Passive Influence: PHIUS+ and QA/QC Principles in Non-Residential Projects

Rob Hosken, AIA, BECxP

Building Performance Architecture

October 15, 2021

Our Mission:

Greatly reduce building energy use and carbon emissions, to speed the transition to a zero-carbon economy.

Our Purpose:

Help leaders of multifamily, commercial, and institutional building projects overcome quality control challenges and achieve project goals by providing expert, hands-on QA/QC solutions.

PHIUS+ 2018 Non-Res Main Performance Criteria

PHIUS+ 2018 Performance Criterion	PHIUS+ 2018 Field Verification Requirement	2018 IECC ("IECC"), ENERGY STAR ("ES")	Recommended Field Verification Requirement
Annual Heating Demand Limit (energy use per unit area per year)	Not field-verified (energy model only)	IECC: Not field-verified ES: Not field-verified	Field-verify with energy dashboard & data logging
Annual Cooling Demand Limit (energy use per unit area per year)	Not field-verified (energy model only)	IECC: Not field-verified ES: Not field-verified	Field-verify with energy dashboard & data logging
Peak Heating Load Limit (energy use per unit area per hour)	Not field-verified (energy model only)	IECC: Not field-verified ES: Not field-verified	Field-verify with energy dashboard & data logging
Peak Cooling Load Limit (energy use per unit area per hour)	Not field-verified (energy model only)	IECC: Not field-verified ES: Not field-verified	Field-verify with energy dashboard & data logging
Whole Building Envelope Air Leakage Limit (air flow volume per unit time at pressure diff. per unit area)	Field-verified via air leakage test	IECC: Air leakage test optional. (C402.5, C406.9) ES: Not field-verified	PHIUS+ 2018 verification, plus required preliminary testing and ASTM E1186
Net Source Energy Demand Limit (energy use per unit area per year)	Not field-verified (energy model only)	IECC: Not field-verified ES: Field-verify site energy use with meters	Field-verify site energy use with energy dashboard & data logging

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PHIUS + VERIFIER

1881

Professional Number

12/12/15

Date Issued

Contingent on annual agreement

Valid Through

The Passive House Institute US Certifies

Rob Hosken

has fulfilled the requirements for becoming a

CERTIFIED PHIUS+ VERIFIER

This certificate hereby attests that the above-named Verifer has completed training provided by Passive House Institute US (PHIUS) relating to quality assessment of large buildings that can meet the criteria of PHIUS' Passive Building Standards for North American climate zones and has passed PHIUS' examination.

Buildings designed, modeled and constructed to meet Passive Building Standards are ultra-efficient and characterized by superior indoor air quality, thermal comfort and durability.

The minimized energy demands of passive houses and buildings reduce building operating costs permanently, while also mitigating the impact of energy price increases over time. The low power requirements provide resilience during outages and help avoid time-of-use surcharges.

Buildings successfully verified and quality assured to Passive Building Standards can achieve carbon neutrality with the addition of a small renewable generation system, thereby putting owners and occupants firmly on the path to a carbon-neutral lifestyle.

PHIUS is the leading North American organization conducting research, training and certification relating to passive buildings. PHIUS' training is the most comprehensive in the industry. Verifiers who complete PHIUS' training and pass its rigorous examination are prepared to provide quality assessment of large buildings maximizing energy efficiency.

Executive Director

PHIUS

Passive House Institute US

West Tower (122 Delaware Street, KC, MO 64105)

Flr1, B	Apt.Type	#Beds	Insp. #s	Flr2, B	Apt.Type	#Beds	Insp. #s	Flr3, B	Apt.Type	#Beds	Insp. #s	Flr4, B	Apt.Type	#Beds	Insp. #s	Flr5, B	Apt.Type	#Beds	Insp. #s	Flr6, B	Apt.Type	#Beds	Insp. #s
				B201	I	Effic.		B301	I	Effic.		B401	I	Effic.		B501	I	Effic.	2,				
B102	E.1	2-Bed		B202	E.1	2-Bed		B302	E.1	2-Bed		B402	E.1	2-Bed	3,6,7,9	B502	E.1	2-Bed					
B103	I.1	Effic.		B203	I.1	Effic.		B303	I.1	Effic.		B403	I.1	Effic.		B503	I.1	Effic.					
B104	H1	1-Bed		B204	H1	1-Bed		B304	H1	1-Bed	3,6,7,9	B404	H1	1-Bed		B504	H1	1-Bed					
B105	H1	1-Bed		B205	H1	1-Bed		B305	H1	1-Bed		B405	H1	1-Bed	3,6,7,9	B505	H1	1-Bed	1,				
B106	I.1	Effic.	2,	B206	H2	1-Bed		B306	H2	1-Bed	2,	B406	H2	1-Bed	2,	B506	H2	1-Bed					
B107	D	2-Bed		B207	D	2-Bed	2,	B307	D	2-Bed		B407	D	2-Bed		B507	D	2-Bed					
B108	H3.1	1-Bed		B208	H3.1	1-Bed		B308	H3.1	1-Bed	2,	B408	H3.1	1-Bed	2,	B508	H3.1	1-Bed					
B109	I	Effic.	3,6,7,9	B209	I	Effic.		B309	I	Effic.	1,	B409	I	Effic.		B509	I	Effic.		B609	I	Effic.	
B110	H3	1-Bed		B210	H3	1-Bed		B310	H3	1-Bed		B410	H3	1-Bed		B510	H3	1-Bed	2,	B610	H3	1-Bed	3,6,7,9
B111	H3	1-Bed		B211	H3	1-Bed	3,6,7,9	B311	H3	1-Bed		B411	H3	1-Bed		B511	H3	1-Bed		B611	H3	1-Bed	
B112	B	2-Bed		B212	B	2-Bed	3,6,7,9	B312	B	2-Bed		B412	B	2-Bed		B512	B	2-bed		B612	B	2-Bed	1,
B113	B	2-Bed		B213	B	2-Bed		B313	B	2-Bed		B413	B	2-Bed		B513	B	2-bed	3,6,7,9	B613	B	2-Bed	2,
B114	E	2-Bed		B214	E	2-Bed		B314	E	2-Bed		B414	E	2-Bed		B514	E	2-bed		B614	E	2-Bed	
B115	H3	1-Bed	1,	B215	H3	1-Bed	2,	B315	H3	1-Bed		B415	H3	1-Bed		B515	H3	1-Bed		B615	H3	1-Bed	2,

