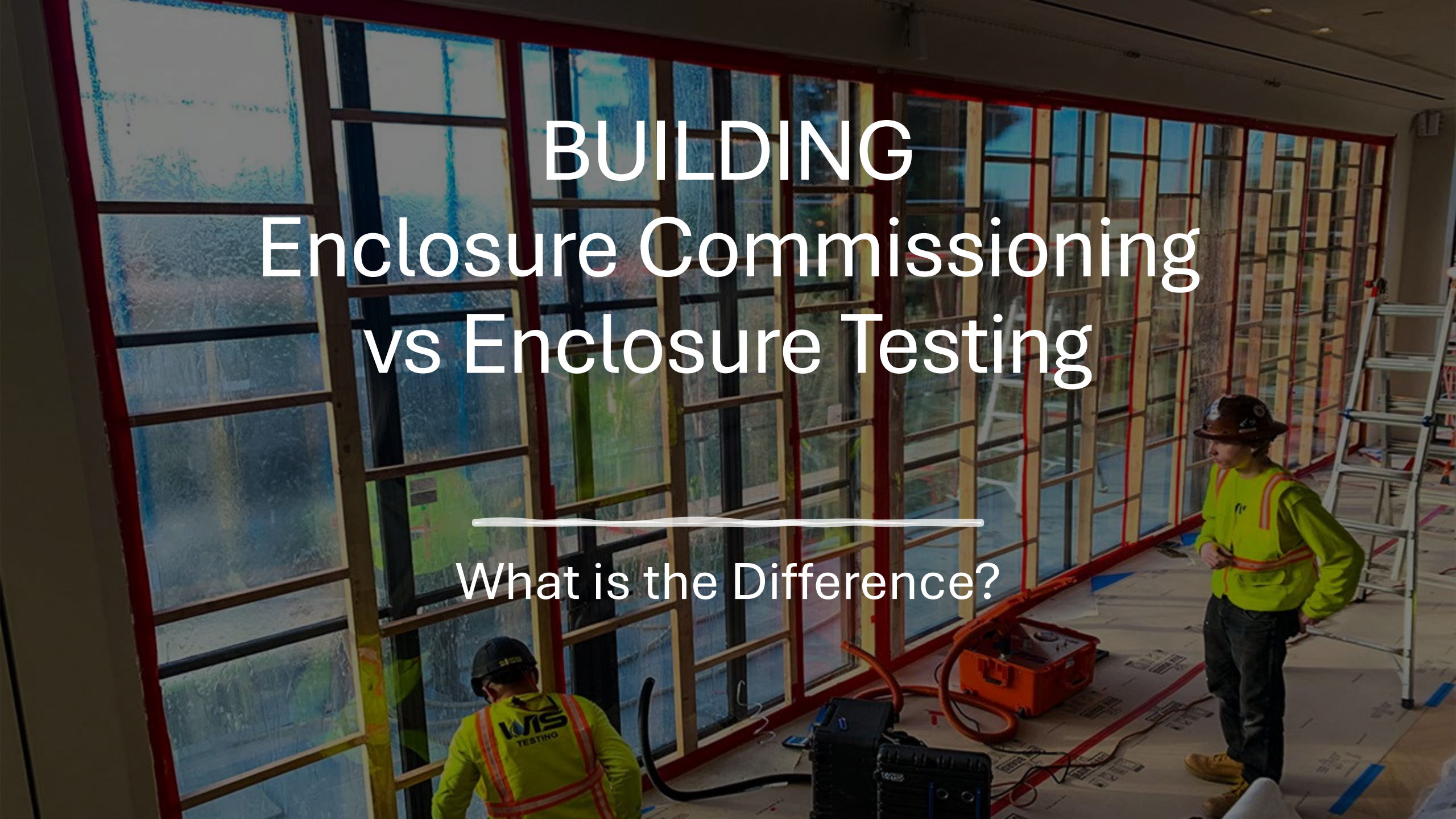

BUILDING
Enclosure Commissioning
vs Enclosure Testing
What is the Difference?
WIS
TESTING

Course Description

- In this session the audience will learn the differences between Building Enclosure Commissioning (BECx) and Building Enclosure Testing (BET).
- We will discuss how the BET requirement for a project starts with the Owner Project Requirements and how the Testing requirement flow through the Commissioning Process, the Design Process and ultimately the Functional Testing process of the Building Enclosure Systems.
- We will discuss the various Standards, Guideline and Codes that govern Commissioning and Testing.
- We will equip the participant to have a common language for discussing Building Enclosure testing methods with the Owner and the whole AEC Team.
- And finally, we will develop an understanding of how the Building Enclosure Commissioning process incorporate Enclosure Testing as the final Functional Performance Test of the various Enclosure Systems

