AABC Commissioning Group
AIA Provider Number: 50111116

Building Enclosure Commissioning (BECx): LEED v4's Envelope Commissioning – An OPR Design Charrette

Course Number: CXENERGY1504

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April 29, 2015

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

SAMPLE SLIDE

Course Description

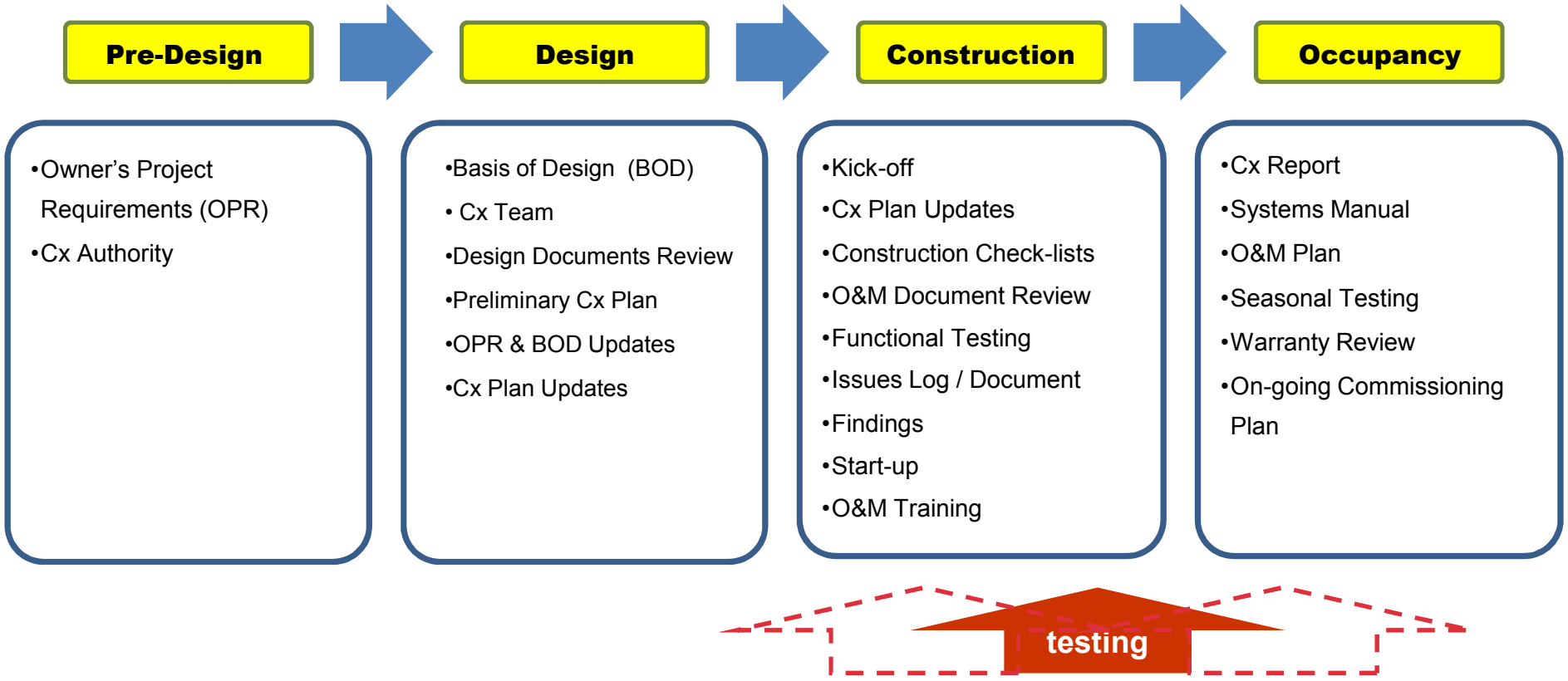
In this session the audience will participate in a design charrette that explores how different 'translations' of the Owner's Project Requirements (OPR) into the design team's Basis of Design (BOD) and enclosure detailing will affect other building system choices and overall building energy efficiency, indoor air quality, daylight penetration etc. The audience will help to decipher sample OPR enclosure requirements into a highly-sustainable/high-performance envelope design, discussing the compromises and performance implications of the group’s proposals.

Learning Objectives

At the end of the this course, participants will be able to:

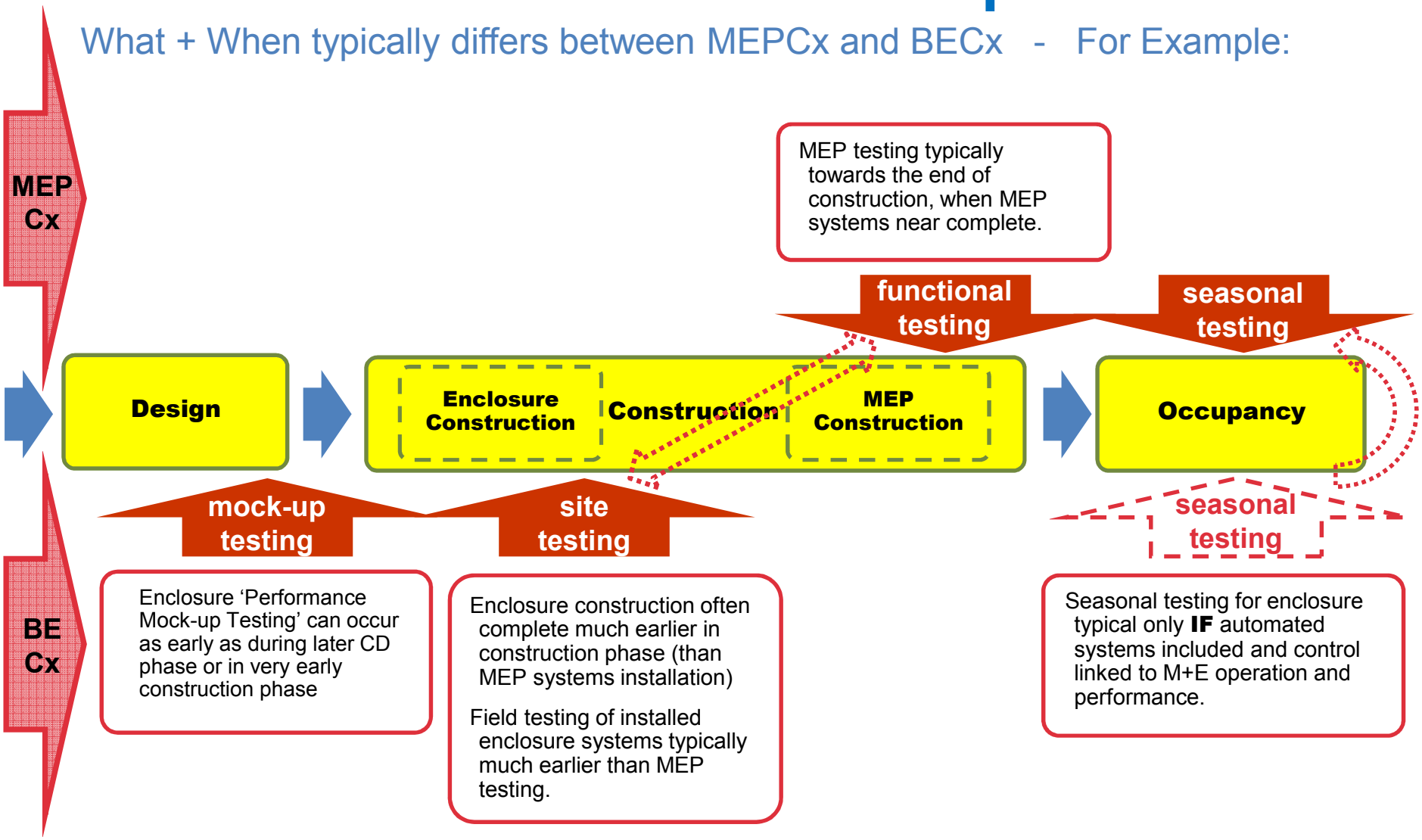
1. Learn the scope of LEED v4 as it pertains to building enclosure commissioning.
2. Understand how owner project requirements relate to design decisions affecting building system selection choices.
3. Learn how building enclosure commissioning decisions affect energy efficiency, indoor air quality and other parameters.
4. Understand how owner project requirements for high performance envelope design may require compromises with respect to other building systems, equipment and operation.

