ABTG

Research Report

Water-Resistive Barriers:
Assuring Consistent Assembly Water-Penetration Resistance

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of the American Chemistry Council

Report Written by:

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Introduction:

Water-resistive barriers (weather-resistant sheathing paper) (WRB) have been required by the model building codes for many years and have been required by the International Code Council model codes since their inception in 2000. Currently, the code defined benchmark for a WRB is stated in *2018 IBC* Section 1403.2 and *2018 IRC* Section R703.2 as, "... one layer of No.15 asphalt felt, free from holes and breaks, complying with ASTM D226 for Type 1 felt or other approved water-resistive barrier shall be applied over studs or sheathing of all exterior walls." To identify these "other approved WRB's", a number of consensus standards and evaluation agency criteria have been developed to address equivalency to the code. Unfortunately, the criteria found in these sources are varied such that products are advantaged or disadvantaged depending on the source they use, and there is not a level playing field with regard to code minimum performance.

The purpose of this report is to summarize the requirements found in the various standards and evaluation agency criteria, evaluate relevant and available test data, and provide a recommendation for the fair treatment of all products based on one performance-based benchmark for water-penetration resistance of WRB assemblies. The scope of this research report is limited to WRB assembly water-penetration resistance. Other factors related to the evaluation of WRB materials, assemblies, and installation methods are not addressed. Also, this research report addresses only the application of WRB materials and assemblies as typically used behind water-shedding claddings, not barrier-type claddings such as exterior insulation and finish systems (EIFS).

Background:

The need for a uniform and effective water-penetration resistance requirement is documented in the literature (Hall and Hoigard, 2005; Dorin, 2006; Lstiburek, 2012). In particular, Hall and Hoigard (2005) evaluated current code requirements, acceptance criteria, and field experience. They also reported comparative test data under installed water exposure conditions, demonstrating that at least some polymeric building wrap materials are capable of performing equivalently to asphalt-saturated felt materials. The relevant conclusions from the study include:

1. "Current building code provisions offer no rational means of assessing the equivalency of alternative WRB products to ASTM D-226 type I asphalt saturated felt ..."
2. "The [material-only water-resistance tests] fail to address several important moisture transport mechanisms that affect the in-service performance of WRBs."

Findings:

Table 1 provides a summary of some of the standards and evaluation criteria currently used.

Additionally, benchmark WRB performance test data from multiple approved agencies (test labs) have been gathered to determine an appropriate level of performance for WRBs. See Table 2 for a summary of these test results. Data from these approved sources, as well as independent research, support the need for uniformity and clarity in assembly water-penetration testing of alternative WRB systems.

Evaluation Reference	Water-Penetration Assembly Test Requirements
ASTM E331	"6.2.4 Water-Spray System – The water-spray system shall deliver water uniformly against the exterior surface of the test specimen at a minimum rate of 3.4 L/m2 (5.0 U.S. gal/ft²-h)." "10.1 The test-pressure difference or differences at which water penetration is to be determined, unless otherwise specified, shall be 137 Pa (**2.86 lbf/ft²**)." "11.5 Apply the air-pressure difference…along with the specified rate of water spray, for **15 min**."
ASTM E2570	"8.5.4 **ASTM E331**…at a minimum pressure difference of 137 kPa (**2.86 psf**) for a period of **15 minutes**" NOTE: The ASTM E331 test occurs after durability testing by applying transverse load (8.5.1), racking displacement (8.5.2), and water/radiant heat cycling (8.5.3)
ASTM E547	"10.1 The test pressure difference or differences at which water penetration is to be determined, unless otherwise specified, shall be 137 Pa (**2.86 lbf/ft²**)." "10.3.2 In no case shall the total time of pressure application be less than **15 min.**" "6.2.4.1 the water-spray…at a minimum rate of 3.4 L/m² (5.0 U.S. gal/ft²-h)"
AAMA/WDMA/CSA 101/I.S.2/A440	Minimum water penetration test pressure = **2.9 psf** NOTE: Unlike WRB systems, windows are not covered by cladding in end use.
AAMA 504	"8.4 The completed mockup shall next be tested for water penetration resistance in accordance with **ASTM E331** at a minimum test pressure of 150 Pa (**3.0 psf**) for **60 minutes**."
ICC-ES AC 71 (Foam Sheathing)	"3.4.1.3 The test assemblies shall be tested at a minimum differential pressure of **6.24 psf** (0.297 kN/m²)." "3.4.1.4 The test assemblies shall be subjected to a minimum test exposure duration of **2 hours**."
ICC-ES AC 38 (Wraps)	**No water penetration assembly test. (0 psf, 0 minutes)**
ASTM E2556 (Wraps)	**No water penetration assembly test. (0 psf, 0 minutes)** "1.2 This specification is limited to the evaluation of materials and does not address installed performance. Although the fastening practices…may affect the installed function of these materials, they are not included in this specification."