Flr1, C	Apt.Type	#Beds	Insp. #s	Flr2, C	Apt.Type	#Beds	Insp. #s	Flr3, C	Apt.Type	#Beds	Insp. #s	Flr4, C	Apt.Type	#Beds	Insp. #s
C101	I	Effic.	2,	C201	I	Effic.	1,	C301	I	Effic.		C401	I	Effic.	
C102	E.1	2-Bed		C202	E.1	2-Bed		C302	E.1	2-Bed		C402	E.1	2-Bed	
C103	I.1	Effic.		C203	I.1	Effic.	3,6,7,9	C303	I.1	Effic.		C403	I.1	Effic.	
C104	H1	1-Bed	2,	C204	H1	1-Bed		C304	H1	1-Bed		C404	H1	1-Bed	
C105	H1	1-Bed		C205	H1	1-Bed		C305	H1	1-Bed		C405	H1	1-Bed	
C106	H2	1-Bed	2,3,6,7,9	C206	H2	1-Bed		C306	H2	1-Bed		C406	H2	1-Bed	
C107	D	2-Bed	2,3,6,7,9	C207	D	2-Bed	2,	C307	D	2-Bed		C407	D	2-Bed	
C108	H4	1-Bed	2,	C208	H4	1-Bed	2,	C308	H4	1-Bed		C408	H4	1-Bed	3,6,7,9
C109	G	2-Bed	2,	C209	G	2-Bed		C309	G	2-Bed		C409	G	2-bed	
C110	G	2-Bed	2,	C210	G	2-Bed		C310	G	2-Bed		C410	G	2-bed	
				C211	B	2-Bed		C311	B	2-Bed		C411	B	2-bed	
				C212	B	2-Bed		C312	B	2-Bed		C412	B	2-bed	2,
				C213	H3	1-Bed		C313	H3	1-Bed	2,	C413	H3	1-Bed	2,
C114	H3	1-Bed		C214	H3	1-Bed		C314	H3	1-Bed	3,6,7,9	C414	H3	1-Bed	1,
C115	I	Effic.		C215	I	Effic.		C315	I	Effic.	2,3,6,7,9	C415	I	Effic.	

26				30				30				30				15				7			

ENERGY STAR Envelope (1-4) Sample Set

Apt.#	#Beds	WallExp	Level
C201	Effic.	E	Mid
A302	2-Bed	W	Mid
A503	Effic.	E	Top
B505	1-Bed	W	Top
D206	1-Bed	E	Mid
B309	Effic.	N	Mid
A610	1-Bed	N	Top
D411	2-bed	SW	Top
B612	2-Bed	NE	Top
A114	2-Bed	S	Bot
C414	1-Bed	N	Top
B115	1-Bed	S	Bot

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WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

The College of Engineering and Interdisciplinary Professional Programs
proudly present to

ROB HOSKEN

this certificate for successful completion of all requirements for

Certificate as Accredited

Building Enclosure Commissioning Process Provider and
Commissioning Authority+Building Enclosure

with the designation of

BECxP and CxA+BE

valid until December 31, 2026

Edward G. Barbely, Associate Dean

Joy E. Altives, Committee Member

John Davis, Committee Member


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Carnegie Library of Pittsburgh

