



**WMU Design Guidelines Instructions:** These guidelines are to be used by the Design Professional to inform the design process and outline WMU-specific desires for University projects. Text appearing in blue indicates a WMU design guideline which must be met for all campus projects unless approved in writing by the University. Blue text that is struck out indicates products or practices that are **not** acceptable, and shall not be included unless similarly approved. Any text remaining in black is to be edited by the Design Professional as part of the normal specifications-writing process. Guidelines language shall be included in the project specifications and their intent incorporated into the drawings.

## SECTION 01 9119.43 - EXTERIOR ENCLOSURE COMMISSIONING

**Designer Note:** The Design Professional shall work with the Building Enclosure Commissioning Authority to edit this section.

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes building enclosure Cx process requirements for the above- and below-grade systems and assemblies:
  - 1. Horizontal and vertical waterproofing.
  - 2. Opaque walls.
  - 3. Roofs.
  - 4. Openings.
  - 5. Interfaces.
  
- B. Western Michigan University has retained the services of **[Building Enclosure Commissioning Authority]** to serve as the project Building Enclosure Commissioning Authority (BECxA). **[Building Enclosure Commissioning Authority]** will perform the items specified under Building Enclosure Commissioning Authority responsibilities.
  - 1. WMU may arrange and pay for the services of an Enclosure Testing Agency, which may be affiliated with or independent from the BECxA, to perform building enclosure component testing. Refer to the BECxA plan.
  
- C. Building enclosure commissioning is a systematic process of verifying that the building skin, window, and roof systems are designed and installed to perform according to the design intent and the Owner's Project Requirements.
  - 1. The BECx Process: There is a clearly defined process that involves the actions of a BECxA, the **[Construction Manager][General Contractor]**, and other members of the team. BECx involves the following specific steps:
    - a. Review of the Design Professional's drawings and specifications during design development and construction document phases.
    - b. Review of submittals related to the building enclosure.
    - c. Field of the proper installation of components and assemblies.
    - d. Field testing of components and systems.
    - e. Observation of training of Owner personnel.
  
    - f. Creation of a Systems Manual for ongoing reference.



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- D. The building enclosure commissioning process requires the active involvement of the **[General Contractor][Construction Manager]** and assigns Work and responsibilities that are specified here.
- E. This section refers to activities performed by others. In the absence of a clear statement identifying the responsible party, it shall be understood that the activity being described shall be performed by the **[General Contractor] [Construction Manager]**.

**Designer Note:** Regardless of whether the project is pursuing LEED certification, WMU projects shall follow the LEED guidelines with regard to commissioning activities

- F. Green Building Design and Construction; LEED Reference Guide for Green Building Design and Construction, published by the U.S. Green Building Council.
  - 1. Envelope Commissioning.

### 1.2 DEFINITIONS

- A. As-built Drawings: Fully dimensioned, to-scale drawings that present an accurate representation of the components and assemblies as they exist in the built Work; when in compliance with other Division 01 sections specifying record documents, these can be legible hand-written marks on hard copies of drawings kept on the job site.
- B. Basis of Design: A document developed by the design team that technically details assumptions made during the creation of the construction documents in order to meet the Owner's Project Requirements to the greatest degree possible.
- C. Building Enclosure: Materials, components, systems, and assemblies intended to provide shelter and environmental separation between interior and exterior, or between two or more environmentally distinct interior spaces in a building or structure. The building enclosure includes, but is not limited to, exterior walls, above and below grade, and roof assemblies.
- D. Commissioning Team: The members of the commissioning team include the Owner, the Building Enclosure Commissioning Authority (BECxA), the **[General Contractor] [Construction Manager]**, the subcontractors and suppliers for the components to be commissioned, the Design Professional and the Enclosure Testing Agency, if different from the BECxA.
- E. Corrective Action: An activity intended to correct a non-conforming item or action, or to prevent further recurrences of non-conformities.
- F. Cx: Commissioning, as defined in Section 01 9113 "General Commissioning Requirements."
- G. CxA: Commissioning Authority, as defined in Section 01 9113 "General Commissioning Requirements."
- H. Deficient or Non-Conforming: At variance with, or likely to become at variance with, any one of the following:
  - 1. Owner's Project Requirements.
  - 2. Contract Documents.
  - 3. Referenced Standards.
  - 4. Governing Codes.



