



NCBFO
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BECxP Building Enclosure Commissioning
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Building Enclosure Commissioning – What is it ?

Commissioning at its most fundamental level is the systematic process that facilitates the communication, coordination, testing, and verification required to deliver building systems that meet the building owner's intentions and requirements.

Although building codes and regulations are in effect, the process is focused on clarifying and realizing the owner objectives for the project.

Building Commissioning

ASHRAE Guideline 0 – Commissioning Process (Cx)

A quality focused process for enhancing the delivery of the project. The process focuses on verifying and documenting that the facility and assemblies are planned, designed, installed, tested, operated and maintained to meet the Owner's Project Requirements.

History of Building Commissioning

- ASHRAE Guideline 1- 1989/96 The HVAC Commissioning Process
- ASHRAE Guideline 0 – 2005/13/19 The Commissioning Process
- NIBS Guideline 3 – 2006 Exterior Enclosure Technical Requirements for the Commissioning Process
- CSA Z320 – 2011 Building Commissioning
- NIBS Guideline 3-2012 Building Enclosure Commissioning Process (BECx)
- ASTM E2813-2012/12e1/18 - Standard Practice for Building Enclosure Commissioning
- ANSI/ASHRAE/IES Standard 202-2013/18 Commissioning Process for Buildings and Systems
- ASTM E2947-2014/15/16A/21/21A- Standard Guide for Building Enclosure Commissioning
- ISO 21105 Building Enclosure Thermal Performance Verification And Commissioning (2019)

Why commit to BECx?

- Construction projects are complex undertakings.
- From design through construction, there are a range of requirements from budgeting, time constraints, defining requirements, design options, performance criteria, construction documentation, material options, constructability issues, built-in performance issues, change orders, and then multiple trades working independently with overlapping installations. All potentially leading to possible building performance issues.
- Building Enclosures are often the most common and costly building failures, leading owners to spend millions of dollars and years to repair construction defects or modify buildings to improve performance.

Why commit to BECx?

Unvetted and poor design and construction issues can lead to,

- Project delays and lost rent
- Numerous change orders
- Increased operating costs
- Inferior energy efficiency
- Lower reliability
- Water intrusion
- Indoor air quality issues

Commissioning – Costs

- Building Commissioning (Cx) can cost between 2 and 4% of construction depending on project complexity and size.
- Typically, owners prioritize reducing up front costs, so the benefits of commissioning must be clear.
- Currently, concerns about energy efficiency driven by more rigorous code requirements and focus on environmental concerns are driving interest in commissioning.
- Although difficult to estimate, the benefits of owners committing to this process can expect overall savings greater than the up-front cost.

Building Enclosure Commissioning – Benefits

- Reduced risk of leaks, disruption, lawsuits, loss of rent, costly repairs
- Reduction in operating costs
- Reduction in project delays
- Resolution of issues in design can avoid expensive change orders during construction
- Quality assurance
- Comprehensive documentation

Building Enclosure Commissioning – What is it?

When applied systematically, BECx can significantly reduce the risk of water infiltration, reduce the risk of air leakage, improve facility operation and maintenance, reduce capital costs during the first year of operation, and reduce the life cycle costs of the facility for the life of the building.



Commissioning works best when not considered as a standalone process, but instead integrated into the construction project. It is most cost effective when BECx starts at the pre-design stage.

Main Objectives of Commissioning

- Document owner's requirements to improve the quality of design deliverables.
- Confirm the BE design meets the objectives of the owner's requirements with the Basis of Design.
- Verify systems and assemblies perform according to the owner's requirements as stated in the OPR.
- Documentation - Confirm that the proper verification has been carried out before, throughout and after construction to the owner.
- Training - Ensure building operators are trained in proper operation of the facility.

So Why Commissioning ?

- The BECx process aims to confirm that the building will fulfill the functional and performance requirements of the owner, occupants, and operators.

Defined Path for
Decisions

Formalized Design Review process

- Code Requirements
- Aesthetics
- Cost
- Constructability
- Durability
- Sustainability
- Thermal Performance/Energy Consumption
- Occupant Comfort
- Weather barrier

Increased Quality
Assurance

What is the Building Enclosure?

Enclosure Systems

Air Barriers

Vapour Retarders

Insulation

Cladding

Roofing

Podium Decks

Below Grade Waterproofing

Windows

Curtain Walls

Storefronts

Doors

Skylights

Scale of Commissioning

Commissioning should be scalable based on project size and complexity but provide a level of service to ensure the OPR are being met.

