Designation: E514/E514M – 14a

Standard Test Method for Water Penetration and Leakage Through Masonry[1]

This standard is issued under the fixed designation E514/E514M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This laboratory test method[2] provides a procedure for determining the resistance to water penetration and leakage through unit masonry subjected to wind-driven rain. This test method is not identical to and the results are not the same as field standard Test Method C1601. This test method measures through-wall water penetration, whereas Test Method C1601 only measures surface water penetration.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the 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 and health practices and determine the applicability of regulatory limitations prior to use.* For a specific hazard statement, see Section 6.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C270 Specification for Mortar for Unit Masonry

C1232 Terminology of Masonry

C1601 Test Method for Field Determination of Water Penetration of Masonry Wall Surfaces

2.2 *The Masonry Society Standards:*[4]

TMS 402/ACI 530/ASCE 5 Building Code Requirements for Masonry Structures

TMS 602/ACI 530.1/ASCE 6 Specifications for Masonry Structures

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 the water on the interior face of the masonry.

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 other terms used in this test method, refer to Terminology C1232.

4. Significance and Use

4.1 This test method provides information that aids in evaluating the effect of four principal variables: materials, coatings, wall design, and workmanship.

4.2 Water penetration and leakage through masonry is significantly affected by air pressure in the test chamber. Data from tests made at different pressures are not comparable.

4.3 The performance of a masonry wall is a function of materials, construction, wall design, and maintenance. In service the performance will also depend on the rigidity of supporting structure and on the resistance of components to deterioration by various causes, such as corrosion, vibration, thermal expansion and contraction, curing, and others. It is impossible to simulate the complex conditions encountered in

[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] This test method is based upon those used by the National Bureau of Standards and described in *NBS Report BMS7*, "Water Permeability of Masonry Walls," 1933, and *NBS Report BMS82*, "Water Permeability of Walls Built of Masonry Units," 1942.

[3] 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.

[4] Published by The Masonry Society, www.masonrysociety.org; American Concrete Institute, www.aci-int.org; and American Society of Civil Engineers, www.asce.org.

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

service, such as variations in wind velocity, negative pressure, and lateral or upward moving air and water. Factors such as location, exposure, and wall openings should be considered.

4.4 Given the complexity of variables noted above, this test method establishes comparative behavior between various masonry wall constructions in a given laboratory.

4.5 Even when a single laboratory tests the same wall design utilizing the same wall materials and the same construction practices, variables such as the level of skill of the mason building the specimen, the temperature and humidity in the laboratory at the time of construction, curing of the specimen, the moisture contents of the materials used to build the specimen, and even the use or lack of use of a lime and water wash on the back of the specimen can affect the results of the test making reliable comparisons dubious. For these reasons and the multi-variables listed in 4.1, 4.2, and 4.3, a meaningful, useful, absolute wall leakage rating standard is impractical and discouraged.

4.6 This test method is similar to but distinct from field Test Method C1601. This laboratory test method is designed to test laboratory fabricated wall specimens. Field Test Method C1601 is designed to test in-situ walls. This test method measures the water that has penetrated into and through the masonry specimen and is collected. Test Method C1601 determines water penetration of the masonry at its surface. Results from Test Method C1601 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 and Fig. 2. Provide an opening with a minimum area of 1.08 m^2 [12 ft^2]. For example, 900 mm [36 in.] wide and 1200 mm [48 in.] high is suitable. Line the edges of the chamber in contact with the specimen with a closed-cell compressible gasket material or appropriate sealant. Provide an observation port in the face of the chamber. Provide a 19.0-mm [¾-in.] diameter corrosion-resistant spray pipe with a single line of 1.0-mm [0.04-in.] diameter holes spaced 25.0 mm [1 in.] apart.

5.2 *Fixtures and Appurtenances to Chamber*—Fixtures and appurtenances to the chamber shall include an air line with manometer, a water line with valves, a flow meter and manometer and a water drain pipe at the bottom of the chamber. Position the water spray pipe so that the water impinges the specimen not more than 75.0 mm [3.00 in.] below the top of the test chamber.

NOTE 1—A drain pipe that discharges into a reservoir equipped with an adjustable depth air outlet pipe and top baffles has been found to reduce surge.

