BEAM03

VERSION 1.0 | 01.30.25

Standard Test Method for Evaluating Water Resistivity of Large Building Envelope Areas Under Static Pressure Differentials

1. Scope

1.1 This test method describes a procedure for evaluating the water resistance of a building enclosure, or portion(s) thereof, under controlled conditions of uniform static interior/exterior air pressure differential and simultaneous exterior water application.

1.2 This test method is applicable to walls, windows, doors, modular enclosures, parapets, roofs, clerestories, storage containers, backup generator enclosures, and other building envelope components, for purposes including diagnostic evaluation, quality assurance, and designed performance validation.

1.3 This test procedure is qualitative in nature, not quantitative. The enclosure element's behavior under this procedure's environment are observed and documented. The specific behavior to be observed in this context is the water-resistive performance of the envelope, focusing on whether water is able to breach the designed water barrier.

1.4 This procedure provides reasonable means for testing larger portions of the building envelope, up to and including the entirety of the envelope, and exceeding those specimen sizes typically used in higher-pressure spot tests.

1.5 The test method results are not predictive of the enclosure element's performance under all possible environmental conditions. The test method results are solely demonstrative of the tested and observed portions of a building enclosure's behavior under the provided test environment.

1.6 The equipment, processes, and default specifications required to conduct this test are described in this document, but test practitioners may devise additional equipment and processes not listed herein to execute the test.

1.6.1 Deviations from the equipment and processes described herein must follow the general requirements. Any modification must be documented, the modifications must be indicated in the test report, and the report must clearly disclose that the procedure executed was a “modified” version.

1.7 The proper use of this test method requires knowledge of the principles of pressure measurement, building envelope air & water management, and the equipment commonly utilized in single and multi zone air barrier testing.

1.7.1 The interpretation of this test method’s results requires knowledge of the subject building envelope’s water management design.

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2. Terminology

2.1 Definitions:

2.1.1 *Building Envelope* — The enclosure boundary or barrier separating environmental conditions within a building from the outside environment.

2.1.2 *Depressurization* — The reduction of air pressure within the interior environment of the test specimen enclosure area relative to the exterior environment, measured in Pascals (Pa).

2.1.3 *Exterior Environment* — The atmospheric conditions immediately surrounding the exterior surface of the test specimen. This includes all outdoor air, barometric pressure, and weather influences (such as wind, rain, or temperature fluctuations) adjacent to and imposed upon the tested portion of the building envelope. References to "exterior environment" within this test procedure are concerned primarily with the air pressure (including any wind effects) of the exterior environment relative to the air pressure of the interior environment of the test specimen.

2.1.4 *High Pressure Side* — The exterior environment of the enclosure portion that includes the test specimen boundary. The air pressure of this exterior environment is higher, relative to the interior environment, during testing.

2.1.5 *Interior Environment* — The controlled interior atmospheric conditions, in any interior room or compartment, measured within 20 feet of the interior plane of the test specimen's boundaries during testing. This includes air pressure, temperature, and humidity levels.

2.1.6 *Low Pressure Side* — The interior environment of the enclosure portion or zone that includes the test specimen boundary. The air pressure of this interior environment is lower, relative to the exterior environment, during testing.

2.1.7 *Pressure Differential* — The air pressure difference between the test specimen's interior and exterior environments, maintained uniformly across the test specimen surface area, expressed in Pascals.

2.1.8 *Single Zone* — A space in which the pressure differences between any two points differs by no more than 5% of the interior to exterior pressure differential. This includes multi-room or "multi-zone" space that is interconnected within itself by, at minimum, standard door-sized openings through any partitions or floors. The air flow rate through that opening must be sufficient to maintain the specified pressure differential uniformly (+/- 5%) across the connected spaces.

2.1.9 *Test Specimen* — A portion or entirety of the building enclosure, as established by the test specifier, comprising all building envelope elements and systems within its defined boundary.

2.1.10 *Water Delivery Apparatus* — An assembly, commonly referred to as a "spray rack," comprised of a calibrated water distribution system and uniformly-spaced water-spraying nozzles used to deliver a controlled flow of water to the test specimen.

2.1.11 *Water Penetration* — Any visible, liquid water that passes from the exterior environment to the interior of the test specimen, through the envelope's defined water barrier line, under the specified test conditions.

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3. Summary of Test Method

3.1 Synopsis: This test method provides a systematic approach to evaluating the water resistance of building enclosures under controlled conditions of simultaneous interior/exterior air pressure differentials and exterior water application. By applying a water volume to the exterior while maintaining a static pressure differential, the method imposes controlled, repeatable environmental stresses on walls, windows, roofs, skylights, and other envelope components. The specimen's behavior under this test environment is then observed and documented.

3.2 Significance and Use

3.2.1 This test method is designed to evaluate the water resistance of large portions of building enclosures under conditions of simultaneous interior depressurization and exterior water delivery.

3.2.2 The objectives of the test include assessing the efficacy of design and construction, identifying potential deficiencies in building envelope assemblies, verifying compliance with quality assurance and performance criteria, and providing data for performance evaluation.

3.2.3 Data collected from this test are used for a variety of purposes, including the following:

• Validating the performance of newly constructed or retrofitted enclosures.

• Diagnosing water intrusion issues in existing structures.

• Informing repair or maintenance strategies for compromised building envelope systems.

• Evaluating the water resistance of building envelopes as part of due diligence assessments during property acquisition

3.2.4 Testing is recommended as soon as the building envelope is substantially enclosed—defined as when all major exterior primary water barrier elements such as walls, roofs, windows, and doors are essentially completed and sealed—to allow for early detection and resolution of potential issues. However, the procedure may also be performed at any stage, including after portions of an enclosure have been made air tight, or after the installation of interior finishes, or post-occupancy - though finishes may impede visibility and thoroughness of inspection. Occupied buildings or enclosures with other existing visual impediments may compel additional logistics deliberation.

