The interaction of the Air Barrier airtightness and the resistance to water penetration through Wall Cladding Systems, as seen by AAMA 508 and 509 Standards

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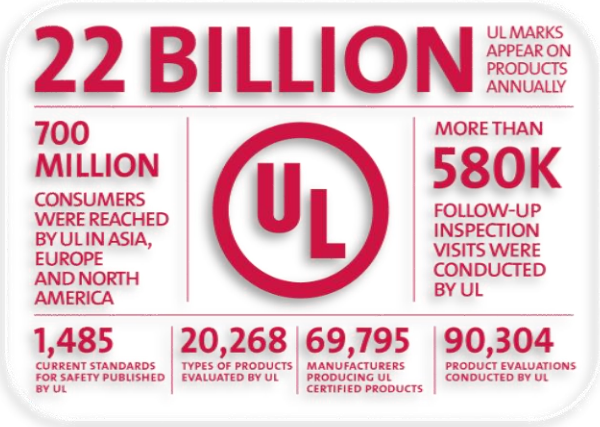
Introduction

Who is UL - CLEB?

- Global independent safety science company
- May - 2017, UL & CLEB combined Building Envelope experience and expertise
- Over 120 years in developing product standards and conducting evaluations of a wide range of building components, materials and systems

Our Mission…"Working for a Safer World"



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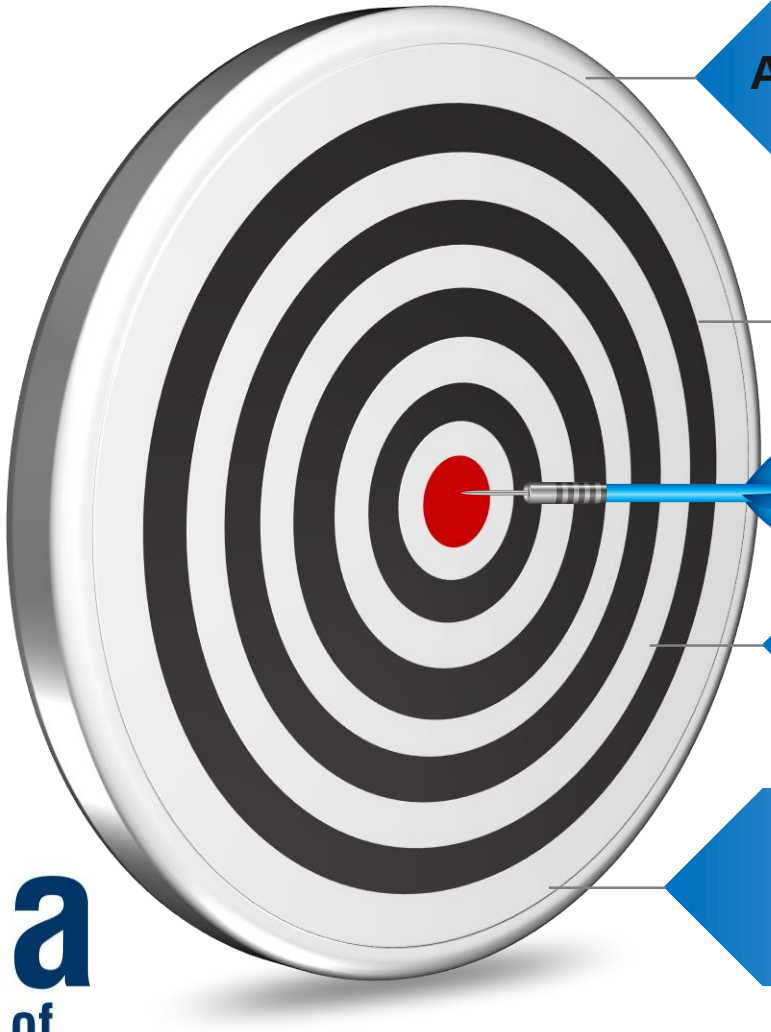
Learning Objectives

Upon completion of this course, participants should:



- Acquire knowledge of the referenced testing standards
- Review the requirements of the testing standards
- Understand the importance of the Air Barrier performance to reduce problems associated with water penetration
- be able to compare the performance results and which Standard to be use in which situation

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Context

The importance of preventing water penetration into wall construction is well documented and is a key factor in providing durability of the built environment, by minimizing wall components deterioration.

There are two concept of Wall Cladding Systems that aims at achieving this goal.

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Context

These are:

1) Pressure Equalized Rain Screen Wall Cladding Systems;

2) Drained and Back Ventilated Rain Screen Wall Cladding Systems.

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Context

The American Architectural Manufacturer Association has developed two test methods that evaluate the performance of these rain screen wall cladding systems. The use of these procedures help in establishing correlations between the airtightness of a building wall, the venting capacity of the cladding system and its ability to prevent problems associated with water penetration.

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Context

AAMA 508-14 Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems, establishes the requirements for test specimens, apparatus, test procedures, test reports and minimum performance criteria to be used in the evaluation of pressure equalized rain screen wall cladding (panel) systems.

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Context

AAMA 509-14 Voluntary Test and Classification Method for Drained and Back Ventilated Rain Screen Wall Cladding Systems, establishes the requirements for test specimens, apparatus, test procedures, test reports and performance data that may be used in the evaluation of drained and back ventilated rain screen wall cladding systems. The primary purpose(s) of this test method is to quantify the volume of rain water contacting an imperfect AWB and the system's ability to allow for ventilation/drying as measured by air flow through the cladding.

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Agenda

- Pressure Equalized Rain Screen per AAMA
- Drained and Back Ventilated Rain Screen per AAMA
- Review of AAMA 508-14
- Review of AAMA 509-14
- Discussions, Questions & Answers

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Agenda

- **Pressure Equalized Rain Screen per AAMA**
- **Drained and Back Ventilated Rain Screen per AAMA**
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- **Discussions, Questions & Answers**

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Pressure Equalized Rain Screen per AAMA

Pressure equalized rain screen wall cladding systems provide a means of excluding rain and weeping potentially harmful water that might otherwise cause hidden condensation and wall deterioration.

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Pressure Equalized Rain Screen per AAMA

The design of pressure equalized rain screen wall cladding systems shall be based on these four essential requirements:

- provide means of preventing water entry;
- provide venting to the exterior of any water vapor, that diffuses from the interior through the wall construction;
- the air/water barrier shall be designed to resist the full positive and negative wind loads;
- the system shall be designed so as not to trap or hold concealed water and to control rain water.

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Pressure Equalized Rain Screen per AAMA

The pressure equalization in the cavity will be greatly influence by the air tightness of the air barrier, it is understood that final construction details and workmanship often results in less than perfect performance of the AWB.

In order to account for such situation the corresponding AAMA test method defines an generic air leakage rate which yields a conservative approach. However, it is also possible to use this method with the actual air/water barrier for the system is used in lieu of the default generic clear plastic air/water barrier.

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Agenda

- Pressure Equalized Rain Screen per AAMA
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Drained and Back Ventilated Rain Screen per AAMA

Drained and back ventilated wall cladding systems differ from pressure equalized rain screen as their main focus is to manage and drain the water that enters the cavity passed the cladding. They are designed primarily to drain by gravity and weep systems and allow drying of residual moisture by venting.

