Construction Cautions and Top 10 Concerns With Enclosures

Presenter: Brian Stroik

- Tremco Sealants & Waterproofing - Manager: Building Envelope Solutions Team
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- Past Chair National Building Enclosure Council (NBEC)
- Voting Member ASTM E 06 – Building Performance
- Co-Chair BEC WI
- Previously the Quality Manager for a Billion Dollar Construction Company
- Past Chair ABAA Research Committee
- Senior Member of the American Society of Quality (ASQ)
- Member - Board of Direction for the Building Enclosure Technology and Environmental Council (BETEC)

Construction Cautions and Top 10 Concerns With Enclosures

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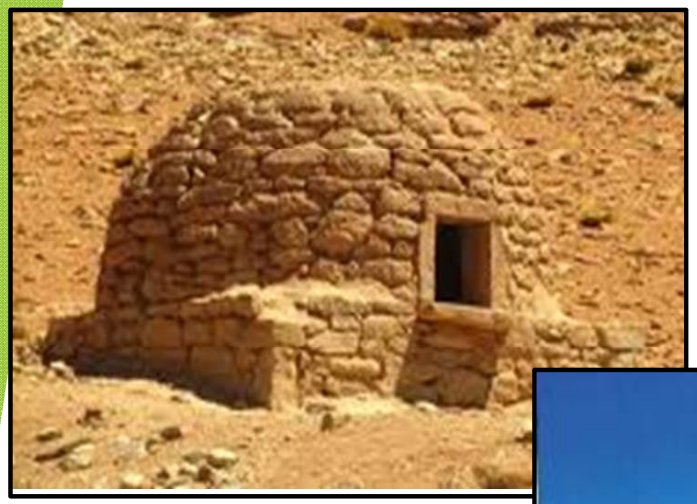
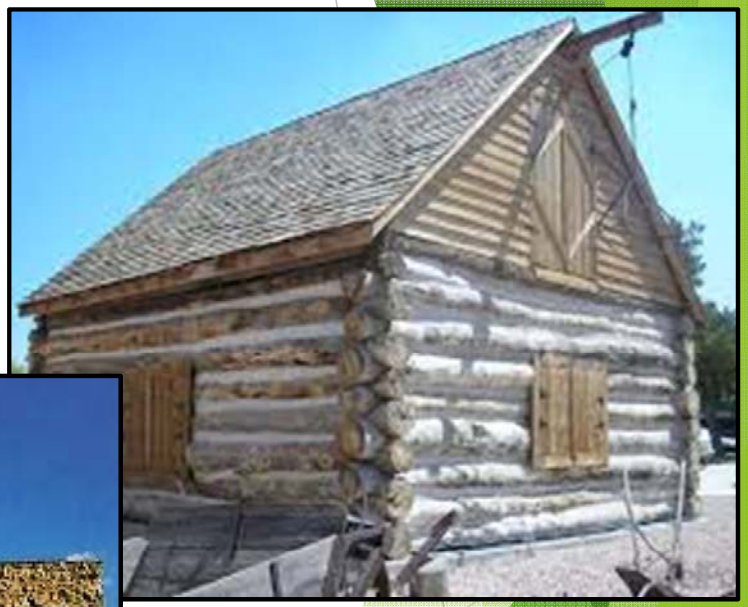
Construction Cautions and Top 10 Concerns With Enclosures

Learning Objectives

- Acquire knowledge in critical aspects of design, based on building science principles, by using sample details for continuity, redundancy and certain code requirements of the air barrier system.
- Describe the process for pre-construction meetings and key criteria and agenda items to ensure performance expectations are met, sequencing is done properly, details are well understood and transition from one trade to another is accomplished using sample plans.
- Explain the various test methods for installation verification for both air and water performance by reviewing ASTM and AAMA test standards and how they conducted and when they should be conducted through examples and photo's
- Plan successful mock up and testing program to verify continuity, compatibility and sequence of construction by review of sample mock-up's and test methods that can be applied to both quantify performance and provide a learning tool for the construction team.

Buildings Today are NOT as Simple as They Once Were?





