RAYMOND
SINCE 1992

PUSHING THE ENVELOPE

An Introduction to Building Envelope Commissioning | BE113

Guido X. Salas, *Vice President*
Rupesh Gulati, *Director of Building Envelope*
Raymond Engineering-Georgia, Inc.
401104237
March 2024

CONTINUING EDUCATION AIA

RAYMOND PRESENTORS

Guido X. Salas, RRC, RRO, Associate AIA
Regional Vice President

Rupesh K. Gulati, RBEC, AIA, RRC, LEED AP, NCARB, CxA+BE, BECxP
Director of Building Envelope

TEAM HIGHLIGHTS

- ✓ 50+ years building envelope experience
- ✓ Licensed Professional Engineers and Registered Architects
- ✓ Certified Building Envelope Credentials through the International Institute of Building Envelope Consultants (IIBEC)
- ✓ Experienced with **Building Envelope Commissioning, Testing,** Building Codes, FMG & ASTM Standards

This course will meet the following learning objectives.

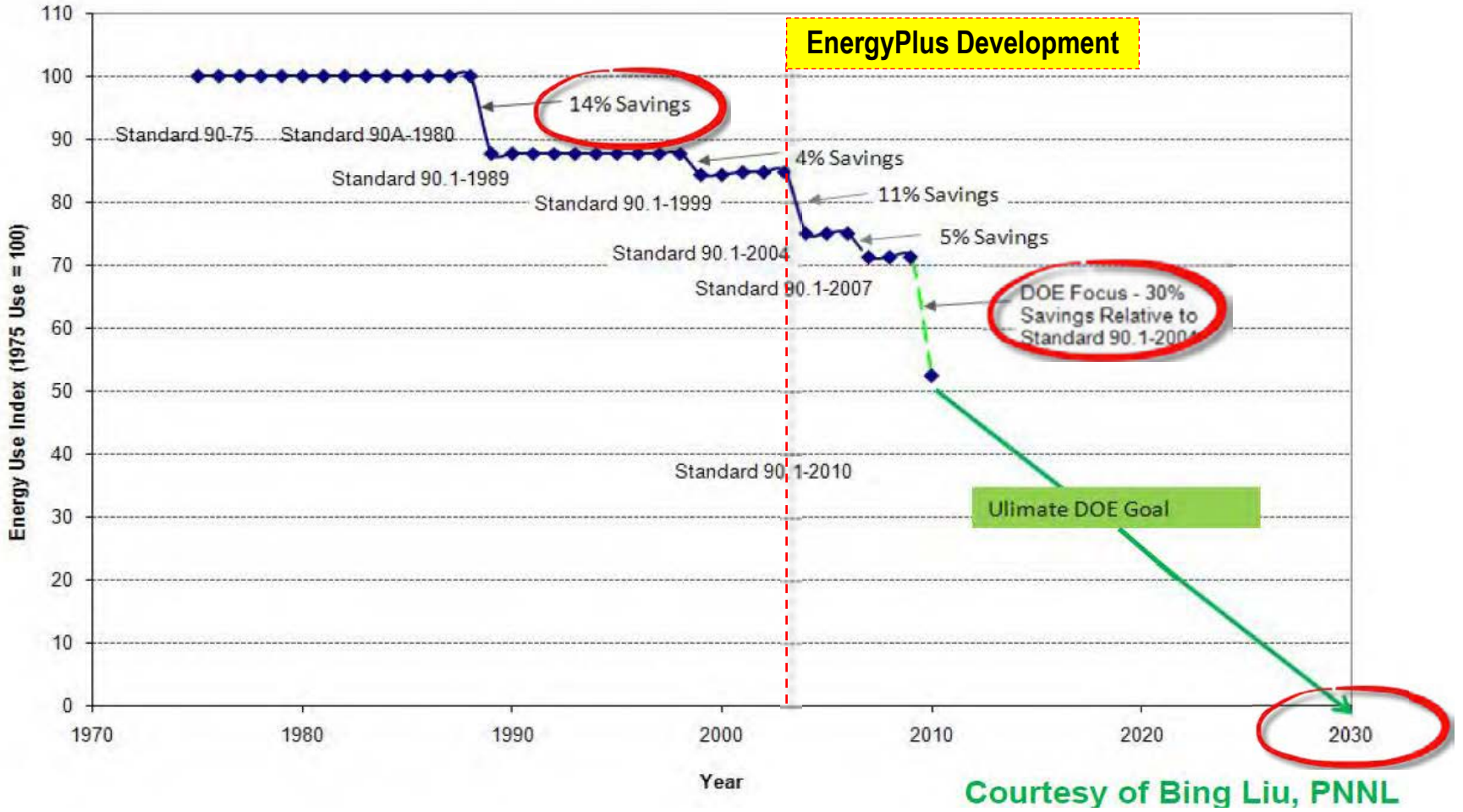
- **Learning Objective 1:** Understand how the Building Envelope impacts the overall building performance and potential impacts of poor design and construction
- **Learning Objective 2:** Discuss the foundational technical standards for performing building envelope commissioning
- **Learning Objective 3:** Review of key best practices and considerations when engaging a building envelope consultant and performing BECx services
- **Learning Objective 4:** Overview of the building performance improvements that can be gained

What is triggering Commissioning of Building Envelope?

