AABC Commissioning Group

AIA Provider Number 50111116

Building Enclosure Commissioning: Growing Trends in Higher Energy Performance & Operational Excellence

Course Number: CXENERGY1713

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Intertek

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Course Description

Ensuring the integrity of building enclosures has become increasingly complex. Over time, commissioning (Cx) and specialty Cx disciplines, such as building envelope commissioning (BECx), have gained momentum as effective processes in achieving high performance. Through the use of case studies, this presentation explores real life examples of how BECx provides comprehensive quality assurance that can save time and money while simultaneously increasing a project's worth.

Learning Objectives

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

1. Review the current codes and standards related to Building Enclosure Commissioning (BECx).

2. Understand the linkage between materials, systems and whole building performance.

3. Understand how our changing environment and construction practices dictate modifications to traditional building enclosure quality assurance.

4. Understand the application of the full spectrum of building enclosure-related testing from laboratory to field.

Program Outline

Drivers

- Failures
- Safe
- Durable
- Savings
- “Green”
- Timely
- Expectations (OPR)

Codes / Building Science

State of the Practice

Tomorrow’s Trends

Environmental Separation

Building enclosures are designed to separate interior from exterior.

Leaks


Géa


GRACE
Bituthene

Air Quality / Health

Durability of Materials


10

Program Outline

Quality Drivers

- Failures
- Safe
- Durable
- Savings
- “Green”
- Timely
- Expectations (OPR)

Codes / Standards

State of the Practice

Tomorrow’s Trends

Energy and the Enclosure

Solar Heat Gain

U-Factor

Air Leakage

Energy and the Enclosure

Solar Heat Gain

<u>SHGC</u>

Transmittance

Reflectance

Absorptance

Emittance

Owner’s Project Requirements

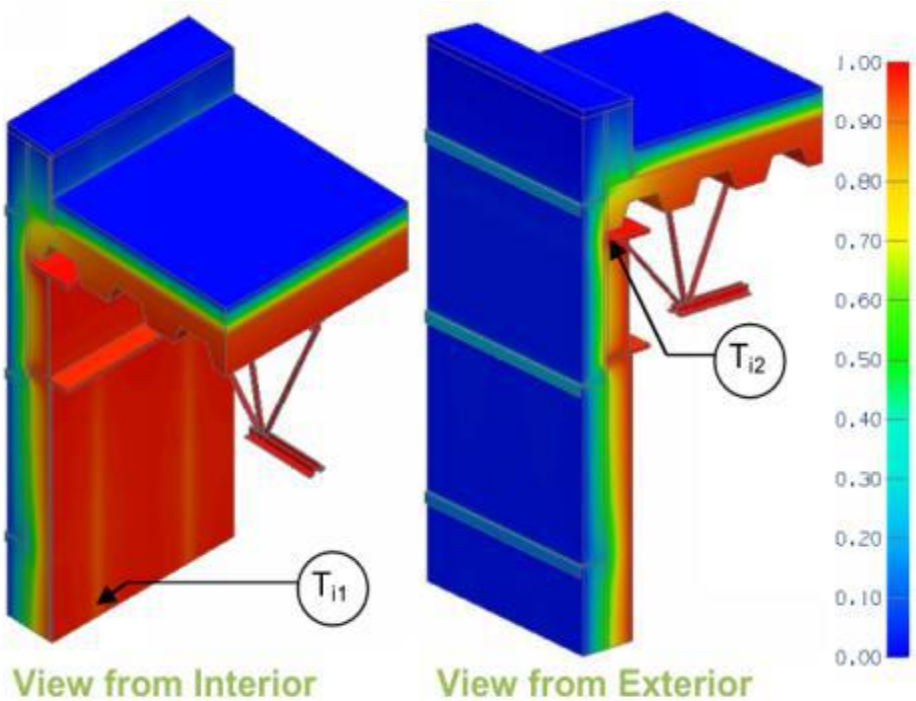
Energy and the Enclosure

Window: Wall

Energy and the Enclosure

Thermal Discontinuities

Energy Modeling & BECx



View from Interior View from Exterior

Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R_{1Dr}, R_{1Dw}	Two base assemblies : r = roof w = wall (Detail 11)
Transmittance / Resistance without Anomaly	U_{or} R_{or} U_{ow} R_{ow}	"clear field" U- and R-values. Separate values presented for the two base assemblies
Surface Temperature Index[1]	T_i	0 = exterior temperature 1 = interior temperature
Linear Transmittance	ψ	Incremental increase in transmittance per linear length of parapet

[1]Surface temperatures are a result of steady-state conductive heat flow with constant heat transfer coefficients. Limitations are identified in final report.

Nominal (1D) vs. Assembly Performance Indicators

Base Assembly – Wall

Wall Exterior Insulation 1D R-Value (RSI)	R_{1D} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	R_{ow} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_{ow} Btu/$ft^2 \cdot hr \cdot {}^oF$ (W/m^2 K)
R-5 (0.88)	R-19.2 (3.38)	R-13.40 (2.36)	0.075 (0.42)
R-10 (1.76)	R-24.2 (4.26)	R-16.28 (2.87)	0.061 (0.35)
R-15 (2.64)	R-29.2 (5.14)	R-18.49 (3.25)	0.054 (0.31)
R-20 (3.52)	R-34.2 (6.02)	R-20.50 (3.61)	0.049 (0.28)
R-25 (4.40)	R-39.2 (6.90)	R-22.14 (3.90)	0.045 (0.26)

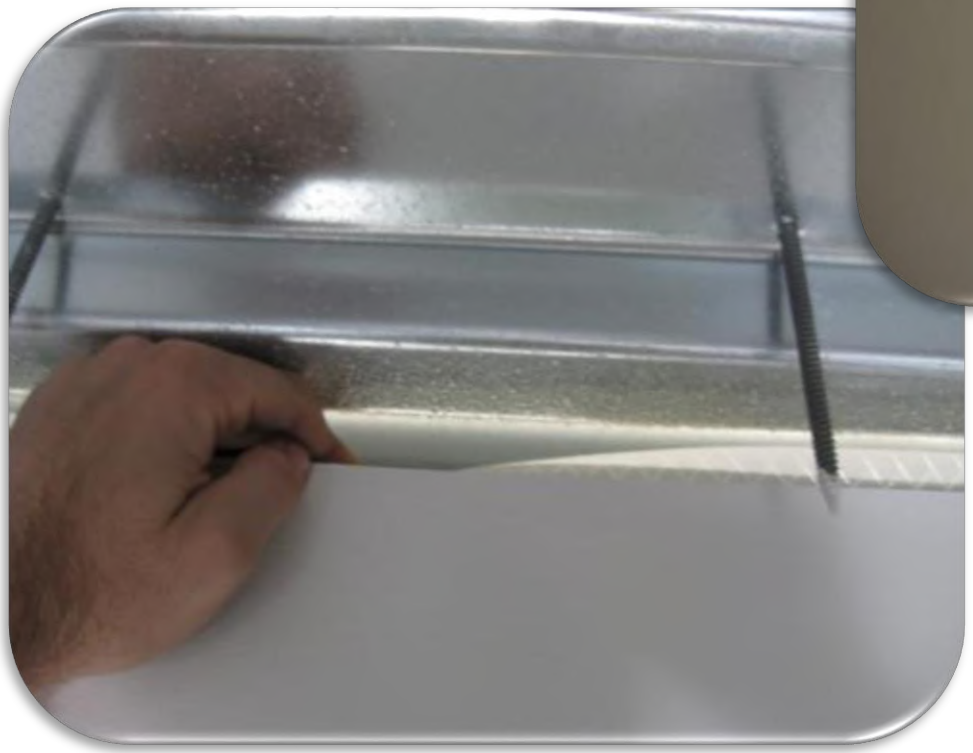
Base Assembly – Roof

R_{1D} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	R_{or} $ft^2 \cdot hr \cdot {}^oF$ / Btu (m^2 K / W)	U_{or} Btu/$ft^2 \cdot hr \cdot {}^oF$ (W/m^2 K)
R-21.2 (3.74)	R-21.0 (3.69)	0.048 (0.27)

Reference ASHRAE 1365 -RP

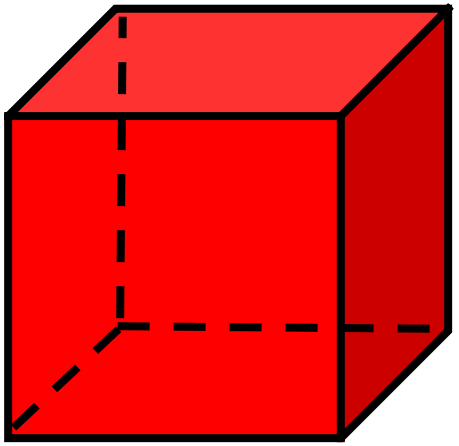
Energy and the Enclosure

HVAC or Envelope?



Energy and the Enclosure

Whole building air test results (ASTM E779) are expressed as air flow through the wall, roof, and floor, not just the facade.



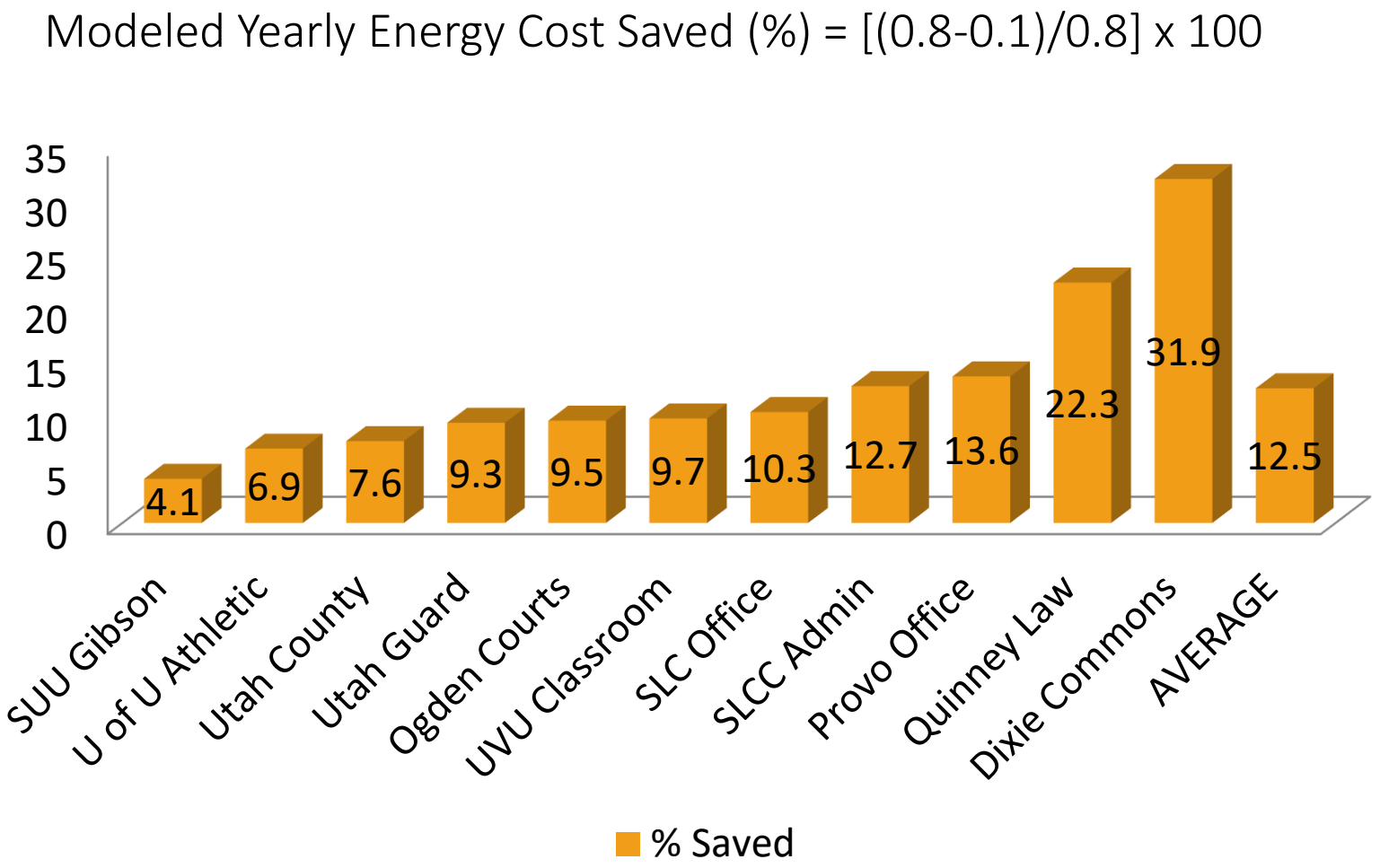
Oak Ridge National Lab - Study

Findings relating to energy modeling and air leakage:

Current modeling software, doesn't do a good job of accounting for energy losses due to air leakage.

- Calculations are based on conductive losses rather than losses due to air leakage.
- Current models appear to underestimate the energy loss due to air leakage.
- Past studies focus on lower R-value walls compared to the higher R-values of today.

DFCM's Case for Rigorous BECx



Achieve Exceptional Energy Savings

Building Envelope Commissioning

Over the years DFCM has learned the immense value of having high performing building envelopes. Quality systems that perform as designed provide value to the building and its occupants for decades.

In an effort to quantify the value of this program, DFCM conducted an analysis utilizing a sophisticated energy modeling process to determine annual energy cost savings ranging from 4% to 32%, with a majority of buildings experiencing savings in the 10% to 15% range.

- John Burningham,
Energy Development Director

Sustainability Drivers

Environmental

Energy Efficiency

Rising Energy Costs

Design Changes

Symbols of Success

Modernization

Social

Regulatory

Life Safety

Code Updates

ASTM

Saving Time – Mockups

Saving Time – Earlier Dry In

Program Outline

Quality Drivers

Codes / Standards

State of the Practice

Tomorrow's Trends

CSA Z320-11

Building Commissioning Standards & Check Sheets

- Does not specify qualifications for BECxA
- Does not require design peer review – only input from Cx team
- Includes Pre-Construction and Functional Performance Testing
- Addresses the objectives of Part 5 – Environmental Separations of the National Building Code of Canada (NBCC) in addition to the OPR
- Includes a comprehensive list of Functional Performance Tests

Table B.1
Architectural testing protocols
(See Clause B.3.)

Test	Property	Field review & compliance testing (static)		Functional performance	Standard	Title
		Compliance test report review (lab)	Field review (visual)	Field testing (mock-up or quality assurance)		
Acoustic performance		X	X	X	ASTM E1425	*Standard Practice for Determining the Acoustical Performance of Windows, Doors, Skylights, and Glazed Wall Systems*
		X	X	X	ASTM E569	*Standard Practice for Acoustic Emission Monitoring of Structures during Controlled Simulation*
Air leakage	Air flow	X	X	—	ASTM E2319	*Standard Test Method for Determining Air Flow through the Face and Sides of Exterior Windows, Curtain Walls and Doors under Specified Pressure Differences across the Specimen*
	Air leakage	X	X	—	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*
		—	X	X	ASTM E779	*Standard Test Method for Determining Air Leakage Rate by Fan Pressurization*
		—	X	X	ASTM E783	*Standard Test Method for Field Measurement of Air Leakage through Installed Exterior Windows and Doors*
		X	X	X	ASTM E1186	*Standard Practice for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems*
		—	X	X	ASTM E1258	*Standard Test Method for Airflow Calibration of Fan Pressurization Devices*
	Air permeance	X	—	—	ASTM E2178	*Standard Test Method for Air Permeance of Building Materials*

(Continued)

ASTM E2813-12

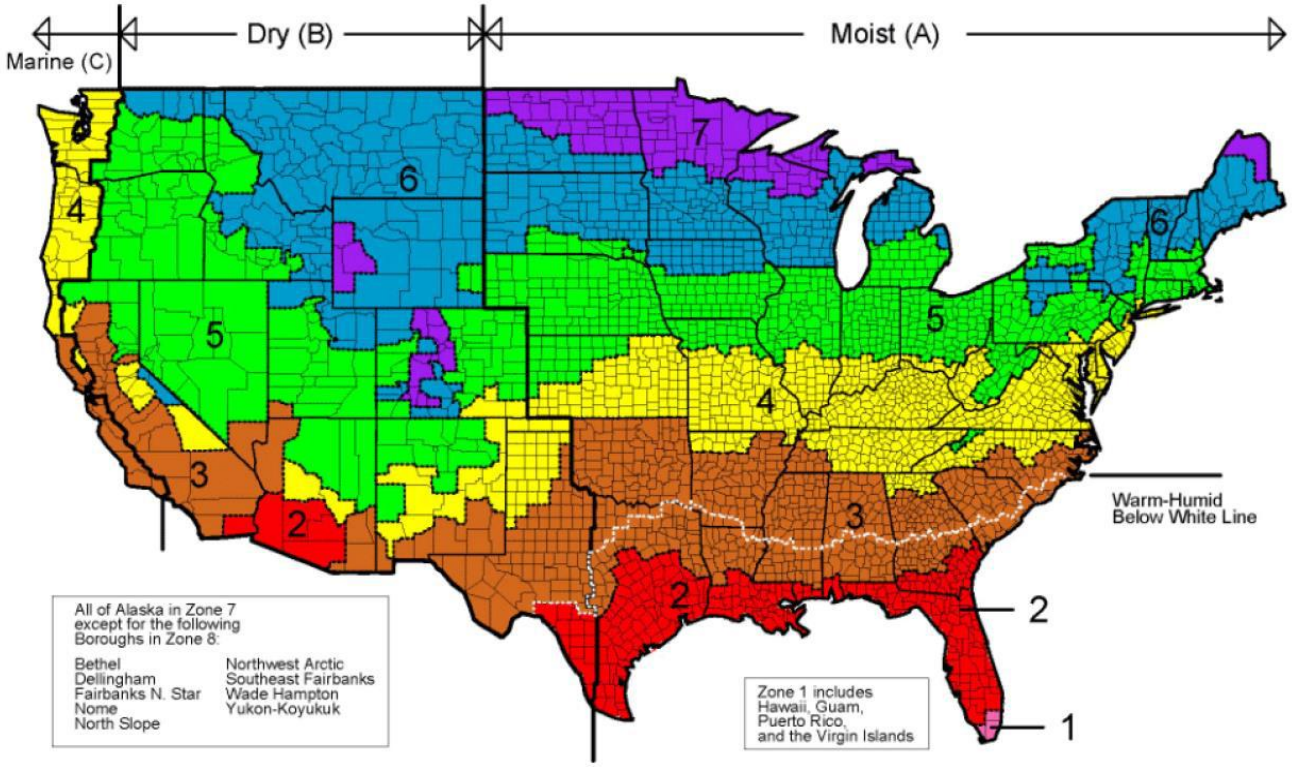
"This practice is intended to serve as a concise, authoritative, and technically sound practice for Building Enclosure Commissioning (BECx) that establishes two levels of BECx: Fundamental and Enhanced.

