

# Building Enclosure Commissioning: An Introduction

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## **Introduction**

The intent of this best practice is to introduce building enclosure commissioning by focusing on ASHRAE Guideline 0-2005, NIBS Guideline 3-2012, ASTM E2813-12, LEED 2009, and the draft of LEED v.4 EA Envelope Commissioning option of Enhanced Commissioning. In the foreword to 0-2005 it states “*The Commissioning Process is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.*” The objective of the building enclosure commissioning process is to achieve a successful building enclosure meeting Owner’s Project Requirements. The building enclosure, per ASTM E2813-12 “refers collectively to all materials, components, systems, and assemblies intended to provide shelter and environmental separation between interior and exterior, or between two or more environmentally distinct interior spaces in a building or structure.”

There are two compelling reasons for owners and architects to consider Building Enclosure Commissioning: 1) the number of problematic issues of enclosures which manifest themselves during construction and the quality of built enclosures, can be a frustration to owners reflecting on the services provided by the design team, and 2) the increased complexity coupled with the drive for improved performance of building enclosures with regard to sustainability considerations. The benefits to owners, architects and contractors can outweigh the costs and increased activities provided that there is a well-developed commissioning plan. Owners, especially large owners such as the federal government, are looking for means to assure quality outcomes of building enclosures.

As such they likely will be embracing Building Enclosure Commissioning. Architects can recognize the benefits that Building Enclosure Commissioning brings to the quality of their services and recommend Building Enclosure Commissioning to their clients.

## **Referenced Documents**

- ASHRAE Guideline 0-2005 - The Commissioning Process [**ASHRAE 0**]
- NIBS Guideline 3-2012 - Building Enclosure Commissioning Process BECx [**NIBS 3**]
- ASTM E2813-12 - Standard Practice for Building Enclosure Commissioning [**ASTM E2813**]
- U.S. Green Building Council LEED Reference Guide for Green Building Design and Construction, 2009 Edition - Energy and Atmosphere Credit 3 - Enhanced Commissioning (Updated June 2010) [**LEED EA3**]
- 2012 Draft (renamed v.4) EA Credit: Fundamental commissioning and verification, EAp1 and Enhanced Commissioning, Option 2, EA3; Envelope Commissioning (2 points) [**LEED EA BECx**]
- International Green Construction Code - 2012 [**IgCC**]

It is important to bear in mind the different nature and content of the referenced materials. They all were developed through the consensus process by groups of well qualified professionals. ASHRAE 0-2005 and NIBS 3-2012 are “Guidelines”; as guidelines they describe a general operating practice and procedure or a **Best Practice** and are intended to be used as the basis from which a project specific commissioning plan is developed. The ASTM E2813-12 on the other hand is a

**Standard Practice**, one of six categories of standards produced by ASTM. A Standard Practice defines specific sequences of operations which are requirements. To be in strict compliance with ASTM E2813-12 could prove to be overly burdensome and unwarranted in many cases. A case in point is that Annex A2, *BECx Performance Testing Requirements* includes a comprehensive listing of required tests for enhanced or fundamental commissioning which are the minimum requirements “*per unique type of enclosure elements.*” The sheer costs of the testing could shy away owners from strict conformance with ASTM E2813. ASTM E2813 needs to be tested on real projects to determine actual cost impacts of this Standard to project budgets. For a client not wishing to adopt the ASTM Standard but are pursuing Building Enclosure commissioning would still be well served to utilize the ASTM Standard as a Guideline in developing the commissioning plan.

LEED 2009 requires fundamental commissioning of HVAC&R systems, lighting and daylighting controls, domestic hot water systems and renewable energy systems. EA Credit 3, LEED 2009, offers 2 points for enhanced Commissioning which requires that the commissioning process begins early in the design process and additional activities are required during construction concluded during the occupancy phase. An innovation credit can currently be earned for “comprehensive envelope commissioning.” In the current draft of LEED v.4 the required fundamental commission and verification, EA p1, requires limited exterior enclosure commissioning and option 2 of Enhanced Commissioning offers 2 points for envelope commissioning. The Envelope Commissioning option requires following the commissioning process for the building’s thermal envelope in accordance with ASHRAE Guideline 0-2005 and NIBS Guideline 3-2006 as they relate to energy, water, indoor environmental quality and durability [LEED EA BECx].