AIA Learning Objectives

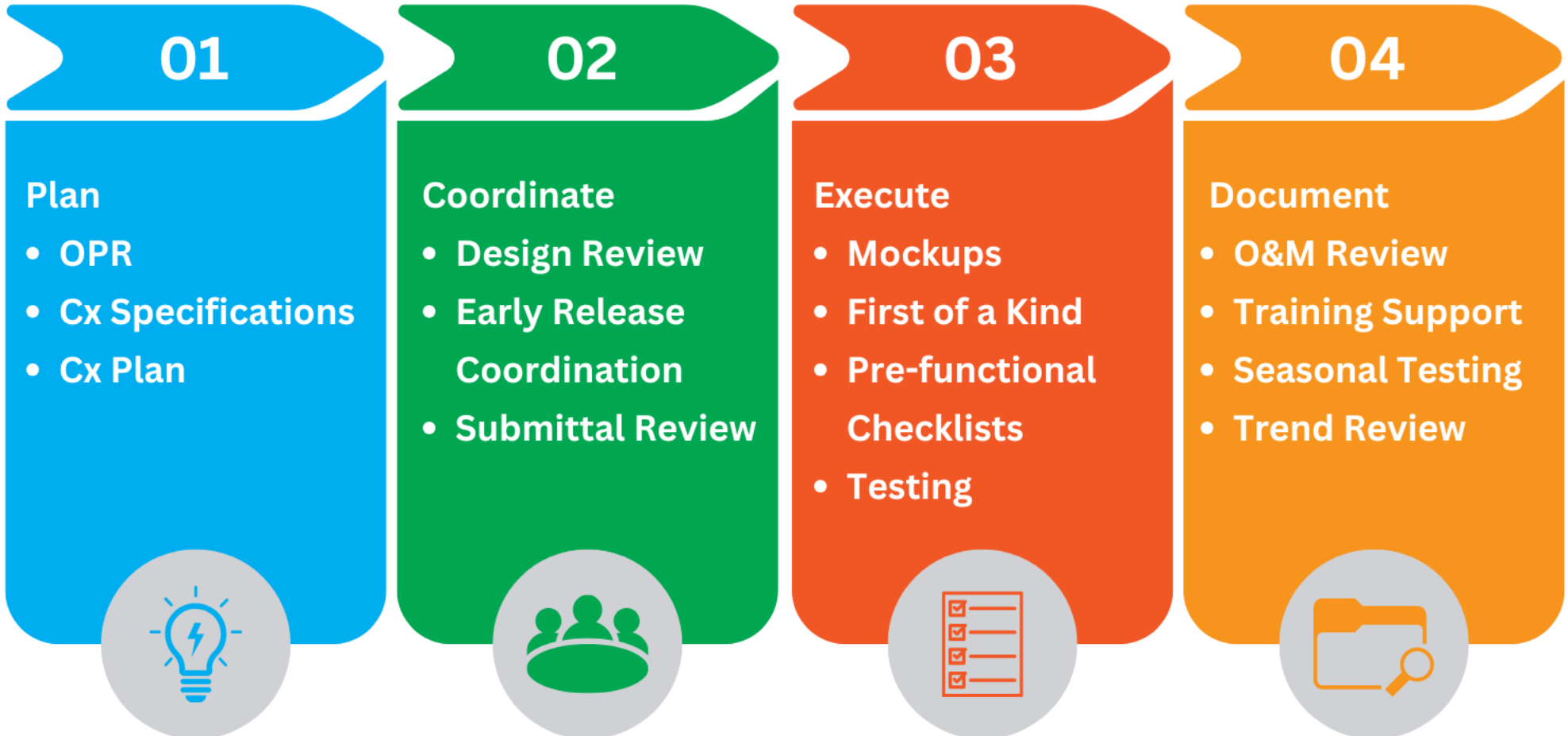
At the end of the presentation, participants will:

- 1. Learn the differences between BE Commissioning and BE Testing.
- 2. Understand how Owner Project Requirements relate to design decisions affecting functional performance testing of the Enclosure
- 3. Develop a common basis for discussing Building Enclosure testing methods with the AEC Team.
- 4. Understand how the Building Enclosure Commissioning process incorporate Enclosure Testing as the final Functional Performance Test of the various Enclosure Systems.

What is Enclosure Commissioning?

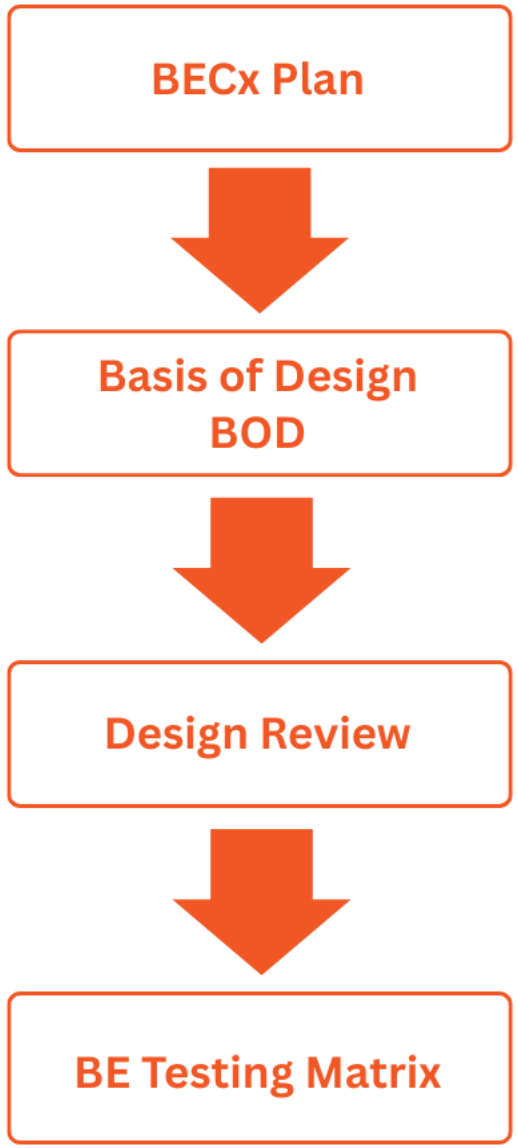
- ASTM E2813 defines Building Enclosure Commissioning as, “Building Enclosure Commissioning (BECx) is a process that begins with the establishment of the Owner’s Project Requirements (OPR) and endeavors to ensure that the exterior enclosure and those elements intended to provide environmental separation within a building or structure meet or exceed the expectations of the Owner as defined in the OPR.”

