PART 1 - GENERAL

1.01 WORK INCLUDED

A. Commissioning requirements common to all Building Enclosure-Related Sections.
B. Validation of proper and thorough installation of Building Enclosure components.
C. Building enclosure component and system performance verification.
D. Documentation of tests, check lists, and installations.
E. Coordination and requirements for field mock-up, trial installation and limited Performance Testing events.
F. Preparation and coordination of Building Enclosure Commissioning Report.

1.02 GENERAL DESCRIPTION

A. Statement of Building Enclosure Design Intent (BEDI): The design intent of this building enclosure is to provide a façade and roof assembly which limits air infiltration to the specified levels as required by the individual Building Enclosure (BE) technical sections in Divisions 03 through 09, that eliminates uncontrolled water infiltration (including condensation), provides thermal insulation continuity; and includes products and assemblies that are technically sound, durable and serviceable.

B. Building Enclosure Commissioning (BECx) facilitates a quality oriented process to verify that all building enclosure components are installed and perform collectively according to the BEDI and that the installation is adequately tested and that the specified performance is verified and documented. It serves as a tool to identify deficiencies in the building enclosure during the preconstruction and construction phases in an effort to advance the building enclosure components from mock-up installations, through installation of the separate components on the structure, to a fully integrated, weather-tight assembly prior to occupancy, thereby reducing impact on the building end user.

C. The Building Enclosure Commissioning Coordinator (BECxC) shall work with the Contractor and Contractor’s Quality Assurance and Quality Control Plan and personnel to oversee the BECx processes and performance testing. The BECxA will observe tests as deemed appropriate. All required testing, unless otherwise specified in each building enclosure related section will be performed and paid for by the Owner.
1.03 SCOPE

A. This Section includes building enclosure commissioning procedures, including exterior facade enclosure, and roofing or other construction that protects climate-controlled interior spaces from unconditioned spaces and the exterior environment, as follows:

1. Building enclosure construction, above grade including exterior opaque walls, windows, and doors including sheathing, framing, insulation and vapor barrier (as required).

2. Roofing, including roofing system, roofing insulation, and skylights, hatches, and other roof openings and penetrations.

3. Foundation waterproofing systems and sub-drainage.

4. The aforementioned items including continuity between all sections (where applicable).

B. Materials, Product and Assembly Performance Testing as required by individual sections, and/or as outlined in Part 3 of this specification. All performance values shall be as described within each relevant section of the Project Specification.

C. Record Documents related to BECx.

1.04 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.05 RELATED SECTIONS

A. Commissioning Specifications: See Division 01 Section 01 19 13 - General Commissioning Requirements for general requirements for MEP commissioning including definitions, means and methods for conducting the commissioning process, commissioning team members, Owner’s responsibilities, Contractor’s responsibilities, and Commissioning Authority’s responsibilities.

B. Individual Building Enclosure Specification Sections: Individual building enclosure technical sections (Divisions 03-09) stipulate requirements for material testing, and warranties for the material, product or assembly specified in the Section. Installation, product testing, and assembly testing are stipulated in each section and/or Part 3 of this section.
1.06 ABBREVIATIONS

AI- Action Item

BECxC- Building Enclosure Commissioning Coordinator

AL- Action List

Owner- Project Management Consultant

A/E- Architect/Engineer-of-Record

POC- Point of Contact

Cx- Commissioning

RFI- Request for Information

CxA- Commissioning Authority for Building Systems

BECxA- Building Enclosure Commissioning Authority

CxT- Commissioning Team

BECx- Building Enclosure Commissioning

1.07 DEFINITIONS

A. Action Item (AI)- Any issue that requires a response, completion, corrective or additional work, or any other action related to the construction. Examples include a Contractor’s Request for Information (RFI), an Architect’s Field Directive, a clarification request, or a documented deficiency in the Work. Action Items must be categorized and assigned to the appropriate party for remedial action.

B. Action List (AL)- This is a list that is maintained and updated by the BECxA that includes all Action Items that relate to BECx activities, including a summary description of each AI (including photograph where appropriate), the date that each AI was first documented, the appropriate party responsible for remedial action, the date corrective action was performed, and a brief summary of the remediation.

C. A/E- Architect/Engineer-of-Record.

D. Commissioning (Cx)- The process of ensuring that all building systems perform interactively according to the design intent, the systems are efficient and cost effective and meet the Owner’s Project Requirements.