3.2.4.1 This test method is also valid and applicable for use in diagnosing water issues and assessing the water resistive properties of seasoned and operational building envelopes.

3.2.5 Compared to other established methods for evaluating building envelope water resistivity, such as ASTM E1105, the BEAM03 procedure provides reasonable means for testing larger portions of the building envelope, up to and including the entirety of the envelope, and exceeding those specimen sizes typically used in higher-pressure spot tests. This method enables comprehensive evaluation of broader envelope areas, offering insights into overall system behavior and transitions between multiple systems under the test environment rather than focusing solely on isolated modules. Specifiers may find this approach beneficial when a larger-scale performance assessment is desired, or when an evaluation of a complex multi-system envelope is required, or as part of a due diligence assessment for building acquisition, providing valuable insights into the condition and performance of the building envelope.

3.2.6 Because the pressure differential imposed by this procedure is relatively low, weather impacts coinciding with the test (wind gusts, light rain) that are reasonable and safe should be considered acceptable and not disqualify the results. This procedure is designed to balance test stringency with real-world effects.

3.2.7 This test procedure is not intended to evaluate air-tightness (though, because some of the equipment and procedures may be similar, it can often be performed in concert with air-tightness evaluations), thermal performance, or other unrelated enclosure characteristics. This test procedure is specifically designed for and limited to evaluations of water penetration resistance under controlled conditions.

4. Apparatus

4.1 The descriptions of apparatus in this section are general in nature, and any arrangement of equipment capable of performing the test procedure within the tolerances specified herein shall be permitted.

4.2 Depressurization Equipment:
4.2.1 A calibrated fan system capable of exhausting interior environment air at a rate necessary to create the specified uniform pressure differential across the test specimen area. Fans must be adjustable, with the ability to maintain steady target pressures during testing. Fans can be single, large high capacity models, or multi-fan setups working in series.

4.2.2 Manometers or equivalent pressure indicator to measure pressure differentials with an accuracy of ±5% of the target pressure differential. These manometers must be provided in sufficient quantity to both a) measure the interior/exterior environment pressure differential at all partially divided compartments within the test specimen (minimum one manometer / pressure reading per divided compartment) and b) each 100 linear feet of specimen enclosure area.

4.2.3 Reference tubes and probes and pressure taps installed to measure differential pressures across the enclosure. These reference tubes must be positioned within 20 feet of the test specimen's interior plane, with a minimum of one tube inside any fully or partially segmented compartment (or zone) within the test specimen's boundary. Segmented compartments should be dictated by the specifying party and must include rooms, floors, 100 linear feet in any direction, and may also include placing a probe into demising wall cavities that terminate into or even penetrate through and form part of the exterior wall assembly. The intent being to verify that all exterior weather barrier systems and surfaces thereof within the test specimen boundary are depressurized and exposed to the pressure differential during the test.

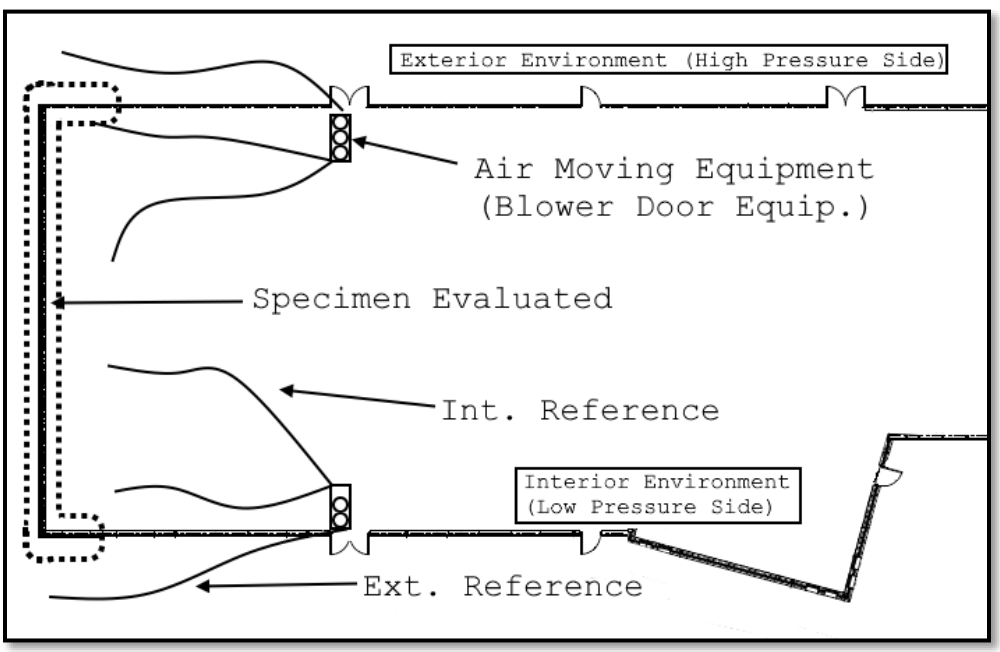

Fig. 1: Example Plan Layout for Equipment and Reference Tubes

4.3 Water Application Equipment:
4.3.1 Minimum Performance Requirements - the water application equipment must be capable of delivering a relatively consistent water spay, verifiably within the rate range of 5 and 10 gallons per square foot per hour.

4.3.2 Minimum Required Components:
4.3.2.1 A grid of spray nozzles uniformly spaced as necessary to produce a relatively consistent spray pattern delivering the prescribed volume of water. This may be referred to as a "spray rack."

4.3.2.2 A water supply capable of delivering the flow rate necessary to power a spray rack's delivery of water at the required rate.

4.3.2.3 A flowmeter for verifying the rate of water delivered to the spray rack. A flowmeter should be attached to each water delivery hose feeding the spray rack(s) and visible/readable during the test. The intent is to double-check the volume of water delivered to the spray rack, and thus the volume distributed to the test specimen (total volume delivered ÷ spray rack coverage area, extrapolated to gallons per square foot per hour).