- Specifies qualifications for BECxA
- Specifies a "process" that has some overlap and conflict with Guideline 0 and ASHRAE Standard 202
- Includes questions representing the minimum range of issues and concerns that must be considered during development of the OPR
- Requires design peer review – Fundamental at CDs, Enhanced at SD, DD and CD
- Includes Pre-Construction and Functional Performance Testing
- Includes a comprehensive list of Functional Performance Tests and outlines mandatory testing for Fundamental and Enhanced.

Air Leakage Requirements

Continuous Air Barrier shall be provided

- IECC: except Zones 1-3
- ASHRAE: except semi-heated spaces in Zones 1-6



Determining Air Infiltration

Materials

- **ASTM E2178**
- 0.004 cfm/sq.ft. @75 Pa

Testing *air barrier materials* is necessary but not sufficient.

Assemblies

- **ASTM E2357**
- 0.04 cfm/sq.ft. @75 Pa

Testing of *air barrier assemblies* is an essential step to demonstrate performance of installed air barriers

Whole Building

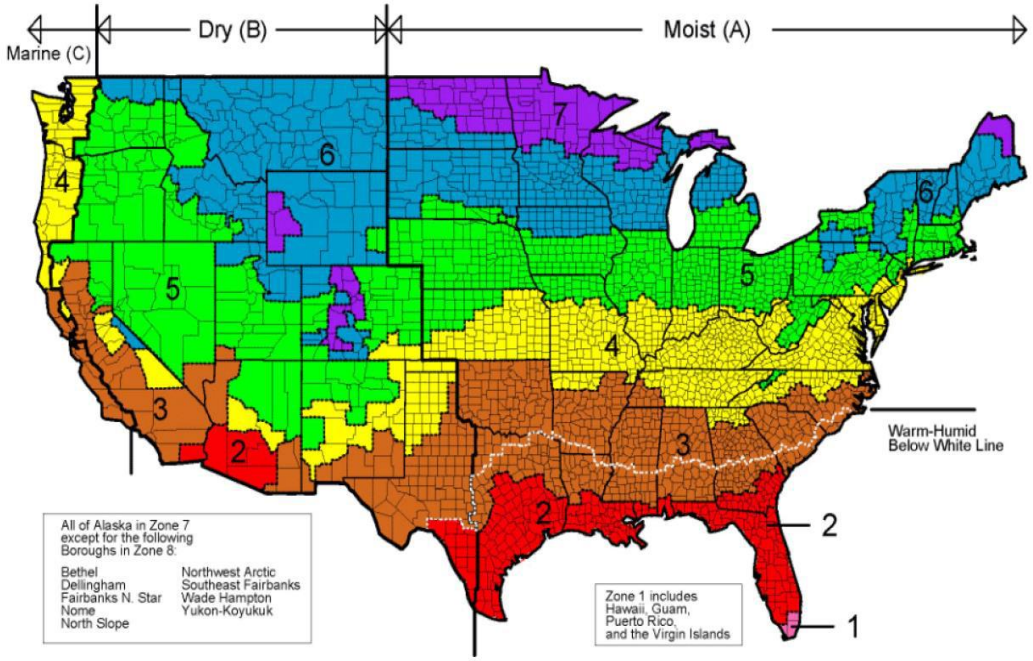
- **ASTM E779**
- 0.25-0.4 cfm/sq.ft.@75 Pa

Testing *whole building* at the end of the project may be too late and/or too expensive to fix mistakes

Vapor Control Layer

Vapor Retarders per IBC 2012:

- Class I or II vapor retarders provided on interior side of frame wall in Zones 5-8 and Marine 4
- Class III permitted conditionally



Exceptions:

1. Basement walls.
2. Below-grade portion of any wall.
3. Construction where moisture or its freezing will not damage the materials.

LEED Version 4

Fundamental Commissioning and Verification

- Inclusion in the owner's project requirements (OPR) and basis of design (BOD)
- Review of the OPR, BOD and project design

Enhanced Commissioning Option 2

- Review contractor submittals
- Verify inclusion of systems manual requirements in CD
- Verify inclusion of operator and occupant training requirements in CD
- Verify systems manual updates and delivery
- Verify operator and occupant training delivery and effectiveness
- Verify seasonal testing
- Review building operations 10 months after substantial completion
- Develop an on-going commissioning plan

Program Outline

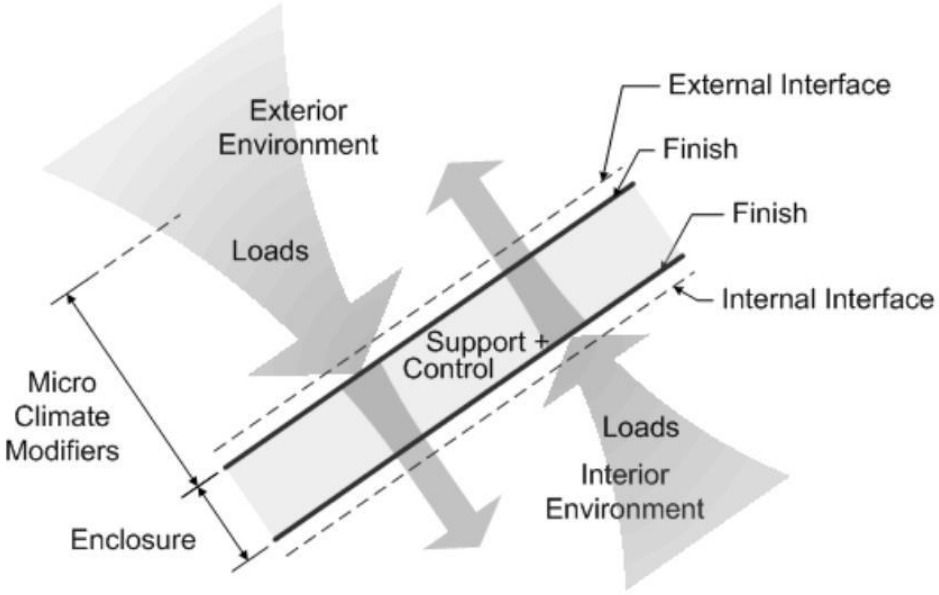
Quality Drivers

Codes / Building Science

- Code Review
- Building Science 101

State of the Practice

Tomorrow's Trends

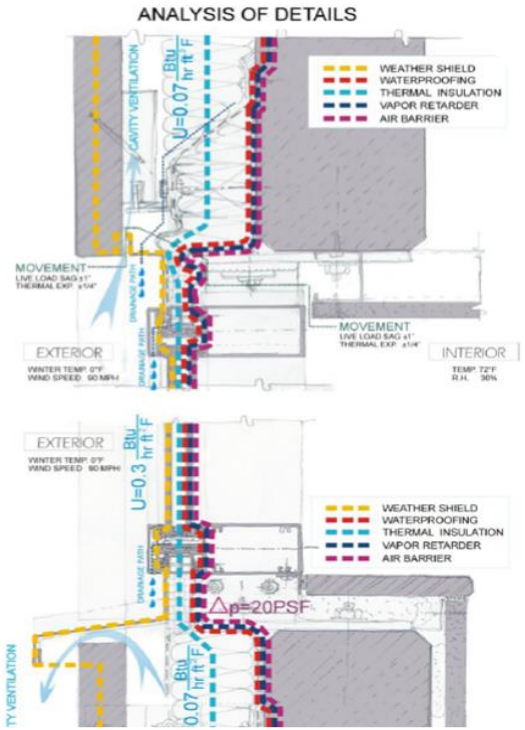


Control Layers

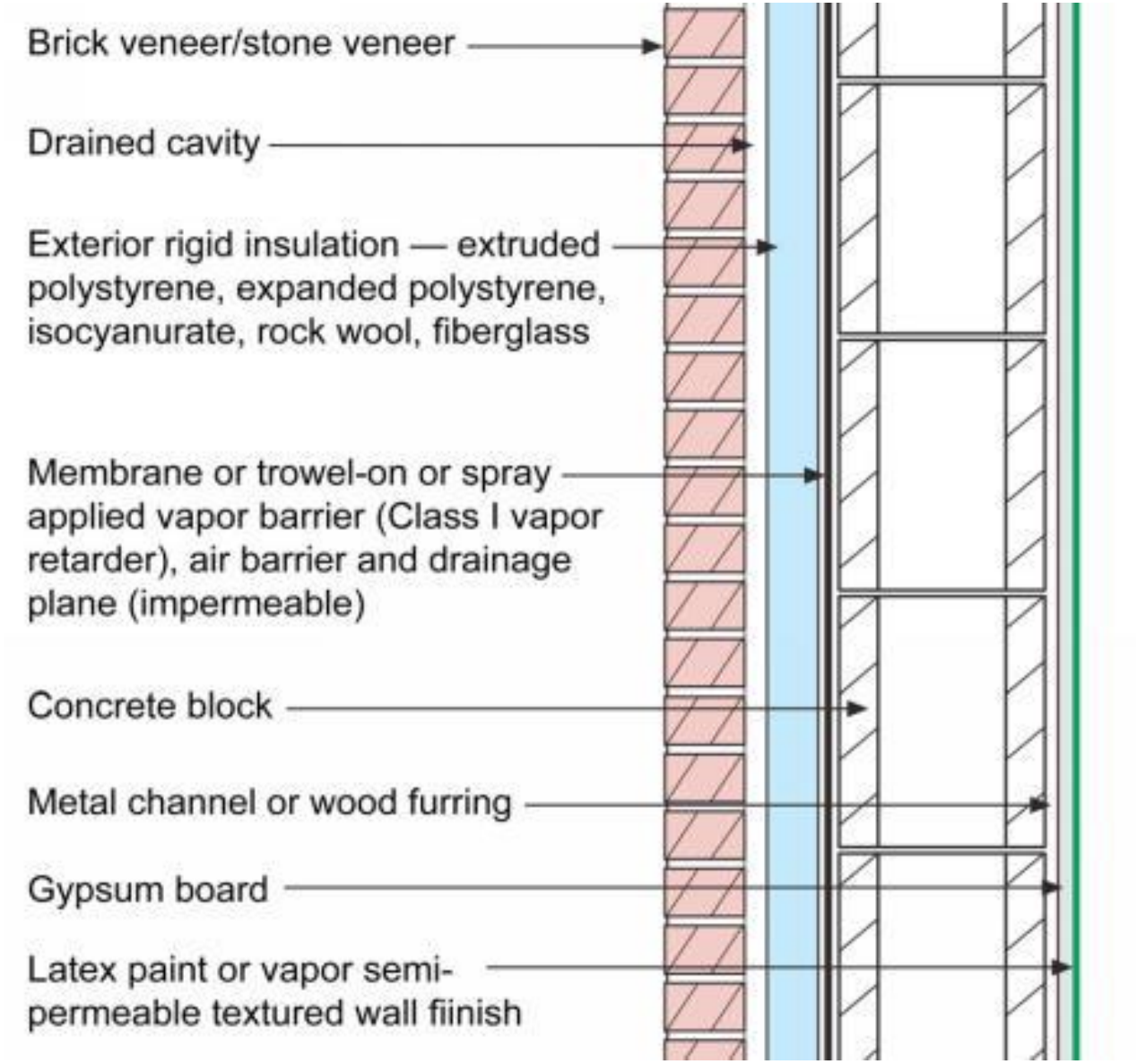
Building enclosures are designed to control multiple loadings.

Control layers include:

1. Water control layer
2. Air control layer
3. Vapor control layer
4. Thermal control layer



Enclosure Design



Enclosure Design

DATE: 2-D
FILE: P:\
sc
PROJECT: SU
SUBJECT: W
LOCATION: Ce
WALL: W

Inside Temperature (T_{inside}):	72	°F
Outside Temperature ($T_{outside}$):	0	°F
Relative Humidity (Φ):	38	%

Total Wall R-Value (R_{tot}) =	23.869	h-ft²-°F/Btu
Total Wall U-Value (U_{tot}) =	0.04	Btu/h-ft²-°F
Heat Flow (Q) =	3.02	Btu/h-ft²
Dew Point Temperature (T_{dp}) =	44.99	°F

Wall Sections

Description	R-Value	T_o (°F)	T_i (°F)	Φ_{max} (%)
Outside Air Film	0.17	0.0	0.5	5.8
1/2" UHPC panel	0.104	0.5	0.8	5.9
Air Space	1.2	0.8	4.4	7.0
2" mineral wool insulated sheathing	7.875	4.4	28.2	19.6
Vapor Barrier	0	0.8	28.2	19.6
7/16" OSB	0.62	28.2	30.1	88.1
10" mtl studs w/2" cell spray-on	12.66	30.1	68.3	88.0
5/8" gyp board	0.56	68.3	69.9	93.3
Inside Air Film	0.68	69.9	72.0	100.0

Notes

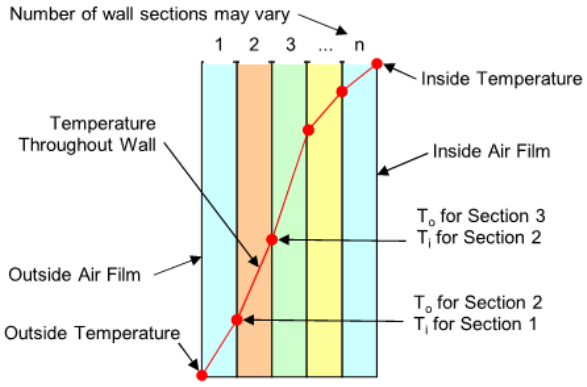
Φ_{max} is the relative humidity at which condensation may occur on the inside

1. surface of the wall section.
   The Φ_{max} value appears red if it is lower than the room humidity and there is no
2. "Vapor Barrier" between the section inside surface and the inside of the room.
   This indicates there may be condensation in the wall on that surface.

Cell Color Legend

Information that must be input by the user.
Typical values that may be changed if needed.
Values that are calculated automatically.

Typical Wall Section



Formulas

$$Q = U_{tot}\left(T_{inside} - T_{outside}\right) \qquad U_{tot} = \frac{1}{R_{tot}}$$

$$R_{tot} = \sum R_{section}$$

All the temperatures in the following equations are in °C and are converted to/from °F as needed in this spreadsheet.

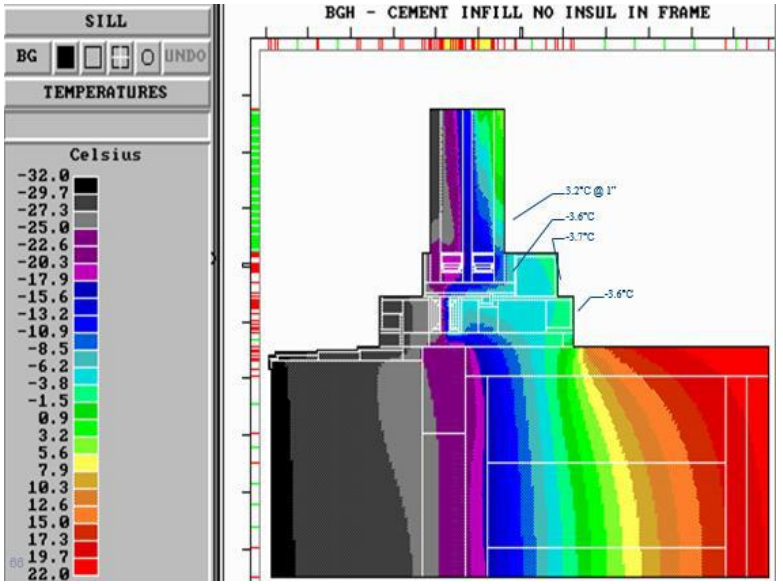
$$T_{dp} = \frac{237.7 \log\left(\frac{P_s \phi}{611}\right)}{7.5 - \log\left(\frac{P_s \phi}{611}\right)} \qquad \phi_{max} = \frac{P}{P_s}100$$