At the outset, the Cx and/or BECx provider can assist the owner with the scope of the commission for a given project including cost estimates.

Scale of Commissioning

- Consideration of project size \$5 million vs \$500 million
- Project complexity, 2-story rectangular office building vs. health care facility with various changes in geometry, numerous cladding and glazing elements and stringent indoor air quality requirements
- Risk tolerance for risk
- Certification Requirements
- Focus on commissioning of some building enclosure assemblies and not others.
- When to perform BECx
 - Type of Building - Hospital
Multi Family Housing
 - Complexity - University Campus
Box Store

Scale of Commissioning

ASTM E2813 lays out two levels of commissioning

Fundamental

- Engaged by Design Development Phase
- Review OPR
- Identifies Scope and Budget
- Assists with BOD and Contract Documents
- Performs at least one design review
- Prepares BECx Plan
- “Direct and Substantive” participation in
 - Bidding and Negotiation
 - Pre-construction
 - Construction administration
 - Occupancy and Operation Phases



Enhanced

- Everything in Fundamental, plus
 - Engaged during Pre-design but latest Schematic design phase
 - Assists with preliminary OPR
 - Perform minimum three design reviews
 - Expanded scope of performance testing to be carried out.

Scale of Commissioning

ASTM E2813 – 18							
TABLE A2.1 <i>Continued</i>							
Property	Standard Designation	Title	Lab System Testing ^a	Enhanced		Fundamental	
				Field Mockup Testing ^b	In-Situ Field Testing	Field Mockup Testing ^b	In-Situ Field Testing
Water Penetration							
Water penetration	ASTM E331	Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference	L (M)
	ASTM E514/ E514M	Test Method for Water Penetration and Leakage Through Masonry	OL	(OF)	(OF)	(OF)	(OF)
	ASTM C1601	Test Method for Field Determination of Water Penetration of Masonry Wall Surfaces	...	(OF)	(OF)	(OF)	(OF)
Static water penetration	ASTM D6957 ^c	Guide for Flood Testing Horizontal Waterproofing Installations	...	(OF)	✓ (All horizontal surfaces)	(OF)	✓ (All horizontal surfaces)
	ASTM E1105	Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference	...	✓ (1X)	✓ (2X)	✓ (1X)	✓ (1X)
Dynamic water penetration	AAMA 501.1	Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure	OL (M)	(OF)	✓ (1X)	(OF)	(OF)
	ASTM E2268 ^d	Test Method for Water Penetration of Exterior Windows, Skylights, and Doors by Rapid Pulsed Air Pressure Difference	OL	(OF)	(OF)	(OF)	(OF)
	AAMA 501.2	Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems	...	✓ (1X)	✓ (1X)	✓ (1X)	✓ (1X)
Durability and Appearance							
Glazing stress testing	ASTM C1279	Test Method for Non-Destructive Photoelastic Measurement of Edge and Surface Stresses in Annealed, Heat-Strengthened, and Fully-Tempered Flat Glass	OL

LEED v4.1

Complete the following commissioning process (CxP) activities for the building's thermal envelope in accordance with ASHRAE Guideline 0-2013 and ASTM E2947 -16: Standard Guide for Building Enclosure Commissioning as they relate to energy air and water tightness, indoor environmental quality, and durability.

BECx Process

The commissioning process lays the groundwork for a set of tasks that can be repeated from project to project with the same level of quality and results.