E. Commissioning Authority (CxA)- The commissioning authority for the building systems.

F. Building Enclosure Commissioning Authority (BECxA)- The Party retained by the Owner will oversee the BECx process, develop and stipulate many of the BECx requirements, manage the BECx process, and validate that building enclosure systems are.
designed, installed and tested to meet the Owner’s requirements and/or contract documents provided by the Architect-of-Record.

G. Commissioning Portal- This is an internet hub for the collaboration on Cx and BECx information. This portal will act as a hub for posting electronic information.

H. Commissioning Report- The Commissioning Report is the final deliverable from the Cx process, and provides the information needed to understand, and maintain the facility’s building enclosure. It should be the repository of all updates and corrections as they occur (even through occupancy). The Facility Manual expands the scope of standard O&M documentation to incorporate additional information developed through the commissioning process. This is also often called a ‘Systems Manual’ throughout ASHRAE Cx references. Traditionally this manual has documented only the MEP systems. For this project, the facility manual will also include the Building Enclosure Commissioning (BECx) Documents.

I. Commissioning Team (CxT)- The group of Parties involved in the commissioning process for any given system. The group is typically comprised of representatives from:
   1. Owner (PM) and his/her consultants
   2. General Contractor and/or Construction Manager (GC or Contractor/CM)
   3. Designer and design engineers (particularly the architect and engineers – A/E)
   4. Building Enclosure Commissioning Authority (BECxA)
   5. Test Technician (TT) (as either trade quality control or BECxA)
   6. Building Enclosure subcontractor and their sub-subcontractors (BESC)
   7. Specialty subcontractors
   8. Any other installing subcontractors or suppliers of materials or systems.

J. Construction Phase- Phase of the project during which the facility is constructed. During this phase the Contractor and subcontractors complete the installation and field testing requirements.

K. Contract Documents- The documents governing the responsibilities and relationships between Parties involved in the design and construction of this project including (but not necessarily limited to):
   i. Agreements/Contracts;
   ii. Construction Document Drawings and Specifications;
   iii. Addenda;
   iv. Change Orders;

L. Construction Documents- Refers generally to the Contract Documents that dictate the details of construction (all but item i. and v. above).

M. Deficiency- A condition in the installation or function of a material, assembly, or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the Design Intent).
N. Contractor- As used herein, ‘Contractor’ is a general reference to the installing Party and can therefore refer to the GC, subcontractors, or vendors as inferred by its usage.

O. BECx Software- A software tool used for collaborative commissioning information management.

P. Building Enclosure Commissioning (BECx)- The process of facilitating the quality installation of the building enclosure materials, components, and systems in accordance with the contract documents and satisfy the requirements of the BEDI.

Q. Building Enclosure Commissioning Coordinator (BECxC)- This refers to the Individual that is designated the POC for BECx activities.

R. Factory/Laboratory Testing: Off-Site Testing of Building Enclosure materials, components and systems at the manufacturer’s facility and/or independent Testing Agency. This testing will be witnessed and documented by the members of the BECx team as appropriate and as specified in the BE technical specifications.

S. Field Testing Authorized/Accredited Representative- On-site testing of Building Enclosure materials, components and systems conducted by an authorized Manufacturer’s Technical Representative and/or independent Testing Agency.

T. Manufacturer’s Technical Representative- An individual in direct employ of the manufacturer of the applicable material, component, or system who is technically qualified in the judgment of BECx to perform the applicable work for which the reference is made.

U. Party- Entity responsible for portion of work.

V. Project Management Consultant (Owner)- Project management consultant to the Owner.

W. Point of Contact (POC)- General reference to the key individual within each Party.

X. Project Phases- Phases of the project including the Pre-Construction Phase, The Construction Phase, and The Warranty Phase, including Post-Occupancy Evaluation to be completed at the Owner’s discretion by the appropriate members of the Commissioning Team for this project.

Y. RFI- Request for Information

Z. Substantial Completion- As defined in the Owner-Contractor agreement. This milestone will coincide with the end of the Construction Period and the acceptance of the Property, or portions thereof, by the Owner. This milestone also coincides with the start of the warranty period.