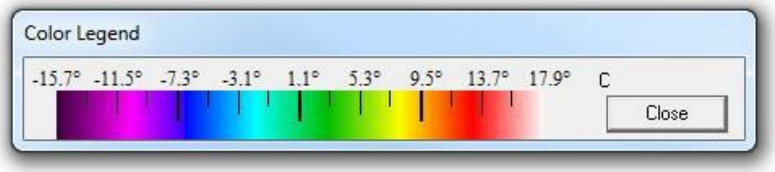
$$P_s = 6.11 \times 10^{\frac{7.5 T_{inside}}{237.7 + T_{inside}}}$$ Saturated Vapor Pressure

$$P = 6.11 \times 10^{\frac{7.5 T_i}{237.7 + T_i}}$$ Actual Vapor Pressure

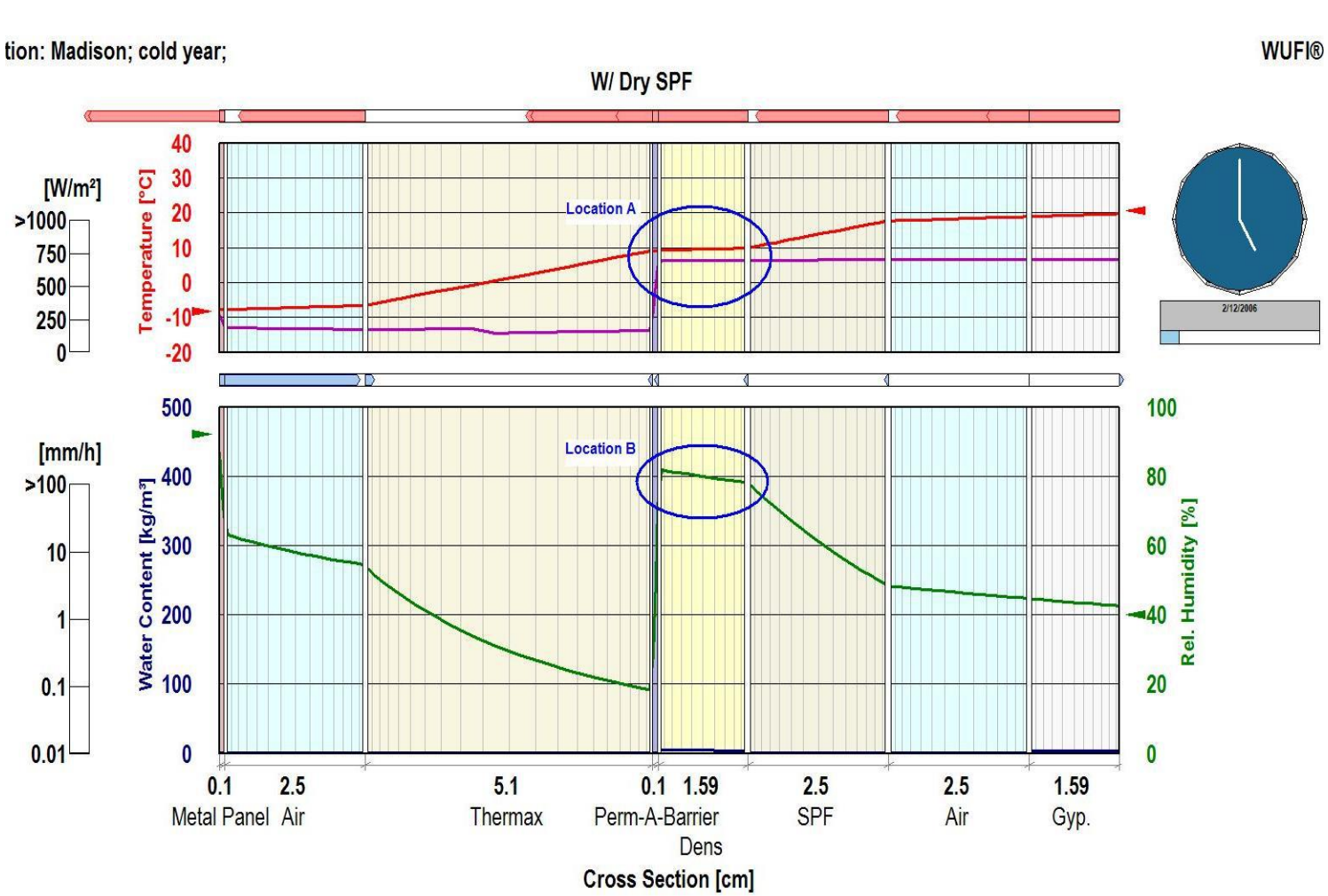
Heat Transfer Simulation

Two-Dimensional Building Heat Transfer Modeling





Enclosure Design



Program Outline

Quality Drivers

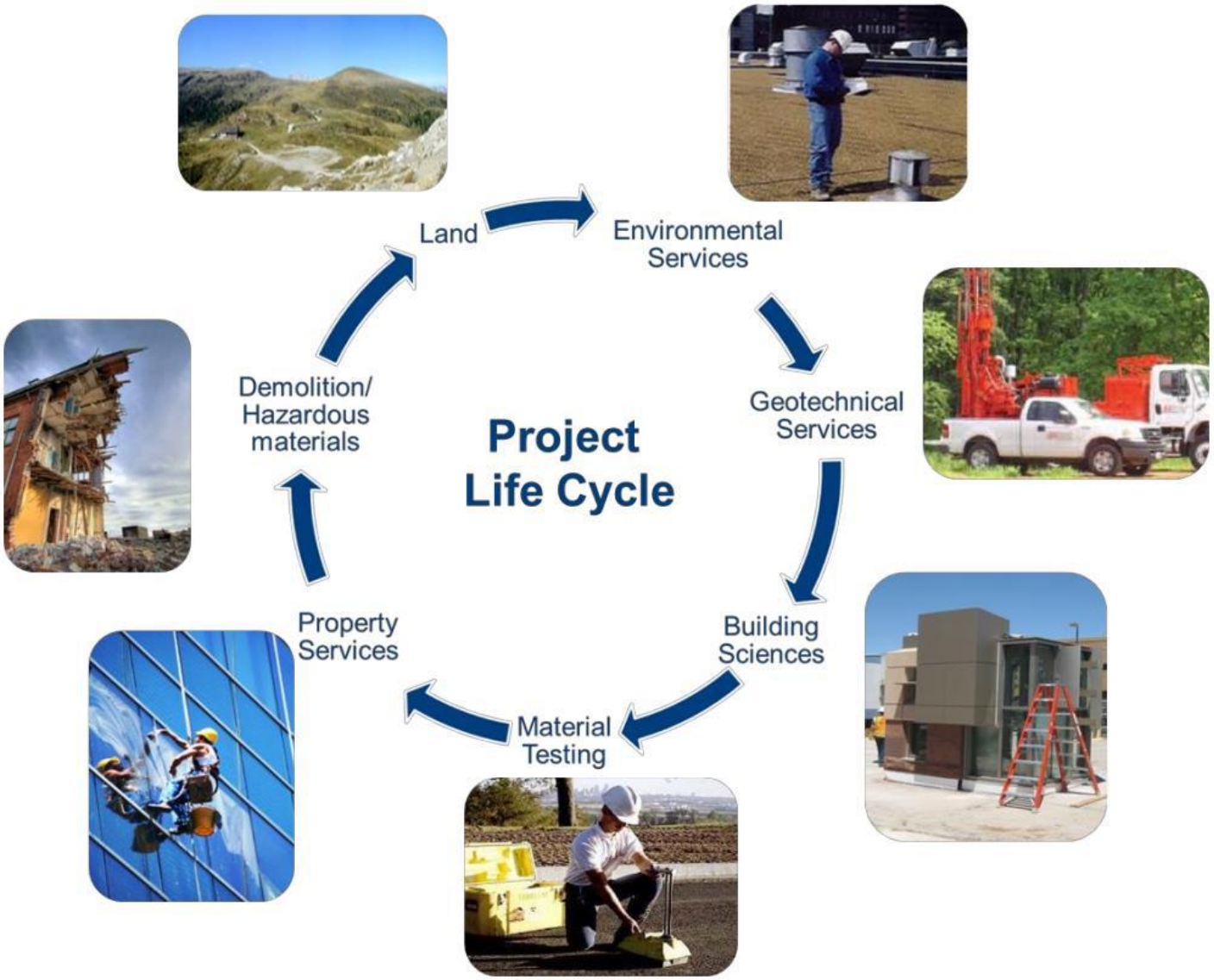
Codes / Building Science

State of the Practice

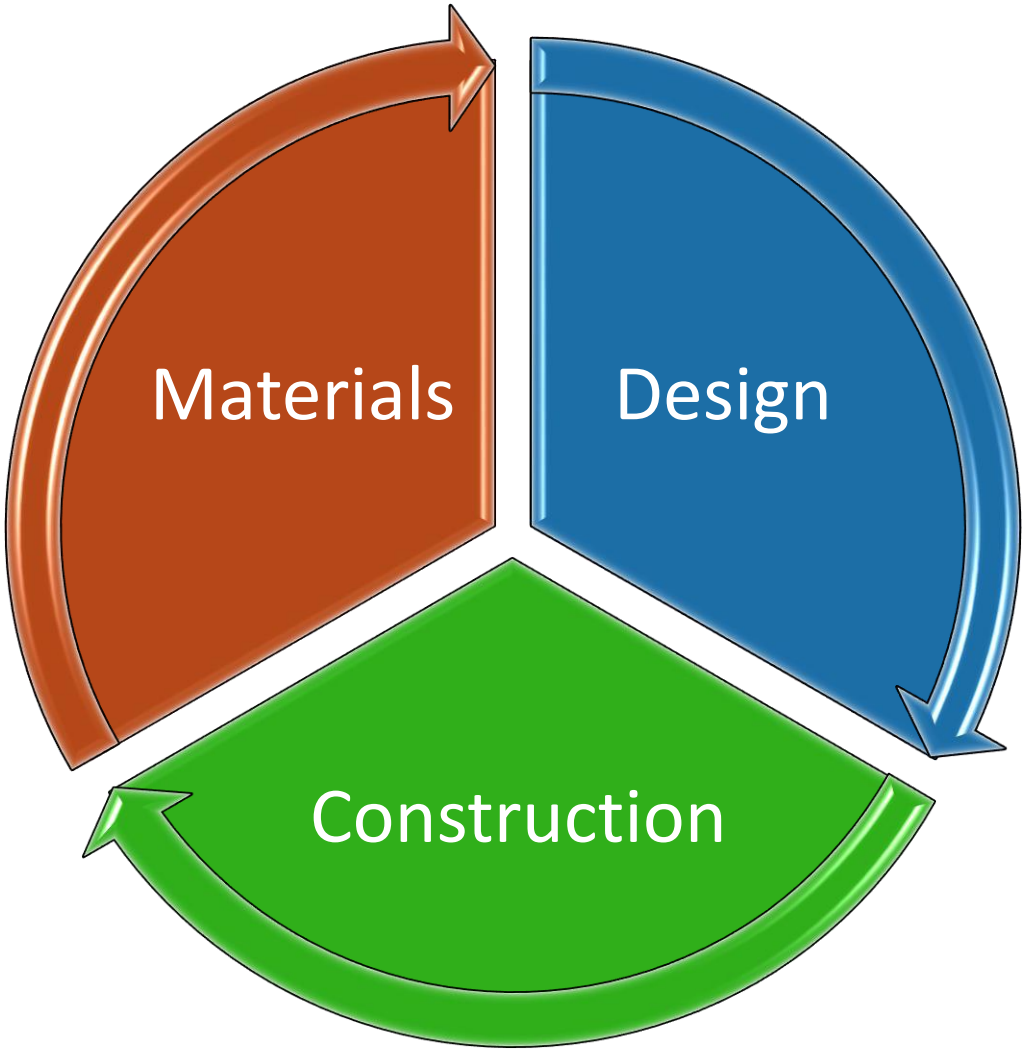
- Materials
- Consulting / Design
- BECx
- Field Testing
- Inspections

Tomorrow's Trends

Project Life Cycle



Common Forms of QA



Arena Blast Testing

Hail Impact Testing

Forced Entry Resistance

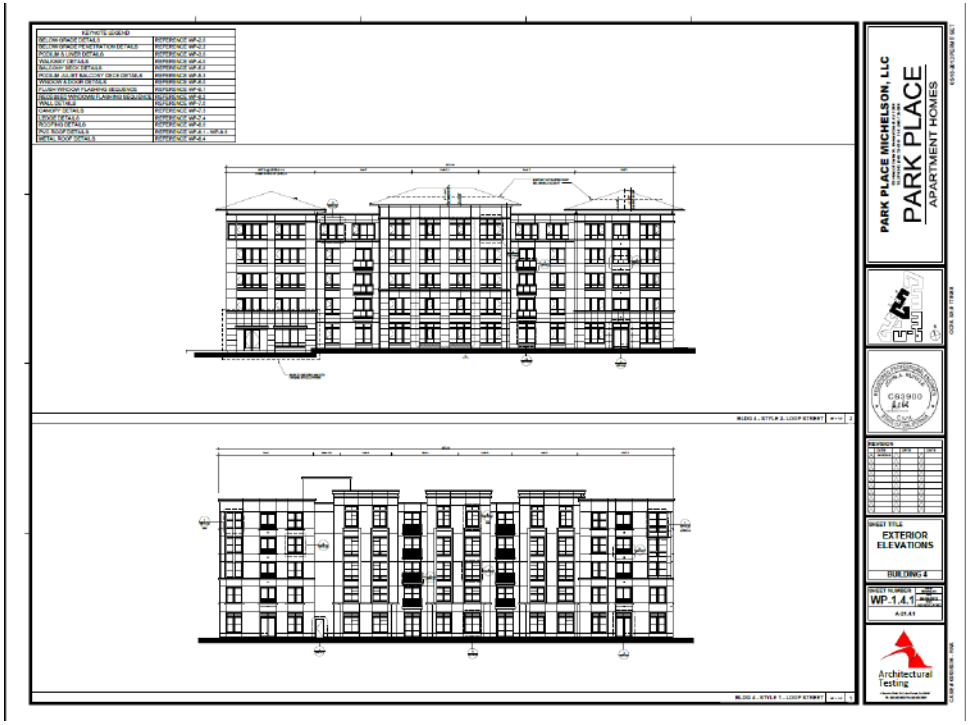
Program Outline

Quality Drivers

Codes / Standards

State of the Practice

Tomorrow's Trends



Consulting –vs- Cx

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

BECx:

- Formal Process (start/end)
- Based on performance
- More accountability
- Based on real world cond.

-VS-

Enclosure Consulting:

- Could be only one task
- Based on reducing liability
- Less accountability
- Based on standards