Table 1: Assessment of WRB Water-Penetration Test Requirements

Product	Test Condition	Performance	Reference[1]
No. 15 Asphalt Felt (*ASTM D4869*, Type I) installed over wood structural panels, 2 reps	***ASTM E331*, 2.86 psf** with 5 gal/hr/ft² water spray	No water penetration at **15 min.**	PEI, 2013
No. 15 Asphalt Felt (*ASTM D226*) installed over wood structural panels, 3 reps	***ASTM E331*, 2.86 psf** with 5 gal/hr/ft² water spray	Water penetration at **5 – 8 min.**	RADCO, 2014
No. 15 Asphalt Felt (*ASTM D226*, Type I) installed over wood structural panels, 1 rep	***ASTM E331*, 2.86 psf** with 5 gal/hr/ft² water spray	Water penetration at **7 min.**	NTA, 2012
No. 15 Asphalt Felt (*ASTM D226*, Type I) installed over open stud cavity	***ASTM E331*, 2.86 psf** with 5 gal/hr/ft² water spray	Water penetration at **0.05 min. (3 sec)**	NTA, 2013a
House Wrap installed over open stud cavity with shingle lapped joints	***ASTM E331*, 2.86 psf** with 5 gal/hr/ft² water spray	Water penetration at **0.1 min. (6 sec)**	NTA, 2013b

Table 2: WRB Benchmark Test Data

Recommendations:

- To coordinate and unify WRB assembly water-penetration testing requirements, one of the following assembly testing requirements must be met using *ASTM E331*:
    1. Test the water-resistive barrier assembly as part of a complete exterior wall envelope system including the protection of a particular non-barrier-type exterior wall finish material per Section 1403.2, or
    2. Test the water-resistive barrier assembly without the protection of a particular exterior wall finish material, also per Section 1403.2, but with test conditions suitable to an exposed WRB test (2.86 psf and 15-minute duration with no water penetration).
- *ASTM D226*, Type 1 asphalt felt shall be recognized as a deemed-to-comply solution (i.e., assembly water resistance testing not required).
- Water-resistive barriers shall be installed in accordance with the manufacturer's installation instructions to assist in proper use and enforcement and ensure the intended performance level is met.

The basis for the recommendation is to use the same test method (*ASTM E331*) and adjust test conditions for two optional qualification approaches to account for the presence or absence of an exterior wall finish material over the water-resistive barrier. It is important to be able to test these two ways to appropriately qualify WRB assemblies (1) for use with a specific exterior wall envelope system (including a specific cladding material) or (2) to more generally qualify a WRB assembly for use with multiple exterior wall finish materials by testing the WRB assembly in an unprotected or exposed condition.

The water-penetration resistance test criteria proposed for the second condition, where the WRB assembly is unprotected, is consistent with criteria specified in *ASTM E331* (e.g., 2.86 psf and 15-minute duration with no water penetration). This requirement is also consistent with that used in another code referenced standard for water-resistive barrier coatings that are tested in an unprotected condition (refer to *IBC* Section 1408.4.1.1) for use with EIFS. Thus, the proposal is consistent with two code referenced standards. It is also reasonably consistent with the performance of asphalt felt when tested in an unprotected condition (see Table 2) and, therefore, complies with the equivalency intent of the code as based on testing by three different certified laboratories where performance of 5 to 15 minutes at 2.86 psf was observed for asphalt felt using *ASTM E331*.

The proposed requirements are consistent with the intent of equivalency between code recognized materials and methods (e.g., asphalt felt) and other alternative WRB materials and assemblies. Therefore, this proposal will help to ensure acceptable and consistent performance of various types of alternative WRB materials and assemblies in a non-exclusionary and effective manner.

References:

1. *2018 International Building Code (IBC)*, International Code Council.
2. *2018 International Residential Code (IRC)*, International Code Council.
3. *AAMA 504-05 – Voluntary Laboratory Test Method to Qualify Fenestration Installation Procedures*
4. *AAMA/WDMA/CSA 101/I.S.2/A440 – North American Fenestration Standard/Specification for windows, doors, and skylights*
5. *ASTM D226 – Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing*
6. *ASTM E331 – Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference*
7. *ASTM D4869 – Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep Slope Roofing*
8. *ASTM E547 – Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cycle Static Air Pressure Difference*
9. *ASTM E 2556 – Standard Specification for Vapor Permeable Flexible Sheet Water-Resistive Barriers Intended for Mechanical Attachment*
10. *ASTM E 2570 – Standard Test Methods for Evaluating Water-Resistive Barrier (WRB) Coatings Used under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage*

11. Dorin, Leonard; "The Importance of Integrating Flashing and the Water Resistive Barrier in the Exterior Wall Systems of Residential Buildings"; *Journal of ASTM International*, Vol. 3, No.5; March 2006.
12. Hall, Garth, AIA and Hoigard, Kurt, PE; "Water-Resistive Barriers: How do they compare?"; *Interface*, November 2005, p.27-34.
13. ICC-ES AC 38 – Acceptance Criteria for Water-resistive Barriers, International Code Council Evaluation Services.
14. ICC-ES AC 71 – Acceptance Criteria for Foam Plastic Sheathing Panels Used as Weather-resistive Barriers, International Code Council Evaluation Services.
15. Lstiburek, Joseph William, Ph.D.; "Leaks and Holes"; *ASHRAE Journal*, December 2012.