

Building Enclosure Commissioning: A Practical Primer for Project Teams

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AIA Quality Assurance



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Course Description

- This session introduces Building Enclosure Commissioning (BECx) as a structured process for improving the design, construction, and long-term performance of building enclosures. Intended for owners, architects, construction managers, and contractors, the course explains how BECx integrates into typical project delivery process to enhance building quality and performance outcomes.
- Presenters will outline the phases of the BECx process, key objectives and milestones, and the roles and responsibilities of the BECx Provider (BECxP) and project team members. The session also covers types of documentation, reviews, and verification activities, helping participants understand what to expect when working with a BECx provider. The presentation follows the BECx process chronologically, from Pre-Design, through Design, Bidding and Construction Phase, to Occupancy and Operations Phase. There are ten interactive questions that test the audience's knowledge on the process.
- The presentation places BECx in context with current industry practices, energy codes, and sustainability certification programs, while maintaining a focus on coordination, quality assurance, and measured performance outcomes for both new construction and renovation projects.

Learning Objectives

1. Describe the phases of the **Building Enclosure Commissioning (BECx)** process and the typical tasks performed during design, construction, and closeout.
2. Identify the roles and responsibilities of the **BECx Provider** in relation to the owner, design team, contractor, and third-party testing agencies.
3. Recognize common building enclosure performance requirements, applicable test standards, and associated risk areas, and understand how BECx **verification and testing activities** address these risks during construction.
4. Describe the **documentation and verification tools** used in BECx, including issue logs, construction checklists, testing records, and construction-phase observations support coordination, quality assurance, and overall project integrity.

About the Presenter

John Wagner, AIA, BECxP, CxA+BE is a Senior Building Enclosure Consultant and leader of the Building Enclosure Performance team at Baumann Consulting.

He is a licensed architect (IL, MI, NC) with 10+ years of experience delivering sustainable, resilient buildings. Bridging his career in architectural practice in Charlotte, Boston and the Midwest into building enclosure specialization and sustainable consulting, he provides expertise in building enclosure performance, decarbonization strategy, and energy code compliance, and commissioning for new construction, adaptive reuse, and historic preservation projects across the US.

John earned a Bachelor of Architecture from Virginia Tech and a Master of Architecture from Harvard GSD.



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01 – BECx Overview

BECx Overview

- Building Enclosure Commissioning (BECx) is a process ensures the exterior **enclosure system's performance** is consistent with **Owner's Project Requirements** and design specifications. Through design review, construction observation, mock-up and field testing, and documentation of the process, the building enclosure commissioning process provides **enhanced quality assurance** towards fulfillment of project **goals for energy, durability, and occupant comfort**, throughout the lifecycle of the building.

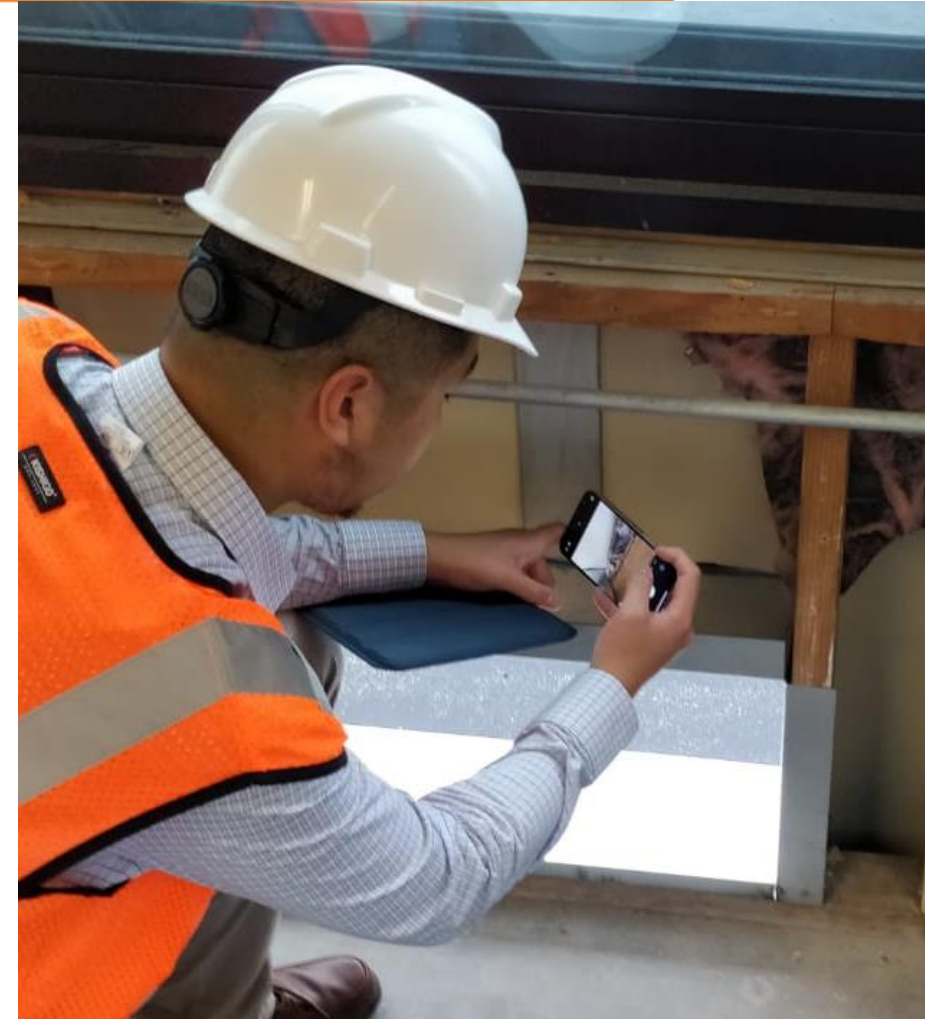
BECx Overview

- A structured **quality-assurance process** to improve building performance and reliability.
- **Reducing risk** of insufficient performance, errors in installation, and premature failures in service.
- Ensuring building envelope is **designed to meet project requirements**, and, increasingly, code compliance requirements.
- **Verifying** detailing + continuity of thermal, air, and moisture control layers.
- **Complements conventional Building Commissioning**, which is typically focused on mechanical, electrical, plumbing, and fire/life-safety systems.

BECx: Routine Scope of BECx Provider

The BECx Provider (BECxP) is responsible for facilitating this process by:

1. Reviewing design documents for envelope continuity and constructability.
2. Advising on code, standard, and project-specific enclosure requirements.
3. Developing and maintaining the commissioning plan, including testing criteria.
4. Coordinating documentation and monitoring compliance with air/water barrier, insulation, and fenestration intent.
5. Providing observation and reporting during construction to verify that enclosure work aligns with design intent and commissioning plan.
6. Compiling Commissioning report of design and construction verification activities.



BECx: Non-Typical Scope of BECx Provider

The BECx Provider (BECxP) is not typically responsible for:

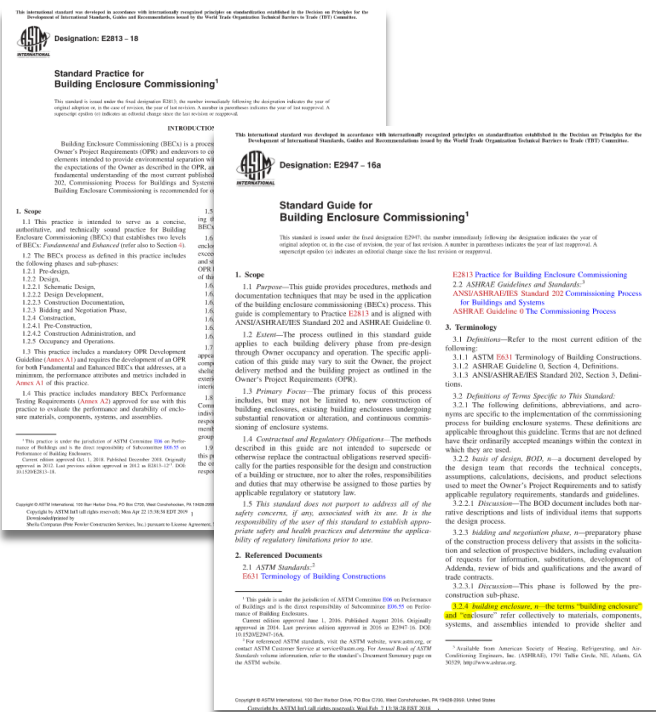
1. Functional performance testing in lab mock-ups or on-site
2. Test scheduling or coordination driven by contractor sequencing
3. Design-assist, authorship of details, or preparation of design alternatives/substitutions
4. Product specifications, procurement, or material selection
5. Construction means, methods, safety, or supervision of trades
6. Quality control duties belonging to the contractor (the BECxP verifies, not manages)
7. Stamping/sealing documents, producing repair designs, or certifying compliance
8. Warranty enforcement, long-term monitoring, or post-occupancy maintenance duties