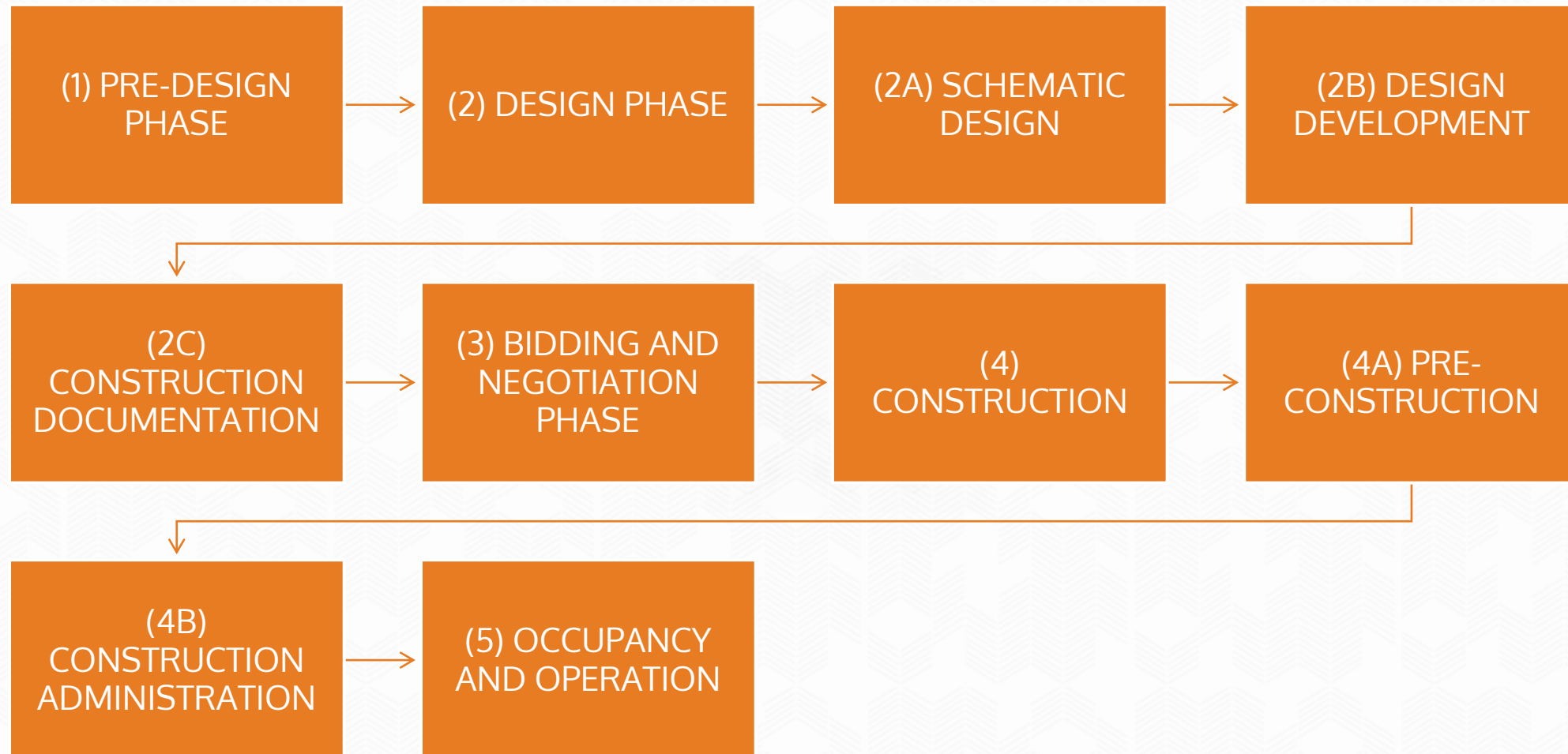
Terms such as “Testing and Balancing” and the use of checklists show where the process started with successful commissioning of mechanical systems.

Building Enclosures have numerous control layers of differing materials, behaviours and environmental conditions and do not easily lend themselves to similar templates and checklists.

Documentation is an important part of BECx, but an overfocus on tasks can lead to an attempt to oversimplify the approach where each project requires unique strategies.

Use of generic checklists or templates for OPR, BOD, QA/QC logs and test matrices can be seen as a time and money saver but run the risk of limiting the real value of the BECx process.

BECx Project Phases



Owners Project Requirements (OPR)

- A written document that details the goals, concepts and criteria are determined by the owner to be important to the success of the project. The portion of the OPR that relates to the Building Enclosure is a “living document” for the BECx process and outlines the objectives upon which the Pre-Design, Design and Construction phases are evaluated.

NIBS Guideline 3

- The ASTM E2813 Manual of Practice for Building Enclosure Commissioning provides a detailed Annex for development of the OPR.
- The OPR is intended to be developed by the designer in conjunction with the owner and technical assistance from the BECxP and is the basis for the BECx process in ensuring the requirements of the OPR are achieved.

BECx Commissioning Plan

- A document that outlines the scope, organization, schedule, allocation of resources, responsibilities, testing and documentation requirements of the building enclosure commissioning process to meet the OPR.

ASTM E2948-16a

- The BECx plan outlines the process to meet the OPR.
- The plan should be appropriate for the size and scale of the project for which it was created and after review and acceptance by the project stakeholders, it should be updated throughout the project to reflect and document any changes as they occur.