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Drained and Back Ventilated Rain Screen per AAMA

The design of drained and back ventilated wall cladding systems shall be based on these four essential requirements:

- provide means of preventing water entry through the wall assembly including the Air/Water barrier (AWB);
- provide primary weather protection by a properly designed and installed AWB;
- provide management and drainage of the water entry in the cavity behind the cladding and allow sufficient venting to dry the cavity;
- provide venting to the exterior of any water vapor, that diffuses from the interior through the wall construction.

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Drained and Back Ventilated Rain Screen per AAMA

The performance of drained and back ventilated wall cladding systems is also influence by the air tightness of the air barrier, it is understood that final construction details and workmanship often results in less than perfect performance of the AWB.

In order to account for such situation the corresponding AAMA test method defines an generic air leakage rate which yields a conservative approach and aims to simulate potential field conditions. However, it is also possible to use this method with the actual air/water barrier for the system is used in lieu of the default generic clear plastic air/water barrier.

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Drained and Back Ventilated Rain Screen per AAMA

The exterior cladding element and cladding support shall also be designed for full wind load.

Additionally, this test method is not intended to be used to determine structural performance; however it does not restrict the user from performing a structural test for a project specific AWB and back-up support system

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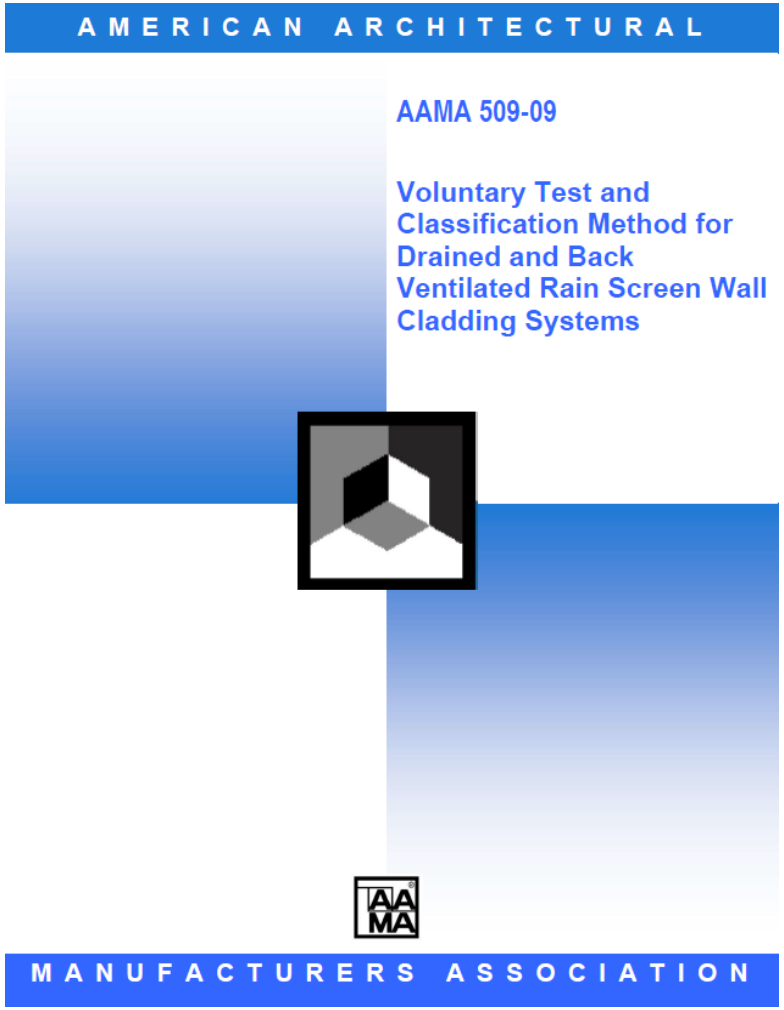
Review of AAMA 508-14

AAMA 508-14 Voluntary Test Method and Specification for Pressure Equalized Rain Screen Wall Cladding Systems



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SCOPE:

This document establishes the requirements for test specimens, apparatus, test procedures, test reports and minimum performance criteria to be used in evaluation of pressure equalized rain screen wall cladding (panel) systems.

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Review of AAMA 508-14

PERFORMANCE CHARACTERISTICS OF A PRESSURE EQUALIZED RAIN SCREEN WALL CLADDING SYSTEM:

- In actual wall system evaluation, the test sample shall be built with the specified air/water barrier to be used in the system and its rigidity shall be representative of the specified air/water barrier.
- In generic exterior rain screen system evaluation, clear plastic air/water barrier shall be utilized.

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PERFORMANCE CHARACTERISTICS OF A PRESSURE EQUALIZED RAIN SCREEN WALL CLADDING SYSTEM:

Primary performance characteristics evaluated:

- ✓ Air Leakage: ASTM E 283 (Static);
- ✓ Water Penetration: ASTM E 331 (Static), AAMA 501.1 (Dynamic);
- ✓ Structural Performance: ASTM E 330 (Static);
- ✓ Pressure Equalization Behavior: ASTM E 1233-Modified - 100 three second cycles at 1,200 Pa (25psf).

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TEST SPECIMENS:

- Specimen: minimum of 2440 mm x2440 mm (96 in x 96 in);
- Back-up wall, air/water barrier and panel supports, with maximum support spacing;
- Default deflection criteria of the wall support framing is L/180 and the actual maximum deflection of the support wall will be reported (results applicable to as stiff or stiffer);
- Simulation of the air/water barrier, use a rigid clear plastic for a generic test or use the actual air/water barrier material for a system specific test;

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TEST SPECIMENS:

- Observations of the water that accumulates on the air/water barrier to be recorded (view holes in job condition system);
- 3 mm (1/8 in) diameter holes to represent purposely designed defects in the air/water barrier (number depends on specified air leakage range, Note: compartmentalized systems);