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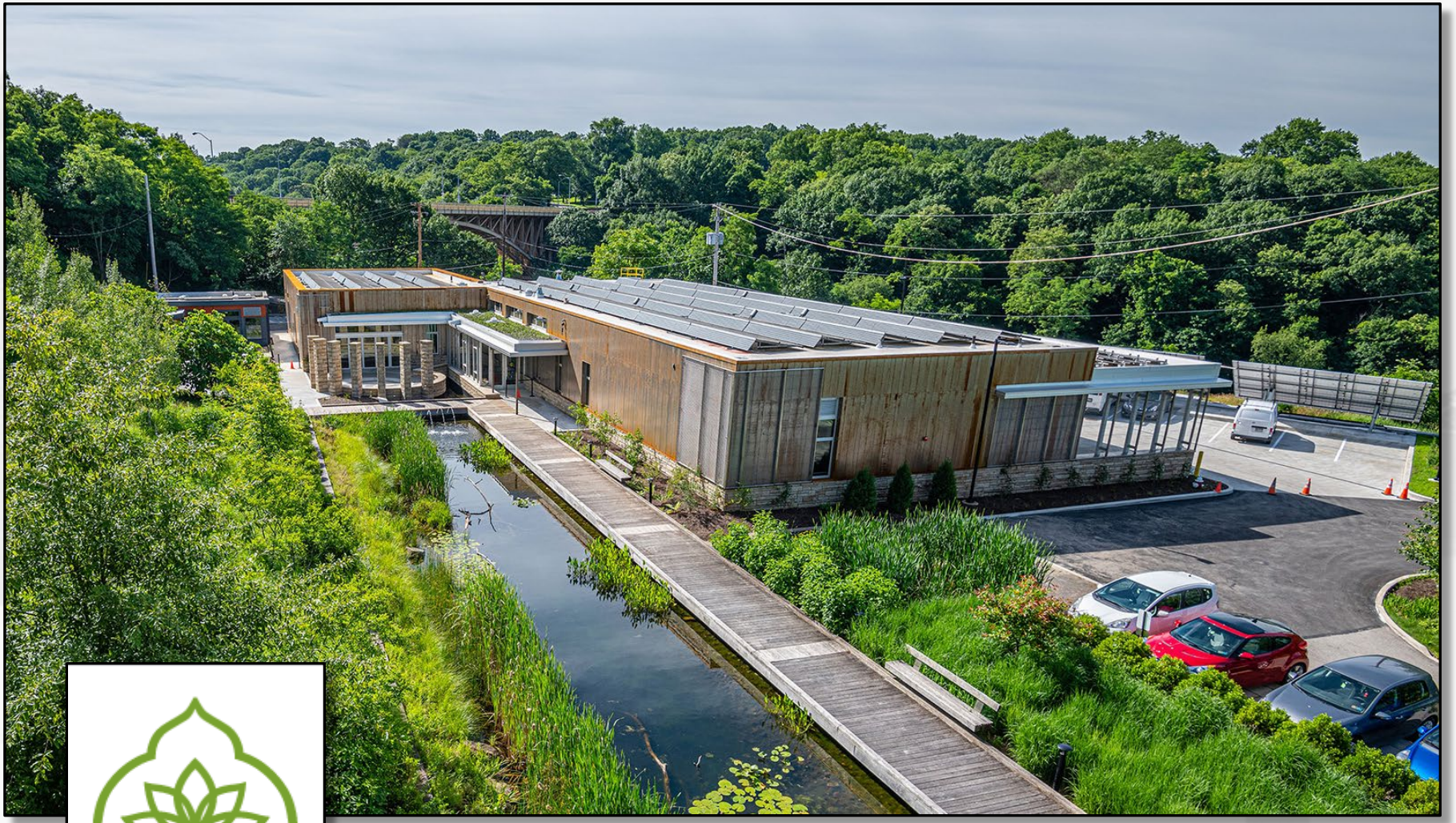

PHIPPS

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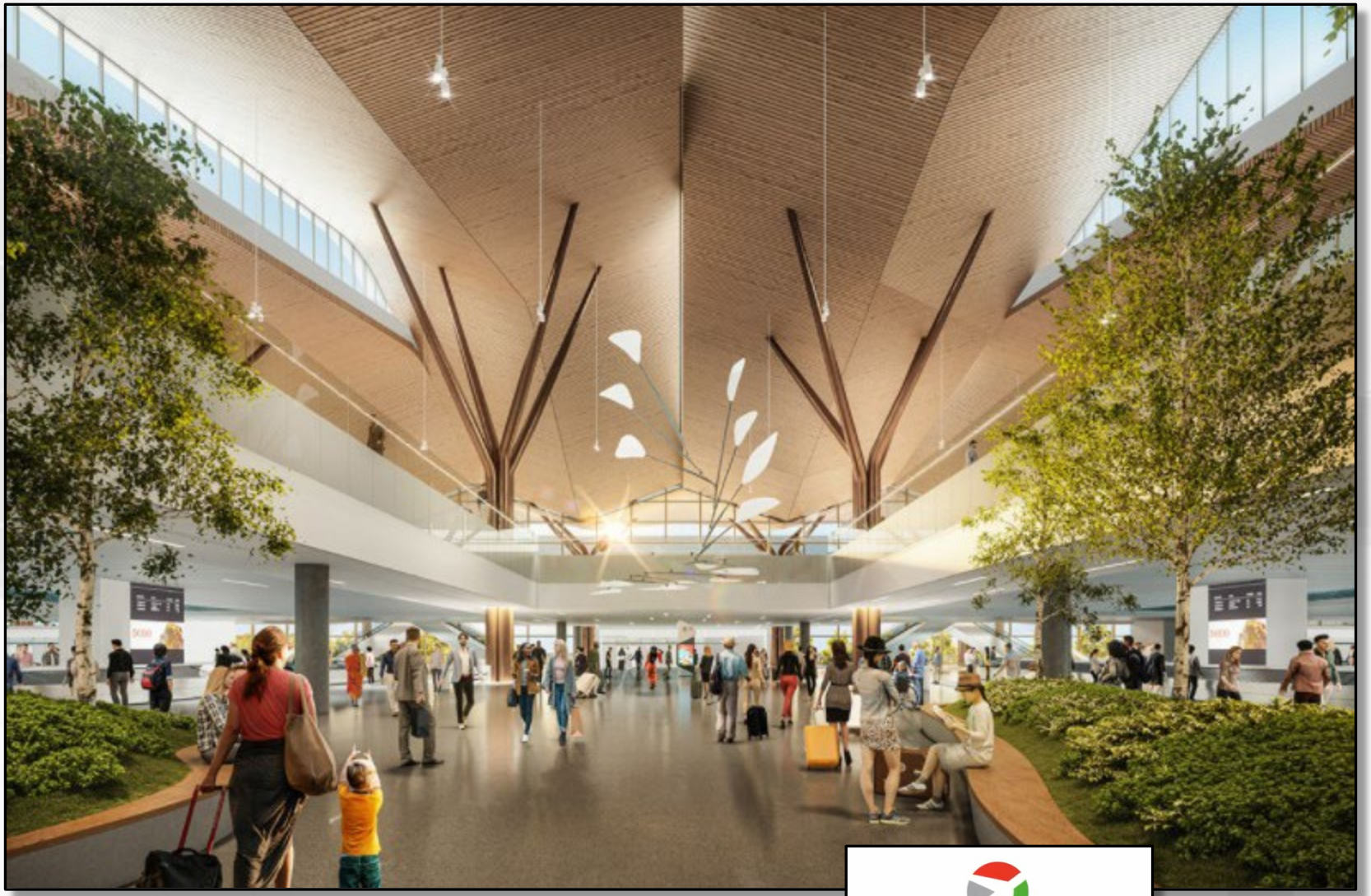
UPMC
LIFE
CHANGING
MEDICINE



