WDP

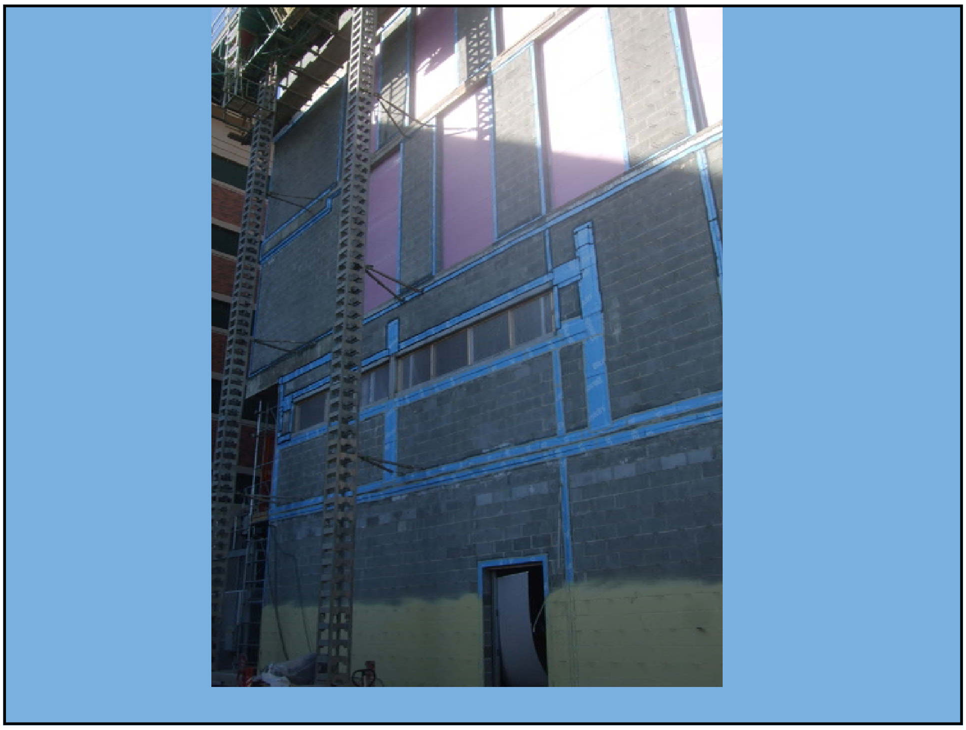
2013 AIVC AIRTIGHTNESS WORKSHOP ON BUILDING AND DUCTWORK AIRTIGHTNESS

Thursday 18 April 2013

Session 4 –Design and Quality Control

Building Enclosure Commissioning BECx for Air Barriers Why, What, How, Were, Who ?

William R. Nash, P.E.
J. Eric Peterson, P.E.
Benjamin Townsend, P.E.




Blue

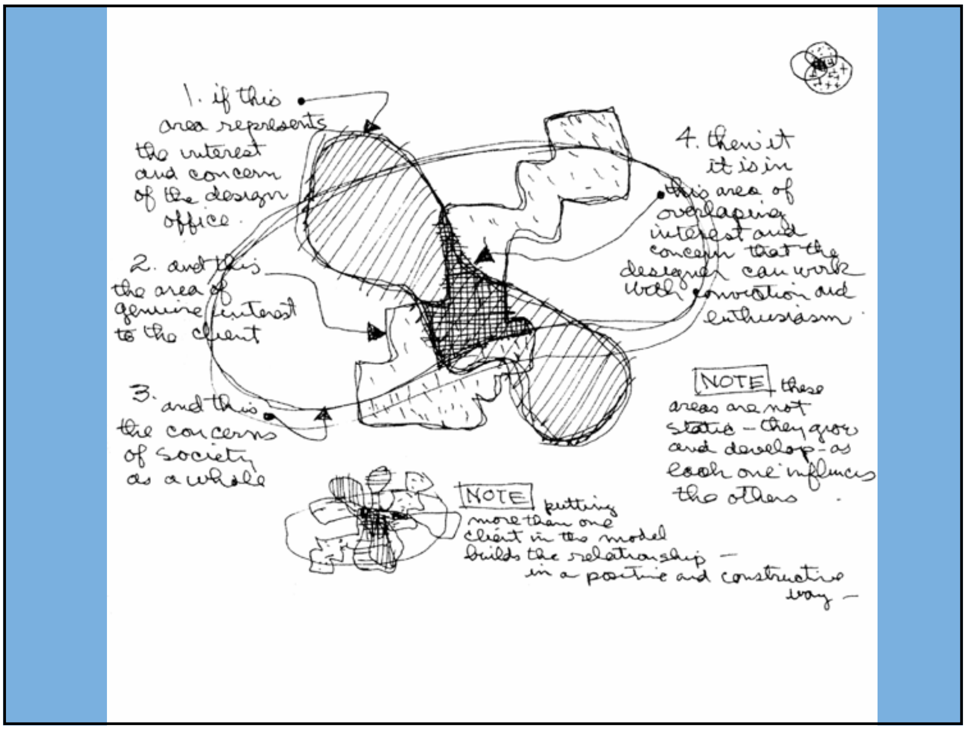

JLG LIFT

Vision Test

Vision Test – What is it that you see ?

Vision Test

Yes – It is a '7 foot tall precast concrete cornfield in Ohio'



Outline of Presentation

Prior to Launch

- Humbled to be asked to share time with you today
- You are acknowledged to be ' the professionals'
- Thank You for your attendance
- Why are we here today ?
- Why is this information relevant today ?
- The 'E ' word -Energy

Topics

- Risks in Building Enclosure Construction
- Risks in Air Barriers
- Self Audit
- Zelda's Questions
- How to improve Building Enclosure Construction ?
- How to improve the process of air barriers ? BECx Process
- Today's &Tomorrow's Issues with Air Barriers

Who Is The Construction Team ?

- Owner
- Architect
- Engineer
- Sub consultants
- Construction Manager
- General Contractor
- Subcontractors
- Manufacturers
- Independent Testing Laboratories

Question For The Construction Team

- Can a project construction team plan and implement a successful building project (defined as a project with a building that performs) without safety as the number one team priority ?

Question For The Construction Team

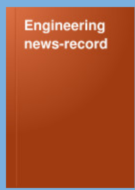
- Where are Owners ,Architects, Engineers, Construction Managers, General Contractors , Subcontractors and Manufacturers with the verification of building enclosure performance ?

Question For The Construction Team

- How many people utilize Lessons Learned ?
- What does history provide to building enclosure professionals in the form of lessons learned ?
- How is it that we learn to move forward from looking over our shoulder ?

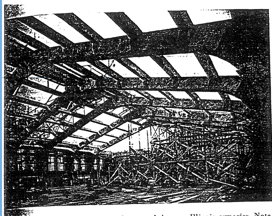
A letter to the Editor

- Of Engineering News Record



New York City - 1938

Rockefeller Plaza --Construction in 1938
2013 – 1938 = 75 years ago



...inforced concrete framing is a feature of the new Illinois armories. Note ...purlins rest on brackets monolithic with bents. Each second purlin is ...forced as a strut.

form system for two adjacent arches with their connecting purlins. The traveler also included a concrete hoist tower. When concreting of one unit was complete and the concrete set, the entire unit was moved ahead two panels and the operation repeated; the purlins in the intermediate or connecting panels were poured later. A 3,000 lb. per sq.in. concrete (at 28 days) was specified for all exterior work. However, to expedite pouring of the arches, high-early-strength cement concrete (3000 lb. in 3 days) was specified for the inclined rafters and purlins.

Personnel

The project is being carried out by the Illinois Armory Board with S. Milton Eichberg as supervising architect and Lieut. Joseph A. Crum, as technical supervisor. The WPA organization constructing the armories is under the supervision of A. M. Crain, director of operations. The writer was consulting engineer on the structural design of the thirteen armories.

