



# *Pushing* the Envelope

Opportunities for Building Enclosure  
Commissioning (BECx) in Commercial  
Passive House Projects

9<sup>th</sup> Annual North American  
Passive House Conference

Friday, September 12, 2014  
Baumann Consulting



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speaker

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## Program Description.

This session focuses on how to deliver high-performance enclosures—from detailing requirements to achieving results. This session is intended to discuss approaches to understanding and applying Building Enclosure Commissioning (BECx) to commercial Passive House projects. New requirements for BECx in LEED v4 is expected to significantly impact the growth of these services. This emerging practice area provides both an opportunity for specialization for individuals and service growth for firms. Learn what BECx is, why it's important and how Passive House practitioners can leverage their building science know-how to reposition themselves as leaders in thermal and moisture performance of the built environment.

## Learning Objectives.

1. Articulate three or more strategies employed in BECx to determine performance compliance.
2. Build knowledge of the best-practice tests and standards used during BECx.
3. Understand how to apply BECx principles to your company's current service offerings.
4. Describe the added value of BECx to clients.

objectives

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LUC RENAMBOT ©

bigger projects = bigger (envelope) problems

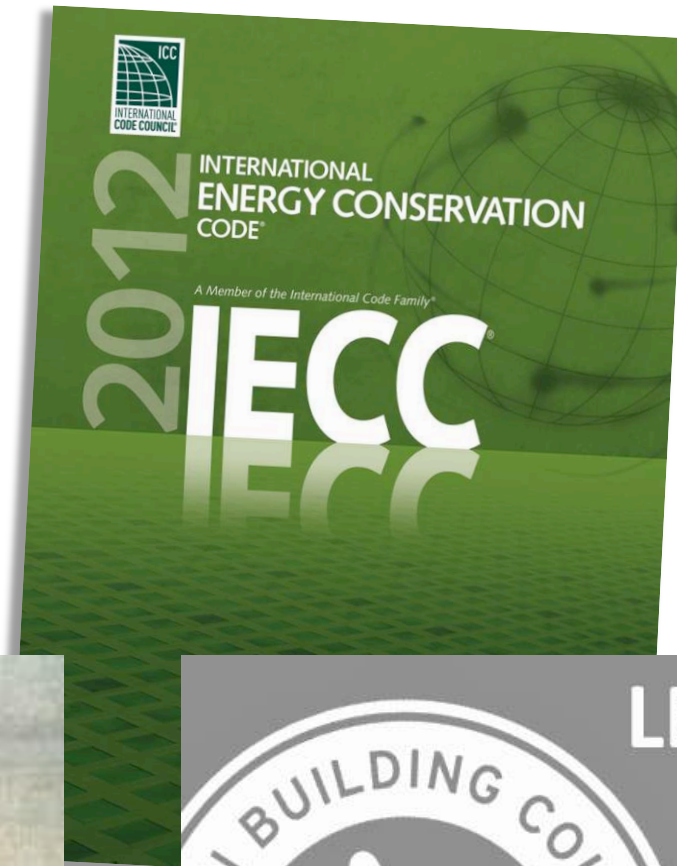
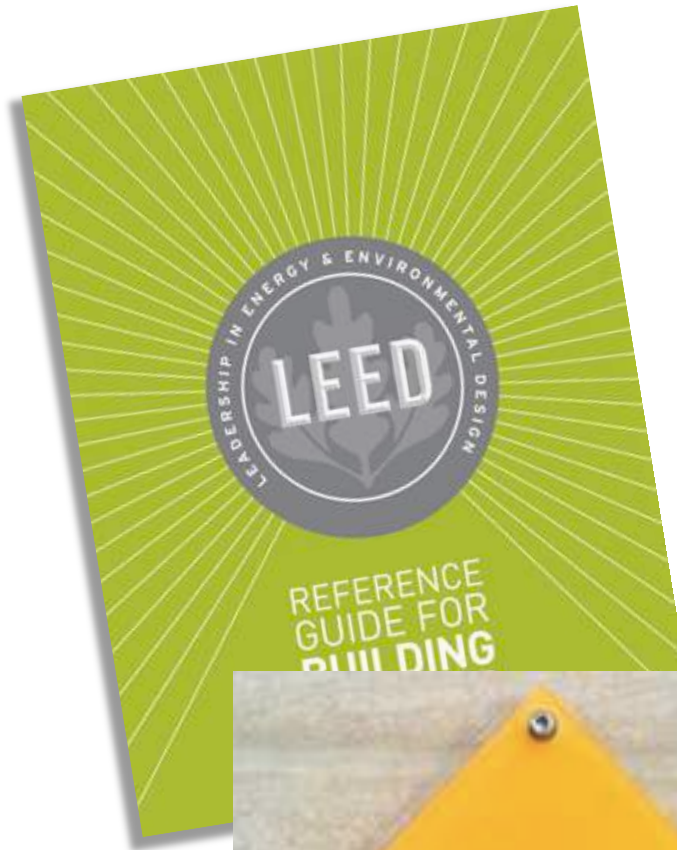
## Passive House Standard

Airtight building envelope  $\leq 0.6$  ACH @ 50 Pascal pressure

Annual heat and/or cooling requirement  $\leq 15$  kWh/m<sup>2</sup>/year (4.75 kBtu/sf/yr)

Primary Energy  $\leq 120$  kWh/m<sup>2</sup>/year (38.1 kBtu/sf/yr)