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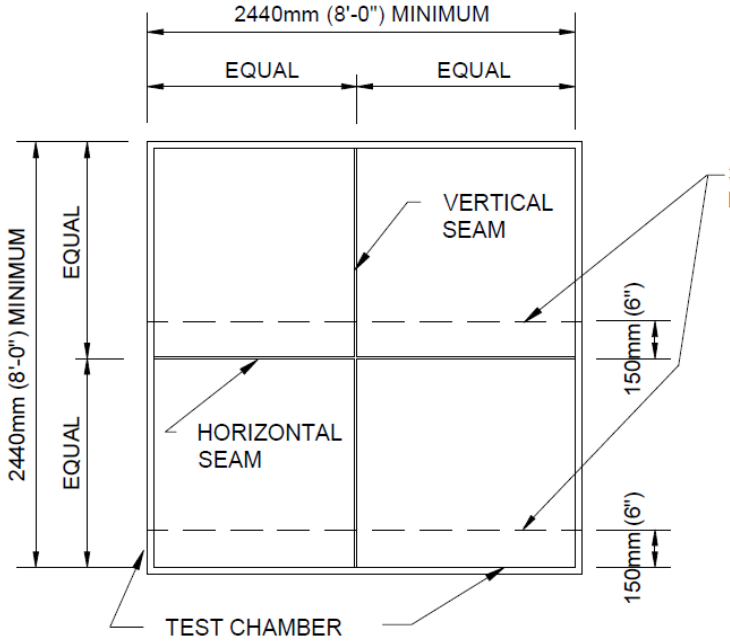
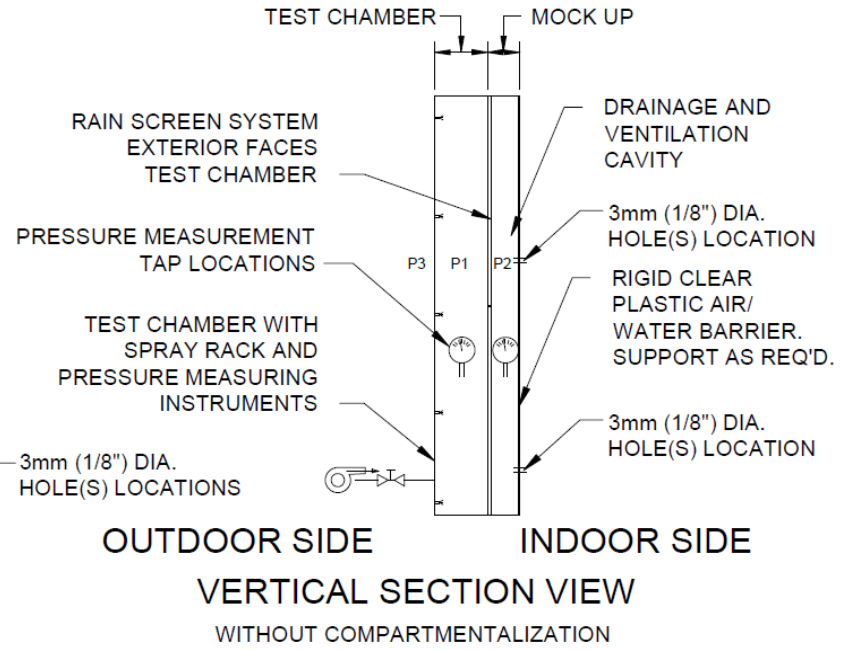
Equal Panels



ELEVATION VIEW

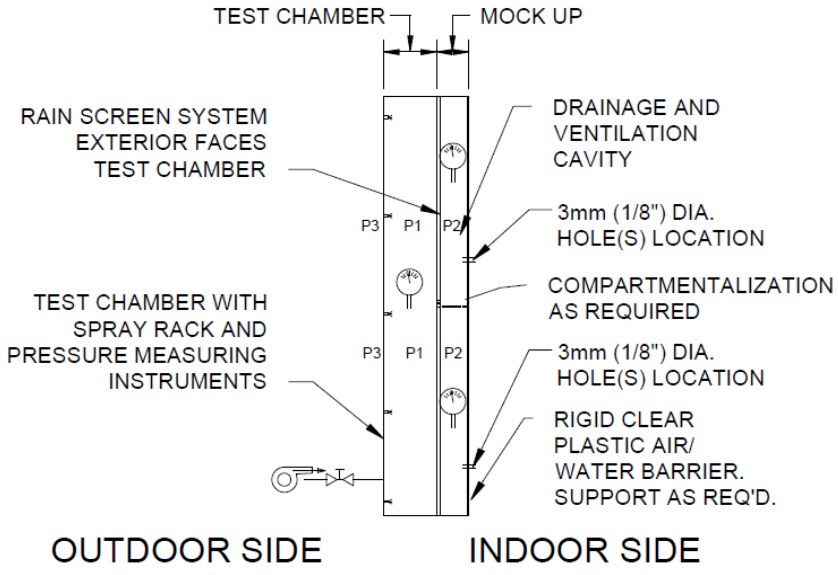
NOTE: NON-TYPICAL PERIMETER CONDITIONS SHALL BE PERMITTED TO BE SEALED AND NOT BE CONSIDERED PART OF THE TEST.

NOTE: PANEL DIMENSIONS ARE TYPICAL



VERTICAL SECTION VIEW

WITHOUT COMPARTMENTALIZATION



VERTICAL SECTION VIEW

WITH COMPARTMENTALIZATION

PRESSURE MEASURED IN EACH COMPARTMENT

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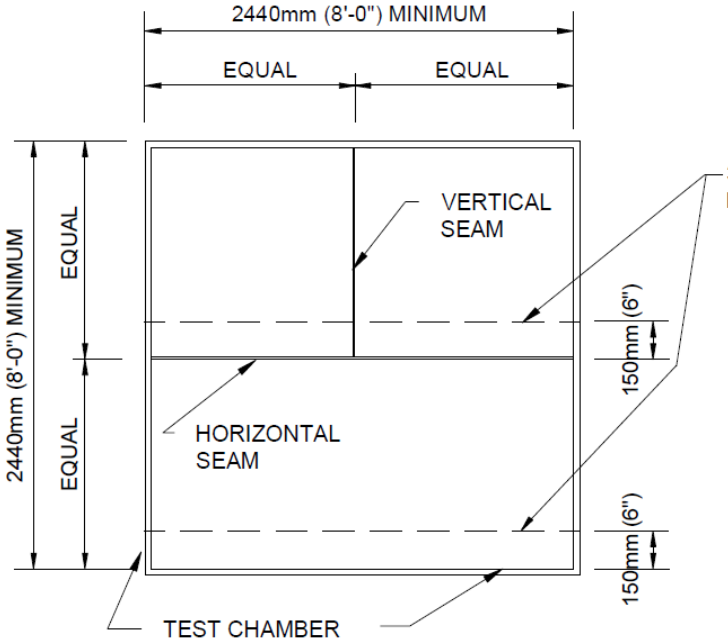
T Panels



ELEVATION VIEW

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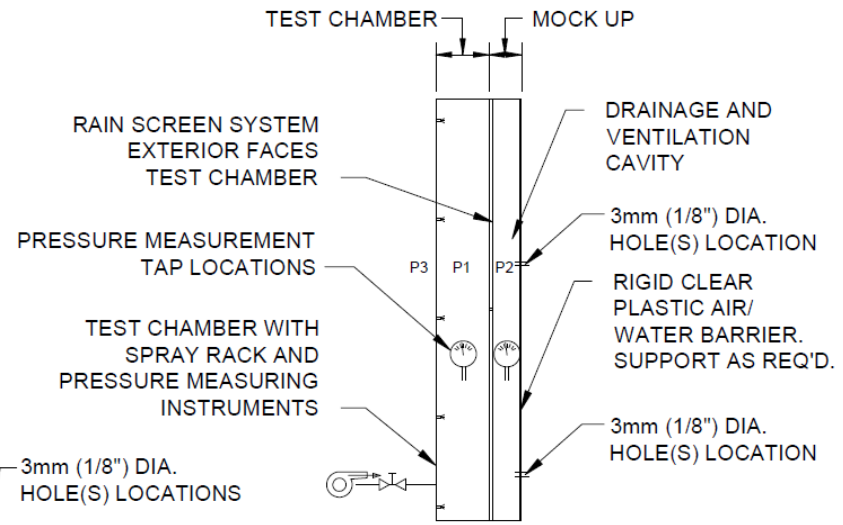
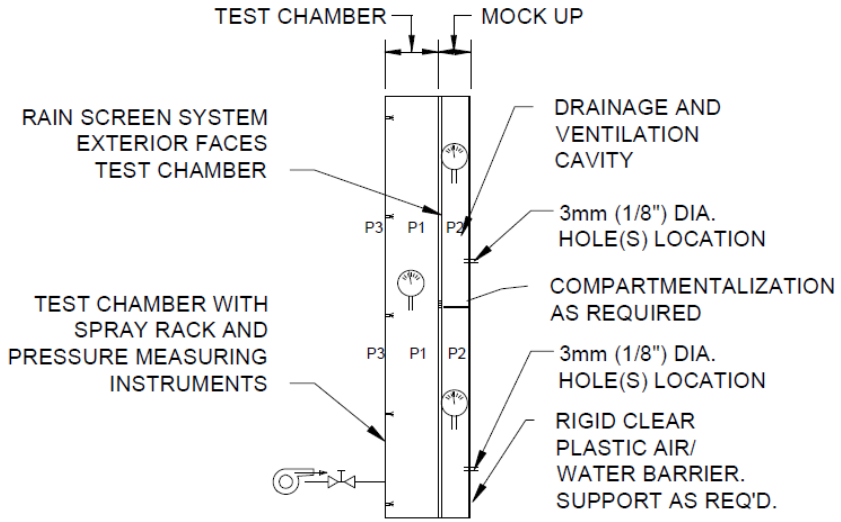