Energy Code Evolution

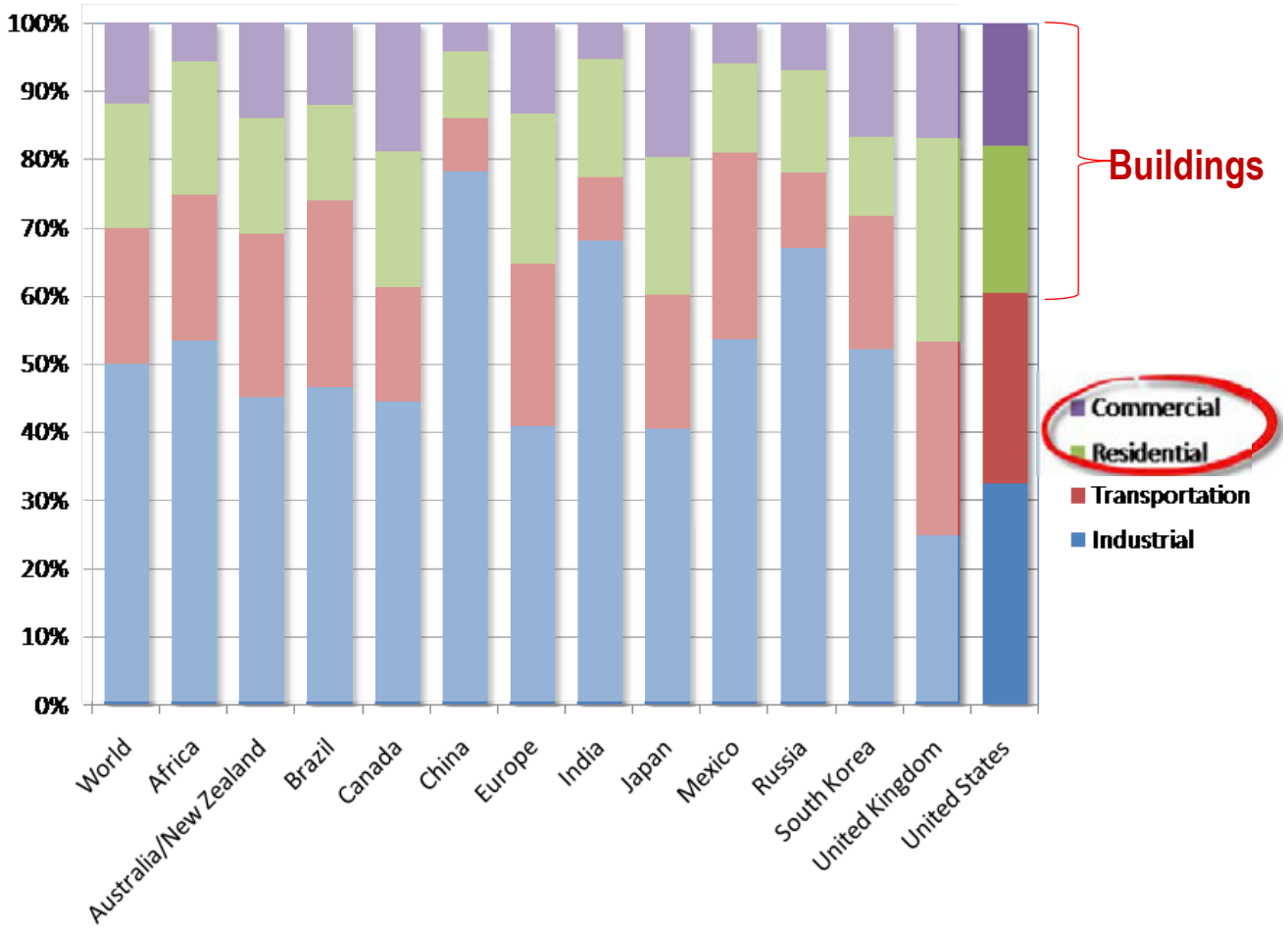
Durability

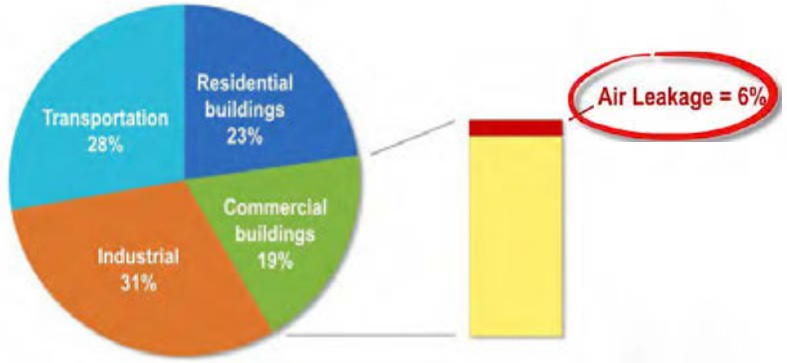
Development of Energy Standards



Courtesy of Bing Liu, PNNL

Building Energy Use - Global





Source: *Windows and Building Envelope R&D: Roadmap for Emerging Technologies, U.S. DOE Building Technologies Office, Feb. 2014*

Energy Code Evolution

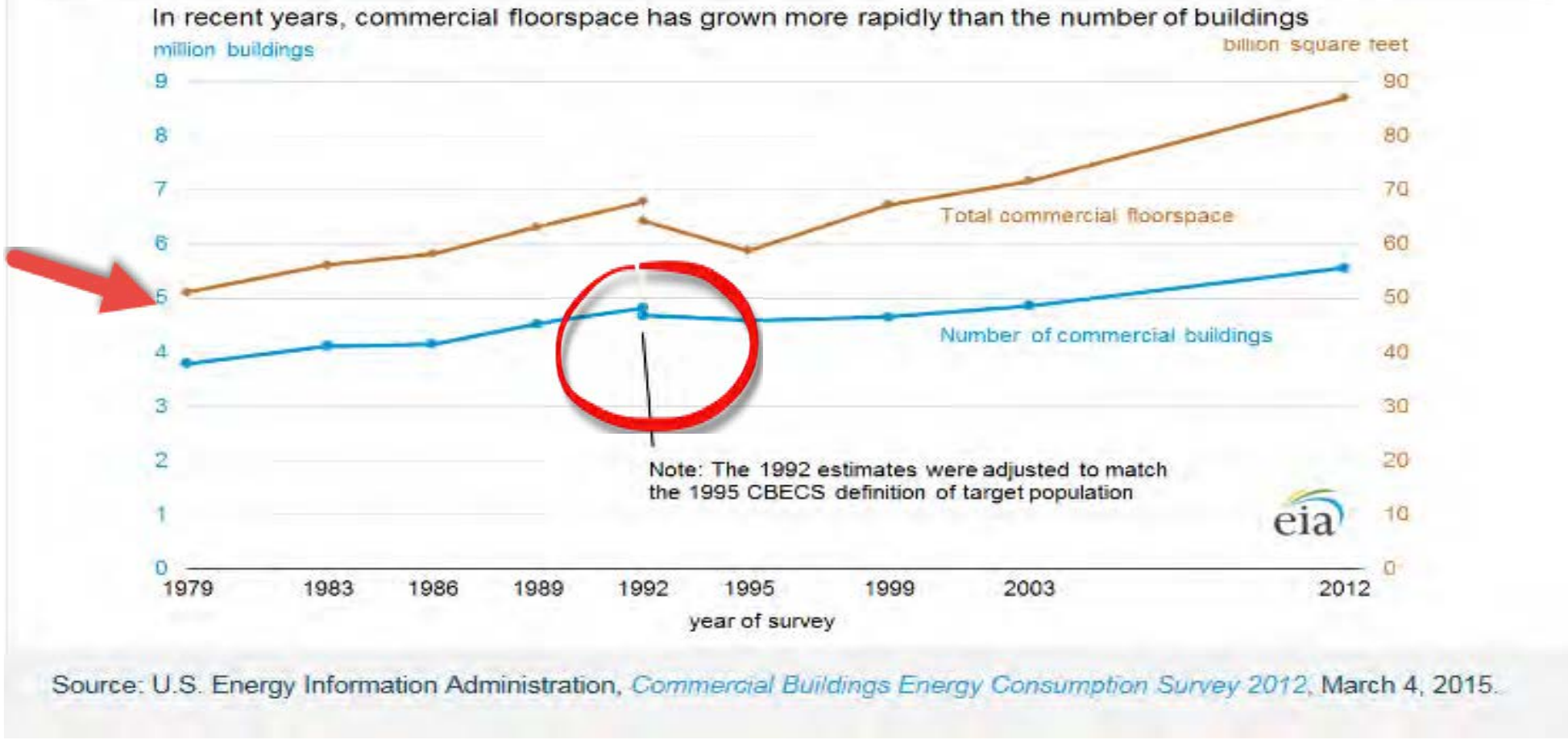
About 50% of the heating load in residential buildings and 60% in commercial buildings results from flows through walls, foundations, and the roof

	Residential		Commercial	
Building component	Heating	Cooling	Heating	Cooling
Roofs	1.00	0.49	0.88	0.05
Walls	1.54	0.34	1.48	-0.03
Foundation	1.17	-0.22	0.79	-0.21
Infiltration	2.26	0.59	1.29	-0.15
Windows (conduction)	2.06	0.03	1.60	-0.30
Windows (solar heat gain)	-0.66	1.14	-0.97	1.38

Source: QUADRENNIAL TECHNOLOGY REVIEW. DOE: AN ASSESSMENT OF ENERGY TECHNOLOGIES AND RESEARCH OPPORTUNITIES. September 2015