Basis of Design (BOD)

A document that bridges the objectives conveyed in the OPR and contract documents. It records through narrative the technical concepts, performance assumptions, decisions and products selections the requirements of the OPR and authorities having jurisdiction.

NIBS Guideline 3

Should include

- Specific codes, standards, guidelines and designer interpretation in meeting OPR objectives
- Design conditions
- Thermal performance requirements and path to having been met per OPR
- Sustainability, LEED, etc.
- Performance criteria for each building enclosure assembly and how part of system to meet the OPR

Design Review

ASTM E2947 and the NIBS Guideline 3 indicate that a knowledgeable and competent person should provide design review.

The Building Enclosure specialist(s) should have expertise in roofing, cladding, structural, glazing and fenestrations, air barriers, building science, thermal enclosures, and construction depending on the specific project requirements.

BECx can include the building enclosure specialist, or they can be part of the design team and BECx can take a verification approach

Technical Review,
refine details

Review
interaction
between systems

Review
specifications

Refine
Commissioning
Plan

Review cost
estimates and
budget

Draft BECx
Specifications

Document
process

Design Review

As part of review, BECx specialist must understand design requirements

- Geotechnical
- Climate Zones
- Local weather, precipitation , wind loads

- Analysis can require
 - Hygrothermal Modelling
 - Computation fluid dynamics
 - Heat transfer simulation

- Constructability Review
 - Pencil test
 - Constructability comments
- Perform reviews at
 - Schematic Design
 - Design Development 50% & 90%

Design responsibility remains with Architect of Record. BECx comments are intended for information & consideration as part of commissioning process.

Testing

Who is carrying out testing?

- BECxP carrying out testing and reporting
- CM or GC carries out testing, BECxP witnesses

Considerations

- How much will the testing Cost \$\$\$
- Who pays for testing?

- What to Test?
- Where to Test?
- When to Test?
- Quantity to Test?
- Size to Test?
- Diagnosis of failure and repair?
- Standard for Test?
- Performance level for Test?

**ENSURE
TARGETED TO
MEET OPR**

Testing

Pre-Construction Testing – Manufacturer Test Reports

Laboratory Mock-up Testing

Field Mock-up Testing

Field First Install Testing

Field Testing during construction

Testing

Air Infiltration

Water Penetration

Water Absorption

Condensation

Thermal Performance

Structural Loading

Acoustics

Adhesion

Whole Building Air Tightness

Testing

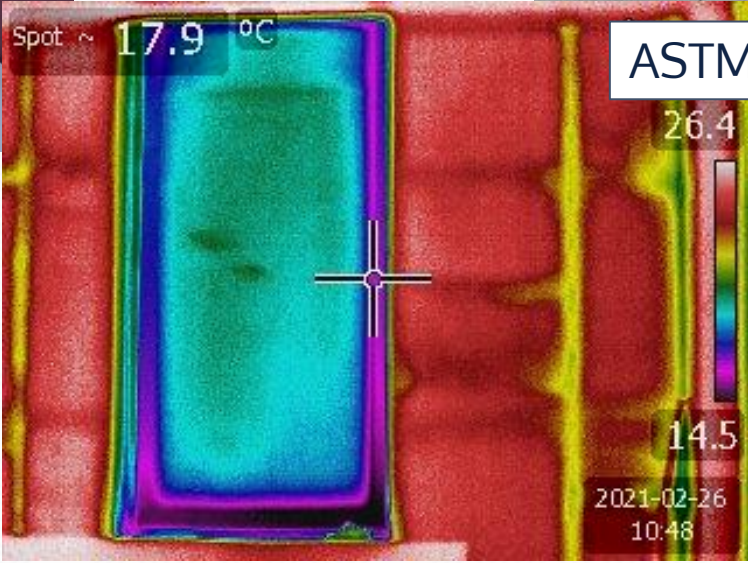
ASTM E1186



ASTM D7877



ASTM E783 & E1105



ASTM C1060

Typical Façade Lab Testing

- **ASTM E283** Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
- **ASTME E331** Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Unifor Static Air Difference
- **ASTM E330** Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
- **ASTM E547** Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Cyclic Air Pressure Differential
- **AAMA 501.1** Standard Test Method for Dynamic Pressure Water Infiltration
- **ASTM E1233** Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Cyclic Air Pressure Differential
- **ASTM C1199** Standard Test Method for Measuring the Steady State Thermal Transmittance of Fenestration Systems Using Hot Box Methods
- **ASTM C1363** Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus
- **AAMA 1503** Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
- **AAMA 507** Thermal Performance Characteristics of Fenestration Systems
- **AAMA 508** Resistance to Water penetration for Pressure Equalized Rain Screen Wall Cladding System