VERTICAL SECTION VIEW

WITHOUT COMPARTMENTALIZATION



VERTICAL SECTION VIEW

WITH COMPARTMENTALIZATION

PRESSURE MEASURED IN EACH COMPARTMENT

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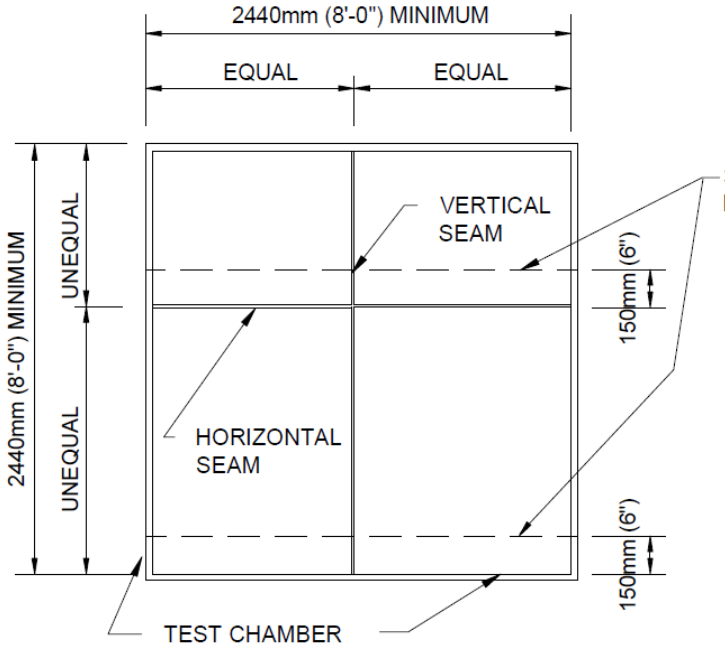
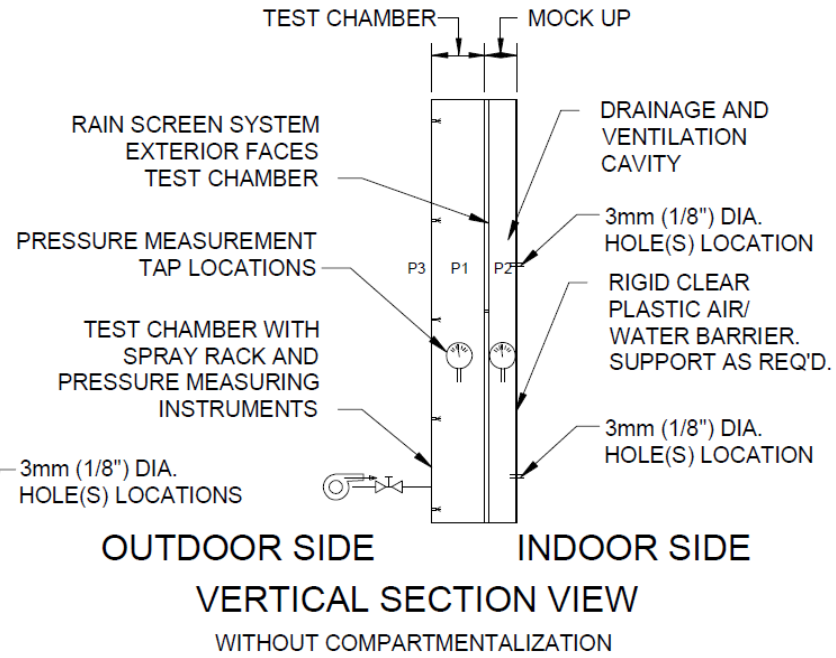
Unequal Panels



ELEVATION VIEW

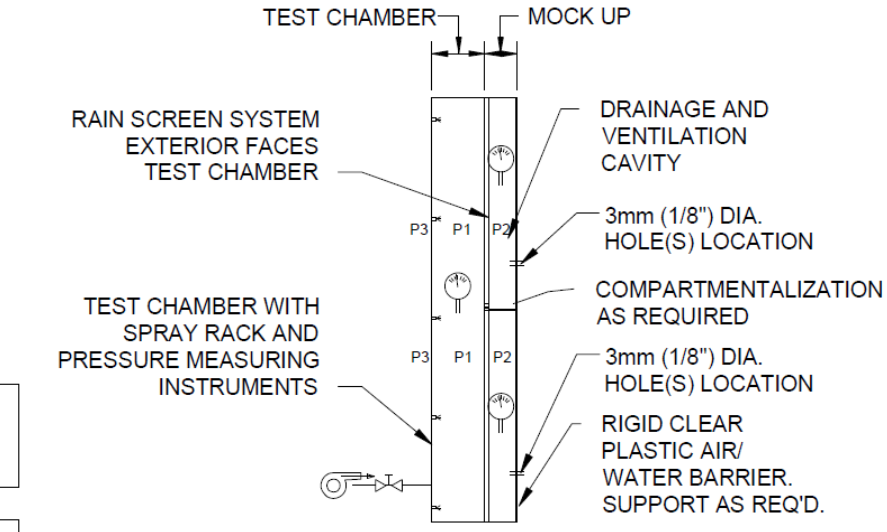
NOTE: NON-TYPICAL PERIMETER CONDITIONS SHALL BE PERMITTED TO BE SEALED AND NOT BE CONSIDERED PART OF THE TEST.

NOTE: PANEL DIMENSIONS ARE TYPICAL



VERTICAL SECTION VIEW

WITHOUT COMPARTMENTALIZATION



VERTICAL SECTION VIEW

WITH COMPARTMENTALIZATION
PRESSURE MEASURED IN EACH COMPARTMENT

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TEST PROCEDURE:

- ASTM E 283 is used to confirm that the air/water barrier leakage is 0.6 L/s•m2 (0.12 cfm/ ft2) ± 10% at 75 Pa (1.57 psf). The test pressure difference shall be positive on the exterior of the air/water barrier and negative on the interior.

The IECC recommends an air leakage rate of 0.2 L/s•m2 (0.04 cfm/ft2) at 75 Pa (1.57 psf) for air barrier assemblies. This procedure uses higher air leakage to simulate possible field defects in as-built conditions[1] and given that this method is to qualify the rain screen.