Energy Code Evolution

A Look at the U.S. Commercial Building Stock: Results from EIA's 2012 CBECS ›

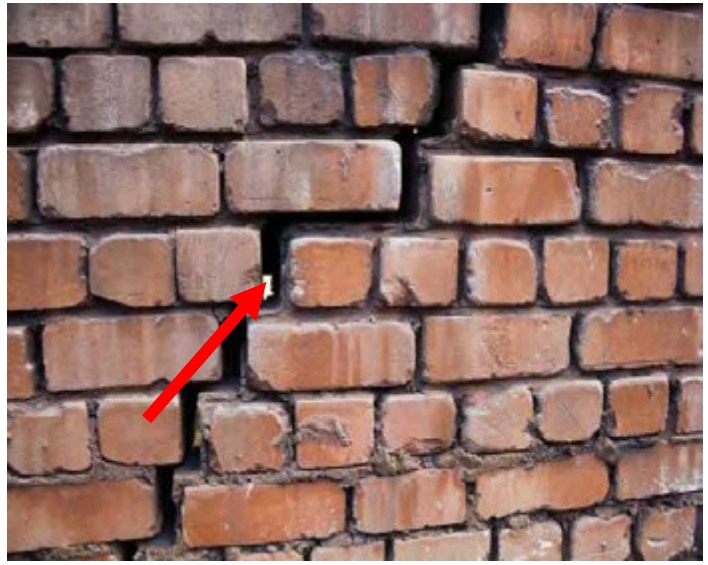


Source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey 2012*, March 4, 2015.

Durability - Common Building Envelope Problems

- Lack of understanding of air, water and thermal barrier within building enclosure i.e., walls, roofs, below grade
- Relying on a single rainwater barrier for building enclosure;
- New untested building materials and assemblies;
- Lack of technical understanding of moisture intrusion mechanisms; flashings
- Lack of understanding of inter-relationship of building enclosure with HVAC systems; positive pressure vs. negative pressure
- Lack of modeling of enclosure assemblies/review/testing/ and
- Lack of defined expectation of the building's performance regarding the selection of materials and details.

What Failure Looks Like



The Impacts

- Poor heating /cooling efficiency
- Higher energy use
  Potential health hazard (e.g. mold)
- Damaged or discolored aesthetics
- Water infiltration
- Structural degradation
  Building system failure

When construction finishes, the Owner *hopes* the facility is setup for long-term success…

40% OF ALL ISSUES DUE TO WATER INFILTRATION

70% CONSTRUCTION LITIGATION DUE TO WATER INTRUSION

60-70% DUE TO CONSTRUCTION AND INSTALLATION

https://www.architectmagazine.com/technology/when-it-leaks-it-pours_o
https://www.e-architect.com/articles/water-damage-from-leaks-construction-lawsuits