4.3.2.4 A water pressure gauge attached to the spray rack water inlet and/or attached to the spray rack system itself. The intent of the pressure gauge is to measure the pressure of the water within the spray rack system, and compare it to the water pressure recorded during calibration of the spray rack. (Reference *Fig. 2*)

4.3.3 Reference *Appendix A: Calibration Procedure for Water Delivery Apparatus*. Calibration procedure must be performed with the frequency deemed necessary by the test agency, or any time a spray apparatus is newly fabricated or modified, and never longer than a 6 month frequency.

4.4 Additional Equipment Required:
4.4.1 Anemometer accurate to +/- 5%
4.4.2 Distance measurement tools (tape measure)

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5. Pre-Test Coordination and Design

5.1 Purpose: Define project-specific test criteria and parameters, align project team on expectations, assess resource needs, and establish clear roles for all involved parties.

5.2 Project-Specific Test Design:
5.2.1 Specimen Boundaries:
5.2.1.1 Before the test, the boundaries of the test specimen must be determined and documented. This includes clearly identifying the size and boundary conditions of the enclosure portion to be tested. Ideally, a highlighted drawing or photo of the test specimen should accompany this determination to provide visual clarification of the specific envelope area to be tested.

5.2.2 Pressure Differential:
5.2.2.1 Determine the interior/exterior air pressure differential for the test.

5.2.2.2 Recommended pressure differentials for this test procedure are between 20 and 100 Pascals, which is the approximate limit of pressure differential achievable with most widely-available air-moving equipment (i.e. blower door kits); however, the pressure differential specified should be based on the specific objectives of the project and the capabilities of the testing agency.

5.2.2.3 The default pressure differential for this procedure, if not modified by the specifier, is 75 Pascals (simulating a pressure differential generated by, roughly, a 25 mph exterior wind).

Fig. 2 – Equivalent Wind Speed Chart

Pressure Differential	25 Pascals	50 Pascals	75 Pascals
Equivalent Wind Speed	14.3 mph	20.2 mph	24.7 mph

5.2.3 Test Duration:
5.2.3.1 Establish the duration of water delivery for the test. If not specified otherwise, the procedure's default duration is 15 minutes for each portion of the overall specimen to be tested. Any deviation from this standard duration must never be less than 15 minutes, must be determined before testing begins, and must be clearly documented in the pre-test design.

5.2.3.2 Some wall assemblies, including complex rain screen or flashing channels impeding exterior water from accessing primary barrier materials, may benefit from longer duration water application.

5.2.4 Weather Parameters:
5.2.4.1 Establish consensus on weather parameters, if the project team wishes to deviate from the baseline standards established herein. The standard guidance per this document is as follows:

• Do not test in rain, snow, or any other precipitation.

• Do not test if average wind speed is over 10 miles-per-hour, or gusts are over 15 mph, or is otherwise deemed unsafe to perform the test.

• Do not test if exterior temperature average over the 12 hours prior to the test (12 hourly temp. ÷ 12) are below 32° F, or if the temperatures during the test will drop below 32° F.

• Do not test if test specimen exterior surface temperatures are below 32 degrees F immediately prior to commencement of the test.

5.2.5 Acceptance of Environmental Variability:
5.2.5.1 Some project teams may choose to deviate from these standard limitations. Modifications to acceptability of precipitation and wind speed are permitted at the discretion of the testing agency. Any deviations must be documented in the pre-test summary for project team review and acceptance before proceeding.

5.2.5.2 The temperature restrictions under 5.2.4 shall not be modified. This test must not be conducted if the temperature conditions fall below the restrictions listed under section 5.2.4.

5.2.5.3 Given the high volume of water delivered under this procedure, moderate precipitation is unlikely to significantly affect the total water volume delivered to the exterior surface during the test.

5.2.5.4 Although the air-moving equipment can automatically adjust exhaust rates to maintain target pressures, wind gusts may temporarily and momentarily increase the effective pressure differential between interior and exterior environments during testing. These fluctuations to the upside must be monitored and recorded during the test. Fluctuations up to 100% of the test pressure (maximum 100 Pascals) shall be allowed during the test, for durations not exceeding 20 seconds. Reference *Section 7.6.2.1.*

5.2.5.5 If wind gusts cause the test pressure differential to exceed the designed capacity of the envelope's water-resistive performance rating, then observations of water penetration under these conditions should not be interpreted as deficiencies.

5.2.5.6 The intent of this Section 5.2.5 is to provide the project team with flexibility in defining project-specific environmental parameters for executing the BEAM03 test, while also allowing for adherence to the default guidance outlined in this document. There must be clear, documented consensus on these parameters prior to the test, and all pertinent environmental conditions must be measured and documented during the test to ensure compliance with those parameters.

5.2.6 Observation / Access
5.2.6.1 Specimens with finishes, access restrictions, or other obstructions that limit visibility of the envelope's primary water barrier, these impediments should be identified to the extent possible.

5.2.6.2 For completed or occupied buildings with completed finishes, interior visibility of envelope primary barriers (and smaller leaks concealed by those obfuscations) may be impeded.

5.2.6.3 The effectiveness of the test is directly related to the level of visibility available for interior conditions and primary barrier details.

5.2.6.4 Stakeholders may choose to perform limited investigative demolition to provide access to and visibility of key details during testing.

5.2.6.5 Limitations to access may be determined by the building's status (e.g. occupancy or construction progress) or during a pre-test site visit.