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TEST PROCEDURE:

- ASTM E 1233 pressure cycle testing (to establish if pressure equalization is present) modified as follows:
  - Positive pressure loading from 240 Pa (5 psf) to 1,200 Pa (25 psf) to 240 Pa (5 psf) based on a maximum average of three second cycle durations for 100 cycles;
  - Measure the pressure in the cavity plot it against the external cyclic wind pressure;
  - If compartmentalized, at least two compartments shall be measured, including one of each type/size (pressure taps shall be centered in the respective compartment);
  - Pressure equalization, lag <= 0.08 sec and pressure difference <=50% of the maximum test pressure.

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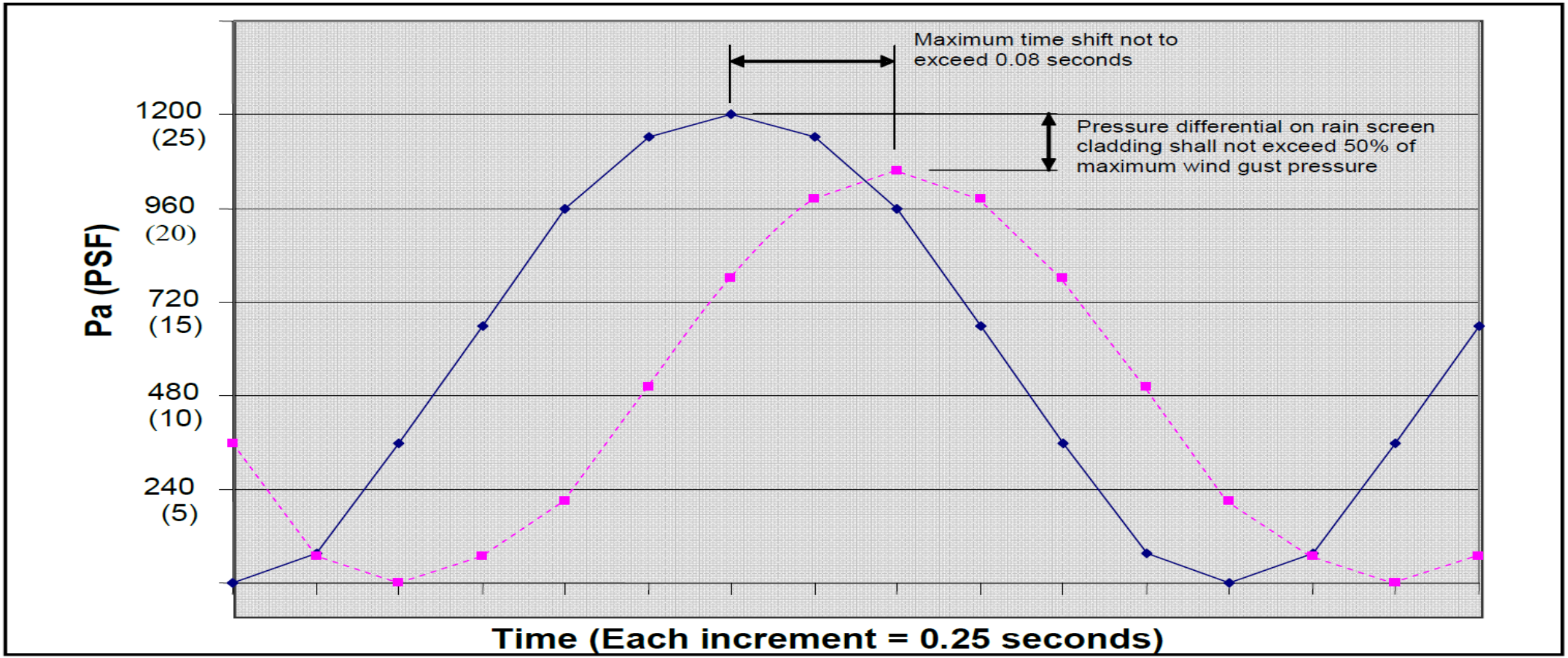

FIGURE 3: PRESSURE EQUALIZATION GRAPH FOR A PRWC WALL[2]
Plotting of Cycle Duration and Dwell Time

LEGEND
Solid Line: External Wind Gust Pressure
Dashed Line: Cavity Pressure

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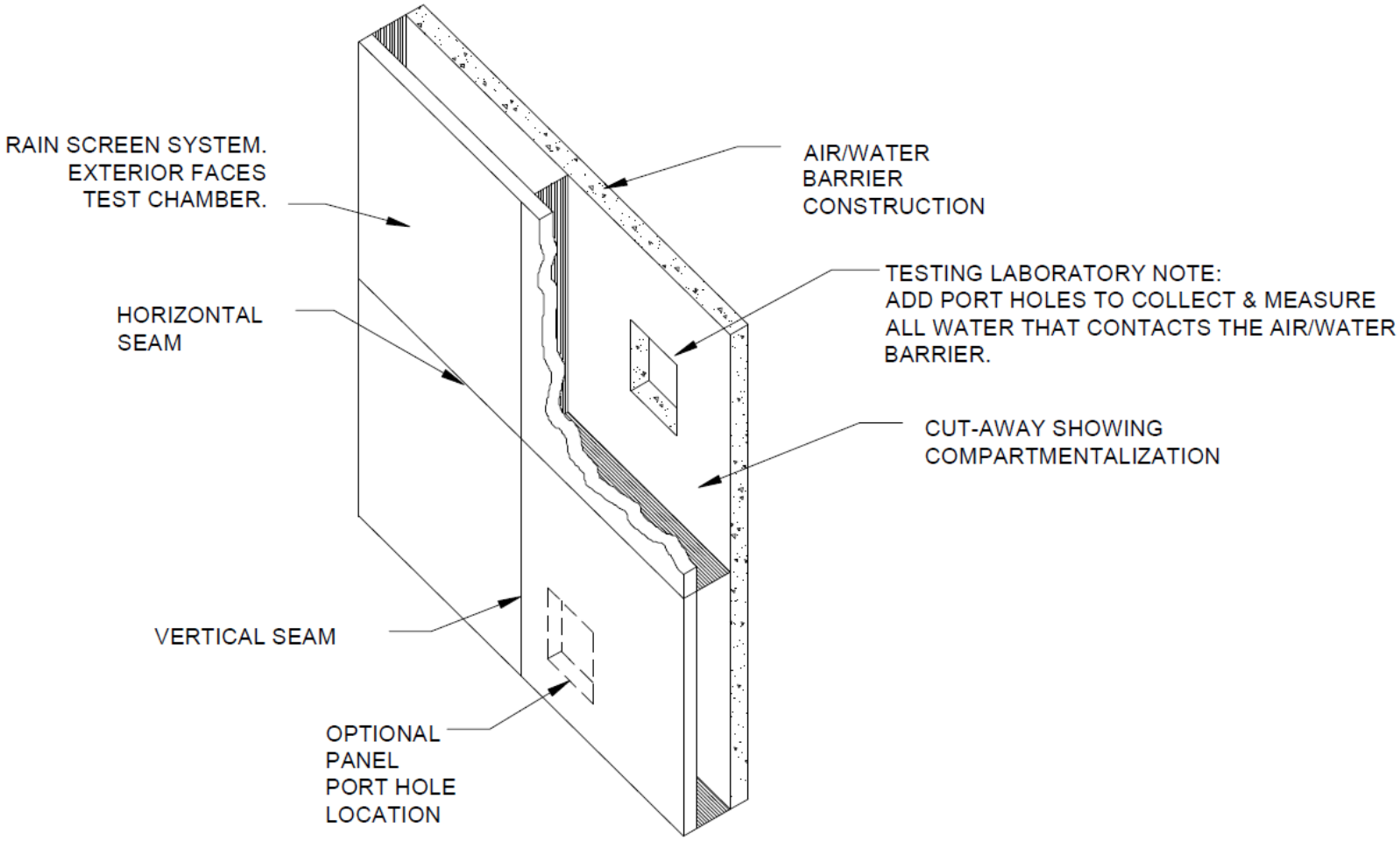