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- I. First-Installation Mockups: Initial installation of specific enclosure materials, components, systems, and assemblies that are part of Work.
- J. Integrated Exterior Mockups: Integrated mockups of the exterior enclosure erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
- K. Issue: An identified condition or component that is deficient or likely to become deficient.
- L. Laboratory Mockups: Full-size physical assemblies constructed at testing facility.
- M. OPR: Owner's Project Requirements, as defined in Section 01 9113 "General Commissioning Requirements."
  - 1. The portion of the OPR that relates to the building enclosure is considered to be a "living document" for the building enclosure commissioning process and outlines the objectives upon which the pre-design, design and construction phases are evaluated.
- N. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.
- O. Water Penetration: Visible evidence of uncontrolled water penetration on or adjacent to the test specimen in a location not intended to collect and drain water to the building exterior.

### 1.3 ABBREVIATIONS

- A. In addition to the abbreviations defined in Section 01 9113 "General Commissioning Requirements", the following industry standard abbreviations are used by WMU and their Building Enclosure Commissioning Authority:
  - 1. BECxA: Building Enclosure Commissioning Authority
  - 2. BECx: Building Enclosure Commissioning
  - 3. BECx Plan: Building Enclosure Commissioning Plan

### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Construction Checklists: Draft Construction Checklists will be created by CxA for Contractor review.
- C. Construction Checklists: Include the following and comply with requirements in Section 01 9113 "General Commissioning Requirements" for Construction Checklists:
  - 1. **<Insert checklist>**.
- D. Cx Process Submittals:
  - 1. Shop Drawings: For mockups, including elevations, plans, sections, and full-size details. Show interface conditions, interconnections, and terminations.



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2. Testing Program: Developed specifically for Project.
3. Test Reports: Prepared by a qualified testing agency for each test.
4. Record Drawings: As-built drawings of mockups showing changes made during testing.

E. Field quality-control reports.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For building envelope systems and components to include in operation and maintenance manuals.

### 1.6 QUALITY ASSURANCE

A. **ASHRAE Guidelines:** The latest version of ASHRAE Guideline 1.1 and ASHRAE Guideline 0.

B. **National Institute of Building Science (NIBS) Guideline 3-2012 Building Enclosure Commissioning Process BECx.**

C. **Testing Agency Qualifications:** Qualified according to ASTM E699 for testing indicated [**and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025**].

D. Build mockups to evaluate constructability and performance, and demonstrate the coordination of trades and sequencing of work necessary to ensure functional and integrated performance of materials, components, systems, assemblies, and interfaces.

1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
2. Notify Architect and CxA [**seven**] **<Insert number>** days in advance of the dates and times when mockups will be constructed and tested.

E. Laboratory Mockups: Build at testing agency facility; use personnel, products, and methods of construction that will be used at Project site.

F. Integrated Exterior Mockups: Build at Project site on site at locations [**indicated on Drawings**] [**as directed by Architect**].

G. First Installation Mockups: Prepare each major exterior enclosure system for testing when first installed and before proceeding with construction of additional similar assemblies. If in compliance, Work may remain as part of the completed construction.

1. Wall Mockups: Extend one full structural bay wide by one full story high plus additional height to connect to assemblies below and above. Include a typical wall to interior floor slab connections.
  - a. Minimum Size: [**100 sq. ft.**] **<Insert size>**.
2. Roof Mockups: Include parapet or roof edge conditions, flashings, and typical pipe, dunnage, and similar penetrations.