The LEED reference guide for Green Building Design and Construction leads to LEED certification, and in order to fulfill the requirements in EA Enhanced Commissioning - Envelope Commissioning points specific commissioning process requirements are defined. However, unlike ASTM E2813-12 the LEED requirements lack technical specificity.

The requirement is to meet the fundamental commissioning requirements as they pertain to the building’s thermal envelope. In addition services are provided in the construction phase and occupancy phase. Since this option is not available until sometime in 2013 those minimum standards have not yet been developed. In practice, there will be developed a consensus minimum service which achieves these credits.

The first edition of the International Green Construction Code was in March 2012. AIA, ASTM, ASHRAE, U.S. Green Building Council and the Illuminating Engineering Society were provided cooperating sponsorships. Chapter 9 of the IgCC, Commissioning, Operation and Maintenance, addresses pre-occupancy and post-occupancy requirements. Building enclosures are not treated in a comprehensive way, but there are references to building enclosures. The required commissioning plan includes moisture control pre-occupancy periodic inspections of foundation dampproofing/waterproofing, under slab water vapor protection and flashing. Another requirement is that the operations and maintenance documents includes glazing systems inspection schedule, performance criteria for replacement parts and repairs, and recommended schedules for routine maintenance.

### **Participants**

Participating in the Building Enclosure Commissioning process are the Owner, Design Team (Architect and Consultants) and Contractor as well as independent commissioning authorities. ASHRAE 0 requires the commissioning authority to be identified by the owner. ASTM E2813 requires that the Building Enclosure Commissioning Authority be retained by the Owner. LEED requires that for fundamental commissioning the commissioning authority is independent of the project’s design and construction management but may be an employee of any of the firms providing project services (second or third party). Enhanced commissioning requires that the commissioning authority be an independent third-party. Building Enclosure Commissioning may be a standalone service or it may be part of a larger commissioning service including the HVAC&R commissioning

process. The commissioning authority may also be the technical specialist.

Commissioning Authority designations:

- **CxA** - Commissioning Authority or Agent: An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the Commissioning process [ASHRAE 0]
- **BECxA** - Building Enclosure Commissioning Authority: A commissioning authority identified by the Owner to lead the building enclosure commissioning and possesses “basic architectural and building science knowledge of the design, performance, systems and construction related to the building enclosure.” [NIBS 3]
- **BES** - Building Enclosure Specialist: This person or party is deemed an expert in the building enclosure systems anticipated to be used on the proposed building and possesses the experience and technical qualifications to design, critique, validate and support the team in the project development and construction validation. [NIBS 3]

#### **Owner’s Project Requirements (OPR) / Basis of Design (BOD)**

One of the most fundamental concepts of the Commissioning process is the requirement that in the Pre-Design phase the Owner’s Project Requirements are developed and defined. Then it follows that the deliverables as prepared by the design team there are documents which constitute a Basis of Design which is a written explanation of how the design meets the Owner’s Project Requirements. NIBS Guideline 3-2012 states that the guideline “*considers the performance objectives required by an Owner for the building enclosure, including the control of moisture, condensation, heat flow, air flow, water vapor flow, noise, fire, vibrations, energy migration, light, infrared radiation, ultraviolet radiation, structural performance, durability, resiliency, security, reliability, aesthetics, value, constructability, maintainability, and sustainability.*” The NIBS 3 Guideline includes checklist annexes for Owner’s Project Requirements and for Basis of Design; these are extensive. Bear in mind that for a cubic building the envelope includes all six sides.