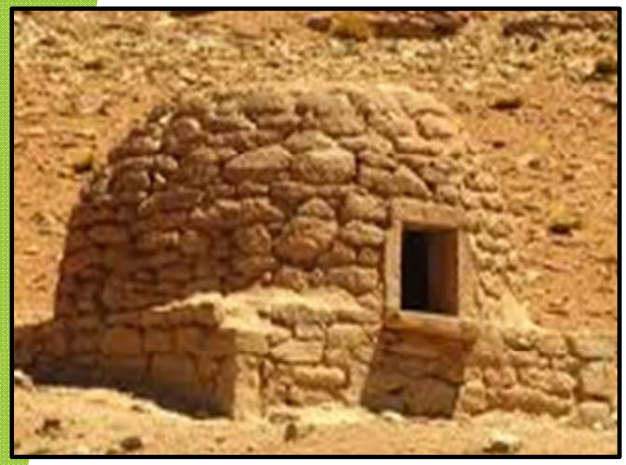
Buildings of Today

How Many Products

Do We Build With Today?

Let's Consider the Following:

- 3 Different Types of Back Up Walls
  - Block, OSB, Exterior Sheathing
- 5 Different Types of AVB
  - Fluid, Self Adhered, SPF, Rigid, Mechanically Fastened
- 4 Different Types of Insulation
  - SPF, Extruded Poly, Poly Iso, Mineral Wool
- 4 Different Types of Exterior Cladding
  - Brick, Metal Panel, EFIS, Cement Board
- *OVER 116* **Wall Configurations**
  - This **DOES NOT** Consider all of the **Different Manufacturers** of each Item



Past & Present

Building Science Progress
Quick Snap Shot of Air Barrier History

- 1st Seen in Canadian Codes 1980's
  - No Quantifiable Performance Standards
- 1990's Major amendments made to NBC Part 5 (commercial buildings)
  - Now called Environmental Separation **Included Airtightness**
  - For the first time, sets out quantifiable requirements for air permeance
- Nov. 2000 Air Barrier Association of America (ABAA) is Born
  - **No US Standards / Not in any Codes / No Specifications**
- **US 2010 to Today**
  - Air Barriers are put into **ASHRAE 90.1, IECC, Whole Building Design Guide, ASHRAE 189.1, NGBS, Army Corp of Engineers, 2015 IBC, ASHRAE 90.1**

DID YOU KNOW???

ASHRAE 189.1-2013 Chapter 10 Addendum H:

- Two options:
  - **Test the whole building** to meet 0.25 cfm/ft2 @ 75 Pa,

    OR
  - **Commission the Air Barrier System**, **including design review of details and field observation and incremental testing of the air barrier.**

Top 10 Construction Enclosure Cautions

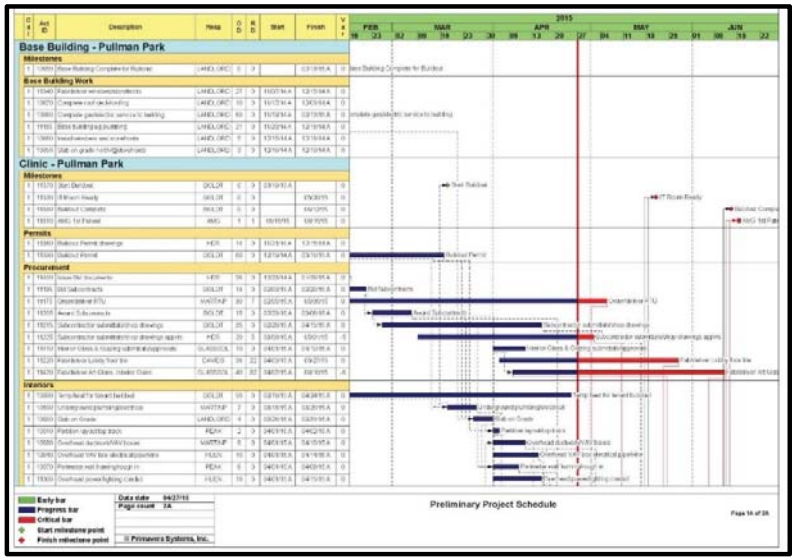
10) CM / GC
9) Designers Lack of Building Science Knowledge
8) Lack of Modeling – Moisture Location
7) Lack Knowledge – Insulating Existing Buildings
6) Thermal Insulation Expectations / Understanding
5) SPF Installation Issues
4) Improper Installation of Materials
3) No Pre Installation Team Meeting
2) No Mock Up & Site Testing
1) Transitions, Transitions, Transitions

Common Theme

Education!!!!!!