02 – BECx Process

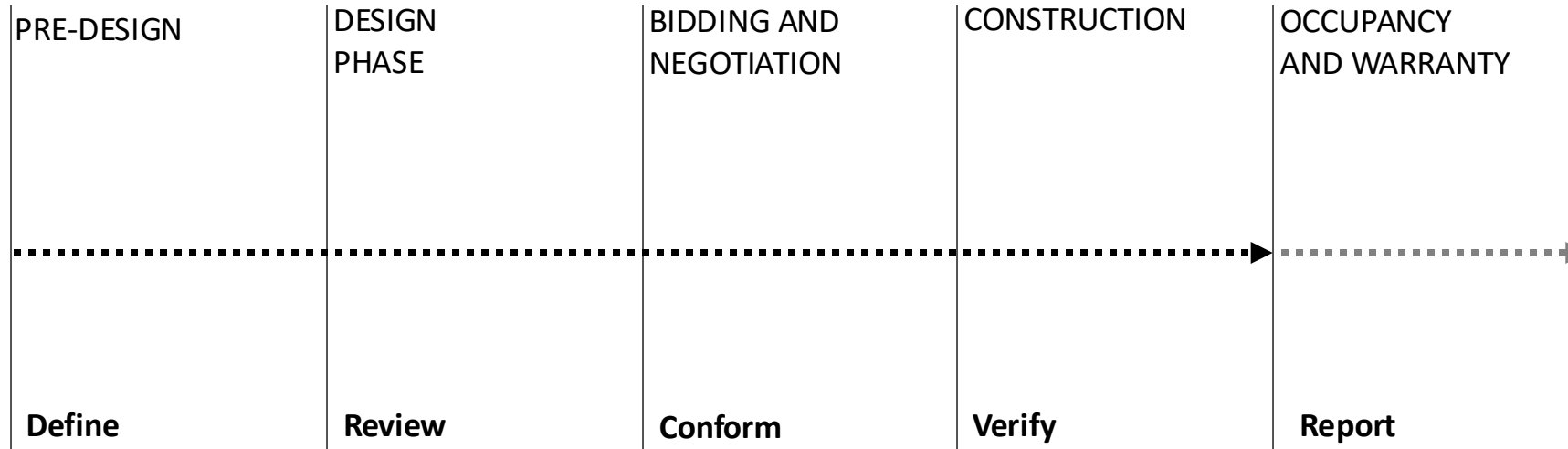
Stages of Building Enclosure Commissioning

- Pre-Design
- Design Phase
- Bidding and Negotiation
- Construction
- Occupancy and Warranty



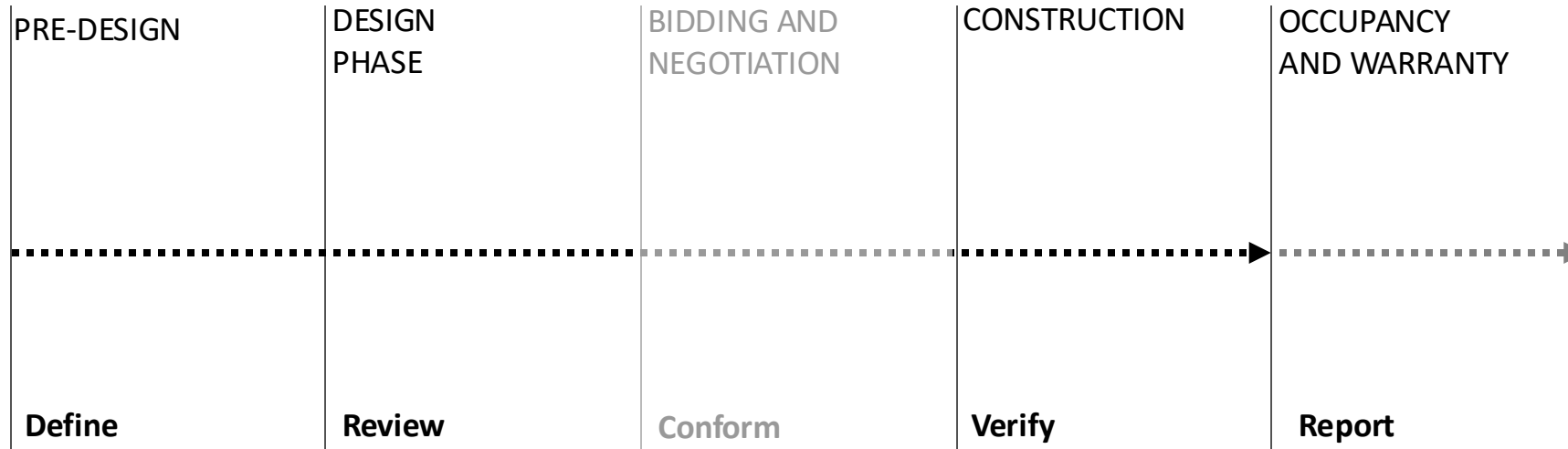
ASTM 2947 Standard Guide for Building Enclosure Commissioning

Stages of Building Enclosure Commissioning



COMPREHENSIVE PROCESS PER ASTM 2947

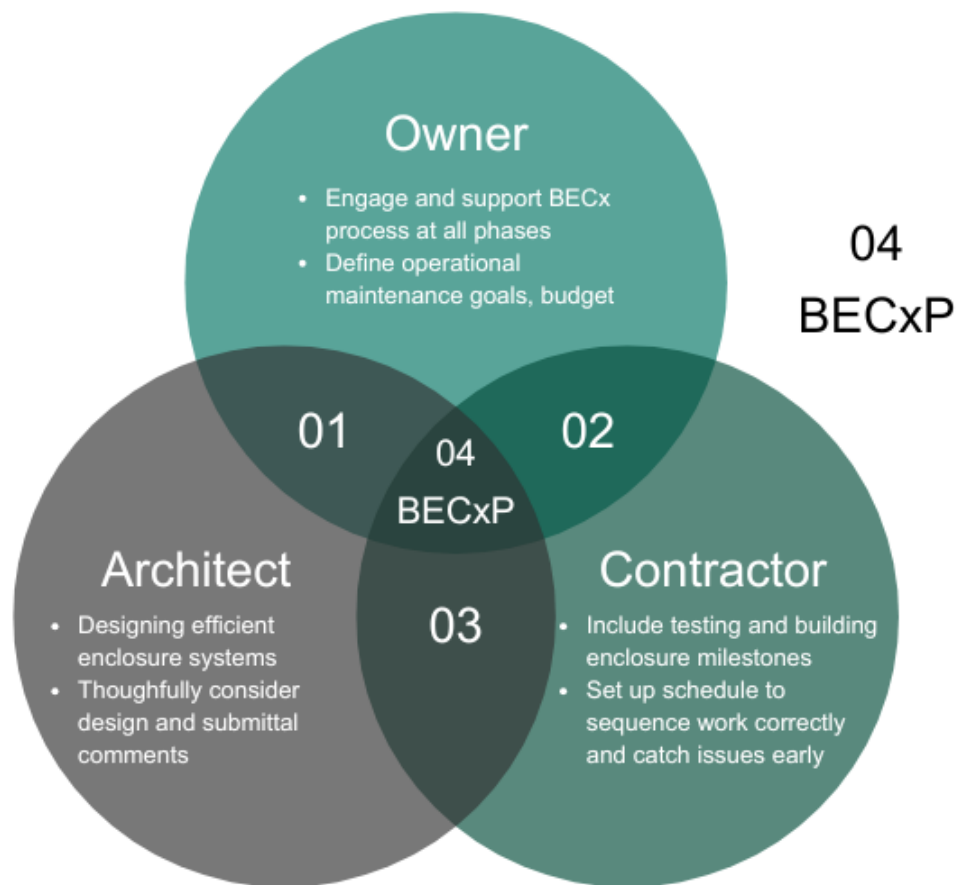
Stages of Building Enclosure Commissioning



