Architects Leading the Commissioning Process

WE302
Wednesday, May 13, 2015 (1:00 PM – 5:00 PM)
Learning Units 3.75LU, GBCI
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Acknowledgements/Credits

B101–2007, Standard Form of Agreement between Owner & Architect
B202–2009, Standard Form of Architect’s Services: Programming
B211–2007, Standard Form of Architect’s Services: Commissioning
Architect’s Handbook of Professional Practice, Fifteenth Edition
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Speakers List

• Michael Chelednik, AIA
  Sr. Airport Terminal Architect, URS

• Maureen Guttman, AIA
  President, Building Codes Assistance Project

• Pamela Sams, AIA
  Technical Director, Gensler

• Daniel J. Lemieux, AIA
  Principal, Wiss, Janney, Elstner Associates, Inc.
Course / Learning Objectives

• Participants will have an understanding of what commissioning is, the benefits and costs of commissioning and the commissioning process from pre-design with the Program and Owner’s Program of Requirements, through post occupancy to lessons learned and additional knowledge and skills required to perform building commissioning.

• Commissioning is found in the ICC International Green Construction Code, ASHRAE 189.1 and the LEED rating system. Participants will learn commissioning requirements in codes and the new technical requirements of IgCC, ASHRAE 189.1 and LEED under the agreement between ASHRAE, AIA, IES, ICC and USGBC.

• Participants will have an understanding of Architects providing Building Enclosure Commissioning (BECx) as defined by ASTM E-2813 - Standard Practice for Building Enclosure Commissioning, ASTM E2947, which is replacing NIBS Guideline 3 and will learn about ASTM certification for BECx and DOE/NIBS Cx certification.

• Participants will be able to assemble and lead a Cx and BECx Project team, learn how to identify Cx provider qualifications, Cx scope during design and construction, Cx documents that need to be included in the Construction Documents and Cx construction activities.
Agenda

• What is Cx and why are we talking about it?
• Chapter 1: What’s Driving Cx?
• Chapter 2: The Cx Process
• Chapter 3: Building Enclosure Commissioning
• Chapter 4: AIA’s Involvement in Cx
• Chapter 5: What’s the Opportunity for Architects
What is Commissioning and why are we talking about it?
What is Commissioning?

Commissioning validates the design!
That the design works and meets the “design intent”

Design Intent

Design
Construction
O & M

Changing Needs

That the systems are installed correctly per the “design”

“Inspections” validate construction

“This is not commissioning!”

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Commissioning Defined

ASHRAE Standard 202 (The Commissioning Process)
“A quality focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operate and maintained to meet the Owner’s Project Requirements.”

Building Commissioning Association (BCA)
“Building Commissioning is a process of documentation, adjustment, testing, verification, and training performed specifically to ensure that the finished facility operates in accordance with the owner’s documented project requirements and the construction documents. It begins in predesign and continues through design, construction, and occupancy of the facility.”

NIBS Building Enclosure Commissioning (BECx)
“The process by which the design and constructed performance of building enclosure materials, components assemblies and systems are validated to meet defined objectives and requirements of the project, as established by the Owner.”
What is Commissioning

An Overview of Building Commissioning

Commissioning ensures that the new building operates initially as the owner intended and that building maintenance staff are trained to operate and maintain its equipment and systems as designed.
Commissioning Defined

Types of Commissioning

Retro Cx/Existing Building Commissioning
Verifying that systems and equipment in existing buildings are operated and maintained in accordance with the buildings current needs.

Continuous Commissioning
Normally computer based monitoring of equipment parameters to verify optimal performance of equipment.

New Building Commissioning
Implementing the commissioning process for a new construction or substantial renovation project.
Commissioning Terminology

• Whole Building Commissioning
• Total Building Commissioning
• Total Systems Commissioning
• Technical Building Commissioning
• Whole Building Systems Technical Cx
Commissioning Terminology

- Whole Building Commissioning
- Total Building Commissioning
- Technical Building Commissioning
- Total Systems Commissioning
- Whole Building Systems Technical Cx

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Typical Project Team Configuration
Up to the Mid 1970’s

- Architect
- Elec. Engineer
- Mech Engineer
- General Contractor
- Elec. Contractor
- Mech. Contractor
Typical Project Team Configuration After the Mid 1970’s

Gaps between disciplines resulting in:
- Poor coordination
- Lost details
- Costly change orders
- Delays in schedule
“...yeah, they’re substantially complete, but...”
New Project Team Configuration with Commissioning

Commissioning helps fill the gaps in coordination.

Commissioning encompasses “All”.

