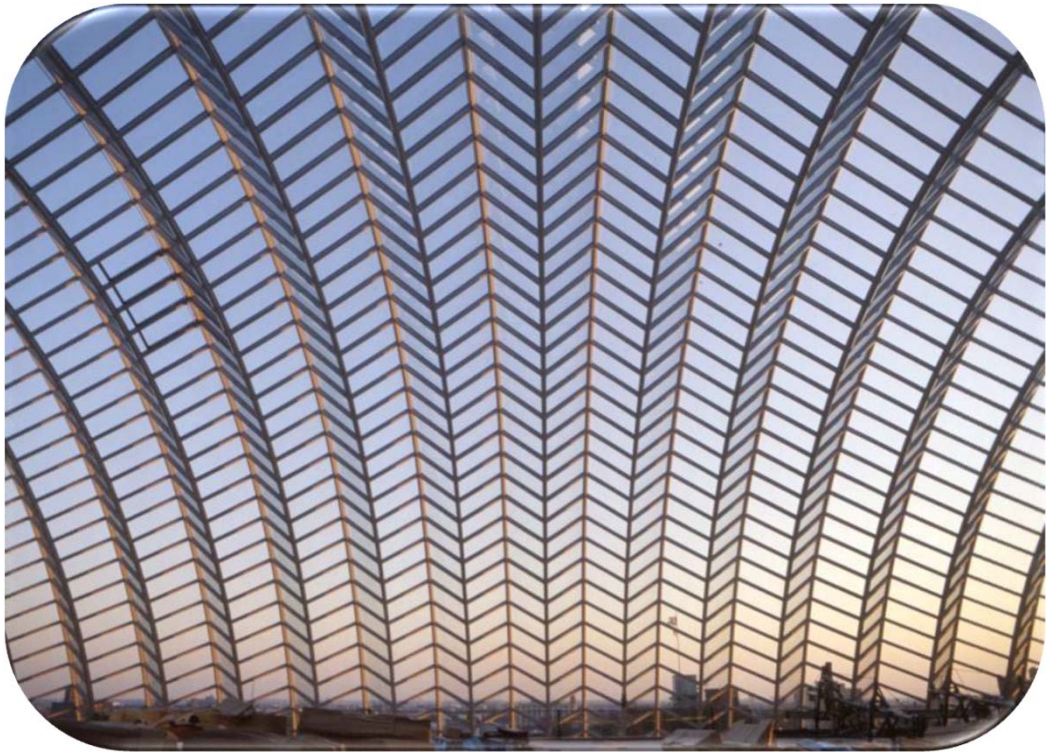
Building Enclosure Commissioning

What is it and why is it important?

Gilles PC Vandevoorde M.M.E.
General Manager – Building Sciences

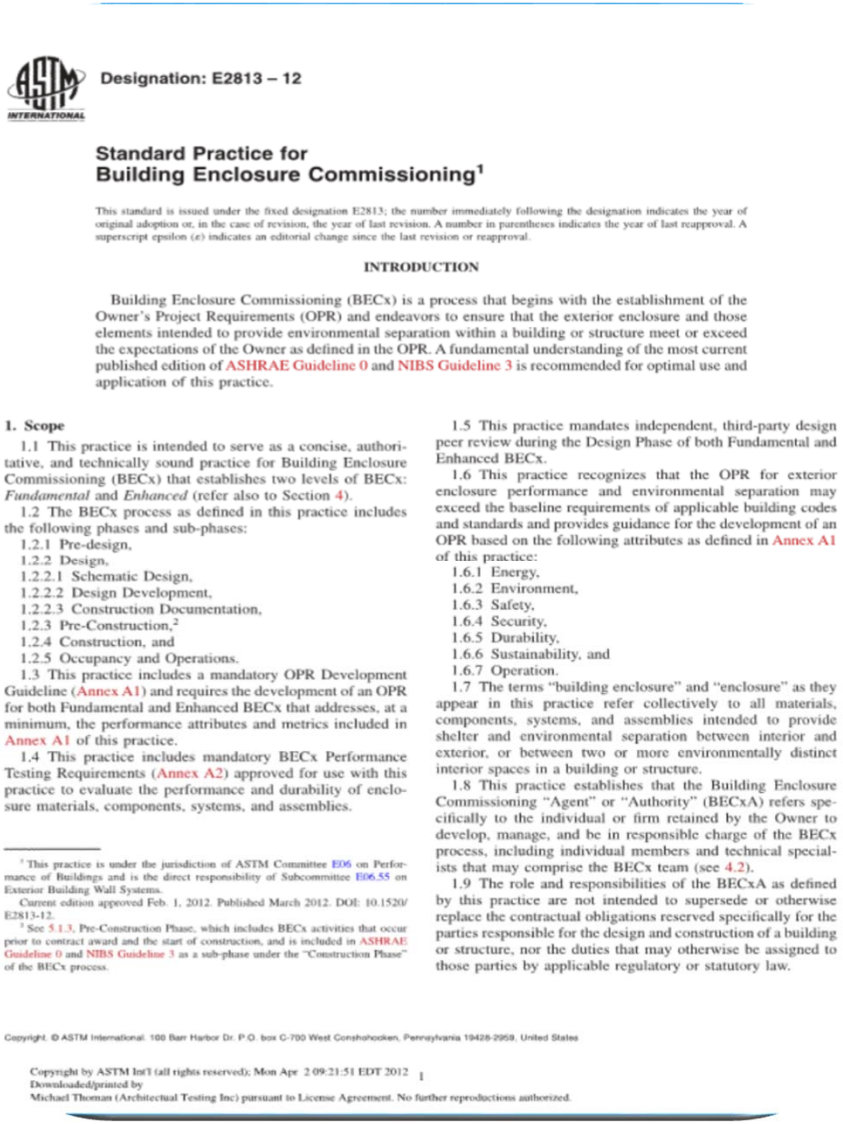
Program Outline

- **Building Enclosure Commissioning Overview**
- BECx Drivers
- BECx Process
- BECx Value



Presentation 30 Minutes with 5 Minutes Q&A

Defining Enclosure Commissioning



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.

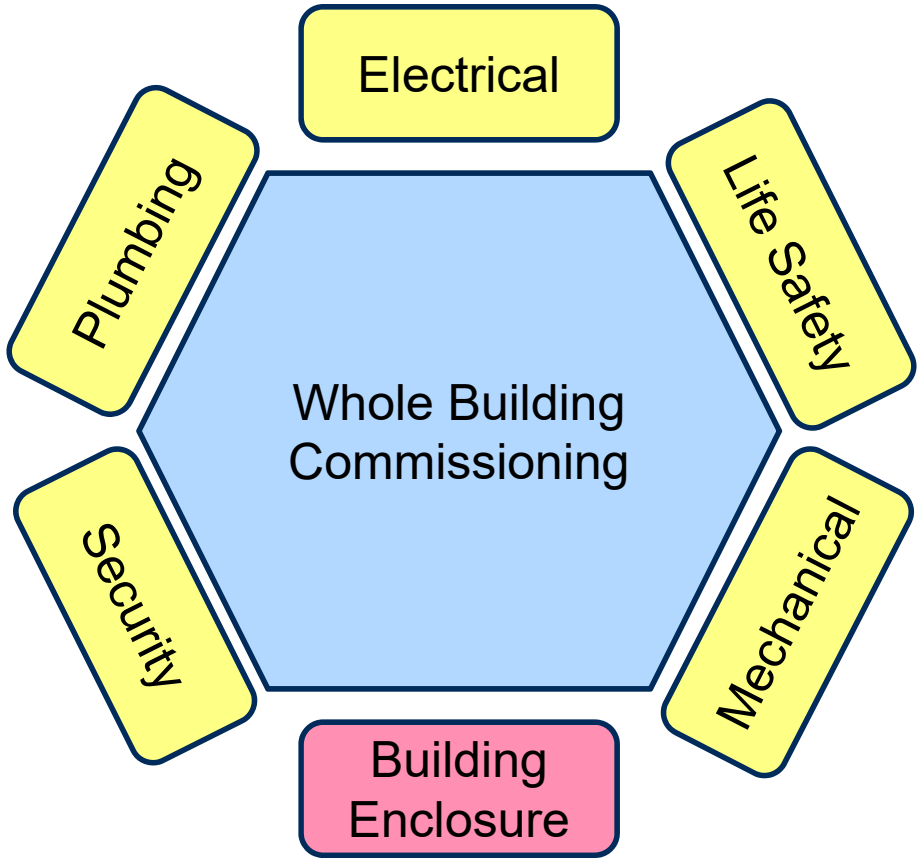
[1] This practice is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.55 on Exterior Building Wall Systems.
Current edition approved Feb. 1, 2012. Published March 2012. DOI: 10.1520/E2813-12.
[2] See 5.1.3, Pre-Construction 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.

Definition: Process that verifies enclosure performance against the Owner's Project Requirements (OPR) and Basis of Design (BOD)

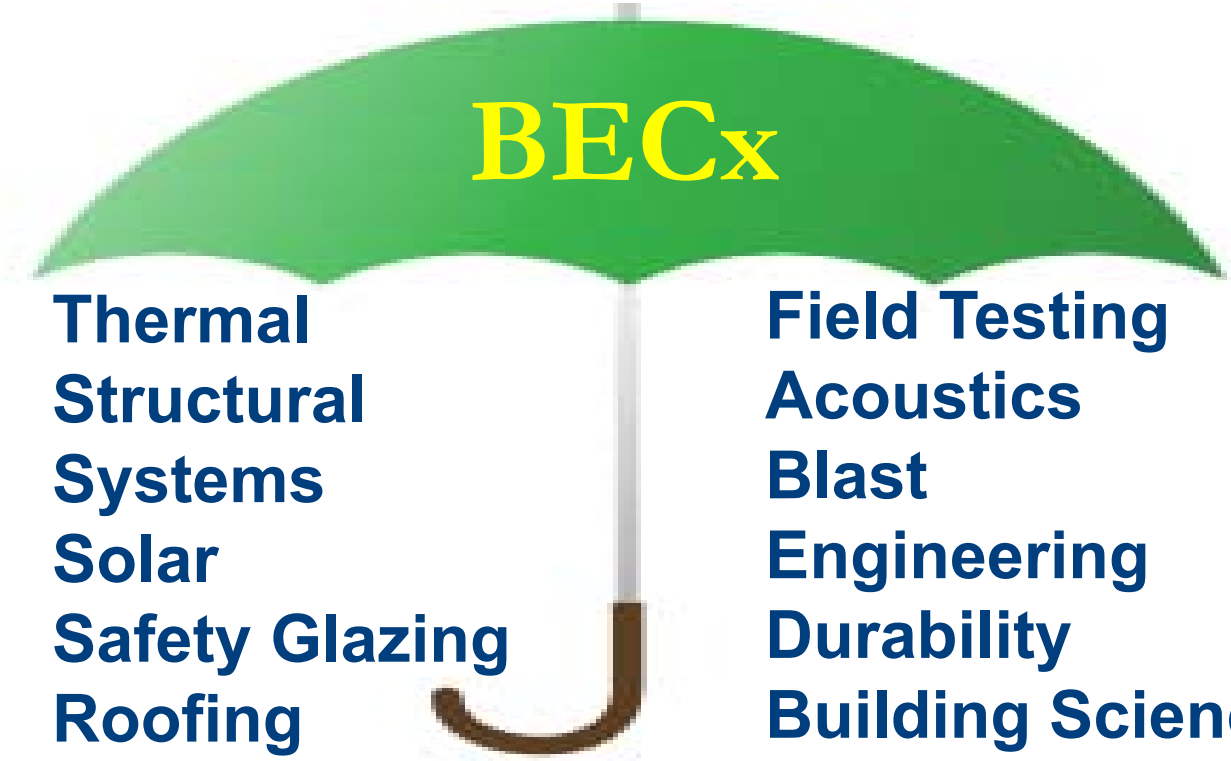
- BECx standards:
  - ASTM E2813
  - CSA Z 320
  - ASHRAE 202
  - VDI 6055

Formalization of the façade consulting practice

Whole Building Commissioning



BECx - Sub Disciplines



- Thermal
- Structural
- Systems
- Solar
- Safety Glazing
- Roofing
- Product Testing
- Materials
- Insulating Glass
- Fire
- Field Testing
- Acoustics
- Blast
- Engineering
- Durability
- Building Sciences
- Calibration
- Code Compliance
- Mock-up
- IAQ

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Section 502.4- Air Leakage

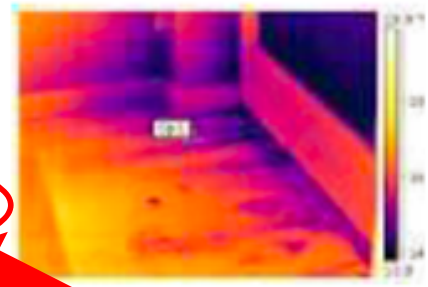
502.4.1 Air Barriers- The building thermal envelope shall be constructed with a continuous air barrier to control air leakage into and out of conditioned space.