FOCUSED PROCESS PER LEEDv4.1/v5

Roles & Responsibilities

Roles and Responsibilities



01

- Align on performance goals
- Support BECx on reviews and testing plans
- Issue resolution and constructability gaps

02

- Support of commissioning activities
- Open, timely communication regarding scope, schedule, testing documentation
- Ensure work is code compliant

03

- Participate in on-site walkthroughs
- Ensure clear and consistent communication of design intent in drawings
- Review submittals/RFIs

04

- Qualified expert in enclosure design, construction, performance
- Independent third party or part of Owner's team (with independent judgment)
- Manages and executes BECx per OPR, codes, and project specs

Roles and Responsibilities: Owner/Owner's Rep

- Provide clear, documented expectations for building performance and operations
- Support and empower the commissioning team throughout the process
- Reinforce the commissioning agent's authority to identify issues and the project team's responsibility to resolve them
- Stay actively engaged to maintain momentum and ensure timely issue resolution
- Ensure participation from design teams, consultants, and operations/maintenance staff for training, demos, and acceptance activities



Roles and Responsibilities: O&M Staff

- Participation focuses only on enclosure-specific performance, documentation, and long-term maintainability
- Provide design-phase input to the OPR on enclosure access, inspection, durability, and maintenance needs
- Identified recipients of enclosure-related turnover documentation
- Observe enclosure-related construction testing to understand intended performance and maintenance considerations
- Support final closeout by receiving enclosure performance criteria, as-built details, product data, warranties, and maintenance intervals
- Ensure continuity of enclosure performance into occupancy—without expanding BECx to include systems, controls, or non-enclosure training



Roles and Responsibilities: BECxP

- Design Phase
 - Engaged as an independent third-party representing owner's interests
 - Defines enclosure performance expectations in OPR
 - Reviews enclosure design documents and provides written comments
- Construction Phase
 - Performs enclosure-focused site observations, submittal reviews, and testing
 - Documents deficiencies and verifies corrective actions
 - Reviews enclosure closeout documents (warranties, maintenance data, etc.)
- Post-Construction
 - Conducts deferred testing and final verification as needed
 - Supports transition to operations



Roles and Responsibilities: Construction Manager

- Coordinate and participate in BECx meetings, site visits, testing, and follow-up on action items
- Gather and provide enclosure-related submittals to the BECxP
- Witness selected enclosure performance tests and compile test documentation
- Support BECxP in organizing and documenting training for O&M staff and occupants
- Collect all commissioning documentation (as-builts, test reports, O&M manuals, warranties, product data)
- Coordinate deferred and post-occupancy testing and ensure closure of BECx issues



Roles and Responsibilities: General Contractor

- Establish clear, documented expectations for building performance and operation and ensure quality control
- Support the commissioning team in carrying out its scope
- Reinforce the commissioning agent's role in identifying issues and the project team's responsibility to resolve them
- Stay actively engaged to maintain momentum and support timely issue resolution
- Ensure participation from the design team, consultants, and operations staff
- Make operations and maintenance staff available for training, demonstrations, and system acceptance



Roles and Responsibilities: Design Professionals

- Includes architect, enclosure consultant, structural engineer, and specialty subconsultants
- Develop construction documents to meet enclosure performance objectives in the OPR and document the BOD
- Ensure enclosure requirements are clearly shown in drawings and specifications (100% CDs / IFC set)
- Respond to BECxP review comments and incorporate commissioning requirements into documents
- Collaborate with the project team to resolve enclosure-related issues during design and construction
- During construction, assist with evaluating field conditions, submittals, and corrective actions related to BECx findings
- On complex projects, may review testing procedures and attend selected enclosure performance tests



Roles and Responsibilities: Subcontractor

- Establish clear, documented expectations for building performance and operation
- Support the commissioning team in carrying out its scope
- Reinforce the commissioning agent's role in identifying issues and the project team's responsibility to resolve them
- Stay actively engaged to maintain momentum and support timely issue resolution
- Ensure participation from the design team, consultants, and operations staff
- Make operations and maintenance staff available for training, demonstrations, and system acceptance



Pre-Design

BECx Pre-Design Phase: Goals

- Establish BECx scope, roles, and communication protocols at project kickoff
- Identify performance objectives and risk drivers influencing enclosure design, durability, and long-term serviceability
- Develop and document Owner's Project Requirements (OPR) for the building enclosure
- Prepare preliminary Building Enclosure Commissioning (BECx) Plan outlining process, deliverables, and verification strategies



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Owner's Project Requirements (OPR)

Owner's Project Requirements

- Functional requirements
- Performance criteria
- Sustainability goals
- Budget and schedule constraints
- Operational expectations
- Maintenance philosophy
- Risk tolerance



Design (SD, DD, CD)

BECx Design Phase: Goals

- Define continuous air, water, thermal, and vapor control strategies
- Identify and resolve high-risk interfaces and transitions
- Coordinate enclosure systems across disciplines
- Integrate constructability, sequencing, and testability into the design
- Develop performance criteria and field verification requirements
- Incorporate enclosure commissioning requirements into the construction documents

Basis of Design

Basis of Design

- It defines the intended enclosure performance.
- It identifies the systems and assemblies selected to meet the OPR.
- It describes key design assumptions, strategies, and performance targets.
- It establishes the measurable criteria against which the enclosure will be verified during commissioning.

SCHEMATIC DESIGN NARRATIVE

OVERVIEW

The following summarizes the schematic design for the Project. This narrative is provided for budgeting purposes, and for adjusting design scope moving into the Design Documentation phase of the project. The overall goal is to provide a budget to move forward into design development and construction documentation.

This report was developed with input from several stakeholders at the service center as well as leadership from various departments. This has allowed the design team to develop a schematic design concept that responds to the needs for future growth at the site as well as prioritize advantageous adjacencies and site flow efficiencies. This also includes revising existing internal departmental adjacencies to create spaces that better reflect the work culture of .

Major drivers for this effort include:

1. Modernizing aging existing infrastructure and facilities
2. Improve inefficiencies of process flows with existing layout
3. Opportunity to update the facility to meet LEED & design standards
4. Enhance overall service center security and access

These major initiatives are all existing needs at the service center.

Existing Facility Summary:

service center is located at the . The existing facility is organized around several main programmatic elements. The existing two-story office building houses most of the traditional office workstations, work crew locker rooms and support spaces. North of the office is the main materials storage building. This area of the facility houses the main warehouse, delivery dock, Gas Service shop and the Sub Metro shop. To the immediate east, is the indoor automotive parking and loading area. East of that is the automotive repair and welding bays.

On the exterior the building is surrounded by a series of covered vehicle parking bays, fuel yard, separate employee and visitor parking areas and the pole storage yard. Pole storage is at a lower section of the site on the east edge of the property. The eastern boundary has a rail line and the southern edge of the property abuts an adjacent private business. The pole storage yard is currently working well for the crews.

Minimal site improvements have been proposed, no existing building utilities or site easements will be affected by the proposed design.

The overall condition of the existing facility is showing wear due to its age and the hi-impact nature of the work being performed. The following sections will provide a high level overview of the existing conditions and provide narrative supplement to the schematic design drawings.