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Cx Process & Guidelines
ASHRAE Guideline 0 & Standard 202
Cx Process & Guidelines
ASTM E2947 Standard Guide for BECx

ASTM E2947
Standard Guide for Building Enclosure Commissioning

NIBS Guideline 3-2012
Building Enclosure Commissioning Process BECx
This Guideline is for Use with ASHRAE Guideline 0-2005:
The Commissioning Process

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Cx Process & Guidelines
GSA Commissioning Guide

the building commissioning guide

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Growth of the Commissioning Industry

Aggregate industry revenue with long-term projections: 1990-2020

Gross Revenues (billion, nominal)

- $15.3 billion (High)
- $13.3 billion (Medium)
- $10.6 billion (Low)

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CHAPTER 1
What’s Driving Commissioning?
What is Commissioning?

• The term *commissioning* comes from shipbuilding
What is Commissioning?

• The term *commissioning* comes from shipbuilding.

• The commissioning of buildings initially focused on energy performance.
What is Commissioning?

- The term 'commissioning' comes from shipbuilding.
- The commissioning of buildings initially focused on energy performance.
- Cx now includes an increasing number of systems.
Building Commissioning
Timeline of Drivers and Support

- 1977: Public Works Canada begins to use Cx in its project delivery system
- 1884: ASHRAE Committee on Cx is Formed
- 1991: Electric Utilities begin to require Cx on energy efficiency installations
- 1995: Energy Star Building Partnership program includes Cx
- 1998: USGBC includes Cx in LEED criteria
- 2001: States begin to incorporate Cx requirements in building codes
- 2005: ASHRAE Guideline 0, The Commissioning Process
- 2011: ICC publishes the International Green Construction Code
Building Commissioning
Codes, Standards and Rating Systems

• International Green Construction Code (IgCC)
• International Energy Conservation Code (IECC)
• ASHRAE Standard 189.1 and 90.1
• CALGreen & California Energy Code
• LEED and other rating systems
Cx Compliance for Code

- Similar to Special Inspector Program
- Utilize Forms for consistency
- Templates are available in the ICC G4 Guideline and other sources
  - Modify to fit local needs
Outcome Based Codes

- Building operation and maintenance have a major impact on energy use.
- Current codes don’t address those issues.
- Outcome based compliance path approved for 2015 LGCC.
Meeting the Challenge with Energy Codes

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CHAPTER 2
The Commissioning Process
An Overview of Cx Process

**Pre-Design Phase**
- Select a Cx Agent
- Cx Meeting
- Develop OPR
- Develop Cx Plan Outline

**Construction Phase**
- Cx Meeting
- Cx Design Review
- Update Cx Plan
- Cx Specifications
- Develop Verification checklists
- Develop Functional tests
- Systems Manual Outline
- Training

**Design Phase**
- Kick-Off Meeting
- Review submittals & coordination drawings
- Review O&M Manuals
- Observations
- Verification checks
- Diagnostic monitoring
- Functional testing
- Cx Report
- Systems Manual
- Training

**Occupancy & Operations Phase**
- Resolve all Cx issues
- Perform seasonal testing
- Perform near warranty-end review
- Prepare Final Cx Report

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Good Design = Good Performance

- Building Life Cycle
- Net Zero Water
- Net Zero Energy
- Occupant
  - Commercial
  - Educational
- Program Occupancy
- Program Occupancy
- Internal Cap & Trade
- 250 Year Structure
- Rainwater Collection
- Mechanical
- Grey Water
- Natural Ventilation
- 50 Year Skin
- Energy
- Waste Compost
- Irresistible Stair
Architects basic services per AIA Document B101

Pre-Design Phase

• Select consultants
• Owner’s Program (by the Owner)
• Schedule
• Budget for the Cost of the Work
• Consider Environmentally responsible design alternatives
• Consider the value of alternative materials, building systems and equipment

Cx Process

Pre-Design Phase

• Select a Cx Agent
• Cx Meeting
• Develop OPR
• Develop Cx Plan Outline
Architects basic services per AIA Document B101

**Design Phase**
- Provide Design Documents
- Provide Specifications
- Schedule
- Budget for the Cost of the Work
- Coordinate design services
- Identify major materials and systems
- Additional Information: Shop Drawings, Product Data, Samples

**Cx Process**
- Cx Meeting
- Cx Design Review
- Update Cx Plan
- Cx Specifications
- Develop Verification checklists
- Develop Functional tests
- Systems Manual Outline
- Training requirements
Architects basic services per AIA Document B101

Construction Phase

- Review submittals
- Confirm work conforms with CDs
  - Visit the site at intervals appropriate to the stage of construction
- Review certificates for payment to contractor
- Inspections of special components or subsystems
  - Substantial and final completion