5.3 *Manometer*—Measure the air pressure in the chamber using a manometer or other device capable of measuring air pressures of at least 51 mm [2.0 in.] of water (71.7 kPa [10.4 psf]) to an accuracy of 2.5 mm [0.1 in.] or 3.6 kPa [0.52 psf]. Connect the manometer or other device to the chamber

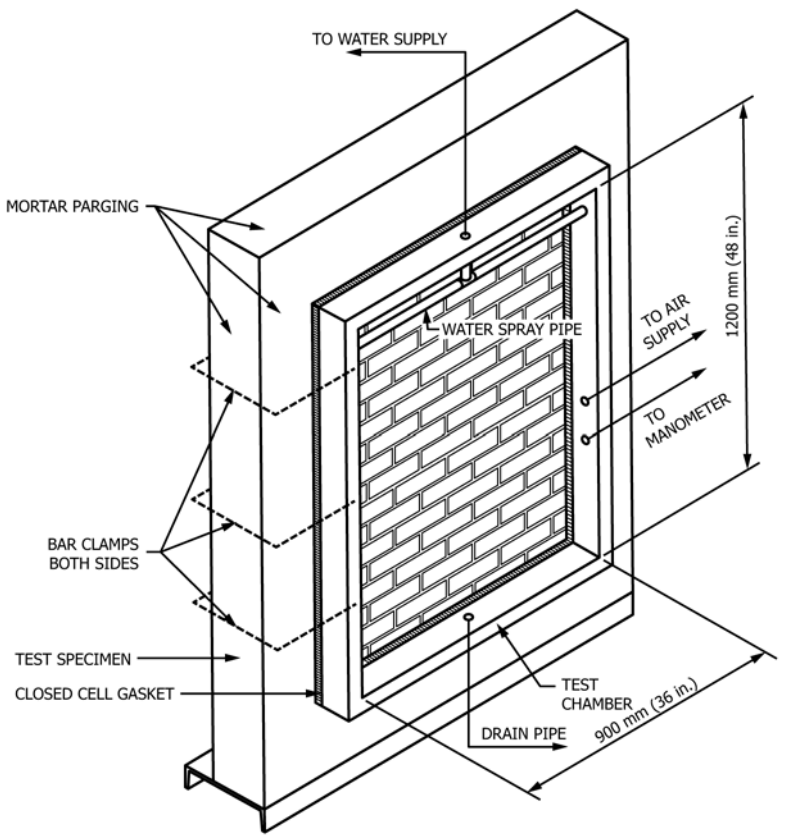

FIG. 1 Isometric Projection of Testing Chamber

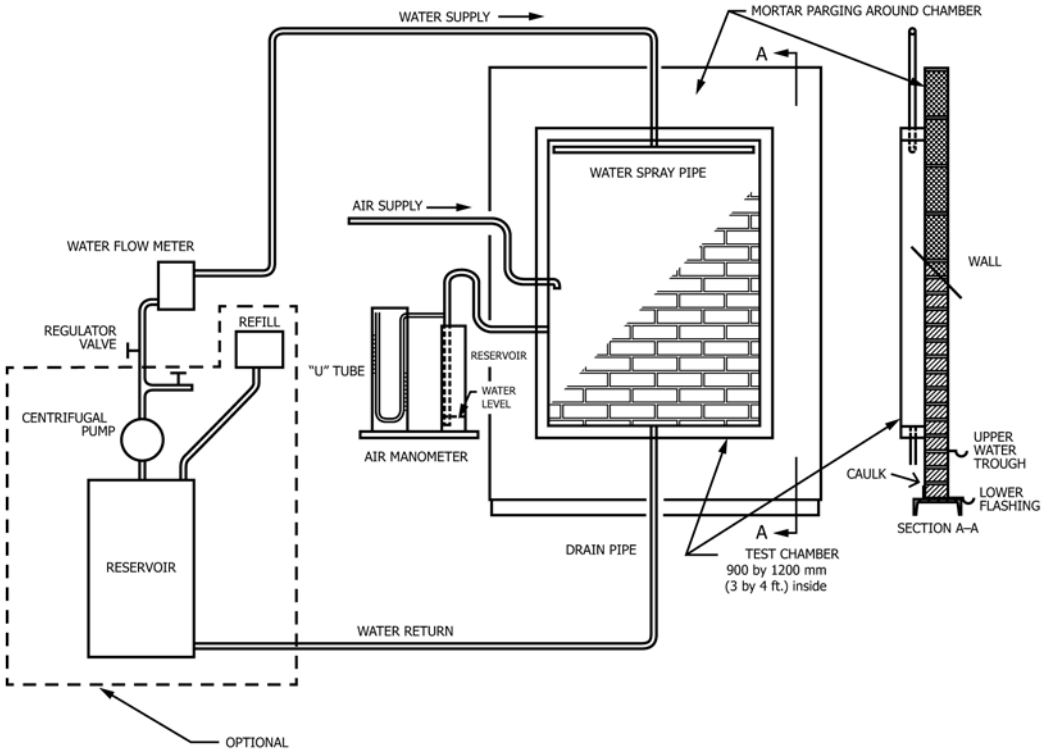

FIG. 2 General Arrangement of Water Penetration Testing Chamber System

away from the air inlet so that the air flow will not significantly influence the pressure reading.

5.4 Other equipment includes devices for handling the specimen and measuring time, water quantities, temperature, and humidity.

6. Hazards

6.1 The use of this test method will require careful design consideration of both air chamber and support of the wall system to avoid possible injury due to equipment or specimen failure.

7. Temperature and Humidity Conditions

7.1 Maintain the air in the laboratory at a temperature of 24 ± 8°C [75 ± 15°F] and a relative humidity of 55 ± 25 %.

8. Test Specimens

8.1 *Masonry Materials*—Masonry and associated materials shall be representative of the construction or the materials that are being considered. Precondition all materials by storing in laboratory environment for not less than 5 days before use.

8.2 *Size of Test Walls*—The height and length of the specimen shall provide a minimum of 1.08 m^2 [12 ft^2] exposed to the test, plus at least a 200-mm [8-in.] overlap on all edges. The minimum height or length of the specimen shall be 1.22 m [4 ft]. The length of the specimen shall be such that at least one head joint in each course of masonry is exposed to the test.

8.3 *Building Wall Specimens*—Construct the specimen using methods and workmanship being considered for the work (Note 2). Build the wall specimen on an inverted steel channel section as shown in Fig. 2 (Note 3). Also, as shown in Fig. 2, build a lower flashing and upper water trough as described in 8.3.1 and 8.3.2.

NOTE 2—Standards for masonry construction are contained in the following documents: TMS 402/ACI 530/ASCE 5 Building Code Requirements for Masonry Structures and TMS 602/ACI 530.1/ASCE 6 Specifications for Masonry Structures.