PITTSBURGH
INTERNATIONAL AIRPORT

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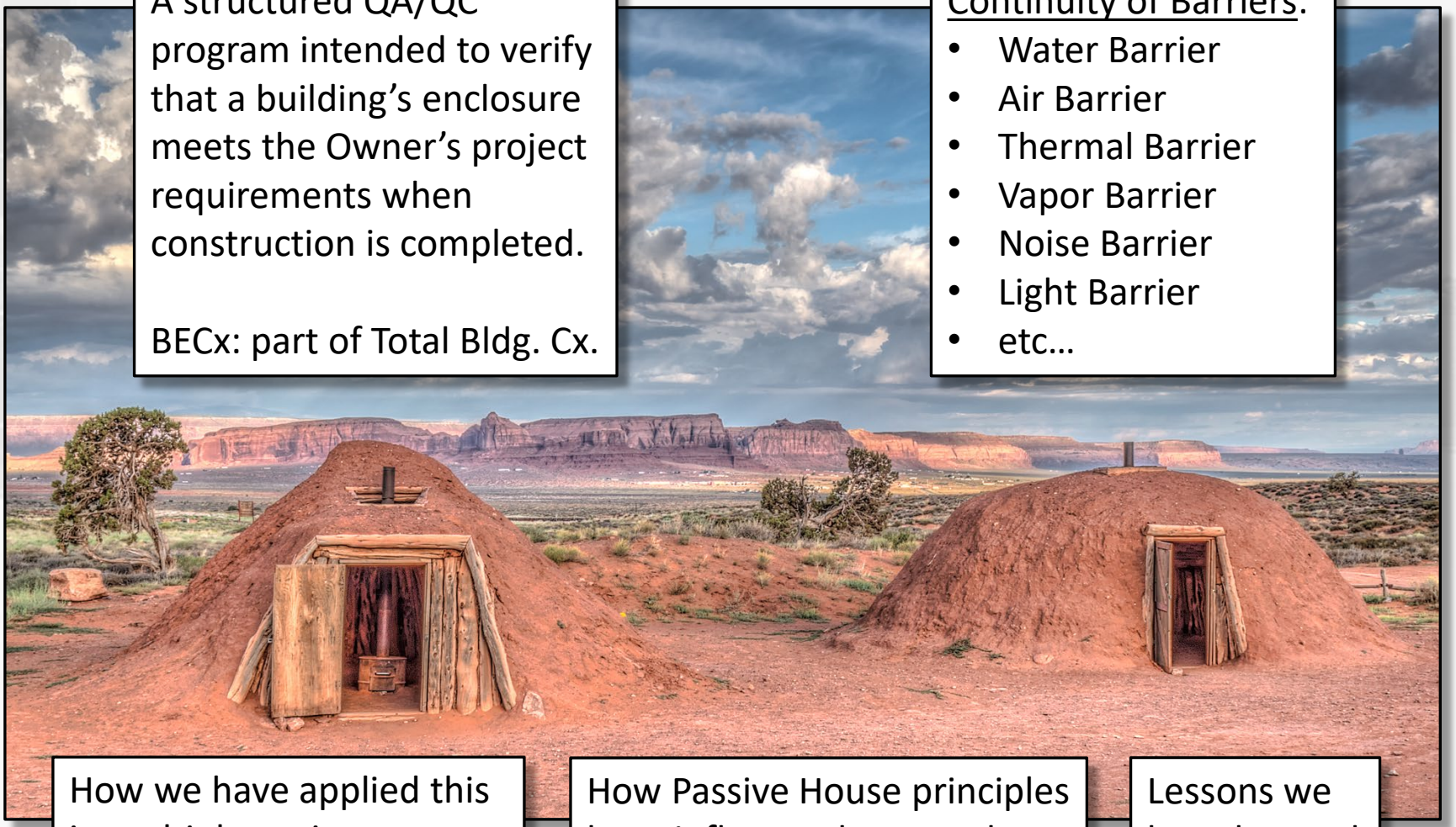
What is Building Enclosure Commissioning?

A structured QA/QC program intended to verify that a building's enclosure meets the Owner's project requirements when construction is completed.

BECx: part of Total Bldg. Cx.

Continuity of Barriers:

- Water Barrier
- Air Barrier
- Thermal Barrier
- Vapor Barrier
- Noise Barrier
- Light Barrier
- etc…