- a. Minimum Size: **[100 sq. ft.] <Insert size>**.
  3. Horizontal Below-Grade Waterproofing and Slab-on-Grade Mockups: Include edge conditions and typical penetrations.
    - a. Minimum Size: **[100 sq. ft.] <Insert size>**.
  4. Vertical Below-Grade Waterproofing Mockups: Include edge, termination, and penetrations.
  5. Building Expansion Joint Mockups: Include starting point at foundation and extend up vertical surfaces, across horizontal waterproofed surfaces and roofs and return to foundation. Include each type of corner, intersection, transition, and termination.
- H. Mockups specified for quality assurance and control in the following sections may be combined with Cx mockups for testing purposes.
1. Section 03 3300 "Architectural Concrete."
  2. Section 03 4500 "Precast Architectural Concrete."
  3. Section 04 2000 "Unit Masonry."
  4. Section 04 4200 "Exterior Stone Cladding."
  5. Section 07 2726 "Fluid-Applied Membrane Air Barriers."
  6. Section 07 6100 "Sheet Metal Roofing."
  7. Section 08 4413 "Glazed Aluminum Curtain Walls."
  8. **<Insert section number and title>**

## PART 2 - PRODUCTS (~~Not Used~~)

### 2.1 EQUIPMENT AND ACCESS

- A. Provide means, including lifts and lift operators, for the Building Envelope Commissioning Authority to access, observe, touch and visually confirm proper installation of components. These means shall be in compliance with all OSHA and job-site safety regulations.

## PART 3 - EXECUTION

### 3.1 CONSTRUCTION CHECKLISTS

- A. Prepare detailed Construction Checklists for exterior enclosure Cx systems, subsystems, equipment, and components. Complete and submit Construction Checklists.

### 3.2 CONSTRUCTION CHECKLIST REVIEW

- A. Review and provide written comments on draft Construction Checklists. CxA will create required draft Construction Checklists and provide them to Contractor.
- B. Return draft Construction Checklist review comments within **[10] <Insert number>** days of receipt.



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- C. When review comments have been resolved, CxA will provide final Construction Checklists, marked "Approved for Use, (date)."
- D. Use only Construction Checklists, marked "Approved for Use, (date)."

### 3.3 GENERAL RESPONSIBILITIES OF THE [Construction Manager][General Contractor]

- A. Become familiar with these specifications and the BECx Plan. Comply with the BECx Plan. In the event of a conflict between the BECx Plan and these specifications, these specifications shall govern.
- B. Cooperate with the BECxA. Provide site access, samples, certifications, reports, equipment, storage and general assistance as requested.
- C. Designate a representative who shall attend a commissioning kickoff meeting and other necessary meetings scheduled by the BECxA to facilitate the commissioning process.
- D. In concert with the BECxA, identify and integrate all commissioning activities into the Master Project Schedule. Identify milestones related to the BECx process, including but not limited to field visits and testing activities.
- E. In each purchase order or subcontract written, include the requirements for submittal data, O&M data, commissioning tasks, and training specified in this and related sections.
- F. Ensure that subcontractors perform their commissioning responsibilities according to the Contract Documents and schedule.
- G. Maintain a section of the project construction meeting minutes and agenda devoted to commissioning activities and issues. Remain familiar with the issues log produced by the BECxA and ensure that open issues are reviewed at appropriate intervals in the construction meetings.
- H. Submit "for-construction" drawings and specifications to BECxA, and submit any revisions to these documents as they become available. Furnish a copy of all construction documents, addenda, RFI's, change orders, and approved submittals related to the commissioned components to the BECxA.
- I. Schedule and host preconstruction conferences for all major building enclosure components and ensure they are attended by supplying and installing subcontractors and the [Construction Manager's][General Contractor's] quality assurance personnel. Minimum agenda:
  - 1. Review of submittal status.
  - 2. Schedule.
  - 3. Design intent.
  - 4. Any outstanding BECx issues for these or related adjacent components.
  - 5. Review installation sequence for related or adjacent components.
- J. Coordinate construction, inspection, and field testing of mock-ups of building enclosure components where specified.



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1. Allow ample time (as coordinated in advance with the BECxA) between informing the BECxA of testing activities and the actual testing date, to allow the BECxA to arrange travel time to the testing site.

**Designer Note:** In general, WMU is willing to pay the reimbursable expenses incurred by the BECxA to travel to and from the testing site for the initial test and one failure. This should be discussed with WMU during the development of these specifications.