Systems which need to be addressed include slab-on-grade, basement walls, roof systems, plaza decks over occupied spaces, opaque wall systems, glazed wall systems, entrances, soffits and projections. Considerations which need to be addressed include:

- Building Description / Objectives
- Context / Site / Access
- Building Code Considerations / Construction Type
- Products / Materials / Finishes
- Standards / Guidelines / Testing
- Industry Standards
- Design sensitivity
- Detailing / System Interfacing
- Constructability
- Structural considerations / Connections
- Movements
- Sustainability
- Water penetration
- Thermal performance
- Air / Vapor Barriers
- Condensation control
- Acoustical
- Security
- Light transmission / Visibility / Glare
- Durability / Warranty
- Maintenance
- Door criteria
- Accessibility

#### **Activities / Requirements**

A broad brush outline of the scope of services follows and is organized by project phase. Associated with Exterior Envelope commissioning specific tasks are presented and provide reference to resources. Building Enclosure commissioning differs fundamentally from MEP commissioning in that there is rarely an opportunity for the enclosure to be adjusted after installation. In Building Enclosure commissioning there needs to be a greater emphasis on technical peer reviews, submittal reviews and, mockup and first-installation testing.

#### **Pre-Design Phase**

- Define Responsibilities, Team Members, and Commissioning Authority [ASHRAE 0 → NIBS 3 → ASTM E2813; LEED 2009 EA Prerequisite1]: Building Enclosure Commissioning Agent

(BECxA) must be independent of the project's design and construction management and preferably a consultant of the Owner; experience requirements outlined

- Kick-off Meeting [NIBS 3 → ASTM E2813]
- Develop **Owner's Project Requirements (OPR)** - Owner's responsibility - BECxA provides technical assistance [ASHRAE 0 - Process → NIBS 3 Annex J - detailed checklist → ASTM E2813 Annex A1 - OPR Development Guideline; LEED 2009 EAc3, required in LEED EA v.4 - owner required to document OPR]
- Develop Scope and Budget for the Commissioning Process [NIBS 3 → ASTM E2813]
- **Commissioning Plan** - Includes roles and responsibilities of team members, communication protocols, communication processes, construction checklists, facility maintenance personnel training, issues / non-conformance log [ASHRAE 0 → NIBS 3; LEED 2009 EAc3, LEED EA BECx]

Design Phase; Schematic Design (SD), Design Development (DD), Construction Documents (CD).

#### I) Basis of Design Documents (BOD) -

Prepared by the Design Team submitted with the Schematic Design deliverables and updated at DD and CD; reviewed by BECxA for conformance with OPR [ASHRAE 0 - Process → NIBS 3 - requires preparation and review by BECxA at SD, requires updated and review at DD and CD → ASTM E2813 - BECxA review and provide technical assistance; LEED 2009 EAc3, required in LEED EA v.4]

- **Technical Peer Reviews** - comprehensive technical reviews - SD review includes impact on the OPR - DD review of detailing, alternative building enclosure systems, plans and details for interface of the various enclosure systems, specifications, thermal analysis, advice on laboratory and field mock-ups... --- CD another extensive technical Peer Review [NIBS 3 → ASTM E2813]

LEED requires the CxA to review the OPR and BOD and requires at least 1 commissioning design review of the design documents prior to midconstruction documents [LEED 2009 EA EA BECx]

- **Commissioning Plan** - Update and expand the commissioning plan to include systems and assemblies to be tested, expand commission plan to address Construction Phase and Occupancy and Operations phase activities [ASHRAE 0 → NIBS 3 → ASTM E2813; LEED 2009 EA BECx]
- **Construction Checklists** - ASHRAE 0 requires construction checklists which "aid the installers by providing specific information on the Owner's Project Requirements for equipment and assemblies for long-term operation." [ASHRAE 0]
- **BECx Reports** - At the end of SD, DD and CD the BECx prepares a report reviewing the objectives of the phase and documenting whether or not the objectives had been met [NIBS 3]
- **Systems Manual** - The Systems Manual is one of the key documents of the ASHRAE 0; it includes the OPR, BOD, record documents, specifications and submittals, O&M Manuals, training materials and commissioning process report [ASHRAE 0] NIBS - 3 requires a Building Enclosure Systems Manual with fewer requirements [NIBS - 3] LEED fundamental requirements include a systems manual "that gives future operating staff the information needed to understand the optimally operate the commissioned systems"; it is a requirement for Enhanced Commissioning [LEED 2009 EAc3 BECx]

#### II) Pre-Construction Phase

The only reference source which specifically designates a separate Pre-Construction Phase is ASTM E2813. Some of the other reference sources, ASHRAE 0 and NIBS 3, require participation in a pre-bid conference.