Typical Façade Field Testing

- **ASTM E783** Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
- **ASTM E1105** Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference
- **AAMA 501.1** Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure
- **AAMA 501.2** Quality Assurance and Water Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems
- **AAMA 502** Field Testing of Newly Installed Fenestration Products
- **AAMA 503** Field Testing of Newly Installed Storefronts, Curtain Walls, and Sloped Glazing Systems
- **ASTM C1521** Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints

Construction Phase

- **Review of**
 - Submittal
 - Shop Drawing
 - RFI's
 - Installation checklists
 - Any 3rd party testing reports
- Meet design contract document requirements
- Meet performance and OPR objectives
- Document and track to become part of BECx record
- Input any concerns in Issues & Resolutions Log

Quality Assurance Review

Site review for observation purposes. The AOR is responsible for addressing alterations, site instructions.

BECx field review to provide observations and documentation of construction progress. Any issues or concerns are documented, but not communicated to the trade.

Occupancy Phase

- Review BECx Close-out report
- Train maintenance and operation staff
 - Ensure operators understand building operations and how maintenance operations impact building performance
- Inform Owner on proper building maintenance requirements
- Warranty review prior to 12-month end of warranty period
- Review current facility requirements



Commissioning is not...

- A simple template to be applied to any project
- A replacement for good design
- A series of checklists and templates
- A way to just fulfill LEED requirements
- A process to be undertaken by people without the appropriate level of expertise

