaccurate.

7.4 *Preconditioning*—Maintain the water flow rate and pressure specified in 7.3 for 30 minutes prior to starting the test. During the last five minutes of this period, adjust the water flow rate and air pressure to the specified test parameters.

7.5 *Standard Test Conditions*—Perform this test using a water flow rate of 3.4 gal/ft^2/h (138 L/m^2/h) and an air pressure of 10 lb/ft^2 (500 Pa). The test duration shall be not less than four hours after the preconditioning period.

7.6 *Alternate Test Conditions*—Special condition testing specified to model different water flow rates or chamber air pressures are acceptable. Procedures for specifying the testing parameters using local climatological data are provided in 7.6.1 and 7.6.2.

7.6.1 *Testing Parameter Determination Using Local Weather Data*—This procedure utilizes local weather data (wind speeds and rainfall intensity) to produce testing parameters (water flow rate, air pressure, and duration of test) for water chamber testing of vertical surfaces. The conversion is accomplished using a numerical approach. The weather data can be obtained from various sources, including the National Climatological Data Center. This procedure does not address the methods used to select weather data nor does it address the significance of using those data in chamber testing.

7.6.2 *Water Flow Rates and Air Pressures*

7.6.2.1 Determine the angle of rainfall, θ, for each time period using wind speed, rainfall intensity, and interpolating using values in Table 1. A time period is the length of time over which the water and air pressures are held constant. A test may consist of one or more time periods.

7.6.2.2 Calculate water flow rate for each period using:

$$Q_0 = 0.0104 \, I \tan\theta \, A \tag{1}$$

where:
Q_0 = water flow rate (gpm)
I = rainfall intensity (in/h)
θ = rainfall angle, measured from vertical (degrees)
A = area of test chamber opening (ft^2)

The flow rate, Q_0, shall not be less than that required to produce streams of water from the spray bar which impact the surface of the test area.

7.6.2.3 Determine the air pressure for each period:

$$P_0 = 0.00256V^2 \tag{2}$$

where:
P_0 = air pressure (lb/ft^2)
V = wind speed (mph)

7.6.3 *Duration of Test*

7.6.3.1 *Real-Time Tests:* Use the time duration of the weather data to be simulated, water flow rates and air pressures for each period within the duration as determined in 7.6.2.2 and 7.6.2.3.

7.6.3.2 *Compressed Time Tests:* Use shorter time periods than actual weather data and modified water flow rates and air pressures based on the shortened periods. Determine the flow rate for each period using:

$$Q = Q_0 \frac{D_0}{D} \tag{3}$$

where:
Q = water flow rate (gpm)
Q_0 = the water flow rate from Eq 1 (gpm)
D = the duration to be used for the test (h)
D_0 = the duration of weather data to be simulated (h)

TABLE 1 Angle of Rainfall, θ, in Degrees Measured from Vertical, for Selected Wind Speeds and Rainfall Intensities

Wind Speed, V (mph)	Rainfall Intensity, I (in/h)						
	0.01	0.04	0.16	0.60	1.60	4.00	10.00
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.5	41.3	19.2	9.9	7.2	5.5	4.2	3.9
3	60.8	34.6	19.3	14.2	10.8	8.4	7.8
5	71.7	48.8	30.1	22.9	17.6	13.9	12.9
7.5	77.7	59.7	40.9	32.2	25.4	20.3	18.9
10	80.9	66.6	49.2	40.1	32.3	26.3	24.5
15	83.8	73.6	59.7	51.2	43.2	36.3	34.2
20	85.4	77.7	66.6	59.1	51.5	44.4	42.2
25	86.4	80.2	71.0	64.6	57.6	50.9	48.6
35	87.4	82.9	76.0	71.0	65.3	59.5	57.5
50	88.1	85.0	80.0	76.4	72.1	67.5	65.8
75	88.8	86.6	83.3	80.7	77.7	74.4	73.2

Determine air pressure for each period using:

$$P = P_0 \left(\frac{D_0}{D}\right)^2 \qquad (4)$$

where:
P = air pressure (lb/ft^2)
P_0 = the air pressure from Eq 2 (lb/ft^2)

7.6.3.2.1 The test pressure, P, shall not exceed that capacity of the chamber and its anchorage to the wall.

7.6.3.3 For tests involving multiple compressed time periods, maintain the same number of periods for the compressed test as for the weather data to be simulated.

8. Record of Observations

Make observations and measurements during the pre-conditioning and each test period as follows:

8.1 Record the initial water flow rate, air pressure within the chamber, and water level within the reservoir at the beginning of the test after the specified preconditioning period.

8.2 Report the water flow pattern as described in 7.3.1.

8.3 Record the water level in the reservoir, air pressure, and water flow rate at the beginning of, at the end of, and at 5-minute (maximum) intervals throughout each test period.

8.4 Record the amount and time at which water is added to replenish the reservoir. Simultaneously, record the new water level with each addition of water to the reservoir.

8.5 Note and photograph visible lateral and vertical migration of dampness outside the chamber. Note leakage from adjacent areas. Note signs of interior moisture or leakage where accessible. Note any interruptions in testing including length of time and reason.

9. Calculations

9.1 Calculate water loss, to the nearest 0.025 gal (0.1 L), from the reservoir at each recorded time interval.

9.2 Plot the loss of water versus time.

9.3 Calculate surface penetration in gal/ft^2/hr (L/m^2/hr) for each period of testing by performing a linear regression fit using all data for that period versus time and dividing the rate of water loss by the area of the chamber opening.

10. Report

Report the following:

10.1 The project name and address of the building;

10.2 Date, time, and temperature during the test;

10.3 Dates and results of previous tests of same area, if applicable;

10.4 Name(s) and address(es) of individual(s) performing the test;

10.5 Description of the construction of the area tested including surface coatings, masonry type, wall assembly structural system, condition of the masonry surface (see Note 7), chamber location including elevation, floor level and position relative to wall ends or openings in the structure, and repairs performed prior to each test;

Note 7—Examples of masonry surface conditions include presence of cracks, deteriorated units, and so forth.

10.6 Description of chamber construction and attachment to wall;

10.7 Statement of test conditions per 7.5 and 7.6, as applicable;

10.8 Record of observations from Section 8; and

10.9 Results of calculations and graphs from 7.6.1, 7.6.2 (as required), and Section 9.

11. Precision and Bias

11.1 *Precision*—Information regarding the precision of this test method for measuring the water penetration of masonry wall surfaces is being collected.

11.2 *Bias*—No information is presented regarding the bias of this test method for measuring water penetration of masonry wall surfaces because this performance characteristic is defined by this test method.

12. Keywords

12.1 field testing; leakage; masonry; water penetration; water testing; wind-driven rain

SUMMARY OF CHANGES

Committee C15 has identified the location of selected changes to this standard since the last issue (C 1601 – 06) that may impact the use of this standard. (Approved Nov. 1, 2008.)

(*1*) Eq 1 of 7.6.2.2 was modified to correct a math operator error with the area term.