Cx Process

- Kick-Off Meeting
- Review submittals & coordination drawings
- Review O&M Manuals
- Observations
- Verification checks
- Diagnostic monitoring
- Functional testing
- Cx Report
- Systems Manual
- Training
Architects basic services per AIA Document B101

**Occupancy & Operations Phase**

- Attend meetings
- Conduct a meeting with the Owner to review the facility operations and performance
- Review certificates for payment to contractor
- Inspections of special components or subsystems

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**Cx Process**

- Resolve all Cx issues
- Perform seasonal testing
- Perform near warranty-end review
- Prepare Final Cx Report
Additional Services per AIA Document B101

4.1.1 Architectural Programming
4.1.6 Building information modeling
4.1.10 Value Analysis (B204™-2007)
4.1.12 On-site project representation
4.1.16 Post occupancy evaluation
4.1.19 Coordination of Owner’s consultants

4.1.22 Commissioning (B211™-2007)
4.1.23 Extensive environmentally responsible design
4.1.24 LEED Certification (B214™-2007)
B202 - 2009, Standard Form of Architect’s Services: Programming

AIA Document B202™–2009 establishes duties and responsibilities where the architect provides the owner with programming services. The architect’s programming services are set forth in a series of iterative steps, from a broad identification of priorities, values and needs of the programming participants to working with the owner to confirm the owner’s objectives for the project. The programming services also include information gathering to develop performance and design criteria, and developing a final program of project requirements. AIA Document B202–2009 may be used in two ways: (1) incorporated into the owner/architect agreement as the architect’s sole scope of services or in conjunction with other scope of services documents, or (2) attached to AIA Document G802™–2007, Amendment to the Professional Services Agreement, to create a modification to an existing owner/architect agreement. B202–2009 is a scope of services document only and may not be used as a stand-alone owner/architect agreement.
B211–2007, Standard Form of Architect’s Services: Commissioning

AIA Document B211™–2007 requires that the architect, based on the owner’s identification of systems to be commissioned, develop a commissioning plan, a design intent document, and commissioning specifications. It also requires that the architect review the contractor’s submittals and other documentation related to the systems to be commissioned, observe and document performance tests, train operators, and prepare a final commissioning report. AIA Document B211–2007 may be used in two ways: (1) incorporated into the owner/architect agreement as the architect’s sole scope of services or in conjunction with other scope of services documents, or (2) attached to AIA Document G802™–2007, Amendment to the Professional Services Agreement, to create a modification to an existing owner/architect agreement. B211–2007 is a scope of services document only and may not be used as a stand-alone owner/architect agreement. B211 was revised in 2007 to align, as applicable, with AIA Document B101™–2007.
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B211–2007, Standard Form of Architect’s Services: Commissioning

AIA Document B211 requires the architect to:

- Develop OPR & BoD,
- Develop a Cx Plan,
- Develop Cx specifications,
- Review the submittals and other documentation related to the systems to be commissioned,
- Observe and document performance tests,
- Train operators, and
- Prepare a final Cx Report

**Pre-Design Phase**
- Develop OPR
- Develop Cx Plan

**Design Phase**
- Cx Specifications
- Develop Verification checklists
- Develop Functional tests

**Construction Phase**
- Observations
- Training

**Occupancy & Operations Phase**
- Prepare Final Cx Report
Owners Project Requirements

“A written document that details the functional requirements of a project and the expectations of how it will be used and operated. This includes project goals, measurable performance criteria, cost considerations, benchmarks, success criteria and supporting information.

(The term Project Intent or Design Intent is used by some owners for their Commissioning Process Owner’s Project Requirements).”

ASHRAE Standard 202

Architectural Programming

“Architectural Programming is a pre-design activity in which the parameters of the project are defined – both quantitatively and qualitatively. This definition forms the critical foundation for the beginning of the design process.”

Architectural Programming (AP)

Can be divided into six steps
1. Research the Project Type
2. Identify Goals and Objectives
3. Gather Data
4. Analyze Information
5. Identify Programmatic Strategies
6. Establish Quantitative Requirements
AP versus OPR
New Airport Terminal

AP will determine number of:
- Outbound bag make-up units
- Bag claim devices

OPR will determine type of:
- Outbound bag make-up units
- Bag claim devices
OPR

Development of specific systems such as:

• Building Enclosure
• HVAC Systems
• Electrical and Special Electrical Systems
• Plumbing Systems
• Fire Protection Systems
• Security Systems
“YOU CANNOT MANAGE THAT WHICH YOU DO NOT MEASURE.”