bigger projects = bigger (envelope) problems



the enclosure is key

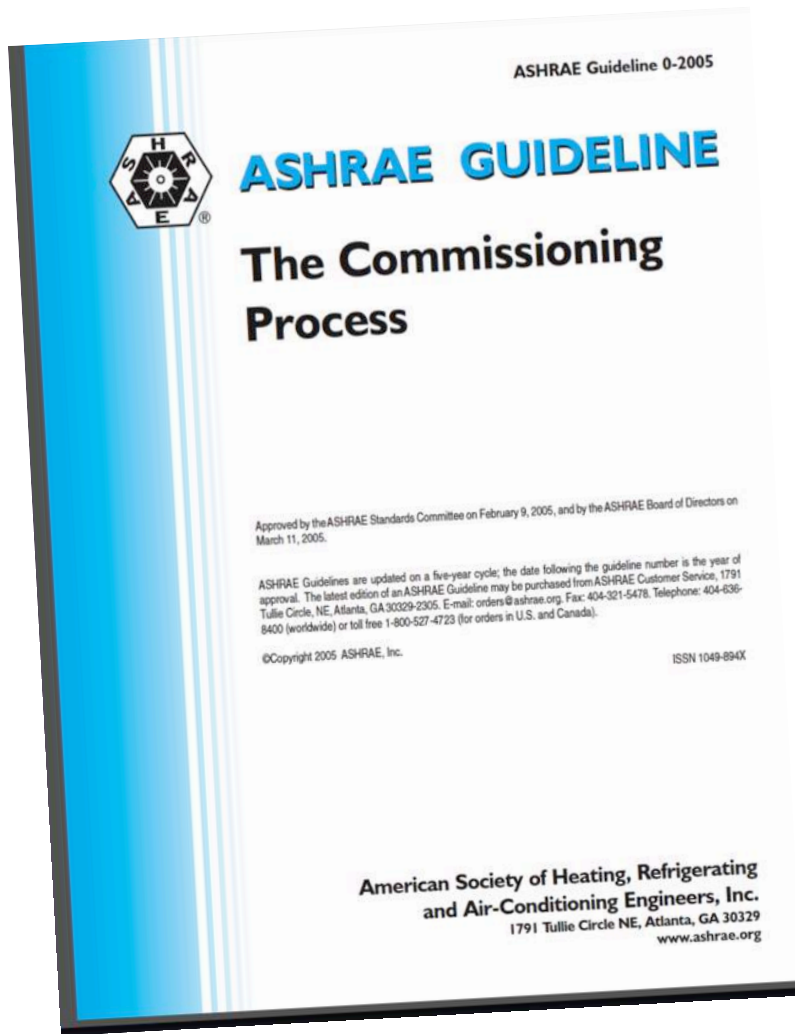
# LEED BD+C: New Construction v4

## Commissioning Requirements



**BAUMANN**  
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Credit	Tasks	Building Systems Cx	Monitoring Based Cx	Building Enclosure Cx
Fundamental Cx EAp (prerequisite)	Cx Plan	●	Not Required	
	OPR/BOD Reviews	●		●
	Design Review	●		●
	Specifications	●		
	Installation & Performance Verification	●		
Enhanced Cx EAac (3-6 points)	Option 1		Option 2	
	Option 1: <u>Path 1</u> (3 pts.)		Option 2 (2 pts.)	
	Submittal Reviews	●	Achieve <u>Path 1</u> & Include Monitoring Based Cx in all the Fundamental & Enhanced Systems Commissioned	Include Building Enclosure Cx in the Fundamental & Enhanced Cx Scope
	Systems Manual	●		
Training	●			



Commissioning Process: “...verifying and documenting that the facility and all of its systems...meet the Owner's Project Requirements.”

- ASHRAE Guideline 0-2005

what the heck is Cx?



# Cx = Documenting Decisions

what the heck is Cx?

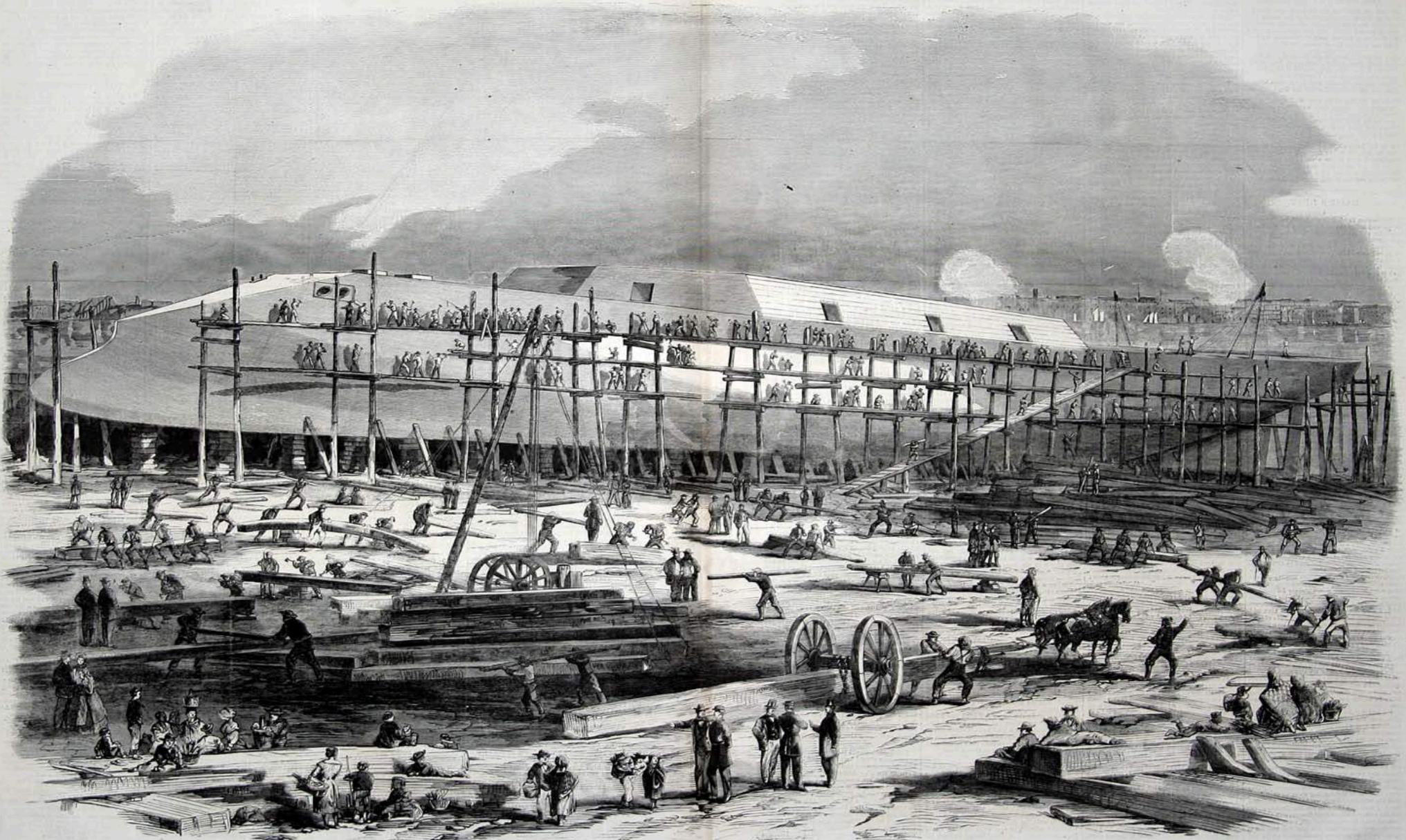
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Cx = Documenting Decisions

Cx = Risk Mitigation

what the heck is Cx?