NOTE 3—The top of the wall may require bracing to be stable.

8.3.1 Install a lower flashing into a mortar joint that is at least one course below the upper water trough. Pass the lower flashing completely through the wall, upturn it on the chamber side, and seal with a bead of caulk. Project this lower flashing out from the backside of the wall with a *u* or *v* profile designed to funnel water that passes through the bottom of the wall into a collection device.

8.3.2 Install an upper water trough in the bed joint immediately below the bottom of the test chamber. Project the upper water trough no more than 25 mm [1.0 in.], or no more than the thickness of a face shell, into a mortar joint on the backside of the wall. Project this upper water trough out from the backside of the wall with a *u* or *v* profile designed to funnel water that penetrates through the wall above the trough into a separate collection device.

8.4 *Number of Specimens*—Test at least 3 specimens.

8.5 *Storage of Specimens*—Retain specimens in the laboratory during storage enclosed in an impervious plastic wrap immediately after construction and cured in this manner for 7 days. After 7 days, remove the wrap and continue curing for at least 7 more days in laboratory air.

9. Procedure

9.1 Apply a 10-mm [⅜-in.] minimum thick coat of mortar parging to all exposed surfaces of the specimen except the back side of the wall and the area enclosed by the test chamber.

9.1.1 For walls constructed with solid units and for walls constructed with hollow units which are filled solid with grout or other materials, apply a minimum 10 mm [⅜ in.] thick coat of mortar parging to the top surface of the specimen. For walls with open cells or cavities, seal an impervious material such as a transparent plastic sheet capable of withstanding the test pressure to the top of the wall to prevent evaporation or air movement through the top of the wall. If the top covering is removed to permit viewing or photographing inside these void spaces, do not remove for longer than 10 min per hour of testing.