- Jack Welch, CEO, General Electric
  “Straight From the Gut”
The Architect can assist the Owner in the development of an OPR
Three principal ways to develop the OPR:
• Survey
• Interview
• Workshop
The Architect can assist the Owner in the development of an OPR Workshop

• Offers a dynamic situation
• A number of participants can be assembled to address a wide range of considerations
• The interaction of diverse individuals can offer valuable ideas that would not otherwise surface
It's about the Science of DESIGN

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Commissioning Plan (Cx Plan)
ASHRAE Standard 202 definition:

“A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the Cx Process.”
Commissioning Plan (Cx Plan)

ASHRAE Standard 2021 definition: "A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the Cx Process."

How many of you provide a Plan similar to the Cx Plan?

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Commissioning Plan (Cx Plan)
Cx Design Review:

- Clarity, completeness & adequacy to the OPR
- Issues in OPR are adequately addressed
- Meeting the requirements of the OPR, BoD & coordination of Cx Systems
Observation & Documentation
Construction Checklists

• Using Drawings, Specifications & Submittals
  – Types of Checklists
  – Expected Outcome from checklists
  – Who uses the checklists?

• Installation Checks
  – Ensure equipment gets installed properly with no obvious problems or deviations from Specifications & Submittals
Observation & Documentation
Construction Checklists

• Functional Checks - Components
  – Ensures each component operates throughout a full range of motion and as designed (sequence of operation)

• Performance Tests - Capacity
  – Ensures total system operation and verifies capacity requirements are met
Observation & Documentation
Construction Checklists

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Training

ASHRAE Standard 202 definition

Training Plan:

“A written document that details the expectation, schedule, budget and deliverables of Commissioning Process activities related to training of project operating and maintenance personnel, users and occupants.”
Training
ASHRAE Standard 202

• Establish training expectations and needs with the Owner
• Verify training of operating & maintenance and building occupants are completed
• Document training was completed according to the contract documents
Systems Manual

ASHRAE Standard 202 definition:

“A system-focused composite document that includes the design and construction documentation, facility guide and operation manual, maintenance manual, training information, commissioning process records, and additional information of use to the Owner during Occupancy and Operations.”
Systems Manual

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Commissioning Report
ASHRAE Standard 202 definition

Commissioning Process Progress Report:
“A written document that details activities completed as part of the Cx Process and significant findings from those activities, and is continuously updated during the course of a project.”

Commissioning Process Report:
“A written document that records the activities and results of the Cx Process and is developed from the final Cx Plan with all of its attached appendices.”
CHAPTER 3
Building Enclosure Commissioning (BECx)
Challenges and Opportunities
LEARNING OBJECTIVES
At the end of this session, participants will be able to discuss…

✓ History and Evolution of Building Enclosure Commissioning
✓ ASTM E2813, Standard Practice for Building Enclosure Commissioning
✓ ASTM E2947, Standard Guide for Building Enclosure Commissioning
✓ Development of the New ASTM/NIBS/ISO Building Enclosure Personnel Certification and Training Program
✓ Alignment of ASTM E2813 with Building Codes and Public Sector Accreditation and Credentialing programs
BUILDING ENCLOSURE COMMISSIONING

What is It?

“Building Enclosure Commissioning (BECx) is a holistic process that endeavors to ensure that enclosure performance meets or exceeds the expectations of the Owner...”

The BECx Process
- Predesign
- Design
- Preconstruction
- Construction
- Occupancy and Operations

Owner Project Requirements (OPR)
- Energy
- Environment
- Safety
- Security
- Durability
- Sustainability
- Operation and Maintenance

Good Design and Construction Practice

Quantifiable Performance
BUILDING ENCLOSURE COMMISSIONING
Why Is It Important?

✓ Uncontrolled rainwater penetration and condensation potential are two of the most common threats to building enclosure performance...

✓ Together, they represent up to 80% of all construction-related claims in the United States...

✓ 90% of all water intrusion problems occur within 1% of the total building area (interfaces)

✓ Built environment accounts for 30%-40% of energy use worldwide and, by some estimates, 60%-70% of the materials extracted, processed, and consumed by our society today...
BUILDING ENCLOSURE COMMISSIONING
How Did We Get Here?

Failure in the Project Delivery Process

✓ Compartmentalization of the Design Profession
✓ Declining Skill Levels in the Construction Trades
✓ Rising Incidence and Cost of Litigation
✓ Failure to Deliver...
“Up until 1945, the liability climate within which the architect worked was fairly stable. Under the common law rule of ‘privity of contract’, the client was the only party likely to gain the court’s permission to sue...”

“The trend against the rule began in the manufacturing sector and reached the architectural profession in the 1950’s...”