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THE "DUNDERBERG," THE GREATEST MAN-OF-WAR IN THE WORLD, AS SHE NOW APPEARS IN WILLIAM H. WEBB'S SHIP-YARD.—[SEE PAGE 727.]

what the heck is Cx?



what the heck is Cx?

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what the heck is Cx?

## Exterior Shell:

- Concrete
- Framers
- Masons
- Steelworkers
- Sheathing(s)
  - Exterior Claddings
- Windows/Doors
- Skylights



what the heck is Cx?

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## **Building Systems:**

- HVAC Trades
  - Plumbers
  - Electricians
- Telecom Trades
- Alarm Systems

what the heck is Cx?

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## Thermal / Moisture:

- Insulators
- Flashing Trades
- Air/Moisture/Vapor Barrier Trades
- Waterproofers
- Caulkers
- Roofers

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what the heck is Cx?



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## Finishes:

- Drywallers
- Window Coverings
- Painters
- Tile Workers
- Ceiling Installers

what the heck is Cx?

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## Building Systems:

- HVAC Trades
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## Specialties/Other:

- Shading Devices
  - Renewable Energy Systems
- Landscaping

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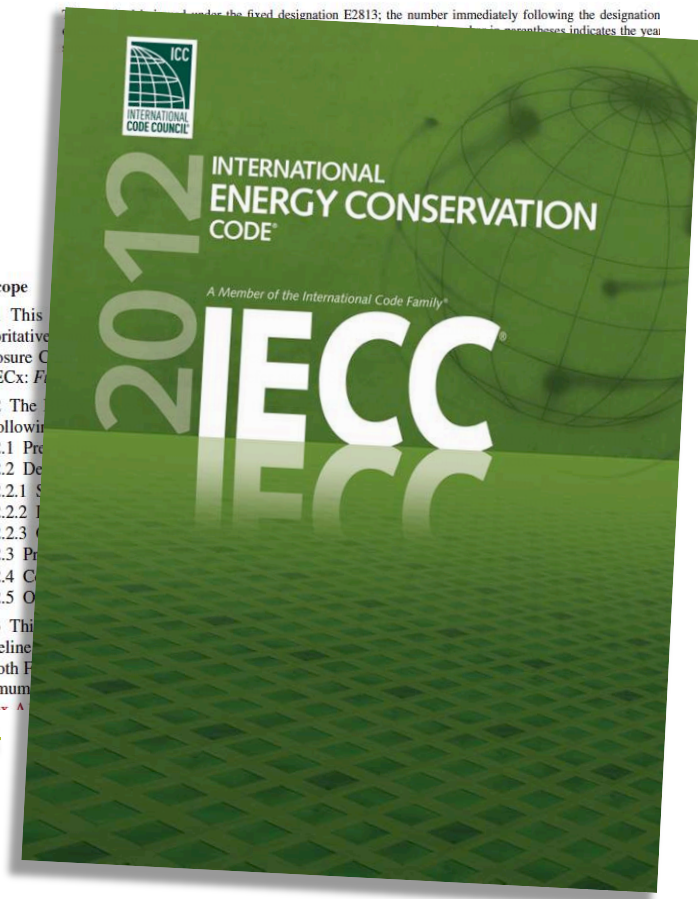
what the heck is Cx?



Designation: E2813 - 12

### Standard Practice for Building Enclosure Commissioning<sup>1</sup>

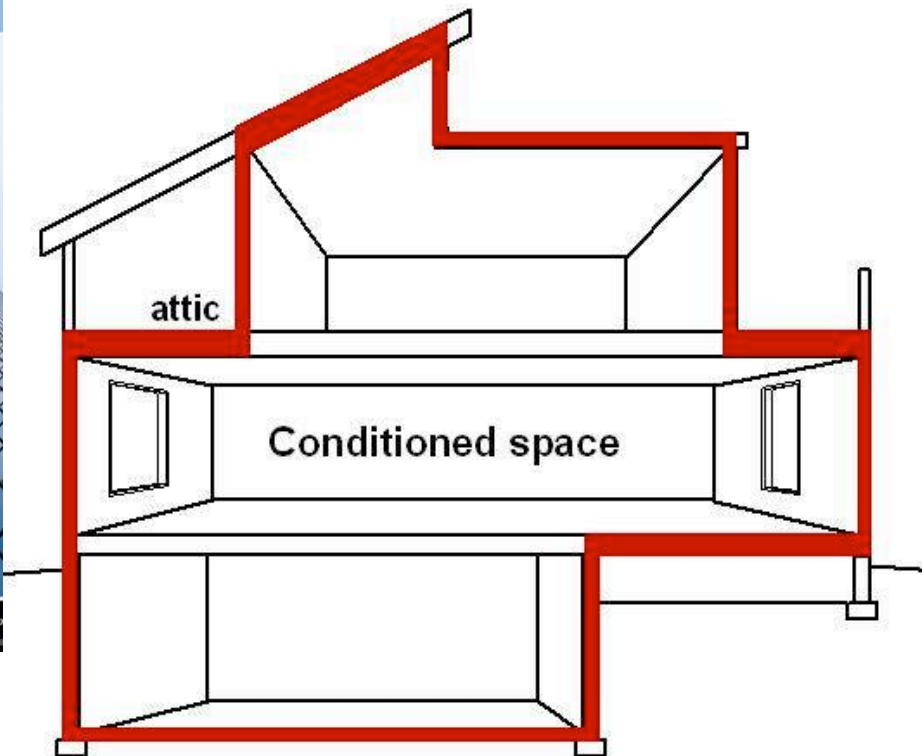
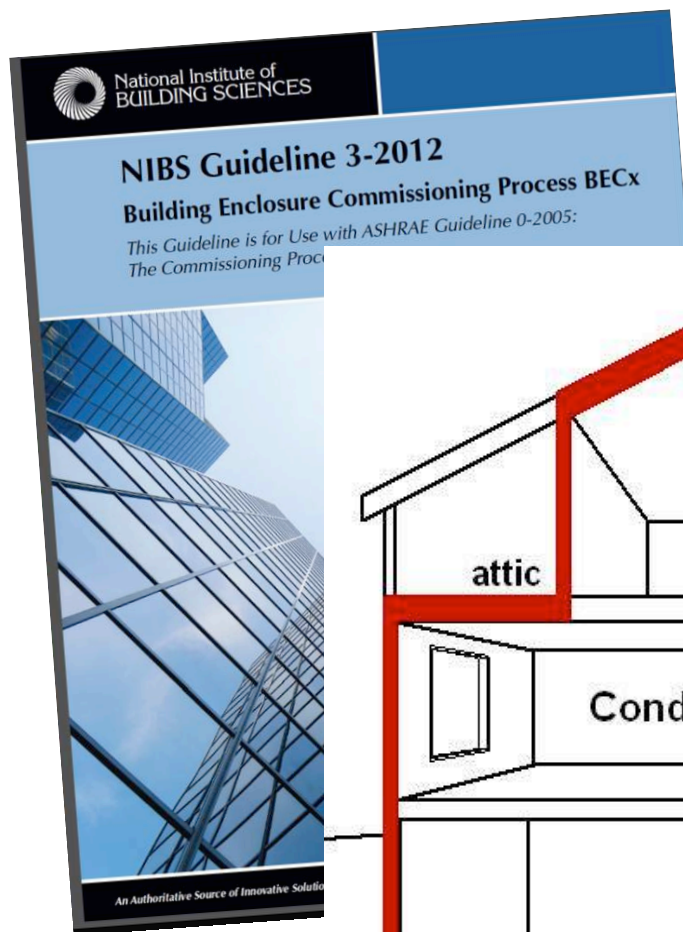
Under the fixed designation E2813; the number immediately following the designation indicates the year of publication; a two-digit year number indicates the year of revision.