Durability – CONTROL LAYERS of Building Envelope

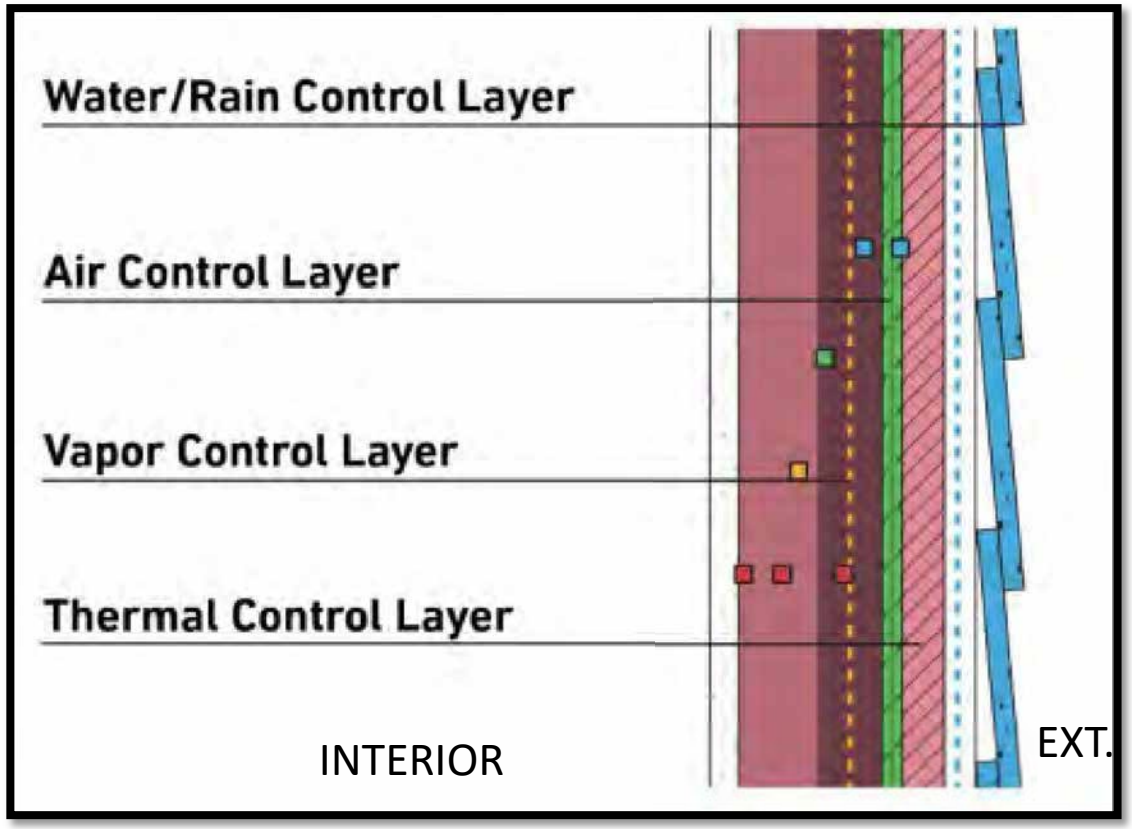


Image Source: Georgia Pacific

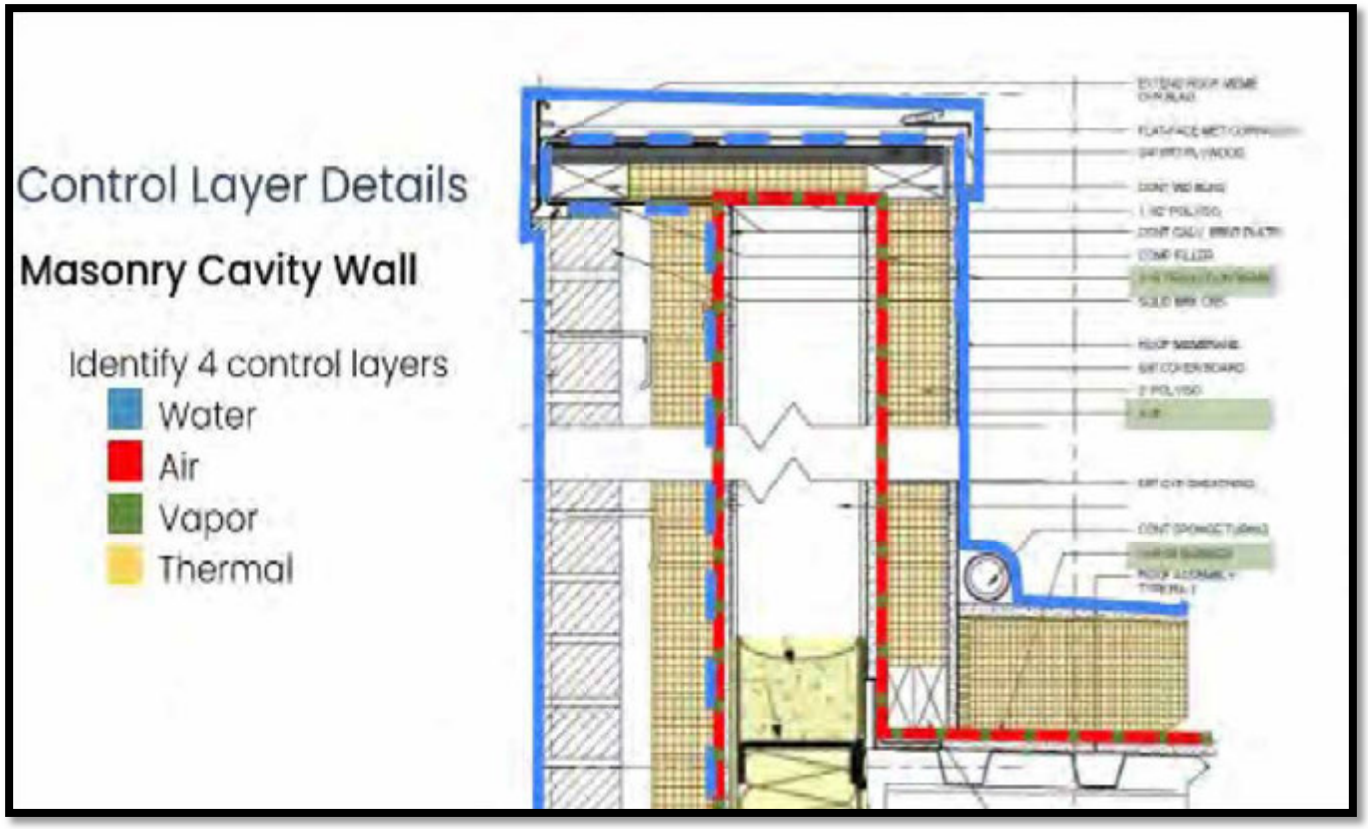


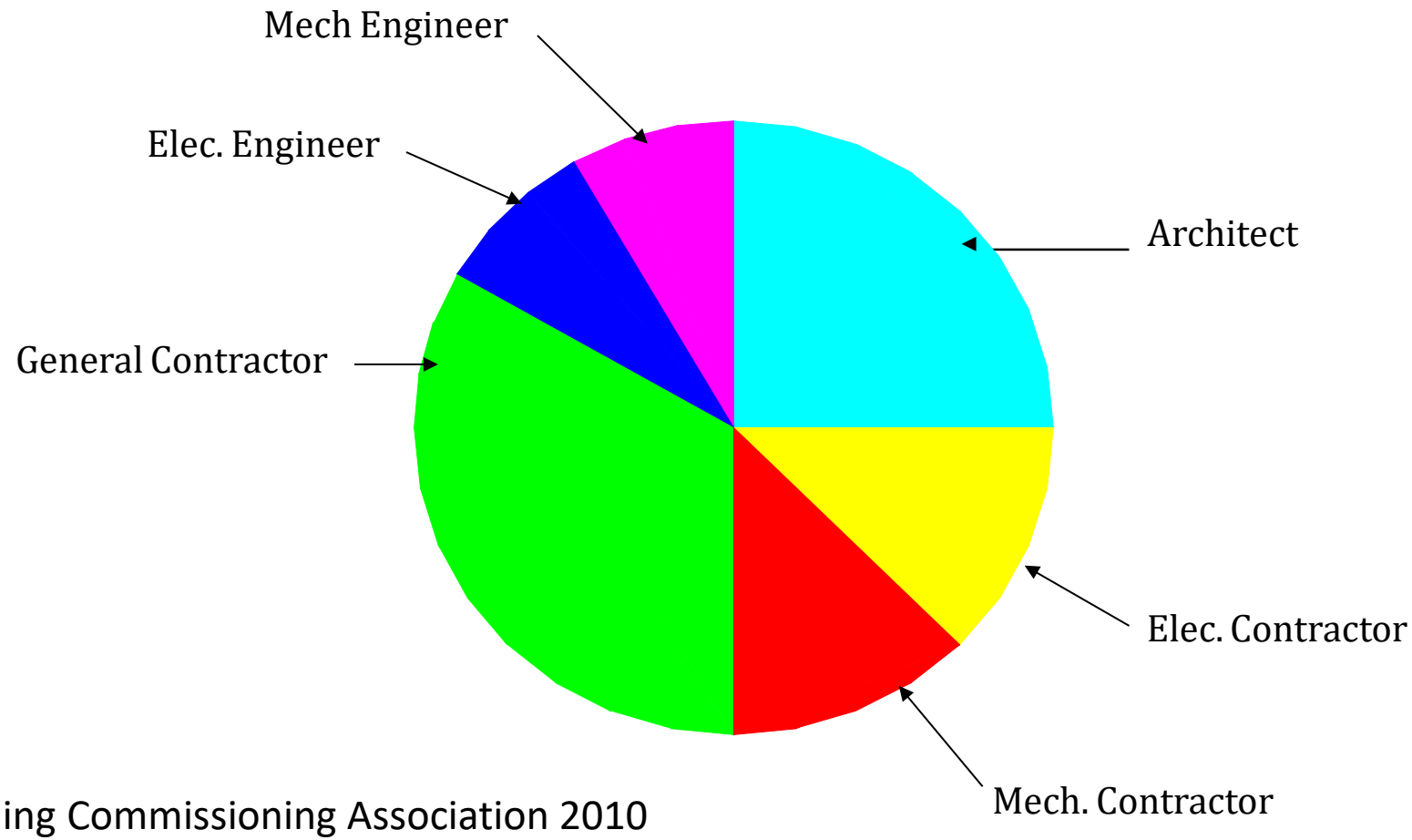
Image Source: Siplast

Air Barrier – Control Layers Of Building Envelope

Air barriers are well-known technologies for achieving airtightness for the building envelope. According to the Department of Energy (DOE) and National Response Coordination Center (NRCC), uncontrolled air movement through the building envelope (infiltration and exfiltration) can account for up to 50 percent of heating loads and a significant part of cooling loads, representing as much as 30 percent of a building's annual HVAC costs.