- AIA Architect’s Handbook of Professional Practice
BUILDING ENCLOSURE COMMISSIONING
Death of the Architect as “Master Builder”

Substituting “Observation” for “Supervision” During the Construction Phase…

- Miller v. DeWitt, 37 Ill.2d 272, 226 N.E.2d 630 (1967)

“Some viewed [this] substitution… as a retreat from the architect’s traditional role, tending to weaken the architect’s services during this crucial project phase…”

- AIA Architect’s Handbook of Professional Practice
“Prior to about 1980 there was no such thing as a CM. However, when interest rates ran close to 20% during the recession of that time… someone came up with the idea of speeding up the process by overlapping design and construction. That occurred at a time when architects were continuing to withdraw from the construction process. Into that void stepped the ‘CM’.”

- Outside Counsel to the AIA
BUILDING ENCLOSURE COMMISSIONING
Architects “Gave It Away”

“The ability to play a controlling role in the construction process was never taken away from architects – they gave it away! That [trend] continues through the most recent iteration of the [AIA] documents. Traditionally, the architect was always the initial [“arbiter”] in the case of conflicts between the contractor and owner. The documents now embrace a third party in that role…”

- Outside Counsel to the AIA
WHAT WE TEACH ARCHITECTS TODAY
NAAB Curriculum Requirements

32 curriculum requirements
Only 6 Related to Building Science and the Technical Rigors of Professional Practice

- A. 1. Communication
- A. 2. Design Thinking
- A. 4. Technical Documentation
- A. 5. Investigative
- A. 6. Fundamental Design
- A. 7. Use of Precedents
- A. 9. Historical Traditions and Global Culture
- A. 10. Cultural Diversity
- B. 1. Pre-Design
- B. 2. Accessibility
- B. 3. Sustainability
- B. 4. Site Design
- B. 5. Life Safety
- B. 6. Comprehensive Design
- B. 7. Financial Considerations
- B. 8. Environmental Systems
- B. 9. Structural Systems
- B. 10. Building Envelope Systems
- B. 11. Building Service Systems
- B. 12. Building Materials and Assemblies
- C. 1. Collaboration
- C. 2. Human Behavior
- C. 3. Client Role in Architecture
- C. 4. Project Management
- C. 5. Practice Management
- C. 6. Leadership
- C. 7. Legal Responsibilities
- C. 8. Ethics and Professional Judgment
- C. 9. Community and Social Responsibility
WHAT WE TEACH ARCHITECTS TODAY

Sample University Curriculum

Total Hours: 174 / 4110

Total University Core Hours: 48 / 720 (18%)

Remaining Hours: 126 / 3390

Total Studio Hours: 42 / 1900 (45%)

Remaining: 84 / 1490

Courses related to Building Science: 12%

Hours related to Building Enclosure: 3%
HOW WE TRAIN ARCHITECTS TODAY
NCARB Intern Development Program

• 17 Experience Areas
• 5600 hours of experience required (about 3 years)
• No Specific Requirement for Training in Building Science or the KSAs Necessary to Deliver Fully Integrated Building Performance

• 1A. Programming (80 hours)
• 1B. Site and Building Analysis (80 hours)
• 1C. Project Cost and Feasibility (40 hours)
• 1D. Planning and Zoning Regulations (60 hours)
• 2A. Schematic Design (320 hours)
• 2B. Engineering Systems (360 hours)
• 2C. Construction Cost (120 hours)
• 2D. Codes and Regulations (120 hours)
• 2E. Design Development (320 hours)
• 2F. Construction Documents (1,200 hours)
• 2G. Material Selection and Specification (160 hours)
• 3A. Bidding and Contract Negotiation (120 hours)
• 3B. Construction Administration (240 hours)
• 3C. Construction Phase: Observation (120 hours)
• 3D. General Project Management (240 hours)
• 4A. Business Operations (80 hours)
• 4B. Leadership and Service (80 hours)
FAILING, BY DESIGN...?

Standard of Care

“It is not the standard of care to provide exhaustively detailed and annotated documents. If architects were expected to provide that level of detail, our fees would need to increase dramatically or we would be out of business quickly…”

-Recent Testimony of an Architect

“Drawings are diagrammatic and do not purport to identify nor solve problems of thermal or structural movement, glazing, anchorage, or moisture disposal...”

-Actual Specification Language
CHALLENGES AND OPPORTUNITIES
What Can We Do?