2. **Cost of Testing:** Work with the Owner and BECxA to define the monetary responsibilities of each party in the event of a testing failure that results in additional trips to the site. Identify who will pay for reimbursable expenses and or labor associated with same.
- K. Ensure adequate monitoring of compliance with surface preparation and environmental installation requirements for all enclosure components. Submit to the BECxA and AOR any proposed deviations from manufacturer's official installation techniques, complete with signed acknowledgment and certification of continued warranty by the company involved.
  - L. Correct Work identified as deficient by the BECxA, in accordance with the Contract Documents and code requirements.
  - M. Complete all commissioning-related activities specified here and included in the BECx Plan prior to building occupancy.

### 3.4 BUILDING ENCLOSURE COMMISSIONING AUTHORITY RESPONSIBILITIES

**Designer Note:** This section may be irrelevant by the time the specifications are ready for issue, as the BECxA may have been on board for some time and the roles may already be spelled out in the BECxA plan. Design Professional to edit accordingly.

- A. The primary role of the BECxA is to develop and coordinate the execution of a commissioning plan, observe and document component installation / performance, and note when systems are not present in accordance with the documented OPR or in accordance with the Contract Documents. The BECxA is not responsible for design concepts, design criteria, compliance with codes, design or general construction scheduling, cost, or construction management.
- B. The BECxA may assist with problem-solving of deficiencies but ultimately the responsibility to clarify the design intent lies with the A/E or EOR. The responsibility to solve non-conformance with the Contract Documents resides with the **[Construction Manager][General Contractor]**.
- C. The BECxA verify compliance of components through submittal reviews, field observations, and testing (when so directed by the Owner).
- D. Limits to the responsibility of the BECxA:
  1. Nothing stated in this section shall be construed to transfer responsibility for the design of the building to the BECxA, nor to relieve the AOR or A/E of responsibility for the design.
  2. Nothing stated in this section shall be construed to relieve the **[Construction Manager][General Contractor]** of responsibility for the means and methods of construction, project costs, scheduling and coordination of construction activities, and on-the-job safety.
- E. The Commissioning Plan (BECx Plan): The BECx Plan is prepared by the BECxA and expands and makes more specific the information contained here. The BECx Plan is issued at or prior to a commissioning kickoff meeting.



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### 3.5 TRACKING OF ISSUES

- A. Issues can be created at any time during design, construction, and occupancy. Any member of the commissioning team may raise an Issue. The BECxA will create and maintain a log of issues [in **CxAlloy**], an on-line website, or other means, allowing all members of the team to:
  - 1. View the issues and related photos and documents.
  - 2. Read any responses.
  - 3. Write responses when the issue is assigned to them.
- B. All issues will be assigned to a member (or members) of the team by the BECxA in a way that will allow them to respond in writing to the Issue and provide photos and documents as part of their response.
- C. For those issues assigned to the [**Construction Manager**][**General Contractor**] or to a sub-contracting entity:
  - 1. Respond in writing to the issue, as a minimum, within ten (10) working days of its published date or the date of any subsequent comment by the BECxA.
  - 2. If work on resolving an issue is in progress, indicate this in writing.
  - 3. Ensure the subcontractors provide information required to solve the issue.
  - 4. Mark issues “ready for verification” when components are installed, complete and ready for the BECxA to verify.
- D. Periodically, all issues that are open and have not been responded to within 10 working days will be submitted to the Owner as delinquent.
- E. The BECxA reserves final discretion in determining the status of issues as “Open”, “Ready for Verification”, or “Closed”. The BECxA may also opt to finalize an issue as “For Record Only”, which denotes that the issue has been terminated without further action or definitive resolution.
- F. The Owner reserves the right to hold retainage for subcontractors with an unacceptable number of open issues where responses are not up-to-date.
- G. The final BECx Report will contain a copy of the issues log identifying the status of all issues.

### 3.6 GENERAL TESTING REQUIREMENTS

- A. If tests cannot be completed because of a deficiency outside the scope of the building enclosure systems, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.
- B. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.
- C. Coordinate schedule with, and perform Cx activities at the direction of the CxA.

### 3.7 LABORATORY MOCKUP TESTING

- A. Laboratory Mockup Testing Service: [**Owner will engage**] [**Engage**] a qualified testing agency to perform testing on laboratory mockups.