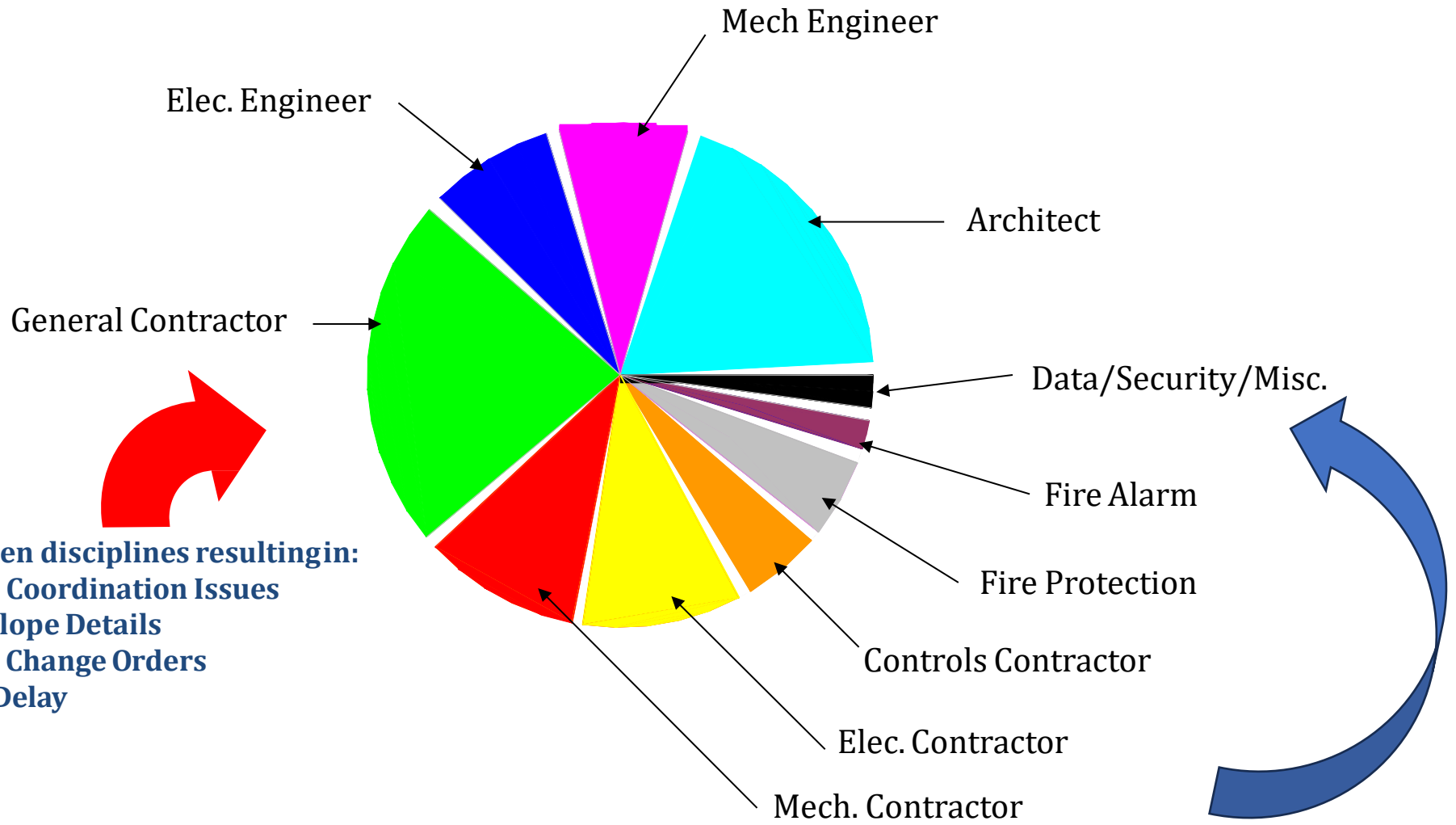
Source: IECC 2015, C402.5.1

Typical Project Team Configuration Up to the Mid 1970's



Source: Building Commissioning Association 2010

Typical Project Team Configuration after the Mid 1970's



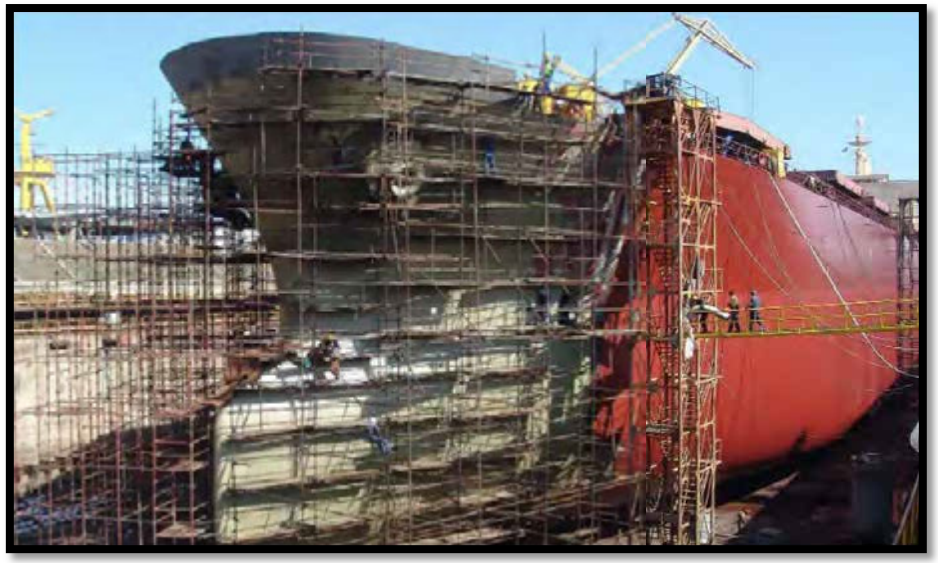
Gaps between disciplines resulting in:

- **Discipline Coordination Issues**
- **Poor Envelope Details**
- **Expensive Change Orders**
- **Schedule Delay**

What is Commissioning?

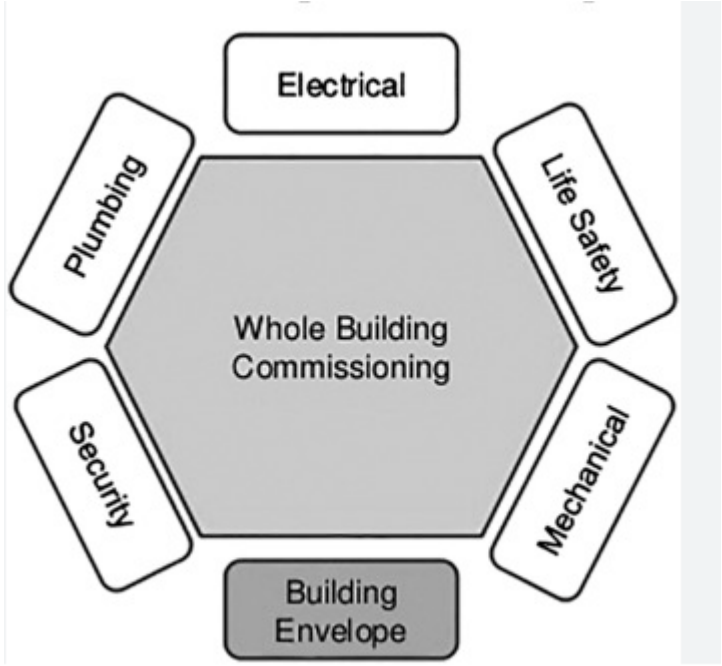
It is an ongoing *process* ideally spanning from predesign stage, design, construction, occupancy and beyond)

It is not an Event/ Specific Task/ Testing Event



What is Commissioning?