502.4.1.2.1 Materials- Individual materials to have an air permeability not to exceed **0.2L/s.m2 at 75 Pa**

502.4.1.2.3 Building Test - The completed the building shall be tested and the air leakage rate of the building envelope shall not exceed **2.0 L/s/m2 at 75 Pa** (7.2 m3/hr @ 75 Pa)

502.4.5.2 Outdoor Intakes & Exhausts- to have class A motorized dampers with maximum leakage of 5.1L/s/m3 @1250 Pa **Exception:** Gravity dampers with leakage rate of 34L/s/m3 at 1250 Pa when intake or exhaust doesn't exceed 300 cfm.

502.4.8 Recessing Lighting- to have a maximum air leakage rate of 0.944 L/s at 75 Pa



10x Leakier than U.S. and Canadian Standards

Credit – Department of Municipal Affairs

Material Air Leakage - ASTM E 2178

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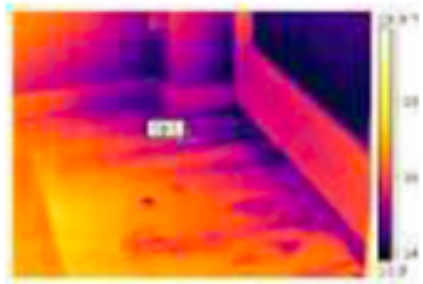
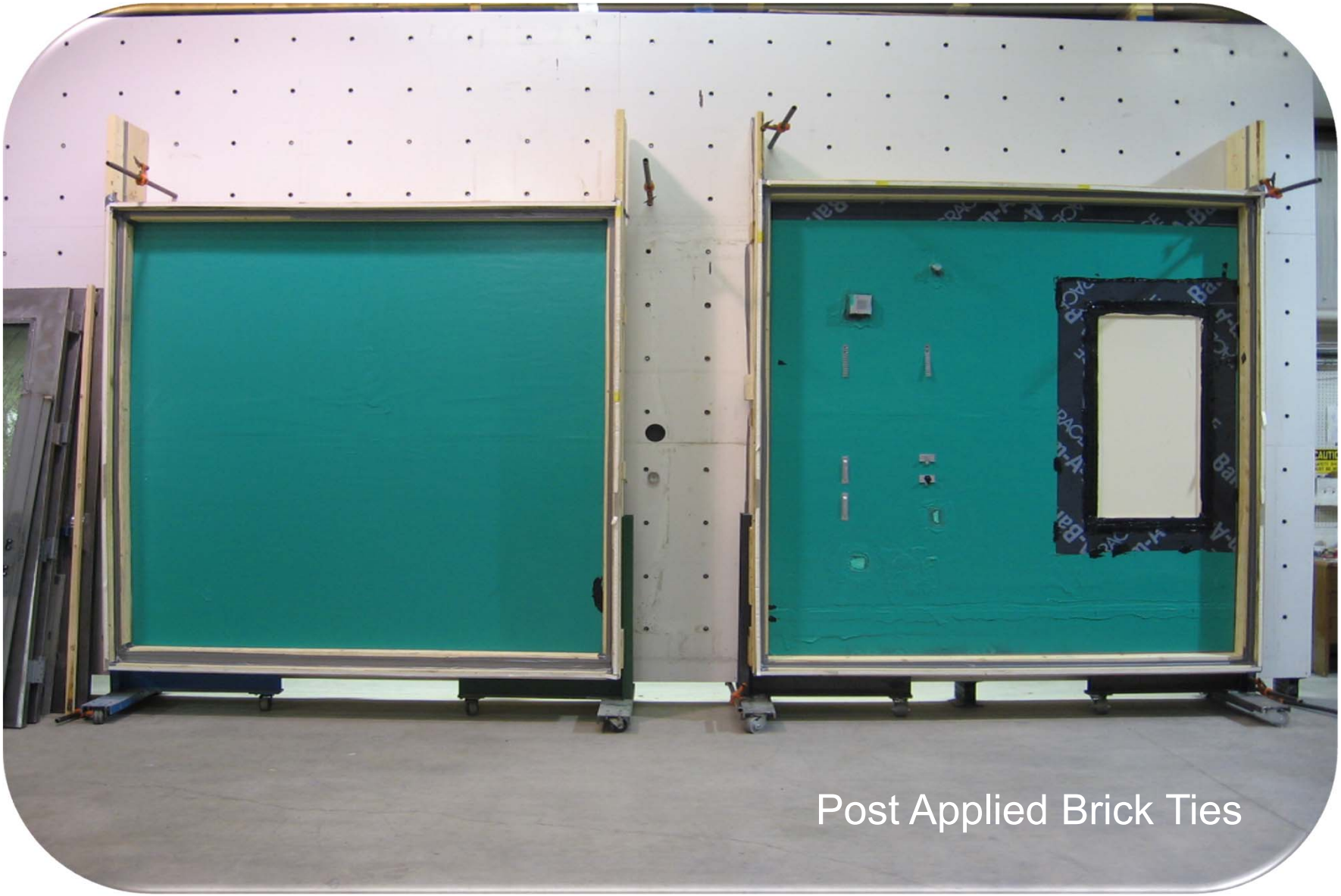


No assembly requirements

Credit – Department of Municipal Affairs

Assembly Air Leakage - ASTM E 2357



Post Applied Brick Ties

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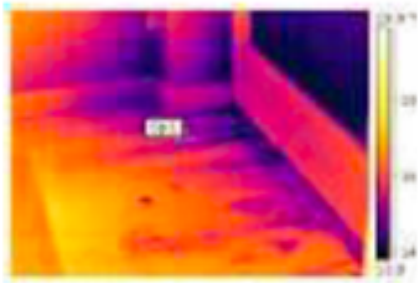

Same as U.S. and Canadian Standards

Credit – Department of Municipal Affairs

Whole Building Air Leakage-ASTM E 779

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Estidama Pearl Building Rating System

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The Pearl Rating System *for* Estidama
Emirate of Abu Dhabi

مجلس أبوظبي للتخطيط العمراني
ABU DHABI URBAN PLANNING COUNCIL

إستدامة
estidama

TEL +971 2 409 6000
FAX +971 2 443 2903
Abu Dhabi U.A.E.
www.upc.gov.ae

Estidama Pearl Building Rating System

IDP-4: Building Envelope Verification

Intent To ensure the building envelope meets the design intent and minimizes building impacts from condensation, water ingress, air infiltration and improper drainage.

Credit

Requirements

GENERAL

Demonstrate that a member of project team involved in the design of the building envelope has performed the following tasks:

During Design

- A review of the design plans and specifications during Detailed Design phase:

During Construction

- Off-site testing of prototypes for custom-made cladding systems before installation;
- A review of standard product pre-testing certificate for pre-tested systems before installation; and
- On-site water infiltration and air-tightness tests of the building envelope to ensure performance once installed.

Credit – Abu Dhabi Urban Planning Council – Estidama – PBRS - PORS

Estidama Pearl Building Rating System

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IDP-R3: Basic Commissioning

Intent	To ensure that the building performs as designed to protect occupant health and provide comfort and ongoing building efficiency.

RE-2: Cool Building Strategies

Intent	To determine the most effective solution to reducing a building's cooling demand by incorporating passive design strategies as a priority.

- ☐ Extracts from specifications relating to construction thermal performance parameters and building envelope air tightness specifications and air testing methodology (where applicable); and
- ☐ Roof drawings and specifications confirming all roof areas except those covered by mechanical plant, shading devices, renewable technologies and designated vegetated roofs use materials with a SRI ≥ 78.

Credit – Abu Dhabi Urban Planning Council – Estidama – PBRS - PORS

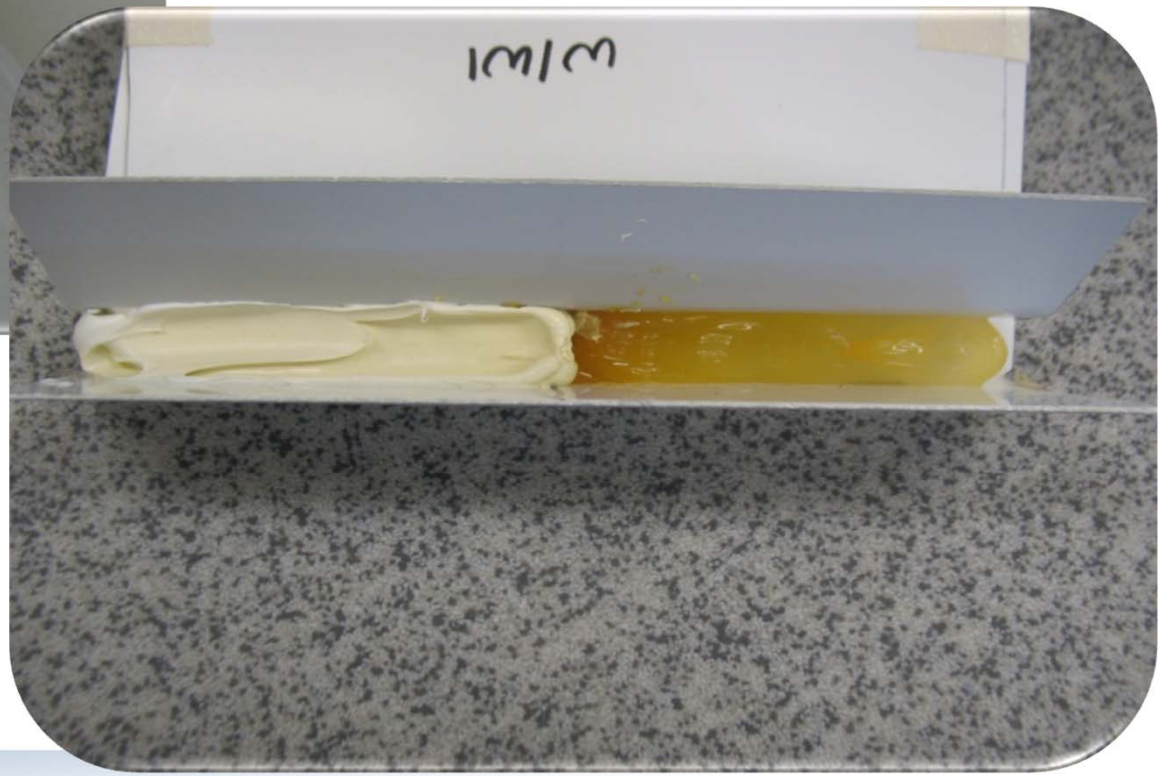
Program Outline

- Building Enclosure Commissioning Overview
- **BECx Drivers**
- BECx Process
- BECx Value

Why Commissioning?