- B. Laboratory Mockup Testing Program: Perform the tests listed below in the following order.
1. Structural: ASTM E330 at 50 percent of positive test load for not less than **[10] <Insert number>** seconds.
    - a. No evidence of deflection exceeding specified limits.
  2. Air Infiltration: ASTM E283 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>**.
    - a. Maximum air leakage of **<Insert value>**.
  3. Water Penetration under Static Pressure: ASTM E331 at minimum static-air-pressure differential of **[20 percent] <Insert differential>** of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.] <Insert value>**.
    - a. No evidence of water penetration.
  4. Water Penetration under Dynamic Pressure: AAMA 501.1 at minimum air-pressure differential of **[20 percent] <Insert differential>** of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.] <Insert value>**.
    - a. No evidence of water penetration.
  5. Structural: ASTM E330 at 100 percent of positive and negative test loads for not less than **[10] <Insert number>** seconds.
    - a. No evidence of deflection exceeding specified limits.
  6. Air Infiltration: ASTM E283 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>**.
    - a. Maximum air leakage of **<Insert value>**.
  7. Water Penetration under Static Pressure: ASTM E331 at minimum static-air-pressure differential of **[20 percent] <Insert differential>** of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.] <Insert value>**.
    - a. No evidence of water penetration.
  8. Water Penetration under Dynamic Pressure: AAMA 501.1 at minimum air-pressure differential of **[20 percent] <Insert differential>** of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.] <Insert value>**.
    - a. No evidence of water penetration.
  9. Thermal Cycling: AAMA 501.5.
  10. Air Infiltration: ASTM E283 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>**.
    - a. Maximum air leakage of **<Insert value>**.



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11. Water Penetration under Static Pressure: ASTM E331 at minimum static-air-pressure differential of **[20 percent]** <Insert differential> of positive wind-load design pressure, but not less than **[6.24 lbf/sq. ft.] [10 lbf/sq. ft.] [15 lbf/sq. ft.] <Insert value>**.
  - a. No evidence of water penetration.
12. Structural: ASTM E330 at 150 percent of positive and negative test loads.
  - a. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding **[0.2]** <Insert number> percent of span.
  - b. Test Durations: As required by design wind velocity, but not less than **[10]** <Insert number> seconds.

### 3.8 INTEGRATED EXTERIOR MOCKUP TESTING

- A. Testing Agency: **[Owner will engage]** **[Engage]** a qualified testing agency to perform tests and inspections.
- B. Integrated Exterior Mockup Testing Program: Perform the following tests in the following order:
  1. Smoke Testing: ASTM E1186 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] <Insert value>**.
  2. Opaque Wall Air Infiltration: ASTM E783 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>**.
    - a. Maximum air leakage of <Insert value>.
  3. Window Air Infiltration: ASTM E783 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>**.
    - a. Maximum air leakage of <Insert value>.
  4. Water Penetration under Static Pressure: ASTM E1105 with minimum **[uniform]** **[and]** **[cyclic]** static-air-pressure differential of **[6.24 lbf/sq. ft.] [8.0 lbf/sq.ft.] [10 lbf/sq. ft.] [12 lbf/sq. ft.] <Insert value>**.
    - a. No evidence of water penetration.
  5. Water Penetration under Dynamic Pressure: AAMA 501.1 at a test pressure of **[6.24 lbf/sq. ft.] [8.0 lbf/sq.ft.] [10 lbf/sq. ft.] [12 lbf/sq. ft.] <Insert value>**.
    - a. No evidence of water penetration.
  6. Pull-off Strength of Adhered Air Barriers: ASTM D4541 as modified by ABAA.
    - a. Minimum **[16 lbf/sq. in.] <Insert value>** adhesion to substrate.
  7. Pull Test for EIFS: ASTM E2359.
    - a. <Insert value>.



8. Sealant Durability: ASTM C794.
  - a. **<Insert peel strength>**.
9. Outdoor-Indoor, Sound-Transmission Loss: ASTM E966.
  - a. **<Insert value>**.
10. Outdoor A-Weighted Sound Levels: ASTM E1014.
  - a. **<Insert value>**.
11. Outdoor Sound Measurements Using Digital Statistical Sound Analysis: ASTM E1503.
  - a. **<Insert value>**.