#### 1. Scope

- 1.1 This authoritative Enclosure Commissioning Process (ECCP) of BECx: F...
- 1.2 The following sections apply to the following:
  - 1.2.1 Pro...
  - 1.2.2 De...
  - 1.2.2.1 S...
  - 1.2.2.2 I...
  - 1.2.2.3 C...
  - 1.2.3 Pr...
  - 1.2.4 C...
  - 1.2.5 O...
- 1.3 This guideline applies to both F... minimum... A...

what the heck is BECx?

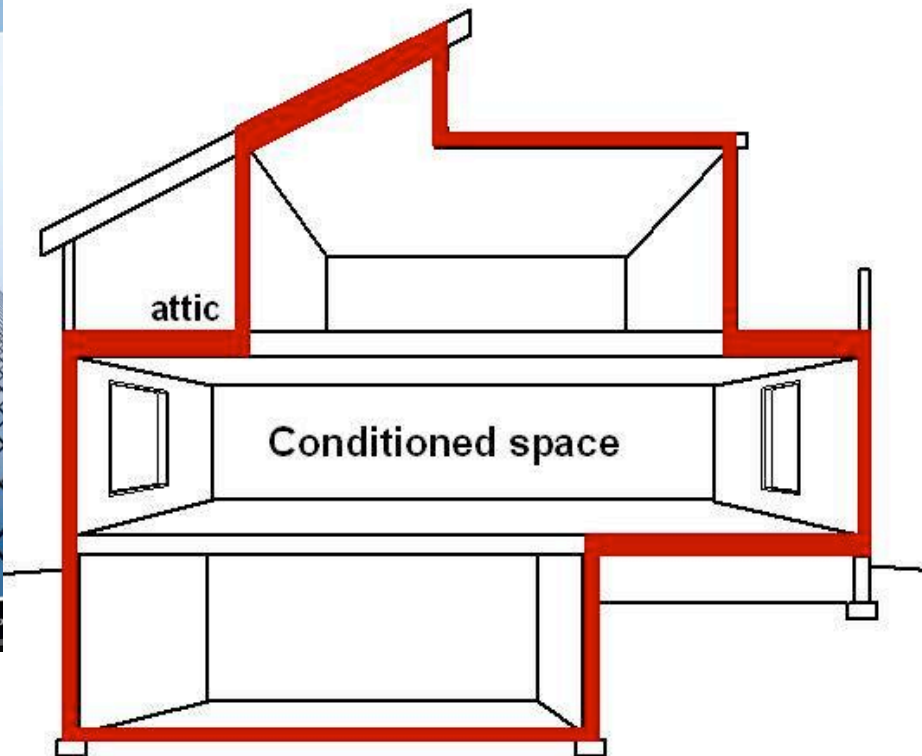
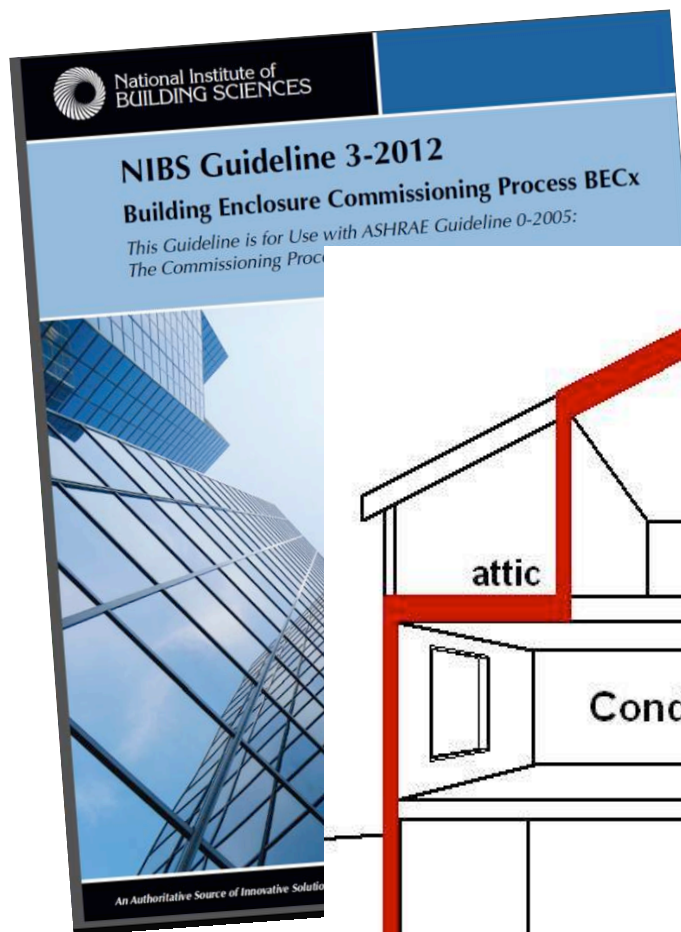


## Building Enclosure:

“...includes systems separating one defined environment from another.”

