Designation: ~~C1601 – 22~~ C1601 – 22a

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

This standard is issued under the fixed designation C1601; 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. This test method is not identical to and the results are not the same as laboratory standard Test Method E514/E514M. Test Method E514/E514M measures through-wall water penetration, whereas this test method only measures surface water penetration.

1.2 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.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1232 Terminology for Masonry

E514/E514M Test Method for Water Penetration and Leakage Through Masonry

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *dampness, n*—visual change in the appearance of a material due to the presence of water.

3.1.2 *surface water penetration, n*—passage of water through the exterior face of the masonry.

3.1.3 *through-wall water penetration, n*—passage of water through a wall and appearance of water on the interior face of the masonry.

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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.

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

3.1.4 *water penetration, n*—water that passes into or through the masonry.

3.1.5 *wind-driven rain, n*—rain water that is directed against the surface of the wall by wind.

3.2 For definitions of terms used in this test method, refer to Terminology C1232.

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. The test method 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 measure the rate of surface water penetration for in-situ masonry and field mockups. 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 E514/E514M. This standard is a field test method designed to test in-situ walls and measures water penetration of masonry at its surface. Test Method E514/E514M is a laboratory test method designed to test laboratory fabricated wall specimens and measures the water that has penetrated into and through the masonry specimen and is collected. Results from this standard and Test Method E514/E514M are not the same.

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 ft^2 (1.08 m^2) 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 in. (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/ft^2 (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

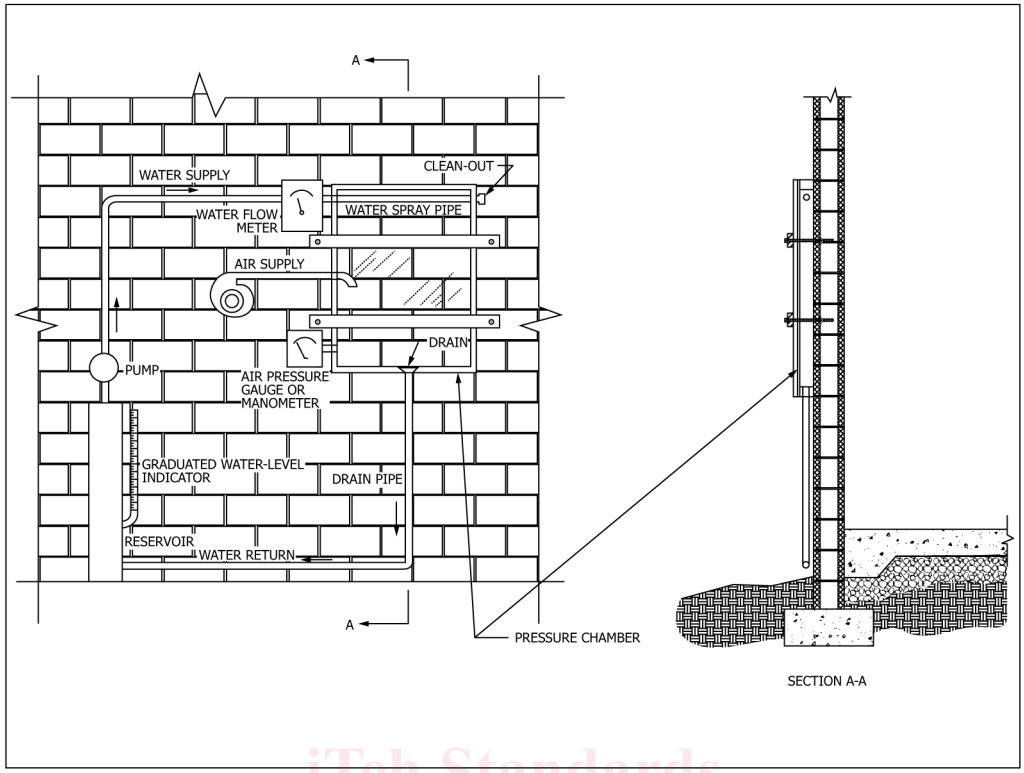

FIG. 1 Water Surface Penetration Test System

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 in. (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. (See Note 6.)

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 (Note 6).

NOTE 6—Applying sealant directly to the face of the masonry should be avoided since it may permanently damage the wall surface. Other methods such

as applying non-marking flexible tape that will conform to the masonry's surface texture prior to applying sealant should be considered to avoid defacing the masonry.

7.3 *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).

7.3.1 *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.

7.3.2 During the test, record the test observations in accordance with Section 8. This includes the test parameters at the beginning of the test and at intervals throughout the test as well as the water flow pattern.

7.3.3 *Duration*—The test shall be performed until a steady state penetration rate ~~occurs.~~ occurs or for 4 hours. A steady state penetration rate is deemed to be achieved when the linear fit of the water penetration versus time as calculated in accordance with 9.4 produces a coefficient of correlation (R^2) of 0.94 or greater over a minimum of a one-hour period (see Note 7). ~~If real time monitoring of penetration rate is not feasible onsite, then run the test for 4 h.~~

NOTE 7—In many tests there may be an initial conditioning period of time, typically 5 to 60 minutes, at the beginning of the test where the penetration rate is not linear. This is due to a number of factors including the moisture content of the masonry at the time of the test and the absorption rate of the mortar and masonry units. While it is important to record and report all of the data from the start of the test, the data points from this initial conditioning period can be removed from the data set when determining the steady state penetration rate using the linear fit of the water penetration versus time calculation as long as the test is continued for a minimum of ~~a~~ one-hour after this initial conditioning period.

7.4 *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 7.4.1 and 7.4.2.

7.4.1 *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.

7.4.2 *Water Flow Rates and Air Pressures:*

7.4.2.1 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.

7.4.2.2 Calculate water flow rate for each period using:

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

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

~~Wind Speed, V (mph)~~ Wind Speed, V (mph)	~~Rainfall Intensity, I (in/h)~~ 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

where:

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