- **Pre-Bid Conference** - Attend a Pre-Bid Conference to review BECx specification [ASTM E2813]
- **Evaluation of Enclosure** - Review bidder requests and bids [ASTM E2813]

### III) Construction Phase

LEED EA BECx requires that the EA Prerequisite for Fundamental Commissioning also apply to the building's thermal envelope in order to comply with the Envelope Commissioning point requirements. The additional Enhanced Commissioning requirements to achieve the BECx points are specific to the Construction Phase and the Occupancy and Operations Phase.

- **Updates** - Update OPR, commissioning Plan, communication channels, etc. [ASHRAE 0]
- **Review Submittals** - Source materials vary on submittal review requirements; ASHRAE 0 recommends a sampling strategy selecting 5% to 10%, but NIBS 3 requires a thorough review of submittals, including shop drawings, mockups, samples, schedules, etc. ASTM E2813 requires "technical assistance" during the review of submittals. LEED requires a review of contractor submittals. [ASHRAE 0, NIBS 3, ASTM E2813, LEED EA BECx]
- **Checklists** - Verify the completion of the Construction Checklists and that they are utilized. [ASHRAE 0 → NIBS 3]
- **BECx Performance Testing Requirements** - ASHRAE 0, NIBS 3 and LEED EAp1 require for testing of systems, but they are not very specific. The BECx Performance Testing Requirements in the ASTM E2813 requires many tests which for the most part are ASTM Standard designations. The ASTM Standard has two levels of requirements, Fundamental and Enhanced. There is no apparent linkage between the ASTM BECx Fundamental or Enhance requirements and LEED Fundamental and Enhanced Commissioning. Mandatory requirements include:
  - Acoustic performance
  - Air leakage
  - Infrared imaging of roofing system
  - Static and dynamic water penetration
  - Sealant

- **Pre-Construction and Pre-Installation Meetings** - Direct and substantive participation [ASTM E2813]
- **Site Visits** - Conduct periodic site visit to verify and document compliance with the Contract Documents [ASHRAE 0 → NIBS 3 → ASTM E2813]
- **Verifies Training** - Specified training completed during the construction phases, generally by Substantial Completion. [ASHRAE 0 → LEED EA BECx]
- **Closeout Documents** - System Manual update: Record drawings, test procedures, updated OPR, updated BOD, updated commissioning plan, outline of "open" items, guideline for maintenance [ASHRAE 0 → NIBS 3 → ASTM E2813]

### IV) Occupancy and Operations Phase

ASHRAE 0 views the Commissioning Process as extending through the contractual warranty period which is generally one year from Substantial Completion.

- **On-going guidance, follow-up and warranty service** - During the warranty period activities include following up on open items, warranty issues, contractor callbacks, training, continual updates of Systems Manual and other activities. [ASHRAE 0 → NIBS 3]
- **Occupancy and Operations Planning Meeting** - BECxA attends a meeting with property management and building engineering team to review enclosure related issues [ASTM E2813]
- **Warranty Period Walk Through** - Conduct a walk through 10 months after substantial completion reviewing the building enclosure and operations of enclosure [NIBS 3, LEED EA BECx]
- **Final Commissioning Report** - Prepare final project commissioning report [ASHRAE 0 → NIBS 3 → LEED EA BECx]

## Other Considerations

Is Building Enclosure Commissioning going to gain traction?