The Commissioning Process



What is Building Enclosure Commissioning?

Building Enclosure Commissioning (**BECx**) is a quality-focused process wherein the energy performance of a facility, system or assembly is evaluated and verified against defined objectives and criteria.



Enclosure Testing
-
The Testing Matrix

- Included in the Building Enclosure Specification
- Included in the BECx Plan
- Collaborative Decision by:
  - Owner
  - Designer
  - Enclosure Consultant
  - CMAR
  - Trade Partners

Table 1. A portion of Table A2.1 from ASTM E2813-18, Standard Guide for Building Enclosure Commissioning[4]

Property	Standard Designation	Title	Lab System Testing	Enhanced		Fundamental	
				Field Mockup Testing	In-Situ Field Testing	Field Mockup Testing	In-Situ Field Testing
Water Penetration							
Water penetration	ASTM E331	Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference	L (M)	–	–	–	–
	ASTM E514/ E514M	Test Method for Water Penetration and Leakage Through Masonry	OL	(OF)	(OF)	(OF)	(OF)
	ASTM C1601	Test Method for Field Determination of Water Penetration of Masonry Wall Surfaces	–	(OF)	(OF)	(OF)	(OF)
	ASTM D5957	Guide for Flood Testing Horizontal Waterproofing Installations	–	(OF)	✔ (all horizontal surfaces)	(OF)	✔ (all horizontal surfaces)
Static water penetration	ASTM E1105	Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference	–	✔ (1X)	✔ (2X)	✔ (1X)	✔ (2X)
Dynamic water penetration	AAMA 501.1	Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure	OL (M)	(OF)	✔ (1X)	(OF)	(OF)
	ASTM E2268	Test Method for Water Penetration of Exterior Windows, Skylights, and Doors by Rapid Pulsed Air Pressure Difference	OL	(OF)	(OF)	(OF)	(OF)
	AAMA 501.2	Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems	–	✔ (1X)	✔ (1X)	✔ (1X)	✔ (1X)

What is Enclosure Testing?

- **NEBB** defines **Building Enclosure Testing (BET)** as the process of testing both the interior and exterior of a building structure to determine if there are any air, water, or thermal leaks.
- It validates the effectiveness of all air barriers, reducing energy consumption and ensuring a comfortable environment for occupants.

Where BE Commissioning and Testing Intersect

Enclosure Commissioning

Design Phase

- Design Reviews to Owner's Project Requirements (OPR)
- Preliminary BECx Plan
- **Building Enclosure Testing Work Plan**

Construction Phase

- Construction Phase BECx Plan
- Construction Submittal Reviews
- Building Envelope Inspection Checklists
- **Building Enclosures Functional Tests**

Construction Phase

- Building Envelope Systems Site Observations
- **Building Enclosure Testing**

Turnover Phase

- Training
- O&M Manual Review
- Final BECx Report

Enclosure Testing

Construction Phase

- **Building Enclosure Testing Work Plan**
- Fluid Applied Air Barrier Tests
- Sealant Pull Tests
- Window Spray and Chamber Testing
- Infrared Thermography Test
- Roof Inspections and Testing
- Electronic Leak Detection
- Whole Building Pressure Testing

Enclosure Commissioning Process

NIBS Guideline 3-2012 Building Enclosure Commissioning Process

ASHRAE Standard 202, Commissioning Process for Buildings and Systems

ASTM E2813, Standard Practice for Building Enclosure Commissioning

ASTM E2947, Standard Guide for Building Enclosure Commissioning

WBDG - Whole Building Design Guide BECx 01-91-19

Project Manual BECx Specifications 01-91-15

Project Manual Specification Division 6,7,8, and 9

Specification for Division 7 & 8
Know what is required and by whom!

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS 084113 Para 3.8			
AMAA 501.2	1. Testing Agency: Owner may engage a qualified testing agency to perform tests and inspections B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum framed entrances and storefronts. 1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration. a. Perform a minimum of three> tests in areas as directed by Architect.	3 Tests by Architect Direction Recommend One additional Chamber test on each window type. Testing of different window types	

Specifications for Division 7 & 8
Know what is required and by whom!