Total Commissioning



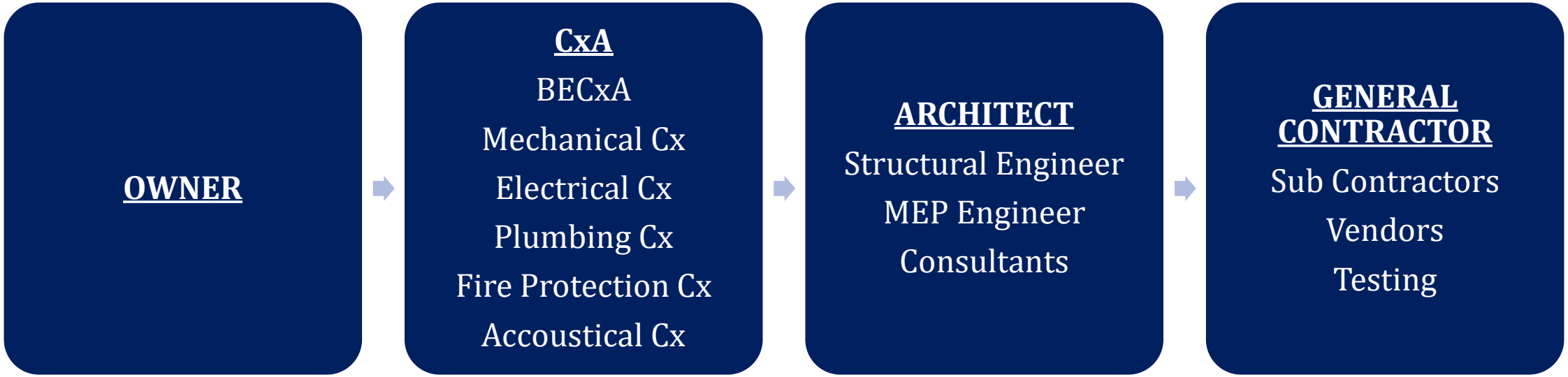
Source: Science Direct

Individual commissioning

- ✓ Emergency Power
- ✓ Lighting
- ✓ Building Automation
- ✓ Fire Alarm
- ✓ Security
- ✓ **Building Envelope**
- ✓ Air Distribution
- ✓ Renewable Energy

- ✓ Chilled Water
- ✓ Heating Hot Water
- ✓ Steam
- ✓ Ventilation
- ✓ Plumbing
- ✓ Fire Protection
- ✓ Electrical Distribution

Commissioning Team



NOTE:

- **CxA (Commission Agent/Authority) is engaged to Owner**
- **BECxA (Building Envelope Commission Agent) and other Cx Agents are engaged to CxA**
- **BECxA is different than MEP Cx**

"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."

NIBS Guideline 3-2012

Commissioning Process (Cx Process): A quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements.

ASHRAE Guideline 0-2013 Definition

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."

Commissioning Process

Building Enclosure Commissioning (BECx): ASTM E2947: architecture or engineering-related technical services or both, performed on behalf of the Owner that implements a quality-focused process for enhancing the delivery of a project by focusing on validating during the design phase and verifying during the construction phase that the performance of building enclosure materials, components, assemblies and systems are designed and installed to meet the Owner's Project Requirements

Building Enclosure Commissioning Plan (BECx plan): ASTM E2947: 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. The BECx plan may be a portion of the whole building Cx plan.

Building Enclosure Commissioning Provider (BECxP): ASTM E2947- a duly authorized person or firm in the jurisdiction of the project retained by the Owner to develop, manage, and be in responsible charge of the BECx process.

EXAMPLE of BECx OPR- RETROFITTING EXISTING 6 STORY FACADE

Major building systems for new construction, including structural and the building envelope, will be commissioned by an independent consultant, with whom the A/E shall plan and coordinate its efforts.

Wherever possible, the project should seek to develop a high-performance building envelope. It is mandatory that the design team has experience in modifying existing building envelopes to bring them to high-performance standards. This includes a systematic approach that improves infiltration/exfiltration rates, increases building R-value, reduces thermal bridging, utilizes thermal mass, and improves durability as well as interior thermal comfort.

H. BUILDING ENVELOPE

The exterior shall be designed to endure for at least 75 years. Selection of materials and detailing of envelope systems shall be consistent with the Florida Building Code and [redacted] Design & Construction Standards; performance-based to allow the building to withstand weather conditions typical of North Central Florida; and esthetically consistent with the area of campus where the facility will be constructed.

Prevention of moisture intrusion is a high-priority goal applicable to all project team disciplines.

History of Commissioning

1982

- ASHRAE begins with Commissioning guidelines

1989

- First ASHRAE Guidelines on Commissioning Mechanical systems

2005

- ASHRAE Guideline 0, The Commissioning Process

2006

- NIBS Guideline 3, Exterior Enclosure Technical Requirements for the Commissioning Process

2011

- California Green Building Standard Code , including Commissioning codified in to Title 24

2012

- ASTM E2813, Standard Practice for Building Enclosure Commissioning (BECx)

2012

- ASTM/NIBS Memorandum of Agreement on Building Enclosure Commissioning

2012

- NIBS Guidelines 3, Building Enclosure Commissioning Process

2013

- ASHRAE Standard 202, The Commissioning Process for Buildings and Systems (Joins ASHRAE GL-0)

History of Commissioning

2014

- ASTM Standard Guide for Building Enclosure Commissioning (Replaces NIBS GL-3)

2015-Present

- ASTM/NIBS BECx Certification and Training Program

2018

- ASTM E2813-18, Revision to Standard Practice for Building Enclosure Commissioning