BECx Specification

BECx Specification

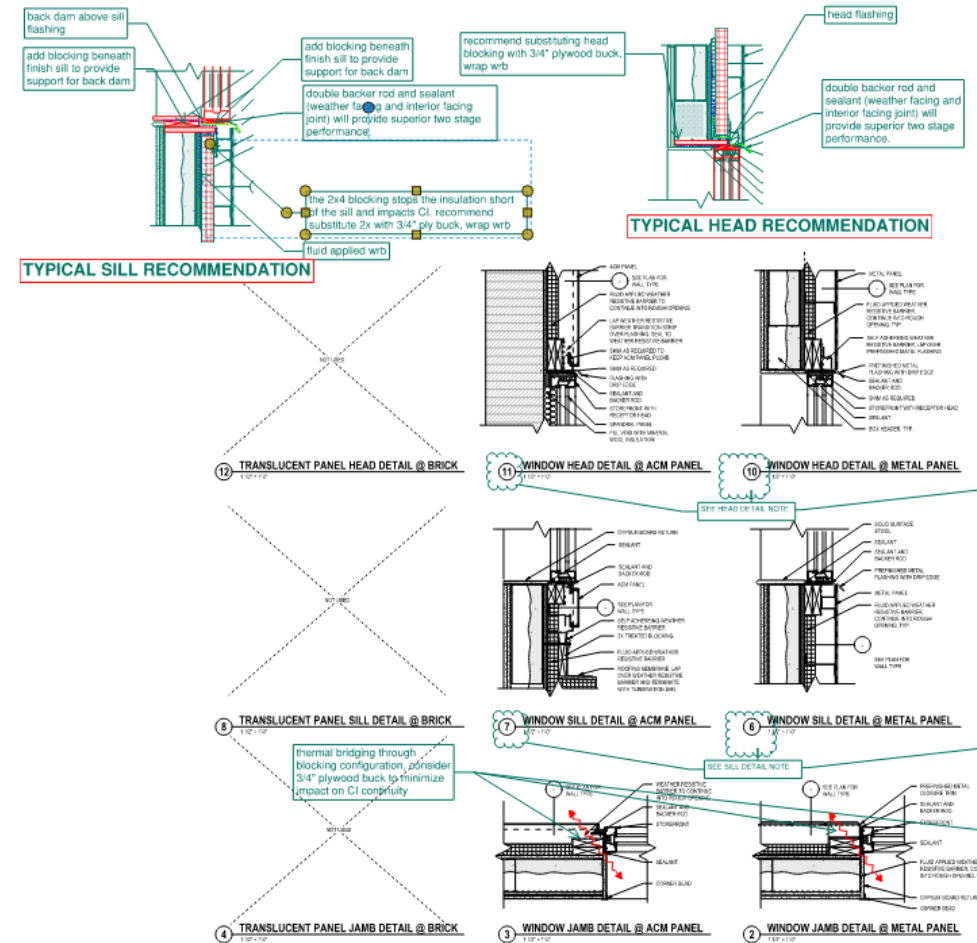
- The project specification section that defines
 - the scope,
 - responsibilities,
 - testing requirements,
 - documentation,
 - verification procedures for Building Enclosure Commissioning (BECx) throughout design and construction.

1	
2	
3	
4	SECTION 01 9119
5	BUILDING ENCLOSURE COMMISSIONING
6	
7	PART 1 - GENERAL
8	1.1 WORK INCLUDES
9	1.2 RELATED WORK
10	1.3 SUMMARY
11	1.4 DEFINITIONS
12	1.5 COORDINATIONS
13	1.6 COMMISSIONING PROCESS
14	1.7 COMMISSIONING TEAM
15	1.8 OWNER RESPONSIBILITIES
16	1.9 ARCHITECT/ENGINEERS (AE) RESPONSIBILITIES
17	1.10 GENERAL CONTRACTOR'S RESPONSIBILITIES (OR "PRIME CONTRACTOR", IF APPLICABLE)
18	1.11 SUB CONTRACTOR'S RESPONSIBILITIES
19	1.12 BUILDING ENCLOSURE COORDINATION DOCUMENTS
20	1.13 FUNCTIONAL PERFORMANCE TESTING (IN-SITU)
21	PART 2 - PRODUCTS (NOT USED)
22	PART 3 - EXECUTION
23	3.1 MEETINGS
24	3.2 ONSITE TESTING
25	3.3 REPORTING
26	
27	PART 1 - GENERAL
28	1.1 WORK INCLUDES
29	A. Base Bid
30	1. General Contractor
31	a. Assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities.
32	b. Provide field quality control testing and inspections on exterior enclosure construction (including filling out commissioning checklists) and submit reports to the Commissioning Agent.
33	c. Participate in testing/inspection procedures meetings.
34	d. Direct appropriate subcontractors to correct deficiencies as interpreted by the Commissioning Agent, Designer, and OWNER.
35	e. During construction, maintain as built redline drawings for all drawings.
36	f. Coordinate with manufacturers to determine specific requirements to maintain the validity of the warranty.
37	g. Provide input for final commissioning documentation to the Commissioning Agent.
38	h. Submit operation and maintenance data for systems, subsystems, and components to the Commissioning Agent.
39	i. Participate in maintenance orientation, training, and inspection.
40	j. Complete paper or electronic construction checklists as work is completed and provide to the CxA on a weekly basis.
41	
42	
43	

Independent Design Reviews (IDR)

Independent Design Reviews (IDR)

- Perform comprehensive enclosure design review and resolve performance gaps
- Analyze system interfaces and continuity of control layers
- Validate specifications against OPR and enclosure performance criteria
- Finalize BECx Plan and scope of verification activities
- Develop and integrate BECx specification into contract documents
- Update OPR and document alignment in the Envelope BOD



Bidding & Negotiation

BECx Bidding & Negotiation Phase: Goals

- Support owner during procurement and bidder inquiries
- Review enclosure-related addenda and proposed substitutions
- Confirm inclusion of BECx requirements in contract documents
- Advise on value engineering impacts to enclosure performance
- Update/refine the BECx Plan to reflect final contract scope

Fees: Fees for the services outlined herein shall be as follows:

Service	Unit	Unit Cost (\$)	Quantity	Total (\$)
Set up & Reporting				
To and from the project site with personnel, materials, equipment, and reporting	per visit	\$850	8	\$6,800
Testing/On-site evaluation				
ASTM E 783, E 1105 - Static Air Infiltration & Water Penetration Testing				
Location not to exceed 120 ft ² each - Storefront	per location	\$2,050	3	\$6,150
Location not to exceed 120 ft ² each - Curtainwall	per location	\$2,050	6	\$12,300
ASTM E 1105 - Water Penetration Testing (Zero Pressure Differential)				
Location not to exceed 100 ft ² each - Hollow Metal Doors	per location	\$850	3	\$2,550
Location not to exceed 100 ft ² each - Storefront Doors	per location	\$850	9	\$7,650
Location not to exceed 100 ft ² each - Overhead Doors	per location	\$850	1	\$850
AAMA 501.2 - Water Penetration Hose Testing				
Location not to exceed 200 lineal ft each - Metal Panel(s), Penetration Firestopping, Joint Sealants, Louvers, and PreCast Structural Concrete	per round	\$1,850	9	\$16,650
ASTM E 1186 - Air Leakage Detection with Leakage Detection Liquid (1 Set - 25 Locations) - TPO Roofing	per set	\$750	2	\$1,500
ASTM D 4541 - Adhesion Test -Foamed Insulation and TPO	per pull	\$250	6	\$1,500
Infrared/Thermal Imaging Review	per visit	\$4,250	1	\$4,250
Free-Standing Mock-Up (Not to Exceed 200 Sq. Ft.)				
ASTM E783, E1105 and D4541	per day	\$3,250	1	\$3,250
Grand Total				\$63,450

BECx Bidding & Negotiation Phase: Goals

- Limited to ASTM 2947 BECx supports
- Not a requirement of LEED v4/v5

Construction Phase

BECx Construction Phase: Goals

- Verify compliance of building enclosure systems with design intent and OPR
- Confirm installation quality and performance of envelope components
- Identify and resolve deficiencies affecting durability, water/air control, and thermal performance
- Document and track issues, corrective actions, and final acceptance
- Support coordination between contractors, designers, and commissioning team
- Perform/observe functional performance tests



Revised BECx Plan

Issue Revised Cx Plan

- Building Enclosure Commissioning Program
 - Goals and Objectives
 - Test Equipment
 - Roles and Responsibilities
 - Commissioning Process
- Commissioning Activities
 - Pre-design Phase
 - Design Phase
 - Construction Phase
 - Warranty Phase