Project Timeline Cx Process



Cx Process Timeline Comparison

What + When typically differs between MEPCx and BECx - For Example:



Three (BECx) Amigos!

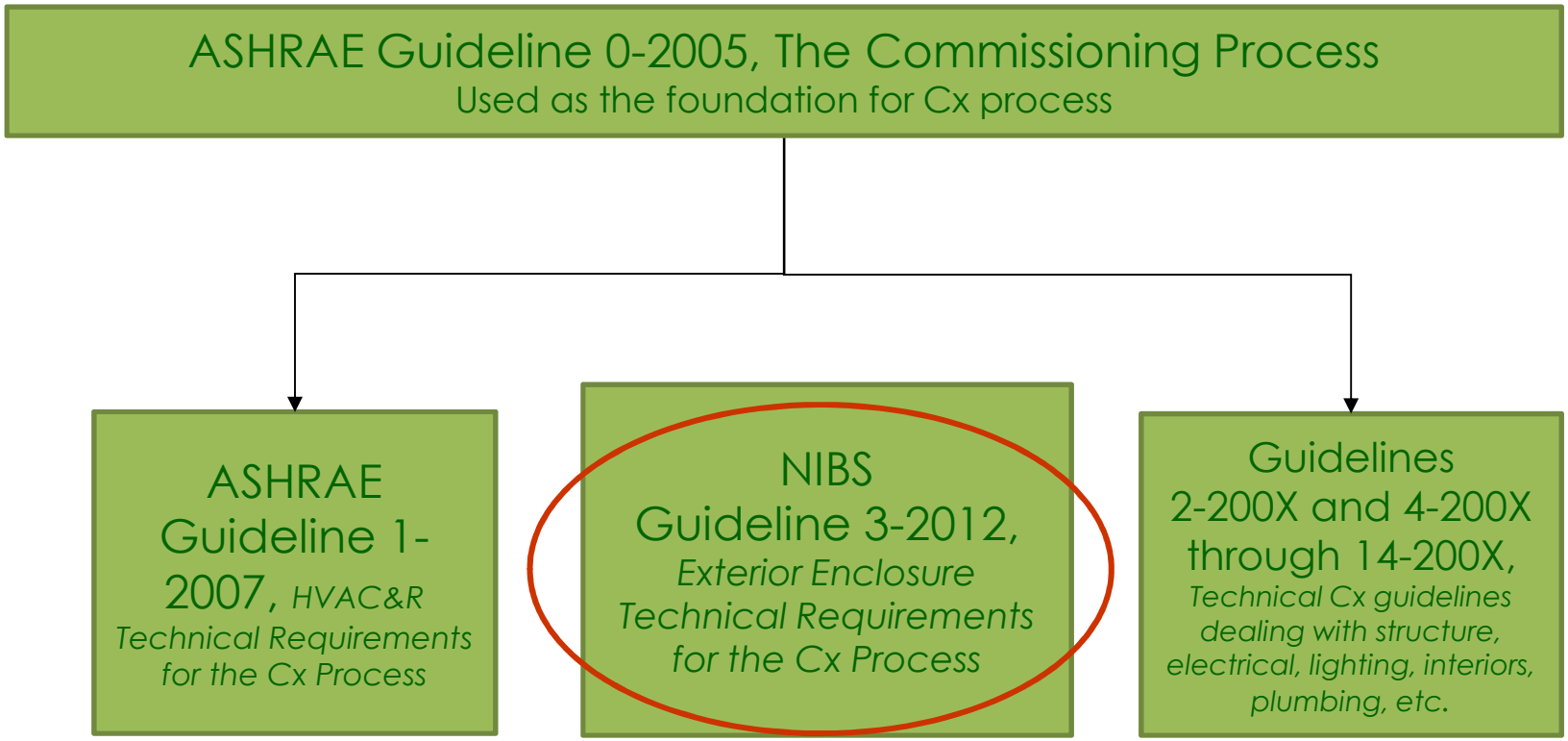
LEED

National Institute of BUILDING SCIENCES

ASHRAE

The Commissioning Process

Using ASHRAE 0-2005 & NIBS 3 - 2012

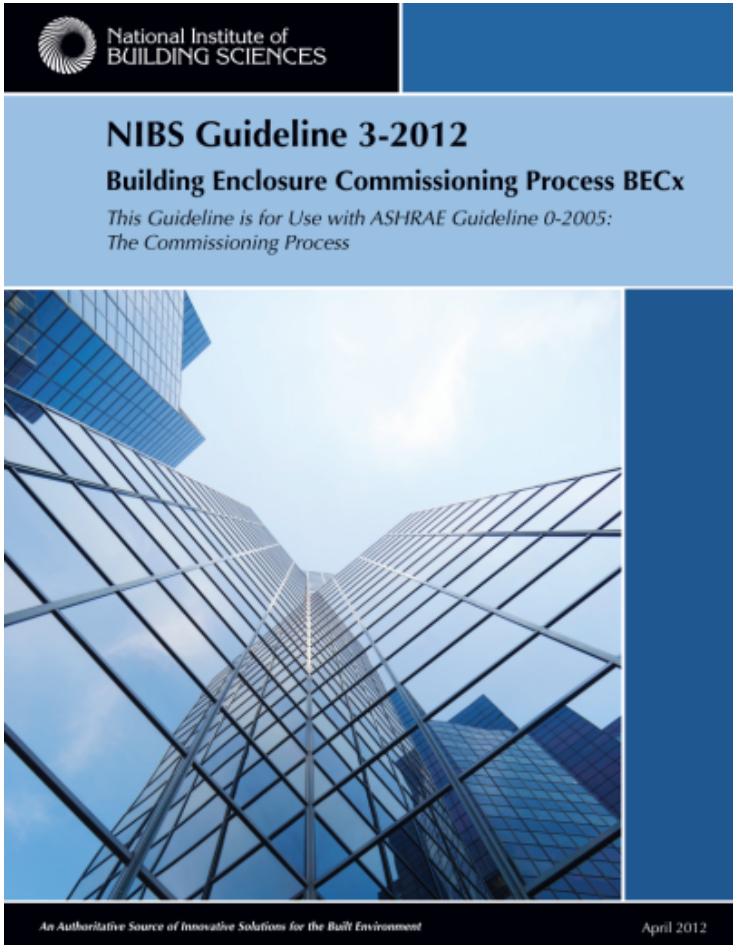


Source: NIBS Guideline 3-2012, *Building Enclosure Commissioning Process BECx.*

NIBS Guideline 3 - 2012

- Guideline focuses on implementation of Cx process for BE systems
- Describes tasks to be completed
- Includes supporting documentation