- NIBS Guideline 3-2012

what is the heck is BECx?



## 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.”

- NIBS Guideline 3-2012

what is the heck is BECx?

# Building Enclosure Commissioning (BECx) Process

Phase	Tasks
<b>Pre-Design</b>	<ul style="list-style-type: none"><li>• Establish the Commissioning (Cx) Team, including project team representatives and Commissioning Agent (CxA).</li><li>• Develop a Cx Plan to serve as a comprehensive checklist and roadmap for the BECx process.</li><li>• Review the Owner's Project Requirements (OPR) and reference relevant standards as necessary. See the comprehensive checklist in NIBS Guideline 3-2012.</li></ul>
<b>Design</b>	<ul style="list-style-type: none"><li>• Develop the Basis of Design (BOD) as an executive summary/game plan of how the OPR will be fulfilled. It is the "how" to the OPR's "what." See the comprehensive checklist in NIBS Guideline 3-2012.</li><li>• Establish Cx specifications detailing the measures to be implemented (including contractor Cx requirements), as well as tests to be performed and performance requirements.</li><li>• Perform Cx Design Reviews to catch potential issues and audit for design quality.</li><li>• Develop checklists to help prevent missed steps during construction. Include installation procedures, test prerequisites, compliance with design and specifications.</li></ul>
<b>Construction</b>	<ul style="list-style-type: none"><li>• The BECxA (building enclosure CxA) reviews submittals for conformity with the specifications.</li><li>• The BECxA conducts onsite inspections using the checklist developed during the design phase to track issues prior to the closing of the enclosure.</li><li>• Onsite testing performed by the contractor, 3rd party and BECxA to quantifiably verify the results of construction. The recommended "Big Five" tests are:<ol style="list-style-type: none"><li>1. Heat, air, moisture</li><li>2. Airtightness (blower door)</li><li>3. Air penetration</li><li>4. Moisture penetration</li><li>5. Thermal imaging</li></ol></li><li>• The following tests and standards are most commonly used during this process:<ul style="list-style-type: none"><li>Windows: ASTM E1105 Water Leakage, AAMA 501.2 Water Leakage, ASTM 783 Air Leakage</li><li>Air Barriers: ASTM 2357 Assembly Air Leakage, ASTM E 779 Fan Pressurization, ASTM E 1827 Blower Door</li><li>Roofing: ASTM C1153 Thermography</li><li>Walls: ASTM C1060 Thermography</li></ul></li><li>• A Systems Manual is developed as the building's guidebook, including as-built drawings, test results and maintenance instructions and schedule. See guidance from NIBS Guideline 3-2012 and LEED v4 Cx requirements.</li><li>• Facilities staff trained on how to use the systems manual and how to check for issues.</li></ul>
<b>Occupancy &amp; Operations</b>	<ul style="list-style-type: none"><li>• Seasonal testing is performed post-occupancy to follow-up on any outstanding issues. Scheduled follow-up testing can be conducted at this time.</li><li>• The Cx Report is completed, documenting the results of all Cx activities and serving as an addendum to the systems manual. The report includes the resolved issues log and benefits of the Cx process.</li></ul>

# Building Enclosure Commissioning (BECx) Process

## Phase

## Tasks

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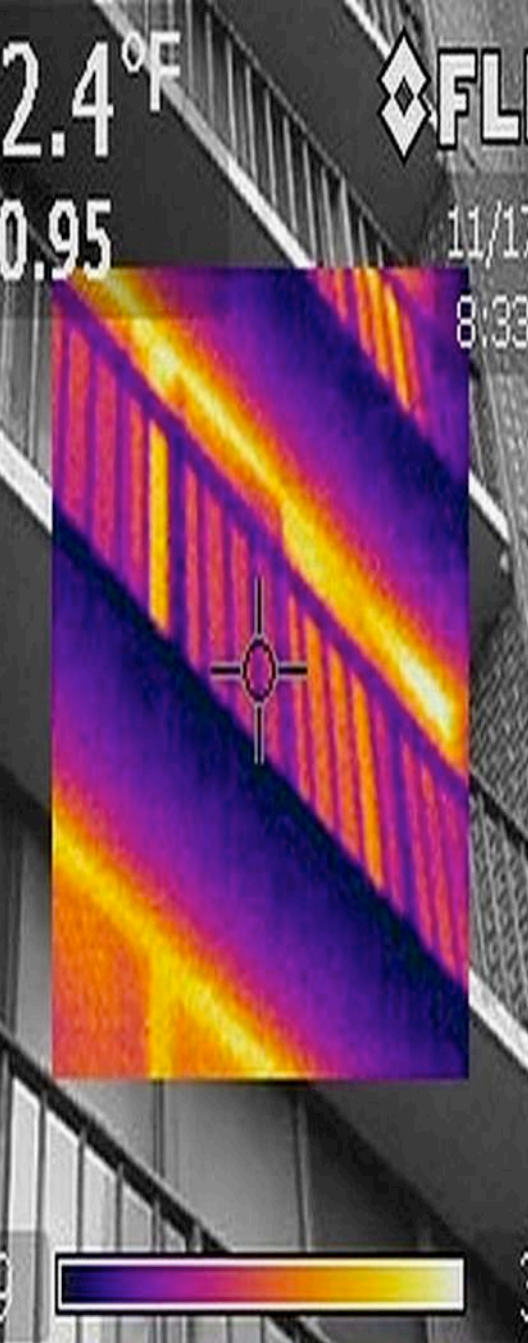
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### Construction

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1. Heat, Air, Moisture

2. Airtightness (blower door)

3. Air Penetration

4. Moisture Penetration

5. Thermal Imaging

onsite testing: the big 5



A large, dark-hulled sailing ship with multiple masts and white sails is sailing on a blue sea under a clear sky. The ship is viewed from a low angle, looking up at the masts. A small boat is visible in the distance on the water.

# BECx and the 7 ~~Seas~~ C's

Cost

Carbon

Claims

Comfort

Certification

Code

Continuity

A large three-masted sailing ship with white sails is sailing on a blue sea under a clear sky. The ship is viewed from a low angle, looking up at the masts and sails. A small motorboat is visible in the distance on the water.

# BECx and the 7 ~~Seas~~ C's

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### Why Do Architects Focus on Art More than Building Science?