BECx Value – Risk Management



Manage/Reduce Risk



Verify systems function prior to installation

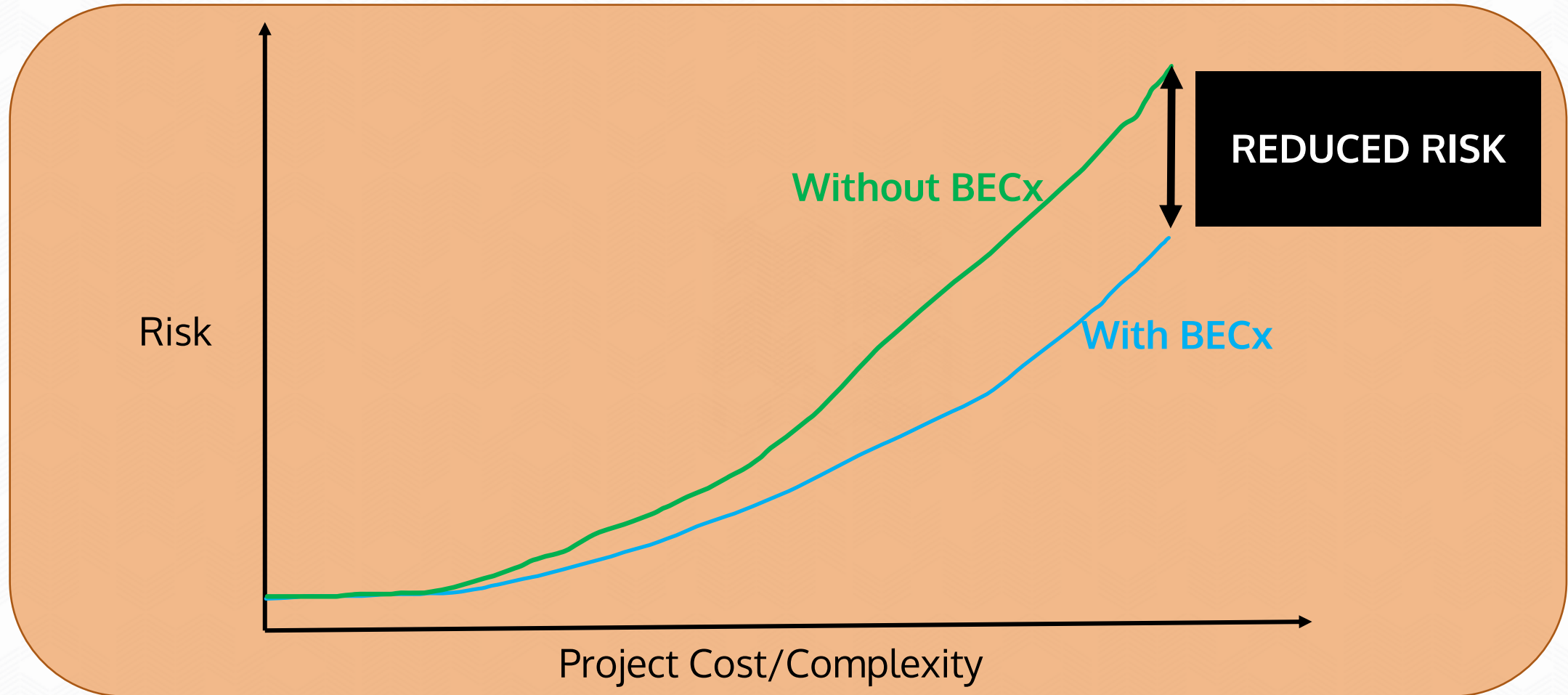


Validate Energy Efficiency claims

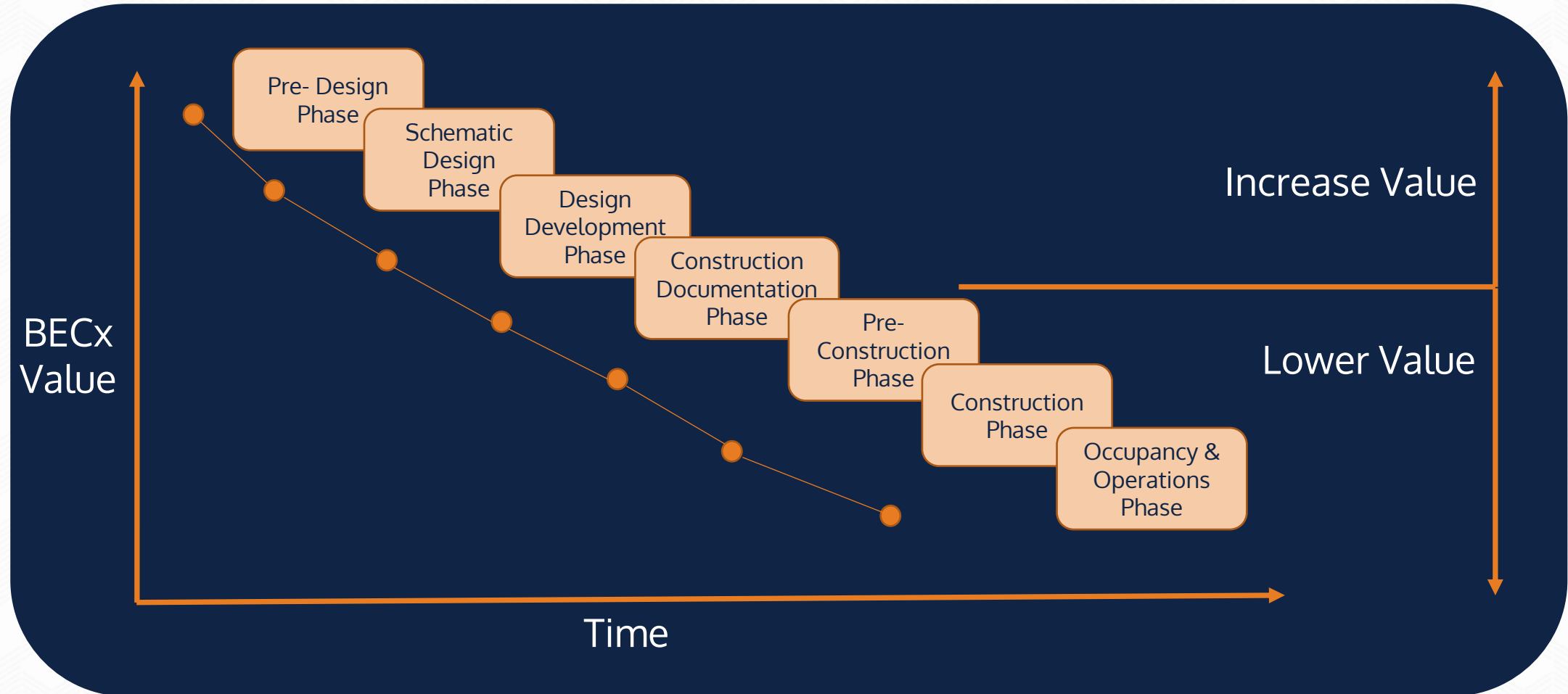


Improve Building Enclosure Longevity

BECx Value – Risk Management



Value of BECx-Process





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