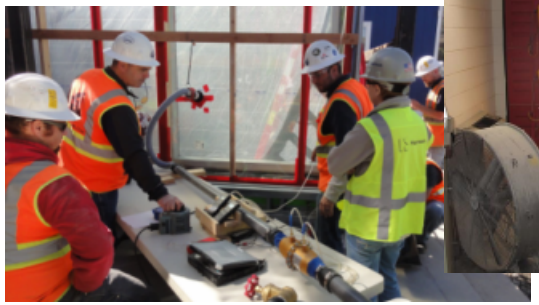
"The commissioning objectives … can vary tremendously…"



ASTM E2813 – 12

Standard Practice for Building Enclosure Commissioning

ASTM INTERNATIONAL

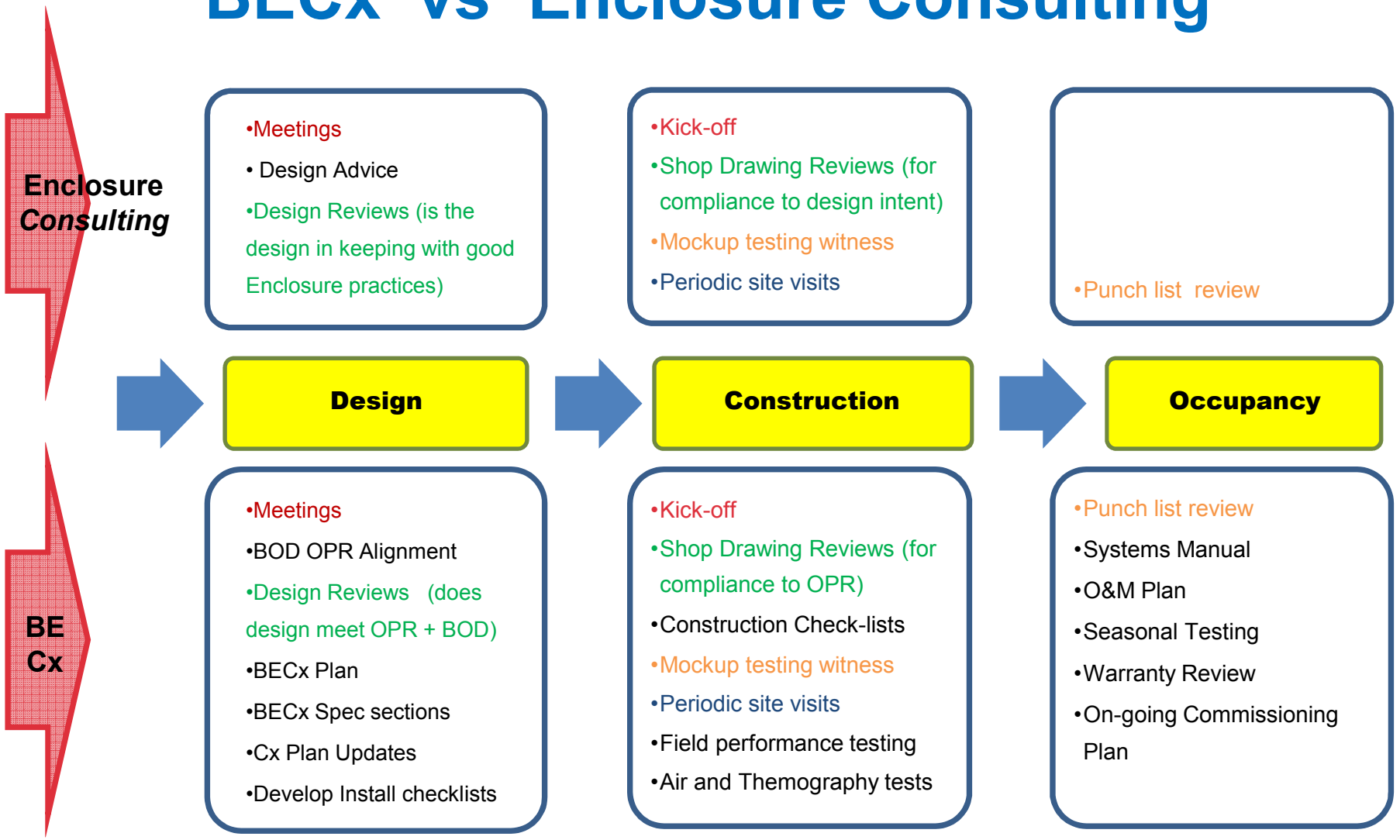


Developed with input from both ASHRAE and NIBS

ASTM E2813 is a Standard Practice, whereas ASHRAE Guideline 0 and NIBS 3 are Guidelines / Best Practice.

May be onerous and unnecessary in many cases as strict compliance requires performing comprehensive list of tests that are minimum requirements, per enclosure type, that would drive up project costs significantly due to amount of testing