5.2.6.6 Limitations to access and visibility shall be documented within the test report.

5.3 Documentation: Prepare a pre-test document that includes, at minimum, the following:

• Test parameters and conditions: the pressure differential to be maintained (in Pascals - default 75 Pascals), the time of water delivery (in minutes, default 15 minutes), confirmation of the definition of water penetration (default per Section 2.1.9)

• Weather condition limits: whether testing can proceed in precipitation, confirmation of temperature limits (default per 5.2.4)

• Specimen diagrams and boundary definition

• Summary of logistics items for coordination (water supply, electric requirements, access)

• Written notice that water penetration may occur in areas where visibility is obscured, such as enclosed wall cavities, or outside the defined boundaries of the test specimen. The authors and specifiers of this procedure accept no responsibility for damage caused by water penetration, whether detected or undetected.

5.4 Stakeholder Coordination: Review and approve pre-test documents and criteria, planned logistics, and test objectives. Review and approve other site impacts, such as total water volume delivery/use anticipated (and its potential drainage or accumulation at grade), total power needs, etc. Review building mechanical system operation, if these are in place and functional.

5.4.1 Coordinate with stakeholders and testing personnel to ensure that all details regarding specimen size, boundaries, pressure differentials, and water delivery duration are understood and agreed upon prior to the start of the test.

5.4.2 For enclosures with operational mechanical systems, coordination is essential. Verify that active systems will not be adversely affected during the application of the interior/exterior pressure differential. While the default pressure differential of 75 Pascals is unlikely to harm most equipment, confirmation is necessary to ensure safe operation. If feasible, temporarily shutting down mechanical systems may be preferred. Refer to *Section 6.4* for additional guidance.

5.5 Assess Resources: based on the project-specific test design, assess the resources needed to conduct the test (labor, water volume, water pressure, power, site access, etc.)

5.5.1 Based on the planned depressurization zone and pressure differential to be generated, estimate the equipment needed to exhaust sufficient CFMs necessary to create the required pressure differential between the test specimen boundary's interior and exterior environments.

5.5.2 Based on the test specimen boundary's size and the site's water availability and calibration/validation data, and the testing agency's availability of water reservoirs and pump equipment, determine the optimal spray rack (water delivery apparatus) size to test sequential portions or the entirety of the selected test specimen boundary.

5.5.3 Based on the equipment assessment, determine the power requirements needed and coordinate availability of that power during the test.

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6. Pre-Test Test Specimen Preparation

6.1 Examination of Test Specimens:
6.1.1 Verify the test specimen's readiness and document any pertinent conditions. The intent is to document any readily visible conditions that are deficient or incomplete, or that may otherwise impact the water resistive performance of the envelope. Examples of pertinent observations to be recorded include; presence or absence of rain screen elements, any damage or deterioration observed, missing or broken components or materials, poorly adjusted operable components, incomplete weatherstrip or other seal-making components, etc.

6.2 Review the test specimen boundary on the enclosure and document areas of obscured interior visibility.

6.3 Ensure the single zone comprising the interior space of the test specimen and/or building is generally and consistently sealed off from adjoining spaces (or the exterior environment) not included in the test. The intent is to minimize or eliminate potential changes in the overall compartment's air barrier integrity during the test, to minimize or eliminate the need to adjust the interior air CFM exhaust rate during the test.

6.4 If allowed, recommended, and/or directed by authorized personnel such as project managers or site engineers, and if the text, given the building envelope in its current state, would benefit, seal unintended openings and penetrations in wall systems within the enclosure surface area of the depressurized zone, but outside the test specimen boundary, using tape or other approved materials. This minimizes extraneous air leakage and reduces the CFMs necessary to achieve the project's established test pressure differential, thereby reducing the equipment and energy load necessary to perform the test.

6.5 Install spray racks on the exterior surface of the test specimen, ensuring a consistent orientation and distance between the rack and the surface that is supported by off-site validation of the spray rack per *Addendum A: Calibration of Water Delivery Apparatus.*

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7. Test Procedure

7.1 Pre-Test Conditions:
7.1.1 Document ambient localized temperature, relative humidity, and wind speed at the interior and exterior of the test specimen area. Record these environment conditions within one hour of the start of each recorded portion of the test.

7.1.2 Ensure all equipment is calibrated/validated and functioning properly.

7.1.3 Ensure all other resources required for the proper execution of the test procedure (e.g. water supplies, electricity supply, labor for setup and observation, etc.) are available and accounted for.

7.2 Depressurization Setup:
7.2.1 Install the blower door system as needed to generate a pressure differential between the interior and exterior environment of the test specimen area.

7.2.1.1 This blower door setup may include placing the blower door at an apartment unit entry, exhausting into a hallway that is also connected to the exterior environment by a series of standard door-size openings.

7.2.1.2 This blower door setup may include a multi-fan setup in an exterior vestibule or garage door, exhausting air from and depressurizing the entire building.

7.2.1.3 The blower door setup may include fan placement in open windows that are outside the test specimen boundary.

7.2.1.4 The key is that the blower door system is evacuating air from the depressurization zone that includes the interior surfaces of the test specimen area in sufficient volume to create the specified interior/exterior test pressure differential.

7.2.2 Connect the manometer(s) to read the interior pressure at the enclosure test area.

7.2.3 Connect the manometer(s) to read the exterior pressure at the enclosure test area. Note that the reference tube for the exterior pressure must reach the exterior environment - not be placed within hallways, stairwells, or other interior portions of the overall enclosure. The intent is to read the air pressure of the exterior environment at the test specimen.

7.2.4 Verify and document the baseline pressure differential reading of the manometer before starting.

7.2.5 Activate the fan system to create the specified negative pressure differential between the interior and exterior environment of the test specimen area. Stabilize the pressure for at least 30 seconds before proceeding with the test.

7.3 Water Application Setup:
7.3.1 Position the spray rack in front of the specimen in a way such that the distance from the specimen and X/Y axis location match the relative position/arrangement of a successful calibration report (reference *Appendix A: Calibration of Water Delivery Apparatus*).

7.3.1.1 If the spray rack coverage is testing a portion of the entire selected specimen boundary, rather than covering the entire selected boundary, then begin testing with coverage on the lower portions first, continuing horizontal to complete the specimen in horizontal bands. Move to upper bands of the specimen boundary only after lower test portions have been completed.