VIEW SHOWING COMPARTMENTALIZATION

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TEST PROCEDURE:

- ASTM E 331 water penetration test performed at a minimum of 300 Pa (6.24 psf);
- AAMA 501.1 dynamic water test performed at a minimum of 300 Pa (6.24 psf);
- When testing the actual air/water barrier for a project specific system, perform static structural performance test ASTM E 330 at 0.5, 1.0 and 1.5 times the specified positive and negative design pressures.

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PERFORMANCE REQUIREMENTS:

- Water penetration through the exterior rain screen cladding to be controlled and drained to the exterior;
- All water that contacts the air/water barrier shall be visually observed and recorded;
  - ➢Water mist or droplets on the air/water barrier surface; and/or
  - ➢Water in a continuous stream on the air/water barrier surface.
- Water mist or water droplets appearing in excess of 5% of the air/water barrier surface, or continuous streaming at any location on the air/water barrier will be considered failure.

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TEST REPORT:

- Air leakage rate reported as L/s•m2 (cfm/ft2);
- All water that contacts the air/water barrier shall be visually observed and recorded;
- Illustrations of the test mock-up;
- Chart showing the cycle duration and loading along with the dwell time between cycles;
- Ratio of cavity volume to vent area expressed as m^3/ m^2 (ft3/ft2).

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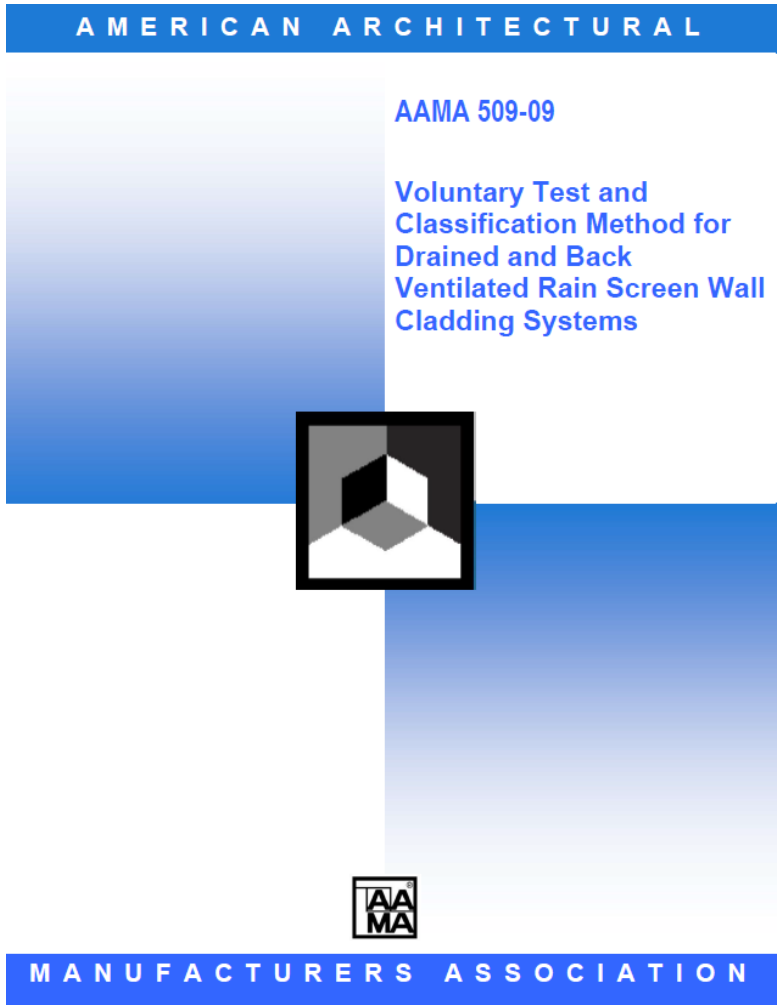
Review of AAMA 509-14

AAMA 509-14 Voluntary Test and Classification Method for Drained and Back Ventilated Rain Screen Wall Cladding Systems



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SCOPE:

This voluntary test and classification method establishes the requirements for test specimens, apparatus, test procedures, test reports and performance data that may be used in the evaluation of drained and back ventilated rain screen wall cladding systems. The primary purpose(s) of this test method is to quantify the volume of rain water contacting an imperfect AWB and the system's ability to allow for ventilation/drying as measured by air flow through the cladding.

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PERFORMANCE CHARACTERISTICS OF DRAINED AND BACK VENTILATED RAIN SCREEN WALL CLADDING SYSTEMS:

- In actual wall system evaluation, the test sample shall be built with the specified air/water barrier to be used in the system and its rigidity shall be representative of the specified air/water barrier.
- In generic exterior rain screen system evaluation, clear plastic air/water barrier shall be utilized.

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PERFORMANCE CHARACTERISTICS OF DRAINED AND BACK VENTILATED RAIN SCREEN WALL CLADDING SYSTEMS :

Primary performance characteristics evaluated:

- ✓ Air flow volumes through the cladding : ASTM E 283 (Static);
- ✓ Water Penetration: ASTM E 331 (Static), AAMA 501.1 (Dynamic);
- ✓ Structural Performance: ASTM E 330 (Static).

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TEST SPECIMENS:

- Specimen: minimum of 2440 mm x2440 mm (96 in x 96 in);
- For classification testing, a minimum of one head to sill vertical joint and one jamb to jamb horizontal joint shall be provided and located in the center of the specimen;
- AWB and panel supports, with maximum support spacing;
- Default deflection criteria of the wall support framing is L/175 and the actual maximum deflection of the support wall will be reported (results applicable to as stiff or stiffer);
- Simulation of the AWB, use a rigid clear plastic for a generic test or use the actual AWB material for a system specific test;

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TEST SPECIMENS:

- Construct the test chamber such that all water runoff from the exterior (cavity side) surface of the AWB and any water that penetrates the purposely designed defects can be collected and quantified;
- The rigid clear plastic AWB shall be equipped with a gate valve that is capable of allowing for the measurement of air flow through the cladding joinery. The gate valve shall be located in the upper section of the specimen so as to not restrict water drainage during water testing.