BECx vs Enclosure Consulting



LEEDv4 Commissioning

REQUIRED
Fundamental

New to LEEDv4

Engage CxA by DD

Cx Review of documents at mid-design

Include exterior enclosure in OPR & BOD

CREDIT (2-6 POINTS)
Enhanced

1

3 POINTS

Enhanced Cx

1 POINT

MBCx

and
-or-

2

Enhanced Cx

as it relates to building envelope

2 POINTS

BECx

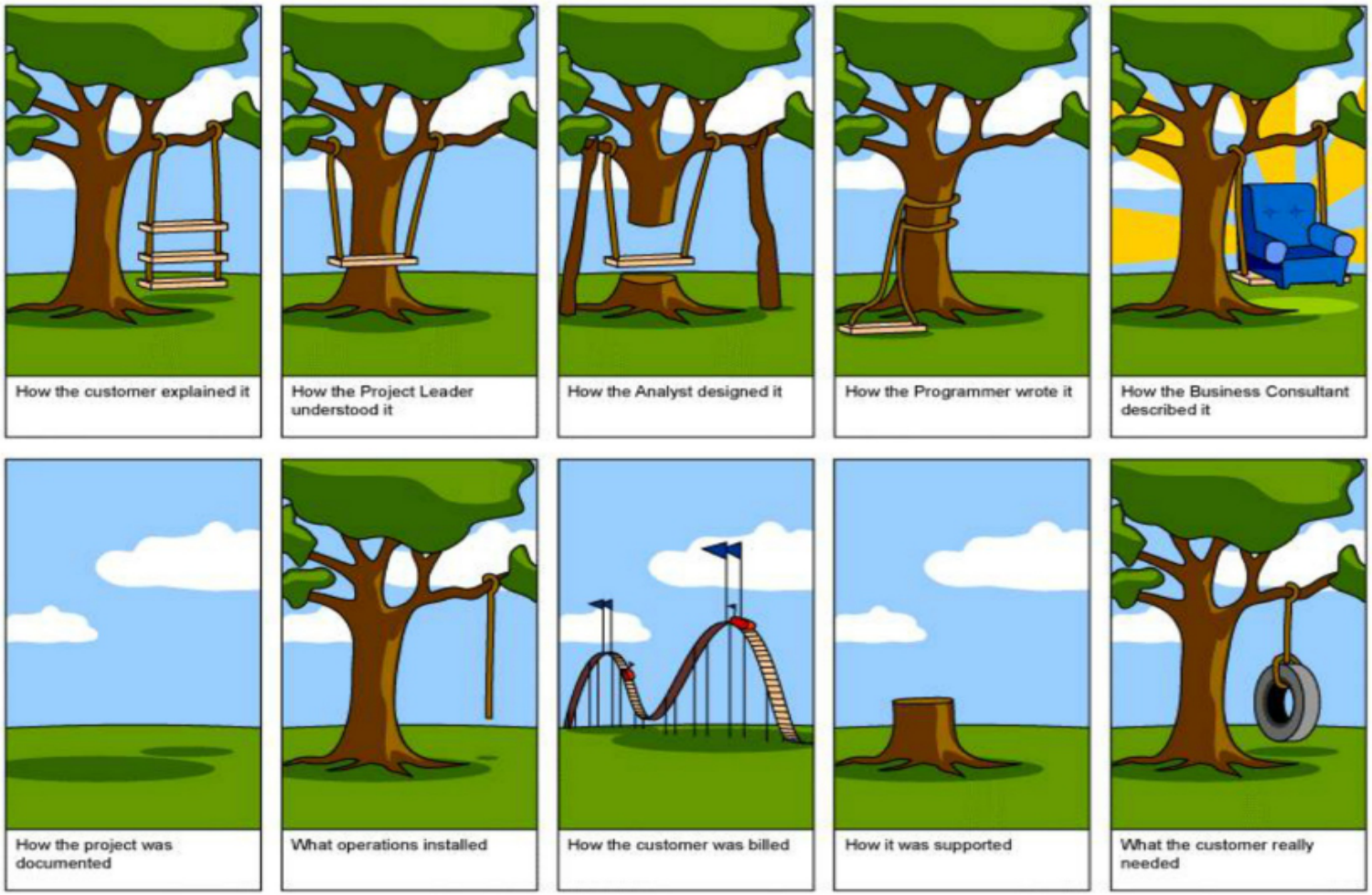
LEEDv4 Commissioning Activities

(From LEED v4 Reference Guide, Table 1. Commissioning Activities)

Phase	Cx task	Responsible party	Cx	Enhanced Cx	MBCx	LEECx
Predesign	Develop OPR	Owner	x	x	x	x
Schematic design	Develop BOD, including envelope requirements	Design team	x	x	x	x
	Include general monitoring, metering, and trending requirements	Design team			x	
Design Development	Engage CxA	Owner	x	x	x	x
	Develop initial commissioning plan	CxA	x	x	x	x
	Include monitoring requirements, equipment	CxA			x	
	Include envelope requirements	CxA				x
	Conduct OPR, BOD, and design document review	CxA, owner, design team	x	x	x	x
	Prepare systems manual outline	CxA, owner		x	x	x
	Include monitoring requirements, equipment	CxA, owner			x	
	Include envelope requirements	CxA, owner				x
	Document training requirements	CxA, owner		x	x	x
	Update OPR and BOD as necessary	CxA, owner, design team	x	x	x	x
Construction documents	Issue Cx specifications for inclusion in bid/permit documents	CxA	x	x	x	x
	Include enhanced Cx requirements	CxA		x	x	x
	Include monitoring-based Cx requirements	CxA			x	
	Include envelope based Cx requirements	CxA				x
	Update OPR and BOD as necessary	CxA, owner, design team	x	x	x	x
	Conduct design review (recommended)	CxA, design team	x	x	x	x

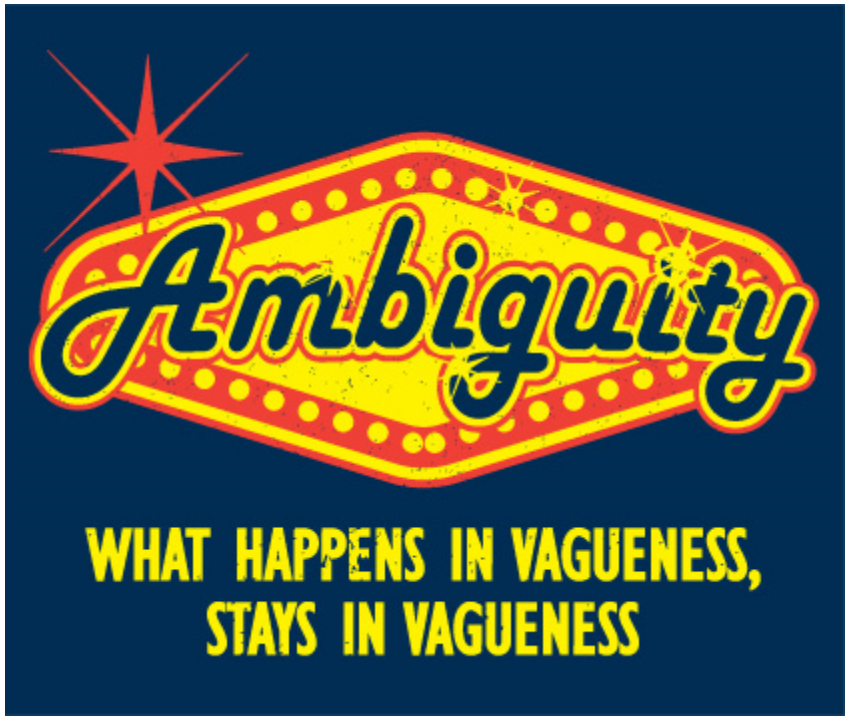
Phase	Cx task	Responsible party	Cx	Enhanced Cx	MBCx	LEED Cx
Construction	Update OPR and BOD as necessary	CxA, owner, design team	x	x	x	x
	Prefunctional inspections	CxA	x	x	x	x
	Complete submittal reviews concurrently with or before acceptance by design team	CxA		x	x	x
	Update OPR, BOD, Cx plan and systems manual as necessary	CxA	x	x	x	x
	Issue owner's training requirements	CxA to contractor		x	x	x
	Issue construction checklists	CxA	x	x	x	x
	Issue functional performance test scripts for contractor review	CxA, contractor	x	x	x	x
	Issue/review verified TAB report	Contractor, CxA	x	x	x	x
	Issue/review completed construction checklists	Contractor, CxA	x	x	x	x
	Functional performance tests	CxA, contractor	x	x	x	x
	Document issues in issues log	CxA	x	x	x	x
	Compile final systems manual	CxA		x	x	x
	Final commissioning report	CxA	x	x	x	x
	Verify training plan has been implemented	CxA, contractor, bldg operators		x	x	x
Occupancy and operations	Complete Cx report	CxA	x	x	x	x
	Compile operations and maintenance plan	CxA	x	x	x	x
	Compile final systems manual	CxA		x	x	x
	Perform seasonal testing	CxA, contractor, bldg operators		x	x	x
	Perform 10-month review	CxA, contractor, bldg operators		x	x	x
	Develop ongoing Cx plan	CxA, bldg operators		x	x	x