7.3.2 Ensure that water source has the required capacity for both flow and pressure necessary to match the same values for a successful calibration report for the spray rack model and size utilized.

7.3.3 Begin water flow through the spray rack and adjust as necessary to achieve the system pressure and intake flow rates matching a successful calibration record for that spray rack model and at the same calibrated distance from the specimen (or calibration spray catch box).

7.4 Testing:
7.4.1 When the spray rack water intake rate and system pressure are confirmed to meet those of a successful calibration record, and the specified interior/exterior air pressure differential is simultaneously maintained, then begin the time period (default: 15 minutes) for this section of the total test specimen (or total specimen, if the spray rack covers the full specimen).

7.4.2 Monitor spray rack pressure and flow rate at a maximum 1-minute interval.

7.4.3 Monitor the pressure differential measurement devices, or manometers, at a maximum 1-minute interval.

7.4.4 Continuously inspect the interior of the test specimen for signs of water penetration during the test without interfering with ongoing conditions.
7.4.4.1 Note the time of observation, relative to the start time of the relevant portion of the test (if the specimen is not covered entirely by one spray rack) and relative to the start of the overall test.

7.5 Post-Test Inspection:
7.5.1 After completing the test, discontinue water application and depressurization.

7.5.2 Visual Inspection:
7.5.2.1 Conduct a thorough visual inspection of the interior, documenting any evidence of water penetration.

7.5.2.2 Inspect all accessible surfaces, including walls, ceilings, and floors, for visible signs of water intrusion such as staining, pooling, or dripping. Pay special attention to joints, seams, and areas around penetrations like windows, doors, and utility openings.

7.5.2.3 Utilize tools like high-intensity lighting and moisture meters (equipment capable of measuring the moisture content in materials based on transmission of low-frequency electronic signal or other means) to enhance detection capabilities.

7.5.2.4 Utilize an infrared camera, borescope, or other minimally- or non-invasive methods and equipment to identify hidden moisture accumulation or subsurface leaks

7.5.2.5 Pay close attention to areas where the envelope's primary barrier is obscured, and where water penetration might not be directly visible, such as within wall cavities, beneath flooring, or behind insulation materials.

7.5.2.6 If further investigation is required, consider coordinating with site managers to open small sections of interior finishes to confirm the presence and source of water intrusion. For areas rendered inaccessible by permanent installations, note these obstructions and associated limitations in the report and use alternative inspection methods, such as moisture meters or infrared imaging, to infer potential conditions.

7.5.2.7 Document each observation with detailed notes and photographs, identifying the exact location and extent of water penetration. Observations should be readily correlated to the corresponding test specimen location.

7.5.2.8 Compile all findings in a systematic report. Document all findings with photographs and notes to provide a comprehensive record of the inspection process. Reference *Section 8. Report.*

7.6 Accuracy and Fluctuations in Pressure Differential:
7.6.1 Maintaining a static pressure differential in a large zone, at the relatively lower pressures prescribed herein, and with high-resolution pressure measurement devices can result in sometimes significant fluctuations in some environments.

7.6.2 Allowable fluctuations to pressure differential measurements due to exterior environment wind and pressure changes may reach + 100% of the established test pressure, up to 100 Pascals (e.g. for a 75 Pascal test, the pressure may rapidly increase briefly to a total net pressure differential of 150 Pascals).

7.6.2.1 Fluctuations greater than 15 Pascals should have durations no more than 20 seconds. We recommend utilizing air moving equipment that automatically adjusts to environment changes in order to maintain consistent target pressure.

7.6.2.2 Maximum pressure differential experienced during the test, and its duration, shall be documented.

7.6.3 Allowable downside fluctuation due to enclosure air tightness changes, equipment malfunction, or energy loss: pressure differential may fluctuate -25% of target pressure (up to 25 pascals) for durations not exceeding 30 seconds. This may occur no more than once per 5 minute interval of the test.

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8. Report

8.1 Test Report Inclusions

8.1.1 Test Specimen Description - description of the test specimen, including dimensions, materials, and construction details. Highlighted elevation drawing of the test specimen, identifying 1) the test specimen boundary, 2) the depressurized area, 3) the applied water areas (including demarcation of "portions" or “bands” of test area, if water was not applied to entire specimen boundary in one period). If no elevation drawing is available, a sketch of the area accurate to +/- 12" height and width dimension is acceptable. Also acceptable is a photo of the tested area exterior, with the above noted dimension and boundary overlays superimposed.

8.1.2 Environment Data - Measurements of ambient conditions, including (at minimum) barometric pressure, temperature, humidity, and wind speed, should be recorded within 1 hour before and 1 hour after each portion of the test is initiated. Record the times of each environmental measurement and include a table of all measurements in the report.

8.1.3 Equipment – descriptions, date of manufacture (or assembly, if in-house constructed by testing agency), name of manufacturer, and calibration dates for all equipment utilized in the test. Include some description or diagram of reference tube positions.

8.1.4 Test Results – Observations of water penetration, including location, description or photos of the extent, and time of occurrence, if known. These observations should be noted on a marked-up elevation of the test area. Utilizing the same highlighted elevation used in the specimen description, mark up the elevation to identify areas of observed water penetration for reference elsewhere in the report. These water penetration instances should be labeled sequentially using the testing agency's preferred labeling sequence (e.g. A, B, C or A.1, A.2, A.3, or 1, 2, 3, etc.). There should then be photos of the interior observation of the water test within the report, labeled to correspond with the water penetration label.

8.1.5 Observation Limitations – limitations to interior specimen visibility (e.g. presence of interior drywall, trim, insulation) on envelope assemblies that obscure the specimen's water barrier line should be documented in the report. The thoroughness of the report's findings will be commensurate with interior access and specimen visibility, and any impediments to the thoroughness of these findings should be documented for full report transparency.