Code / Special Inspections

Comprehensive Enclosure QA

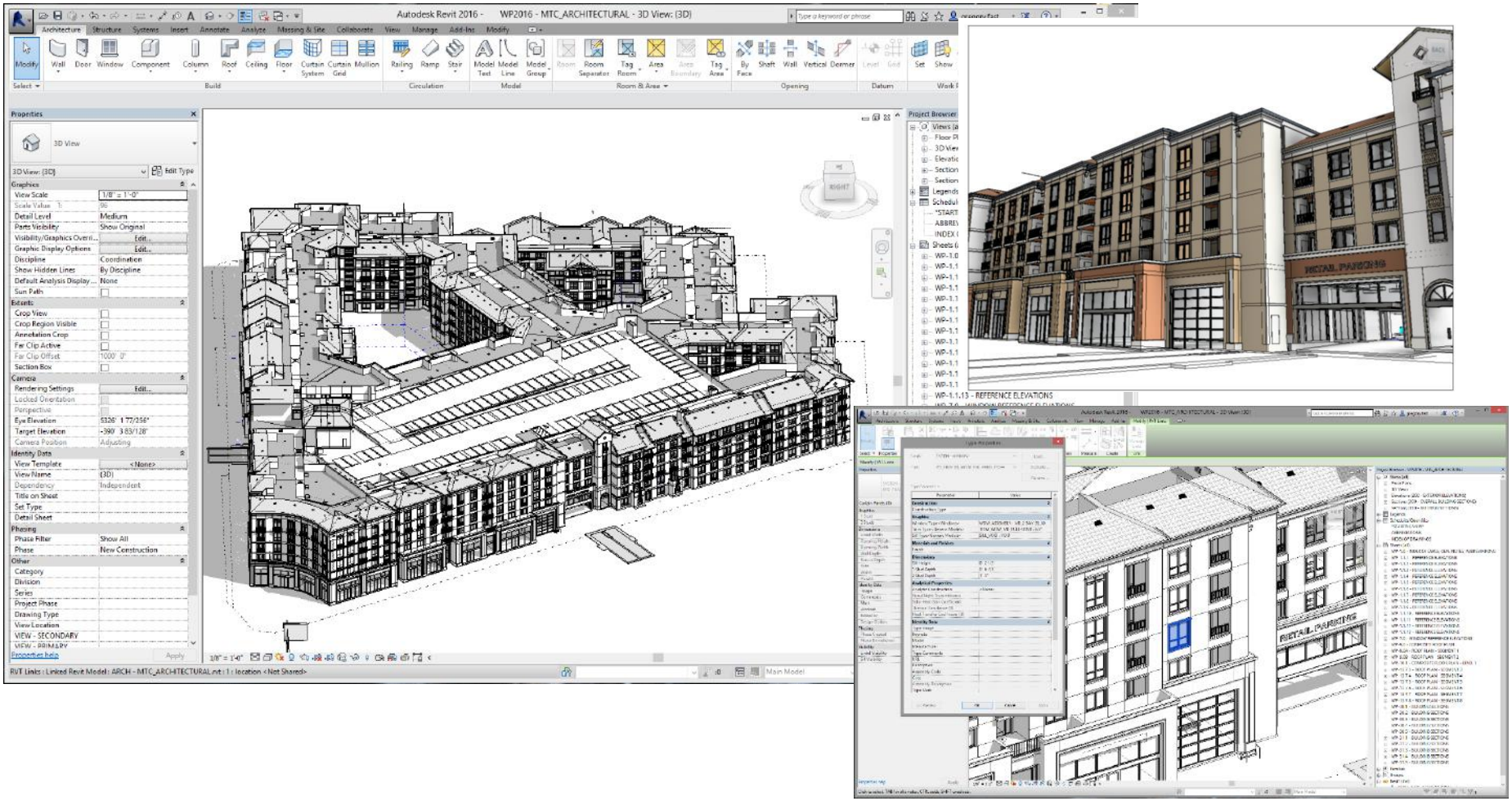
Field QA Inspection

- Electronic Field Reports

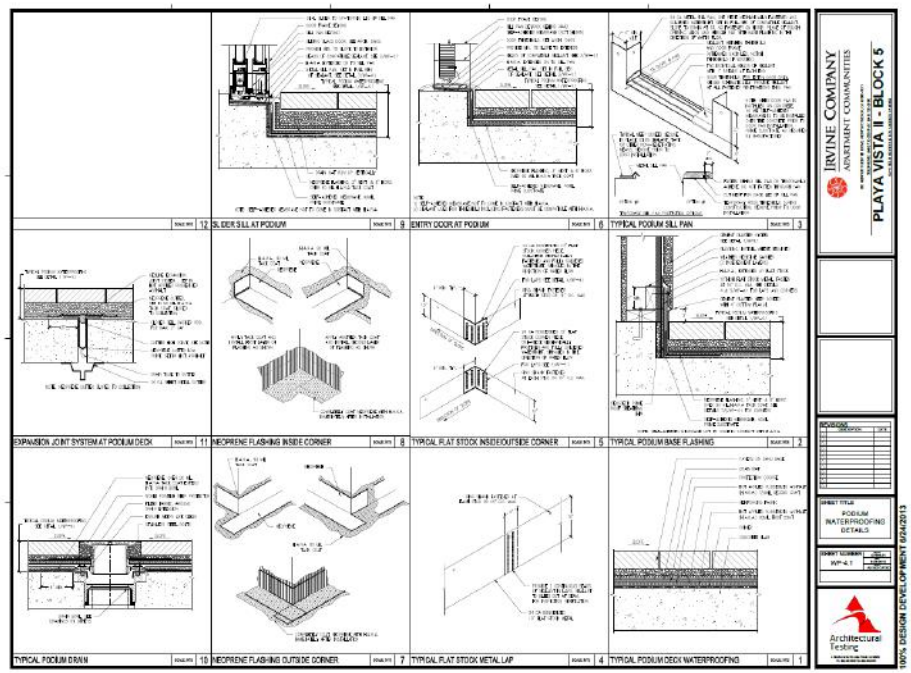
Centerpointe	01/14/2015	Log 337
Exterior Doors Flashing		
1. Self-adhered membrane installed at door jambs.	Checked	
2. Door Pan flashings fabricated with a 1/2" vertical dam.	Checked	
3. Door pan flashings installed tightly into rough opening.	N/A	
4. Door threshold substrate slope reviewed prior to pan installation.	N/A	
5. All fasteners flush.	Checked	
6. Door back dams are protected.	Checked	
Windows Flashing		
1. Rough opening clean and framing ready for flexible flashing application.	N/A	
2. All fasteners are flush.	Checked	
3. Self-adhered membrane primer installed.	N/A	
4. Self-adhered membrane shingled where required.	Checked	
5. Self-adhered membrane/flexible flashing laps reviewed.	Checked	
6. Self-adhered membrane paper backing removed where required.	Checked	
Exterior Door Installation		
1. Review flexible flashing at 2-Hour firewall conditions.	N/A	
2. If drywall is required for fire, flexible flashing is to be installed over the drywall.	N/A	
3. If the jamb is metal, J-mold is required along the jambs and a min. of 1/4" between the door trim and J-mold is required to allow for backer rod.	N/A	
4. Head flashing installed over the door jamb/flexible flashing wrapping into opening.	N/A	
5. Door jambs notched around the back jamb.	N/A	
Window Installation		
1. Review sealant type used at flexible flashings.	Checked	
2. Window installed with sealant oozing from the	Checked	

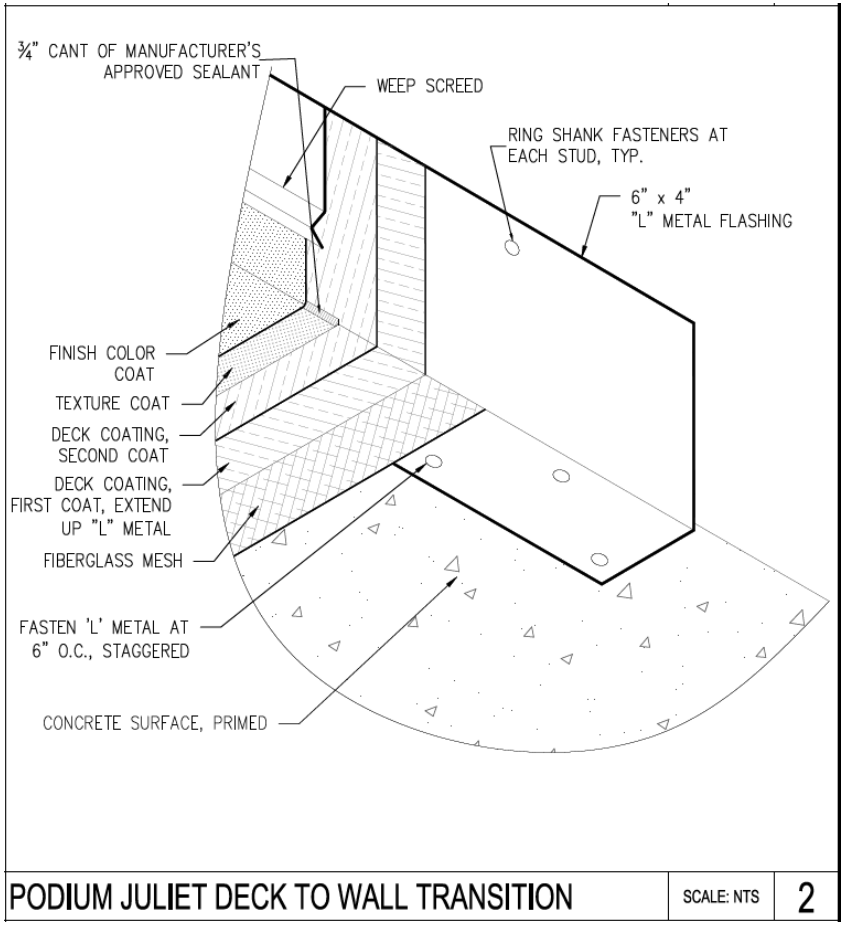
Consulting/Design QA

Revit Model



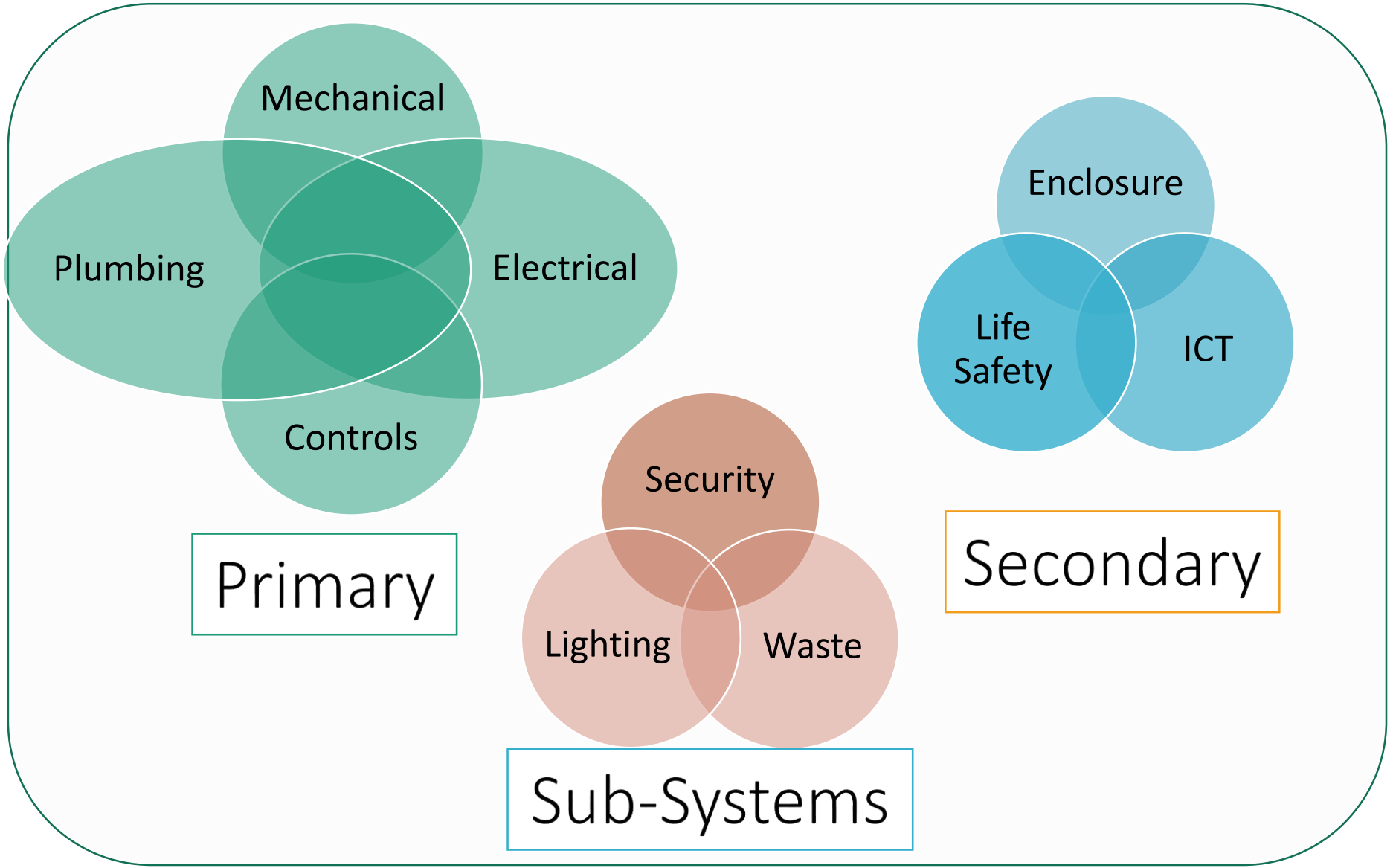
Waterproofing & Air Barrier Design





Discipline Specific Cx

Whole Building Commissioning



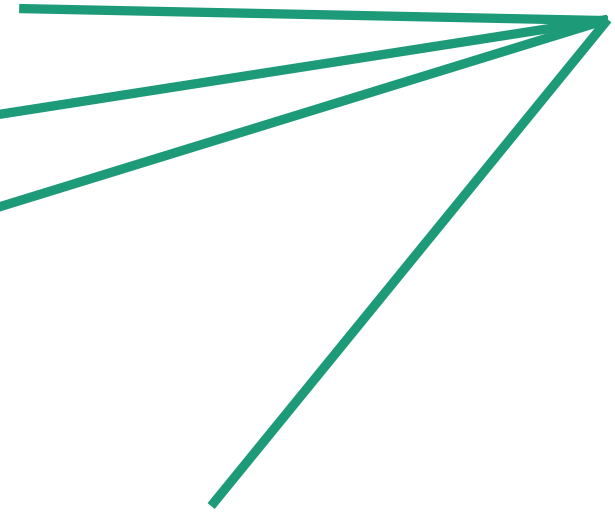
Commissioning Twin Track

Systems to be Cx

- Mechanical
- Electrical
- Plumbing
- Life Safety
- ICT
- Building Enclosure

Performance (OPR)

- Energy
- Acoustical
- Air Quality



Commissioning Twin Track

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Commissioning Twin Track

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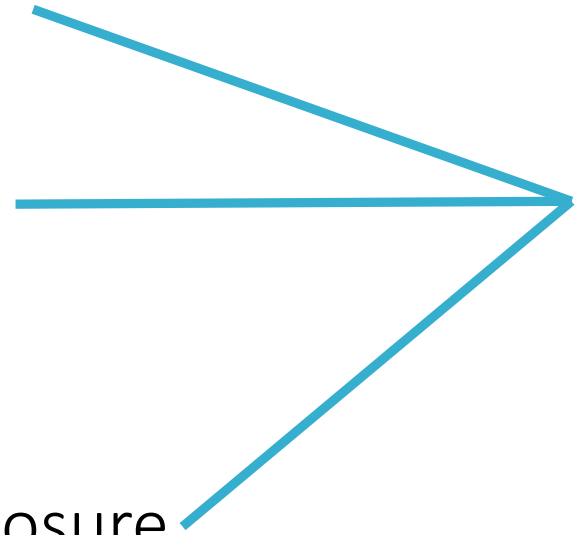
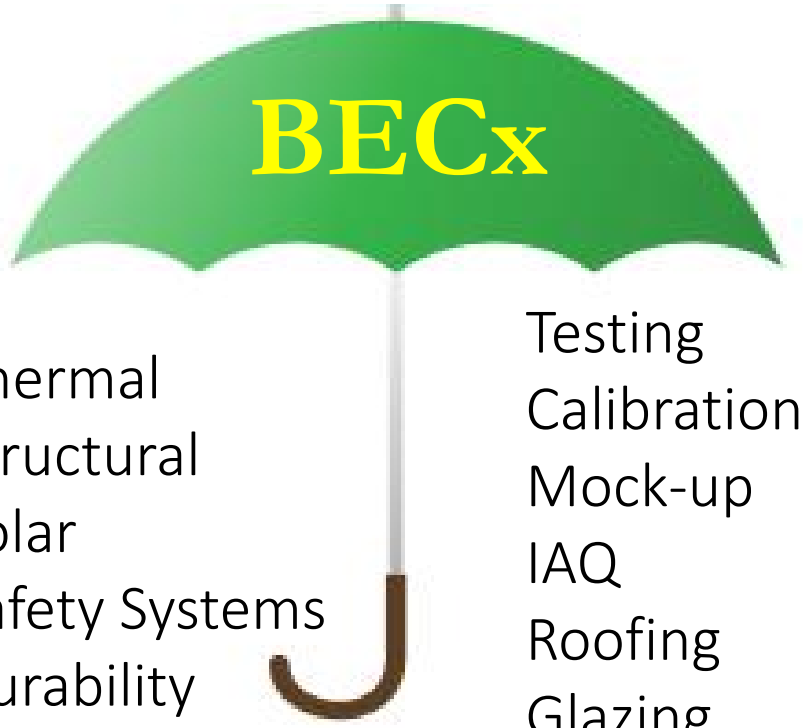


Performance (OPR)

- Energy
- Acoustical
- Air Quality

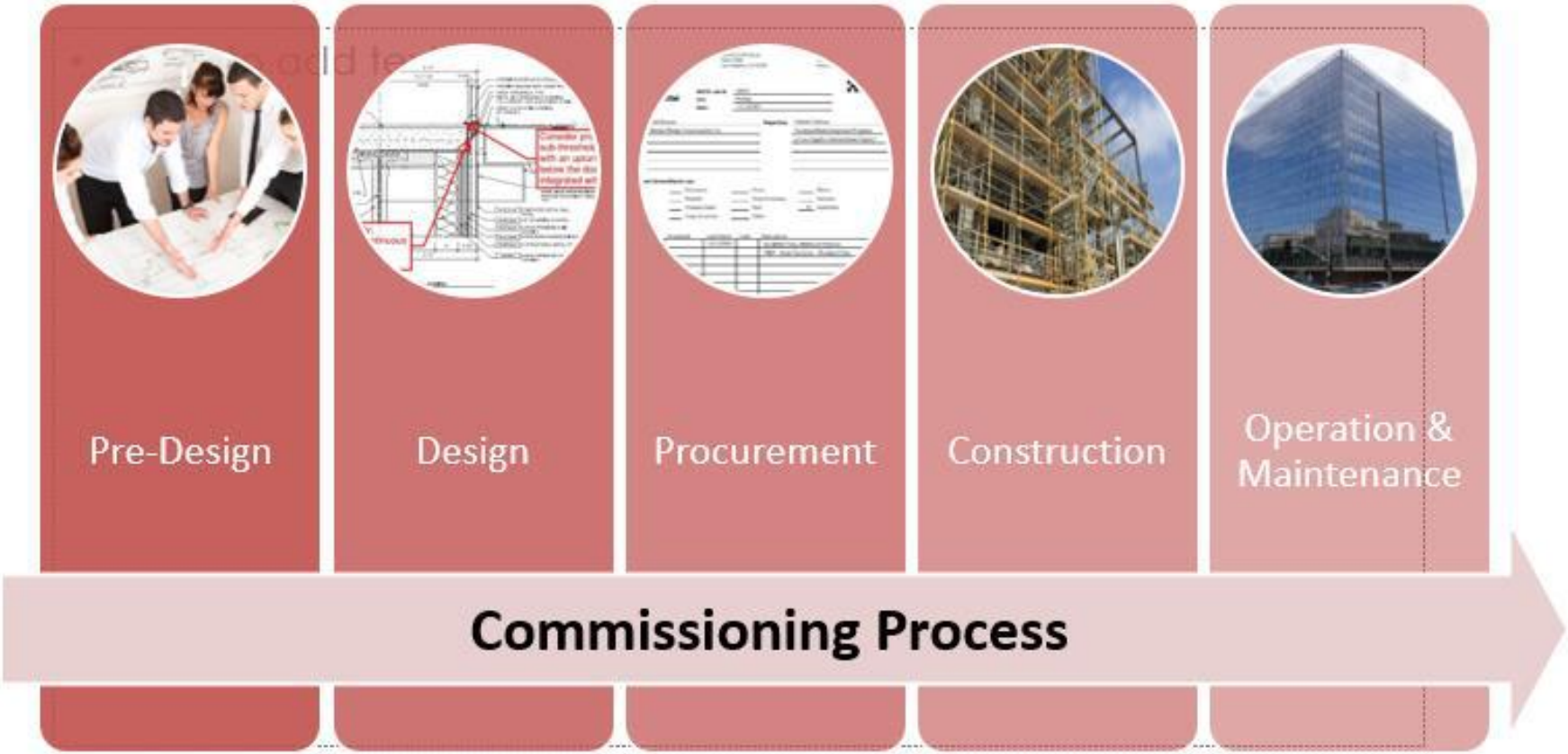
Sub-Discipline Specific Cx



Thermal
Structural
Solar
Safety Systems
Durability
Fire
Acoustics
Blast
Water / Air

Testing
Calibration
Mock-up
IAQ
Roofing
Glazing
Façade
Waterproofing
Material
Properties

BECx Process



Pre-Design

Project Planning Conference

- Introduce BECx process
  - Objectives
  - Tasks and milestones
  - Responsibilities

BECx Plan

- Roles and responsibilities
- Communication protocols
- Format for reporting

Owner's Project Requirements (OPR)

- Establish enclosure performance criteria

Construction Documents

Design Review(s)

- At multiple phases: SD, DD, CD
- Review drawings and specifications
- Comment on water, air, thermal, and vapor control
- Review for compliance with OPR (Owner's Project Requirements) and the Basis of Design (BOD)