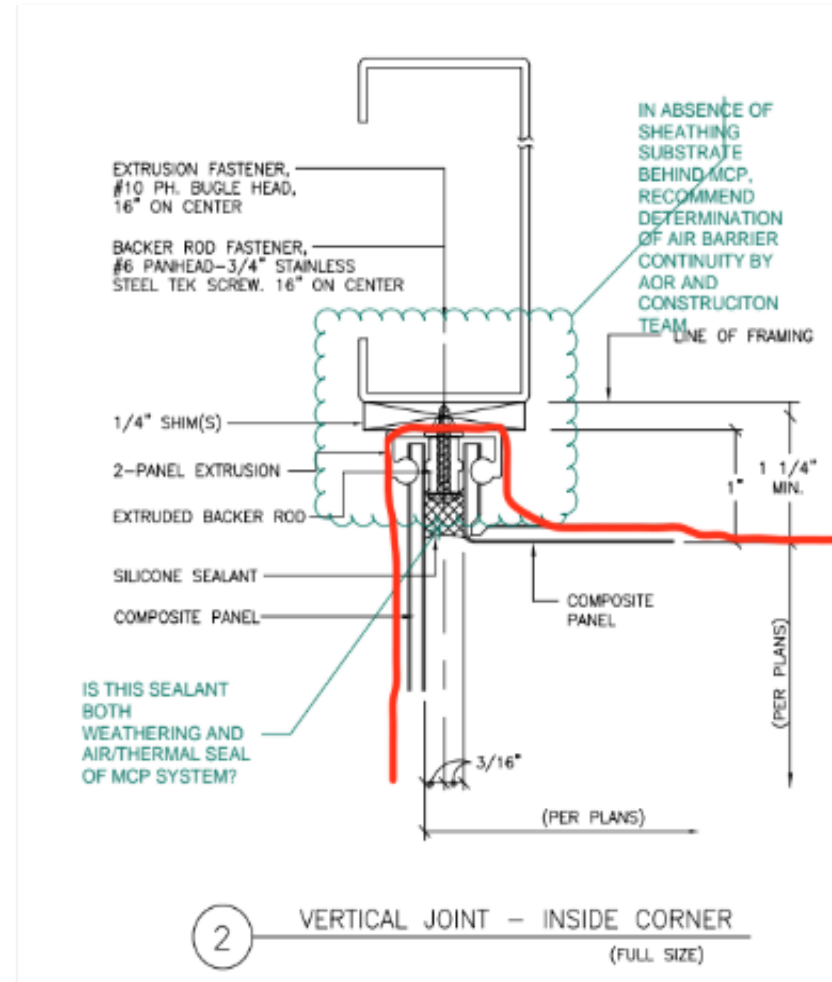


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Submittal Review

- Verify Submittal Consistency with:
 - BECx-related equipment
 - OPR, BOD, design drawings.
 - Specification
- Provides Recommendations:
 - to AOR / EOR consideration
 - Not reviewed for approval
 - Recommendation path only
- Meetings as requested



Equipment in Scope

Project-Specific Equipment Divisions in BECx Scope

Functional Performance Testing Field Mock-up
Functional Performance Testing Field Installed

07 2726 Fluid-Applied Membrane Air Barriers

07 5423 TPO Roofing

07 4213.23 Metal Composite Material Wall Panels

08 4523 Fiberglass Sandwich Panel Wall System

08 4113 Aluminum-Framed Entrances and Storefronts

07 1416 Cold Fluid-Applied waterproofing

07 9200 Joint Sealants

08 1113 Hollow Metal Doors (exterior doors only)

08 3323 Overhead Coiling Doors

08 3600 Sectional Overhead Doors

08 4229.23 Sliding Automatic Entrances

019119 - Building Enclosure Commissioning Requirements

Field Inspection Requirements

07 2726 Fluid-Applied Membrane Air Barriers

07 4213.23 Metal Composite Material Wall Panels

07 4619 Preformed Steel Siding

07 5423 TPO Roofing

07 6200 Sheet Metal Flashing and Trim

07 7233 Vegetated Roof Systems

07 8413 Penetration Firestopping

07 8446 Fire-resistive joint systems

07 9500 Expansion Joint Control System

08 1113 Hollow Metal Doors (exterior doors only)

08 3113 Access Doors and Frames

08 4229.23 Sliding Automatic Entrances

08 7100 Door Hardware

08 8726 Bird Control Film

BECx Construction Phase

Test Summary Matrix

Appendix C: Building Enclosure Commissioning Test Summary Matrix		Project: Project Number: Date of Issuance: Print Date: Revision: R00					BAUMANN CONSULTING 180 N. LaSalle Street Suite 2210 Chicago, IL 60601 main +1 312 270 1406 baumann-us.com							
Equipment	Test Name	Test Type	Test Description	Quantity per round	Responsible Party	Onsite Verification by Baumann	Timeframe of Construction and Test Quantities							
							Mockup	10%	30%	50%	70%	100%	Total Tests	
07 21 00 Thermal insulation	ASTM C1153 In sequence Infrared Evaluation	Performance Test	Infrared Imaging	Two sets after completion of roof or wall assemblies, with a minimum 18" F temperature differential between conditioned interior and exterior air.	GC- per 01 40 00	TBD				1		1	2	
07 42 13 Metal Wall Panels	AAMA 501.2 Water Spray Test	Performance Test	Hose Test	100 linear feet of joints and trasitions including sill, jamb, header and intermediate of at least two modules of the panel system.	Owner - per 07 42 13	TBD	1	1	1				3	
07 42 13 Metal Wall Panels	ASTM E1105 Water Penetration Test	Performance Test	Spray Rack Test	Minimum one test per metal panel type.	Owner - per 07 42 13	TBD	1		1				2	
07 42 13 Metal Wall Panels	ASTM E783 Air Leakage Volume Test	Performance Test	Chamber Test	Minimum one test per metal panel type.	GC- per 01 40 00	TBD	1		1				2	
07 54 23 Thermoplastic-Polylefin (TPO) Roofing	ASTM D4541-95 Adhesion Test	Performance Test	Pull-Off Adhesion Test (Building Wrap Only)	Minimum three locations per membrane barrier type and substrate interface.	GC- per 01 40 00	TBD	1	1		1			3	
07 54 23 Thermoplastic-Polylefin (TPO) Roofing	ASTM E1186 Qualitative Air-Leakage Test	Performance Test	Bubble Test	Two sets of 25 locations.	GC- per 01 40 00	TBD	1		1				2	
07 92 00 Joint Sealants	ASTM C1193, Appendix X1 - Method A	Performance Test	Hand Pull Test	Perform ten tests for the first 1000 feet of joint length for each kind of sealant and joint substrate. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.	GC- per 01 40 00	TBD	*	*	*	*	*	*	*	
08 44 13 Glazed Aluminum Wall Assemblies	ASTM E1105 Water Penetration Test	Performance Test	Spray Rack Test	Minimum one test per curtain wall type.	GC- per 01 40 00	TBD	1		1				2	
08 44 13 Glazed Aluminum Wall Assemblies	ASTM E783 Air Leakage Volume Test	Performance Test	Chamber Test	Minimum one test per curtain wall type.	GC- per 01 40 00	TBD	1		1				2	
08 44 13 Glazed Aluminum Wall Assemblies	AAMA 501.2 Water Spray Test	Performance Test	Hose Test	100 linear feet of joints and trasitions including sill, jamb, header and intermediate of at least two modules of the panel system.	Owner - per 08 44 13	TBD	1	1	1				3	
08 44 13 Glazed Aluminum Wall Assemblies	ASTM C1401 Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.	Performance Test	Hand Pull Tab	Minimum six areas on each building façade.	Owner - per 08 44 13	TBD	12		12				24	
						Onsite	Performance Test - TOTAL							45
							Timeframe of Construction and Test Quantities							

BECx Construction Phase

Division (per round)