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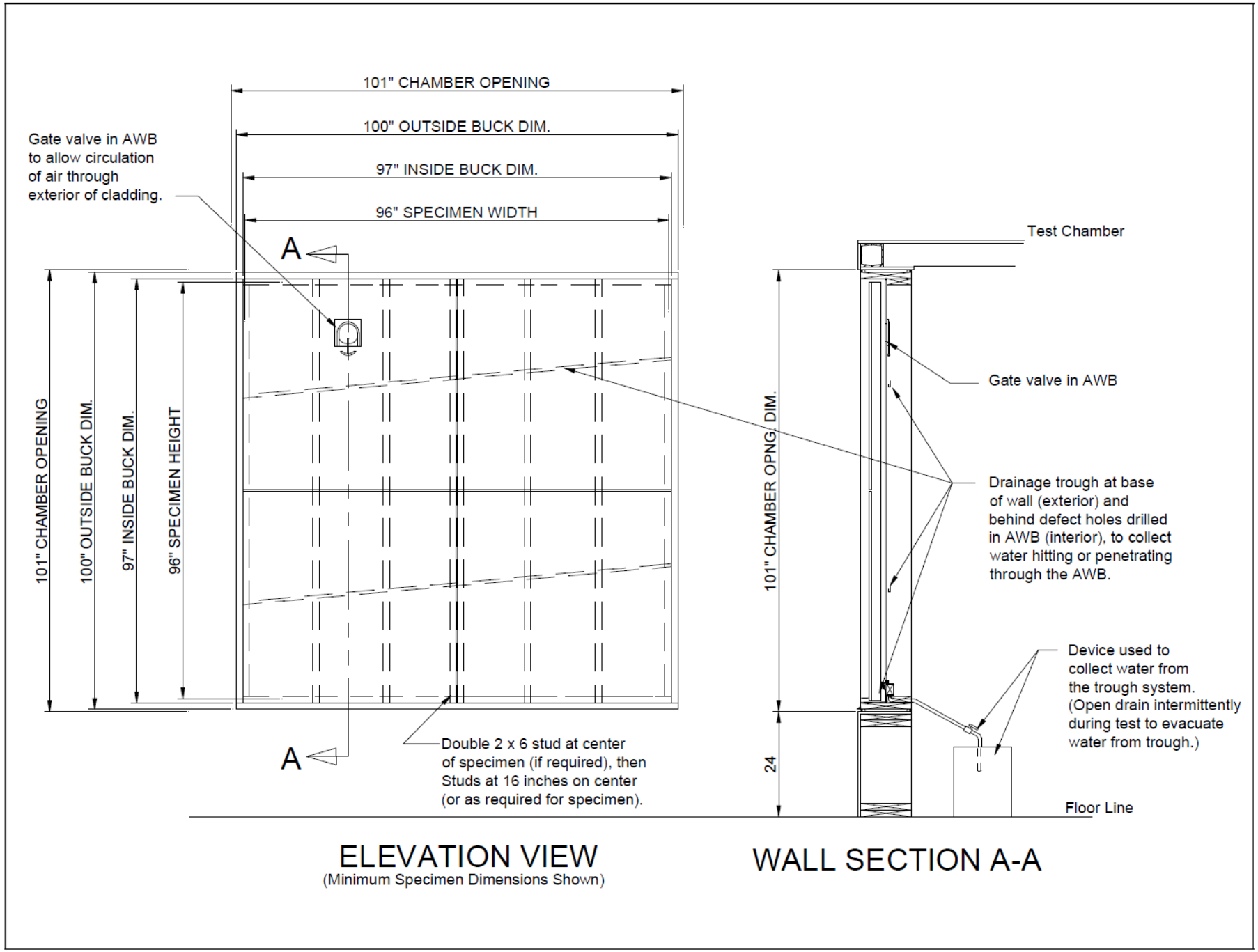
Mock-up elevation



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TEST PROCEDURE:

AIR INFILTRATION MEASUREMENT

- Perform an air infiltration test on the test chamber using ASTM E 283 at 75 Pa (1.57 psf). This test establishes the initial tare of the chamber and AWB assembly which will be used in subsequent testing;

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TEST PROCEDURE:

AIR INFILTRATION ADJUSTMENT TO THE SPECIFIED AIR LEAKAGE RANGE

- Within the specimen (generic or project specific), adjust the air infiltration of the AWB by introducing 3 mm (1/8 in) diameter holes to represent purposely designed defects in the AWB assembly;
- The holes introduced into the AWB shall be of sufficient number to produce air leakage of 0.6 L/s•m2 (0.12 cfm/ft2) ± 10% at 75 Pa (1.57 psf) (if compartmentalized each one allowed the air leakage range).

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TEST PROCEDURE:

AIR INFILTRATION ADJUSTMENT TO THE SPECIFIED AIR LEAKAGE RANGE

- Retest air infiltration through the AWB using ASTM E 283 to confirm that the AWB air leakage is 0.6 L/s•m2 (0.12 cfm/ft2) ± 10% at 75 Pa (1.57 psf). The test pressure difference shall be positive on the exterior side of the AWB and negative on the interior side. While running the air infiltration test, drill the required number of holes through the AWB to achieve the desire air leakage (± 10%) through the specimen. (e.g. Based on a 2.44 m x 2.44 m (8’ x 8’) specimen size, multiply 5.95 m2 (64 ft²) by 0.6 L/s•m2 (0.12 cfm/ft²);

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TEST PROCEDURE:

AIR INFILTRATION ADJUSTMENT TO THE SPECIFIED AIR LEAKAGE RANGE

- which equals 3.57 L/s (7.68 cfm), which is the prescribed air leakage rate through the AWB. Add that sum to the tare found to determine the total air leakage rate desired through the specimen.

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TEST PROCEDURE:

AIR INFILTRATION ADJUSTMENT TO THE SPECIFIED AIR LEAKAGE RANGE

- Install the Wall Cladding System;
- Repeat Air Infiltration Testing With Cladding System Installed using ASTM E 283 at 75 Pa (1.57 psf) to measure air infiltration through the exterior cladding inclusive of the AWB for the purpose of documenting any cladding installation effects on the air leakage (if 10% or more block 1/8 holes);

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TEST PROCEDURE:

AIR FLOW MEASUREMENTS THROUGH CLADDING

- Seal all test specimen joints and open gate valve in AWB;
- Using ASTM E 283 at 26 Pa (0.55 psf) perform an air flow test to determine the air flow tare. The air flow tare determined during this test will be subtracted from the measured air flow through each individual joint test that follows in order to determine the net air flow through each joint;
- Isolate and test the individual specimen joints (head/sill/verticals, horizontals), for air flow measurement through the cladding surface. Jambs shall remain isolated and sealed.

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TEST PROCEDURE:

OPTIONAL STRUCTURAL PERFORMANCE

- When testing the actual AWB for a project specific system, perform a static structural performance test; with all previously applied isolation/joinery seals removed, using ASTM E 330 at 0.5 and 1.0 times the specified positive and negative design pressures. Other project specific structural testing shall be performed as required, with structural proof testing (1.5 times the specified positive and negative design pressure) being performed after all other testing is complete;

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TEST PROCEDURE:

OPTIONAL STRUCTURAL PERFORMANCE

- If the optional structural performance testing is performed, repeat the air leakage test (see Section 5.6), using ASTM E 283 at 75 Pa (1.57 psf) to determine the difference (if any) between the measured air infiltration before and after design pressure.