- **Create durable structures**
- Save energy
- Improve indoor air quality
- Prevent leakage
- Increase occupant comfort
- To deliver a building that works

Material Compatibility



Clear silicone turns yellow when exposed to light. White turns yellow when exposed to clear!

Material Compatibility

Example of staining due to leading edge of asphaltic membrane touching the sealant.

Why Commissioning?

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- Improve indoor air quality
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Energy Usage and Building Enclosures

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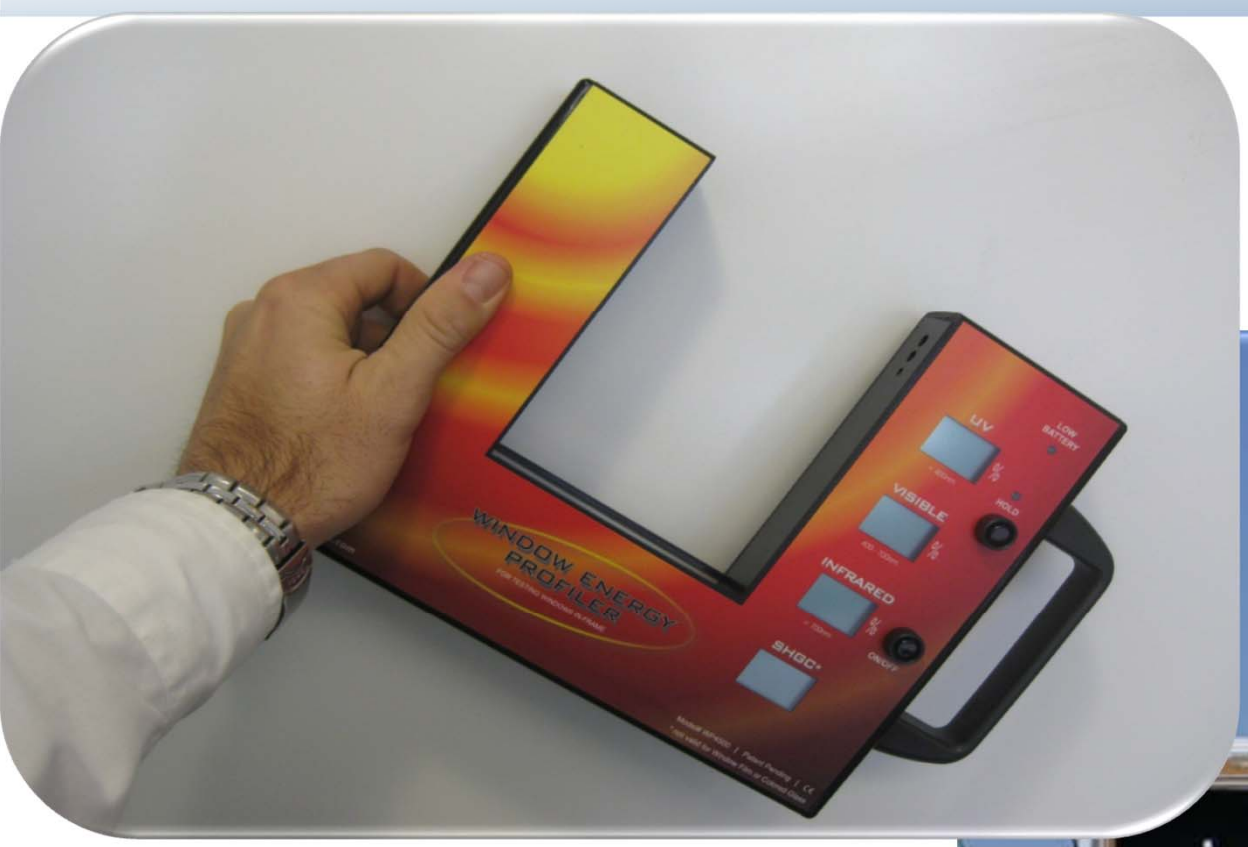
Solar Heat Gain

U-Factor

Air Leakage

Solar Heat Gain

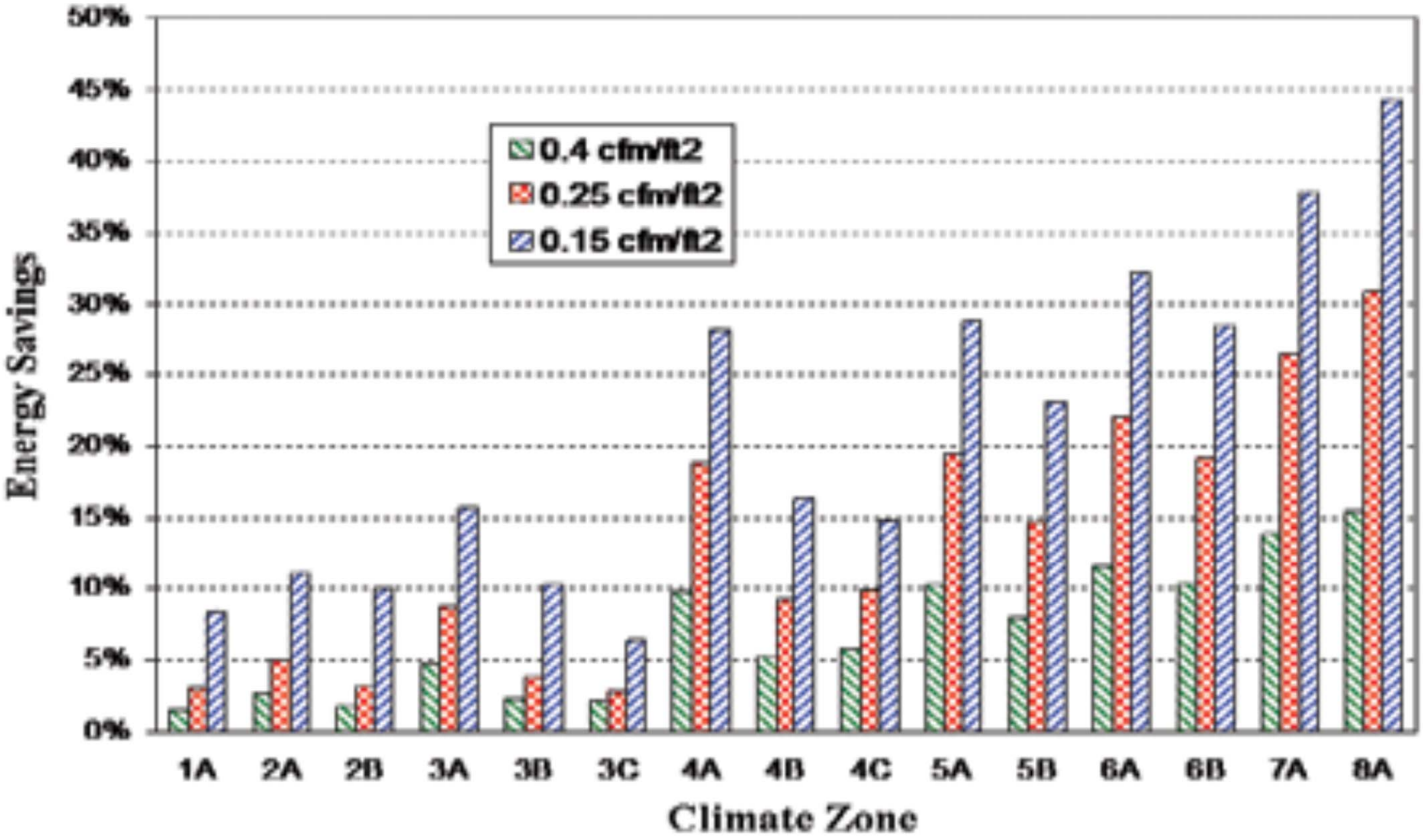


SHGC
Transmittance
Reflectance
Absorbance
Emittance

Window-to-Wall Ratio

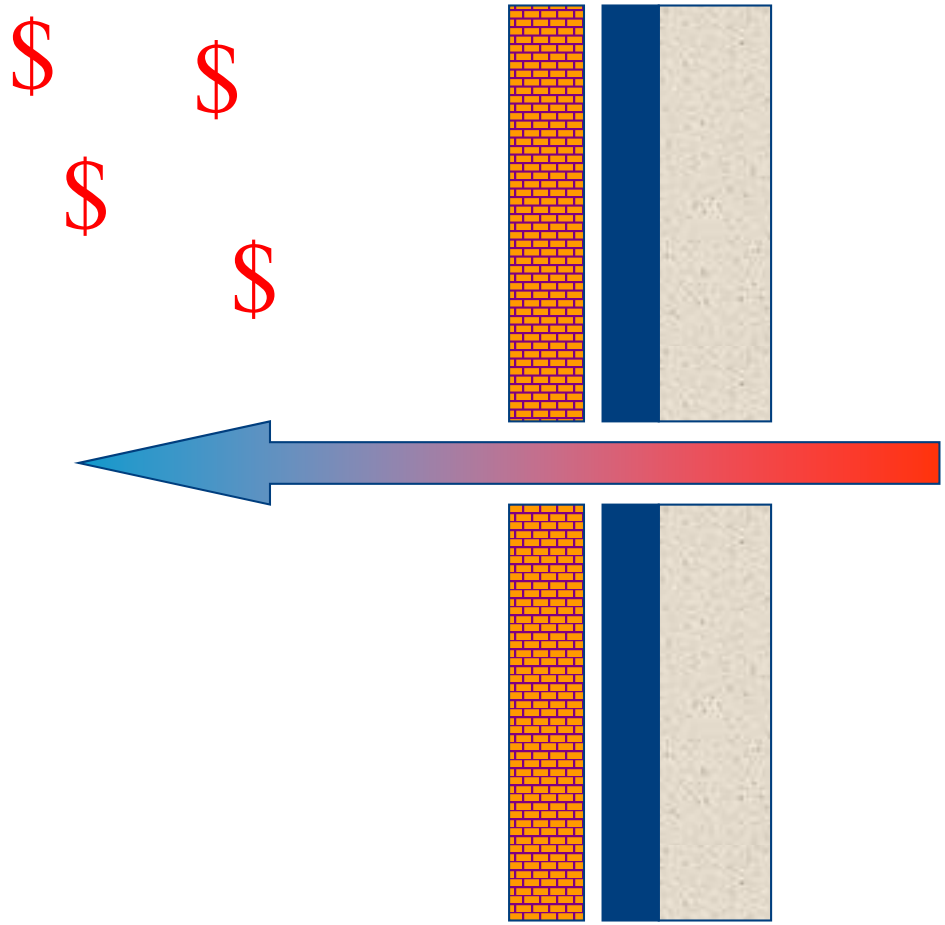
Thermal Discontinuities

Energy Usage vs Air Leakage

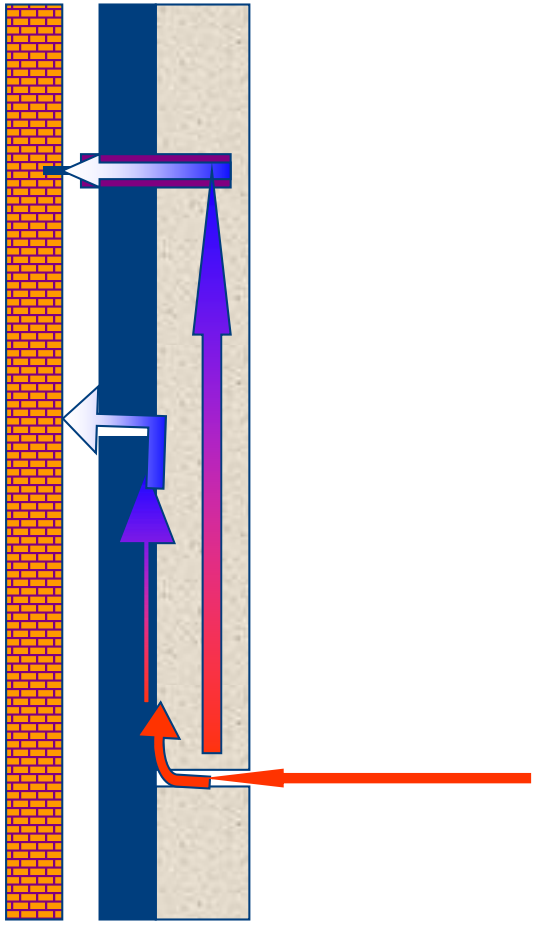


Credit: Journal of Building Enclosure Design Summer 2011 “Improvement of Air Tightness in U.S. Army Buildings” pgs. 11-13