Appendix C: Building Enclosure Commissioning Test Summary Matrix				Project: Project Number: Date of Issuance: Print Date: Revision: R00				 2020-12-15 10:00 AM CST 2020-12-15 10:00 AM CST 2020-12-15 10:00 AM CST							
Equipment	Test Name	Test Type	Test Description	Quantity per round	Responsible Party	Onsite Verification by Baumann	Timeframe of Construction and Test Quantities								
							Mockup	10%	30%	50%	70%	100%	Total Test		
07 21 00 Thermal Insulation	ASTM C1153 In sequence Infrared Evaluation	Performance Test	Infrared Imaging	Two sets after completion of roof or wall assemblies, with a minimum 18 °F temperature differential between conditioned interior and exterior air.	GC - per 01 40 00	TBD				1		1	2		
07 42 13 Metal Wall Panels	AAMA 501.2 Water Spray Test	Performance Test	Hose Test	50 linear feet of joints and transitions including sill, jamb, header and intermediate of at least two modules of the panel system.	Owner - per 07 42 13	TBD	1	1	1				3		
07 42 13 Metal Wall Panels	ASTM E1105 Water Penetration Test	Performance Test	Spray Rack Test	Minimum one test per metal panel type.	Owner - per 07 42 13	TBD	1		1				2		
07 42 13 Metal Wall Panels	ASTM E783 Air Leakage Volume Test	Performance Test	Chamber Test	Minimum one test per metal panel type.	GC - per 01 40 00	TBD	1		1				2		
07 54 23 Thermoplastic-Polyolefin (TPO) Roofing	ASTM D4541-95 Adhesion Test	Performance Test	Pull-Off Adhesion Test (Building Wrap Only)	Minimum three locations per membrane barrier type and substrate interface.	GC - per 01 40 00	TBD	1	1		1			3		
07 54 23 Thermoplastic-Polyolefin (TPO) Roofing	ASTM E1186 Qualitative Air-Leakage Test	Performance Test	Bubble Test	Two sets of 25 locations.	GC - per 01 40 00	TBD	1		1				2		
07 92 00 Joint Sealants	ASTM C1193, Appendix X1 - Method A	Performance Test	Hand Pull Test	Perform ten tests for the first 1000 feet of joint length for each kind of sealant and joint substrate. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.	GC - per 01 40 00	TBD	*	*	*	*	*	*	*		
08 44 13 Glazed Aluminum Wall Assemblies	ASTM E1105 Water Penetration Test	Performance Test	Spray Rack Test	Minimum one test per curtain wall type.	GC - per 01 40 00	TBD	1		1				2		
08 44 13 Glazed Aluminum Wall Assemblies	ASTM E783 Air Leakage Volume Test	Performance Test	Chamber Test	Minimum one test per curtain wall type.	GC - per 01 40 00	TBD	1		1				2		
08 44 13 Glazed Aluminum Wall Assemblies	AAMA 501.2 Water Spray Test	Performance Test	Hose Test	50 linear feet of joints and transitions including sill, jamb, header and intermediate of at least two modules of the panel system.	Owner - per 08 44 13	TBD	1	1	1				3		
08 44 13 Glazed Aluminum Wall Assemblies	ASTM C1401 Destructive Test Method A, and Pull Tab (Destructive), Appendix X2.	Performance Test	Hand Pull Tab	Minimum six areas on each building façade.	Owner - per 08 44 13	TBD	12		12				24		
							Performance Test - TOTAL								
							45								

BECx Construction Phase

- Facilitates Conformance
- Outlines Construction Phase Expectations
- Triggers GC to schedule test within the critical-path of project delivery
- Testing timeline that distributes tests throughout different stages of construction (10%, 30%, 50%, 70%, 100%)

Test Summary Matrix

Appendix C: Building Enclosure Commissioning Test Summary Matrix						Project: Project Number: Date of Issuance: Print Date: Revision: 800		 2025.04.01 - 2025.04.01 - 2025.04.01 - 2025.04.01 2025.04.01 - 2025.04.01 - 2025.04.01 - 2025.04.01							
Equipment	Test Name	Test Type	Test Description	Quantity per round	Responsible Party	Onsite Verification by Baumann	Timeframe of Construction and Test Quantities								
							Mockup	10%	30%	50%	70%	100%	Total Tests		
07 21 00 Thermal insulation	ASTM C1153 in sequence Infrared Evaluation	Performance Test	Infrared Imaging	Two sets after completion of roof or wall assemblies, with a minimum 18°F temperature differential between conditioned interior and exterior air.	GC - per 01 40 00	TBD				1		1	2		
07 42 13 Metal Wall Panels	AAMA 501.2 Water Spray Test	Performance Test	Hose Test	100 linear feet of joints and transitions including sill, jamb, header and intermediate of at least two modules of the panel system.	Owner - per 07 42 13	TBD	1	1	1				3		
07 42 13 Metal Wall Panels	ASTM E1105 Water Penetration Test	Performance Test	Spray Rack Test	Minimum one test per metal panel type.	Owner - per 07 42 13	TBD	1		1				2		
07 42 13 Metal Wall Panels	ASTM E783 Air Leakage Volume Test	Performance Test	Chamber Test	Minimum one test per metal panel type.	GC - per 01 40 00	TBD	1		1				2		
07 54 23 Thermoplastic-Polyolefin (TPO) Roofing	ASTM D4541-95 Adhesion Test	Performance Test	Pull-Off Adhesion Test (Building Wrap Only)	Minimum three locations per membrane barrier type and substrate interface.	GC - per 01 40 00	TBD	1	1		1			3		
07 54 23 Thermoplastic-Polyolefin (TPO) Roofing	ASTM E1186 Qualitative Air-Leakage Test	Performance Test	Bubble Test	Two sets of 25 locations.	GC - per 01 40 00	TBD	1		1				2		
07 92 00 Joint Sealants	ASTM C1193, Appendix X1 - Method A	Performance Test	Hand Pull Test	Perform ten tests for the first 1000 feet of joint length for each kind of sealant and joint substrate. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.	GC - per 01 40 00	TBD	*	*	*	*	*	*	*		
08 44 13 Glazed Aluminum Wall Assemblies	ASTM E1105 Water Penetration Test	Performance Test	Spray Rack Test	Minimum one test per curtain wall type.	GC - per 01 40 00	TBD	1		1				2		
08 44 13 Glazed Aluminum Wall Assemblies	ASTM E783 Air Leakage Volume Test	Performance Test	Chamber Test	Minimum one test per curtain wall type.	GC - per 01 40 00	TBD	1		1				2		
08 44 13 Glazed Aluminum Wall Assemblies	AAMA 501.2 Water Spray Test	Performance Test	Hose Test	100 linear feet of joints and transitions including sill, jamb, header and intermediate of at least two modules of the panel system.	Owner - per 08 44 13	TBD	1	1	1				3		
08 44 13 Glazed Aluminum Wall Assemblies	ASTM C1401 Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.	Performance Test	Hand Pull Tab	Minimum six areas on each building facade.	Owner - per 08 44 13	TBD	12		12				24		
						Onsite	Performance Test - TOTAL						45		

BECx Construction Phase

Construction Checklists

- (Digitally Distributed via Online Platform)
- Subs to complete Construction Checklists during equipment installation
- Most checklists require 2+ subs to complete (e.g. Window Installer/Enclosure Assembly Contractor)
- **Contractors can also use their own checklists IF provided to BECx team for review prior to equipment installation, otherwise, BECxP's checklists are required**
- No testing until checklists complete

PFC - Building Enclosure - Joint Sealants

Lines 32

PRE-CONSTRUCTION QUALITY CONTROL TEST PREREQUISITES

- | | |
|---|--|
| 1 | Exterior Wall Contractor to submit to Manufacturer size and quantity of required substrate materials for testing |
| 2 | Confirm that all relevant substrates including, but not limited to, finished aluminum, GFRC, metal panels, vision glass, spandrel glass, gaskets, glazing accessories, as well as any other material which will contact the weather seals/structural silicone sealant either during installation or normal wall movements, are included for testing. |
| 3 | Substitute actual job substrate materials in lieu of standard test materials, |
| 4 | Confirm tests will use same sealant types on the project, including color, and approximate joint size and configurations. |
| 5 | Will the project be using previously conducted testing or project specific testing? |
| 6 | Testing will not be required if certified tested reports using project specific materials can be furnished by Manufacturer. Reports to be dated within 2 years from the date the document is submitted. |

PRE-CONSTRUCTION QUALITY CONTROL TEST

- | | |
|----|--|
| 7 | Verify completion of Sealant Adhesion Testing per ASTM C 794 |
| 8 | Verify completion of Sealant Compatibility Testing per ASTM C 1087 |
| 9 | Verify completion of Sealant Stain/Migration Testing per ASTM C 1248 |
| 10 | Verify testing of sealant effects on Laminated Glass per ASTM C 1248 |
| 11 | Verify sealant testing on Weather Barriers - Sealant Adhesion Testing per ASTM C 794 |
| 12 | Verify sealant testing on Weather Barriers - Sealant Compatibility Testing per ASTM C 1087 |
| 13 | Verify Structural Silicone Quality Control Test |

PRE-CONSTRUCTION QUALITY CONTROL TEST DOCUMENTATION

BECx Construction Phase

On-site Test Verification

- Field testing conducted during construction to confirm that installed building enclosure components meet specified performance criteria, with documented results used to validate compliance and identify deficiencies requiring corrective action.