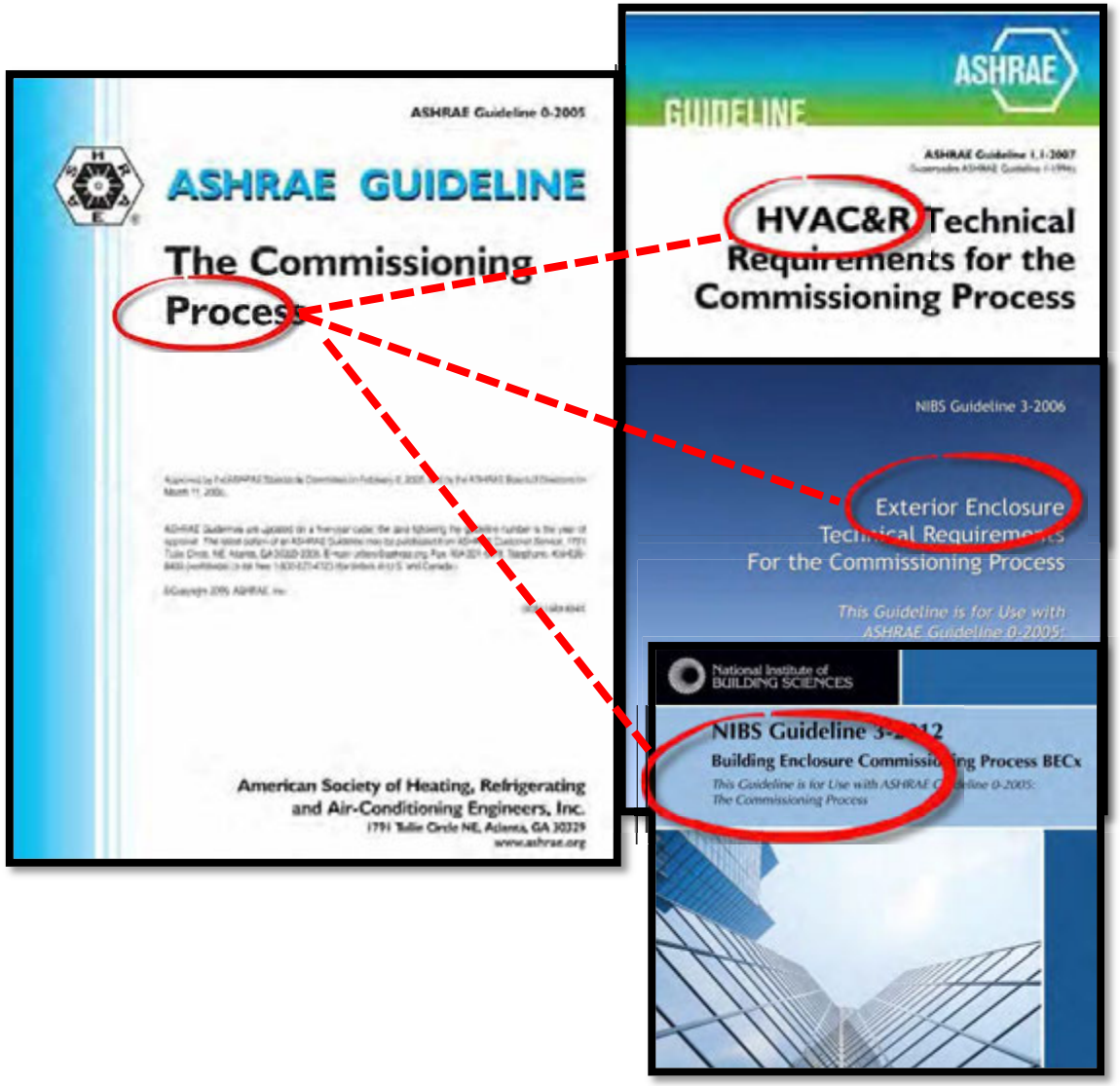
2019

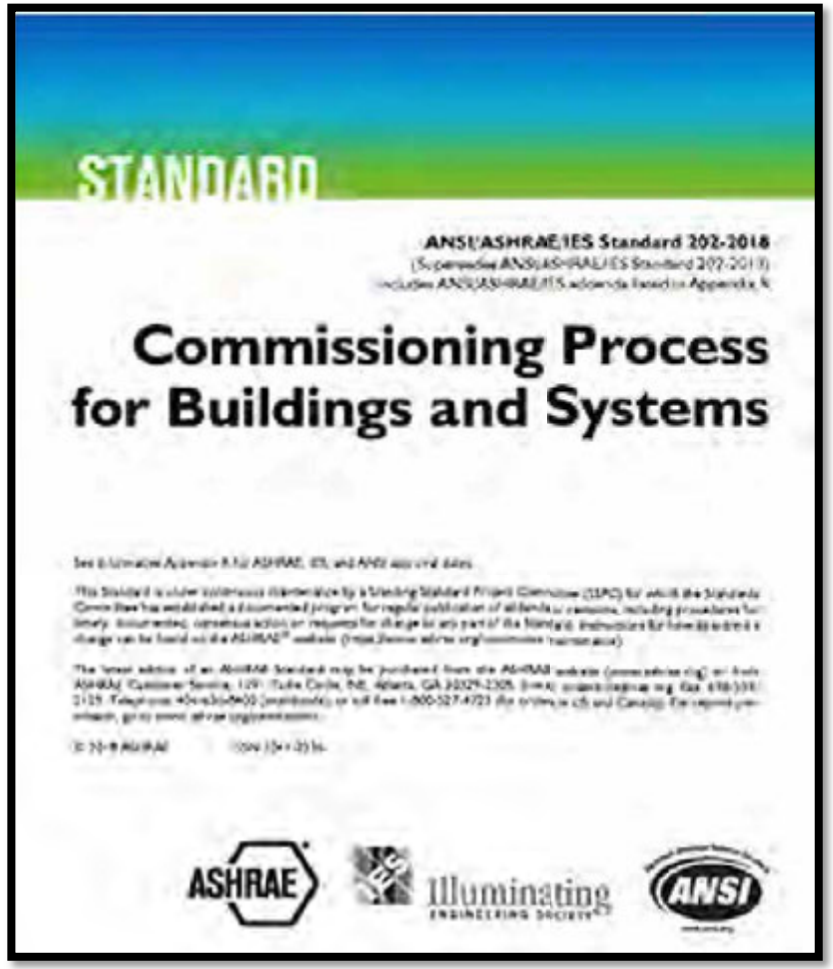
- ISO 21105-Building Envelope Performance Verification and Commissioning Program

2021

- ASTM E2947-21a, Standard Guide for Building Enclosure Commissioning

History of Commissioning

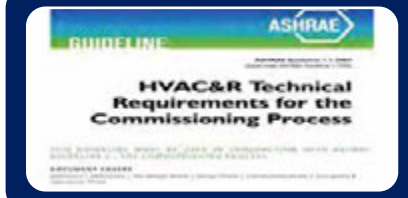




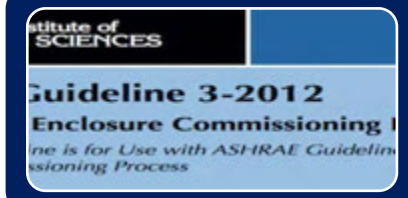
To recap…

ASHRAE Guideline 0

Defines process- for any system or discipline



ASHRAE Guideline 1.1 How to apply process to HVAC&R



NIBS Guideline 3 How to apply the process to building enclosure elements 6 sides i.e. Walls , Roofs, Fenestration

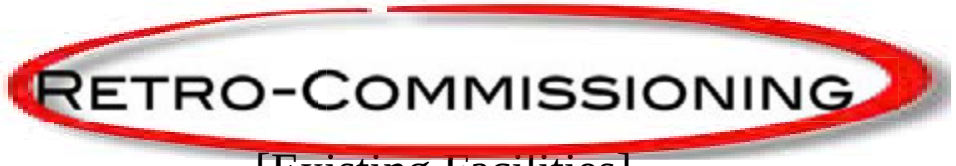
ASTM E2813, ASTM2947

New vs. Existing

While the overall concept and process is the same, there are slight differences when applying commissioning to new construction vs. existing building projects

[New Construction]

Project commissioning is the process of assuring that all systems and components of a building or industrial plant are designed, installed, tested, operated, and maintained according to the operational requirements of the owner or final client.



[Existing Facilities]

A systematic process to improve an existing building's performance. Using a whole-building systems approach, retro-commissioning seeks to identify operational improvements that will increase occupant comfort and save energy.

A key difference is that retro-commissioning is seeking to solve existing problems, while new construction commissioning is more similar to ensuring construction

Both processes need the commissioning third-party to be involved starting during design

Achieving BECx PROCESS

PREDESIGN

- OPR
- Basis of Design

DESIGN REVIEW

- Control Heat, Air , Vapor Flow
- Control Bulk Water Penetration
- Control Light and Solar Radiation

CONSTRUCTION PHASE

- Submittals review,
- Monitor and Verify Construction
- Test and Verify Installed Assemblies
- Systems Manual
- Training

POST OCCUPANCY

- 10th Month Warranty Inspection
- Interview Occupants
- Resolve Outstanding Cx Issues

Commissioning Process

PRE- DESIGN

- Cx Agent is Selected
- OPR is initiated
- Cx Meeting
- Initiate Cx Plan, Plan will Outline BECx role

DESIGN

- Develop Cx Plan, Update OPR
- Cx Meeting
- BECx Design & Specification Review
- Update Cx Plan
- Develop Verification checklists
- Develop Functional tests
- Systems Manual Outline
- Training requirements

CONSTRUCTION

- Kick-Off Meeting w/ Contractor, Subs, Owner, Cx
- Review submittals & coordination drawings
- Review O&M Manuals
- Observations
- Verification checks
- Diagnostic monitoring
- Functional testing
- OPR Update, Cx Report
- Systems Manual
- Training of Facilities Personnel

OCCUPANCY/ OPERATIONAL

- Resolve all Cx issues
- Perform seasonal testing
- Perform near warranty- end review
- OPR Review, Prepare Final Cx Report