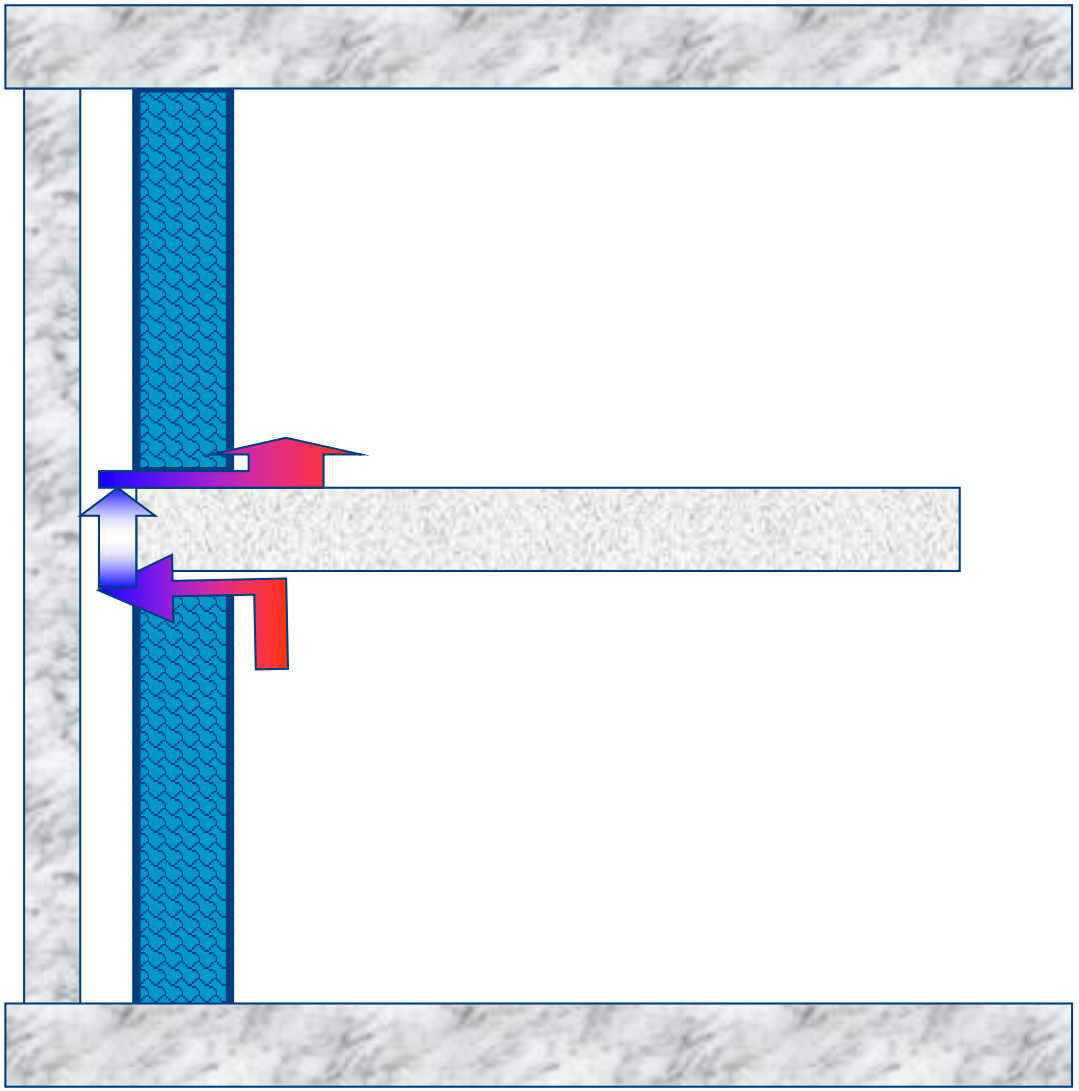
Orifice Leaks



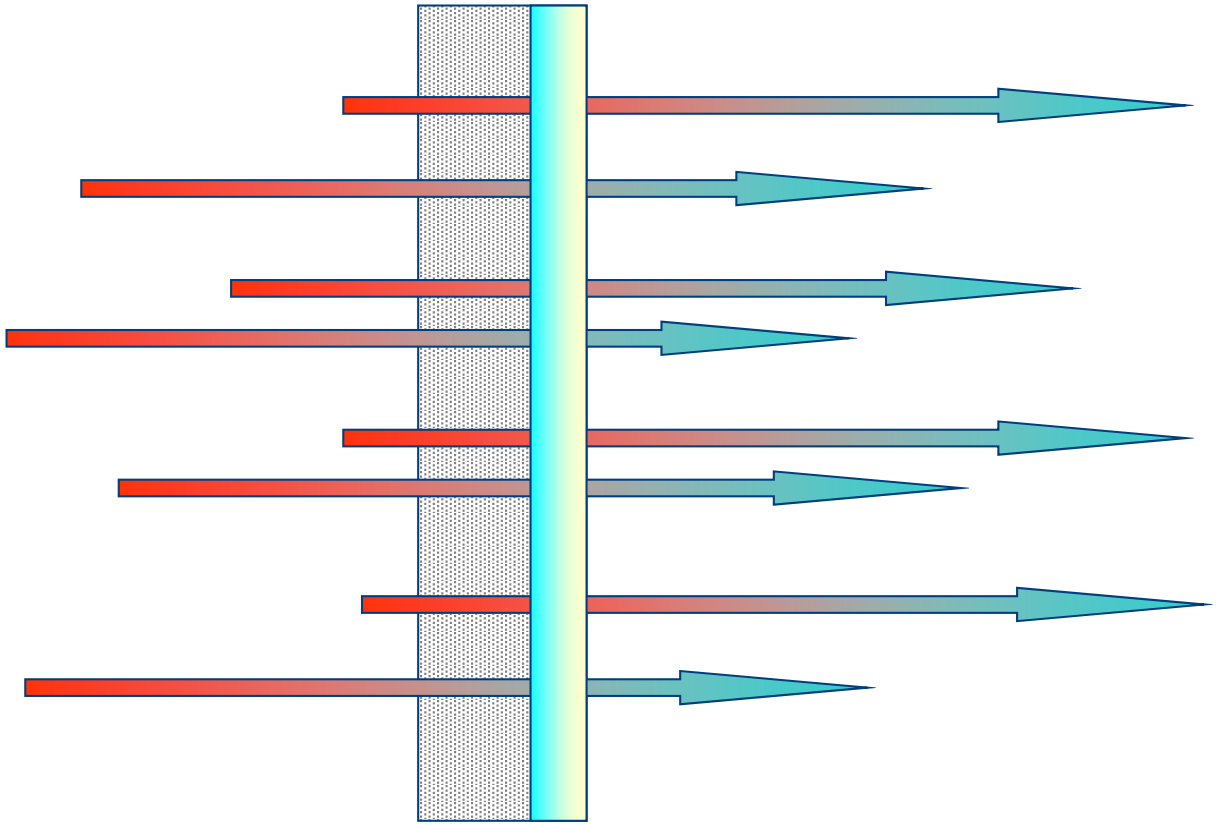
Channel Leaks



Flow Leaks



Diffusion



Why Commissioning?

- Create durable structures
- Save energy
- **Improve indoor air quality**
- Prevent leakage
- Increase occupant comfort
- To deliver a building that works


الشرطة

Why Commissioning?

- Create durable structures
- Save energy
- Improve indoor air quality
- **Prevent leakage**
- Increase occupant comfort
- To deliver a building that works

Building Requirements

Buildings are designed to protect the inhabitants from environmental conditions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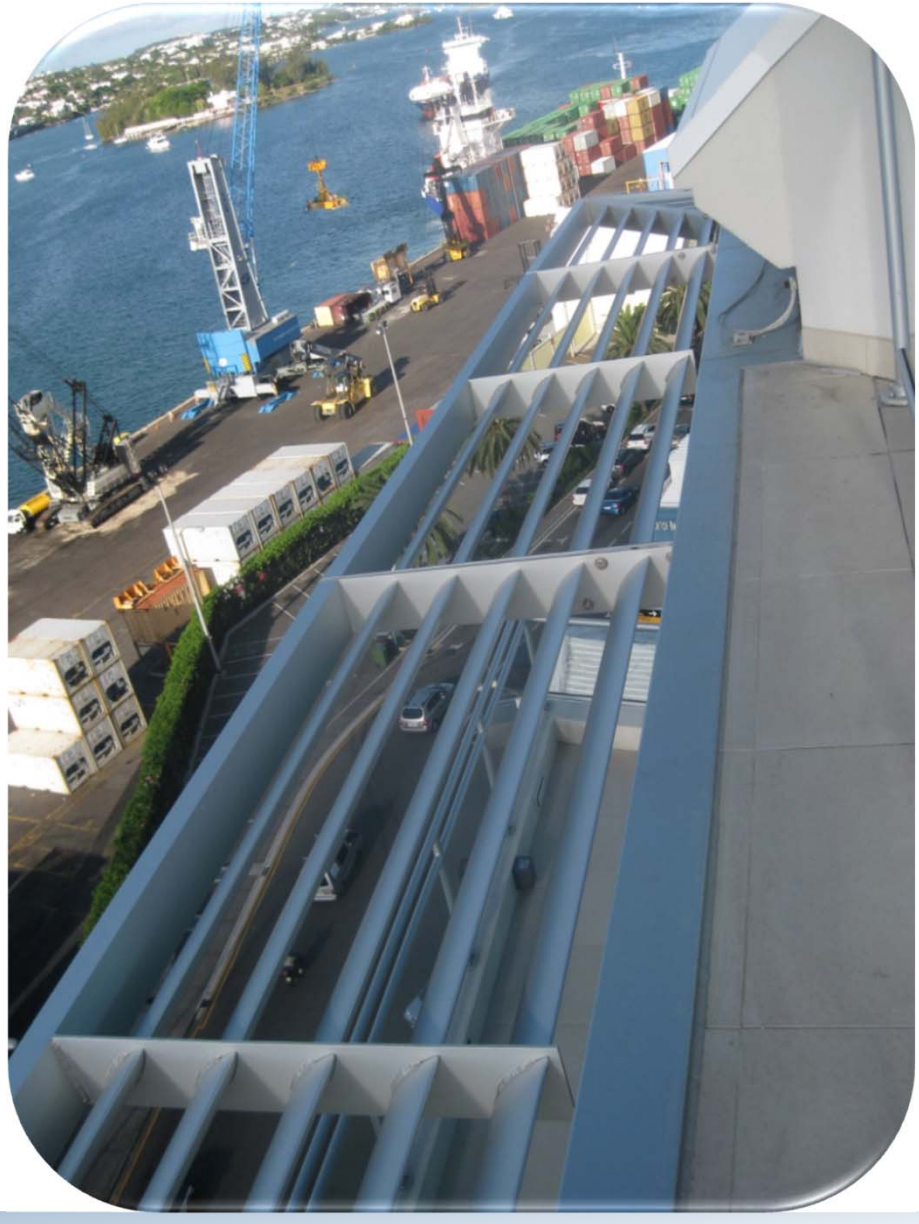
Géa


8 3:10PM

Why Commissioning?