BECx Construction Phase

Issues Log (Digitally Distributed)

- Issues logged and Tracked on digital Commissioning Management platform
- Owner/AOR/EOR/Contractor responses
- Will serve as a parallel punch-list prior to project closeout

The screenshot displays a web-based 'Design Issues' log. At the top, there's a blue header with the title 'Design Issues' and a sub-header '23 Issues sorted by status'. On the right of the header are buttons for 'Export', 'Email', 'PDF', and a settings icon. Below the header, there's a navigation bar with 'Select All', 'Deselect All', and pagination controls showing 'Page 1 of 1'. A 'Show 50 per page' option is also present. The main content area is titled 'OPEN' and shows a progress bar indicating '8 of 8' items. Three issue entries are visible, each with a checkbox, a title, a description, and a right-hand sidebar with details.

Issue ID	Status	Assigned To	Discipline	Drawing	Due Date
DR-2-9	OPEN	Michael Brinkman Electrical Engineer, CannonDesign	Lighting	J437-123-W-E001	8/11/2021
DR-2-8	OPEN	Andrew Koffke Mechanical Engineer, CannonDesign	Mechanical	J437-123-W-M601	8/11/2021
DR-2-7	OPEN	Andrew Koffke Mechanical Engineer, CannonDesign	Mechanical	J437-123-W-M601	8/11/2021

BECx Construction Phase

Digital Real-Time Tracking

- Modern BECx (and Cx) are facilitated by real-time tracking through online dashboards.
- Provide in-the-field access to Owners, Architects, Contractors, Subcontractors and BECxP to monitor the status of issues and report on corrective actions.
- Recommended that your RFP solicit firms that use any of the numerous digital platforms available.



Occupancy & Warranty Phase

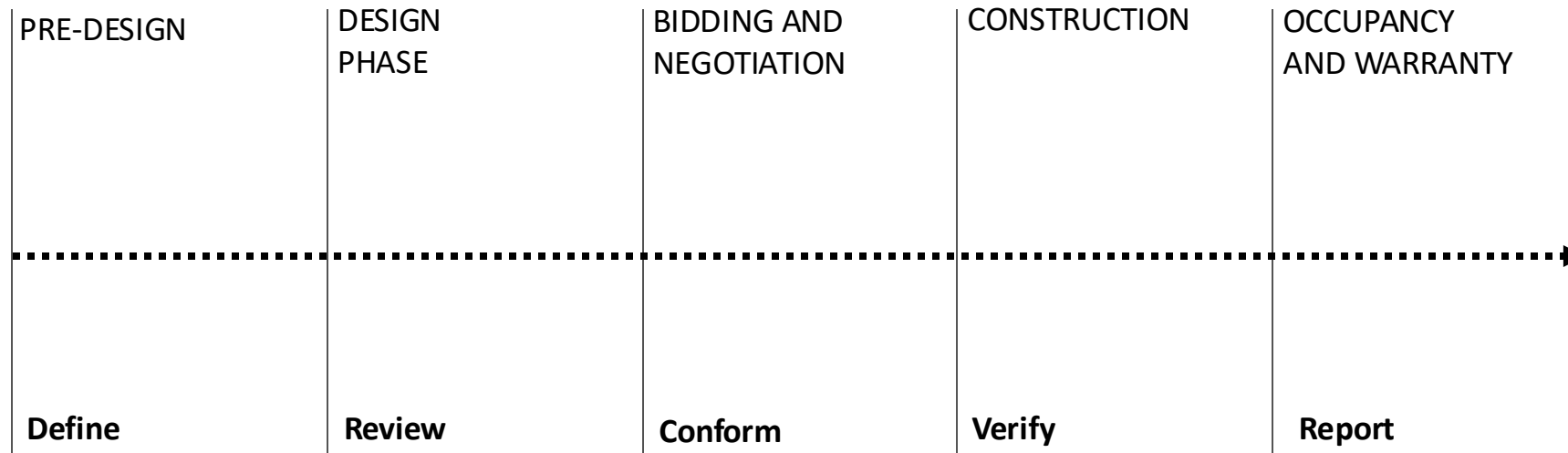
BECx Occupancy & Warranty Phase: Goals

- 10 Month Warranty Site Walk
- Verification of Performance
- Issues Identification and Reporting



BECx Process Recap

Stages of Building Enclosure Commissioning



03 – BECx Testing Scope

BECx Building Elements in Scope

Including but not limited to:

1. Below-Grade Waterproofing Systems
2. Above-Grade Water Control Systems
3. Air Barrier Systems
4. Thermal Control Systems
5. Exterior Wall Cladding Systems
6. Roofing Assemblies
7. Roof-to-Wall and Parapet Transitions
8. Fenestration and Door Interfaces





Big Three: Air, Water, Thermal Testing

BECx Building Elements in Scope



Air Leakage Testing

**AIR LEAKAGE
TESTING**



Water Leakage Testing



2025

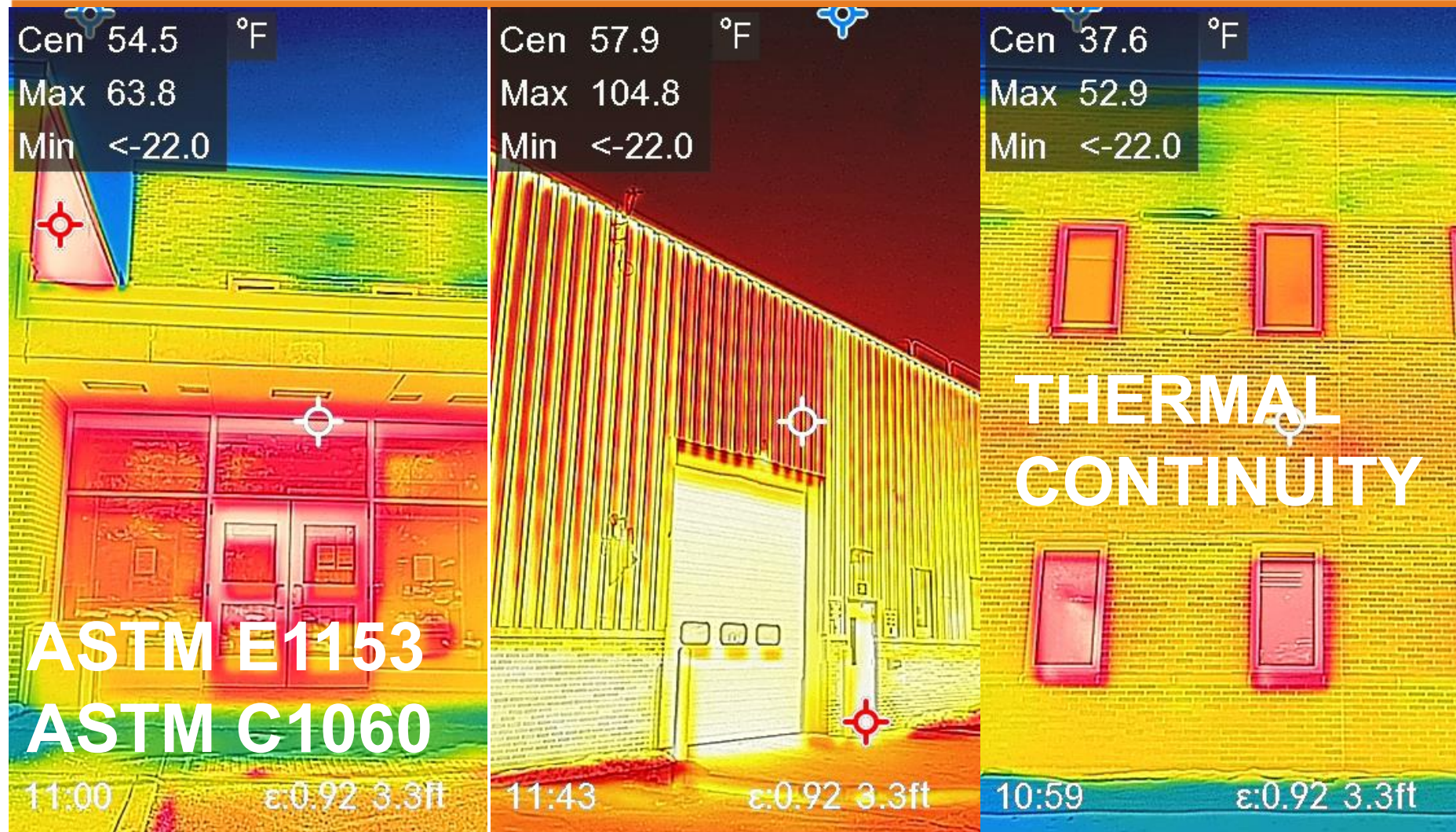


BCxA



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Thermal Testing



BECx How to Specify Tests?

