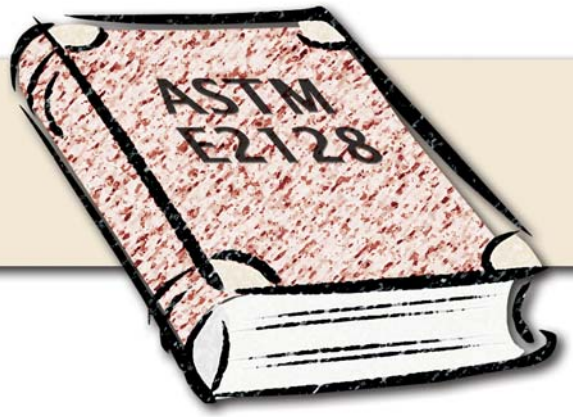
OVERVIEW OF ASTM E2128



(Standard Guide for Evaluating Water Leakage of Building Walls)

By Lonnie Haughton and Colin Murphy, RRC, FRCI

The authors of this article have long been strong proponents of the merits of ASTM E2128-01a, Standard Guide for Evaluating Water Leakage of Building Walls, published in January 2002 by ASTM International (see *Figure 1*). Jointly and separately, we have pointed a spotlight on this excellent standard in a variety of nationwide forums and industry publications, including an RCI symposium in 2003; an ASTM symposium in 2006; a peer-reviewed paper published in the *Journal of ASTM International* in 2007; a FEWA symposium in 2008; an *Interface* article in 2008; and an RCI symposium in 2010.

To a large degree, our past praise for ASTM E2128 has centered on the guidance found in the Investigative Testing and the Analysis sections of this standard; however, the overall breadth and depth of ASTM E2128 is exemplary. Consider, for example, the tightly focused but surprisingly bold scope of this seminal publication:

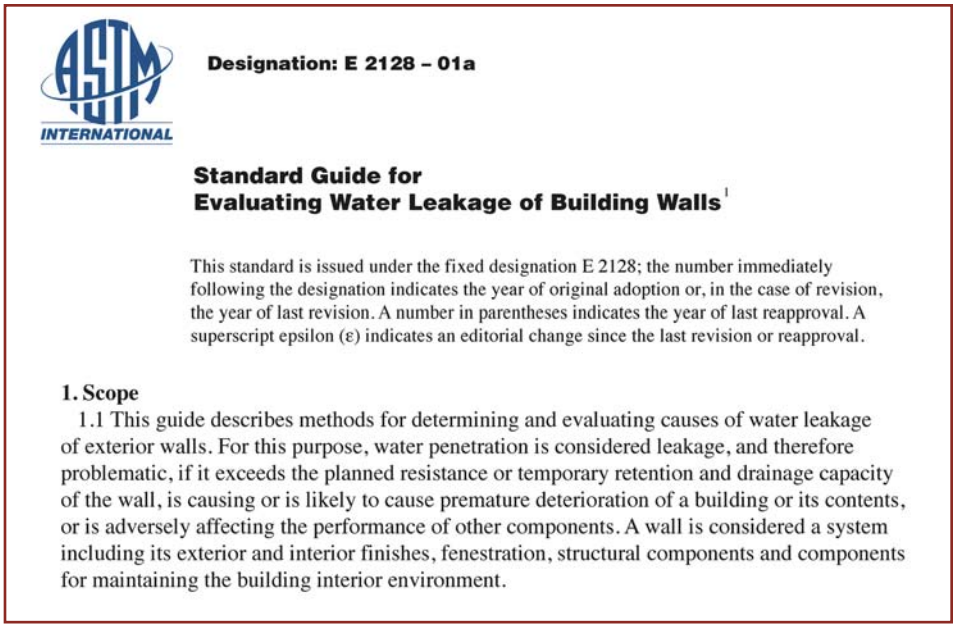
- This guide describes methods for determining and evaluating causes of water leakage of exterior walls.
- This guide is intended to provide building professionals with a comprehensive methodology for evaluating water leakage through walls. It addresses the performance expectations and service history of a wall, the various components of a wall, and the interaction between these components and adjacent construction.

The 35-page document (including 23 pages of "nonmandatory" appendices) provides concise, carefully worded guidance on carrying out a "systematic approach to an evaluation." The recommended process includes:

1) Review of project documents,
2) Evaluation of the wall's design concept,
3) Determination of the building's service history,
4) Inspection,
5) Investigative testing,
6) Analysis, and
7) Report preparation.

The authors of ASTM E2128 note that this proposed "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."

The first three activities in the recommended investigation sequence can be classified as the initial homework to be completed before the investigators set foot on the property. This ensures that the investigative team is well prepared for any variables it may encounter. The review process should include a thorough understanding



Designation: E 2128 – 01a

Standard Guide for Evaluating Water Leakage of Building Walls[1]

This standard is issued under the fixed designation E 2128; 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.

Figure 1 – ASTM E2128-01a, Standard Guide for Evaluating Water Leakage of Building Walls, published in January 2002 by ASTM International.

of local construction practices. The project's specified performance requirements must be consistent with the wall design. Careful evaluation of the efficacy of the existing design relative to the building's performance specifications may indicate inconsistencies that could contribute to leakage.

The service history includes maintenance and remediation records that identify where and when water leakage has occurred in the past and what type of repairs have been carried out to correct these conditions. The authors of ASTM E2128 report, "Gathering information on service history related to leakage problems serves several purposes. First, patterns in the observed leakage and visible damage can provide an indication of the cause(s) and where to focus the investigation. Second, and more importantly, the information provides a checklist against which failure theories and conclusions can be evaluated."