- Create durable structures
- Save energy
- Improve indoor air quality
- Prevent leakage
- **Increase occupant comfort**
- To deliver a building that works

Shading



Why Commissioning?

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- Prevent leakage
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- **To deliver a building that works**

Case Study 1

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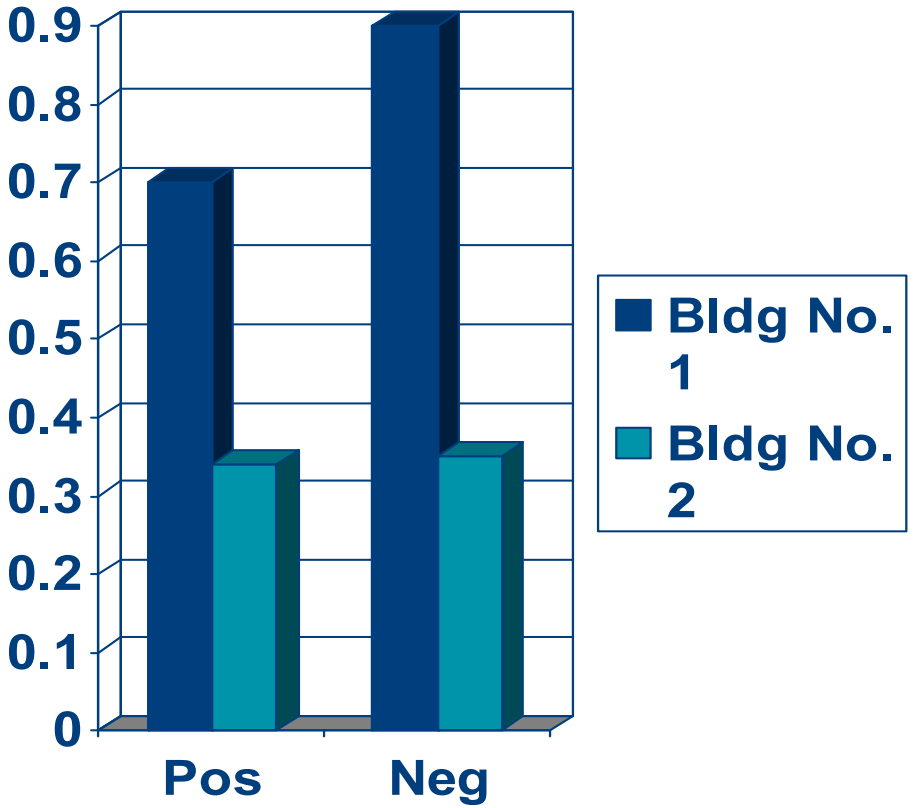
Building No. 1

Building No. 2

Case Study 1



Whole Building Air Tightness Testing

Building No. 1 (Existing): @ 75 PA = 0.70 - 0.90 cfm/ft²

Building No. 2 (New Construction): @ 75 PA = 0.34 – 0.35 cfm/ft²

Program Outline

- Building Enclosure Commissioning Overview
- BECx Drivers
- **BECx Process**
- BECx Value

BECx Process

- **Programming**
- Pre-Design
- Design
- Pre-Construction
- Construction
- Operations & Maintenance

Develop the Enclosure Specific OPR

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Building Enclosure Commissioning Selection Guide

Select all options that apply to specific project

	Performance	Functional Performance Testing
	----------Service Life in Years----------	
☐	Beyond code minimum fire protection required	
☐	Within 5 miles or 65 dBA or higher contour curve of airport	
☐	Interior dBA levels less than 45	
☐	Within 1000 ft of freeway, fire station, sports arena, racetrack	
☐	Within 3000 ft of active railway, helicopter pad	
☐	School, hospital, theater, mixed use residential/commercial	
☐	Beyond code minimum energy efficiency desired	
☐	Blast, forced entry or security performance required	
☐	Basic wind speed in excess of 100 mph	
	----------Tolerance to Water Intrusion----------	Enter applicable option from drop down box
	----------Thermal Conditions----------	Enter applicable option from drop down box
☐	LEED V3 2009 innovation point for Building Envelope Cx	
	----------Building Pressurization----------	Enter applicable option from drop down box
☐	No time loss facility (e.g. data center)	
☐	Functional performance layers are non-maintainable	
	----------Project Delivery----------	Enter applicable option from drop down box
	----------Project Schedule----------	Enter applicable option from drop down box
	----------Intererior Rh and climate----------	Enter applicable option from drop down box

Recommended Level of Thermal FPT	**No FPT Required**
Recommended Level of Acoustical FPT	**No FPT Required**
Recommended Level of Water FPT	**No FPT Required**
Recommended Level of Air FPT	**No FPT Required**
Recommended Level of Solar FPT	**No FPT Required**
Additional Miscellaneous Testing (Fire)	**No Additional Testing Required**
Additional Miscellaneous Testing (Blast)	**No Additional Testing Required**
Additional Miscellaneous Testing (Structural)	**No Additional Testing Required**
Recommended Level of Commissioning	**Basic Commissioning**

Energy Modeling & BECx

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Energy modeling influences design

- Modeling is performed in programing phase
- Used to validate design and evaluation options
- Scope of analysis is beyond MEP
- Traditionally performed by MEP professionals

BECx Process

- Programming
- **Pre-Design**
- Design
- Pre-Construction
- Construction
- Operations & Maintenance

Successful Design

- **Achieve environment separation**
- Meet durability/sustainability
- Fulfils desired use
- Simple
- Redundant
- Constructible

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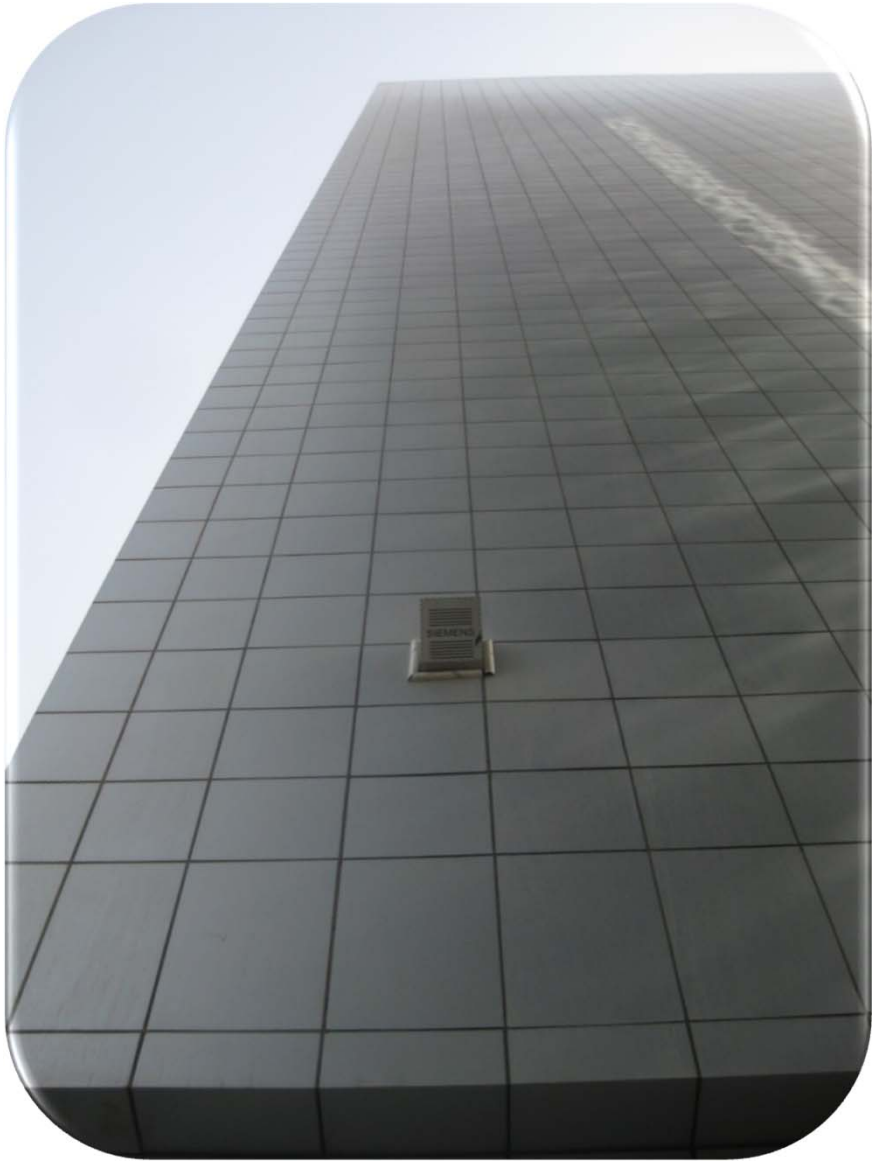

Successful Design

- Achieve environment separation
- Meet durability/sustainability
- Fulfils desired use
- Simple
- Redundant
- **Constructible**

BECx Process

- Programming
- Pre-Design
- **Design**
- Pre-Construction
- Construction
- Operations & Maintenance

Design Phase

- Review design against OPR and BOD
- Perform hygrothermal computer modeling (WUFI & Therm)
- Review construction sequencing and scheduling
- Write BECx and functional performance testing specifications
- Draft BECx plan