AA. Testing Agency- An independent agency, fully accredited by the appropriate governing body for each of the materials, components or systems to be tested or evaluated for compliance with requirements of the contract documents. The Testing Agency shall submit qualifications as required in Section 01450 and individual BE technical sections for review and acceptance by the A/E and BECxA.
BB. Warranty Phase- Beginning on the date of Substantial Completion and continuing through the Warranty Period of each Building Enclosure material, component, and system.

1.08 REFERENCE STANDARDS

A. ASHRAE NIBS Guideline 3-2012 “Building Enclosure Commissioning Process BECx”

Reference standards as identified in the individual Building Enclosure technical sections of this specification.

1.09 DOCUMENTATION

A. BECxA shall perform a constructability review and provide comments related to the durability, performance and BE conformance with the Owner Project Requirements (OPR) for consideration by the Owner, A/E and Contractor.

B. The Contractor shall provide to the BECxA the following per the procedures specified herein and in other BE Technical Sections of the specification (Divisions 03-09) for review and comment by the BECxA:

1. Shop Drawings and Product Data: Provide shop drawings and submittal data for materials, products, systems and equipment that will be part of the BECx process. Refer to Section 01 91 00 for additional requirements.

   a. The Contractor shall forward to the BECxA one copy of Shop Drawings and Product Data concurrent with distribution to the A/E. BECxA shall review and provide comments to the Owner and A/E, who will then review and incorporate the BECxA comments at their discretion and return to the Contractor. The Contractor shall then copy BECxA with the reviewed submittal with A/E submittal review stamp.

   b. Any action taken by the A/E or Contractor based in whole or in part on the comments and recommendations provided by the BECx as part of its submittal review shall be the sole responsibility of the A/E or Contractor.

2. Factory/Laboratory Test Reports: The Contractor shall provide any factory or laboratory testing documentation or certified test reports required by the specifications. These shall be provided prior to acceptance and installation of the specific item.

3. Schedule Updates: The Contractor shall issue periodic updates to the construction schedule every two week or less as appropriate. Contractor shall use schedule to notify BECx team of scheduled tests and milestone installation events. Contractor shall coordinate with BECxA for meetings as appropriate prior to and during construction.
4. **Action Item Response**: Respond to Action Items to which BECx team members assign the Contractor responsibility within 10 business days of issue.

5. **Testing Agency Reports**: Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to acceptance by A/E and installation.

C. **Record Drawings**: The Contractor shall maintain at the site an updated set of record or ‘As-Built’ documents reflecting actual installed conditions and all approved changes and modifications to the contract documents. The Contractor shall provide access to the BECxA to review the As-Built and Record Drawings. The Record Drawings shall be maintained concurrently with construction.

1.10 **COORDINATION MANAGEMENT PROTOCOLS**

A. Unless otherwise defined and agreed to by the parties to the contract documents for this project, coordination responsibilities and management protocols relative to BECx are defined below, subject to further refinement during the Construction Phase BECx pre-construction meeting.

1. **Submittals and Shop Drawings**: The BECxA shall review submittals and shop drawings in accordance with paragraph 1.09.B.1 above and Section 01 19 13.

2. **Deficiencies Identified by the BECxA**: When the BECxA identifies a deficiency, the Contractor shall make a good faith assessment of responsible parties. Those parties shall be notified of the perceived deficiency. This communication is for information only and is not a direction to resolve the deficiency. Contractor may accept responsibility and resolve the deficiency voluntarily. If Contractor contests either the deficiency or responsibility for that deficiency, Contractor shall respond to that affect in writing to the BECxA. If a consensus is not reached as a result of this process, then the Contractor shall issue a work directive or RFI response via the normal contractual channels to resolve the issue.

3. **Requests for Meetings (beyond regularly scheduled meetings)**: In general request by the Contractor for additional meetings with the BECxA shall be routed through the Owner who will then confirm the necessity for the meeting. Note that every attempt should be made to deal with BECx issues at regularly scheduled BECx Meetings.

4. **Scheduling Coordination** – Contractor shall review the BE technical specifications, identify required BECx items (including field and laboratory test requirements, specified test standards, mock-ups, product submissions, milestone installations and similar) and provide a schedule to the BECxA with anticipated dates for each. It is the responsibility of the Contractor to provide adequate time from submission of each BECx requirement to response from the BECx, and resolution of any identified deficiencies without unnecessary deleterious impact on the project schedule.
5. Notification of Completion Milestones – Contractor shall notify Owner and BECxA at least two weeks prior to an anticipated BECx activity or BECx milestone (such as installation of a new façade component). Contractor and BECxA shall then coordinate the scheduling of the activity between all required parties as applicable. Notification shall be via e-mail.