Inspection techniques and methods range from visual surveys using binoculars to close documentation of existing conditions to destructive openings into the building envelope (see *Photo 1*). The experienced investigator has numerous options for intrusive and nonintrusive testing, including inspection mirrors, fiber-optic borescopes, moisture detectors, and infrared thermography. The authors of ASTM E2128 state, "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."

Field testing commonly is carried out "to verify and extend hypotheses arrived at during the document review and inspection phases of the program using controlled and reproducible procedures." The goals of such investigative testing are to re-create leaks, to trace the internal path of a leak, to correlate test results with observed damage, and to verify previously developed hypotheses. *Photo 2* presents an example of field testing of a suspect window installation in general accordance with ASTM E1105.



Photo 1 – Test opening at EIFS-clad wall.

The authors of ASTM E2128 confirm that spray-nozzle "testing of isolated areas usually begins at the bottom of the test area and progresses vertically to the top as selective masking is removed or as selective testing with a calibrated nozzle advances. Starting at the bottom helps eliminate ambiguity about the origin of a leak that might result from water running vertically down the surface of the test area."

Article 11 of ASTM E2128 includes, in part, the following analytical protocol:

- An evaluation is conducted in response to a problem situation and a nonperforming wall and may involve several techniques and procedures specifically adapted and applied in a systematic manner to diagnose a specific problem.
- The information systematically accumulated in a leakage evaluation is analyzed as it is acquired. The new information may motivate a change in approach or focus for subsequent steps in the evaluation process.
- The evaluator is expected to establish a cause-and-effect relationship between wall characteristics and observed leakage. This requires an appropriate selection of activities and a logical analysis and interpretation of the acquired information.
- The conclusions and findings from an evaluation must be rationally based on the activities and procedures undertaken and the information acquired, if they are to be considered legitimate and substantiated.
- The record should be sufficiently complete so that any interested party can duplicate the evaluation program and acquire similar information. Notes on the analysis and interpretation of the acquired information should be clear and complete enough to be understood by any other building professional skilled in leakage evaluation.

In short, the authors of ASTM E2128 are prescribing a purposeful qualitative inquiry in which the goal of the skilled investigator is to produce findings that identify cause-and-effect relationships between building envelope characteristics and observed leakage and resulting damage. To this end, the building envelope professional must provide a record of the investigation and analysis that is sufficiently complete to enable another professional to duplicate the intertwined processes of observation, sampling, and analysis. The last step in this standard's investigative protocol is the development of "a report describing the conditions under which the



Photo 2 – Field testing of suspect window installation.

evaluation was conducted, the methodology used, the observations and measurements made, and the findings and conclusions."

Experienced building envelope professionals will recognize that, for a variety of legal and access considerations, not all investigations can be carried out in such an orderly and efficient manner. For example, it is not uncommon for numerous key project documents to be unavailable to leakage investigators. Such constraints and inconveniences do not diminish the value of the systematic approach recommended by authors of ASTM E2128, who are careful to define reasonable and realistic "expectations" for limited investigations and surveys:

> 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 require additional localized evaluation effort. The potential results and benefits of the evaluation program should not be over-represented.

Within ASTM E2128, the authors' extensive guidance regarding the recommended systematic evaluation process, then, is followed by a mandatory appendix that discusses the following:

a) The consequences of water leakage in exterior walls;
b) Performance criteria for exterior wall assemblies and fenestration;
c) Maintenance of exterior walls;
d) Sources of water leakage; and
e) Methods of resisting leaks.

Finally, the standard contains nonmandatory appendixes that briefly review the installation, weather-resistive performance, detailing, workmanship, inspection, and testing of the following exterior wall systems: sealants, masonry, windows, glass/metal curtain walls, exterior insulation finish systems (EIFS), cement stucco and tile systems, wood and wood-based siding systems, fiber-cement and cement-bonded particle board siding systems, and precast concrete panels.

In short, ASTM E2128 contains a wealth of information and guidance for consultants, designers, and builders. We have the utmost respect for the ASTM committee members who were willing to volunteer their

extended service toward producing this excellent standard. Our admiration extends further when we consider the general excellence of their results. Certainly it is true that any such broadly brushed document can foster a few quibbles of criticism if reviewed with a narrow lens, but the standard as a whole represents a laudable and highly successful effort to promote and advance the field of professional evaluations of water leakage conditions at exterior walls.

The merits of the investigative protocol promulgated by ASTM E2128 also have been recognized by the authors of the relatively recent industry standard, AAMA 511-08, Voluntary Guideline for Forensic Water Penetration Testing of Fenestration Products, published by the American Architectural Manufacturers Association:

> ASTM E2128 provides the foundation for field investigations of water leakage in building walls. This document is designed to provide supplemental guidance and highlight required information and actions regarding fenestration product investigations. ASTM E2128 identifies seven steps of forensic investigations, and this document provides additional information regarding each step, grouped into two categories: four steps prior to testing and three steps during and after testing.

In summary, ASTM E2128 presents a clear and concise protocol for the evaluation of exterior wall systems that have known or suspected water leakage. The standard's qualitative approach to data collection and field evaluation establishes a logical, comprehensive, and cost-effective methodology for conducting building envelope investigations. We highly recommend close review of this seminal standard by consultants, designers, and builders across North America.

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