How to Build Leaky Brick Walls With Good Materials

A. B. MacMillan
Vice-president, Aberthaw Company, Boston, Mass.

No attempt will be made here to describe how to produce good brick walls. The problem after all is reasonably simple, and therefore capable of solution. However, judging from examples on every hand, much effort has gone into the production of leaky walls, even though carefully specified and selected materials were used. Up to the present time, in so far as the writer knows, there has been no concerted effort to educate the public to understand exactly how poor walls may be produced at will. There are a number of steps in the process; for some the owner and designer are responsible, and for some the builder may take all credit.

Without attempting to place the responsibility for any of the steps individually on either of the several participants, let us consider what these steps are.

First, there is compatability of materials. Just as incompatability in marriage leads to divorce, so in building materials it leads to separation. Each material used has characteristics peculiarly its own. For instance, the coefficient of expansion of brick masonry is approximately 0.0000031; that of limestone 0.0000044; and that of concrete 0.0000067. This simply means that in a length of 100 ft. with a temperature change of 100 deg., neglecting the effect of moisture, brick masonry if unrestrained would expand or contract ⅜ in.; limestone 9/16 in.; and concrete 13/16 in.

Plain arithmetic

It is evident then that if an artificial stone (concrete) coping is placed on top of a brick wall and the end joints between adjacent stones are filled with a hard mortar, the stone in its endeavor to move twice as far as the supporting brickwork, in response to temperature

ENR
December 1, 1938
Letter to the Editor

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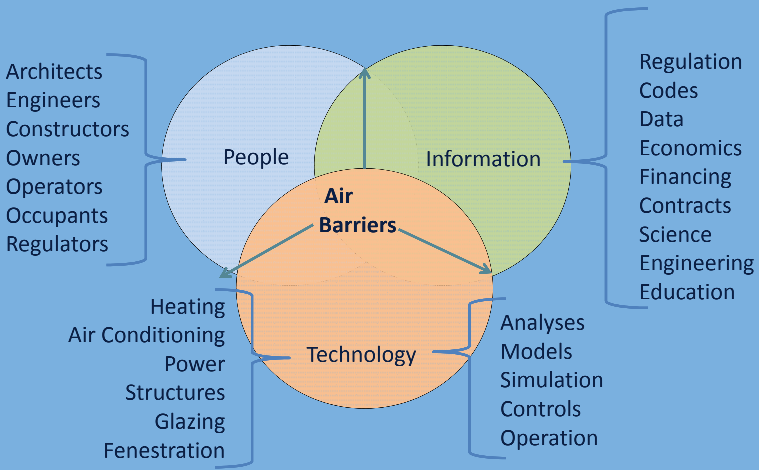
Question For The Construction Team

- Where are we with building enclosure performance after 75 years when Rockefeller Plaza was constructed in New York City ?

Air Barrier

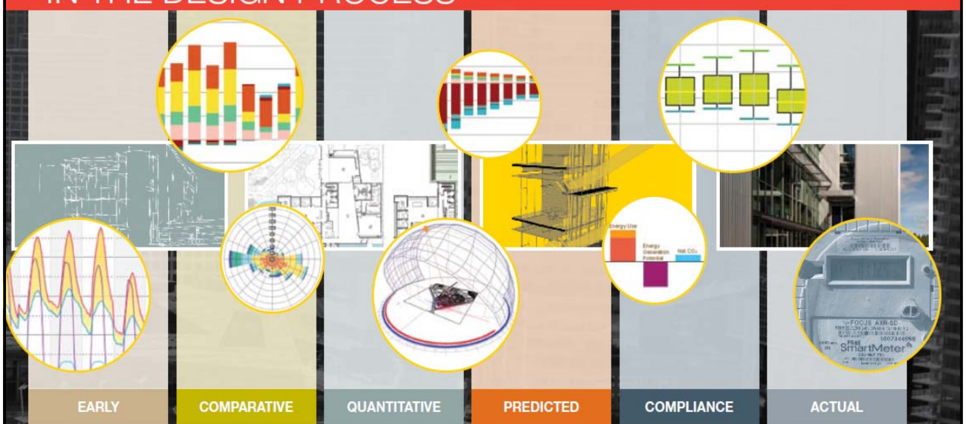


Question For The Construction Team

- Why are air barriers critically important to building performance ?

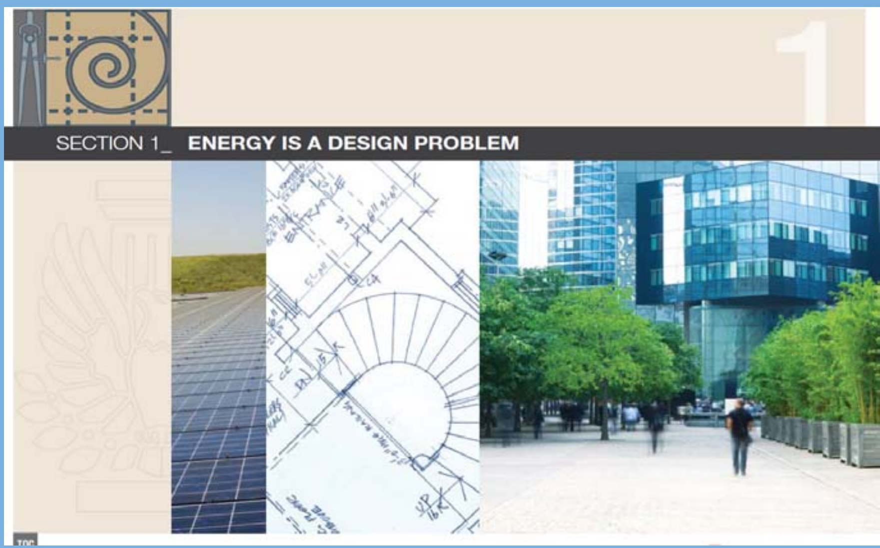
An Architect's Guide to

INTEGRATING ENERGY MODELING IN THE DESIGN PROCESS



THE AMERICAN INSTITUTE OF ARCHITECTS

An Architect's Guide to Integrating Energy Modeling in the Design Process

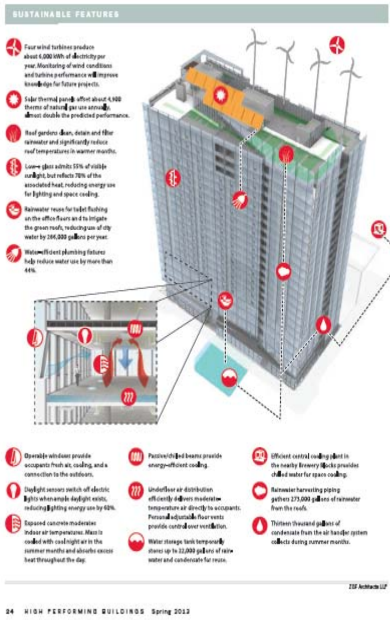


An Architect's Guide to Integrating Energy Modeling in the Design Process

Section 1_

ENERGY IS A DESIGN PROBLEM

Designing spaces and places in the built environment with energy in mind takes much more than a technical understanding of science, tools and technology. The physics of materials and enclosure, no matter what the architectural form, define the need for supplemental building systems, including mechanical or passive heating, cooling, air circulation, lighting, and human conveyance. For much of the last century and in large part since architecture and engineering became separate professions, energy has typically been addressed at the building systems level, taking a back seat to many other drivers of the design and construction process.



INDUSTRY NEWS

La Jolla Commons II aims to be largest NZEB.

Largest NZEB Under Way

SAN DIEGO—The 13-story La Jolla Commons II office building, under construction in San Diego, aims to be the largest net zero energy building in the U.S., according to its developer, the Hines real estate firm. To achieve zero net energy use, Hines is employing directed biogas and onsite fuel cells that will generate a projected 5 million kW of electricity annually. The fuel cells will convert methane to electricity, tapping methane in landfills and wastewater plants. Construction on the 415,000 ft^2 (38 600 m^2) building is expected to be completed in April 2014.