6. Action List: BECxA maintains a categorized Action List which tracks the BECx related action items. All content of the Action List will be available to all parties who have credentials on the portal. Any party with credentials may post an Action Item. Any party that is copied on an email resulting from an Action Item posting may respond to it and contribute to the dialogue.

1.11 CONTRACTOR’S RESPONSIBILITIES

A. As defined in this Section and in the individual BE technical sections, including but not limited to the following:

1. Attend the routine BECx meetings.

2. Coordinate and Chair preconstruction and construction-phase coordination meetings.

3. Provide summary and schedule of laboratory and field quality control tests and inspections required by the Contract Documents to BECxA.

4. Participate in Pre-construction Mock-Up and Field testing coordination meetings.

5. Coordinate with the BECxA pre-construction and construction testing and submit laboratory and field quality control testing, field checklists and inspection reports on building enclosure construction to the BECxA. Perform out of sequence work as required to facilitate field tests.

6. Develop and maintain check lists for building enclosure assemblies.

7. Submit maintenance data for products, assemblies, and components to the BECxA.

8. Provide test data, inspection reports, and certificates to BECxA.

9. Review and respond to AI in a timely manner (typically within 10 business days).

10. Contractor is responsible for the cost of all re-tests and compensation of time for Architect and BECxA related to all additional work necessitated by re-testing of specimens following an initial test failure.

11. Provide input for final commissioning documentation.
1.12 A/E RESPONSIBILITIES

A. As defined in this Section and in the individual BE technical sections, including but not limited to the following:

1. Attend the routine BECx meetings.
2. Attend preconstruction and construction-phase coordination meetings.
3. Participate in Pre-construction Mock-Up and Field testing coordination meetings.
4. Provide resolution to items for which the BECxA and Contractor may be in disagreement.
5. Provide input for final commissioning documentation.

1.13 BECxA RESPONSIBILITIES (BECxA is not to be retained by the Contractor)

A. Develop Construction Phase BECx plan.
B. Provide review comments on the 100% CD’s related to the BE for compliance with the design intent and Owner’s Project requirements. Refer to Part 1.09A for further information. The CxA shall review the design, identify design issues and/or conflicts that would present a problem for the total system commissioning.
C. Provide comments on submittals related to building enclosure. Provide written comments to A/E for their consideration in their review of the submittals. Refer to Part 1.09B for further information.
D. Convene Preconstruction Commissioning Conference: BECxA will schedule a preconstruction BECx conference before construction of the building enclosure starts, at a time convenient to Owner, A/E and Contractor. The BECxA will conduct the meeting to review commissioning responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Owner, BECxA, Contractor, A/E, and Contractor’s superintendent; major BE subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to commissioning.
2. Agenda: Discuss items of significance that could affect progress, including the following:
   a. Commissioning Plan and related Specifications
   b. Tentative construction schedule per Contractor.
   c. Phasing and “Building Dry” milestone per Contractor.
d. Critical work sequencing and long-lead items per Contractor.

e. Designation of key personnel and their duties.

f. Field testing schedule, including any special provisions necessary for tests.

g. Procedures for testing and inspecting.

h. Submittal procedures.

i. Coordination of Record Documents.

j. Owner's occupancy requirements.

3. Minutes: BECxA will record and distribute meeting minutes.

E. Participate in Project-Specific mock-ups and outline the commissioning process and Performance Test procedures. Attend the construction and testing of the mock-up to observe progress and provide written summary report.

F. Witness building enclosure component testing, milestone installations, and perform periodic site visits to document that work is being performed in compliance with the project specifications and Part 3. Conduct visits no less than weekly during construction of the BE.

G. Conduct routine BECx meetings to review progress on AI list/ Portal and resolve issues affecting the building enclosure. Conduct meetings no less than every two weeks during construction of the BE.

H. Compile test data, inspection reports, and certificates and provide them to the CxA for inclusion in the final Commissioning Report.