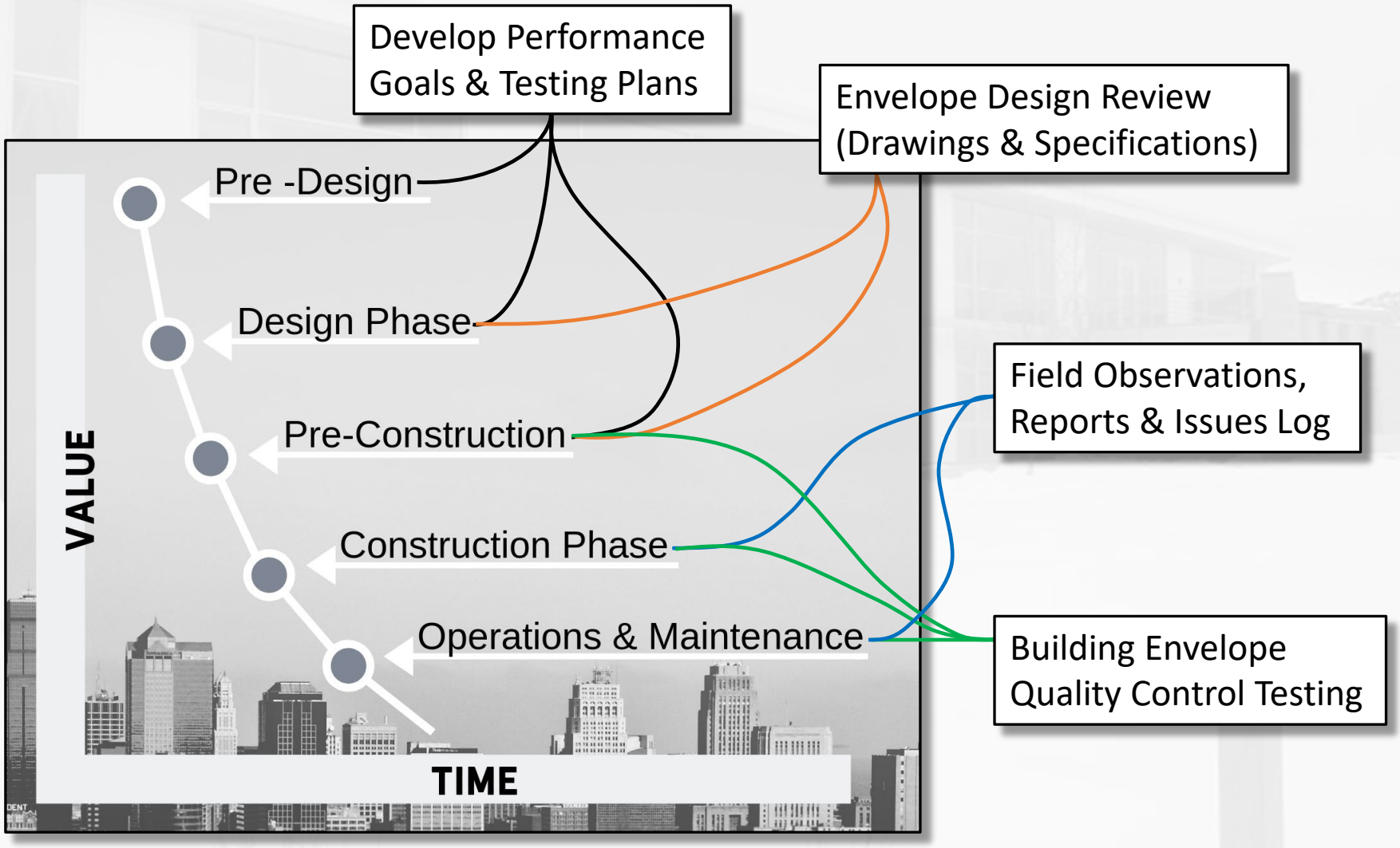


How we have applied this in multiple projects

How Passive House principles have influenced our work

Lessons we have learned

BECx Activities through the Project



Develop Performance Goals & Testing Plans

"What do you think would be a reasonable envelope air leakage target?"

Owners' Project Requirements Document

Energy Use Reduction Strategies

To meet the energy use reduction goals listed above, the following strategies will be employed:

- Use active energy modeling to evaluate design options and optimize building configuration, envelope and systems. Determine actionable energy efficiency measures in a timely and actionable manner for CMU's evaluation as a function of ROI. Provide energy model with inputs and outputs for owner team review at 100% DD, 50% CD and 100% CD milestones.
- The building envelope shall have continuous, unbroken air and thermal barriers.
- Whole building envelope air barrier shall perform at a leakage rate of 0.2CFM /sf of envelope surface area, including intersections with existing buildings. This represents whole building air leakage performance mid-way between "tight" and "average," as described in the 2009 ASHRAE Handbook of Fundamentals.
- Continuous unbroken thermal barriers (e.g. insulating layers) are to meet or exceed building code requirements in all areas of the building envelope, including assembly prescriptive requirements, overall UA comparison and total building annual energy use comparison.

Envelope Design Review (Drawings & Specs)

3.5 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Air-barrier dry film thickness.
3. Continuous structural support of air-barrier system has been provided.

D. Tests: As determined by testing agency from among the following tests:

1. Air-Leakage-Location Testing: Air-barrier assemblies will be tested for evidence of air leakage according to ASTM E 1186, chamber pressurization or depressurization with smoke tracers.
2. Air-Leakage-Volume Testing: Air-barrier assemblies will be tested for air-leakage rate according to ASTM E 2357.
3. Adhesion Testing: Air-barrier assemblies will be tested for required adhesion to substrate according to ASTM D 4541 for each 600 sq. ft. (56 sq. m) of installed air barrier or part thereof.

Develop Performance Goals & Testing Plans

Designation: E2813 – 18

Standard Practice for Building Enclosure Commissioning[1]

			Lab System Testing[A]	Enhanced		Fundamental	
				Field Mockup Testing[B]	In-Situ Field Testing	Field Mockup Testing[B]	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/ E514M	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[J]	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[K]	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)

Develop Performance Goals & Testing Plans

SECTION 01 91 19.43 - EXTERIOR ENCLOSURE COMMISSIONING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes building enclosure systems and assemblies:

1. Horizontal and vertical waterp
2. Floor Slabs
3. Opaque walls.
4. Roofs.
5. Openings and fenestration.
6. Interfaces.

3.3 LABORATORY MOCKUP TESTING

A. Laboratory Mockup Testing Service: Engage a qualified testing agency to perform testing on laboratory mockups.

B. Laboratory Mockup Testing Program: Perform the tests listed below in the following order.

1. Individual Stone Anchor to Stone Testing: ASTM C1354 / C1354M, (4) sets of (5) stone samples for each stone anchor proposed. One set shall be tested with the load applied outward, one set shall be tested with the load applied inward. For the load applied parallel to the panel, one set of five shall be tested with the load applied in each the direction the anchor is being tested.