ALUMINUM WINDOWS 085113 Para 2.10

AMAA 502	A. Testing Agency: Engage a qualified testing agency to perform tests and inspections. 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements. B. Testing Services: Testing and inspecting of installed windows shall take place as follows: 1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502. 2. Air-Infiltration Testing: a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated. b. Allowable Air-Leakage Rate: 1.5 times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class	Recommend striking: b. Allowable Air-Leakage Rate: 1.5 times the applicable and 3a est Pressure: Two-thirds times test pressure required to determine compliance No defined number of windows listed Perform in conjunction with 08-4113 testing

A Suggested BE Testing Methodology

- Three (3) ASTM 501.2 WINDOW SPRAY TESTS on Areas Selected by Architect and Consultant
- Three (3) ASTM 1105 & 783 CHAMBER TEST on Areas Selected by Architect and Consultant
- Ten (10 tests) per 1000’ ASTM 1193 of SEALANT PULL TEST or as decided by Arch/Consult
- ASTM 4454 - FLUID APPLIED AIR BARRIER TEST
- One (1) ASTM C1153 THERMOSCAN OF THE ROOF
- *Should the Project and/or Budget Warrant. Pass Fail Test at the End of the Project*
    - ASTM E779 Whole Building Pressurization Test

Window Test AAMA 501.2 - Procedure

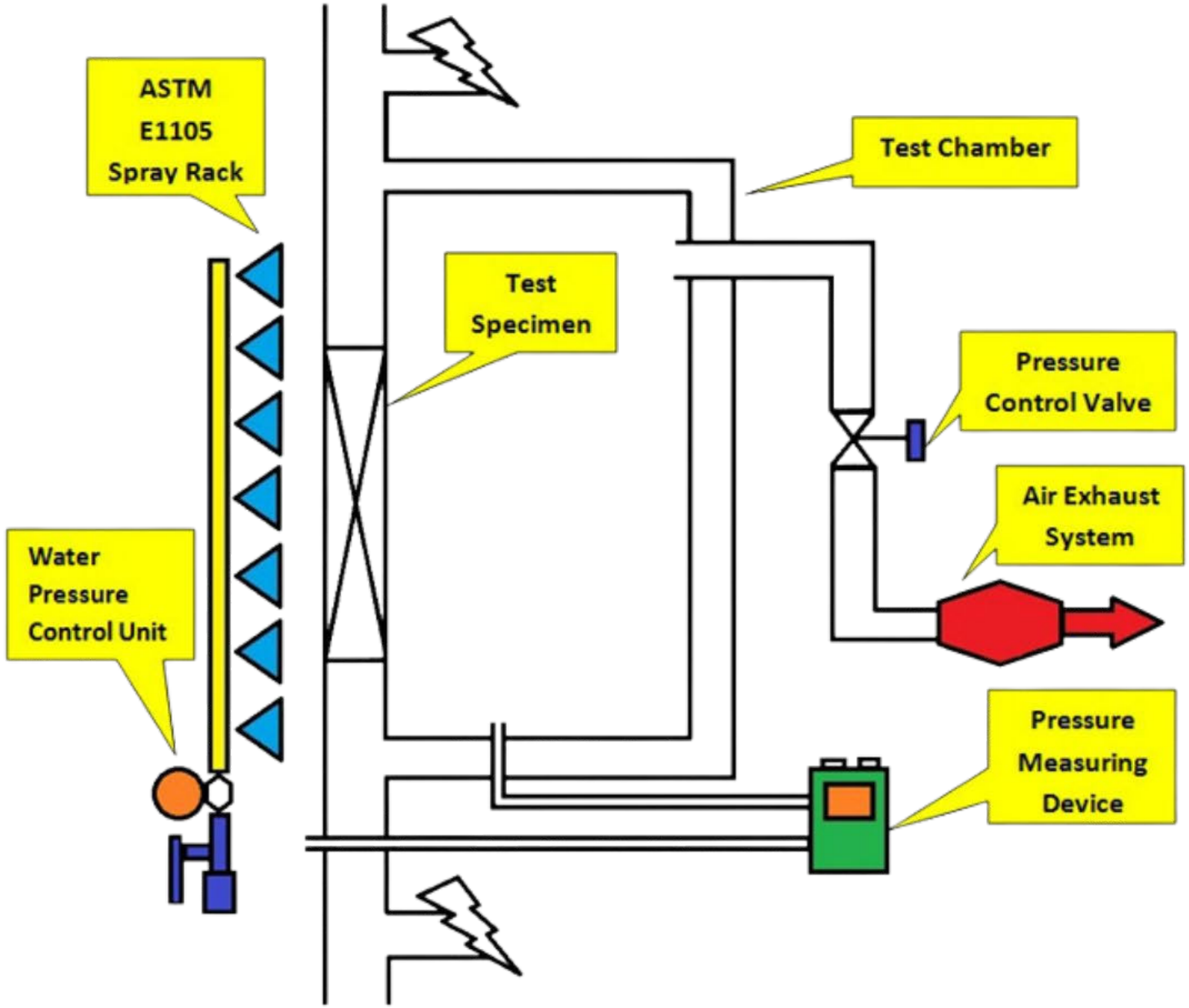
- Pressure of 30-35 psi
- Applied from a 3/4” hose fitted with special nozzle
- Monarch Manufacturing ½” brass nozzle
- Test a 5-foot section sample with both frame and a joint in the glass.
- nozzle is held 1-foot away from the glass and slowly moved back and forth for the
- Duration of test is 5-minutes