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TEST PROCEDURE:

TESTS FOR WATER PENETRATION

- During water penetration testing, collect all water that drains off of and/or penetrates through the defect holes in the AWB. All water collected shall be weighed and the data shall be recorded in the test report;
- ASTM E 331 static water penetration tests are performed at a test pressure of 300 Pa and 577 Pa (6.24 psf and 12 psf);
- AAMA 501.1 dynamic water penetration tests are performed at a test pressure of 300 Pa and 577 Pa (6.24 psf and 12 psf).

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TEST REPORT:

- Air leakage rate reported as L/s•m2 (cfm/ft2);
- air flow measurement of each test shall be reported as L/s (cfm);
- For each water penetration test, record the total water collected by weight as kg or g (lbs or oz) from each of 4 tests completed and calculate the resulting amount of liquid water in ml (oz.);
- For each water penetration test, determine the water volume ml/m² (ounces per/ft²) of wall system area;
- Determine the sum total of all four water tests and then determine an average of the results in ml/m² (oz/ft²).

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CLASSIFICATION DETERMINATION:

- Using the data obtained from the air flow and water penetration tests, determine the appropriate classification by plotting the point resulting from the air flow and water coordinates on the classification chart;
- A table showing all recorded air and water values shall be included in the report;
- A copy of the classification chart indicating the system classification shall be included in the test report.

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TEST RESULTS - AIR FLOW MEASUREMENT ACROSS THE CLADDING ELEMENTS						
Data	Head	Sill	Horizontal	Vertical	[3]Sum (cfm)	[4]cfm/ft²
[1](cfm)	195.65	252.15	263.15	62.05	773.00	12.08
[2](cfm/ft)	24.46	31.52	32.89	7.76	Not Required	Not Required

(1) Record the data for each element (1) head/sill/horizontal(s)/vertical(s) and express as cfm.

(2) Calculate the cfm per lineal ft. of each element - head/sill/horizontal(s)/vertical(s) and express as cfm/ft.

(3) Sum the total cfm from all of the elements and then divide the total sum by the total square footage of the specimen and (4) express as cfm/ft².

(4) Use the results of (4) for classification purposes. This number is used to determine the "V-axis". (See Chart A1.)

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TEST RESULTS - WATER COLLECTED OFF/THROUGH THE AWB							
Data	6.24 psf static	12 psf static	6.24 psf dynamic	12 psf dynamic	(3)TTL oz.	(4)Sum oz/ft²	(5)Avg. oz/ft²
(1)liquid oz.	433.92	399.41	424.57	396.65	1654.55	Not Required	Not Required
(2)oz/ft²	6.78	6.24	6.63	6.20	Not Required	25.85	6.46

(1) Record the raw data of each test (1), and express as liquid oz. (Calculate from weight as required.)

(2) Record results of individual tests (2) and express as oz/ft². (For informational purposes.)

(3) Sum the results of the four water tests from (1) and express as total ounces (3).

(4) Using the sum from (3) determine the sum per ft² of specimen area. (For informational purposes.)

(5) Calculate the average oz/ft² of each test by dividing the sum/oz/ft² (4) by four (i.e number of tests run).

(6) Use the result from (5) to for classification purposes. This number is used to determine the "W-axis". (See Chart A1.)

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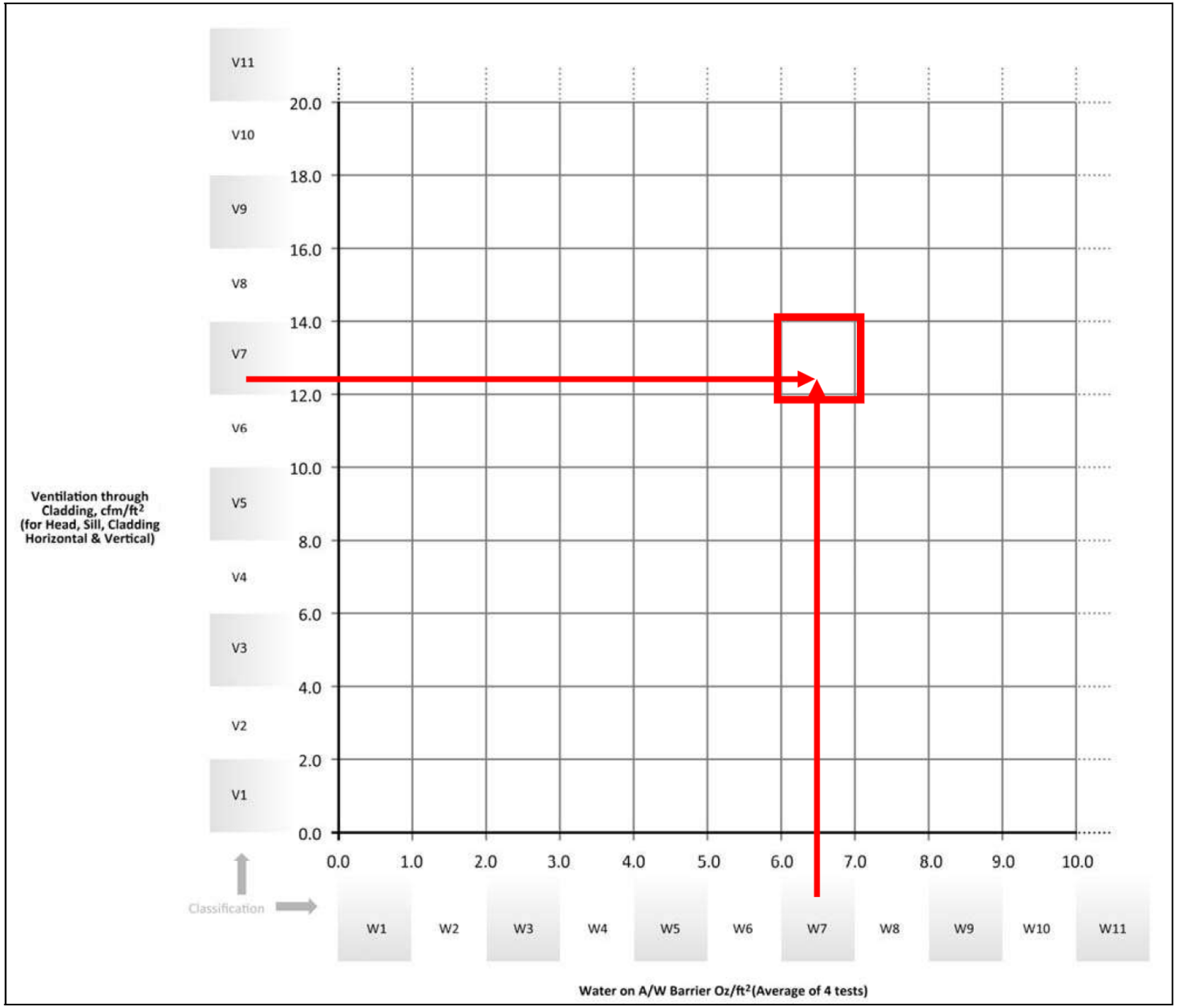

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Agenda

- Pressure Equalized Rain Screen per AAMA
- Drained and Back Ventilated Rain Screen per AAMA
- Review of AAMA 508-14
- Review of AAMA 509-14
- Discussions, Questions & Answers

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Discussions

- Understand the importance of the Air Barrier performance to reduce problems associated with water penetration;
- Differences of the methods;
- Compare the performance results;
- Which Standard to be use in which situation;

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