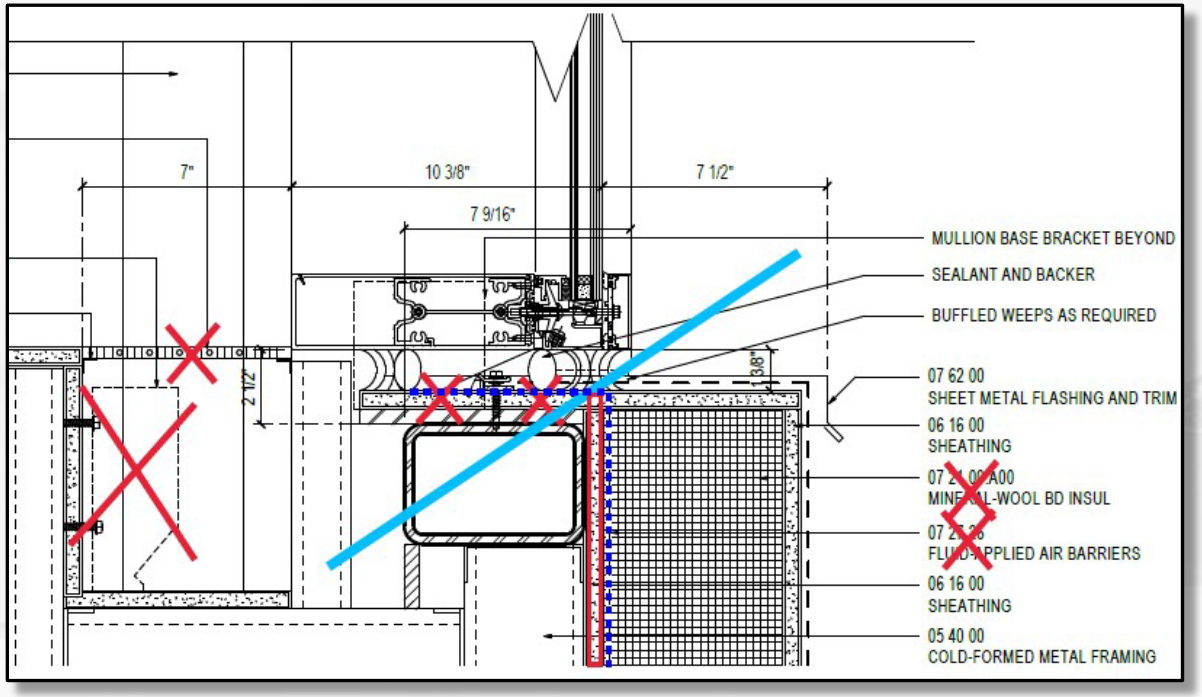
    a. Test the assembly to failure and record the test pressure at failure. Record the type of failure, anchor pull-out or stone breakage, and any other pertinent information, all in accordance with the requirements outlined in ASTM C 1354/C 135M. In addition, submit load deflection curves of each test assembly.

2. Joint Sealant Adhesion in Peel: ASTM C794, for each combination of exterior wall joint sealant and substrate shown in the Drawings. Test each sealant-substrate combination once with the substrate primed, and once with the substrate unprimed.

    a. Minimum peel adhesion value after 7 day immersion not less than 13 pli.

Envelope Design Review (Drawings & Specs)

A: Roof vapor barrier not shown in right position with respect to roof deck cover board.
B: Roof vapor barrier end point not clearly defined.
C: Addition of fluid-applied air barrier at short vertical wall below fenestration creates unnecessary complexity.
D: The membrane directly outside the vertical stud wall & sheathing does not wrap into the curtain wall opening (could lead to air and/or water leakage).
E: Roof top cover board and membrane should not wrap up over vertical mineral wool insulation (mineral wool insulation is not part of the roofing system).
F: There is a layer of gypsum sheathing between the curtain wall sill and its steel structural support. Gypsum sheathing is not an acceptable material to serve as weight-bearing blocking for the curtain wall.
G: The vertical face of the sheet metal sill flashing is shown as a different height in detail 3/A5109 than in 1/A5105.
H: The sealant joint between the curtain wall sill and the wall opening is dimensioned at 1 3/8" wide. This is an excessive width for a sealant joint, and may lead to sealant failure.
I: Directly below the curtain wall sill, there is a path through the envelope assembly where there is no insulation; the thermal barrier is not continuous. This will allow excessive heat transfer between indoors and outdoors.
J: Presumably to reduce the chance of condensation on the clerestory glazing, the design team has shown an electric resistance heater at the indoor side of the curtain wall sill. The use of electrical energy to prevent indoor condensation runs counter to the goal of energy efficiency as well as the benefits of envelope design best practices.



We recommend the following:
A: Show the roof vapor barrier above the bottom roof deck sheathing, not inside it.
B, C and D: Delete fluid-applied membrane air barrier from short vertical wall below the curtain wall. Wrap the roof vapor barrier up the vertical wall sheathing and into the bottom of the curtain wall opening.
E: Delete mineral wool insulation and instead continue roof insulation vertically & extend roof membrane vertically outside the insulation, lapping onto the roof vapor barrier inside the curtain wall opening.
F: Delete the horizontal sheathing between the structural steel and the curtain wall sill.
G: Since roof membrane and protection board will cover vertical insulation, sill flashing may extend down only about 2 inches.
H: Reduce the width of the sealant joint at the curtain wall sill to 3/4" maximum; 1/2" joint width would be better.
I: Push the curtain wall toward the outdoors at least 1 1/2"; along with reducing the thickness of the sealant joint, this will allow the envelope thermal boundary to be continuous, without a significant gap at the curtain wall sill.
J: After optimizing the envelope detailing around the clerestory to provide water, air, thermal, and vapor barrier continuity and performance, consider removing the electric heaters from below the clerestories; the envelope may be able to prevent indoor condensation.