NOTE 4—Historically, 10 mm [⅜ in.] thick mortar parging has been used as an air and moisture barrier on all exposed surfaces except the backside of the wall and the area enclosed by the test chamber. Alternative coating materials may be used if they provide resistance to movement of air and moisture that is the same as or greater than the mortar parging. Research has found that typical parge coats of Specification C270 proportioned mortars have air permeances in the approximate range of 7.5×10^{-4} to 7.5×10^{-3} l/(s·m^2)[1.5×10^{-4} to 1.5×10^{-3} ft^3/min/ft ^{2}] and water vapor permeances of approximately 1400 to 3100 ng/(s·m^2·Pa) [25 to 55 perm]. Using a coating as a substitute material may not be appropriate for highly irregular surfaces such as split face architectural concrete masonry units because of difficulty of obtaining a seal with the test chamber. In those cases, a 10 mm [⅜ in.] thick parge coat of mortar provides a smooth surface to facilitate establishment of a seal.

NOTE 5—A lime and water wash may be brush applied to back face of the wall to make moisture detection easier on dark surfaces. A portland cement and water wash should not be used.

9.2 *Mounting Chamber*—Position the test chamber on the specimen and clamp firmly in place, compressing the gasket or applying a sealant to form a seal.

NOTE 6—Too much clamping force could crack the specimen.

9.3 Adjust the rate of water application to 138 L/m^2 [3.4 gal/ft^2] of wall per hour.

9.4 Simultaneously with the application of water, increase the air pressure within the chamber. If the pressure is not specified, apply a pressure of 500 Pa [10 lbf/ft^2]. Supply slightly more air than is needed to maintain pressure and adjust, if necessary, to prevent excessive surge in the water reservoir.

9.5 Maintain the specified conditions for a period of not less than 4 h.

NOTE 7— Care should be taken in specifying the test duration. The test should be long enough to permit evaluation of the materials, coatings, design, and workmanship.

10. Record of Observation

10.1 During the 4 h of testing, make observations at 30-min intervals. If testing is extended beyond 4 h, establish observation intervals beyond 4 h as required to document specimen performance. Record the following:

10.1.1 Time of appearance of dampness on back of specimen.

10.1.2 Time of appearance of first visible water on the back of the specimen.

10.1.3 Area of dampness on back of wall expressed as a percent of the chamber area.

10.1.4 Total water collected from the upper water trough.

10.1.5 Total water collected from the lower flashing.

11. Retesting

11.1 If required, return the specimens to storage and retest at age 28 days or later and re-evaluate.

12. Report

12.1 Report the following information:

12.1.1 Description of all materials including coatings, masonry units, mortar materials, and composition of mortar used to construct the wall specimens, and their properties as determined by the appropriate standards.

12.1.2 Description of specimen wall design and details of construction. Include photographs and drawings as necessary.

12.1.3 If an alternative air and moisture barrier material is used as a substitute for the mortar parging at the sides and front of the test specimen, provide the type, minimum applied thickness, manufacturer, and brand name of the substitution material.

12.1.4 Detailed description of the quality of workmanship used in construction of test specimens.

12.1.5 Conditions of test.

12.1.6 Record of observations as required in Section 9.

12.1.7 Record of temperature and humidity in the laboratory during construction, curing, and test periods.

12.1.8 Age of test specimen at the time of test, and re-test, if applicable.

13. Precision and Bias

13.1 No statement is made either on the precision or on the bias of this test method for testing water penetration or leakage through masonry due to the test variables involved.

14. Keywords

14.1 air-pressure; laboratory test; manometer; masonry; simulated wind driven rain; test chamber; water penetration; water spray pipe

SUMMARY OF CHANGES

Committee C15 has identified the location of selected changes to this standard since the last issue (E514/E514M – 14) that may impact the use of this standard. (July 1, 2014)

(1) Old subsections 1.2 and 1.3 were consolidated into 1.1. *(2)* Keyword definitions in 3.1.2 and 3.1.3 were modified.