Design Reviews

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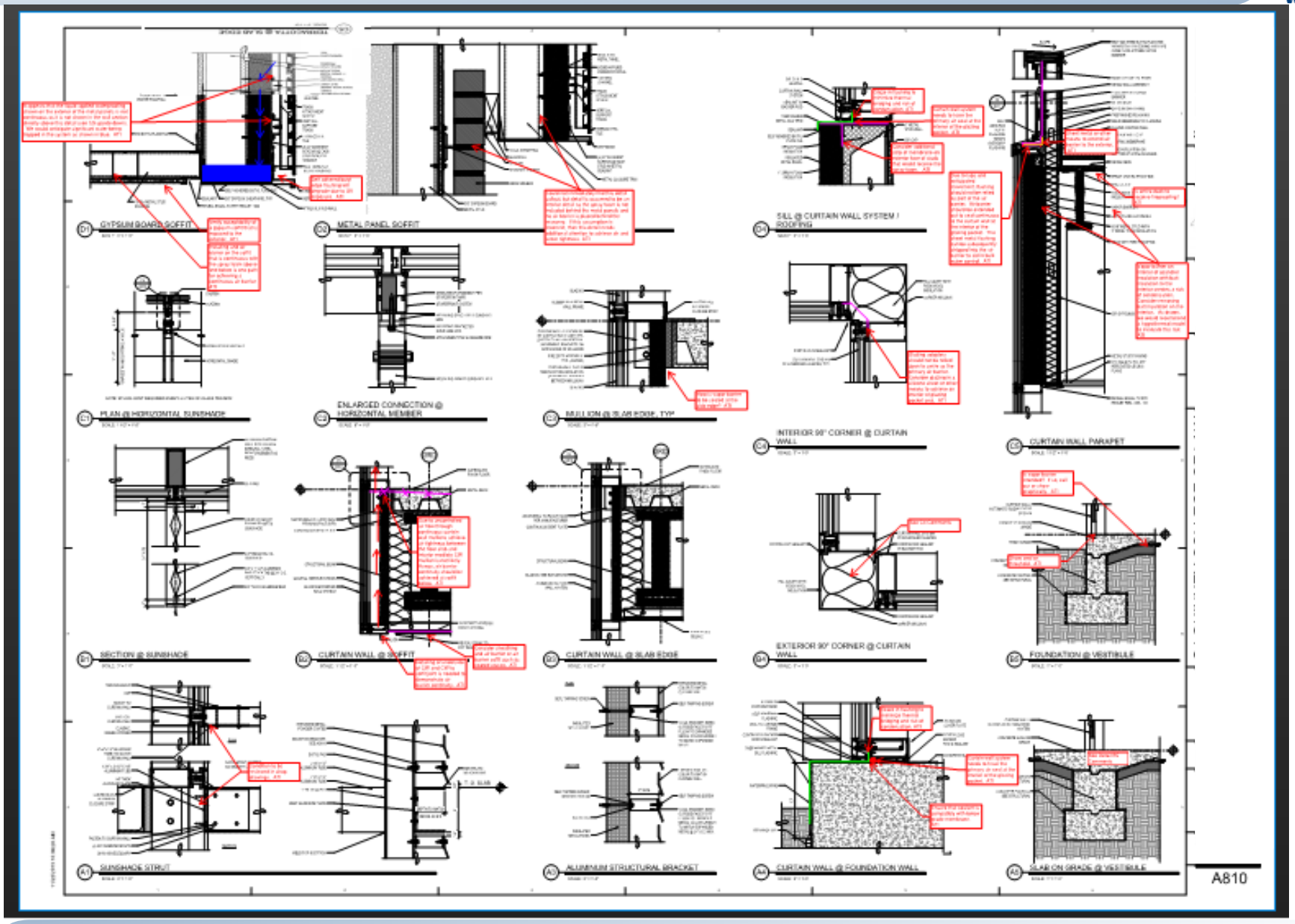

Detailed, Functional Design

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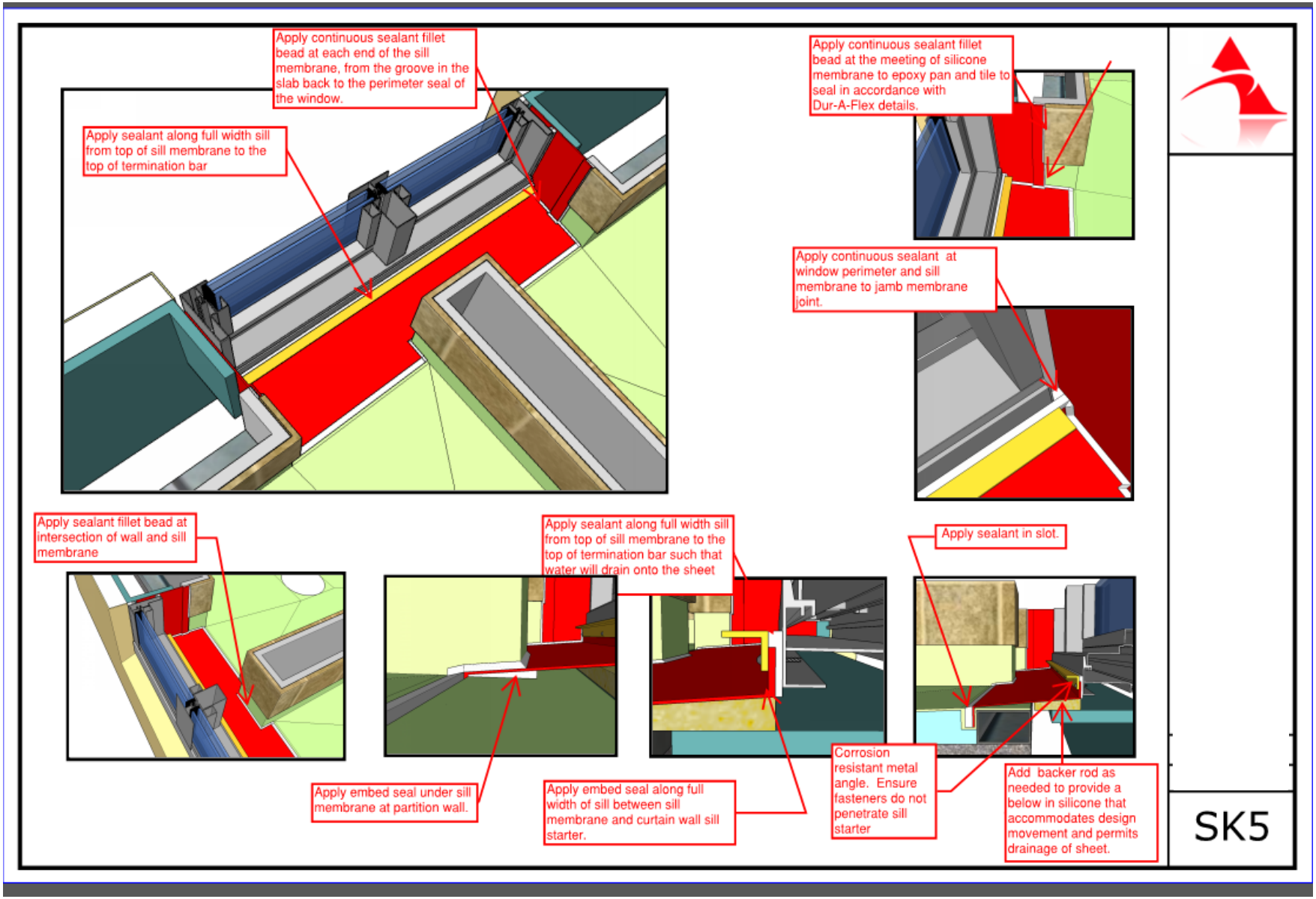

Hygrothermal Modeling

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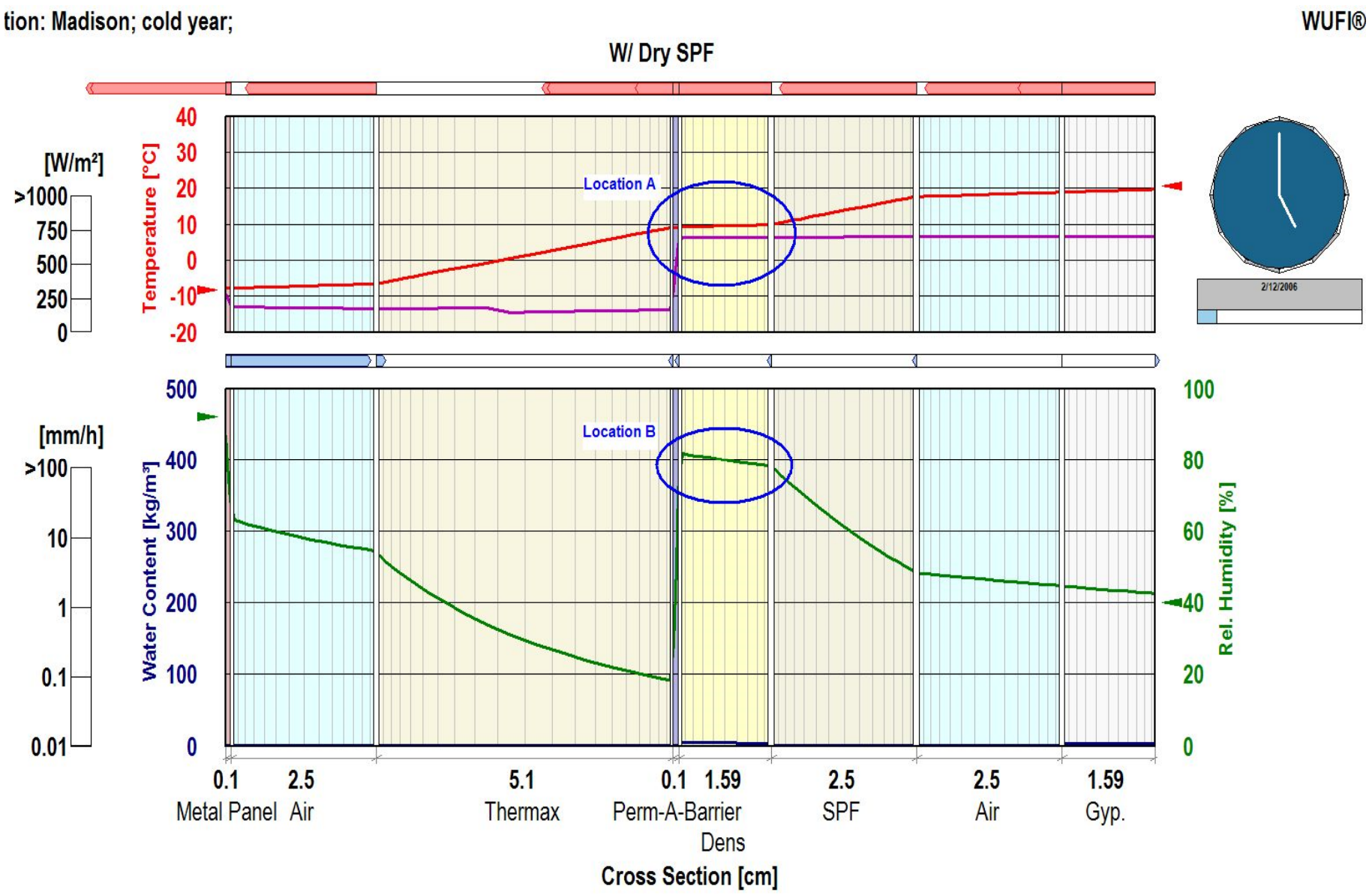

BECx Process

- Programming
- Pre-Design
- Design
- **Pre-Construction**
- Construction
- Operations & Maintenance