Source: Hines ■

HFO Blend for AC, Heat Pumps

KOBE, Japan—Honeywell has announced its first HFO blend is now commercially available as an alternative to R-410A for both stationary air conditioning and heat pumps.

Honeywell claims its Solstice L-41 reduces GWP by 75% compared to R-410A. In addition, it says the refrigerant has excellent energy efficiency and can be used in existing equipment designs with minimal changes.

Source: Refrigeration and Air Conditioning News magazine (UK) ■

Danfoss Full Owner of Turbocor

BALTIMORE, Md.—Danfoss has announced that it has acquired full ownership of the joint venture company, Danfoss Turbocor Compressors. Danfoss has held a 50% stake since 2004. The company develops, produces and markets high-efficiency variable speed compressors in the range of 75 – 200 tons (250 – 700 kW).

Source: Danfoss ■

Furnace Rules Dropped

WASHINGTON—The U.S. Department of Energy (DOE) has agreed to withdraw new rules that would require consumers in more than two dozen northern states to purchase high-efficiency furnaces beginning this spring. The decision is the result of a legal settlement between DOE and the American Public Gas Association (APGA). APGA argued that the new regulations would prove too costly for consumers and ultimately steer some of them to heat their homes with other, less-efficient fuels.

Source: St. Louis Post Dispatch ■

8 ASHRAE Journal February 2013

Largest NZEB
La Jolla Commons
13 story
415,000SF
5,000,000 Kw annually
Completed April 2914
San Diego, California

La Jolla Commons II aims to be largest NZEB.

INDUSTRY NEWS

China Building World's Largest

CHENGDU, China—China is hoping for a June opening for what it calls the largest freestanding building in the world. The New Century Global Centre is 500 m (1,640 ft) long, 400 m (1,312 ft) wide and 100 m (328 ft) tall. That is almost three times the size of the Pentagon. The Global Centre will be home to business offices, hotels, theaters, high-end shopping malls, a faux Mediterranean village, family-themed attractions, university complexes and more. Various media have reported on masses of Chinese workers rushing to complete the building in time for the June 6–8 global forum hosted by Fortune magazine. Construction began in 2010. Source: Agence France-Presse ■

New Century Global Centre is largest.

Technology Controls Heat Like Light

CAMBRIDGE, Mass.—An MIT researcher has developed a technique that provides a new way of manipulating heat, much as light waves are controlled by lenses and mirrors. The approach relies on engineered materials consisting of nanostructured semiconductor alloy crystals. The spacing of tiny gaps in these materials is tuned to match the wavelength of the heat phonons, said Martin Maldovan, the author. By reducing the range of heat frequencies, more than 40% of the total heat flow is concentrated onto the crystals. These "thermocrystals" can be used in a range of applications, such as improved thermoelectric devices, which convert differences of temperature into electricity. Source: Science Daily ■

Utilities to Double Efficiency Funding

BERKELEY, Calif.—Spending on energy efficiency programs funded by electric and natural gas utility customers will double by 2025 to about $9.5 billion per year, according to projections published by researchers at Berkeley Lab.

These funds, which come from a charge on utility bills, historically constitute the nation's largest source of spending on programs to foster the adoption of more efficient products and buildings. Source: Berkeley Lab

Read the rest: http://tinyurl.com/afo9y2e ■

Photo: ETGCN

New Century Global Centre is largest.

Question For The Construction Team

- What will assist the building construction industry to move forward to ZNEB ?

What will assist the industry to move forward to ZNEB ?

- What building enclosure design and construction processes will provide the design team the initiative to accomplish enclosures with innovation in the functional performance of waterproofing, air barriers, windows, curtain wall, storefront, insulation, day lighting , thermal continuity and roofing to meet the challenges of zero net energy buildings ?

Self Audit

- Questions posed by Zelda

Questions For The Construction Team

- Are Owners, A/Es, CMs, GCs and Subcontractors proactive with the design, construction, and maintenance of building enclosures (air barriers) ?

Question For The Construction Team

- Can a project construction team plan and implement a successful building project (defined as a project with a building that performs) without safety as the number one team priority ?

What is the Number One Priority in Construction?

Questions For The Construction Team

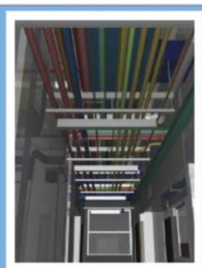
- What word should be banned in construction?
- What is both the most overused and the most misused word in design and construction that begins with the letter Q?

Zelda Says:

- Quality is a word that is overused and misused within the design and construction industry. Quality is a word that requires definition – It must be defined by the user .– In the instance of a construction project it must be defined by your specific plans and specifications.
- Unfortunately there are as many definitions for the word quality as there are construction team members involved with a project.
- Suggest to substitute the word **performance** for the **Q** word

~~QUALITY~~

ENR Article - Issue: 12/03/2012
Contractors Confront the Growing Costs of Rework



Rework plagues U.S. commercial construction projects, causing problems ranging from longer construction schedules and late delivery to worker injuries and billions a year in lost revenue. In the long term, rework can also affect a construction company's reputation and its ability to attract new business.

The problem of rework has been largely ignored by the construction industry, but tighter profit margins during the recent recession have prompted contractors to look for new ways to shave expenses as well as boost earnings. Preventing, or at least curtailing, rework is one cost-cutting measure embraced by more and more contractors. Those efforts include using processes such as building information modeling and lean construction techniques to detect and correct mistakes virtually, as well as common-sense practices such as involving owners, users and other stakeholders throughout planning and construction.

"When you think about doing a job that costs a total of $100 million, you can spend something like $900,000 on rework," says Wayne Crew, CII director. "The questions become: Can you afford that and how much effort do you put into saving $900,000?"

CBQ
ENR Contractor Business Quarterly

Contractors Confront the Growing Costs of Rework - ENR

The Cost of Rework

Rework costs—including labor, materials, equipment and subcontractors—can run from 2% to 20% of a project's total contract amount. That equates to an estimated total of $15 billion a year, according to CII. Breaking that down further, the institute found the direct cost of rework averaged 2.4% of total contract value for standard industrial construction projects and 12.4% for civil and heavy industrial projects.

Some construction industry executives and consultants call the CII's annual dollar estimates low. "The $15-billion figure is a drop in the bucket," says McLin.

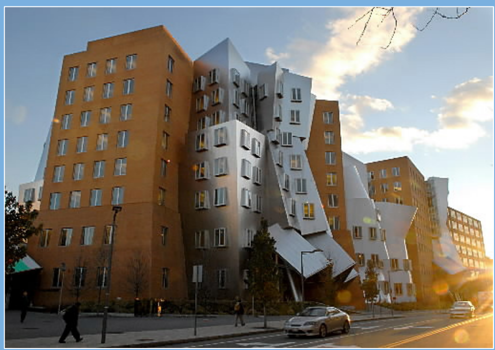
Construction Risk Management

- Risk Assessment
- Positive / Negative
- Unfavorable consequence
- Unwanted outcome
- Variability
- Ambiguity
- Perception
- Lack of certainty

- Weather
- Inexperienced workmen
- Sequence of Installation
- Hazards
- Market
- Schedule
- QC Testing
- QA audits
- Damage by other trades

What Makes Building Enclosures Problematic ?

- Infinite combinations of materials and systems, each with specific performance attributes
- Multiple trades involved in interfacing construction
- Enclosure systems are interconnected and co-dependent



Building Enclosure

- Six sides of the 'box'
- Control the flow of air, heat, moisture, light and sound
- Effectiveness of the enclosure has a very large influence on:
  - Heating and cooling loads, moisture control, utility cost,
  - HVAC equipment size,
  - Durability of the structure,
  - Occupant health, safety, and comfort.