### 3.9 FIRST-INSTALLATION MOCKUP TESTING

- A. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
- B. Wall Mockups: Perform the following tests in the following order:
  1. Smoke Testing: ASTM E1186 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] <Insert value>**.
  2. Opaque Wall Air Infiltration: ASTM E783 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>**.
    - a. Maximum air leakage of **<Insert value>**.
  3. Window Air Infiltration: ASTM E783 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>**.
    - a. Maximum air leakage of **<Insert value>**.
  4. Water Penetration under Static Pressure: ASTM E1105 with minimum **[uniform] [and] [cyclic]** static-air-pressure differential of **[6.24 lbf/sq. ft.] [8.0 lbf/sq.ft. (384 Pa)] [10 lbf/sq. ft.] [12 lbf/sq. ft.] <Insert value>**.
    - a. No evidence of water penetration.
  5. Water Penetration under Dynamic Pressure: AAMA 501.1 at a test pressure of **[6.24 lbf/sq. ft.] [8.0 lbf/sq.ft.] [10 lbf/sq. ft.] [12 lbf/sq. ft.] <Insert value>**.
    - a. No evidence of water penetration.
  6. Pull-off Strength of Adhered Air Barriers: ASTM D4541.
    - a. **<Insert value>**.
  7. Pull Test for EIFS: ASTM E2359.



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- a. **<Insert value>**.
  8. Sealant Durability: ASTM C794.
    - a. **<Insert peel strength>**
  9. Outdoor-Indoor, Sound-Transmission Loss: Per ASTM E1332, determined by testing according to ASTM E966.
    - a. **<Insert OITC value>**.
  10. Outdoor A-Weighted Sound Levels: ASTM E1014.
    - a. **<Insert value>**.
  11. Outdoor Sound Measurements Using Digital Statistical Sound Analysis: ASTM E1503.
    - a. **<Insert value>**.
- C. Roof Mockup: Perform the following tests in the following order:
1. Air Leakage Site Detection: ASTM E1186.
    - a. No evidence of air penetration.
  2. Flood Testing of Horizontal Waterproofing: ASTM D5957.
    - a. No evidence of water penetration for a minimum 48 hours.
  3. Water-Spray Test: AAMA 501.2.
    - a. No evidence of water penetration.
  4. Electronic Leak Detection:
    - a. No evidence of water penetration.
- D. Horizontal Below-Grade Waterproofing and Slab-on-Grade Mockups: Perform the following tests in the following order:
1. Water Penetration: ASTM D5957.
    - a. No evidence of water penetration.
  2. Water-Spray Test: AAMA 501.2 for terminations and interface conditions.
    - a. No evidence of water penetration.
  3. Electronic Leak Detection.
    - a. No evidence of water penetration.
- E. Vertical Below-Grade Waterproofing Mockups: Perform the following tests in the following order:



1. Water Penetration: ASTM E1105 without air-pressure differential.
    - a. No evidence of water penetration.
  2. Water-Spray Test: AAMA 501.2.
    - a. No evidence of water penetration.
- F. Building Expansion Joint Mockups: Perform the following tests in the following order:
1. Water Penetration under Static Pressure: ASTM E1105 with minimum **[uniform] [and] [cyclic]** static-air-pressure differential specified for laboratory testing, but not less than 6.24 lbf/sq. ft..
    - a. No evidence of water penetration.
  2. Water-Spray Test: AAMA 501.2.
    - a. No evidence of water penetration.