Window Test AAMA 501.2 - Results

- Leakage at the gaskets
- Leakage at the bottom sill
- Leakage through the extrusion
- Poor workmanship: Extra sealant on the joints to prevent water leakage

ASTM 1105 Process Diagram

- Water spray rack in place
- Chamber constructed over test specimen
- Vacuum system in place
- Pressure measuring equipment in place



ASTM 1105
Exterior View

- Spray rack delivering 5 gph/sq ft
- Test for 15 minutes

ASTM 1105
Interior View

- Plastic Chamber constructed to enclose the test specimen
- Vacuum of 6.24 psi being applied to chamber while water is applied to the exterior
- BECxP inspecting for leaks

ASTM 1105 Nota Bene:

- The ASTM 1105 is often done in conjunction with the ASTM 783
- This combination is also referred to as AAMA 502
- ASTM 783 is done before the water spray is performed
- This gives an idea of the air leakage through the assembly
- BE SURE TO SPECIFY BOTH!

ASTM 4454 - Fluid Applied Air Barrier Test

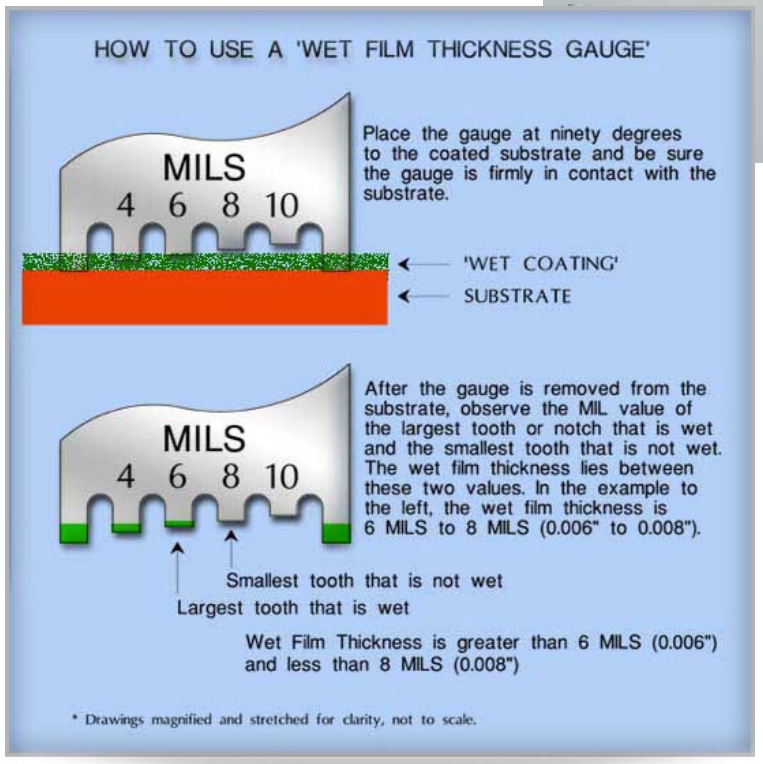
Aka: the Puck Test

- A good practice to include in a specifications or When in doubt
- Destructive Test
- Pull test to failure of a sample of the adhesion of the membrane to the Sheathing
- Adhesion Tensile strength per manufacturer’s recommendation

Fluid Applied Air Barrier
Visual Observation

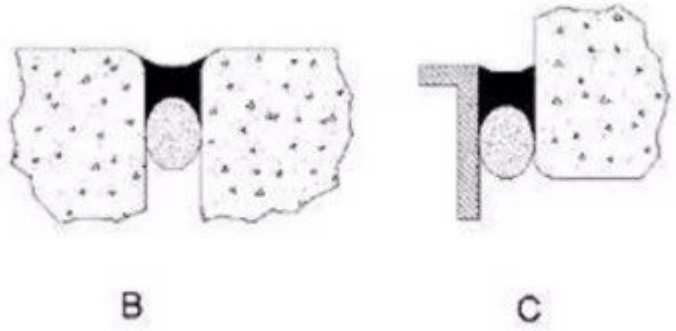
- Thin depth of application
- Run-off
- Worm holes
- Missed areas