Working Around the System

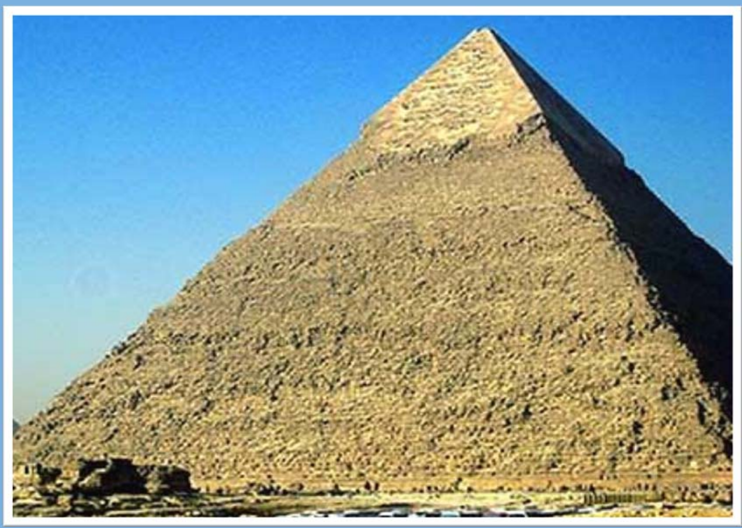
Questions for the Construction Team

- Are we improving the building enclosure construction process ?

The Industry Must Be Improving The Building Enclosure Because We Have Better Tools ?

- Computer Modeling - Thermal, Moisture
- BIM
- Virtual Mock Ups
- Integrated Project Delivery
- Co Located Design and Construction personnel during DD+CD
- Construction site web portals/ wireless communications
- Tablet computers

Issues with Building Enclosure Performance are Not New



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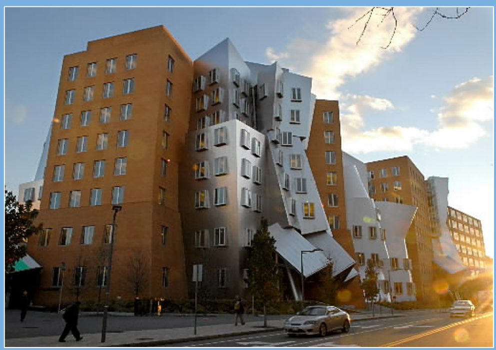

Types of Building Enclosure Problems

Common failures in Building Enclosures include:

- Water Infiltration
- Air Leakage
- Condensation
- Energy Losses

Construction Work Sequence

- Should electrical conduit be installed prior to the air barrier but after the masonry thru wall flashing ?

Questions For The Construction Team

- What are the advantages to a building construction project of the implementation of a Building Enclosure Coordination Program / Building Enclosure Commissioning Program ? for air barriers ?

Zelda Says:

- Manages risks (field performance) posed by multiple material types installed by multiple subcontractors on a building
- Reduces the potential for construction defects
- Ensures consistent construction of a structure / building with the functional performance required by the plans and specifications.
- Delivers the Owner's expectations
- Creates a construction team focused on the project specific delivery of performance
- Promotes the construction team goal of zero rework
- Reduces both project costs and schedule duration

Questions For The Construction Team

- What are the primary causations of buildings with enclosure performance issues ?

Why Do Buildings Have Issues?

The three primary categories of causation for buildings with issues are:

- Design
- Construction
- Operation and Maintenance



Questions For The Construction Team

- Who defines the use of building enclosure coordination/ building enclosure commissioning process for a project ?
- What process can be utilized to manage the risks posed by the building enclosure/ air barrier ?

Building Enclosure Risk Management

Components of a BE Coordination Program

BE review of the Construction Documents during design

- BE Assessment during estimating of contract documents
- BE Shop drawings / submittal review
- BE Mock Ups / Performance Testing
- BE Subcontractor Coordination of Shop drawings for interfacing materials
- BE Field Performance Verification Testing
- BE Non Conformance Process
- BE warranty walk thru at 10 months

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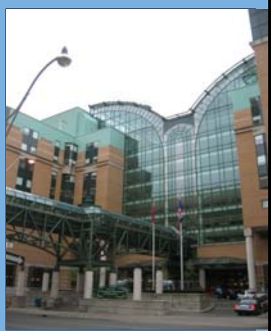
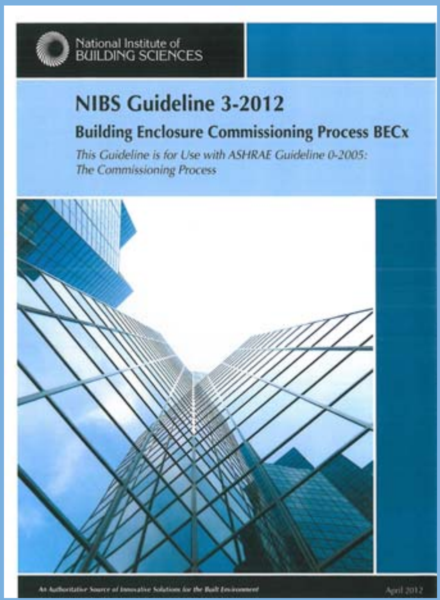
Details and Interfaces

- Plans and Specifications -- Air , Water , Thermal Management
- Waterproofing
- SOG Vapor Retarder
- Walls
- Windows , storefront, curtain wall, Doors
- Masonry
- Stone
- Stucco
- Metal Panels
- Parapets
- GFRC
- EIFS
- Roof
- Expansion Joints
- Subgrade Drainage

- Specification – Division integration
- 01400 specification
- Mock up Specifications
- BECx Specification
- Compatibility
- Tolerances
- Flashings
- Interfacing details of enclosure materials
- Coordination and integration with other building systems
- Penetrations, MEP, HVAC
- Specifications
- BECx specification development



NIBS Guideline 03- 2012



NIBS Guideline 03-2012 :
Building Enclosure Commissioning Process BECx , National Institute of Building Sciences,

Downloadable free from the NIBS WBDG web site -- http://www.wbdg.org/ccb/NIBS/nibs_gl3.pdf

NIBS Guideline 3 - 2012

- Table of Contents
- Executive Summary
- Forward
- 1. Purpose
- 2. Scope
- 3. Definitions
- 4. Pre-Design Phase
- 5. Design Phase
- 6. Construction Phase
- 7. Occupancy and Operations Phase

NIBS Guideline 03

Building Enclosure Commissioning (BECx):

- *The process by which the design and 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.*

Building Enclosure Commissioning Authority (BECxA):

- *Entity who is designated by the team to formally document the project specific Building Enclosure Commissioning. This individual should be trained and knowledgeable in the process of building enclosure commissioning and possess basic architectural and building science knowledge of the design, performance, systems and construction related to the building enclosure. The BECxA role may be accomplished by the BES, CxA or an additional member to the team.*

ASTM E 2813-12

Designation: E2813 – 12

Standard Practice for Building Enclosure Commissioning[1]

This standard is issued under the fixed designation E2813; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

Building Enclosure Commissioning (BECx) is a process that begins with the establishment of the Owner's Project Requirements (OPR) and endeavors to ensure that the exterior enclosure and those elements intended to provide environmental separation within a building or structure meet or exceed the expectations of the Owner as defined in the OPR. A fundamental understanding of the most current published edition of ASHRAE Guideline 0 and NIBS Guideline 3 is recommended for optimal use and application of this practice.

1. Scope

1.1 This practice is intended to serve as a concise, authoritative, and technically sound practice for Building Enclosure Commissioning (BECx) that establishes two levels of BECx: *Fundamental* and *Enhanced* (refer also to Section 4).