Pre-Construction - Shop Drawing Review

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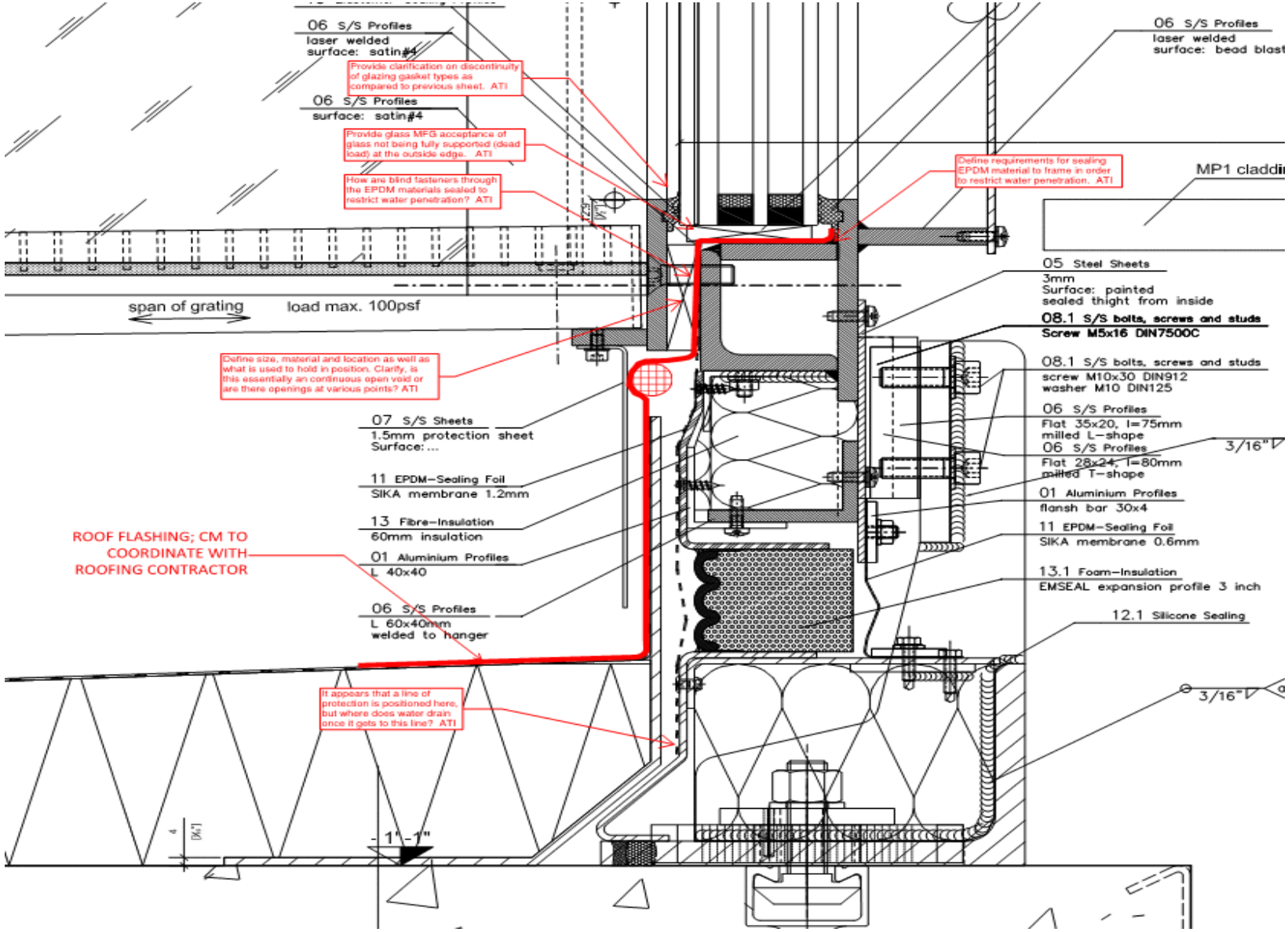



ectural
Testing
Link-Belt
9262


ectural
Testing


ASTME 283


ectural
Testing

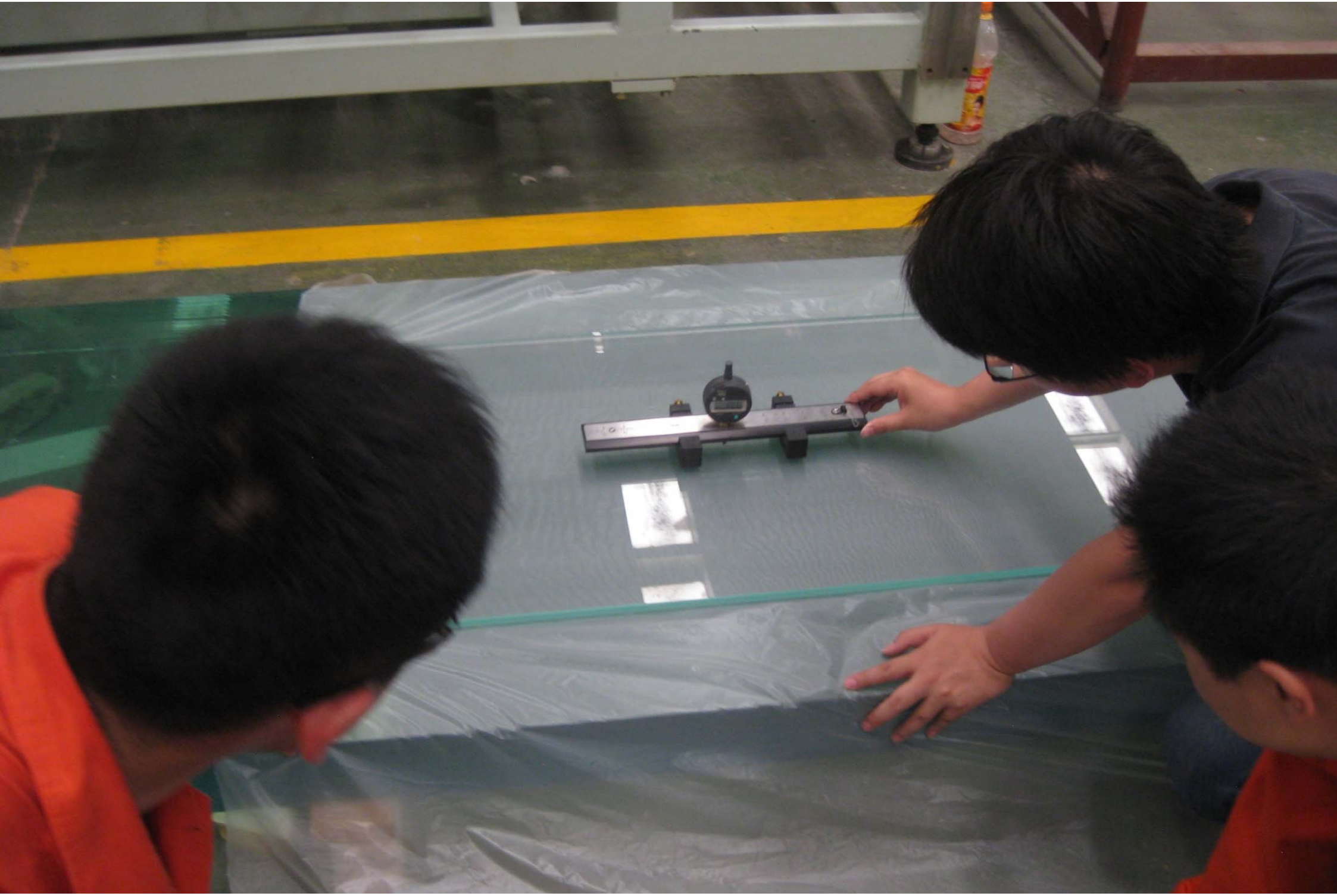
Mock-up Structural Testing – ASTM E330


Leak Location 2
Leak Location 1
SPEED LIMIT
30


GRACE
Perm-A-Barrier

BECx Process

- Programming
- Pre-Design
- Design
- Pre-Construction
- **Construction**
- Operations & Maintenance

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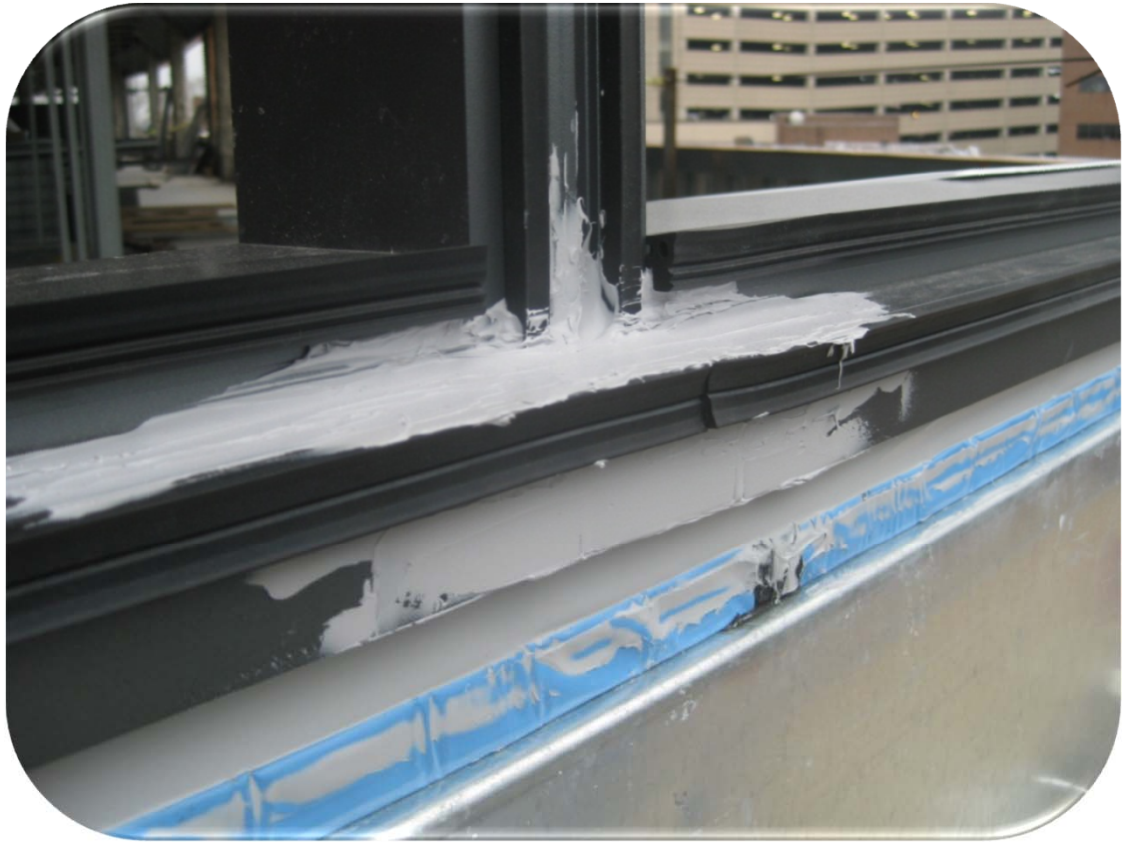
Thermal Losses


Blueskin

Installation Inspections



Architectural Testing

Project Name:	U Penn Fisher Translational Research Center	**Client:**	University of Pennsylvania Health System (UPHS)
Location:	Philadelphia, PA		
ATI Project No.:	84941.01-115-27	**Present:**	B. Monahan — ATI
			G. Swallow — UPHS
Reported by:	B. Monahan - Architectural Testing Inc. (ATI)		J. DeFelice — LF Driscoll (LFD)
Reported to:	G. Swallow - UPHS		K. Whalen — National Glass and Metal Co. (NGMC)
Weather:	Clear - 42° F		
On/Off Site Time:	8:45 AM 1:00 PM		

Work In Process: Stip window glazing installation at northwest corner, snap covers at north elevation
Insulation and vapor barrier installation at west elevation, 4th floor
Louver pan flashing completed at 5th floor, north, east and west elevations

Field Report No.: 4
Site Visit Date: 03/12/09

Item:	Observation:	Attention Required By:	Floor:	Elev.:	Location:	Photo No.:
11	The sealant applied between the back leg of the sill starter and the sill frame is adhered to the window sticker of the sill frame. All sealant substrates are to be cleaned and prepared in accordance with the manufacturers recommended installation procedures. NGMC removed the sealant and sticker, prepared the sealant substrates and reapplied the sealant prior to ATI leaving the site.	None	3	North	Column Q-2	1194
12	The joints between the back leg and end dam of the metal pan located below the louvers are unsealed at several locations. ATI notified LFD that sealing the joints of the metal pan is required to properly drain water collecting in the pan.	DeMeyo	5	North and West	Column P.6-5, Adjacent to columns L-2 and H-2	1188, 1189, 1191
13	Two fasteners penetrating through the metal pan flashing below the louvers were unsealed. ATI notified LFD that all fasteners through the flashing are to be sealed as indicated in the shop drawing detail.	DeMeyo	5	West	North of column E-2	1192

Additional Comments:

The above conditions represent discrepancies that we observed in the installed work compared to construction documents, installation instruction, shop drawings and good industry practice. Additionally, we noted conditions that are repairs or steps that are repairs or steps that they installers took in reaction to our observations. This report does not include our opinion regarding the merits of the remedial efforts, but we would be pleased to provide our opinion or other consulting services upon request. Unless the condition above states that it was repaired during our site visit, the condition remains outstanding. Our inspections do not constitute 100% inspections and Contractors are responsible to carry out 100% inspections of their work and corresponding repairs. Repeat conditions are indicative that this inspection is not being performed by the contractors.