Fundamental HVAC commissioning and Enhanced HVAC commissioning gained more traction and entered the main stream in project services when fundamental commissioning became a prerequisite for New Construction LEED projects offering 2 points for enhanced commissioning. Fundamental commissioning requires commissioning process activities of HVAC&R systems, lighting coupled with daylighting controls, domestic hot water systems and renewable energy systems. Enhanced Commissioning, LEED 2009 Edition, provides an innovation credit for comprehensive envelope commissioning. In the current draft of LEED v.4 EAp1 requires limited enclosure commissioning including development of the owner's project requirements (OPR) and basis of design (BOD). LEED v.4 Enhanced commissioning offers 4 - 6 points are offered for enhanced commissioning with 2 of the points for envelope commissioning. In the introduction to LEED 2009 the assignment of the allocation of points between credits is based on the potential environmental impacts and human benefits of each credit with respect to a set of impact categories. The credit weighting and expansion of Enhanced Commissioning expected in LEED v.4, as well as the introduction of the NIBS Guideline 3 and the ASTM E2813-12 Standard suggest that the industry is anticipating that Building Enclosure Commissioning will gain traction. LEED v.4 which will be introduced sometime in 2013 could be the impetus which moves Building Enclosure Commissioning forward.

Who is qualified to be a Building Enclosure Commissioning Agent (BECxA) or a Building Enclosure Specialist (BES)?

NIBS Guideline 3-2012 describes generally what Building Enclosure Commissioning Agents and Building Enclosure Specialist entail. Commissioning Authorities and Building Enclosure Commissioning Authorities are to be well-versed in the requirements of the commissioning process. They are responsible for managerial and administrative tasks, as well

as being familiar with the building design and project construction processes and they possess basic architectural and building science knowledge. A Building Enclosure Specialist is expected to be an expert. The NIBS 3 definition requires expertise "in building enclosure systems anticipated to be used on the proposed building and possesses the experience and technical qualifications to design, critique, validate and support the team in the project development and construction validation." [NIBS 3]" The following are considerations for qualification as a BES:

- Project Experience - at least 10 years of experience as an architect, contractor or related professional where they have direct hands on experience in dealing with the issues of roofing, waterproofing, opaque wall construction, entrances and glazing systems.
- Education Experience - college degree in architecture, engineering or construction management.
- Active professional affiliations
- Demonstrable technical expertise in materials, systems and the building sciences as related to building enclosures
- Continuing education

While currently there are no established certification programs in place for Building Enclosure Commissioning Agents or for Building Enclosure Specialists there are organizations looking at providing certification programs. The University of Wisconsin - Madison College of Engineering Department of Engineering Professional Development formally launched a Commissioning Process (CxP) certification program in 2003. They offer multiple Commissioning Process certifications and are currently in the process of developing certifications and programs. These efforts are aimed at the Building Enclosure Commissioning Process Professional (BECxA) and potentially for the Building Enclosure Specialist (BES). The International Accreditation Service (IAS), a subsidiary of the International Code Council, is also discussing the development of accreditation criteria for commissioning agencies. The ASTM Committee E06 on Performance of Buildings is also beginning to look at specialty certifications relative to building commissioning.

## CONCLUSION

In the introduction the argument for why architects can embrace Building Enclosure Commissioning is laid out; 1) the number of problematic issues of enclosures which manifest themselves during construction and the quality of built enclosures can be a frustration to owners, reflecting on the services provided by the design team, and 2) the increased complexity and the drive for improved performance of building enclosures especially with regard to sustainability considerations. Engaging in Building Enclosure Commissioning has project specific benefits in improving the quality of the building enclosure for the project. But, there is the residual benefit of providing focus on technical excellency of building enclosure design.

## About Our Contributor

Micheal J. Lough, AIA, is a principal of Integral Consulting, a Quality Management consulting practice. The practice focuses on Peer Reviews, Building Enclosure Commissioning, Specifications and other technical services designed to assist firms and project teams in improving the successful implementation and execution of architectural projects. Clients include architects, owners, development management companies and contractors.

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## References

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- NIBS Guideline 3-2012 - Building Enclosure Commissioning Process BECx [**NIBS 3**]
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## Keywords

- Commissioning
- Building Enclosure
- Building Envelope
- Owner's Project Requirements
- Basis of Design