1.14 PERFORMANCE TESTING (BUILDING ENCLOSURE)

A. Quality Assurance and Control: Specific BECx quality-assurance and quality-control requirements for individual Building Enclosure and materials, methods, and assemblies are specified in the BE Technical Sections relating to those activities. Specified commissioning tests, inspections, and related actions are specified in Part 3 of this section, do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.

B. The objective of Performance Testing is to demonstrate that each Building Enclosure system, and system-to-system interfaces meet or exceed the performance requirements of the Contract Documents and the BEDI.

C. Costs associated with re-testing caused by failure of the building enclosure tests, during mock-up or construction phase work shall be the responsibility of the Contractor.
A. **Non-Conformance.** Non-conformance deficiencies identified during Periodic Site Visits or Performance Testing shall be resolved as follows:

1. The BECxA will record the results of the review / functional performance test in the BECx Software project database. All deficiencies or non-conformance issues shall be noted as Action Items and reported to the Contractor.

2. Corrections of identified minor deficiencies may be made during the review / tests at the discretion of the BECxA. In such cases the deficiency and associated resolution will be documented in the database.

3. Every effort will be made by the BECxA to expedite the review / testing process and minimize unnecessary delays, while not compromising the integrity of the procedures.

4. As reviews / tests progress and a deficiency is identified, the BECxA will discuss the issue with the Contractor for follow-up and resolution.

   a. When there is no dispute with respect to the deficiency and the Contractor accepts responsibility to correct it:

      1) The BECxA shall document the deficiency and the Contractor’s response. A copy/email/portal issue of the deficiency shall be generated and provided to the Contractor. The Contractor corrects the deficiency, completes the Action Item response certifying that the issue is resolved and/or the product, material or assembly is ready to be retested and notifies the Project Team.

      2) The Contractor reschedules the test and the test is repeated. This process is repeated until the test result(s) meets or exceeds the requirements of the contract documents and, at the discretion of the Owner, the remedial action taken will be implemented on a project-wide basis where applicable. The Contractor is responsible for all retest costs incurred by the BECxA, test agency, Owner and A/E.

   b. If there is a dispute about a deficiency:

      1) The deficiency shall be documented as an Action Item with the Contractor’s response and the Contractor will be notified. The Contractor will track this issue under the construction contract dispute resolution provisions.

      2) Final interpretive authority is with the Owner. Final acceptance authority is with the Owner or A/E.

      3) The BECxA documents the resolution to the Action Item.
4) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, and responds to the Action Item indicating completion. The Contractor reschedules the review/test and the review/test is repeated until satisfactory performance is achieved. The Action Item is then considered as closed.

B. **Failure:** As defined in each BE Technical Sections (Divisions 03-09) and/or Part 3. In event of test failure the Contractor shall provide the Owner with the following:

1. Installer/Manufacturer’s response in writing as to the cause of the failure and proposed resolution.

2. Installer/Manufacturer shall implement their proposed resolution on a representative sample of the product.

3. The Owner will determine whether a replacement of all identical units is required or if a repair is acceptable.

4. Upon acceptance, the responsible Party shall replace or repair all identical items at their expense and shall extend the warranty accordingly.

5. Systemic or frequent failures may result in additional testing beyond originally identified to verify performance. Additional costs to test systems due to deficiencies is to be borne by the responsible Contractor.

### 1.16 COMMISSIONING REPORT CONTENT

A. Report content and format shall be as specified in Section 01 19 13.

B. Commissioning Report

1. **Maintenance Schedule:** Contractor will provide a summary table that indexes the building enclosure component requiring maintenance and indicates the frequency each component will require repair or replacement (i.e. replacement of sealants, gaskets, IGUs, repair of paints or coatings). Contractor will provide subcontractors with an Excel spreadsheet that will be completed by each applicable subcontractor and returned to the Contractor for incorporation in the Commissioning Report by the BECxA.

2. **Maintenance Information** Contractor shall provide Maintenance Information for each entry containing the following:

   a. **Product Data Sheet:** Provide a summary of performance data.
b. **Extended Warranty Information**: Include all warranties for products, equipment, components, and sub-components whose duration exceeds one year. Include warranties on components with the system they are a part of. Reference all specific operation and maintenance procedures that must be performed to keep the warranty valid.

c. **Sources of Material**: Include reference to contact information where specific materials can be obtained.

d. **Installation and Maintenance Instructions**: For each material, component or system.