1.2 The BECx process as defined in this practice includes the following phases and sub-phases:

1.2.1 Pre-design,

1.2.2 Design,

1.2.2.1 Schematic Design,

1.2.2.2 Design Development,

1.2.2.3 Construction Documentation,

1.2.3 Pre-Construction,[2]

1.2.4 Construction, and

1.2.5 Occupancy and Operations.

1.3 This practice includes a mandatory OPR Development Guideline (Annex A1) and requires the development of an OPR for both Fundamental and Enhanced BECx that addresses, at a minimum, the performance attributes and metrics included in Annex A1 of this practice.

1.4 This practice includes mandatory BECx Performance Testing Requirements (Annex A2) approved for use with this practice to evaluate the performance and durability of enclosure materials, components, systems, and assemblies.

1.5 This practice mandates independent, third-party design peer review during the Design Phase of both Fundamental and Enhanced BECx.

1.6 This practice recognizes that the OPR for exterior enclosure performance and environmental separation may exceed the baseline requirements of applicable building codes and standards and provides guidance for the development of an OPR based on the following attributes as defined in Annex A1 of this practice:

1.6.1 Energy,

1.6.2 Environment,

1.6.3 Safety,

1.6.4 Security,

1.6.5 Durability,

1.6.6 Sustainability, and

1.6.7 Operation.

1.7 The terms "building enclosure" and "enclosure" as they appear in this practice refer 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.

1.8 This practice establishes that the Building Enclosure Commissioning "Agent" or "Authority" (BECxA) refers specifically to the individual or firm retained by the Owner to develop, manage, and be in responsible charge of the BECx process, including individual members and technical specialists that may comprise the BECx team (see 4.2).

1.9 The role and responsibilities of the BECxA as defined by this practice are not intended to supersede or otherwise replace the contractual obligations reserved specifically for the parties responsible for the design and construction of a building or structure, nor the duties that may otherwise be assigned to those parties by applicable regulatory or statutory law.

[1] This practice is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.55 on Exterior Building Wall Systems.

Current edition approved Feb. 1, 2012. Published March 2012. DOI: 10.1520/E2813-12.

[2] See 5.1.3, Pre-Construction Phase, which includes BECx activities that occur prior to contract award and the start of construction, and is included in ASHRAE Guideline 0 and NIBS Guideline 3 as a sub-phase under the "Construction Phase" of the BECx process.

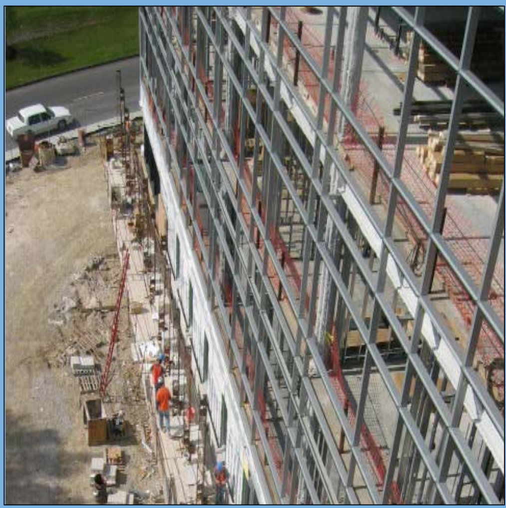
ASTM E 2813- 12 ANNEXES (Mandatory Information)

- *A1. OPR DEVELOPMENT GUIDELINE*
- A1.1 The OPR is a written document that includes the programmatic, aesthetic, and functional performance requirements of a building or structure and the expectations of the Owner relative to its intended use, occupancy, operation, and service-life.

ASTM 2813-12- Owners Project Requirements

•A1.1.1 - Development of the OPR must include, at a minimum, documented and verifiable consideration of the following attributes:

- *(1) Energy*
- *(2) Environment*
- *(3) Safety*
- *(4) Security*
- *(5) Durability*
- *(6) Sustainability*
- *(7) Operation*



ASTM E 2813 - Annex A2. BECx PERFORMANCE TEST REQUIREMENTS

- A2.1 - Table A2.1 includes an outline of the minimum required tests for *Fundamental and Enhanced BECx* as defined by this practice. The minimum number of tests required to achieve *Fundamental or Enhanced BECx* refers to the number of tests required per unique type of enclosure element as defined by the *AOR in consultation with the BECxA,*

- A2.2 - Mandatory field tests are indicated in Table A2.1 with a check mark ("U"), followed by the minimum number of tests required to achieve either *Fundamental or Enhanced BECx.*

ASTM E 2813 - Annex A2.
BECx Performance Test Requirements

Property	Standard Designation	Title	Lab System Testing	Enhanced		Fundamental	
				Field Mockup Testing[A]	In-Situ Field Testing	Field Mockup Testing	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	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)
	ASTM D5957[F]	Guide for Flood Testing Horizontal Waterproofing Installations	...	(OF)	✓ (All horizontal surfaces)	(OF)	✓ (All horizontal surfaces)
Static water penetration	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[G]	Standard 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)

ASTM E 2813 - Annex A2. BECx PERFORMANCE TESTING REQUIREMENTS

A2.3 - Selection, interpretation, application, and use of each test standard included in Table A2.1 shall be specified at the sole discretion of the AOR in direct consultation with the BECxA during the *Design Phase of the BECx process, subject* to final review and approval by the Owner..

A2.4 - Use of the optional test standards listed herein, or tests not specifically listed herein but determined by the AOR and BECxA to be appropriate for the evaluation of project-specific enclosure materials, components, systems, and assemblies, shall be specified at the sole discretion of the AOR, subject to final review and approval by the Owner.

How good are Air Barriers ??

Air Barriers will be as good as :

- The interfacing details in the plans
- The specifications for Air Barriers & QC/QA
- The subcontractor prequalification
- Requiring full submittals
- The preconstruction meeting & planning
- The subcontractor's supervision
- The diligence of the field verification of the work
- The CM/GC's planning and attention to detail
- Making no assumptions

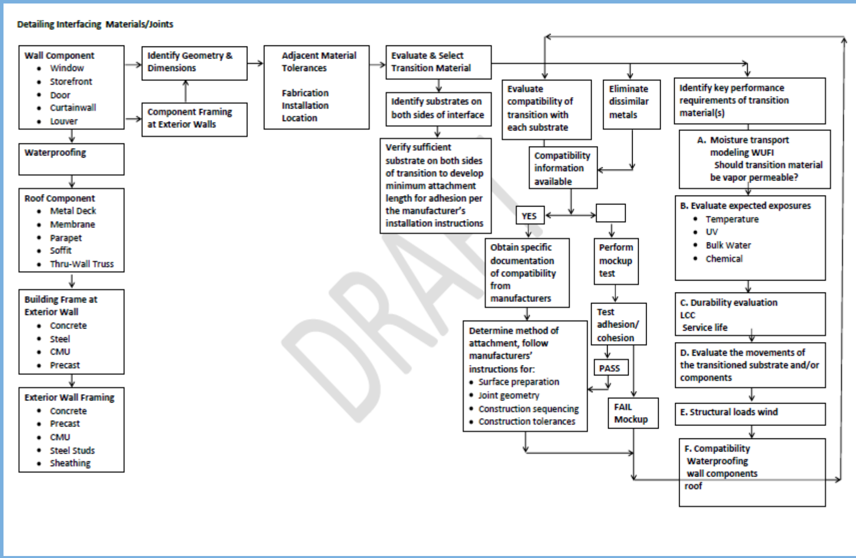
How to Improve the Processes of Air Barrier Design and Construction ?