Construction Documents

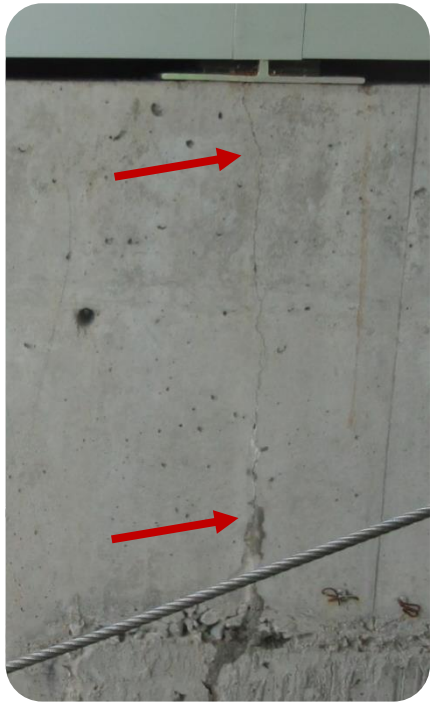
- Incorporate BECx requirements into the CDs:
  - Building Enclosure Commissioning (BECx) specification
  - Functional Performance Test (FPT) specification
- Update BECx and FPT specifications each design phase

Other BECx Activities

- Update the OPR
- Update the BECx Plan
- Building enclosure systems maintenance manual

Functional Performance Testing

Typical Failures:



Concrete cracks

Z-girt fasteners

Brick ties

Functional Performance Testing

Performance Requirements

- Building Enclosure Functional Performance Testing Specification Section
- This Section shall supersede other Sections where contradictions occur

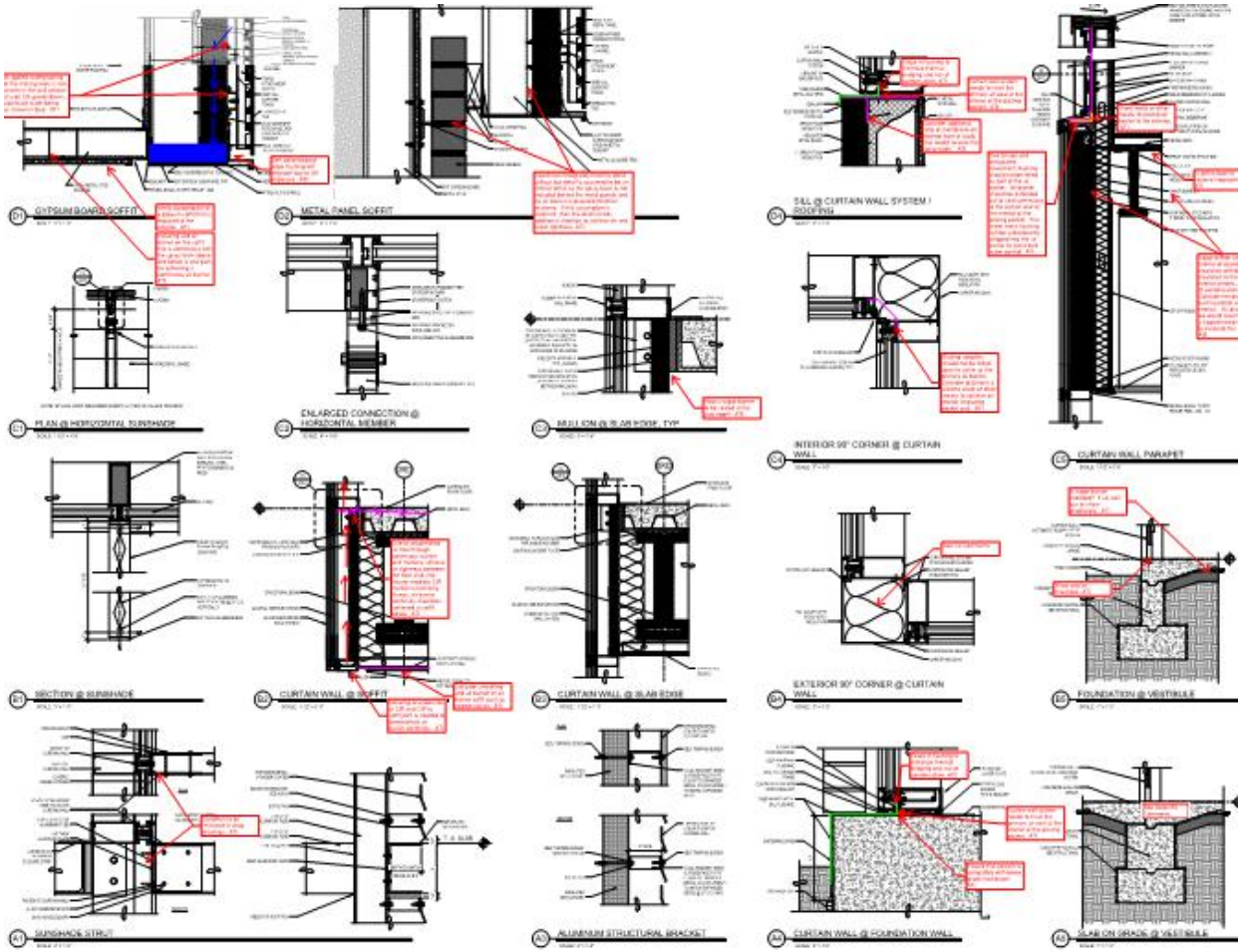
Component	Performance Criteria	
	Air	Water
Curtain Wall/ Fenestrations/ Skylights	ASTM E 1186 (4.2.7) – No major air leaks. A major leak is defined as air and smoke are visible and easily detectable by hand within one inch of the leak location(s)	AAMA 501.1/ ASTM E 1105 - No uncontrolled water leakage when tested under a pressure difference of 8.0 lbf/sq. ft
	ASTM E 783 – Maximum air leakage of .09 cfm/ft at an air pressure differential of 6.24 psf	
Air Barrier Assemblies	ASTM E 1186 (4.2.6) – Pass/fail criteria shall be no bubbles observed in the leak detection liquid.	AAMA 501.1/ ASTM E 1105 - No uncontrolled water leakage when tested under a pressure difference of 8.0 lbf/sq. ft
	ASTM E 783 – Maximum air leakage of .04 cfm/ft at an air pressure differential of 1.57 psf	
	ASTM E 1186 (4.2.7) – No major air leaks. A major leak is defined as air and smoke are visible and easily detectable by hand within one inch of the leak location(s)	
Roofing Systems	ASTM E 1186 (4.2.6) – Pass/fail criteria shall be no bubbles observed in the leak detection liquid.	ASTM D5957 – No leaks through membrane/roof deck after 48 hours of 2.5" ponded water.

C. Water leakage is only acceptable if ALL of the following conditions are satisfied:

1. Water is contained and drained to the exterior.
2. There is no wetting of a surface that is visible to the building occupants.
3. There is would be no staining or other damage to the completed building or finishes.

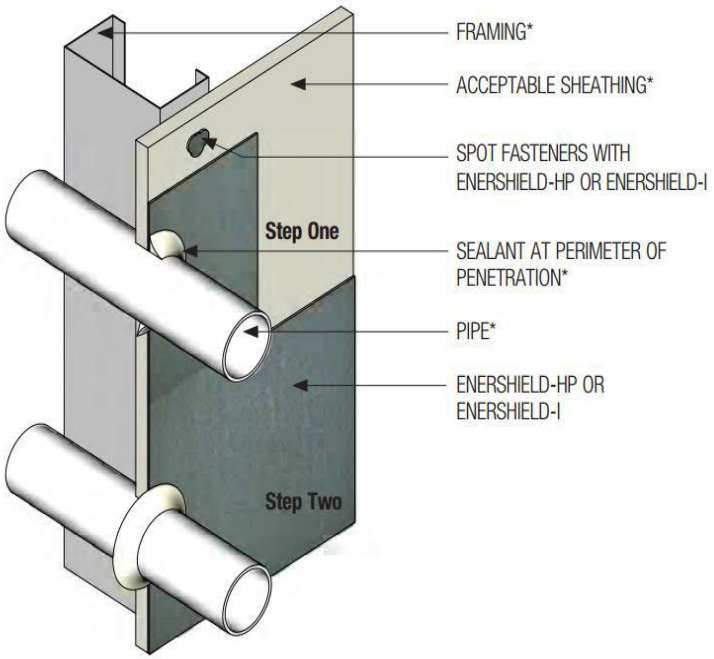
Design Phase

Design Reviews:

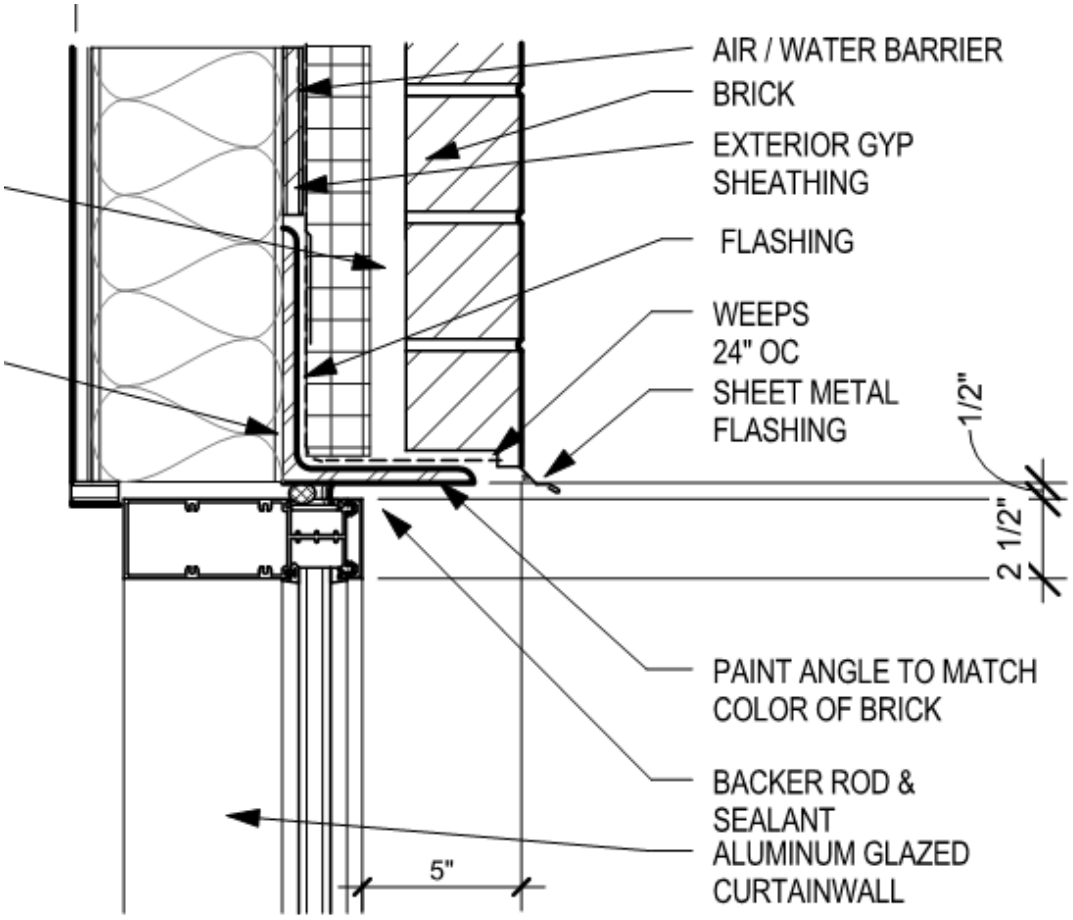


Typical Interface Concerns

Penetrations:

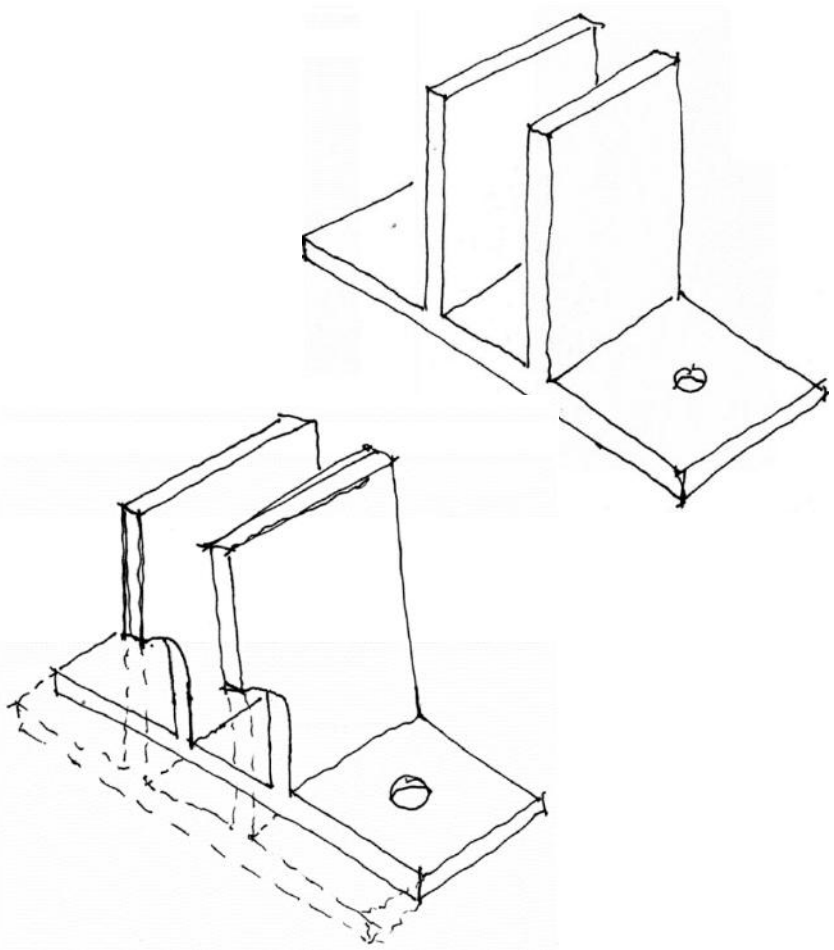


Head Detail

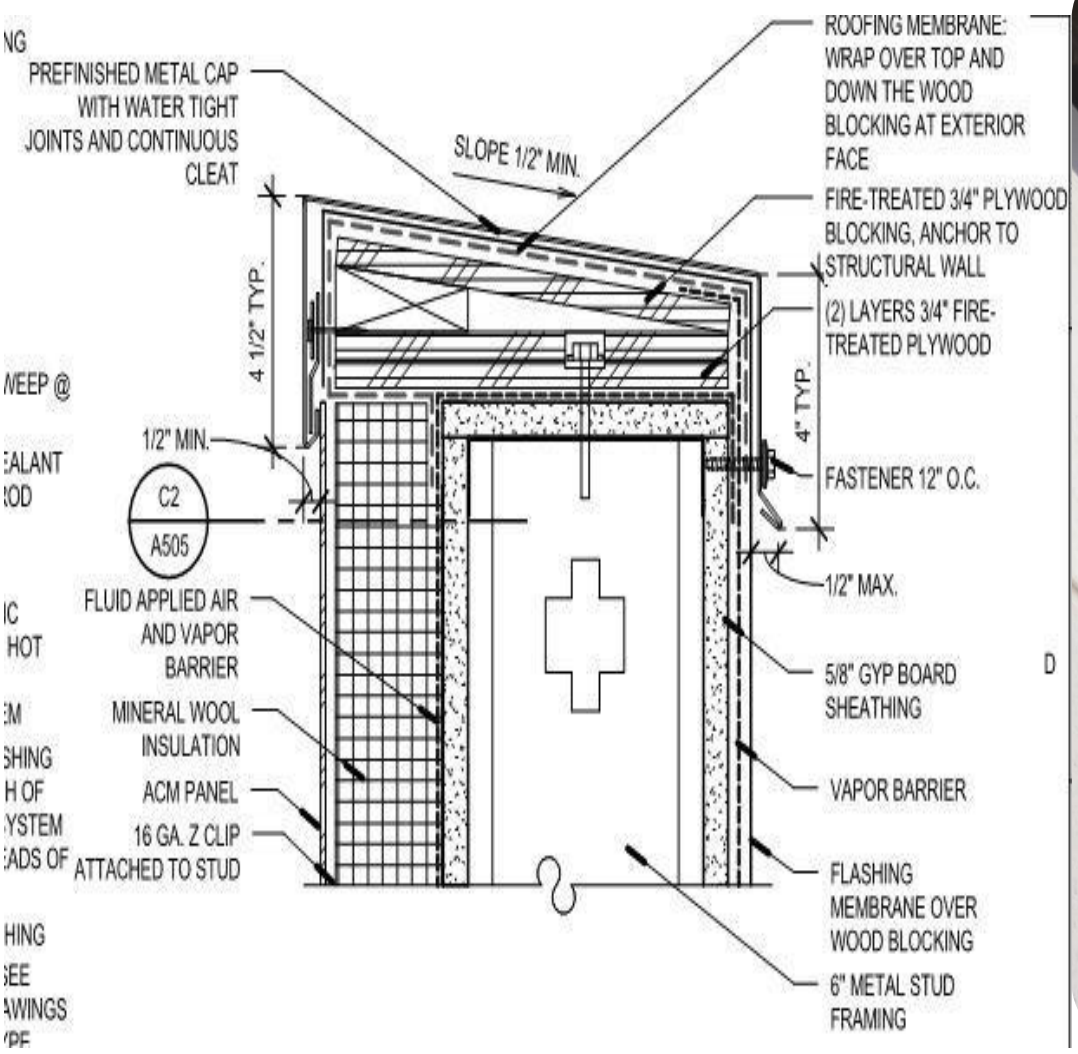

AIR / WATER BARRIER
BRICK
EXTERIOR GYP SHEATHING
FLASHING
WEEPS 24" OC
SHEET METAL FLASHING
1/2"
2 1/2"
PAINT ANGLE TO MATCH COLOR OF BRICK
BACKER ROD & SEALANT
ALUMINUM GLAZED CURTAINWALL
5"