*Posted by Allison Bailes on Fri Jun 01, 2012*



*"If architects did their job there wouldn't be any need for building science." So says Joe Lstiburek, principal at Building Science Corporation, in an [interview with Andrew Michler of Inhabitat](#). Actually, there still would be building science. It's just that it would be fully integrated into the design process, where it belongs.*

The photo at left is the Aqua Tower in Chicago. As Lloyd Alter points out in his [Treehugger article about this abomination](#), this building has been called "architectural pornography" by engineer Ted Kesik. This building exhibits two of the biggest problems with the design of commercial buildings: Too much glass and too much thermal bridging. If you don't believe it, see the thermal image in [engineer Robert Bean's article about the Aqua Tower](#).

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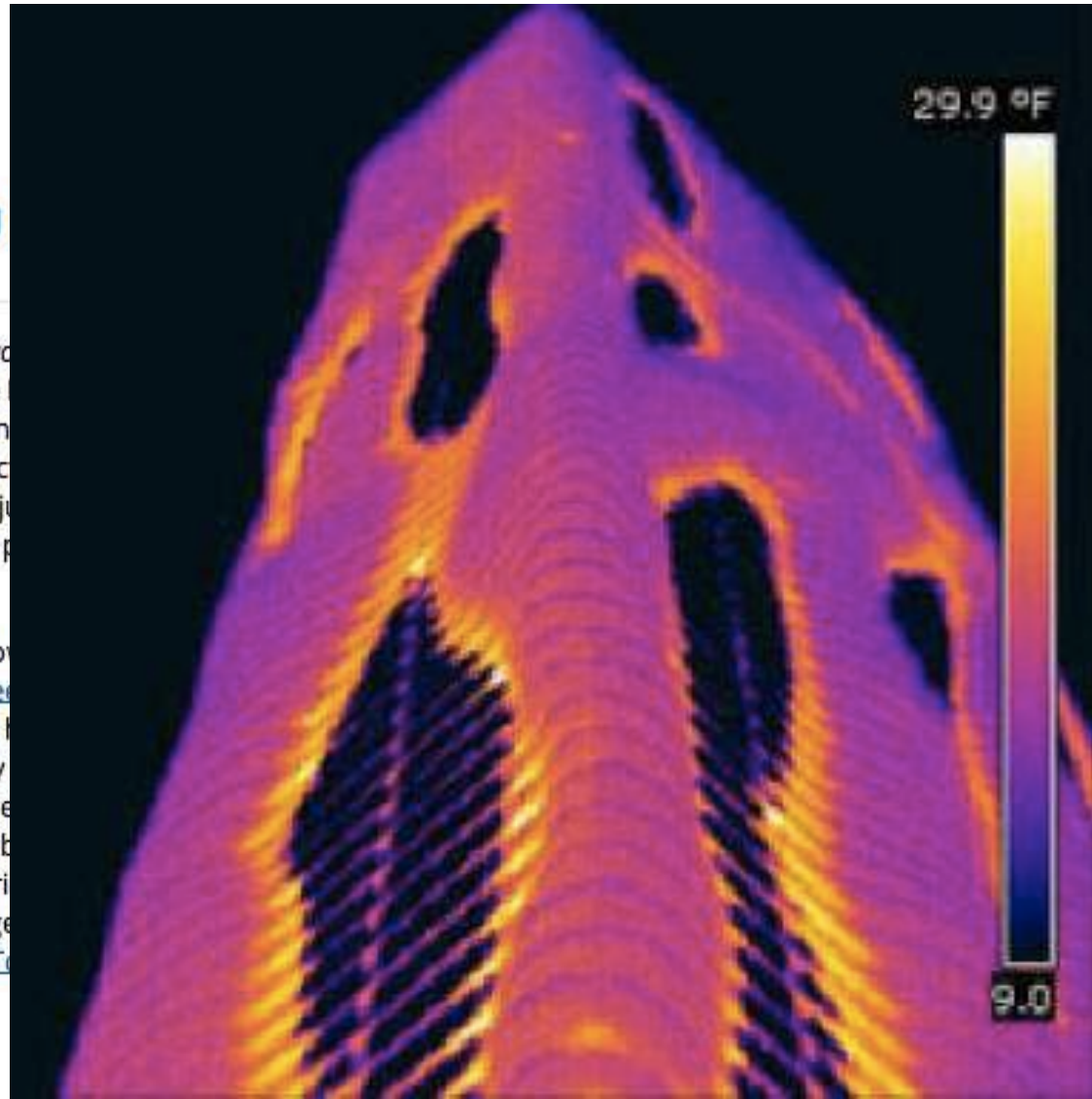
*Posted by Allison Bailes on Fri Jun 01, 2012*



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The photo at left is the Aqua Tower. Joe Lloyd Alter points out in his [Treat this abomination](#), this building is "architectural pornography" by its very nature. This building exhibits two of the worst things with the design of commercial buildings: too much glass and too much thermal bridging. I believe it, see the thermal image [Bean's article about the Aqua Tower](#).

<http://www.energyvanguard.com/blog-building-science-HERS-BPI/bid/53700/Why-Do-Architects-Focus-on-Art-More-than-Building-Science>



<http://blogs.healthyheating.com/2012/05/what-happens-when-artistic-expression-and-culture-trump-common-sense-and-principles-in-sustainability.html>

comment

recommend (6)

NEWS:

## Lawsuit Suggests New Liability for Architects

By Fred A. Bernstein

August 20, 2014



Photo © Flickr user LA Wad

<http://archrecord.construction.com/news/2014/08/140820-Lawsuit-Suggests-New-Liability-for-Architects.asp>

comment

recommend (6)

NEWS:

## Lawsuit Suggests New Liability for Architects

By Fred A. Bernstein

August 20, 2014

“In prior cases, California courts had ruled that an architect owes no duty of care to ‘downstream’ users. This time, the court held that such a duty exists, in part because architects, in the court’s view, are uniquely qualified to choose the right building materials.”