### 3.10 BUILDING ENCLOSURE TESTING

- A. Building Enclosure Testing: Perform testing before installation of interior finishes unless otherwise indicated.
- B. Testing Agency: **[Owner will engage] [Engage]** a qualified testing agency to perform tests and inspections.
- C. **<Insert Type>** Building Enclosure Testing: Perform the following tests in the following order:
1. Smoke Testing: ASTM E1186 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] <Insert value>**.
  2. Opaque Wall Air Infiltration: ASTM E783 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>**.
    - a. Maximum air leakage of **<Insert value>**.
  3. Window Air Infiltration: ASTM E783 at a static-air-pressure differential of **[1.57 lbf/sq. ft.] [6.24 lbf/sq. ft.] <Insert value>**.
    - a. Maximum air leakage of **<Insert value>**.
    - b. Perform a minimum of two tests.
  4. Air Leakage Site Detection: ASTM E1186.
    - a. Maximum air leakage of **<Insert value>**.
  5. Water Penetration under Static Pressure: ASTM E1105 with minimum **[uniform] [and] [cyclic]** static-air-pressure differential of **[6.24 lbf/sq. ft.] [8.0 lbf/sq.ft.] [10 lbf/sq. ft.] [12 lbf/sq. ft.] <Insert value>**.
    - a. No evidence of water penetration.



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6. Water Penetration under Dynamic Pressure: AAMA 501.1 at a minimum air-pressure differential of **[6.24 lbf/sq. ft.] [8.0 lbf/sq.ft.] [10 lbf/sq. ft.] [12 lbf/sq. ft.] <Insert value>**.
  - a. No evidence of water penetration.
7. Water-Spray Test: AAMA 501.2.
  - a. No evidence of water penetration.
8. Flood Testing of Horizontal Waterproofing: ASTM D5957 on all exterior horizontal surfaces.
  - a. No evidence of water penetration.
9. Location of Wet Insulation in Roofing Systems: ASTM C1153.
  - a. No wet insulation.
10. Pull-off Strength of Adhered Air Barriers: ASTM D4541 as modified by ABAA.
  - a. Minimum **[16 lbf/sq. in.] <Insert value>** adhesion to substrate.
11. Anchor Pull-Out: ASTM E488/E488M.
  - a. **<Insert value>**.
12. Pull Test for EIFS: ASTM E2359.
  - a. **<Insert value>**.
13. Sealant Durability: ASTM C794.
  - a. **<Insert peel strength>**.
  - b. Perform a minimum of three tests.
14. Whole Building Air Leakage Rate by Fan Pressurization: ASTM E779.
  - a. Maximum Air Leakage Rate: **<Insert value>**.
15. Whole Building Air Tightness Using an Orifice Blower Door: ASTM E1827.
  - a. Maximum Air Leakage Rate: **<Insert value>**.

### 3.11 RECORD DOCUMENTS

- A. For building enclosure components, and in accordance with the related sections, provide the final version of the following to the BECxA for information:
  1. Operation and Maintenance manuals.
  2. Spare parts and extra stock materials lists, where required.
  3. Warranty forms executed for this project.



4. As-built drawings and specifications
- B. Make corrections, clarifications, and updates to these documents recommended by the C.
- C. Provide revised copies for inclusion in a systems manual to be prepared by the BECxA.

### 3.12 TRAINING OF OWNER PERSONNEL

- A. Coordinate and schedule training for Owner's designated personnel.
  1. Facilitate a sign-in process and submit sign-in sheet to BECxA.
- B. The BECxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.
- C. Prepare a training outline and submit to BECxA for comment and approval. Provide training of the Owner's personnel.
- D. Coordinate and schedule training, and ensure that training is completed, for those systems identified for training in the commissioning plan.
- E. Prepare a training agenda with scheduled dates, and submit to Building Enclosure Commissioning Authority for information. Make changes to the agenda recommended by the Building Enclosure Commissioning Authority. Make provision for Building Enclosure Commissioning Authority to attend training. Provide training for the personnel identified by the Owner in accordance with related sections.

### 3.13 POST OCCUPANCY RESPONSIBILITIES

- A. During Warranty Period:
  1. Coordinate with system and material manufacturers to determine specific requirements necessary to maintain the validity of the warranty.
  2. Execute seasonal or deferred functional performance testing, witnessed by the BECxA, when specified as part of the commissioning process.
  3. Correct issues of non-compliance. Make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
  4. Provide all requested submittal data, including specific responsibilities of the Owner to keep warranties in force.

### 3.14 BUILDING ENCLOSURE TESTING SCHEDULE

END OF SECTION 01 9119.43