- Simple Test:
- Use a thickness gage



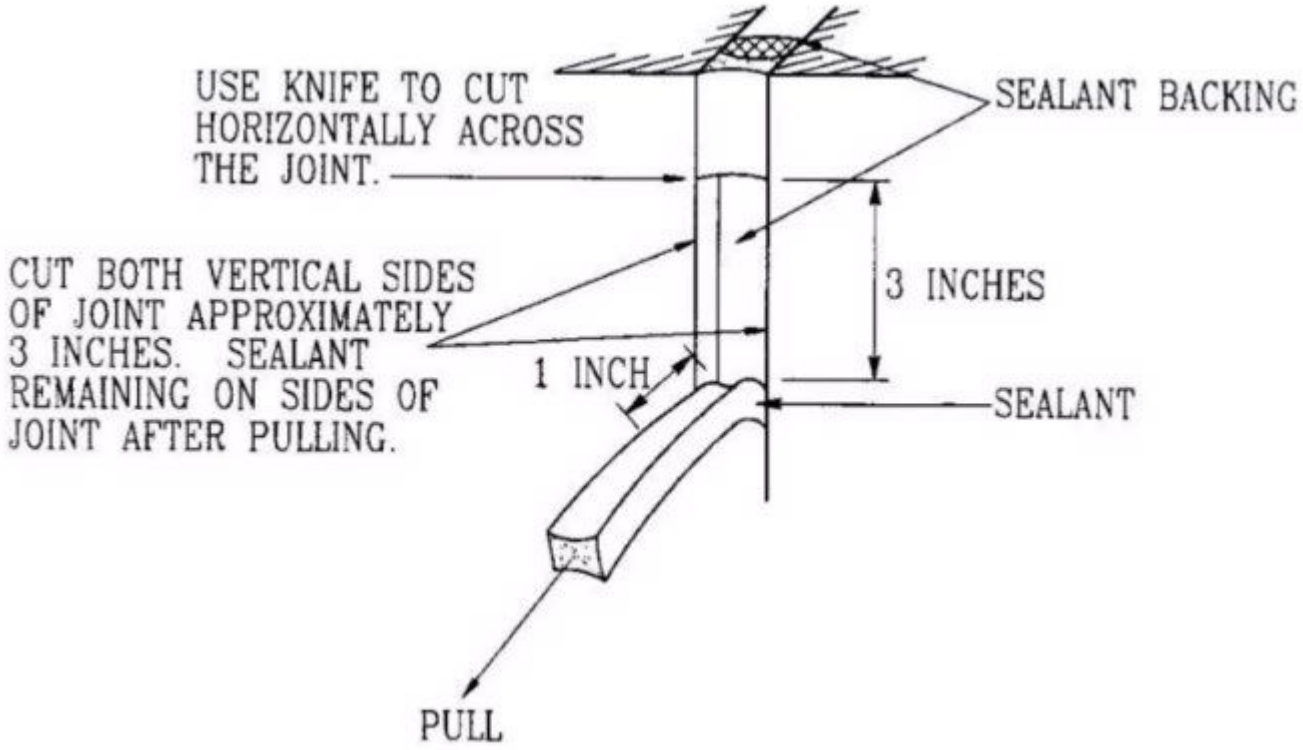
ASTM C11193

Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints



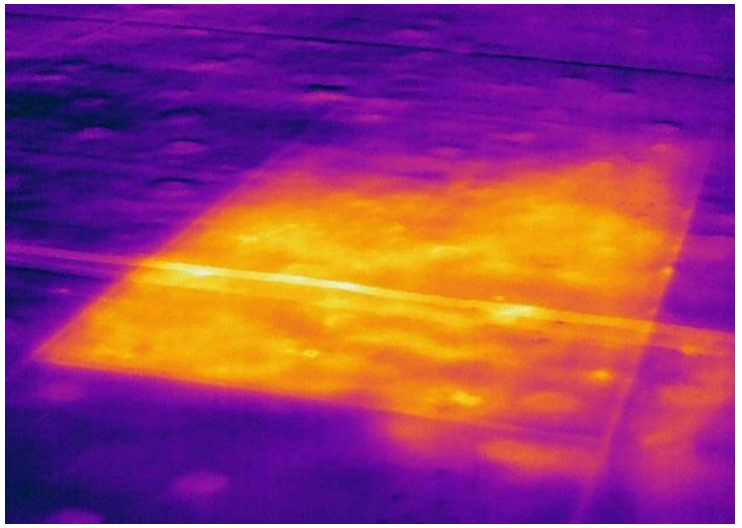
- Destructive Test
- Adhesion of sealant to substrate
- Tensile strength of the sealant bead

- Simple Test:
- The manufacturer is usually willing to perform: Tremco, Dow, Carlisle