Commissioning Process

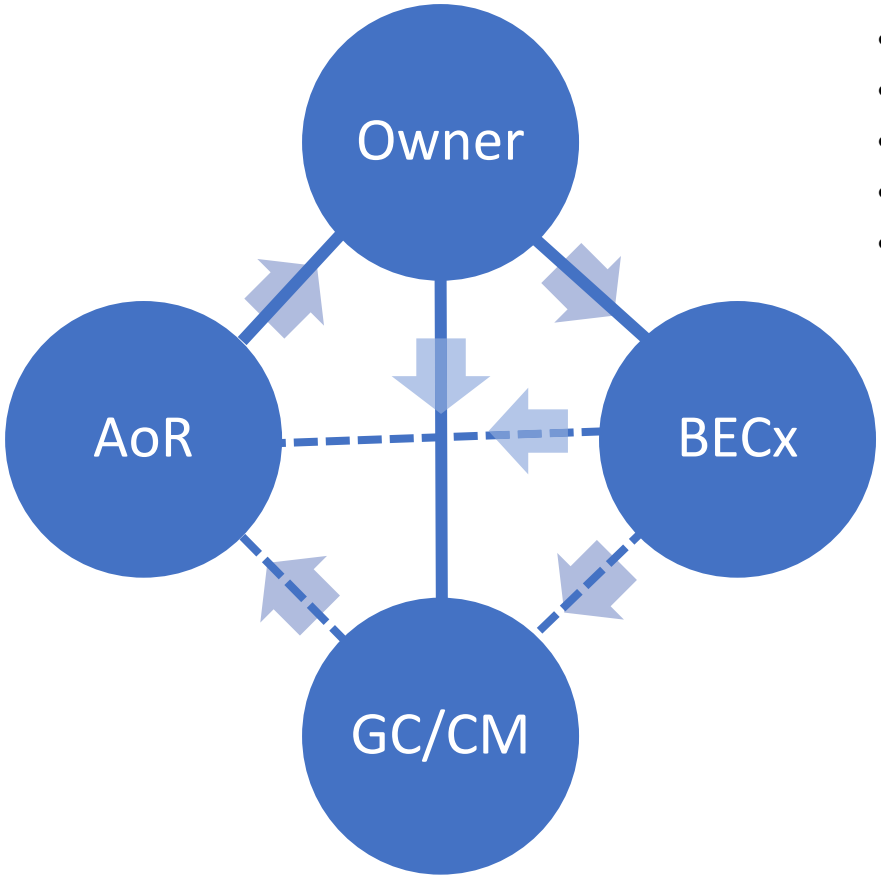
Owners Project Requirements

"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

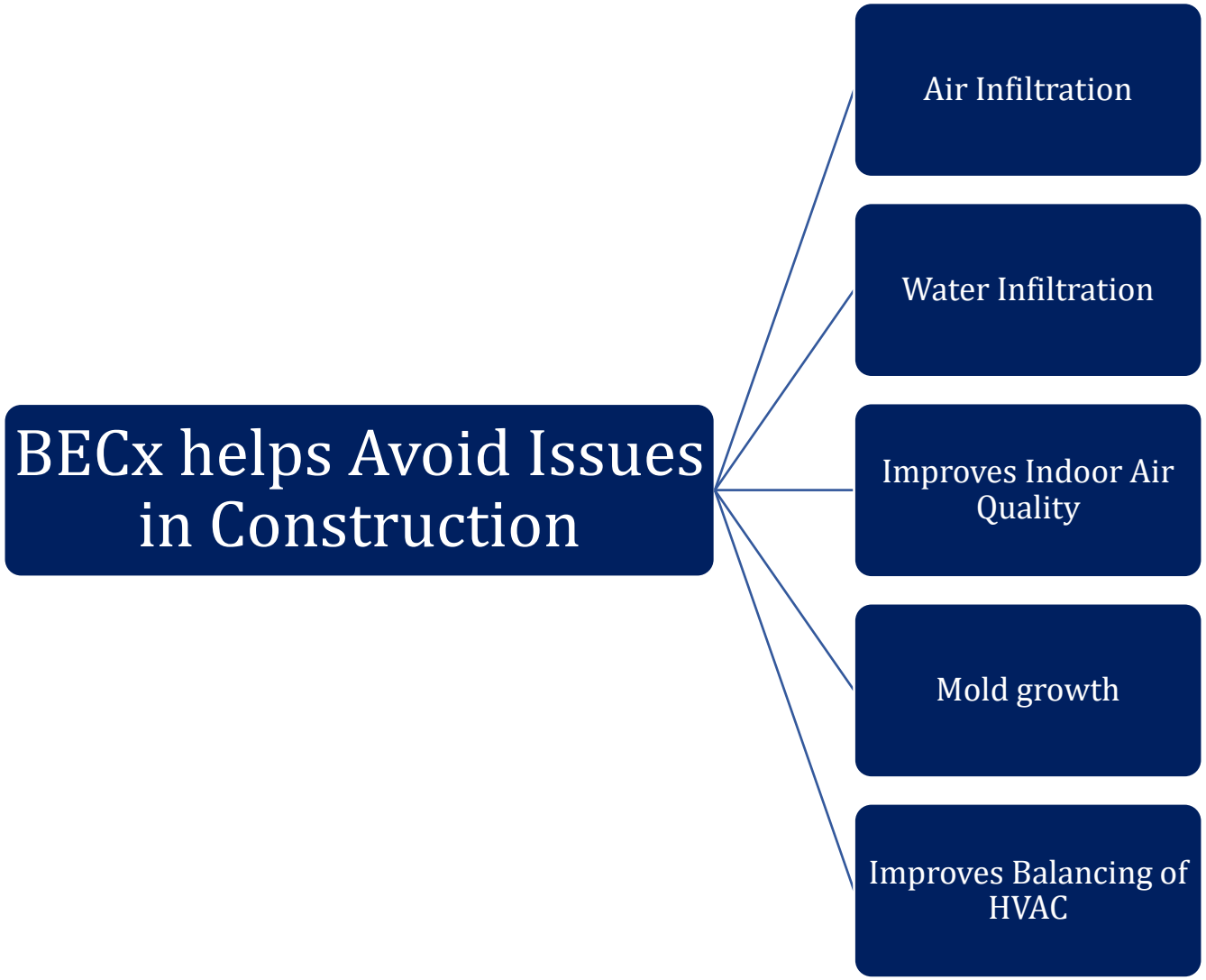
BECx PLAN



OUTLINES:

- Design Review Process
- Communication Method
- Documenting Issues
- BECx Resolution
- Training of Facility
- Contact Information of Team

Commissioning Process



Long Term Benefits

- *Improved building durability*
- *Improved building performance*
- *Confirmation that the design intent has been achieved*
- *Education of building operators*

- *Elevated QA awareness*
- *Clear definition of roles and responsibilities*
- *Clear Owner Project Requirements and project priorities leading to improved decision making*

- *BECx can provide a 2-credit point option under LEED v4 or a 1-point ID credit under LEED 2009 (Enhanced Cx).*
- *Required for compliance with certain energy codes - such as the 2015 CA adoption of the IECC requiring commissioning of all building systems.*

ASTM E 2813

Identifies Mandatory Design Reviews For Commissioning Projects
Fundamental - (1) Design Review
Enhanced - (3) Design Reviews

Identifies Mandatory Tests For Commissioning Projects
Fundamental
Enhanced

ASTM E2813 Does Not Particularly Specify That Lab Testing Is Required.