C. **Construction Documentation**

1. **Record Drawings**: Contractor shall provide an index of all record drawings with drawing number, title, and electronic file name(s) including electronically referenced drawings.

2. **Record Specifications**: Contractor shall provide a detailed index of the record specification. Include sections and major items in the specification all indexed to the appropriate page number.

3. **Approved Product Data and Shop Drawings**:
   a. Contractor shall provide an index of all product data and shop drawings. This shall list all BE materials, components or systems with the associated submittal number.

   b. Contractor shall organize and compile only approved product data and shop drawings. Providing these in a filing format is acceptable provided all files are identified and organized for easy access.

   c. Inclusion of any of this information in previous sections of the Commissioning Report does not allow exclusion in this section.

4. **Commissioning Record**: BECxA shall provide complete commissioning records including all Performance Test documentation, in both written and electronic format at the discretion of the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 **BE PERFORMANCE TESTING**
A. Site Testing: In coordination with the Contractor, the BECxA will evaluate in-service performance of building enclosure assemblies and construction, and submit reports.

1. Provide site testing as scheduled at the end of this Section.
2. Carry out testing in accordance with Section 01 19 13.
3. Schedule and number of tests shall be conducted as defined in each BE Technical Sections (Divisions 03-09).
4. Test requirements apply only as appropriate to the materials, components, and systems specified in each BE Technical Sections (Divisions 03-09).

B. Adhesion Tests: Arrange for field tests to take place with joint-sealant and adhered membrane manufacturer’s technical representative present. Field test sealant joints and self-adhering membranes for adhesion to substrates as follows:

1. Test each type of sealant/membrane in each installation at every substrate indicated.
3. For joints between dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
4. For sealants that fail adhesively, retest until satisfactory adhesion is obtained. Do not use sealants that fail to adhere to joint substrates during testing.

C. Fenestration Field Water Tests:

1. Test installed fenestration systems according to AAMA 501.2 “Field Check of Metal Storefronts, Curtain Walls and Sloped Glazing Systems For Water Leakage,” and ASTM E-1105: Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Static Air Pressure Differential
2. Complete testing prior to installation of interior insulation and gypsum board.
3. Contractor to provide powered scaffold, hose, water supply, communication system and manpower to perform tests.
4. Contractor will work with the Test Engineer and CxA to determine necessity for additional test methods and for field chamber tests based upon evaluation of initial test results. The BECxA will interpret marginal results and adjust the test procedures as appropriate.
5. Contractor to perform out-of-sequence work as required facilitating system tests.

D. Fenestration Field Air Leakage Tests:

1. Test installed fenestration systems and interfaces with adjacent substrates according to AAMA 502-08 “Voluntary Specifications for Field Testing of Newly Installed fenestration Products”, and AAMA 503-08 “Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems”.


3. Complete testing prior to installation of interior insulation, gypsum wall board and interior finishes or systems that may impede the completion of the tests.

4. Test specimen to include the perimeter material substrate and the perimeter seals.

5. Contractor to provide powered scaffold, hose, water supply, communication and manpower to perform tests.

6. Contractor will work with the Test Engineer and BECxA to determine necessity for additional test methods and for field chamber tests based upon evaluation of initial test results. The CxA will interpret marginal results and re-write the test procedures as appropriate.

7. Contractor to perform out-of-sequence work as required facilitating system tests. Contractor to install all air seals / dams concealed within the mullions to facilitate air tests at curtain wall assemblies.

E. Air Barrier Field Air Leakage Tests:


2. Complete testing prior to installation of interior insulation, gypsum wall board and interior finishes.

3. Test specimen to include the perimeter material substrate and the perimeter seals.

4. Provide powered scaffold, water, electric supply, communication and manpower to perform tests.

5. Contractor will work with the Test Engineer and CxA to determine necessity for revised test methods and for field chamber tests based upon evaluation of initial test results. The CxA will interpret marginal results and adjust the test procedures as appropriate.
6. Contractor to perform out-of-sequence work as required facilitating system tests.

F. Roof and Waterproofing Field Water and Air Leakage Tests:

1. Test installed roofing systems and interfaces with adjacent substrates using high- or low-voltage electronic leak detection and ASTM C1153 Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging and Capacitance.
3. Test installed horizontal waterproofing systems and interfaces with adjacent substrates according to ASTM D5957 Guide for Floor Testing Horizontal Waterproofing Installations.
4. Complete testing prior to installation of interior insulation, gypsum wall board and interior ceiling finishes.
5. Contractor will work with the Test Engineer and CxA to determine necessity for revised or supplemental test methods. The CxA will interpret marginal results and adjust the test procedures as appropriate.