Design Process

- Material Selection
- Specification- Integration
- Plans
- Details
- Mock Ups
- Performance Verification
- 14000 Specification -First Level QC + self audits
- Large size details/isometrics
- BECx

- **Construction Process**
- Safety
- Subcontractor Prequalification
- Shop Drawings
- Building Enclosure Risk Management
- Field Performance Testing Verification
- Mock Ups – Virtual + off building
- Educated CMs & GCs
- BECx

Air Barrier Selection Process



Air Barriers --Today's Issues

- **Materials**
- Fire/ Life Safety
  Environmental Conditions
  Service Life
  Compatibility
- Durability
- Sustainability
- Design Process
- Standards

Air Barrier Process Improvements

- Technical Data – manufacturers
- Technical information available to Design Professionals
- Integration of Air Barriers + Flashings
- Field Performance Verification Testing
- Substrate Moisture Measurements
- Equipment Maintenance
- Project Specifications – integrated across all Divisions to accommodate air barriers – shop drawings, compatibility, installation work sequence, mock ups, field performance verification
- Plans – large size details, isometrics

What are the Air Barriers Issues of Today ?

- Substrate Moisture verification testing
- Compatibility
- Durability
- Terminations

Risk Management of the Air Barrier

- Plans
- Specifications
- Prequalification of subcontractors
- Building Enclosure Co-ordination Program
- Submittals/ Shop Drawings
- Mock ups
- First Work and Crew Performance Evaluation
- Substrate preparation
- Field Performance Verification Testing

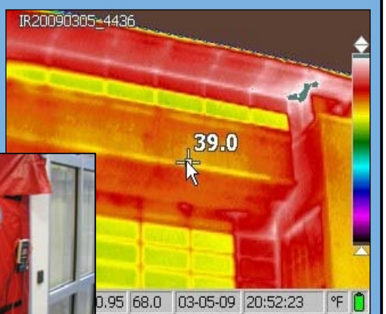
Quantitative Testing of Air Barrier Assemblies

ASTM E 779 – Determining Air Leakage by Fan Pressurization

ASTM E 1827 – Determining Air tightness of Buildings Using an Orifice Blower Door

- Based on enclosure area (ft^2)
- A/E Defined Performance

  Example - 0.25 cfm/ft^2 @ 1.57 psf (USACE)
- Verification of installed air barrier assembly in place
- Provides most reasonable estimate of overall building air infiltration/ex-filtration



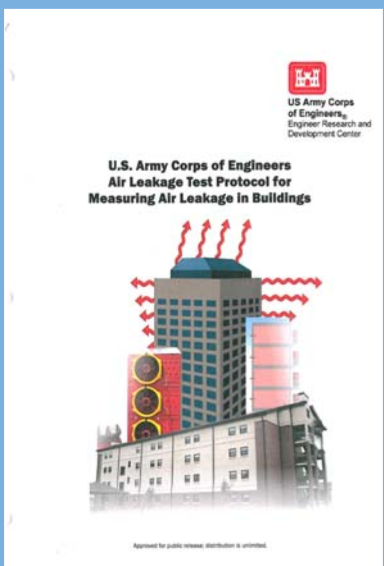
Field Testing for Air Leakage

- ASTM E 783 – Field Measurement of Air Leakage Through Installed Exterior Windows and Doors
- ASTM E 2357 – Air Leakage of Air Barrier Assembles
- ASTM E 779 – Determining Air Leakage by Fan Pressurization
- ASTM E 1827 – Determining Air Tightness of Buildings Using an Orifice Blower Door
- ASTM E1186 – Practices for Air Leakage Site Detection

Blower Door Testing ASTM E 779

- Air leakage rate of the building envelope does not exceed 0.25 cfm/ft2 at a pressure differential of 0.3" w.g.
- ASTM E 779 or
- ASTM E-1827

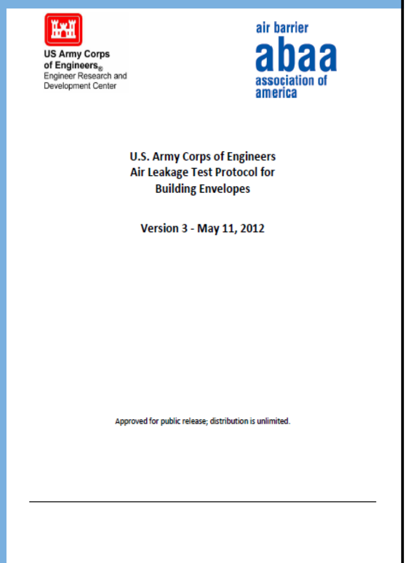
USACOE Air Leakage Test Protocol



US Army Corps of Engineers®
Engineer Research and Development Center

U.S. Army Corps of Engineers
Air Leakage Test Protocol for
Measuring Air Leakage in Buildings

Approved for public release; distribution is unlimited.



US Army Corps of Engineers®
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air barrier
abaa
association of america

U.S. Army Corps of Engineers
Air Leakage Test Protocol for
Building Envelopes

Version 3 - May 11, 2012

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Question For The Construction Team

- What are the components of a process to manage the risks posed by the building enclosure to air barriers ?

Considerations for the Improvement of Air Barriers

- Improvement in Safety Training of air barrier installers
- Improvement of the air barrier materials
- Improvement of air barrier field testing methods
- Improve substrate moisture testing and documentation
- Improve Mock up testing – both off and on building
- Processes to improve Air Barrier installation
- Processes to improve the documentation of air barrier installation
- Processes to improve Project Design -- Plans and Specifications
- Improvement of Whole Building Air Leakage Testing - (WBALT)

BECx Process

Develop the Owner's Project Requirements (OPR)
Develop the Basis of Design (BOD)
Review the OPR, BOD and the project design
Develop and implement a Cx plan
Incorporate Cx requirements into the construction documents
Develop Construction Checklists
Develop system test procedures
Verify installation performance – Mock Ups, First Work, First Crew
Maintain an Issues and Benefits Log throughout the enclosure process
Prepare a final building enclosure verification report
Document all findings and recommendations and report directly to the Owner throughout the enclosure process

BEC /BECx Process includes :

A peer review of the plans and specifications for conformance with the OPR and BOD as well as air, water, and thermal continuity during construction document development at established levels of completion.
Construction team preconstruction and regular coordination meetings with A/E, CM, GC, subcontractors and manufacturer's technical representatives.
Field performance testing of representative critical enclosure components and systems.
Review of shop drawings and submittals, including quality assurance/control procedures performed during construction.
Field construction observation and the establishment of a non-conformance documentation process to track, discuss, resolve and document issues for the CM, GC and the Owner.

Examples of the key project task activities specific for air barriers include:
Develop enclosure performance verification specifications for the air barrier with performance testing acceptance criteria
Determine special testing needs for the specific project (laboratory and field)
Establish requirements for acceptance testing of the air barrier on a mock up or "first work" example to provide verification of skills for each construction crew performing air barrier installation work on the building
Perform testing of the air barrier system using industry standard tests such as ASTM E 783 and ASTM E 2357
Review and verification testing of the first work of air barrier installation on the building
Perform inspection and documentation of the air barrier during installation to verify the project air barrier installation for each type of substrate, terminations, and work sequences
Establish air barrier performance verification testing budgets for both the mock-up and during construction
Establish air barrier project schedules inclusive of submittals and mock ups, and field performance testing
Establish and implement installer performed Inspection Test Plans (ITPs), self-audits, third party audits for the verification of the air barrier installation.

Current Obstacles to Commercial Building Enclosures

1-Durability and compatibility of air barrier materials

2-The existence of a Standardized protocol and computation methods for Whole Building Air Leakage Testing

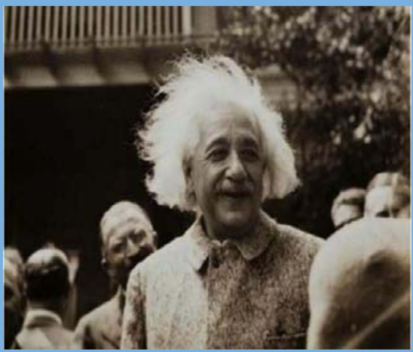
3-The existence of a standardized training and certification program for personnel to perform air leakage testing

4-Improving the reliability of air leakage testing methods, equipment, and computations for building energy consumption.