Develop Enforceable Consensus Standards
- ASTM E2813, Standard Practice for Building Enclosure Commissioning
- ASTM E2947, Standard Guide for Building Enclosure Commissioning

Re-Embrace a Holistic Approach
- Predesign
- Design
- Preconstruction
- Construction
- Occupancy and Operations

Demand Quantifiable Performance
- Energy
- Environment
- Safety
- Security
- Durability, Sustainability, Operation and Maintenance
BUILDING ENCLOSURE COMMISSIONING
Timeline of Standards Development

✓ 2005:  ASHRAE Guideline 0, *The Commissioning Process*
✓ 2012:  ASTM E2813, *Standard Practice for Building Enclosure Commissioning (BECx)*
✓ 2012:  ASTM/NIBS Memorandum of Agreement on Building Enclosure Commissioning
✓ 2012:  NIBS Guideline-3, *Building Enclosure Commissioning Process*
✓ 2015:  ASTM/NIBS/ISO BECx Certification and Training Program
ASTM E2813-12
Standard Practice for Building Enclosure Commissioning
ASTM E2813-12, STANDARD PRACTICE FOR BECx
History and Significance

- Originally Published in 2012
- Recognized by the ICC (IgCC and IAS AC476)
- Developed in Collaboration with...
  - National Institute of Building Sciences (NIBS)
  - U.S. Department of Homeland Security
- Includes Minimum Core Competencies of the BECx Provider
- Includes Minimum Enforceable Levels of BECx
  - Fundamental
  - Enhanced
- Includes an OPR Development Guideline
- Includes Requirements for Quantifiable Performance Testing
ASTM E2813-12, STANDARD PRACTICE FOR BECx
Enforceable Levels of BECx

“Fundamental”
✓ BECxA Engagement During the Design Phase
✓ Minimum of One (1) Independent, Third-Party Design Review (CD Phase)...
✓ Minimum Level of Performance Testing (Annex A.2)

“Enhanced”
✓ BECxA Engagement During the Pre-Design Phase
✓ Minimum of Three (3) Independent, Third-Party Design Review (SD/DD/CD Phases)
✓ Minimum Level of Performance Testing (Annex A.2)
## ASTM E2813-12, STANDARD PRACTICE FOR BECx
Minimum Requirements for Performance Testing

### TABLE A2.1 Continued

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard Designation</th>
<th>Title</th>
<th>Lab System Testing⁸</th>
<th>Enhanced Test Method</th>
<th>Field Mockup Testing⁹</th>
<th>In-Situ Field Testing</th>
<th>Field Mockup Testing</th>
<th>In-Situ Field Testing</th>
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<td>ASTM C1153</td>
<td>Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging</td>
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<td>Temperature index calculation/ test</td>
<td>AAMA 501.5</td>
<td>Test Method for Thermal Cycling of Exterior Walls</td>
<td>OL¹⁰</td>
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<td>Thermal performance Insulation</td>
<td>CAN/CGSB 149.6P-2MP</td>
<td>Manual for Thermographic Analysis of Building Envelopes</td>
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<td>Heat Loss</td>
<td>ANSI-ASHRAE 101</td>
<td>Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings</td>
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**Notes:**

⁸ Lab System Testing: Initial testing setup.
⁹ Enhanced Test Method: Additional tests.
¹⁰ Field Mockup Testing: Field simulation.
¹¹ In-Situ Field Testing: Testing in the actual environment.
ASTM E2813-12, STANDARD PRACTICE FOR BECx
Minimum Required Core Competencies of the BECxP

✓ Building and Materials Science
✓ Procurement and Project Delivery
✓ Contract Documents and Construction Administration
✓ Performance Test Standards and Methodology
ASTM E2813 STANDARD PRACTICE FOR BEC\textsubscript{x}
Minimum Required Core Competencies of the Service-Provider

**Building and Materials Science**

- Principles associated with heat transfer via conduction, convection, radiation, and air infiltration/exfiltration

- Principles associated with moisture storage and transport via gravity, diffusion, convection, capillary action, absorbed flow, and osmosis…

- Characteristics and behavior of materials, components, systems, and assemblies when specified for a given application, geographic region, location, exposure, or climate…
Influence of the project delivery method on the scope and cost of the BECx process

Influence of the number and type of contracts between the Owner and the project team on the role and responsibilities of the BECxP

Influence of design scheduling, phasing, and sequencing of the work on the BECx process

Influence of the experience, qualifications, technical depth, and commitment of the design and construction teams on the successful integration and delivery of the BECx process
ASTM E2813 STANDARD PRACTICE FOR BEC\textsubscript{x}  
Minimum Required Core Competencies of the Service-Provider

**Contract Documents and Construction Administration**

- Interpretation and enforcement of the Contract Documents...
- Importance of shop drawing review and design refinement at interfaces...
- Influence of allowable construction tolerances on detailing and construction...
- Material compatibility and continuity of primary heat, air, and moisture control layers...
- *Timely delivery of BEC\textsubscript{x} work product...*
Performance Test Standards and Methodology

- Quantifiable thresholds of performance...
- Clear and unambiguous definitions of failure...
- Appropriate interpretation of test results...
- Documentation of all modifications to the design arising from pre-construction mock-up testing and translation into the field...
- Distinction between errors and omissions in architectural design vs. product design
- Conflicts between industry standards and open, consensus-based standards and impact on the enforcement of the Contract Documents...
BUILDING ENCLOSURE COMMISSIONING
Why Spend the Money?