Why is a clear OPR important?



BECx – Clear OPRs

Engaging a BECx Authority early



Developed prior to design team's pre-design activities such as Architectural Programming

Owner's Project Requirements

General Objectives

- Quality / Aesthetics
- Durability / Service life
- Use / Expansion
- Form / Shape / adaptability
- Owner's vision
- Energy (code to regenerative)
- Impact on Occupant Health

Owner's Project Requirements

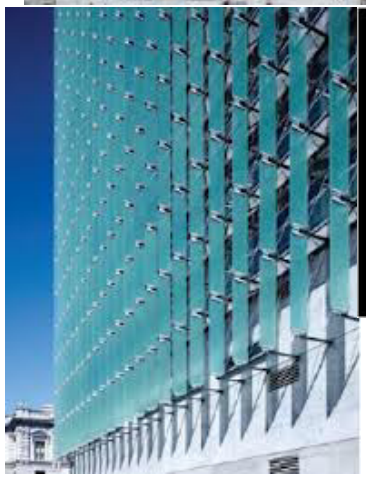
Specific Objectives - Assemblies

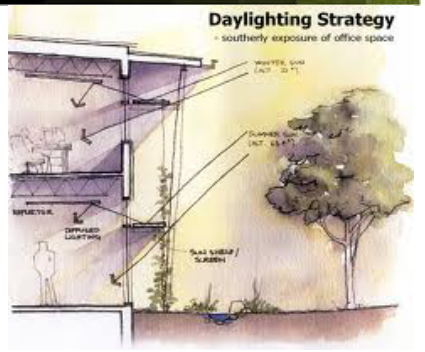
- **OPAQUE WALLS**
  - LEED Goals
  - R-values,
  - Warranties,
  - Number of claddings,
  - Interface compatibility
  - Life Expectancy,
  - Maintenance expectations,
  - Disassembly
  - LCA impact

Vs.

Owner's Project Requirements

Specific Objectives - Assemblies





- **WINDOWS**
  - LEED Goals,
  - % of building walls,
  - U-value,
  - vision,
  - Views / daylighting,
  - Operable / automated,
  - acoustics,

Owner's Project Requirements

Compare & Contrast Examples

OPR sample 1

Envelope

1. Owner's Vision

Describe the owner's vision for the building exterior enclosure as it relates to such issues as the building's function, orientation, compatibility with existing building(s), integrated envelope systems (such as active facades), image and aesthetic appeal, energy efficiency, maintenance and renewal expectations, and durability. Detail any non- mandatory standards or Code of Practice or Guidelines that are to be adhered to.

- Building envelope to be high performance

2. Roof

Describe any specific requirements or manufactured products such as accessible roof areas, reflective or light coloured roofs, "vegetated roof", standard or extended warranties, roof anchors, swing stage tracks or datum arms, or exclusions such as " no products by Manufacturer 'A' " and life expectancy.

- Meet Durability service life requirements of 50 years.

3. Opaque Wall

Describe any specific requirements or manufactured products such as "brick veneer façade", number of cladding types, or exclusions such as "no curtain wall" and life expectancy. (Discuss major maintenance activities such as re-caulking, or renewal dates such as full cladding replacement, that might affect owner decisions).

- Meet Durability service life requirements of 50 years.

4. Windows - Physical

Describe any specific requirements or exclusions, maximum percentage of glazing, window sizes, style of window, level of occupant control (operable windows, etc). Discuss conflict of window size / orientation with energy efficiency and topics below.

5. Windows - Thermal

*Describe any requirements, such as must satisfy LEED thermal comfort credit ** / ASHRAE 55 or any concerns about condensation (If space required high humidity in winter). Discuss conflict of size vs thermal comfort. Discuss allowable off-design conditions such as "condensation acceptable on glass up to 50 hours per year", number of panes (double, triple), frame type (fiberglass, aluminum, vinyl), Low E coatings, argon gas, etc.*

- Triple glazing to be considered.
- Operable windows to allow environmental control desirable but only if concerns about potential increased energy use or freeze-up risks can be alleviated

OPR sample 2

Envelope

1. Owner's Vision

Per the Owner's Design Guidelines for Educational Facilities. The building envelope and its components shall be based on the following criteria.

- High Performance Building
- Ashrae 90.1
- Building Aesthetics
- Building Design Service Life: 75 years
- Quality Daylighting
- Initial Cost
- Maintenance and Life Cycle Cost
- Material Availability
- Environmental Friendly Materials:
- Low VOC content,
- Recycle content,
- Minimal Urea Formaldehyde
- No HCFH or CFC

2. Roof

2.1 Roof – Air, Vapor, Thermal

- Average R value = 30 (RSI 5.28) using Minimum R 20
- Roofing principles shall be in keeping with good roofing practices as
- outlined by the National Roofing Contractors Association.
- No pressure treated wood to be used on roofs.

2.2 Roof – Sustainability

- Green roofs may be considered upon Owner's rep review and written approval.
- Materials shall include their performance characteristics for solar reflectance and emissivity. LEED Sustainable Sites credit 7.2 is not required.
- Granulated membrane cap sheet color: White
- Environmentally friendly materials (low VOC content, recycle content, minimal urea formaldehyde).
- Metal roofing: SRI >78 for 75% of surface and comply with Energy Star.

2.3 Roof – Warranty

- Workmanship 5 years.

Owner's Project Requirements

Compare & Contrast Examples

OPR sample 1

2. Roof

Describe any specific requirements or manufactured products such as accessible roof areas, reflective or light coloured roofs, "vegetated roof", standard or extended warranties, roof anchors, swing stage tracks or datum arms, or exclusions such as " no products by Manufacturer 'A' " and life expectancy.