ASTM 2813-12

Standard Practice of Building Enclosure Commissioning

- Includes routine tests for different performance characteristics:
 - Air Infiltration
 - Water Penetration
 - Thermal Performance and Condensation Resistance
 - Durability and Appearance
- Tests are typically performed

Property	Standard Designation	Title	Lab System Testing	Enhanced		Fundamental	
				Field Mockup Testing ^a	In-Situ Field Testing	Field Mockup Testing	In-Situ Field Testing
	ASTM E2249	Test Method for Laboratory Measurement of Airborne Transmission Loss of Building Partitions and Elements Using Sound Intensity	OL	---	---	---	---
	ANSI S12.8	Methods for Determination of Insertion Loss of Outdoor Noise Barriers	---	(OF)	(OF)	(OF)	(OF)
	ANSI S12.60	Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools	OL	---	---	---	---
Air Infiltration							
Air flow	ASTM E2319	Test Method for Determining Air Flow Through the Face and Sides of Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen	OL	---	---	---	---
Air leakage	ASTM E283	Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen	L (M)	---	---	---	---
	ASTM E779	Test Method for Determining Air Leakage Rate by Fan Pressurization	---	---	✓ (1X)	---	(OF)
	ASTM E1827	Test Methods for Determining Airtightness of Buildings Using an Office Blower Door	---	---	✓ (1X)	---	(OF)
	ASTM E783 ^a Opaque Walls	Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors	---	✓ (1X)	✓ (1X)	✓ (1X)	✓ (1X)
	ASTM E783 Windows	Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors	---	✓ (1X)	✓ (2X)	✓ (1X)	✓ (1X)
	ASTM E1196	Practice for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems	---	(OF)	✓ (1X)	(OF)	✓ (1X)
Air permeance	ASTM E2178	Test Method for Air Permeance of Building Materials	OL	---	---	---	---
	ASTM E2357	Test Method for Determining Air Leakage of Air Barrier Assemblies	OL	---	---	---	---
Thermal Performance and Condensation Resistance							
Condensation resistance	AAMA 1503	Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections	OL ^c (M)	(OF) ^a	(OF)	(OF)	(OF)
Insulation	ASTM C1153	Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging	---	---	✓ (1X) ^b	---	✓ (1X)
Temperature index calculation/test	AAMA 501.5	Test Method for Thermal Cycling of Exterior Walls	OL (M)	(OF)	---	(OF)	---
Thermal performance	CAN/CSG 149-GP-25MP	Manual for Thermographic Analysis of Building Envelopes	ref	---	---	---	---
Insulation	ASTM C1060	Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings	---	---	(OF)	---	(OF)
Dew point of IGU	ASTM E576	Test Method for Frost/Dew Point of Sealed Insulating Glass Units in the Vertical Position	---	(OF)	(OF)	(OF)	(OF)
Heat Loss	ANSI-ASHRAE 101	Application of Infrared Sensing Devices to the Assessment of Building Heat Loss Characteristics	---	(OF)	(OF)	(OF)	(OF)
U factor	NFRC 100	Procedure for Determining Fenestration Product U-Factors	OL	---	---	---	---
	ASTM E2264	Practice for Determining the Effects of Temperature Cycling on Fenestration Products	OL	---	---	---	---

BECx How to Specify Tests?

- LEEDv5
 - Requires project to fulfill basic air leakage, water penetration and thermal testing

PATH 2. ENHANCED COMMISSIONING FOR BUILDING ENCLOSURE (1 POINT)

Comply with all tasks and deliverables referenced with *ASTM E2947-21a*, "*Standard Guide for Building Enclosure Commissioning*," except Sections 7.2.4 and 7.4.3.

Comply with the following field-testing requirements:

- Building air leakage testing per *ASTM E783*, *ASTM E779*, *ASTM E1186*, or *ASTM E3158*.
- Water penetration testing per *ASTM E1105* or *AAMA 501.2*.
- Infrared imaging per *ASTM C1153* or *ASTM C1060*.

During occupancy, review the training materials to confirm that they meet the training requirements provided in the building enclosure commissioning (BECx) plan or specification, and confirm that the training occurred.

BECx How to Specify Tests?

- IECC & ASHRAE
 - Requires project to fulfill basic air leakage, water penetration and thermal testing
 - Requires projects to fulfill basic air leakage testing

C402.6.2 Air leakage compliance.

Air leakage of the building thermal envelope shall be tested by an approved third party in accordance with Section C402.6.2.1. The measured air leakage shall not be greater than 0.35 cubic feet per minute per square foot (1.8 L/s × m²) of the building thermal envelope area at a pressure differential of 0.3 inch water gauge (75 Pa) with the calculated building thermal envelope surface area being the sum of the above- and below-grade building thermal envelope.

Exceptions:

1. Where the measured *air leakage* rate is greater than 0.35 cfm/ft² (1.8 L/s × m²) but is not greater than 0.45 cfm/ft² (2.3 L/s × m²), the *approved* third party shall perform a diagnostic evaluation using a smoke tracer or infrared imaging. The evaluation shall be conducted while the building is pressurized or depressurized along with a visual inspection of the *air barrier* in accordance with ASTM E1186. All identified leaks shall be sealed where such sealing can be made without damaging existing building components. A report specifying the corrective actions taken to seal leaks shall be deemed to establish compliance with the requirements of this section where submitted to the *code official* and the building owner. Where the measured *air leakage* rate is greater than 0.45 cfm/ft² (2.3 L/s × m²), corrective actions must be made to the *building* and an additional test completed for which the results are 0.45 cfm/ft² (2.3 L/s × m²) or less.
2. Buildings in Climate Zone 2B.
3. Buildings larger than 25,000 square feet (2323 m²) floor area in Climate Zones 0 through 4, other than Group I and R occupancies, that comply with Section C402.6.2.3.
4. As an alternative, *buildings* or portions of *buildings* containing Group I-1 and R-2 occupancies shall be permitted to be tested by an *approved* third party in accordance with Section C402.6.2.2. The reported *air leakage* of the *building thermal envelope* shall not be greater than 0.27 cfm/ft² (1.4 L/s × m²) of the *testing unit enclosure area* at a pressure differential of 0.2 inch water gauge (50 Pa).

BECx Code Considerations

- Air Barrier Verification is a code requirement under 2024 IECC where whole building pressurization testing is not pursued
- BECx for jurisdictions such as Chicago Energy Transformation Code and Washington District of Columbia Energy Conservation Code also satisfies LEED requirements.

04 – Key Takeaways

BECx Key Takeaways

- **Plan Early** – Define BECx scope and performance goals.
- **Review Design** – Check assemblies, details, and specs.
- **Document** – Set testing and verification requirements.
- **Oversee Construction** – Monitor installation against design.
- **Test & Verify** – Confirm air, water, and thermal performance.
- **Resolve Issues** – Correct deficiencies before occupancy.
- **Report** – Summarize verified performance for authorities.



BECx Key Takeaways

- BECx is a quality assurance process that helps improve quality, durability and performance of buildings
- The process engages Owners, Architects, Contractors, Subcontractors and a BECx Provider in a comprehensive quality assurance process from Pre-Design to Warranty & Occupation.
- BECx typical tests verify air tightness, water leakage, and thermal performance.
- Digital tools integrate into the process to provide real-time dashboards of the status of building construction.

Questions?

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