Regardless of the Scale and Complexity of the Project, Preliminary Data Suggests that the Cost of BECx will typically be...

✓ 3%-4% of Design Fee
✓ Less than 1% of Total Construction Cost
ASTM/NIBS Memorandum of Agreement

- **Support** the development of standards, guidelines, certifications and education and training materials and programs for building enclosure design, construction and commissioning;

- **Promote** and encourage discussion, training, education, technology transfer and engage in the exchange of information about all matters concerning the building enclosure and the related science;

- **Initiate** and promote cross-disciplinary dialogue between all sectors of the building community and professions in the interest of high performance building enclosures;

- **Facilitate** improvements in the building process, including inspection, approval, codes, regulations, standards, liability matters, and the other areas affecting building enclosures;

- **Improve** the knowledge of their respective memberships in building enclosure science.
ASTM/NIBS Memorandum of Agreement

  ✓ Open Consensus Standards Development Process
  ✓ Streamlined and Enforceable in the Broader Context of Project Delivery
  ✓ ASTM E2947, *Standard Guide for Building Enclosure Commissioning*

• Jointly Develop a Fully Accredited BECx Personnel Certification and Training Program
  ✓ ISO 17024 Compliant
  ✓ ASTM: Scopes/JTAs/KSAs/Exam Development
  ✓ NIBS: BECx Training Program
  ✓ Technically Robust
  ✓ Continuing Education and Training Required
  ✓ Eliminate Confusion in the Marketplace
BUILDING ENCLOSURE COMMISSIONING Standards Development

ASTM E2947, Standard Guide for Building Enclosure Commissioning (BECx)

- Published in December, 2014
- Replaces NIBS Guideline 3 in January, 2015
- Aligned with ASTM E2813
- Provides Guidance to Owner (“Fundamental” or “Enhanced”)
- Provides Roadmap for Practitioners (Who, What, When, and Why?)
- Establishes Two Levels of BECx Service Provider
  - BECx Provider
  - BECx Specialist
- Will include Sample Documents and Exemplars
  - BECx Specification/BECx Plan/Role and Responsibilities Matrix
ASTM/NIBS/ISO
Personnel Certification and Training Program
Personnel Certification vs. Training-Based Certificate Programs…

• ANSI/ISO/IEC 17024, General Requirements for Bodies Operating Certification of Persons

  ✓ Define What It Is You Examine
    ✓ ASTM E2813 Core Competencies
  ✓ Develop Job Titles, Scopes, and Job Task Analyses (JTAs)
  ✓ Establish Minimum Required Knowledge, Skills, and Abilities (KSAs)
  ✓ Create an Examination Independent from Training
    ✓ Do Not ‘Train-to-the-Test’ (Training-Based “Certificate” Programs)
  ✓ Deliver Certified Professionals Who Have Demonstrated the Ability to Apply Knowledge, Skills, and Abilities in BECx
  ✓ Require Continuing Education
    ✓ Align with AIA CES and State Licensing Boards
Training-Based Certificate Programs

Wisconsin

BCxA

NEBB

ACG

CSI

Atlanta

AIA Convention 2015
May 14–16, Atlanta
Personnel Certification and Training Program

ASTM E2813 Core Competencies

✓ Building and Materials Science
✓ Procurement and Project Delivery
✓ Contract Documents and Construction Administration
✓ Performance Test Standards and Methodology

AIA Convention 2015
May 14–16, Atlanta
ASTM BEC\textsubscript{x} Personnel Certification Exam

**ASTM BEC\textsubscript{x} Exam Breakout**

- **50%** Material and Building Science, Design and Inspection
- **20%** Contracts & Construction Documents
- **20%** Process
- **10%** Testing

**AIA Convention 2015**
May 14–16, Atlanta
NIBS BECxD Training Program

- Day 1: BECxD Process
- Day 2: Building Science
- Day 3: Building Science
- Day 4: Building Systems
- Day 5: Systems (cont’d) - Testing and Sampling
NIBS BECxD Training Program – Day 1