G. Concrete Moisture Tests:

1. Test installed concrete that will serve as a substrate to coating systems, roofing materials, and associated flashings for moisture according to ASTMD4263 Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

3.2 FIELD PERFORMANCE TEST SCHEDULE

A. Performance testing locations to be determined by A/E and BECxA.

B. Schedule and number of tests shall be conducted as defined in each BE Technical Sections (Divisions 03-09), with the parameters provided below to serve as a guide.

C. Test requirements listed below apply only as appropriate to the materials, components, and systems specified in each BE Technical Sections (Divisions 03-09). Additional test requirements may be included as specified in each BE Technical Sections (Divisions 03-09).

D. Performance testing to be performed by BECxA:

**Supplementary Performance Testing schedule:**

<table>
<thead>
<tr>
<th>Location / Test Type</th>
<th>Testing Standard</th>
<th>Description</th>
<th>Criteria</th>
<th>Schedule &amp; Number of Tests</th>
</tr>
</thead>
</table>

BUILDING ENCLOSURE COMMISSIONING 01 91 15 - 16
<table>
<thead>
<tr>
<th>Field Air leakage testing:</th>
<th>ASTM E783</th>
<th>Field air leakage testing</th>
<th>&lt;0.09 cfm/sq.ft at 6.24 lb/sq.ft. minimum.</th>
<th>10% completion: 1 test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Storefront</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curtain Wall</td>
<td>ASTM E783</td>
<td>Field air leakage testing</td>
<td>&lt;0.09 cfm/sq.ft at 6.24 lb/sq.ft. minimum.</td>
<td>10% and 50% completion: 2 tests</td>
</tr>
<tr>
<td>Ribbon Window</td>
<td>ASTM E783</td>
<td>Field air leakage testing</td>
<td>&lt;0.09 cfm/sq.ft at 6.24 lb/sq.ft. minimum.</td>
<td>10% and 50% completion: 2 tests</td>
</tr>
<tr>
<td>Air Barrier transitions to adjacent systems, field of AB, penetrations (3 locations)</td>
<td>ASTM E783</td>
<td>Field air leakage testing for air barrier assembly</td>
<td>0.04 cfm/sq.ft at 1.57 lb/sq.ft.</td>
<td>10%, 20% and 50% completion: 3 tests</td>
</tr>
<tr>
<td>Air Barrier transitions to adjacent systems, field of AB, penetrations (4 locations, measuring 10’ x 20’)</td>
<td>ASTM E1186</td>
<td>Field air leakage testing for air barrier assembly</td>
<td>No visible sign of air leakage</td>
<td>Throughout construction (perform 4 smoke test and 6 bubble gun tests at each location)</td>
</tr>
<tr>
<td>Field Water leakage testing:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curtain Wall (min chamber size to be determined by A/E)</td>
<td>ASTM E1105</td>
<td>Field water leakage test</td>
<td>no water at 0.67x (specified design pressure or 20% of wind load)</td>
<td>2 locations @ 10% and 50%, completion (4 total tests).</td>
</tr>
<tr>
<td>Curtain Wall &amp; AB interface (min chamber size to be determined by A/E)</td>
<td>ASTM E1105</td>
<td>Field water leakage test</td>
<td>no water at 0.67x (specified design pressure or 20% of wind load)</td>
<td>2 location @ 10%, and 50% completion (4 total tests).</td>
</tr>
<tr>
<td>Punch window - all frame joinery and perimeter joints</td>
<td>AAMA 501.2</td>
<td>Field water testing with hose</td>
<td>No leaks</td>
<td>2 locations @ 10% completion</td>
</tr>
<tr>
<td>Component</td>
<td>Specification</td>
<td>Test Method</td>
<td>Results</td>
<td>Percent Complete</td>
</tr>
<tr>
<td>-----------</td>
<td>---------------</td>
<td>-------------</td>
<td>---------</td>
<td>------------------</td>
</tr>
<tr>
<td>Windows</td>
<td>ASTM E1105</td>
<td>Field water leakage test</td>
<td>no water at 0.67x (specified design pressure or 20% of wind load)</td>
<td>2 locations @ 10% completion</td>
</tr>
<tr>
<td>Air Barrier with metal panel attachments in place (minimum area to be determined by A/E)</td>
<td>ASTM E1105</td>
<td>Field water leakage test</td>
<td>no water at zero pressure differential, 30 minute duration</td>
<td>2 location @ 10%, 50% completion (4 total tests).</td>
</tr>
<tr>
<td>Louver - Perimeter of louver to AB interface</td>
<td>AAMA 501.2</td>
<td>Field water testing with hose</td>
<td>No leaks</td>
<td>2 locations @ 10% completion</td>
</tr>
<tr>
<td>Storefront (min. chamber size to be determined by A/E)</td>
<td>ASTM E1105</td>
<td>Field water leakage test</td>
<td>no water at 0.67x (specified design pressure or 20% of wind load)</td>
<td>1 location @ 10% completion</td>
</tr>
<tr>
<td>Expansion Joints</td>
<td>AAMA 501.2</td>
<td>Field water testing with hose</td>
<td>no leaks</td>
<td>3 locations at 100% completion of all EJ including all vertical and horizontal EJs</td>
</tr>
<tr>
<td>Louver Sill pan flashing- Sill Dam Test</td>
<td>AAMA 511- Optional Sill Dam Test</td>
<td>Sill dam water testing</td>
<td>no water</td>
<td>5 locations @ 10% complete, prior to setting louver</td>
</tr>
<tr>
<td>Roofing membrane transitions to adjacent systems</td>
<td>AAMA 501.2</td>
<td>Field Water Testing with Hose</td>
<td>No leaks.</td>
<td>10 locations</td>
</tr>
</tbody>
</table>

