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Standard Guide for Evaluating Water Leakage of Building Walls¹

This standard is issued under the fixed designation E2128; 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 guide describes methods for determining and evaluating causes of water leakage of exterior walls. For this purpose, water penetration is considered leakage, and therefore problematic, if it exceeds the planned resistance or temporary retention and drainage capacity of the wall, is causing or is likely to cause premature deterioration of a building or its contents, or is adversely affecting the performance of other components. A wall is considered a system including its exterior and interior finishes, fenestration, structural components, and components for maintaining the building interior environment.

1.2 Investigative techniques discussed may be intrusive, disruptive, or destructive. It is the responsibility of the investigator to establish the limitations of use, to anticipate and advise of the destructive nature of some procedures, and to plan for patching and selective reconstruction as necessary.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.3.1 *Exception*—Solely inch-pound units are stated in 10.3.1, 10.3.2.1, X1.5.3.7, X2.5.1.3, X3.4.3.3, X5.1.2.2, X5.5.5, X5.6.3, and X8.5.1.3.

1.4 *This practice does not purport to address all of the safety concerns, if any, associated with its use. Establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. Awareness of safety and familiarity with safe procedures are particularly important for above-ground operations on the exterior of a building and destructive investigative procedures which typically are associated with the work described in this guide.*

1.5 *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

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

C1715/C1715M Test Method for Evaluation of Water Leakage Performance of Masonry Wall Drainage Systems

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

E860 Practice for Examining And Preparing Items That Are Or May Become Involved In Criminal or Civil Litigation

E1105 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

E1188 Practice for Collection and Preservation of Information and Physical Items by a Technical Investigator

2.2 AAMA Standards:³

AAMA 501.2 Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems

AAMA 511 Voluntary Guideline for Forensic Water Penetration Testing of Fenestration Products, Article 4.2.1.3.1 Optional Sill Dam Test (This test method previously appeared in AAMA 502.)

3. Terminology

3.1 *Definitions*—Refer to Terminology E631.

¹ This guide is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.55 on Performance of Building Enclosures.

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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>.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *incidental water, n*—unplanned water infiltration that penetrates beyond the primary barrier and the flashing or secondary barrier system, of such limited volume that it can escape or evaporate without causing adverse consequences.

3.2.2 *water absorption, n*—a process in which a material takes in water through its pores and interstices and retains it wholly without transmission.

3.2.3 *water infiltration, n*—a process in which water passes through a material or between materials in a system and reaches a space that is not directly or intentionally exposed to the water source.

3.2.4 *water leakage, n*—water that is uncontrolled; exceeds the resistance, retention, or discharge capacity of the system; or causes subsequent damage or premature deterioration.

3.2.5 *water penetration, n*—a process in which water gains access into a material or system by passing through the surface exposed to the water source.

3.2.6 *water permeation, n*—a process in which water enters, flows, and spreads within and discharges from a material.

4. Significance and Use

4.1 This guide is intended to provide building professionals with a comprehensive methodology for evaluating water leakage through walls. It addresses the performance expectations and service history of a wall, the various components of a wall, and the interaction between these components and adjacent construction. It is not intended as a construction quality control procedure, nor as a preconstruction qualification procedure. It is intended for evaluating buildings that exhibit water leakage.

4.1.1 *Qualifications*—This guide requires the evaluator to possess a knowledge of basic physics and of construction and wall design principles and practices.

4.1.2 *Application*—The sequential activities described herein are intended to produce a complete and comprehensive evaluation program, but all activities may not be applicable or necessary for a particular evaluation program. It is the responsibility of the professional using this guide to determine the activities and sequence necessary to properly perform an appropriate leakage evaluation for a specific building.

4.1.3 *Preliminary Assessment*—A preliminary assessment may indicate that water leakage problems are limited to a specific element or portion of a wall. The preliminary assessment may also indicate that the wall is not the source of a leak even though it is perceived as such by the building occupant. The presence of water might result from a roofing problem, a condensation problem, a plumbing problem, operable windows or doors left opened or unlatched or some other condition not directly related to water leakage through the building wall and is outside the scope of this guide. The evaluation of causes may likewise be limited in scope, and the procedures recommended herein abridged according to the professional judgement of the evaluator. A statement stipulating the limits of the investigation should be included in the report.

4.1.4 *Expectations*—Expectations about the overall effectiveness of an evaluation program must be reasonable and in proportion to a defined scope of work and the effort and

resources applied to the task. The objective is to be as comprehensive as possible within a defined scope of work. The methodology in this guide is intended to address intrinsic leakage behavior properties of a wall system, leading to conclusions that generally apply to similar locations on the building. Since every possible location is not included in an evaluation program, it is probable that every leak source will not be identified. Leakage sources that are localized and unique may remain and may require additional localized evaluation effort. The potential results and benefits of the evaluation program should not be over-represented.

4.2 This guide is not intended as a design guide or as a guide specification. Reference is made to design features of a wall only for the purpose of identifying items of interest for consideration in the evaluation process.

4.3 This guide does not address leakage through roofs, leakage below grade, or water that accumulates due to water vapor migration and condensation. It is not intended for use with structures designed to retain water, such as pools and fountains.

SYSTEMATIC APPROACH TO AN EVALUATION

5. Overview

5.1 The methodology presented in this guide is a systematic approach to evaluating wall leaks and is applicable to any wall system or material. It differs from other approaches that are material specific or component specific and which are basically adaptations of quality control procedures. The sequence of activities is intended to lead to an accumulation of information in an orderly and efficient manner, so that each step enhances and supplements the information gathered in the preceding step.