• What and Why of Commissioning
• Commissioning in Codes and Standards
  – ASHRAE Standard 202
  – ASTM E 2813 (Mandatory Practice) and ASTM E2947 (Voluntary Guide)
  – LEED 4.0
  – IgCC
  – ASHRAE 189.1 and 90.1…
• Phases of Commissioning
• Project Delivery Methods
• OPR Development
• The BECxD Plan
• The BECxD Specification
NIBS BECx Training Program – Day 2

- The Indoor Environment
- Heat Transfer
- The Outdoor Environment
- The Nature of Air
- Psychometrics
- Calculating Surface Temperatures
- The Environment Below-Grade
- Terminology
- Dew Point Analysis
- Hygrothermal Analysis - WUFI
- Materials, Moisture Content and Storage Capacity for Moisture
NIBS BECx Training Program – Day 3

• Rainwater Wetting and Penetration
  – Pressure Equalization
  – The Drained “Rainscreen” Approach
• Air Pressures in Buildings
  – Air Barriers
  – Testing and Cx of Air Barriers
• Joints in Buildings
  – Control Joints vs Expansion Joints
  – Sizing Joints and Specifying Joint Sealant
• Material Distress
  – Electrochemical Series
  – Corrosion and Protection of Metals
  – Freeze-Thaw Damage
• Energy Code Compliance
• Benefits and Uses of THERM® & WINDOW®
NIBS BECx Training Program – Day 4…

• Substructures and Waterproofing
  – Data Collection
  – Foundation Types
  – Waterproofing

• Roofing
  – Low-Slope
    • Principles of Roof Design and Drainage
    • Roofing Types
    • Assembly Design
  – Pitched Roofs
    • Principles of Roof Design and Drainage
    • Roofing Types
    • Assembly Design
NIBS BEC\textsubscript{x} Training Program – Day 4

- Flashing Strategies
- Insulation Strategies
- Cladding Strategies
- Masonry & Stone
- Precast Concrete and Cast Stone
- Wood Siding, EIFS
- Metal Panel, Fiber-Cement and Rainscreen Claddings
NIBS BECx Training Program – Day 5

• Windows, Storefront, Curtainwall
• Louvers, Skylights and Sloped Glazing
• Glass and Glazing
• Typical Design Reviews – Work Product
  – Drawing Reviews
  – Specification Reviews
• Testing Basics and Qualifications
• Pre-Construction Laboratory and Field Mock-Up Testing
• Construction Phase Field Testing in BECx
• Testing and Sampling Strategies- Failure Consequences
The Road Ahead…

- **ASHRAE/ICC/USGBC M.O.U. - 189.1 as the new Ig**
  - ✔ ASTM E2813 Under Consideration…
  - ✔ ASTM E2947 Available for Consideration…

- **ICC 1000, Standard for Commissioning**
  - ✔ Out for Public Comment…
  - ✔ ASHRAE Standard 202 and ASTM E2813 Under Consideration…
  - ✔ ASTM E2947 Available for Consideration…

- **ICC/IAS AC476, Accreditation Criteria for Organizations Providing Training or Certification of Commissioning Personnel**
  - ✔ ASTM E2813 Included by Reference with Emphasis on Core Competencies…

- **NIBS/U.S. Department of Energy Commercial Workforce Credentialing Program**
  - ✔ ISO/IEC 17024 Compliance Required…
  - ✔ ASTM/NIBS BECx Personnel Certification and Training Program Developed to Comply…
The Road Ahead

• ASTM/NIBS Second Workshop on Building Science Education North America

January 11, 2016 – Washington, D.C.

✓ National Architectural Accreditation Board (NAAB)
✓ National Council of Architect Registration Boards (NCARB)
✓ Society of Building Science Educators (SBSE)
✓ Industry Experts
✓ Public/Private Institutional Property Owners
QUESTIONS?

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CHAPTER 4
AIA’s Involvement in Commissioning
1. AIA needs to accept that building commissioning is here to stay and that commissioning is not just about HVAC
2. The AIA is promoting and helping to shape the future direction of Cx
3. The AIA should educate our membership in understanding what commissioning is, where it currently stands in the built environment and commissioning as a supplemental service
4. AIA members are leaders in the BECx Process
5. The AIA is involved in developing the qualifications (certifications) of those taking leadership roles in Cx
6. AIA is engaged with other organizations in developing Cx processes, services and qualifications
CHAPTER 5
What’s the Opportunity for Architects
The Architect in Building Commissioning
Role of the Architect

A robust commissioning process is the only method the design and construction team has of demonstrating to the owner that the delivered, building performs to the level of the owner’s expectation.