**Adhesion Testing:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
<th>Test Method</th>
<th>Results</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Barrier to transition membrane to fenestration adhesion</td>
<td>ASTM C1521, Method A</td>
<td>Sealant adhesion</td>
<td>Per manufacturer adhesion test data</td>
<td>10 locations throughout construction</td>
</tr>
<tr>
<td>Joint Sealants to substrates</td>
<td>ASTM C1193 X1-Method A</td>
<td>Sealant Adhesion - Hand Pull Tab</td>
<td>Per manufacturer adhesion test data.</td>
<td>10 locations throughout construction</td>
</tr>
<tr>
<td>Test Type</td>
<td>Description</td>
<td>Test Method</td>
<td>Result/Notes</td>
<td>Notes</td>
</tr>
<tr>
<td>-----------------------------------</td>
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<td>------------------------------</td>
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<tr>
<td>Joint Sealants to substrates</td>
<td>Sealant Adhesion</td>
<td>Per manufacturer adhesion test data.</td>
<td>10 locations throughout construction</td>
<td></td>
</tr>
<tr>
<td>Coatings</td>
<td>Pull-off Strength of Coatings using Portable Adhesion Testers</td>
<td>Per manufacturer adhesion test data.</td>
<td>10 locations throughout construction</td>
<td></td>
</tr>
<tr>
<td><strong>Electronic Leak Detection Test:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Roofing Systems</td>
<td>Electronic leak detection using high or low voltage equipment</td>
<td>electronic leak detection</td>
<td>No breaches in roofing system</td>
<td>1 @ 100% completion</td>
</tr>
<tr>
<td><strong>Thermography Imaging Survey:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roofing systems</td>
<td>Infrared imaging and capacitance</td>
<td>Diagnostic tool - no pass/fail criteria</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>Whole Building Testing:</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Whole Building Air Barrier</td>
<td>Whole building Air Leakage testing upon completion</td>
<td>0.25cfm @75 Pascal for above grade enclosure</td>
<td>Whole building at substantial completion of building enclosure.</td>
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<tr>
<td><strong>Flood Testing:</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Waterproofing</td>
<td>Flood testing</td>
<td>no leaks</td>
<td>All horizontal surfaces</td>
<td></td>
</tr>
<tr>
<td><strong>Concrete Moisture Testing:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete surfaces used as substrates for coatings, roofing materials, and associated flashings</td>
<td>Moisture in concrete by the plastic sheet method</td>
<td>Per manufacturer data</td>
<td>Each coating system with sampling size per ASTM D4263</td>
<td></td>
</tr>
</tbody>
</table>
END OF SECTION 011915