- Meet Durability service life requirements of 50 years.

* Audience exercise feedback notes in red

OPR sample 2

2. Roof

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2.3 Roof – Warranty

- Workmanship 5 years.
- Roof assembly warranty – minimum 20 year assembly warranty

2.4 Roof – Drainage

- A scupper detail is only to be used when drainage to the exterior and a raised roof edge are necessary, and is only suitable for a wall supported roof deck.
- All new roofs shall have a minimum slope of 1:50.

2.5 Roof – Wind uplift

- No specific requirements.
- **FM-global lb/sqin requirements**

- **Code requirements (list of code requirements**
- **Roof Maintenance (renewables, replacement)**
- **Roof access - Pathways to equipment (from a maintenance perspective)**
- **Safety (parapet heights, railings, tie-offs, etc.)**
- **Local ordinaces (for screen walls)**
- **Testing!!!**

Owner's Project Requirements

Exercise 1 – Audience Feedback

OPR sample 1

2. Roof

Describe any specific requirements or manufactured products such as accessible roof areas, reflective or light coloured roofs, "vegetated roof", standard or extended warranties, roof anchors, swing stage tracks or datum arms, or exclusions such as " no products by Manufacturer 'A' " and life expectancy.

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OPR sample 2

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Owner's Project Requirements

Exercise 2

Review and add suggestions to make the following a clear OPR section.

OPR sample 2

3. Opaque Wall

3.1 Opaque Wall – Cladding

- Metal siding is not to be installed between grade and 6 inches above grade without written approval from the Owner's rep.
- Exterior insulated, rain-screen approach to be incorporated into opaque wall assemblies.
- Minimize maintenance expectations
- Sealants: conform to minimal SCAQMD requirements.

3.2 Opaque Wall – Reclaimed materials

- Salvaged existing brick supplied by school district from stockpile.

3.3 Opaque Wall – Thermal Barrier

- Minimum thermal resistance of exterior walls shall be 30% below Ashrae 90.1
- Above grade walls: RSI 3.75 (R21).
- Thermal bridging to be minimized.
- Insulation to be layered to minimize thermal bridging.
- Thermally broken z-girts to be used for metal cladding attachment.

3.4 Opaque Wall – Air Barrier

Comply with:

- ASTM E283 – Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- ASTM E1186 Standard Practices for air leakage site detection in building envelope and air retarder systems.
- The design goal air tightness is to limit air leakage to 0.40 cfm/ft2 at 1.57 psf.
  - Wall systems are to limit air leakage to 0.04 cfm/ft2 at 1.57 psf.
  - Glazing systems without doors are to meet 0.03 cfm/ft2 at 6.24 psf.
  - Doors are to meet 0.155 cfm/lineal crack of door.

3.5 Opaque Wall – Vapor Barrier

- Comply with E96 – Standard Test Methods for Water Vapor Transmission of materials.(Owner Design Guidelines)

3.6 Opaque Wall – Moisture Barrier

3.7 Opaque Wall – Testing Requirements

Owner's Project Requirements

Exercise 3

Discuss whether suggestions in Ex 2 makes the OPR clear or too prescriptive

OPR sample 2

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3.7 Opaque Wall – Testing Requirements

Relating specific material manufacturers (to include and not to include)
Salvaged brick quantified
Better qualify some of the generalities like "minimize maintenance" or "thermal bridging"
Location of project (Climate zone)
Future expansion plans?

* Audience exercise feedback notes in red

Owner's Project Requirements

Exercise 4

Break into groups of 4 or 6 with half being the 'owner' and the other being the BECx Authority / Design team that would be assisting in development of OPRs. Further refine the glazing section of OPR sample 2.

OPR sample 2

5. Windows – General

- Criteria for window selection and window placement should include glare control, transmissivity, solar heat gain coefficient, ventilation and safety.
- All windows are to be tested in accordance with the current edition of ASTM
- and meet the following criteria:
  - Air tightness: A3 or Fixed
  - Water tightness: B7
  - Wind Load Resistance: C5.
- All windows to have operable vents c/w insect screens. Windows shall be operable without the use of pole.

5.1 Windows – Physical

- Aluminum windows shall be used for the entire school. Operable windows with removable screens are required for the classrooms.
- Anodized finishes only will be permitted (no special paint coatings) unless approved by the Owner's rep.
- Isolate windows from masonry, mortar and dissimilar materials with caulking or gasket.

5.2 Windows - Thermal

- Windows: overall U=value of 2.68 W/m2 C, RSI 0.37 (R 2.10)
- Design shall consider use of Low-E coatings/films and low conductivity spacers and insulating gas fill.
- Glazing on South elevation: SHGC of 0.38, VLT of 0.7
- All frames to be thermally-broken.
- Translucent panels to be used for clearstory.
- Condensation resistance – RH levels, ventilation, positioning of HVAC

5.3 Windows – Vision

- Achieve daylighting in at least 75% of the regularly occupied areas. (Owner Design Guidelines)
- Note: Interior surface reflectance: ceilings 80%, walls 50%, floors 20%. Glazing placed on east and west facing elevations shall be minimal. (Owner Design Guidelines)
- Minimum visible light transmittance (VLT): 0.73
- Glare controlled by interior blinds.
- No daylighting controls.

5.4 Windows – Physical Security

- All operable windows shall have locks. No specific physical security levels.

5.5 Windows - Testing Requirements

- ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Wall by Uniform or Cyclic Static Air Pressure