8.1.6 Optional Appendix, Data Logs – e.g. Data logs of pressure differential and water application rates.

8.1.7 Optional Appendix, Photos – additional photos of specimen, site logistics, air sealing, observations of note outside the boundary of the test specimen (e.g. water penetration observed below the defined test specimen), water barrier visibility obstructions, and any other photos deemed worth inclusion by the testing agency or specifier, for record.

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9. Safety Precautions

9.1 The authors and specifiers of this test procedure accept no liability for safety hazards, injuries, or damages that may occur during its implementation. The responsibility for ensuring safe execution of the test procedure lies solely with the testing personnel and organizations performing the test.

9.2 Ensure all electrical equipment is properly grounded and protected from water exposure. The testing organization must verify compliance with applicable safety standards and regulations prior to commencing the test.

9.3 Personnel conducting the test must wear appropriate protective clothing and equipment and adhere to all relevant safety protocols. It is the responsibility of the testing personnel and their employer to ensure training, proper use of equipment, and compliance with local safety requirements.

9.4 Testing personnel must exercise caution when installing and operating spray racks to avoid damage to the test specimen or surrounding areas.

9.5 Take whatever additional precautions are necessary to protect persons from water spray, falling objects (which may include tools), the spray system, and all other hazards.

9.6 Water penetration may occur in areas where visibility is obscured, such as enclosed wall cavities, or outside the defined boundaries of the test specimen. The authors and specifiers of this procedure accept no responsibility for damage caused by water penetration, whether detected or undetected. Responsibility for assessing and mitigating potential risks lies with the testing personnel and organizations executing and/or reviewing and/or managing the procedure, or others.

9.7 This procedure is merely an observation of a defined envelope area's water-resistive performance under specific environmental conditions at a singular point in time. This procedure does not purport to predict the water resistive performance of the test specimen area long term, or predict the performance of envelope areas outside the test specimen boundary. The authors and specifiers of this procedure accept no responsibility for future damage caused by water penetration, whether detected or undetected.

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10. Precision and Bias

10.1 Variability in results may arise from inconsistencies in water flow, impacts on zone air seals and pressure differentials, or environmental conditions. Adherence to the procedure's specified ranges and monitoring frequency minimizes these effects.

10.2 Environmental factors, such as ambient temperature, relative humidity, wind speed, and direction, can influence the test environment. For example, wind gusts may alter the exterior pressure reference, leading to fluctuations in the measured pressure differential.

10.3 Differences in construction materials, assembly techniques, and installation quality within the test specimen can lead to variability in water penetration outcomes. These factors are outside the control of the test procedure and should be documented. Examples of such differences include variations in sealant application, use of non-standardized materials, or differing workmanship quality. Testing personnel should ensure these factors are observed and noted in the test report to provide context for the results, though the ultimate responsibility for test data interpretation is by others.

10.4 Limitations in equipment precision, such as minor inaccuracies in manometer readings or water flow rates, may also contribute to test variability. Ensure all devices have been calibrated, within the last 6 months, to the accuracy ranges prescribed herein prior to use.

10.5 No statement is made either on the precision or bias of this test method's inducement and/or documentation of water penetration since the result merely states whether there is conformance to the criteria specified prior to the test. This is because the test is designed solely to create the specified environment and document the specimen's behavior under that environment, rather than to quantify precision or establish bias. The absence of these metrics reflects the in-situ field nature, as opposed to controlled lab comforts, and adopts the inherent variability in construction materials, assembly techniques, and environmental factors, which are outside the direct control of this procedure.

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11. Keywords

11.1 *Building envelope, rain screen, enclosure, water penetration, leak testing, windows, curtain wall, doors, skylights, wall assemblies, metal cladding, weather barriers, flashing, roofing*

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Written by Bill Bahn, 2025

Appendix A: Calibration of Water Delivery Apparatus (Spray Rack)

A1. Purpose

This Appendix outlines the procedure for validating the ability of the water delivery apparatus (spray rack) to deliver consistent and accurate water application during testing. This procedure specifies the equipment, the steps required, the timing of calibration, and the acceptable tolerances for a spray rack's successful performance verification.

A2. Scope

This calibration procedure applies to water delivery systems used in the BEAM03 building envelope water resistance test procedure. It verifies the water delivery apparatus ability to deliver water delivery rates within the procedure's specified tolerances (5 to 10 gallons per square foot per hour) and verifies system functionality.

A3. Timing of Calibration

A3.1 Initial Calibration:

Conduct an initial calibration before using any newly-constructed water delivery system for the first time on a project or after any significant modifications to the system.

A3.2 Routine Calibration:

Recalibrate the water delivery system every six months to maintain compliance with this standard.

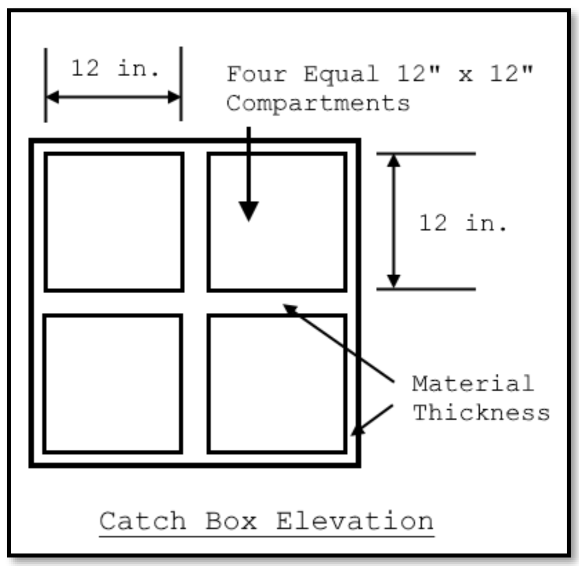
A3.3 Post-Event Calibration:

Perform recalibration after any event that may affect the water delivery system’s performance, such as equipment damage, component replacement, or extreme weather exposure.