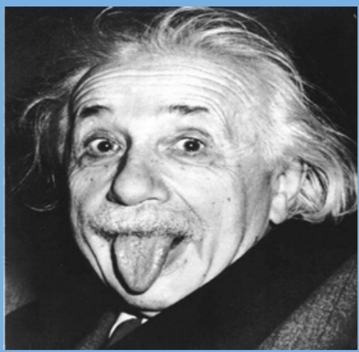
Air Barrier to be fully integrated into the envelope, it must be considered throughout all project specifications to include:

Submittals
Shop drawings
Field mockups
Field performance verification testing such as first work or mock-up leakage testing or whole building air leakage testing
Installation of acceptable substrates for the air barrier installation
Structural continuity for support of the air barrier
Compatibility with each of the individual interfacing materials with the air barrier
Detailing for all penetrations for fenestration, piping, conduits, and signage
Vigilant maintenance/protection of the air barrier and its continuity post installation by the construction manager, general contractor and each of the interfacing trade subcontractors.

Albert Einstein stated:



- Intellectuals Solve Problems



- Geniuses prevent them

- "Remember whatever you do – do it well "
- You can not improve what you do not measure
- Join the movement -- 'Ban the 'Q' Word'

Thank You for Your Attendance and Interest

WDP Contact

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703.257.9280

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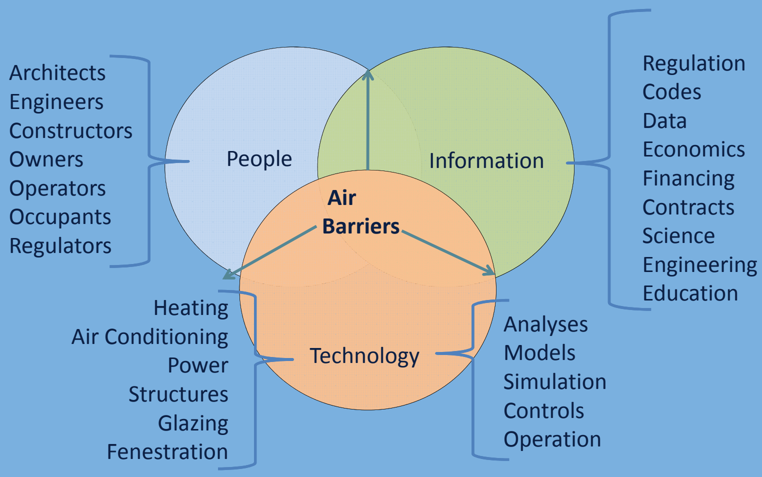
bnash@wdpa.com

Air Barrier

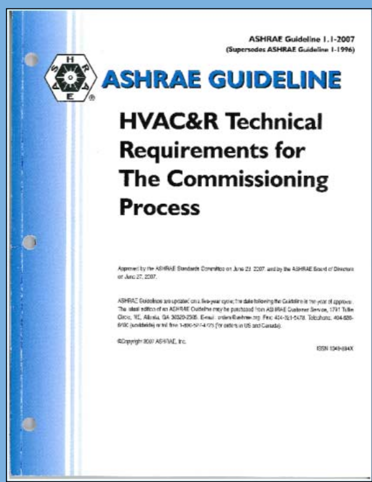

Architects
Engineers
Constructors
Owners
Operators
Occupants
Regulators
People
Information
Regulation
Codes
Data
Economics
Financing
Contracts
Science
Engineering
Education
Air
Barriers
Heating
Air Conditioning
Power
Structures
Glazing
Fenestration
Technology
Analyses
Models
Simulation
Controls
Operation

ASHRAE COMMISSIONING GUIDELINES

ASHRAE Guideline 0 - 2005: The Commissioning Process

ASHRAE Guideline 1.1 – 2007

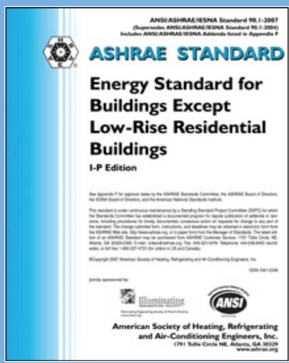
HVAC&R Technical Requirements for the Commissioning Process

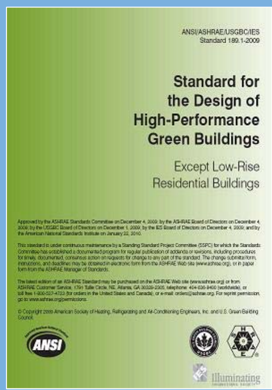

ASHRAE Guideline 1.1-2007
(Supersedes ASHRAE Guideline 1-1996)

ASHRAE GUIDELINE

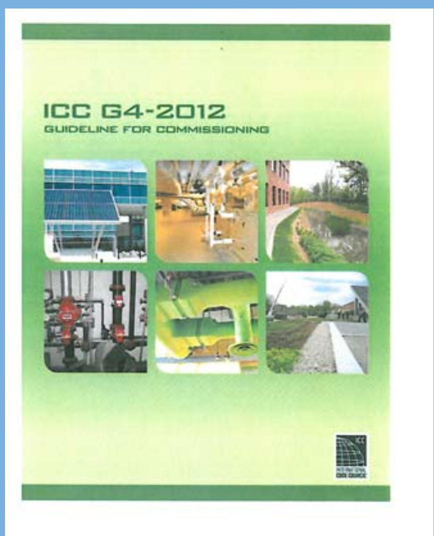
HVAC&R Technical Requirements for The Commissioning Process

ASHRAE Standards





International Code Council – G4-2012



ICC Commissioning Guideline

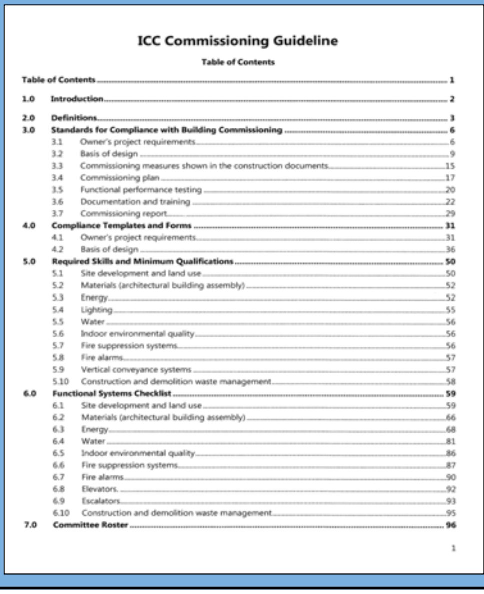

ICC Commissioning Guideline

Table of Contents

1

ICC Commissioning Guideline

OPR Building materials selection:

1. Moisture mitigation. List materials used to keep moisture from accumulating inside the building, such as flashing, waterproofing, sub-drains, etc.
2. Foundation drainage and waterproofing.
   - Provide a narrative description
3. Flashing
   - Provide a narrative description
4. Exterior wall coverings.
   - Provide a narrative description
5. Roof coverings.
   - Provide a narrative description

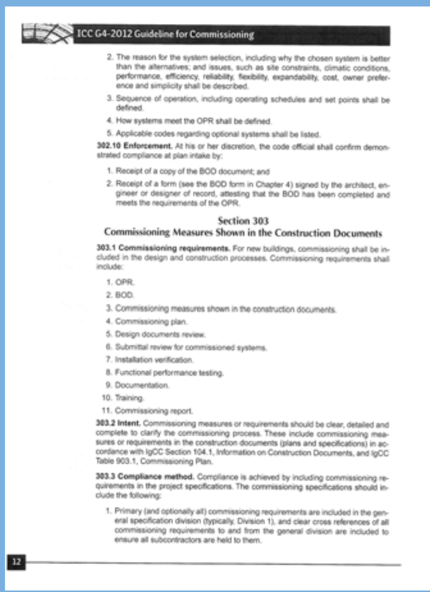
BOD/Materials:

1. Narrative description of the foundation drainage and waterproofing materials used.
2. Narrative description of flashing materials used.
3. Narrative description of exterior wall covering materials used.
4. Narrative description of roof-covering materials used.