Owner's Project Requirements

Exercise 4

Discuss whether suggestions makes the OPR clear or too prescriptive

OPR sample 2

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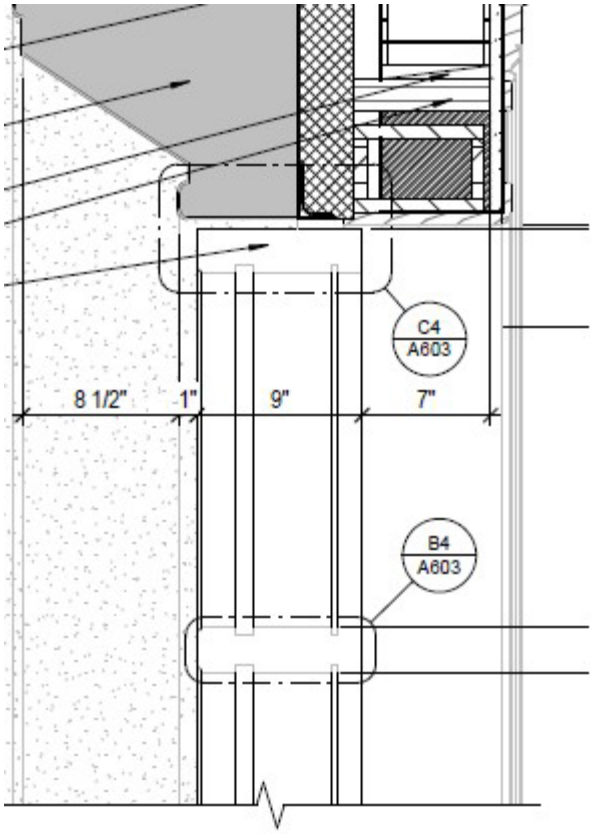
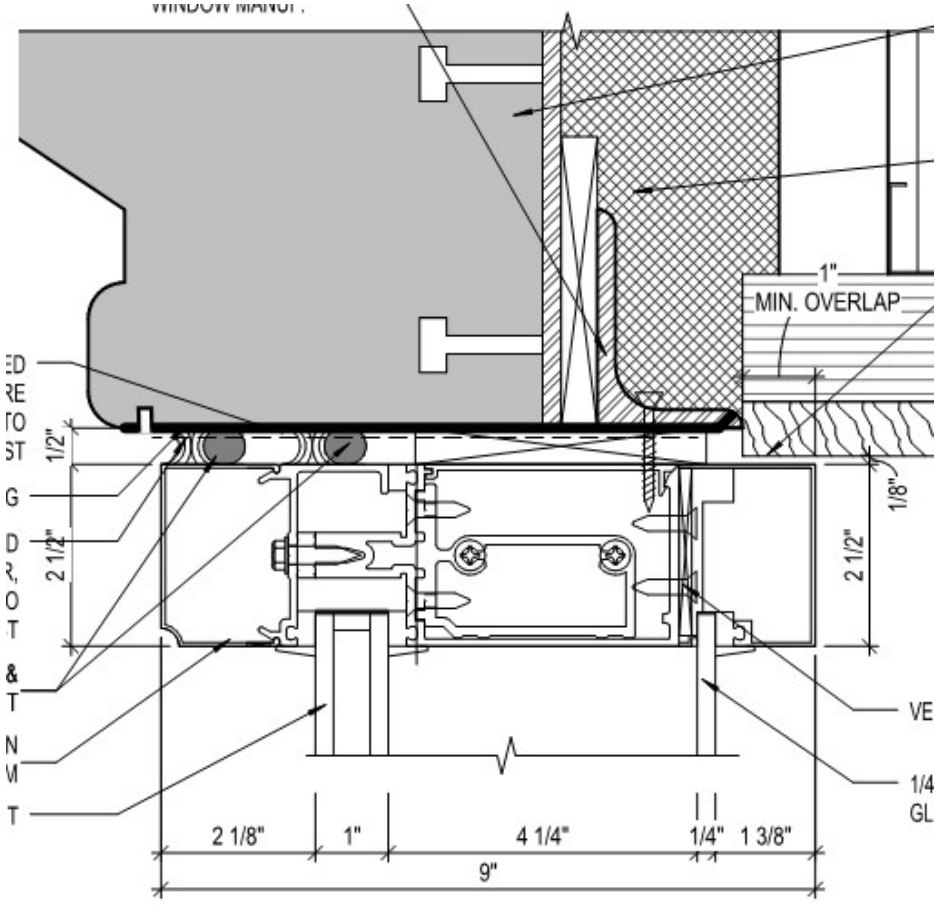
Owner's Project Requirements

Exercise 4



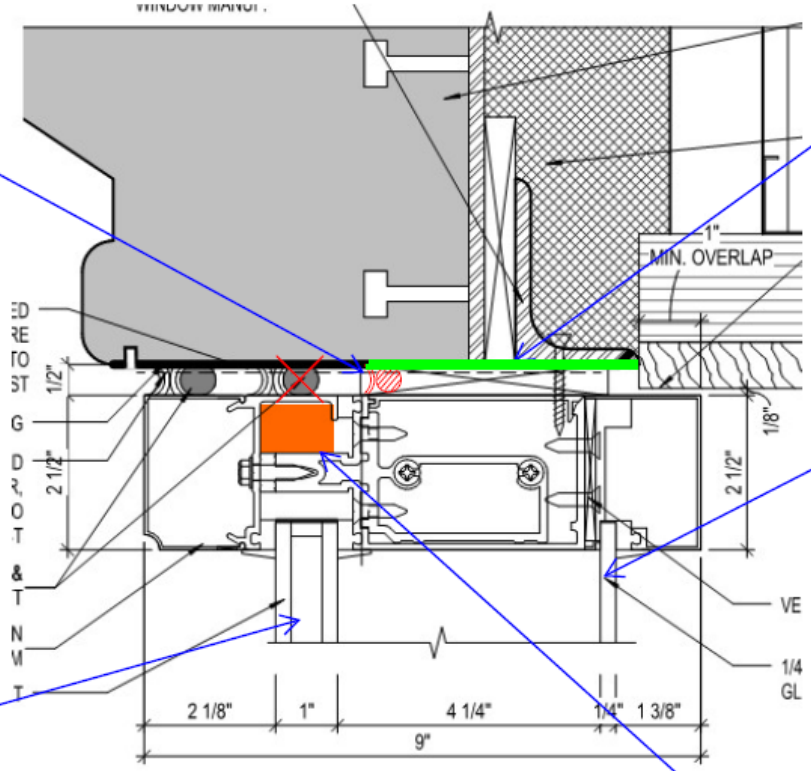


Owner's Project Requirements

Exercise 4

Curtain wall carries it's air seal at teh shoulder of the frame. Interior air seal should be between curtain wall shoulder and precast

Metal flashing creates thermal bridge as drawn. Consider replacing sheet metal with aerogel strip (shown in green) to reduce precast thermal bridge



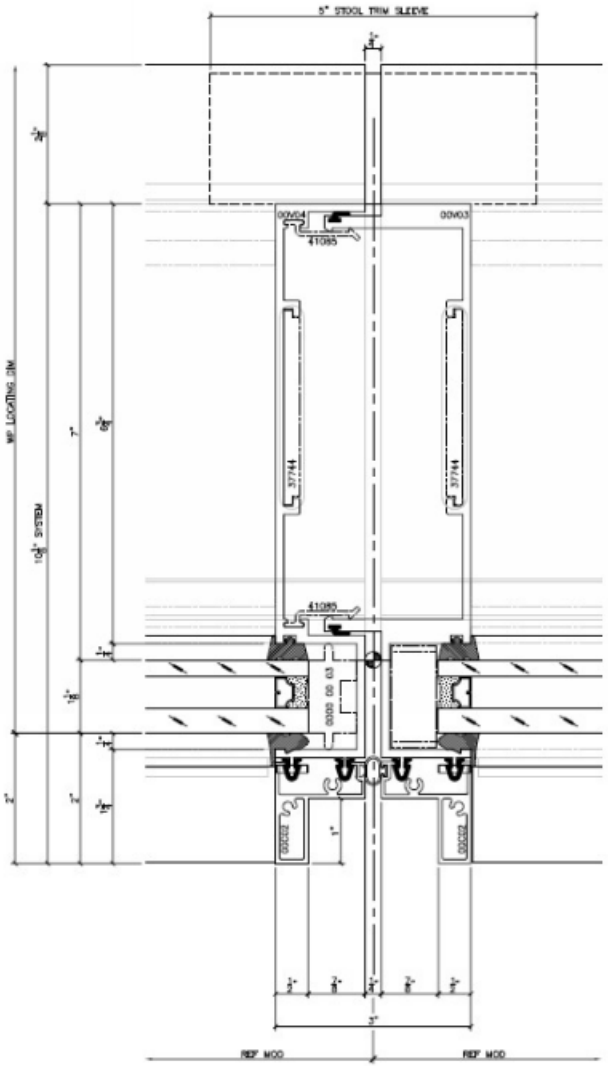
Cavity should be vented between decorative glass and IGU to prevent pressure buildup, but not enough to allow significant dust/dirt entry