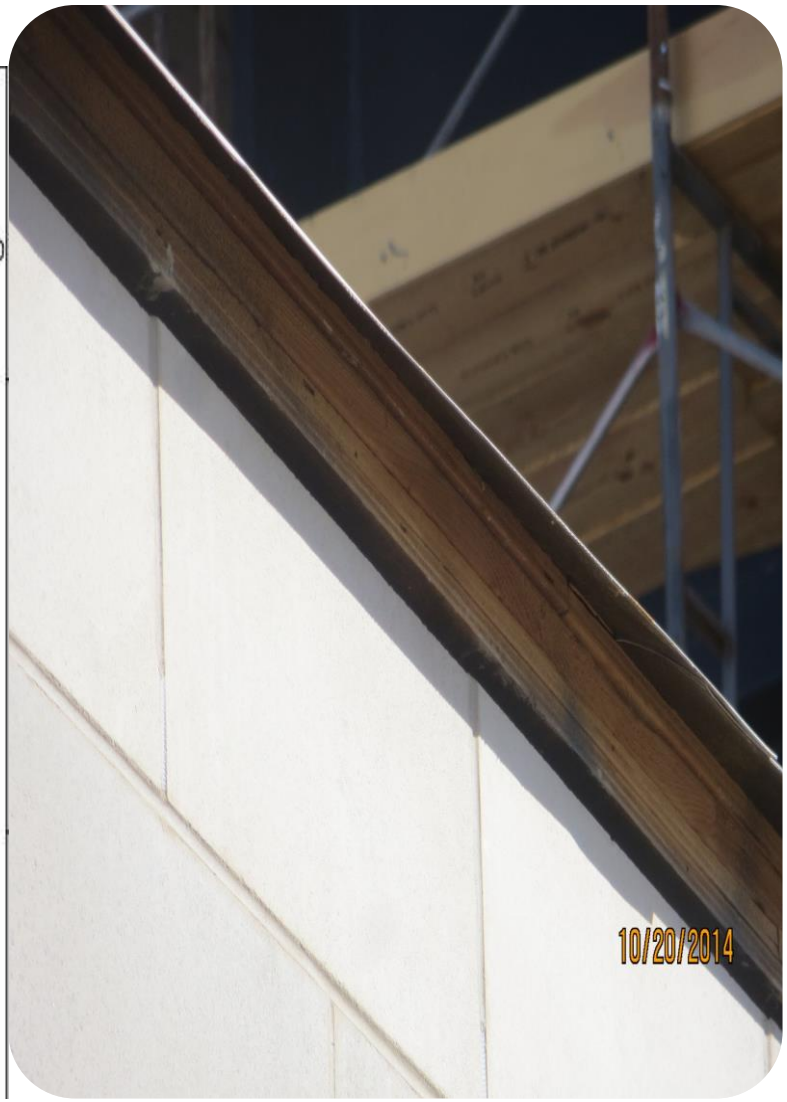

01/14/2

Typical Interface Concerns

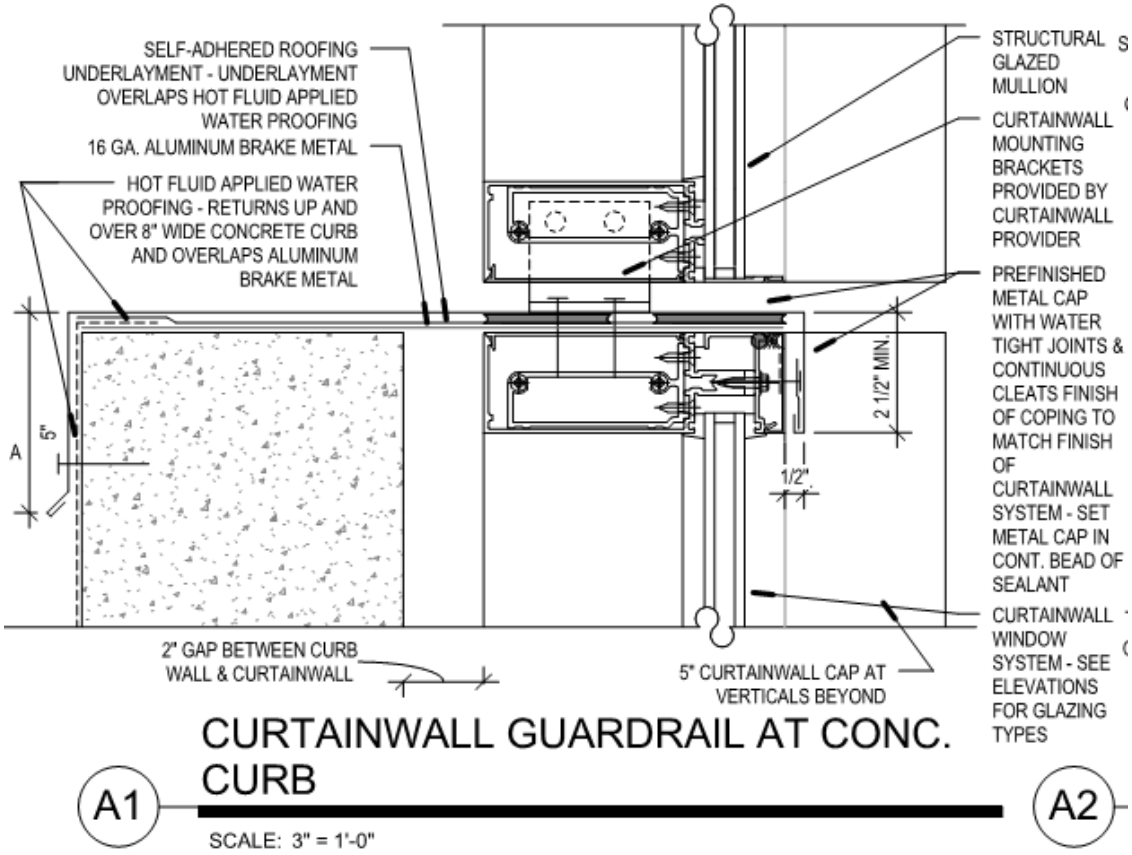


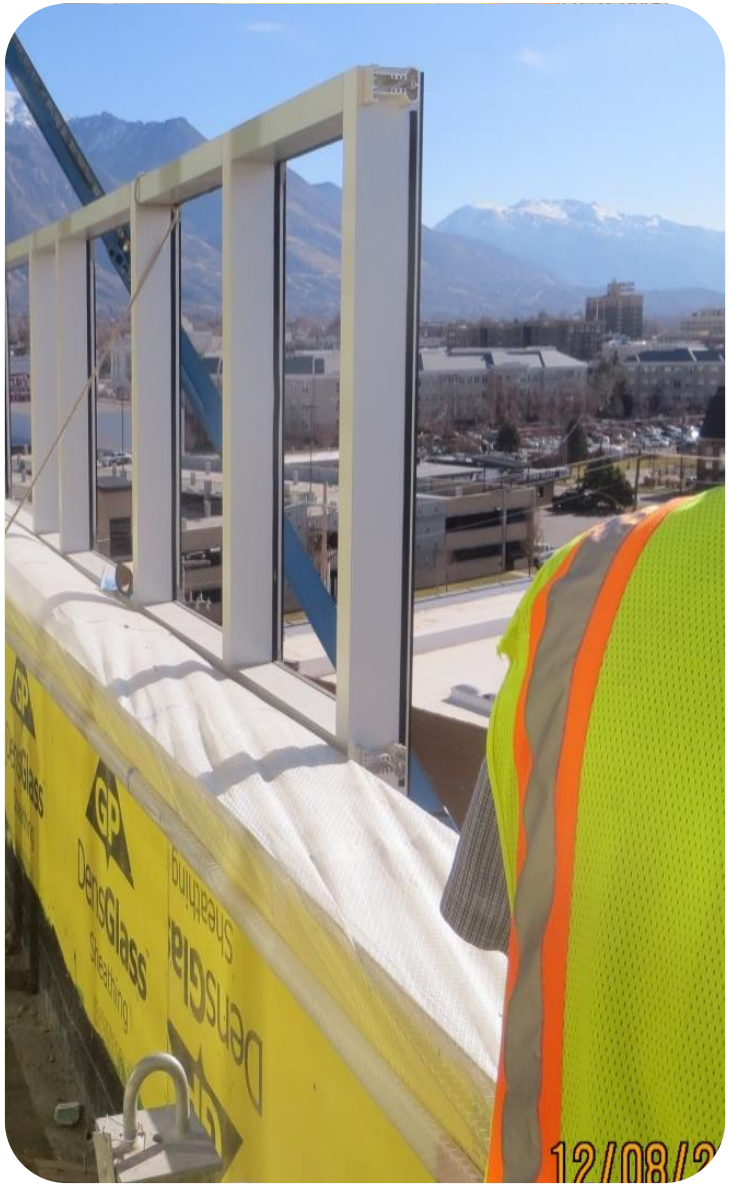
Parapet Cap


PREFINISHED METAL CAP WITH WATER TIGHT JOINTS AND CONTINUOUS CLEAT
SLOPE 1/2" MIN.
ROOFING MEMBRANE: WRAP OVER TOP AND DOWN THE WOOD BLOCKING AT EXTERIOR FACE
FIRE-TREATED 3/4" PLYWOOD BLOCKING, ANCHOR TO STRUCTURAL WALL
(2) LAYERS 3/4" FIRE-TREATED PLYWOOD
4 1/2" TYP.
4" TYP.
1/2" MIN.
C2
A505
FASTENER 12" O.C.
1/2" MAX.
FLUID APPLIED AIR AND VAPOR BARRIER
5/8" GYP BOARD SHEATHING
MINERAL WOOL INSULATION
VAPOR BARRIER
ACM PANEL
16 GA. Z CLIP ATTACHED TO STUD
FLASHING MEMBRANE OVER WOOD BLOCKING
6" METAL STUD FRAMING