Field Observations, Reports, and Issues Log

FO-11-1 OPEN MODERATE

Welding & Spray Room 112A, The air barrier does not continue all the way into the corner of the plan south wall. Batt insulation has been packed into the gap, but this is not sufficient to stop air leakage.

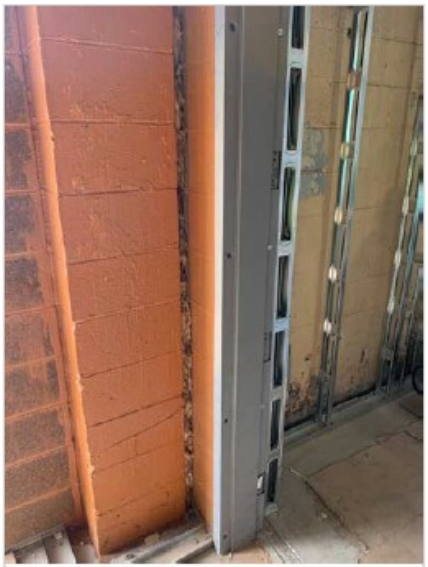
Assigned To	Mark Kacvinsky
Asset	Envelope
Due Date	2/21/2019
Created By	Cole Williams
Identified On	2/7/2019 11:50 AM

4/12/19: There is been no change in this condition since last field observation. Status and changed

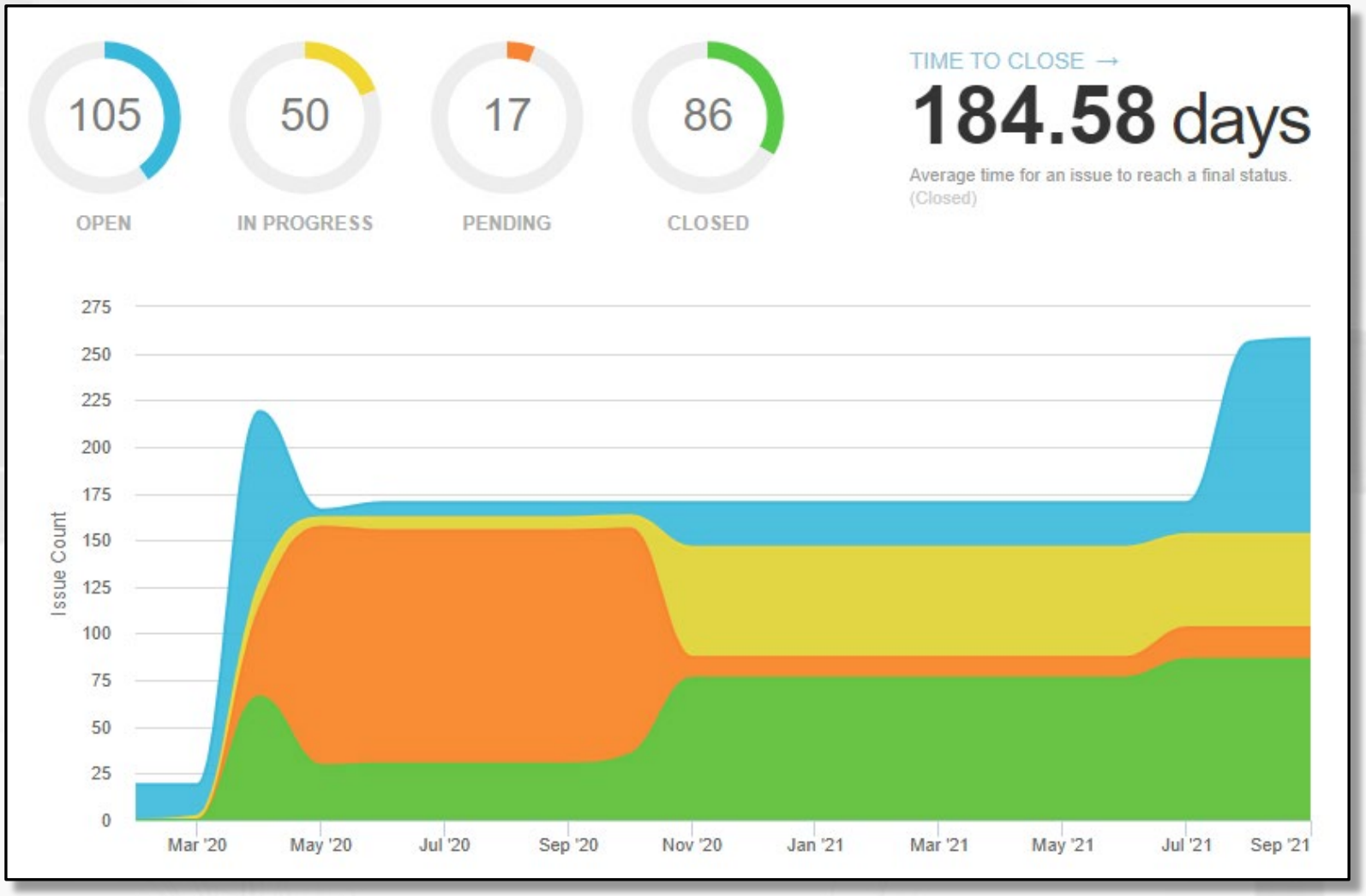
Cole Williams on 04/12/2019 at 07:55 AM

We recommend removing the batt insulation that has been packed into the gap and continuing the air barrier to the exterior wall. The batt insulation does not need to be replaced after the air barrier application.