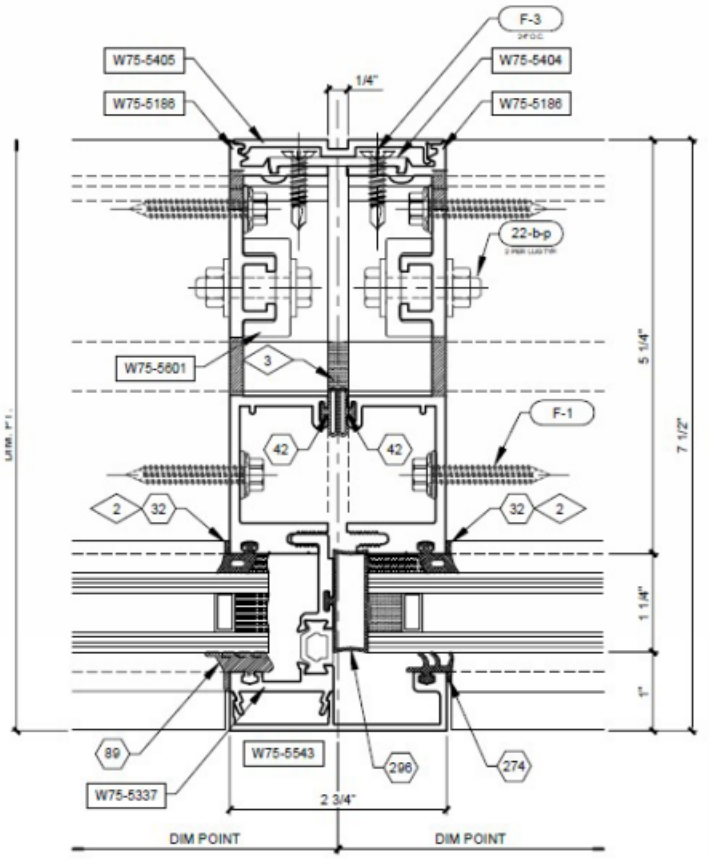
Position of window in the frame presents a decrease in thermal performance due to glazing being outboard of sprayfoam insulation.

This configuration creates a significant thermal bridge. Recommend providing XPS insulation in PVC sleeve in empty glazing pocket to increase thermal performance. Verify with manufacturer

Owner's Project Requirements

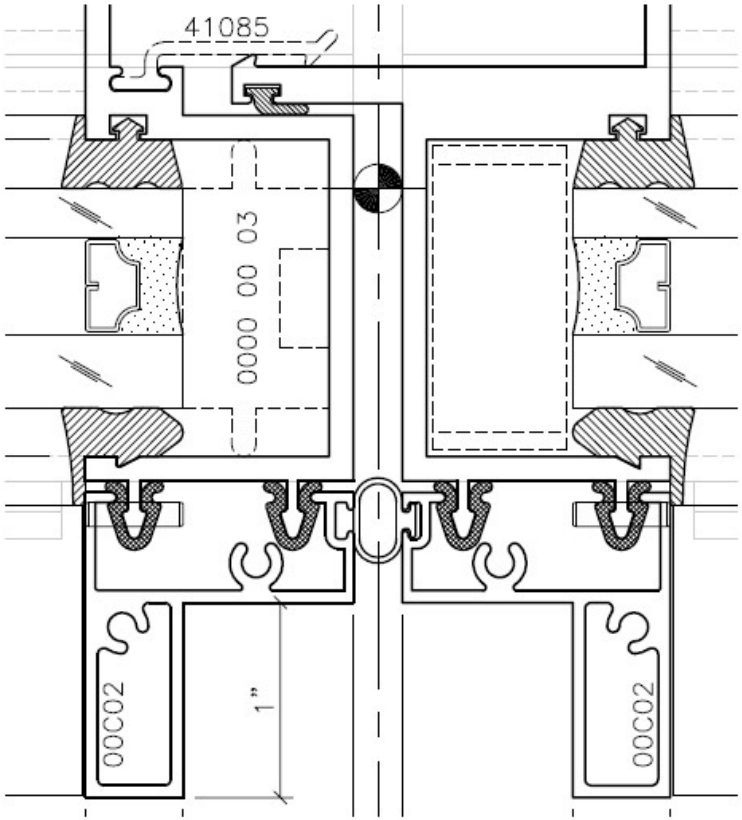
Exercise 4

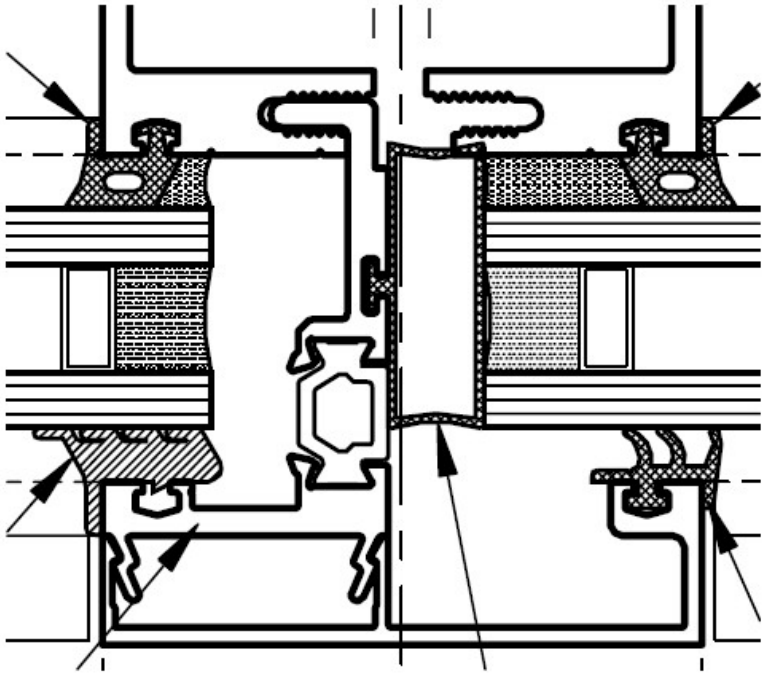




Owner's Project Requirements

Exercise 4





This concludes The American Institute of Architects Continuing Education Systems Course

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