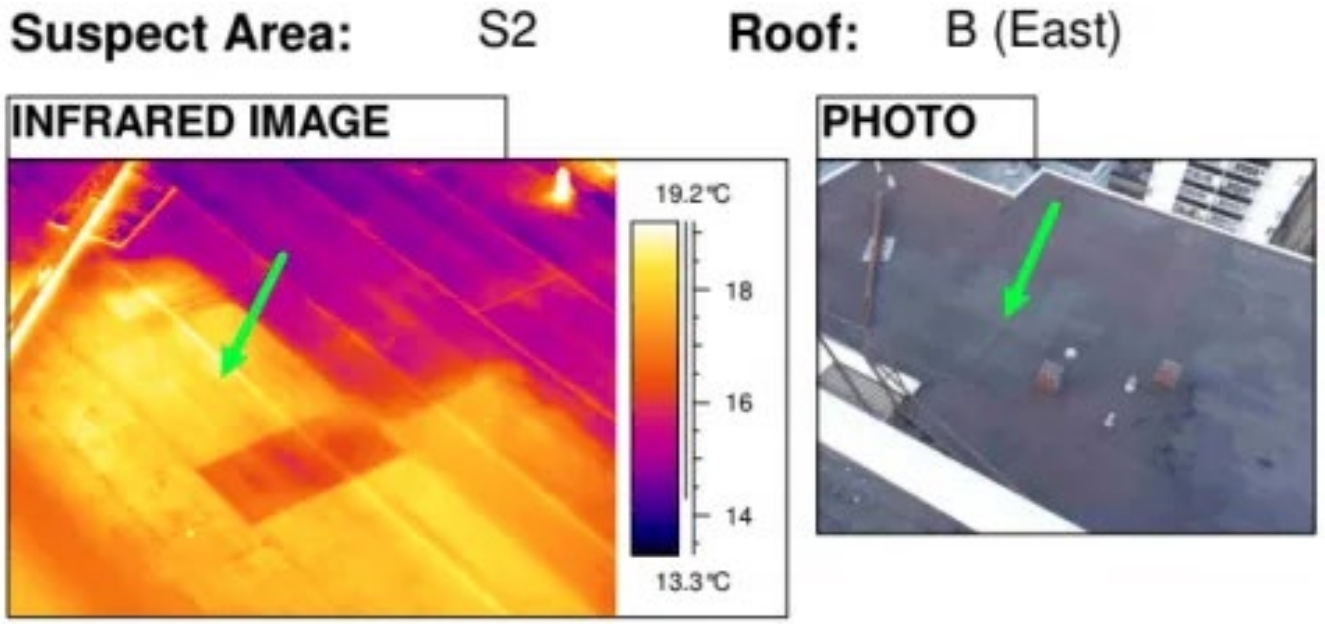


ASTM **C-1153**

Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging



- A good practice to include in specifications
- Infrared surveys to locate trapped moisture in flat and low sloped roofs
- This is after the fact, not a real-time test
- Critical to a 20°F delta T from the conditioned space to the exterior

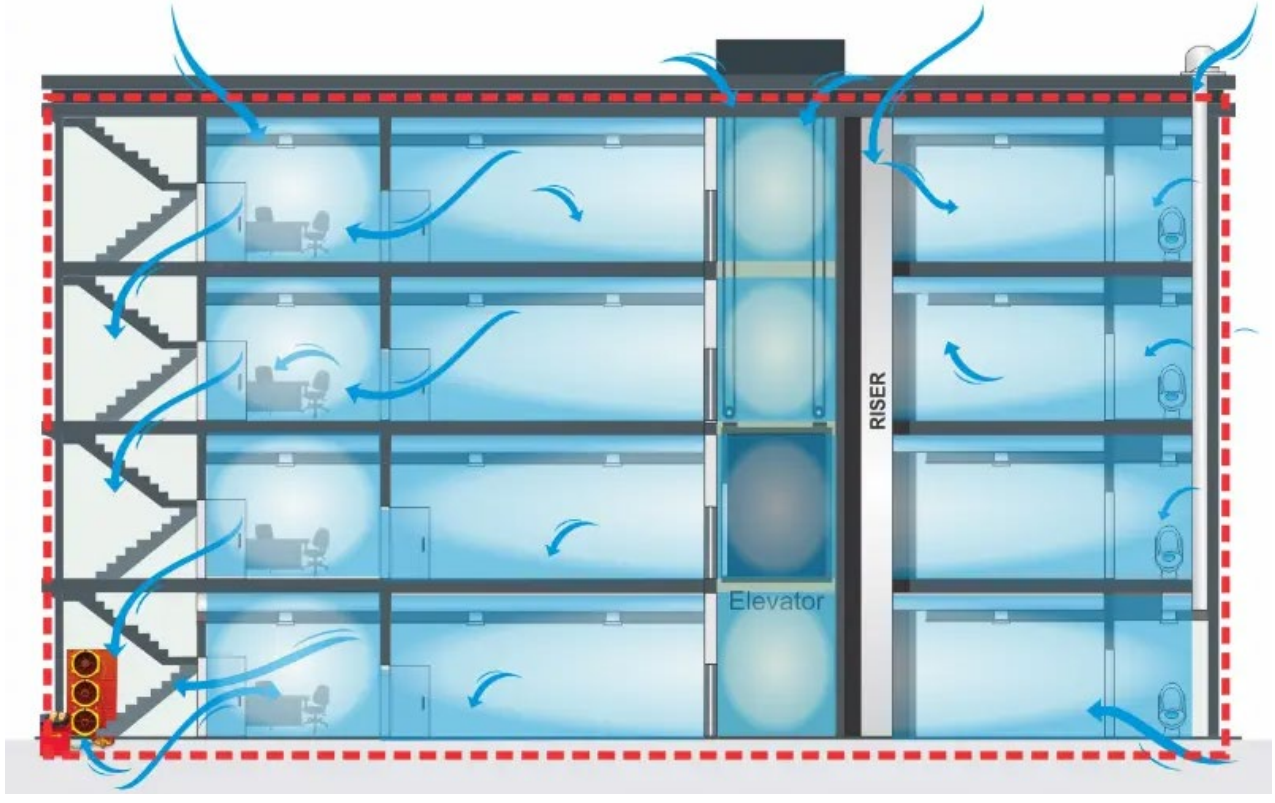


ASTM **E779** Whole Building Pressure Test

- A good practice to include in specifications
- Must be made aware to all parties at the beginning of the project. Every party must expect it before design starts
- What standard do you hold the team to?
- It is strictly pass/fail test
- A failure is messy to correct
- You can’t add quality at the end of the project!