A4. Equipment Required

A4.1 Calibration Catch Box:

The calibration catch box is designed to capture water impinging directly on the simulated exterior plane of the test specimen, while excluding all runoff water from above or otherwise outside the box. The exterior plane of this box measures 576 inches square (4 square feet) and is divided into four equal compartments, each box a 12 inch (305 mm) by 12 inch square, to facilitate precise measurement of water distribution across the surface. The water impinging on each individual compartment shall be captured and measured separately.



A4.1.1 Each catch box quadrant may have a drain line leading to storage containers for weighing or otherwise measuring the water collected in each quadrant.

A4.2 Calibrated Flow Meter:

For measuring the flow of water supplying the spray rack, accurate to within ±0.5 gallons per minute.

A4.3 Calibrated Pressure Gauge:
For measuring the pressure of water within the spray rack system and/or at the water supply inlet supplying the spray rack. Accurate to within ±5% of the spray rack's operational range.

A4.4 Stopwatch or Timer:
Accurate to within ±1 second over a 5-minute timing range, ensuring precision appropriate for short-duration water flow measurements.

A4.5 Measuring Tools:
E.g. tape measure. For recording spray rack dimensions and distance from the test specimen and catch box surface.

A4.6 Data Recording Sheet:
For documenting calibration results, including distance of spray rack to exterior plane of catch box, position of catch box relative to the spray rack, spray rack nozzle grid dimensions, water flow rates, water pressures, water volume collected in each catch box quadrant, conversion of captured water volume to gallons per hour per square foot.

A4.7 The Water Delivery Apparatus to be Calibrated - Consists of a modular grid of nozzles designed to evenly distribute water at controlled rates across the test specimen surface.

A4.7.1 The water delivery apparatus must have a unique identifying serial number permanently affixed to the system.

A4.7.2 The water delivery apparatus delivers water in a consistent and uniform spray pattern, with the capacity to adjust pressure and flow settings within or outside the apparatus.

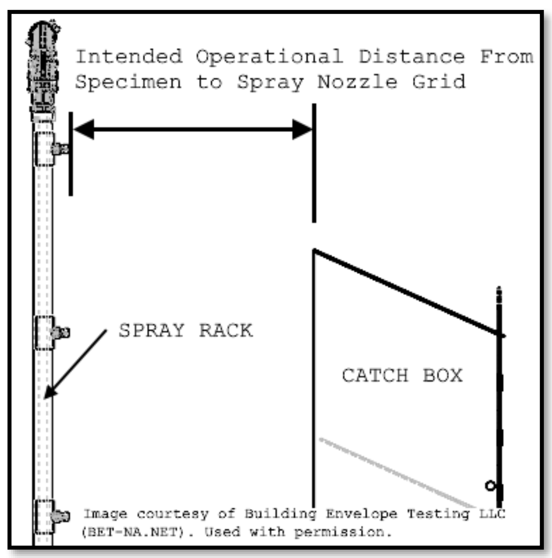
A4.7.3 If a number of identical, contiguous, modular spray systems are used, only one module need be calibrated.

A5. Calibration Procedure

A5.1 Setup:

A5.1.1 Assemble the spray rack in a controlled environment with access to a sufficient water supply. If necessary, furnish a reservoir and pump(s) to supply the spray rack with sufficient volume and pressure to meet the target calibration range.

A5.1.2 Position the calibration catch box parallel and directly in front of the spray rack nozzles at the intended operational field test distance (the intended distance between the nozzle grid and the theoretical exterior plane of the test specimen).

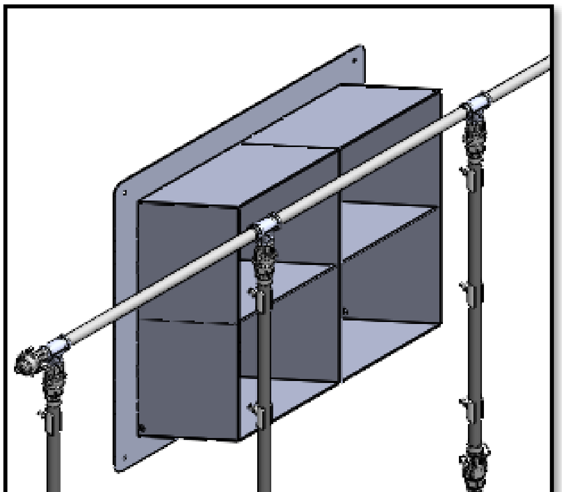


A5.1.3 The catch box must be positioned, and the procedure completed, at the two upper corners of the spray rack, one lower corner, and one true center position under the equivalent system water pressure and water supply rate. (Alternate: reference Section 6.3.1)

A5.2 Water Delivery Measurement:

A5.2.1 Connect the water supply to the spray rack and start water flow.

A5.2.2 Collect water in the calibration catch box for an interval equal to or greater than 5 minutes.



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A5.2.3 Measure the volume of water in each quadrant of the catch box and calculate the hourly rate for each quadrant (extrapolate the volume collected for the time interval to a one hour interval).

A5.2.4 Verify that each square foot quadrant receives a volume of water equivalent to, or extrapolated to, between 4 and 10 gallons per square foot per hour. Verify that the total water delivery rate across the catch box four quadrants is within 5 to 10 gallons per square foot per hour.

A5.3 Pressure Measurement:

A5.3.1 Attach a pressure gauge that has been calibrated to +/- 5% of its operational range to the spray rack water inlet or to the spray rack system itself.

A5.3.2 Record the water pressure during operation and ensure that it is consistent through the calibration duration.

A5.4 Procedure Steps:

A5.4.1 Verify that the catch box is positioned in front of and parallel to the spray rack nozzle grid. Verify that the catch box and associated containers do not carry a significant volume of water.