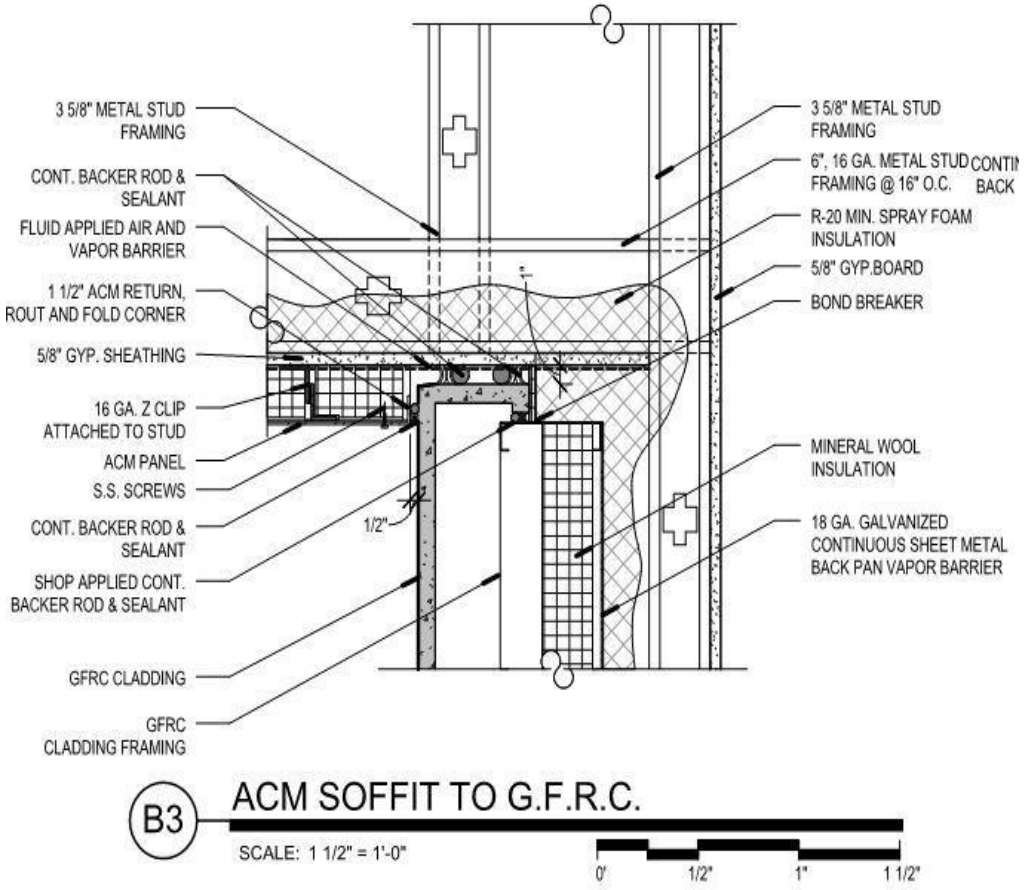

10/20/2014

Extended Curtain Wall

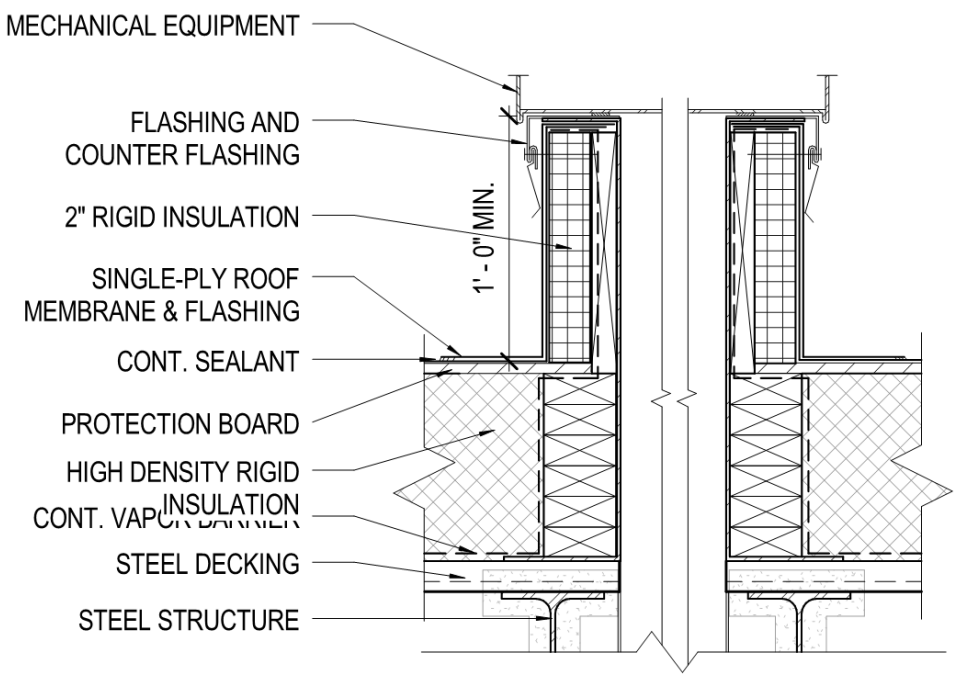




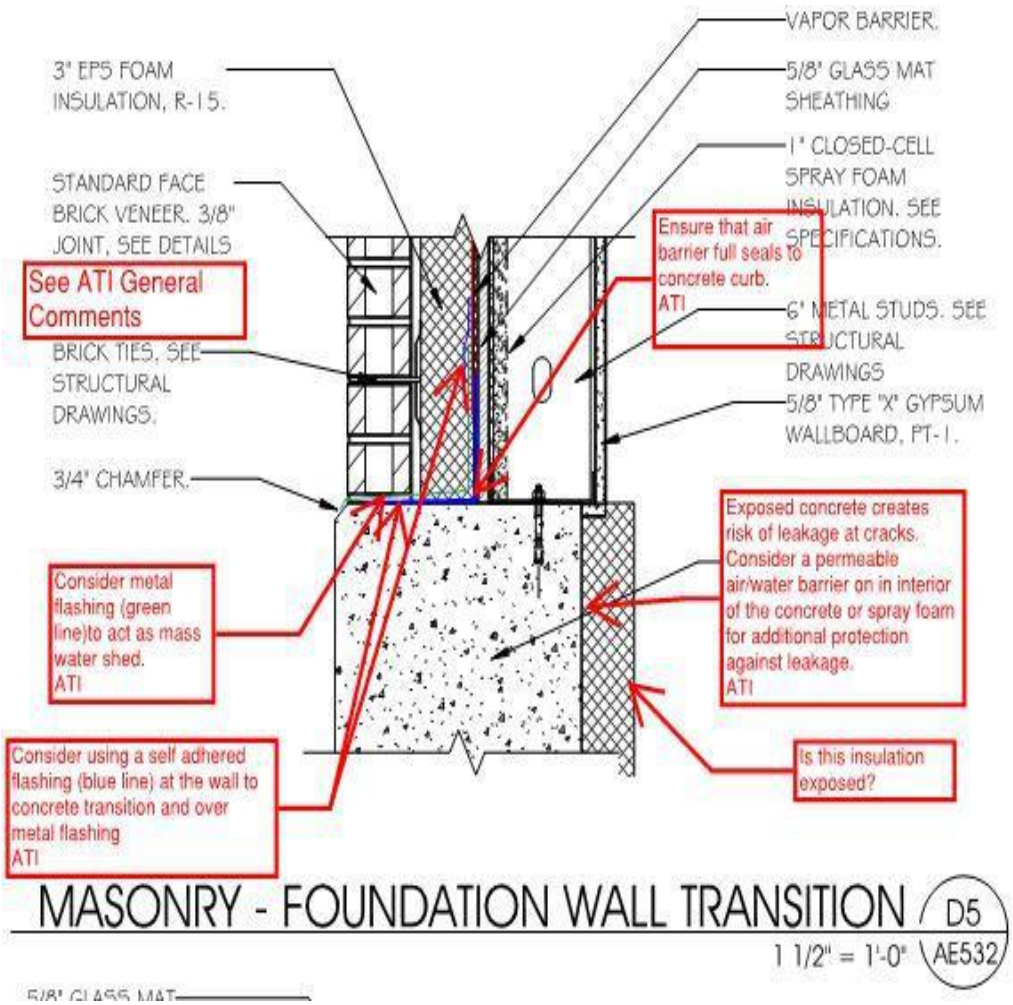
Soffits

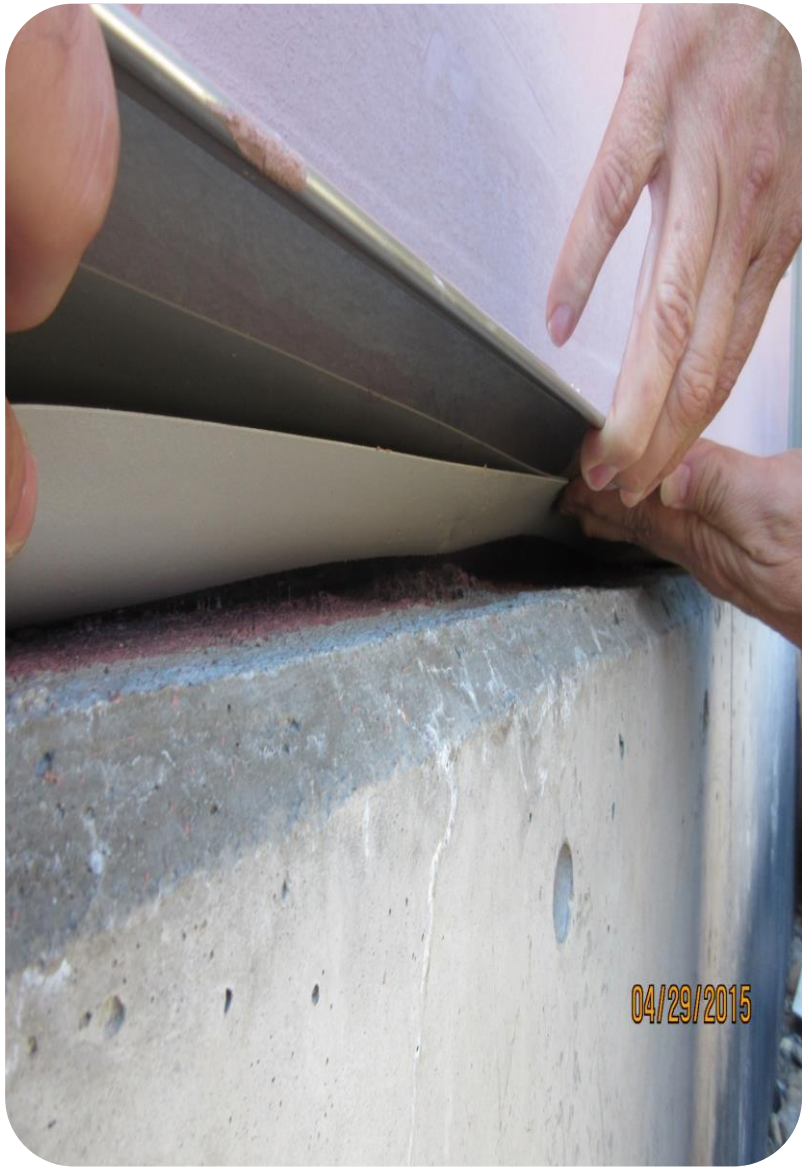

3 5/8" METAL STUD FRAMING
CONT. BACKER ROD & SEALANT
FLUID APPLIED AIR AND VAPOR BARRIER
1 1/2" ACM RETURN, ROUT AND FOLD CORNER
5/8" GYP. SHEATHING
16 GA. Z CLIP ATTACHED TO STUD
ACM PANEL
S.S. SCREWS
CONT. BACKER ROD & SEALANT
SHOP APPLIED CONT. BACKER ROD & SEALANT
GFRC CLADDING
GFRC CLADDING FRAMING
1/2"
3 5/8" METAL STUD FRAMING
6", 16 GA. METAL STUD FRAMING @ 16" O.C.
CONTI
BACK
R-20 MIN. SPRAY FOAM INSULATION
5/8" GYP.BOARD
BOND BREAKER
MINERAL WOOL INSULATION
18 GA. GALVANIZED CONTINUOUS SHEET METAL BACK PAN VAPOR BARRIER
B3
ACM SOFFIT TO G.F.R.C.
SCALE: 1 1/2" = 1'-0"
0'
1/2"
1"
1 1/2"

Mechanical Equipment



Wall to Foundation





Successful Design

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

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- Simple
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Pre-Construction Phase

Meetings	• BECx kickoff meeting • Preconstruction meetings
Review for Compliance with the OPR and Contract Documents	• Submittals • RFI, ASI, CCD • Change Order • Substitution Request • Value Engineering
Mockup	• Construction • Observation • Testing

Pre-Construction Phase

Types of Mock-ups:

- Freestanding fully enclosed
- Freestanding partially enclosed
- In-situ

Pre-Construction Phase

Value of Mock-ups:

- Verify the performance of the systems
- Set construction standards
- Establish sequencing of work
- Verify material selection

Pre-Construction Phase

Mock-up Testing:

Who should witness?

- Contractor
- Air barrier subcontractor
- Glazing subcontractor
- Roofing subcontractor

Construction

Field Observations

- Quality assurance tool
- Verifying compliance with:
  - Contract documents
  - Submittals and shop drawings
  - Product installation instructions
  - Industry standards

Functional Performance Verification

- Verify the performance of the systems (including interfaces)
- Verify installation methods
- Avoid late stage (expensive) problems with early detection.

Other BECx Activities

- BECx meetings to review building enclosure schedule, testing, and Issues
- Update OPR and BECx plan
- Review contractor checklists
- Construction phase BECx report

Program Outline

Quality Drivers

Codes / Building Science

State of the Practice

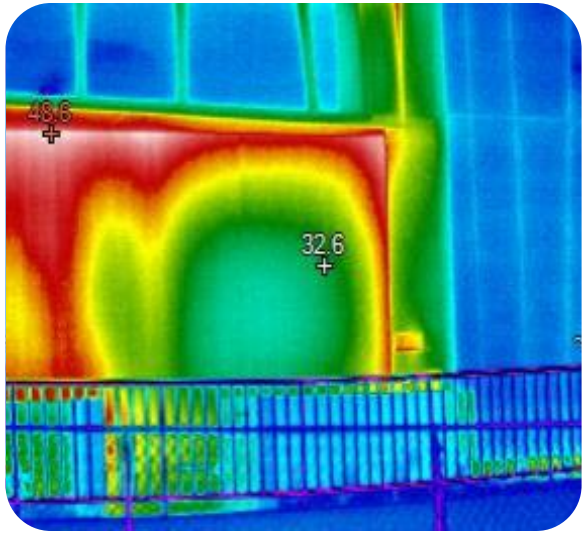
- Materials
- Consulting / Design
- BECx
- Field Testing
- Inspections

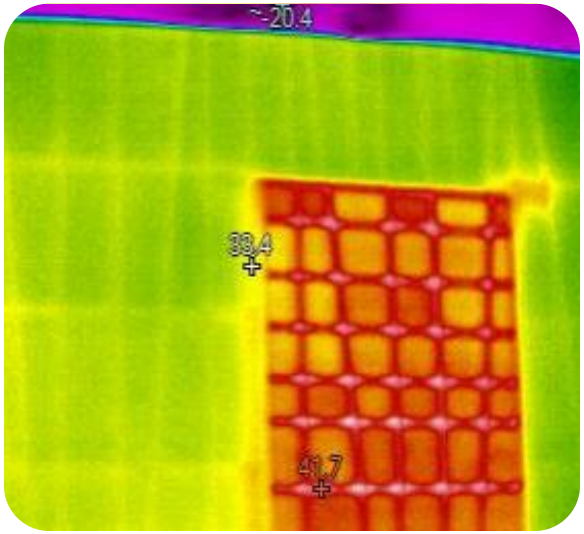
Tomorrow's Trends

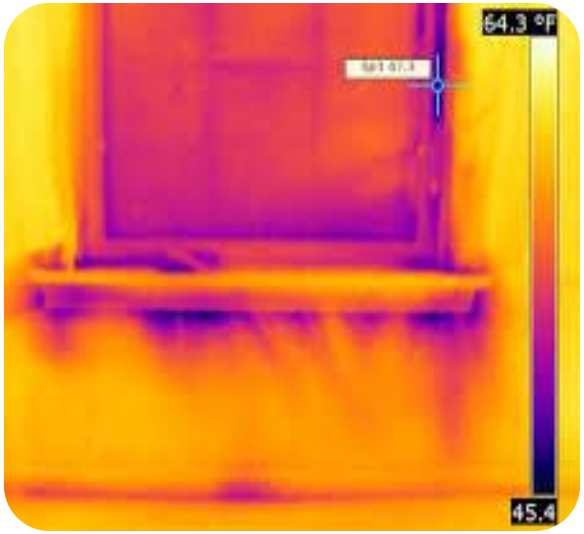
Functional Performance Testing

ASTM E1186, Practice 4.2.1

- Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems - Building Depressurization (or Pressurization) with Infrared Scanning Techniques
- Qualitative Air Infiltration/Exfiltration Test







Functional Performance Testing

ASTM E1186, Practice 4.2.6

Functional Performance Testing

ASTM E1186, Practice 4.2.7

- Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems – Chamber Depressurization in Conjunction With Leak Detection Liquid
- Qualitative Air Infiltration/Exfiltration Test

Functional Performance Testing

ASTM E1186, Practice 4.2.7

Functional Performance Testing

AAMA 501.1


Genie S-40
Genie
4x4
08/14/2014


09/10/2014

Field Observations

Typical Observations:

Curtain wall fasteners

Unadhered flashing

Field Observations

Typical Observations:

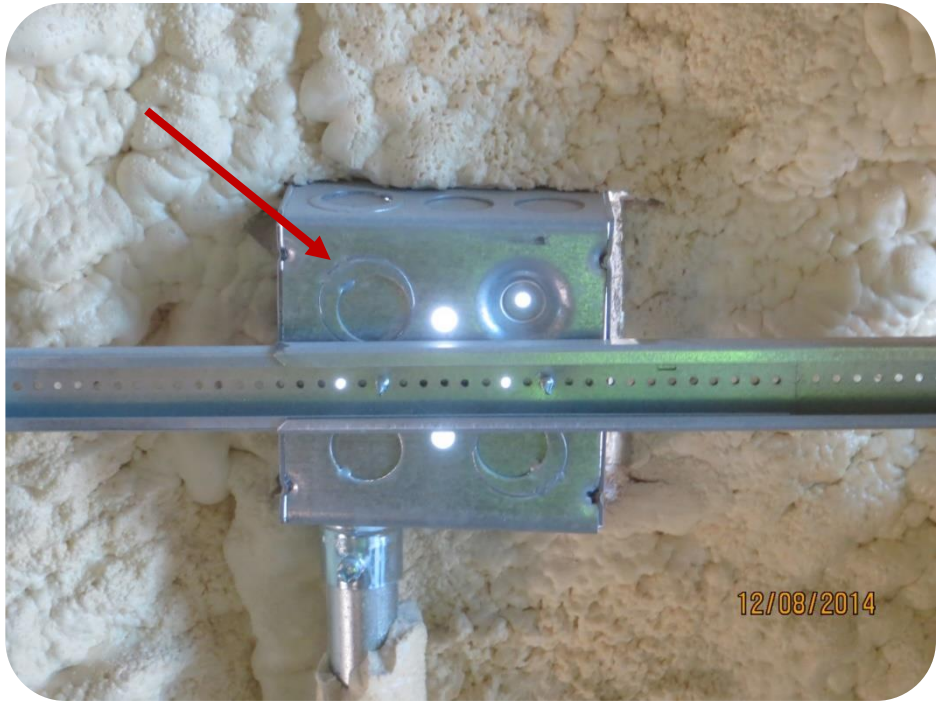
Thin air/vapor barrier

Missed fasteners

Field Observations

Typical Observations:

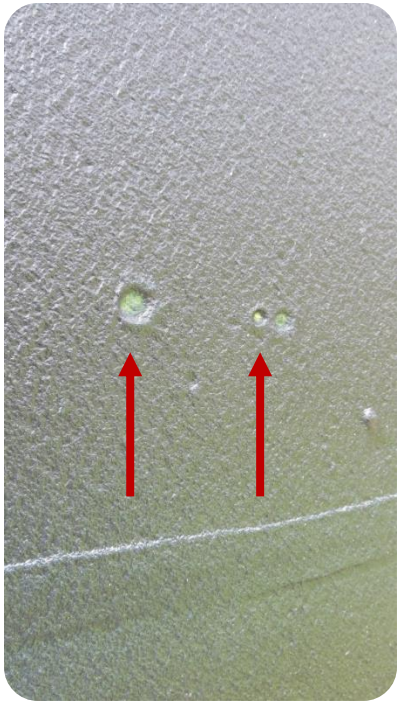
Insufficient spray foam



Unsealed electrical box

Field Observations

Typical Observations:

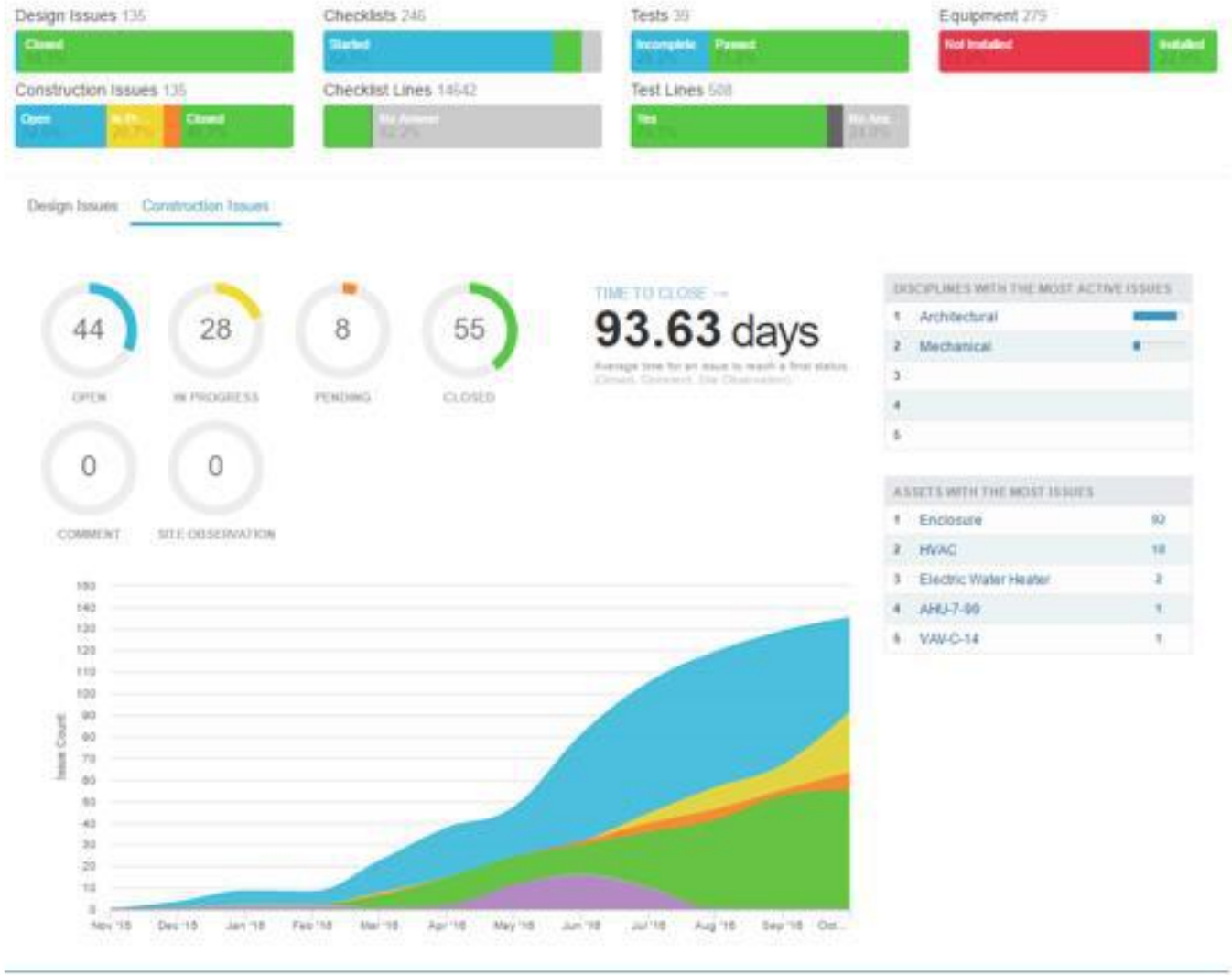


Air/Vapor Barrier

Unsealed holes

Holes in flashing

Field Observations



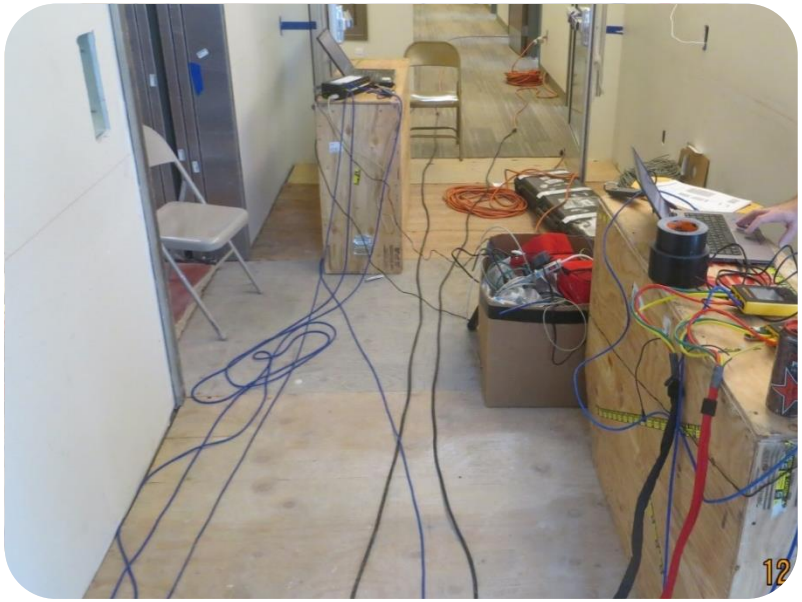
O & M Phase


EVALUATE IMPACT OF NON-CONFORMANCE ITEMS
ORGANIZE ALL COMMISSIONING DOCUMENTATION
END OF WARRANTY PERFORMANCE REVIEWS
OPERATIONS AND MAINTENANCE TRAINING
PERIODIC PERFORMANCE REVIEWS
VERIFICATION OF SEASONAL PERFORMANCE LEVELS
FINAL PROJECT COMMISSIONING REPORT