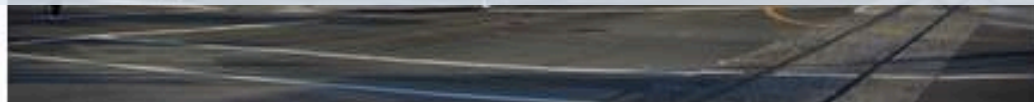
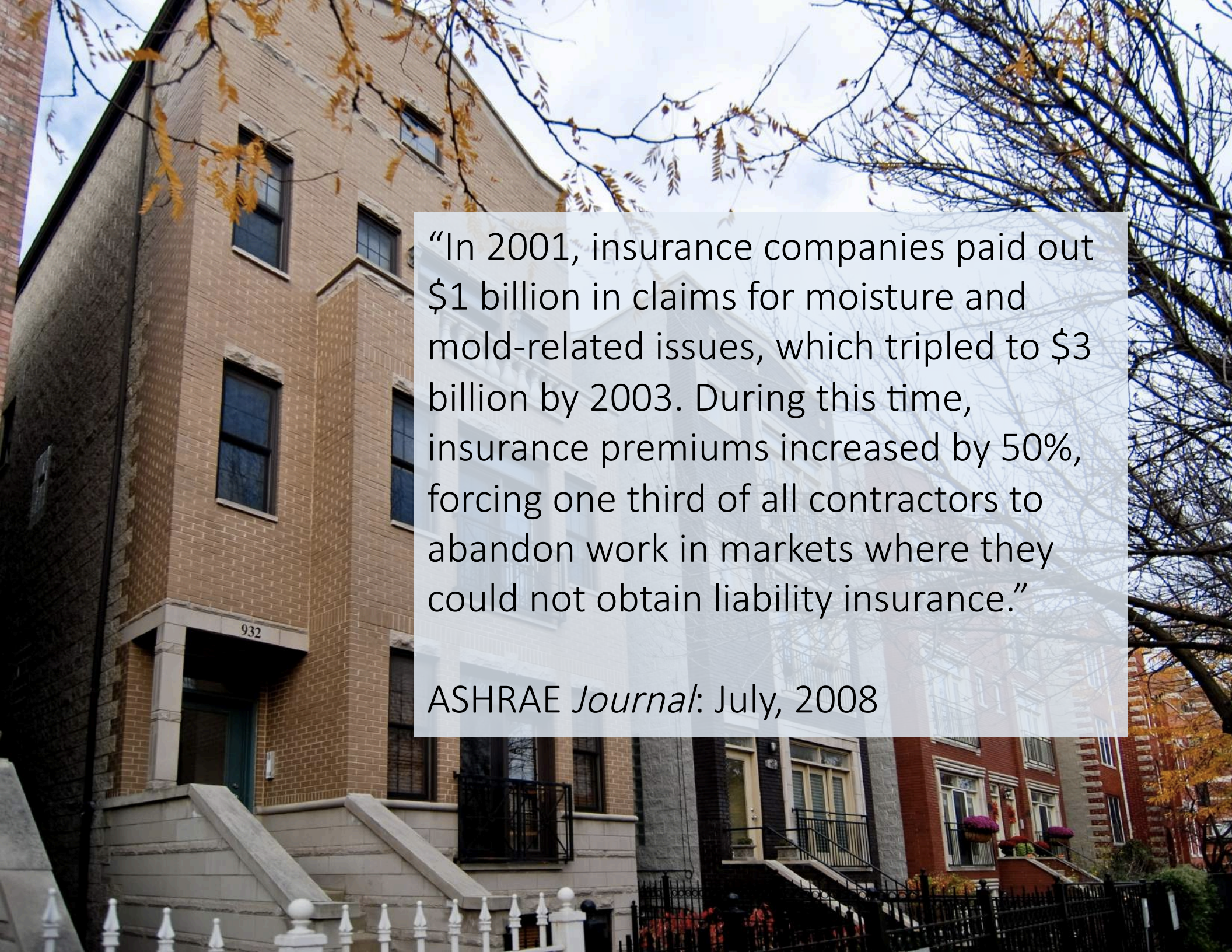


Photo © Flickr user LA Wad

<http://archrecord.construction.com/news/2014/08/140820-Lawsuit-Suggests-New-Liability-for-Architects.asp>



“In 2001, insurance companies paid out \$1 billion in claims for moisture and mold-related issues, which tripled to \$3 billion by 2003. During this time, insurance premiums increased by 50%, forcing one third of all contractors to abandon work in markets where they could not obtain liability insurance.”

*ASHRAE Journal: July, 2008*

A photograph of a row of multi-story brick townhouses. The building in the foreground is light-colored brick with a dark green door and a small balcony. The number '932' is visible above the door. To the right, other townhouses in various colors (dark grey, red) are visible. The sky is overcast, and there are bare trees and some yellowing leaves in the foreground.

“Moisture-related defects alone represent 69% of all claims.”

Association of General Contractors (AGC)