Cole Williams on 02/07/2019 at 11:50 AM

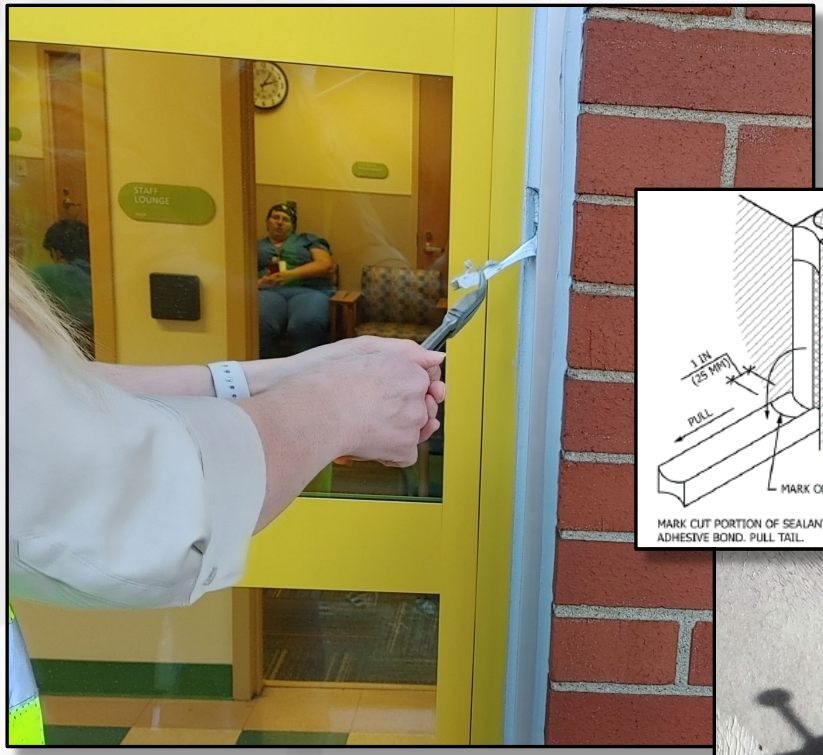


Field Observations, Reports, and Issues Log

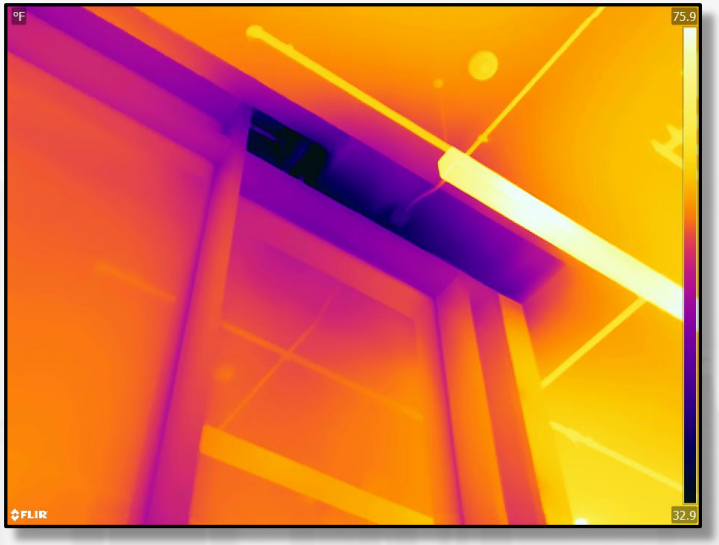


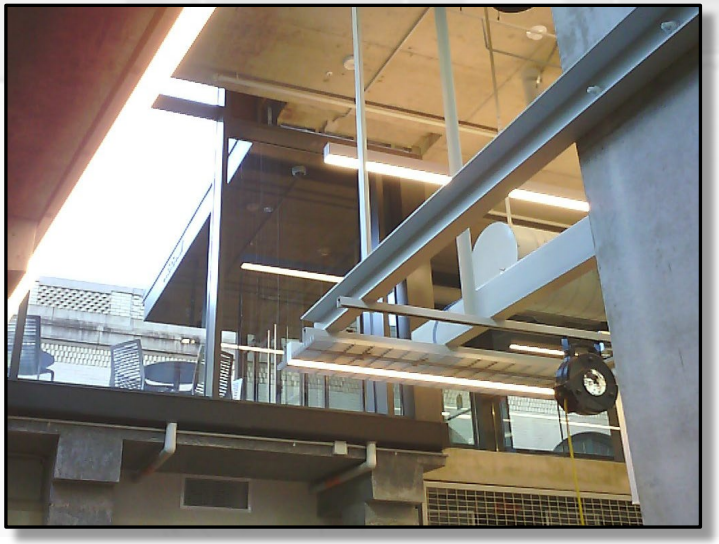
Building Envelope Quality Control Testing

Building Envelope Quality Control Testing



Building Envelope Quality Control Testing





Envelope + MEP = Total Building Commissioning

Construction Phase Commissioning Plan

Project:
Owner's Contact:
Date: June 21, 2021

1. Overview

1.1 Abbreviations and Definitions

The following are common abbreviations used in this document. Definitions are found in the Specifications.

A/E	Architect and design engineers	GC	General contractor
BEC	Building Envelope Consultant	MC	Mechanical contractor
BECxA	Building Enclosure Commissioning Authority	Mfr	Manufacturer's representative
CxA	Commissioning Authority	OR	Owner's Representative
CC	Controls contractor	PC	Plumbing contractor
CM	Construction Manager	PFC	Prefunctional checklist
Cx	Commissioning	PM	Owner's Project Manager
Cx Plan-	Commissioning Plan document	Subs	Subcontractors
EC	Electrical contractor	TAB	Test and balance contractor
FT	Functional performance test		

Total Building Commissioning + Passive House

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