ASTM **E779**
Whole Building Pressure Test

- A good practice to include in specifications



Let’s Re-Review our Suggested BE Testing

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BEST PRACTICES
The Mock-up

- Insist on an Actual Building Mock-up, not an as-built
- Too often it is an afterthought
- Have the Architect draw it as a section
- Have the CMAR build it in its entirety
- Don’t let the CMAR drag it out as the Trades arrive on the job.
- Don’t miss the chance to gain knowledge and experience

BEST PRACTICES On-Site Inspections

- Catch issues before it is too late
- Correct oversight while CMAR and Trade partners are on the job.
- The Air Barrier is a delicate thing; once it is covered by finishes it becomes impossible to patch
- Have all trade partners be particularly attentive to and aware of breaches of the Air Barrier
- Empower everybody on the job to bring these details to the attention of the appropriate party

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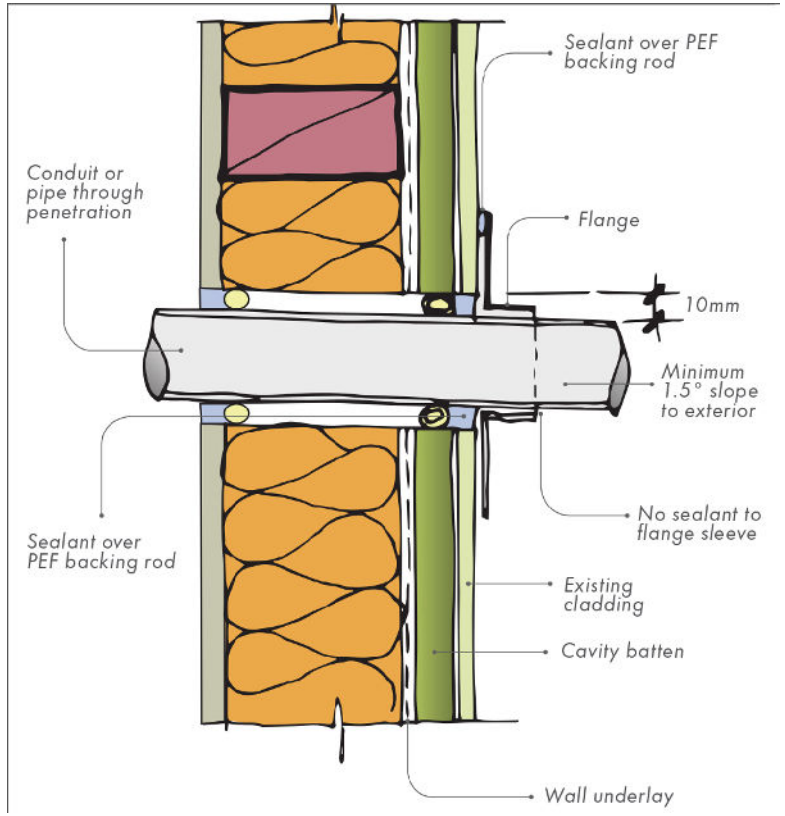
Food for Thought



Penetration Planning Made Easy

By Corey Zussman, QAQC Vice President, AECOM Hunt

Best Practices for Coordinating AVB Installations with MEP Trades

Penetration detailing relies heavily on the materials and timing of the MEP installer's work. Therefore, AVB contractors must collaborate with MEP trades early in the project to discuss penetration requirements in advance.

When a project involves lightning protection or an exterior grounding wire, the braided wire will likely penetrate the AVB (or waterproofing). Braided wires cannot be effectively sealed—unless the wire is made solid. Coordination with the lightning protection and electrical contractors is essential to implement a solid section through soldering, installing a solid material, or similar methods. Additionally, it is critical to ensure the braided wire is rigidly supported on the interior side.

In one example, an electrical contractor installed a flexible conduit that penetrated the AVB. However, flexible conduit cannot be properly sealed. Instead, rigid conduit or "Liquid Tight" conduit should be used. Be sure to confirm the compatibility of the AVB with the "Liquid Tight" conduit. As with braided wires, the conduit must also be rigidly supported on the interior side.

Lack of Proper Coordination

A lack of proper coordination can lead to costly corrections. For instance, installing conduit directly against the CMU and adjacent to a plumbing drain caused issues.The conduit had to be removed and relocated to allow for the proper installation of the AVB—an added expense.

The correction involved moving the conduit away from the wall, enabling the AVB to be installed behind it. This ensured the conduit could be properly sealed at the wall exit point and was positioned above the plumbing drain.

Questions?

- AAMA 501.1
- Dynamic Pressure Test
- Simulates a severe weather event

BD+C Enhanced CX (optional)

- Option 1. Path 2. Enhanced CX for Building Enclosure Systems
  - Comply with all tasks and deliverables within ASTM E2947-21a “Standard Guide for Building Enclosure CX”, except Sections 7.2.4 and 7.4.3
  - Comply with the following field-testing requirements:
    - Bldg air leakage testing, as per ASTM E783, ASTM E779, ASTM, E1186, or ASTM E3158
    - Water penetration testing, as per ASTM E1105 or AAMA 501.2
    - Infrared imaging, as per ASTM C1153 or ASTM C1060
  - Additional requirements beyond E2947-21a (During occupancy)
    - Review training material to confirm they meet the training requirements in the BECx Plan or specs
    - Confirm training occurred


Designation: E2947 - 21a

Standard Guide for
Building Enclosure Commissioning[1]

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