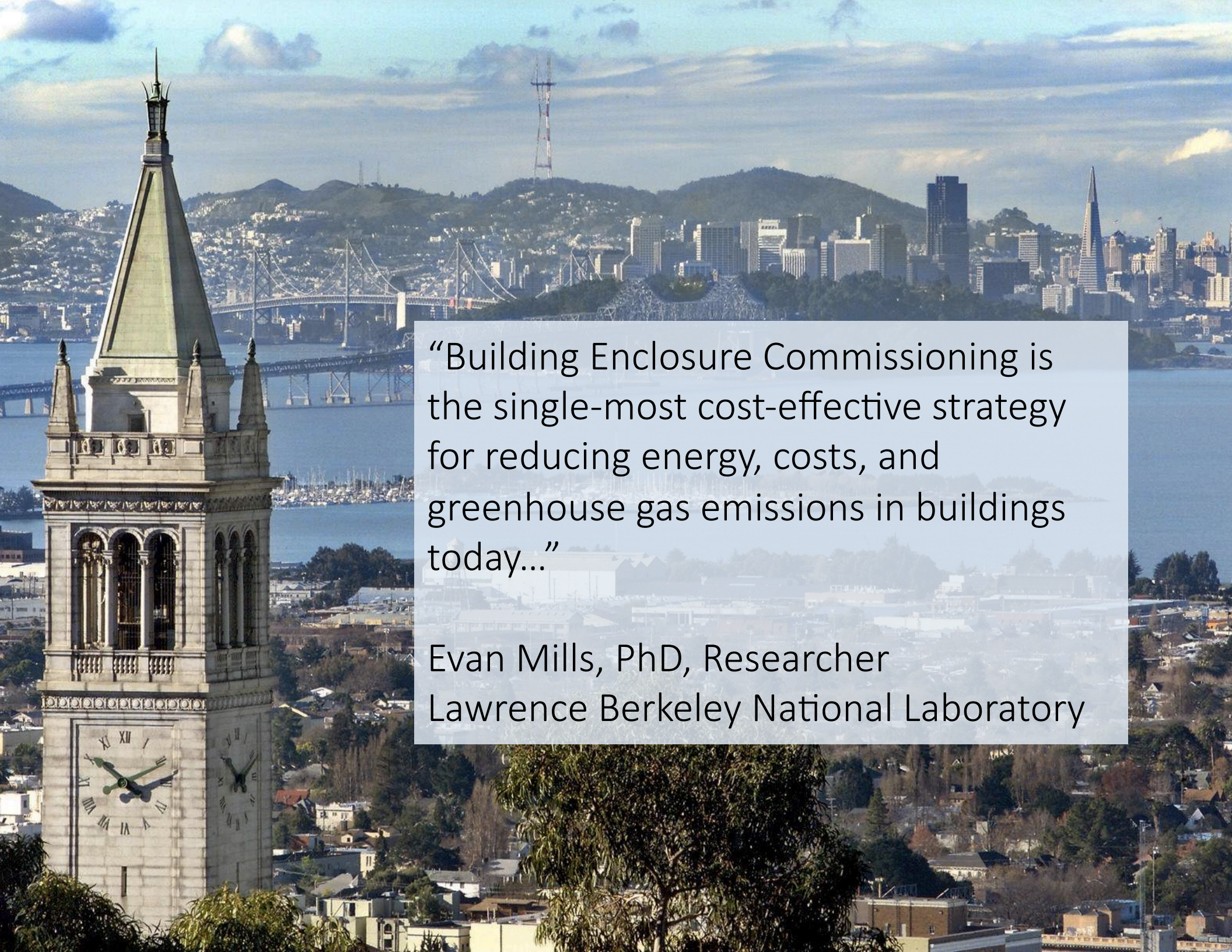


A photograph of a row of multi-story brick townhouses. The building in the foreground is light-colored brick with a dark door and a small balcony. The number '932' is visible above the door. To the right, other townhouses in various colors (dark grey, red) are visible. The sky is overcast, and there are bare trees and some yellowing leaves in the foreground. A semi-transparent white text box is overlaid on the center of the image.

“Thermal comfort in commercial buildings remains one of the top three occupant complaints.” (in addition to visual comfort/glare and acoustics)

BOMA

(Building Owners and Managers Association)

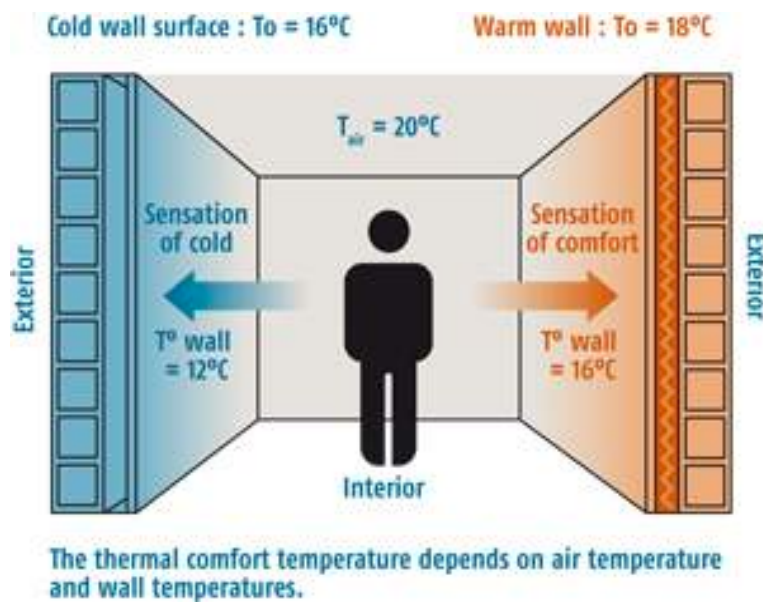
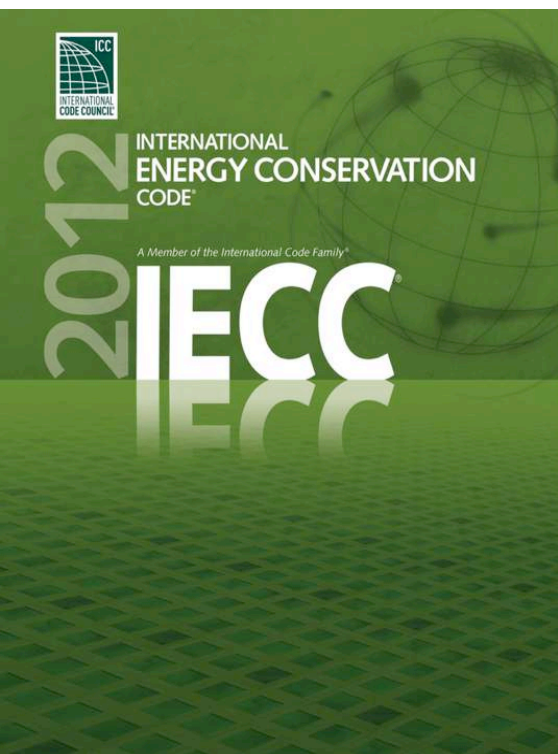
A scenic view of San Francisco, California, featuring the Golden Gate Bridge, the city skyline, and a prominent clock tower in the foreground. The clock tower is a tall, ornate structure with a green roof and a clock face. The city skyline includes the Transamerica Pyramid and other skyscrapers. The Golden Gate Bridge is visible in the middle ground, spanning the Golden Gate Strait. The background shows the city's hills and the bay.

“Building Enclosure Commissioning is the single-most cost-effective strategy for reducing energy, costs, and greenhouse gas emissions in buildings today...”

Evan Mills, PhD, Researcher  
Lawrence Berkeley National Laboratory



LEED v4



selling the 7 C's

*AAMA 501.2: Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems*

*ASHRAE Guideline 0-2005: The Commissioning Process*

*ASTM E779-10: Standard Test Method for Determining Air Leakage Rate by Fan Pressurization*

*ASTM E783-02 (2010): Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors*

*ASTM C1060-11a: Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings*

*ASTM E1105-00 (2008): 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*

*ASTM C1153-10: Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging*

*ASTM E1827-11: Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door*

*ASTM E2357-11: Standard Test Method for Determining Air Leakage of Air Barrier Assemblies*

*ASTM E2813-12: Standard Practice for Building Enclosure Commissioning*

*NIBS Guideline 3-2012: Building Enclosure Commissioning Process BECx*

*Passive House Institute U.S. (PHIUS): Passive House Building Standard*

*U.S. Green Building Council (USGBC), LEED v4: Fundamental Commissioning and Verification & Enhanced Commissioning*

## references

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