Functional Performance Testing

ASTM E779 (Whole Building Air Test)

- Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
- Quantitative Whole Building Air Leakage Test

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Program Outline

Quality Drivers

Codes / Building Science

State of the Practice

Tomorrow's Trends

- One world
- Tighter Schedules
- More on-site chemistry
- Ambiguity in Qualifications
- Robust energy models
- Desire for green

Geographical Expansion

- The recognition of building enclosure commissioning has expanded beyond US
- International labor force
- Increase in foreign fabrication /materials

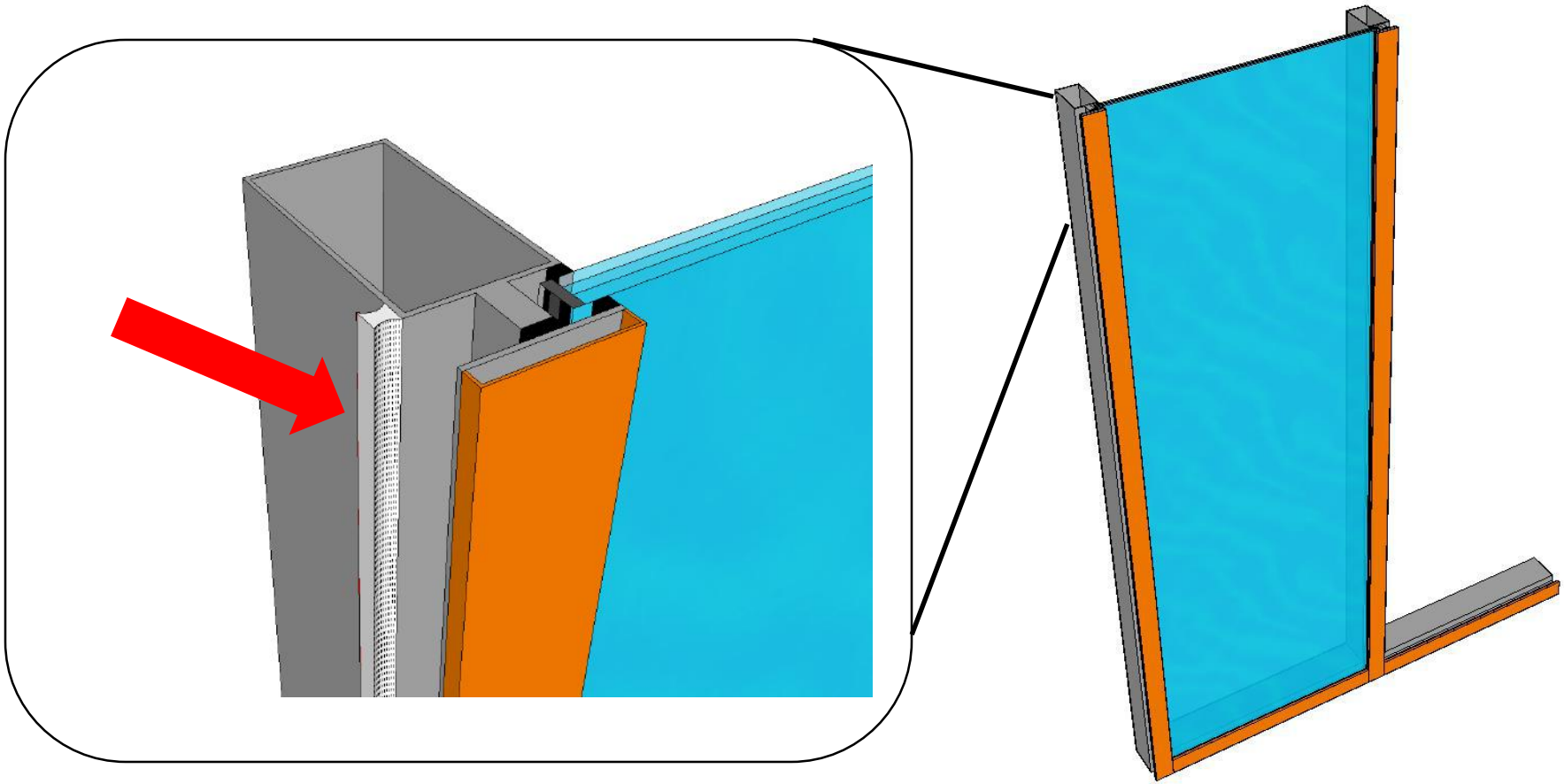
Tighter Schedules

Fluid-Applied

- Asphalt
- Acrylic
- STPE
- Silicone

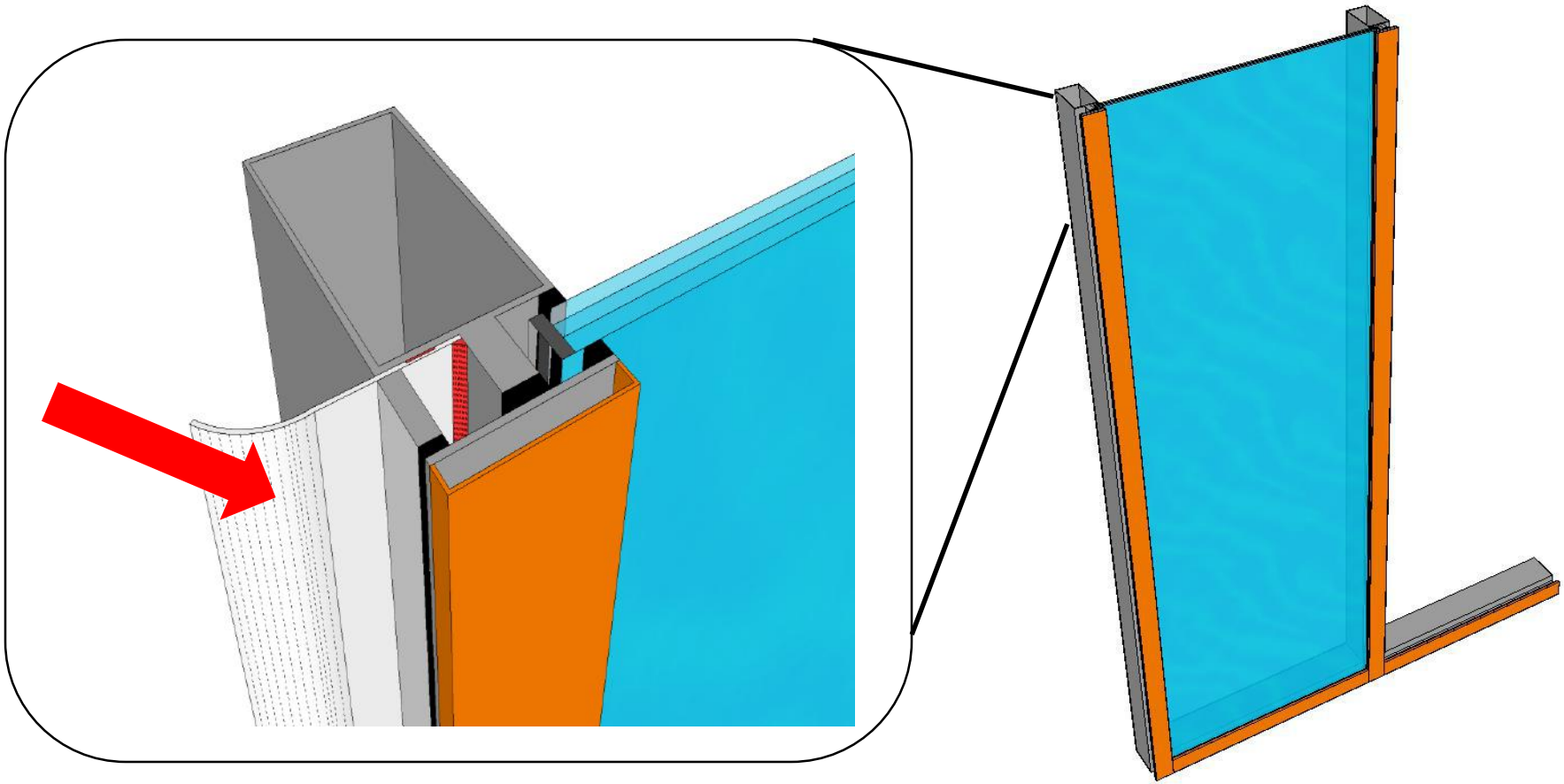
Primary Air and Water Seal

Sealant



Primary Air and Water Seal

Silicone Sheet



Primary Air and Water Seal

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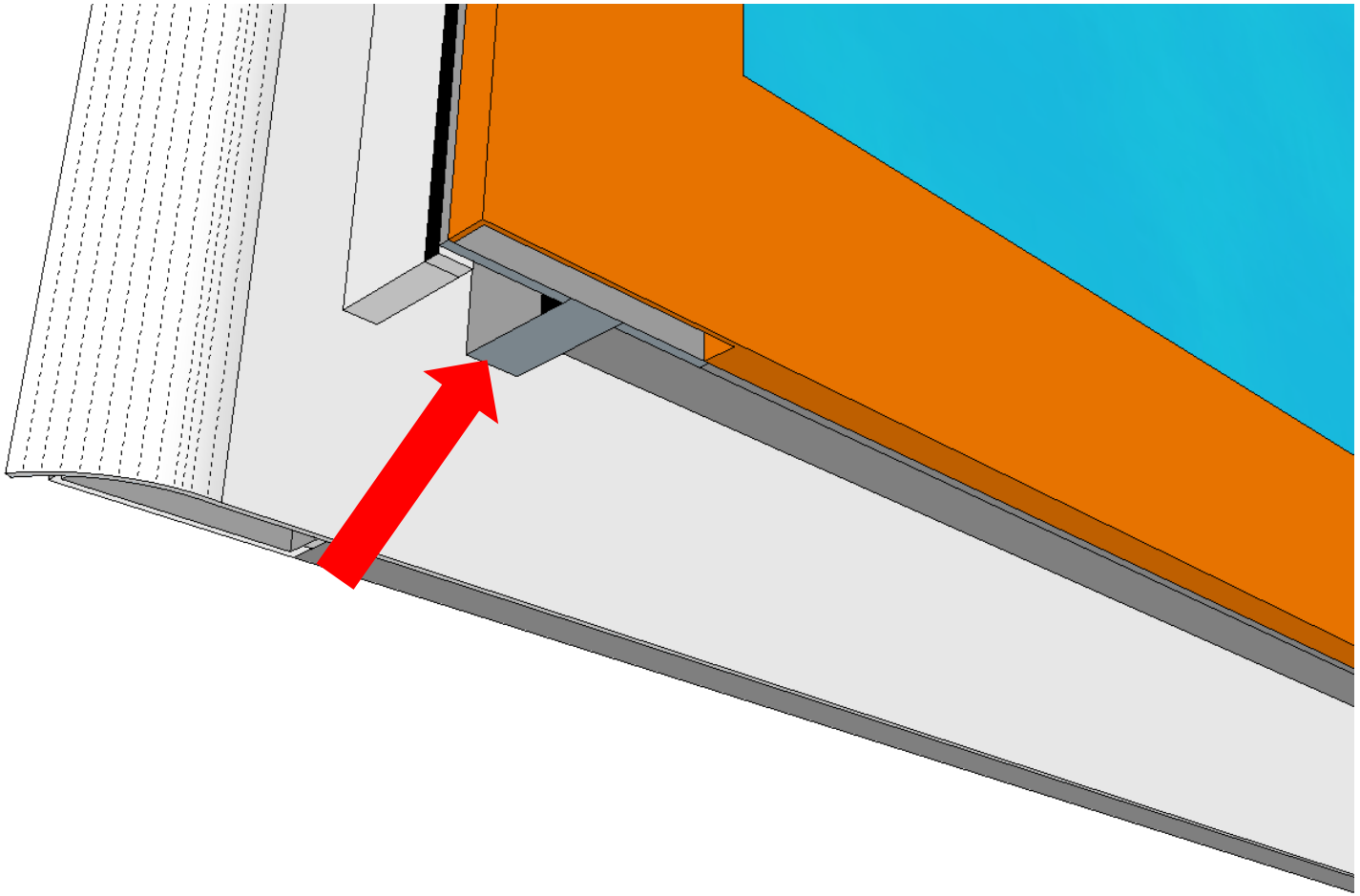


Vapor Control Layer

Variable Permeance Materials

MemBrain™, The SMART Vapor Retarder & Air Barrier Film

PRODUCT DESCRIPTION

Basic Use: CertainTeed MemBrain Smart Vapor Retarder is a vapor retarder sheeting intended for use with unfaced, vapor permeable mass insulation (fiber glass and mineral wool) in wall and ceiling cavities.

Benefits: MemBrain Smart Vapor Retarder is a polyamide film that changes its permeability with ambient humidity conditions. The product's permeance is 1 perm or less when tested in accordance with ASTM E 96, dry cup method, and increases to greater than 10 perms using the wet cup method. This process allows closed building envelope systems to increase their drying potential with seasonal climatic changes. With a high

Energy Modeling & BECx

Trends:

- Model accuracy is increasing
- Model comparison with actual performance is increasing
- Most projects have modeling requirements
- Modeling is dictating some design decisions

Case Study 1- Philadelphia

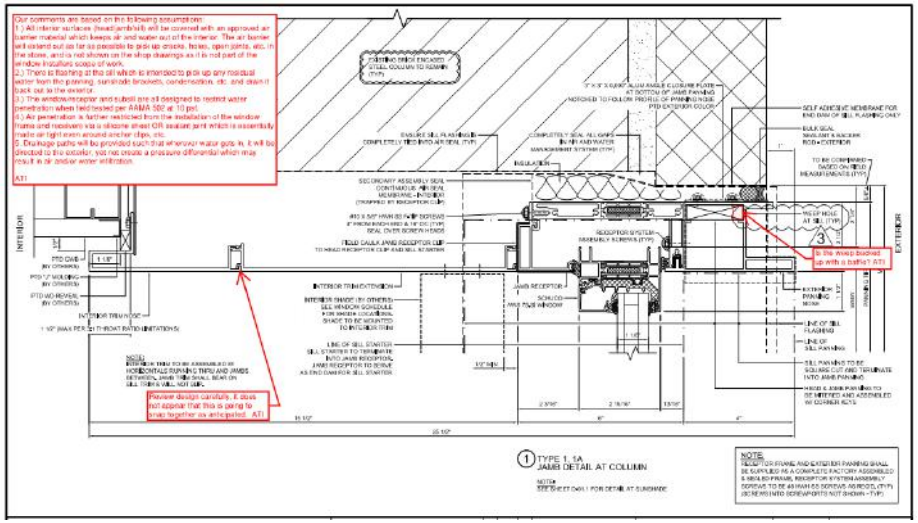
- Built in 1980's
- Active water and air leakage
- Client is upgrading building to increase commercial leasing value/solve problems.

Case Study 1 - Philadelphia

- Existing BECx starts with an investigation
- Mock-ups were key to verifying repair scope
- New windows, insulation, air barrier, roof, existing cladding to remain
- Air leakage performance increase by 10x

Case Study 2 – New York City

- Built in 1940's
- 14 stories, 460,000 sf
- Concrete encased steel frame
- Client is upgrading building to change use from manf. to education
- Client looking to greatly increase energy performance
- Minor façade repairs



Case Study 2 – New York City

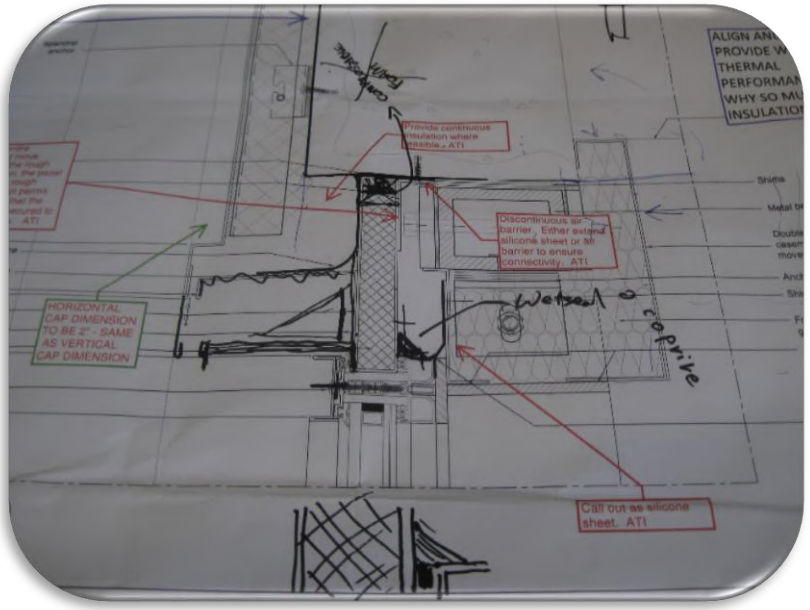
- Existing BECx starts with an investigation
- Mock-ups were key to verifying repair scope
- New windows, insulation, air barrier, roof, existing cladding to remain
- Air leakage performance increase by 10x

Case Study 3 – New York City

- Built in 1930's
- 7 stories
- Client is upgrading building to change use from manf. to residences
- Modest façade repairs
- Desire energy savings

Case Study 3 – New York City

- Existing BECx starts with an investigation
- Mock-ups were key to verifying window performance
- New windows, roof and exterior coating / air barrier



This concludes The American Institute of Architects
Continuing Education Systems Course

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