A5.4.2 Cover the face of the catch box with a minimum 30 inches by 30 inches plate in order to prevent water from entering the calibration box before the desired pressure is reached and before/after the timed interval.

A5.4.3 Activate the water flow and pressure until the pressure measured in the spray rack system and/or water inlet is stable at the desired pressure.

A5.4.4 Remove the cover plate and simultaneously start the stopwatch or timer to begin the collection interval (minimum 5 minutes). Deactivate the spray rack and place the cover plate over the catch box at the end of the collection interval.

A5.4.5 Measure the volume of water captured in the four quadrants during the measurement interval. Verify water collection in each section to ensure a total equivalent to an extrapolated rate of at least 20 gallons total per hour, with no less than 4 gallons per hour and no more than 10 gallons per hour in any single quadrant. This is achieved by extrapolating the water measured in each section for the collection time duration and extrapolating it to the rate of collection per hour.

A5.4.6 Repeat the water collection procedure at four locations on the spray rack: upper right corner, upper left corner, lower right corner, and lower left corner. Ensure the average delivery rate across these areas falls within the required range (5 to 10 gallons per square foot per hour). The average delivery rate of each corner must also be within the range of 5 and 10 gallons per square foot per hour. The intent is to ensure that taller spray racks deliver water within this pressure range at the uppermost and lowermost nozzles simultaneously during a test.

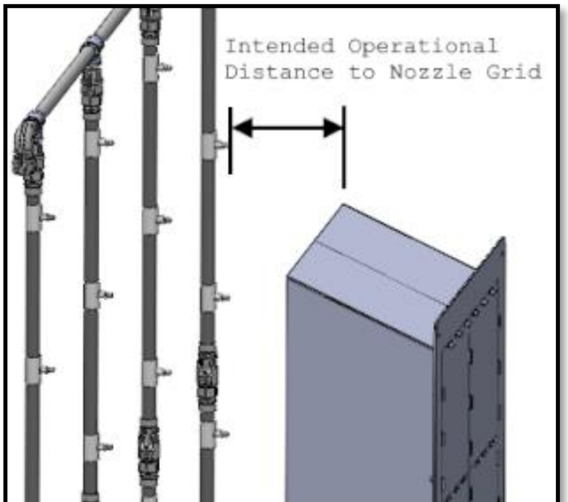

Image courtesy of Building Envelope Testing LLC (BET-NA.NET). Used with permission.

A5.4.7 Measure and record the water pressure at the intake line of the spray rack and/or elsewhere within the spray rack system (e.g. on a header crossbar or manifold of the spray rack system). Critically, wherever the water pressure measurement is taken (wherever the gauge is positioned) during this validation procedure, it must also be visible and recorded in the same position in the field during this test procedure.

A5.5 Documentation:
For each of the four corners of the spray rack, document the following:

A5.5.1 Document the distance of the spray rack from the exterior plane of the catch box

A5.5.2 Document the distance (in X/Y axis) of the outermost corner of the catch box to the outermost corner of the spray rack nozzle grid. The intent is for the catch box to simulate the theoretical test specimen boundary corner, so that the spray rack is positioned similarly (in X/Y axis) in field testing.

A5.5.3 Document the identification or serial number and dimensions of the spray rack nozzle grid.

A5.5.4 Document the flowmeter reading (total flow volume over the minimum 5-minute validation period).

A5.5.5 Document the spray rack water pressure measurement.

A5.5.6 Document the collection time interval used.

A5.5.7 Document the extrapolated water collection measurement (expressed in gallons per square foot per hour) for each quadrant, and each overall catch box measurement.

A5.5.8 Record the date, time, and personnel performing the calibration.

A5.5.9 Record the environmental conditions, including at minimum temperature and barometric pressure. If wind is present, record the wind speed and direction.

A5.5.10 Maintain validation results in the equipment maintenance logs for the useful life of the associated spray rack equipment model/design.

A5.6 Calibration Matrix:

A5.6.1 For reference in the field, consider assembling a matrix of calibration results for each water delivery apparatus model. This matrix is optional, and not necessary to meet the requirements of this test procedure.

A5.6.2 The calibration matrix may include distance from rack on one axis, and water pressure on another, with the resulting blended rate of water delivery (over four corner measurements) at those variables.

A5.6.3 The intent of this matrix is to provide quick reference for a range of variables that have been proven to deliver the prescribed water delivery. This would allow testing agencies to better accommodate site conditions, water availability, etc.

A6. Acceptance Criteria

A6.1 Water Delivery Rate:

A6.1.1 Total water delivery rate for each catch box collection interval (minimum 5 minutes) must be between 5 and 10 gallons per square foot per hour.

A6.1.2 A spray that provides at least 20-gal/h total for the four quadrants and not less than 4 gal/h nor more than 10 gal/h in any one quadrant shall be acceptable.

A6.2 Failure to Meet Criteria:

A6.2.1 If the flow rate does not meet the criteria, the spray rack cannot be utilized in the field at the position (distance from specimen face, X/Y axis position at corners), pressure, and flow rate utilized during this calibration effort. Document these variables and the failed water delivery rate so that these variables are not repeated during a future field test.

A6.2.2 If the flow rate does not meet the criteria, the calibration procedure should be repeated, utilizing different distance, water pressure, and flow rate variables to try again to achieve the specified water delivery rate (5-10 gallons per square foot per hour).

A6.3 Alternate Calibration Procedure:

A6.3.1 A water delivery apparatus, or spray rack, that has successfully been calibrated under ASTM E1105 is considered valid and acceptable under this version of BEAM03. The calibration variables (distance from specimen, water pressure, gauge position, size of spray rack) from the successful ASTM E1105 calibration must be replicated for water delivery under BEAM03 testing and documented.

A7. Safety Precautions

A7.1 Ensure all electrical components, if utilized, are properly grounded and shielded from water exposure during calibration.

A7.2 Secure the spray rack and catch box to prevent tipping or movement during operation.