Field Testing


Henry
BlueskinVP


Henry
BlueskinVP


Henry
Blueskin
160 SA
Blueskin VP

Quantitative Field Air Testing


ASHCROFT
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On
Off
Zero
Clear
260
MAX

Tracking Non-Compliance

Intertek
Valued Quality. Delivered.

JOB SUMMARY DASHBOARD

Job Name	Utah State Hospital
Job Number	CO175.01-010-10

Client	DFCM
Contact	John Buningham
Email	[redacted]
Phone	801-841-7278

Contractor	Layton Construction
Contact	Brian Molleth
Email	[redacted]
Phone	801-568-9393

Architect	HMK
Contact	Eric Thompson
Email	[redacted]
Phone	801-531-8388

Co Agent	
Contact	
Email	
Phone	

Notes	DFCM Project No. 13080400
	DFCM Contract No. 147817

FIELD OBSERVATION CONDITION STATUS BY PERCENTAGE

Open Conditions Closed Conditions

100% 80% 60% 40% 20% 0%

01 02 03 04 05 06 07 08 09 10

Field Observation Report

DRAWING REVIEW CONDITION STATUS BY PERCENTAGE

Open Conditions Closed Conditions

100% 80% 60% 40% 20% 0%

01 02 03 04 05 06 07 08 09 10

Drawing Review Report

SUBMITTAL REVIEW CONDITION STATUS BY PERCENTAGE

Open Conditions Closed Conditions

100% 80% 60% 40% 20% 0%

01 02 03 04 05 06 07 08 09 10

Submittal Review Report

FIELD TEST REPORT SUMMARY

Field Test Reports	8
Specimens Tested	35
Specimens Retested	14
Total Tests	49
Passed Tests	33
Failed Tests	7
NA Result Tests	9

TEST RESULTS BY PERCENTAGE

100% 50% 0%

- All Test Specimens have received a PASS result.
- Test Specimens remain with a FAIL result.
  Test Specimens remain with a FAIL result but continued testing is not required.
- Field Testing was completed as required.
  Field Testing modified from the original contract.

Notes: The Pediatric and the Payne building mockup testing was abandoned before all specimens could be tested to a PASS result due to scheduling issues. Failed specimens were not always retested because of access or availability of a rough terrain forklift.

FIELD OBSERVATION REPORT SUMMARY

Report	01	02	03	04	05	06	07	08	09	10	Totals
Observation Date	06-25-2013	08-08-2013	08-29-2013	09-24-2013	10-02-2013	10-09-2013	12-17-2013	01-14-2014	#N/A	#N/A	
Total Conditions	18	17	15	7	6	22	8	1	0	0	82
Closed Conditions	18	17	15	7	6	22	8	1	0	0	81
Open Conditions	0	0	0	0	0	0	1	0	0	0	1

DRAWING REVIEW SUMMARY

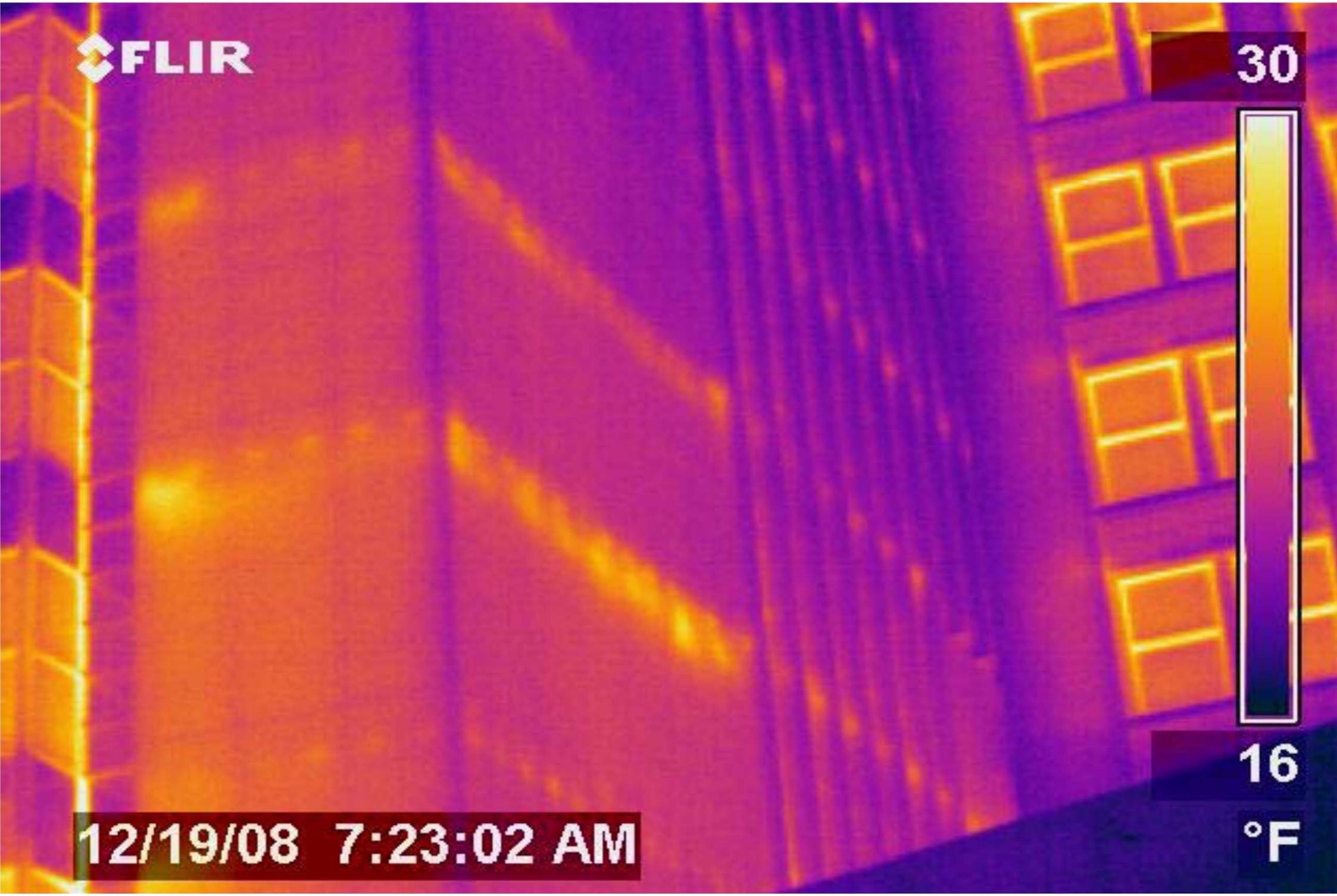
Report	01	02	03	04	05	06	07	08	09	10	Totals
Drawing Set	11111 USH Physio	11111 USH Pediatrics	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	

BECx Process

- Programming
- Pre-Design
- Design
- Pre-Construction
- Construction
- **Operations & Maintenance**


DO NOT MAKE REPAIRS OR ALTERATIONS
TO THIS STANDING SEAM METAL ROOF
WITHOUT APPROVAL
FROM THE BASE ENGINEER
THIS PRODUCT IS WARRANTED UNTIL
SEPTEMBER 2031
BY FIRESTONE BUILDING PRODUCTS
250 WEST 96TH STREET, INDIANAPOLIS, IN 46260
PH: 800-428-4511
FAX: 317-575-7227
DATE OF INSTALLATION: SEPTEMBER 2011


EXIT
EXIT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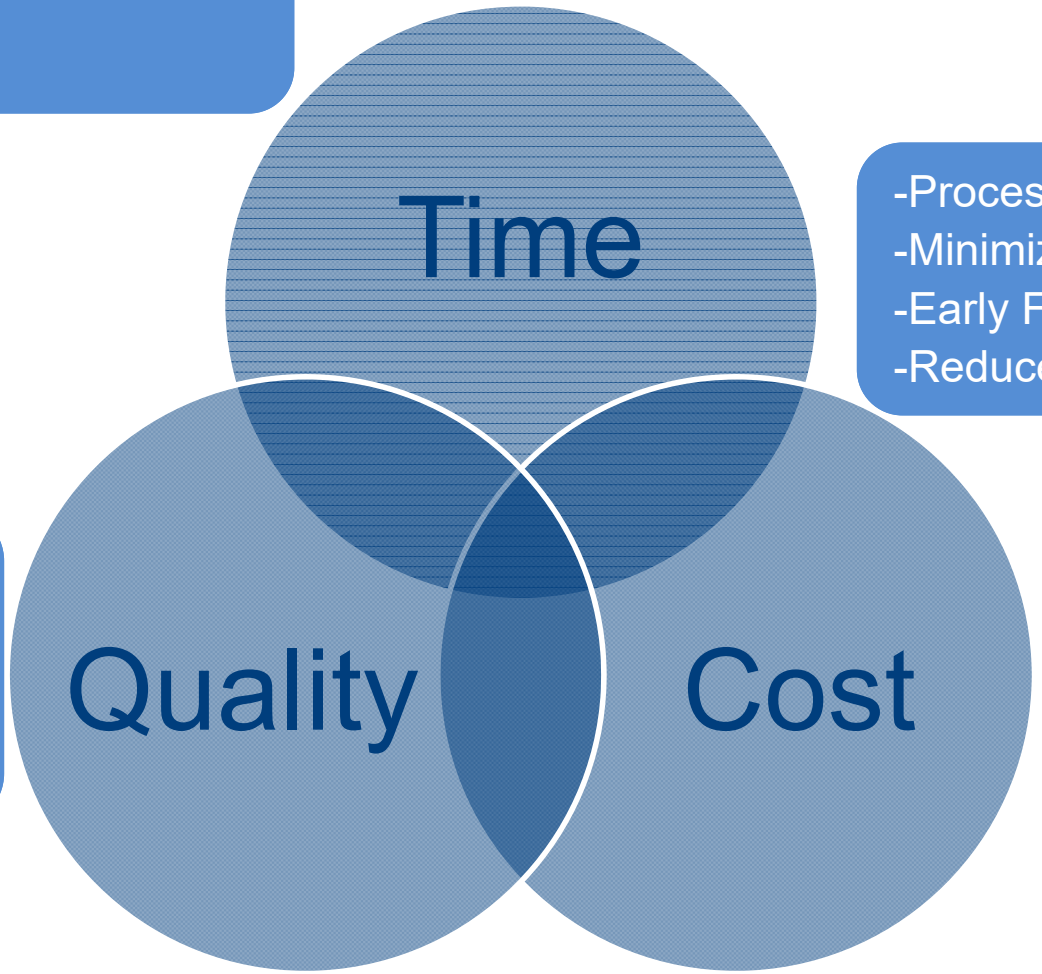
Program Outline

- Building Enclosure Commissioning Overview
- BECx Drivers
- BECx Process
- **BECx Value**

BECx Value Proposition

Intertek
Valued Quality. Delivered.

-Early Project Learning
-Design / Model Reviews
-Minimize Delays
-Tested Mock-ups



-Process Pays for Itself
-Minimize Change Orders
-Early Failure Identification
-Reduces Risk/Call Backs

-Value Based Service
-Minimize performance Errors
-Verifies Performance
-Focus is on End User Needs

Questions?

Intertek Locations

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