International Code Council – G4-2012 Guideline for Commissioning

- Chapter 3- Standards for Compliance with Building Commissioning
- Section 301 -OPR
- Section 302-BOD
- Section 303- Commissioning measures shown in the construction documents
- Section 304-Commissioning Plan

International Code Council – G4-2012


ICC G4-2012 Guideline for Commissioning

2. The reason for the system selection, including why the chosen system is better than the alternatives; and issues, such as site constraints, climatic conditions, performance, efficiency, reliability, flexibility, expandability, cost, owner preference and simplicity shall be described.
3. Sequence of operation, including operating schedules and set points shall be defined.
4. How systems meet the OPR shall be defined.
5. Applicable codes regarding optional systems shall be listed.

302.10 Enforcement. At his or her discretion, the code official shall confirm demonstrated compliance at plan intake by:

1. Receipt of a copy of the BOD document; and
2. Receipt of a form (see the BOD form in Chapter 4) signed by the architect, engineer or designer of record, attesting that the BOD has been completed and meets the requirements of the OPR.

Section 303
Commissioning Measures Shown in the Construction Documents

303.1 Commissioning requirements. For new buildings, commissioning shall be included in the design and construction processes. Commissioning requirements shall include:

1. OPR.
2. BOD.
3. Commissioning measures shown in the construction documents.
4. Commissioning plan.
5. Design documents review.
6. Submittal review for commissioned systems.
7. Installation verification.
8. Functional performance testing.
9. Documentation.
10. Training.
11. Commissioning report.

303.2 Intent. Commissioning measures or requirements should be clear, detailed and complete to clarify the commissioning process. These include commissioning measures or requirements in the construction documents (plans and specifications) in accordance with IgCC Section 104.1, Information on Construction Documents, and IgCC Table 903.1, Commissioning Plan.

303.3 Compliance method. Compliance is achieved by including commissioning requirements in the project specifications. The commissioning specifications should include the following:

1. Primary (and optionally all) commissioning requirements are included in the general specification division (typically, Division 1), and clear cross references of all commissioning requirements to and from the general division are included to ensure all subcontractors are held to them.

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International Code Council – G4-2012

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
Heat Island Mitigation: • Energy consumption • Air pollutant emissions • Greenhouse gases • Trees and vegetation	• Verify cool roof complies with thermal emittance, solar reflectance, or SRI values per the code. • Verify structural and vegetative elements of the green roof. • Verification of the water quality as it pertains to the mitigation techniques utilized in the original construction of the site. • Verify that the O&M manual meets the needs of the property owner. • Check and document the energy consumption savings as they pertain to the mitigation techniques used in the construction of the site. • Check and document the decreased air pollutant emissions and greenhouse gases produced and released as they pertain to the mitigation techniques utilized in the original construction of the site. • Verification and documentation of the water quality as it pertains to the mitigation techniques utilized in the original construction of the site.
Lighting: • Site lighting • Security lighting • Area lighting • Landscape lighting • Sports lighting	• Verify exterior lighting meets light pollution plan. • Check and document that all fixtures are in compliance with the definitions as defined by the IESNA. • Check peripheral vision enhancement. • Check and document that the smallest wattage lamp source available is used to meet the desired lighting levels. • Check and document that the ratios of illuminance and luminance values are in compliance with the IESNA's 9th Edition *Handbook Recommended Standards*. • Verify that all fixtures installed have been either selected from the specified product group or submitted as approved alternatives, as approved by the governing body of the local area. • Check and document that primary entry lighting, exterior emergency egress lighting, service area lighting, surface parking, parking garage and roadways are in compliance with the final lighting commissioning plan. • Verification and documentation that the O&M manual meets the goals of the owner.
Brownfield Mitigation: • Baseline risk assessment • Corrective action plan • Remedial action plan • Remedial investigation/ feasibility study	• Verification and documentation that the baseline risk assessment clearly and correctly identified and evaluated the threat to human health and the environment. • Verification and documentation that the recommended cleanup criteria and alternatives for remediation are aligned with the extent of contamination on the site. • Observation, verification and documentation that the cleanup of the site is at a level determined to be health protective for its intended use.

Table 602
Materials (Architectural Building Assembly)

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
• Foundations subsoil drainage system	• Verify compliance with approved plans, specifications and construction documents.
• Foundation dampproofing and waterproofing	
• Flashing at exterior doors, skylights, wall flashing and drainage systems	
• Exterior wall coverings	
Optional systems (not in the IgCC)	
• Moisture envelopes	• Meet OPR, BOD, Cx specifications.
• Exterior below-grade walls	• Check for proper drainage system at exterior wall perimeter to keep water from entering the building.

International Code Council – G4-2012

RELATED SYSTEMS, EQUIPMENT, ASSEMBLIES AND COMPONENTS	TASKS/COMMENTS
• External floor and soffits, slab-on-grade	• Check for thermal resistance or insulation when required. • Check the IECC, when applicable. • Slabs: Check drainage for moisture penetration.
• Exterior walls	• Check drawings for wall assembly requirements and any sound transmission class (STC) requirements in accordance with ASTM E 90 and ASTM E 413. • Check for compliance with Section 1403.2 of the 2009 *International Building Code* (IBC).
• Exterior glazed window fenestration: windows, glazed doors and skylights	Drawing reviews and contractor submittal reviews: • Check that fenestration products are labeled with a U-factor (see NFRC 100) and a solar heat gain coefficient (SHGC) (see NFRC 200), and certification for the air infiltration requirement of 0.3 cfm/ft² of the 2010 *California Energy Code* (CEC) or other approved standards. • Check for proper flashing and caulking at walls and roof assemblies. Glazed doors: • Check for proper flashing, and seals and gaskets; and proper pull force, if provided with a closer. • Check for proper door swing. • Check for STC requirements, if applicable.
• Site-built fenestration: curtain walls and store-front systems, and atrium roof systems	• Check for a label certificate issued by the National Fenestration Rating Council (NFRC) or a label certificate issued by the glazing fabricator that meets the default U-factor of the 2008 CEC and SHGC; or an NFRC component modeling approach (CMA) label certificate or another approved standard. • Check for proper door swing. • Check for STC requirements, if applicable.
• Field-fabricated fenestrations: fenestration made at the site, not preformed or cut	• Check for compliance with the default U-factor and the default SHGC in accordance with the tables of the 2008 CEC or another approved standard.
• Exterior doors	• Check for proper flashing installation at header, walls and floor. • Check for U-factor requirements for swinging and nonswinging doors. • Check for appropriate manufacturer's referenced standard [American Architectural Manufacturer's Association (AAMA); Canadian Standards Association (CSA); and Window and Door Manufacturer's Association (WDMA) or other approved standard] product data sheets.
• Sealants, control joints and flashing (stationary and moveable)	• Check for proper installation in accordance with the manufacturer's written instructions. • Check for proper flashing installation.
• Shading devices (stationary and moveable)	• Check for proper anchoring to building with proper flashing at wall connections. • At mechanical devices: check for proper installation and controls.
• Structural systems	• Check for proper anchoring in accordance with construction documents, including metal connectors and beam supports.
• Materials and finishes	• Check for compliance with allowed volatile organic compound limits and proper manufacturer's installation application. • Review product data sheets.

For SI: 1 cubic foot per minute per square foot = 0.00508 $m^3/(s \cdot m^2)$.

Other Project Requirements (not required by the IgCC)

• Structural systems	• Check for proper anchoring in accordance with the construction documents, including metal connectors and beam supports.
• Structural requirements for mechanical systems and renewable energy systems	• Prefunctional checklists, site observations and construction testing.