5.1.1 *Sequence of Activities*—The recommended sequence of activities, discussed in individual sections below, are:

- 5.1.1.1 Review of project documents.
- 5.1.1.2 Evaluation of design concept.
- 5.1.1.3 Determination of service history.
- 5.1.1.4 Inspection.
- 5.1.1.5 Investigative testing.
- 5.1.1.6 Analysis.
- 5.1.1.7 Report preparation.

5.1.2 The first four recommended activities, and their descriptions in the body of the guide, are: *6. Review of Project Documents*; *7. Evaluation of Design Concept*; *8. Determination of Service History*; and *9. Inspection*. These activities intentionally precede *10. Investigative Testing* because they facilitate a rational determination of the spectrum of conditions, and are the basis for a rational selection of investigative test locations and procedures.

5.2 The protocol in this guide is not based on conventional hypothesis testing and quantitative random sampling.⁴ The starting premise for the application of this guide is that the building is suspected or known to leak. The objective of this

⁴ Houghton, L.L., and Murphy, C.R., "Qualitative Sampling of the Building Envelope for Water Leakage," *Journal of ASTM International*, Vol 4, No. 9, paper ID JAI100815, 2007.

guide is qualitative, purposeful, and intended to address the question of why, how and to what extent a building leaks. A statement stipulating the limits of the investigation and the starting premise of the investigative program should be included in the report.

5.3 Scope of Investigation—It is not assumed or expected that all locations with similar design, construction and service characteristics will be currently performing in precisely the same manner. Likewise, it is not necessary to establish such in order to reach technically valid conclusions about why and how a building leaks. The evaluation of water leakage of building walls is a cognitive process in which technically valid conclusions are reached by the application of knowledge, experience and a rational methodology to determine the following:

5.3.1 The intrinsic properties of the wall.

5.3.2 The cause(s) and mechanism(s) of leakage.

5.3.3 The applicability of findings to similar un-inspected or un-tested locations on the building.

5.3.4 And, if within the scope of the evaluation, to acquire and report sufficient information to permit an assessment, within a reasonable degree of scientific certainty, of the likelihood of additional water leakage to occur arising from the conditions identified and the conclusions reached as a result of the evaluation.

5.4 Sampling—The recommended sampling method for the application of this guide is to consider the spectrum of wall conditions from apparently performing to apparently non-performing areas, and from un-deteriorated or un-damaged areas to deteriorated or damaged areas. It is also important to distinguish between varying conditions which may result from prior modifications or attempted repairs, and to determine the extent of sampling necessary to address and evaluate these variations in conditions.

5.5 Analysis and Interpretation—The information systematically gathered during a leakage evaluation is analyzed as it is acquired. The sequential activities described in this guide are not intended to imply that analysis and interpretation of the information occurs only at the completion of all activities.

6. Review of Project Documents

6.1 Ideally, project documents including wall component shop drawings will be available and accessible for review. The discussion in this section assumes that a project was organized on a conventional Owner/Architect/Contractor model. Building projects can be delivered in a variety of ways, and the actual method used will dictate the appropriate organization of the project documents. Regardless of how a project is organized and administered, the information discussed below should be available for review somewhere in the project documents.

6.1.1 Design, Bidding, and Contract Documents—These documents include architectural and engineering drawings and specifications and may also include calculations, wind tunnel reports, correspondence, meeting minutes, addenda, substitution proposals, product literature, test reports, etc. They contain the information necessary to understand the performance

criteria, the design intent, the required materials, and relationships among wall components.

6.1.1.1 Documents may be revised or supplemented over the course of construction. Revisions to drawings are typically recorded by number and date with a cross reference to other accompanying documents. Reviewing all revisions and issuances of the documents, and understanding the differences between them and the reason for the differences, is part of a comprehensive evaluation.

6.1.1.2 Documents with the most recent issue date and the highest revision number establish the requirements for the project. Ideally, a set of documents marked “as-built” or “record set” intended to show the actual construction will be available.

6.2 Referenced Codes and Standards—Project documents usually contain references to regulatory codes and industry standards. Standards and referenced codes often contain default or minimum criteria that might have been relied upon to establish the performance criteria for the wall. Conflicting requirements between referenced standards and codes, and those explicitly stated in the project documents, should not be assumed to be a cause of leakage without further investigation.

6.2.1 Regulatory codes and industry standards change over time. The version of regulatory codes and industry standards examined as part of the review of project documents should be those listed with dates in the project documents, or if not listed with dates, those in effect when the building permit was issued. Understanding the history and background of referenced codes and standards is part of a comprehensive evaluation.

6.3 Submittals—Additional documents are generated after the award of contracts and are submitted to the design professional for review and inclusion in the project record. The submittals usually apply to a specific material, component, assembly, or installation method; and the information contained will augment the project documents. There are often a number of revisions to submittals prior to final approval. The standard for the project is set by the submittals approved by the design professional. Submittals include some or all of the following: shop drawings, test reports, product literature, manufacturers’ recommendations, installation and maintenance guidelines, warranties, etc.

6.3.1 Test reports provided by manufacturers and suppliers should have been performed by an independent laboratory or witnessed by an independent agency. Review the test dates and the description of what was tested to determine if and how the information actually applies to the project.

6.3.2 Manufacturers’ and suppliers’ information, and the exclusionary language in warranties, may suggest circumstances under which a component may not function properly. Project conditions should be evaluated to determine if an appropriate product selection was made.

6.3.3 Submittals should be reviewed for maintenance recommendations and guidelines.

6.4 Pre-Qualification and Mock-Up Reports—Compliance with project requirements may have been demonstrated by a mock-up test. Mock-ups of complex wall systems rarely pass all tests on the first attempt. The mock-up report should contain