10 - CM / GC

- **Schedule Push vs Pull (LEAN)**
- Substrate Not Ready to Receive Air Barrier Material
- Lack of Understanding in Building Science
- Root Cause Constraints



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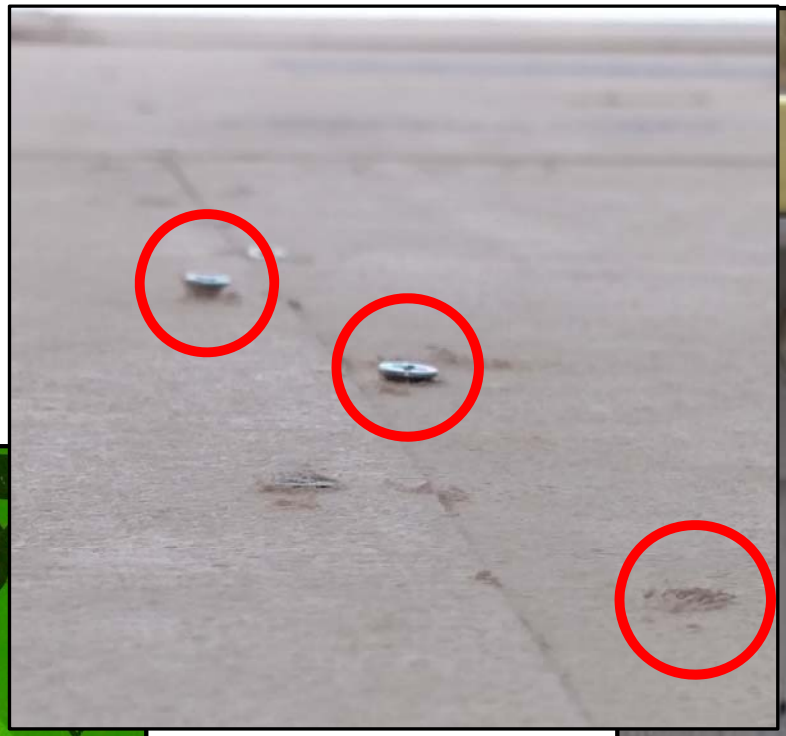
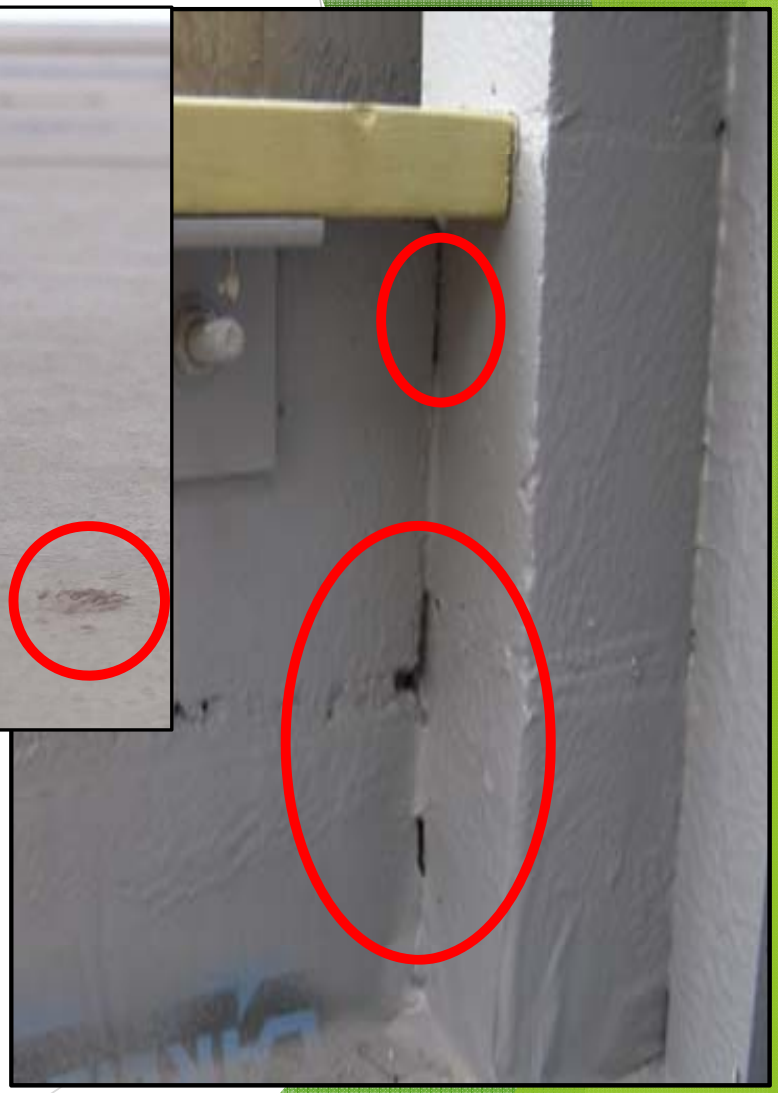
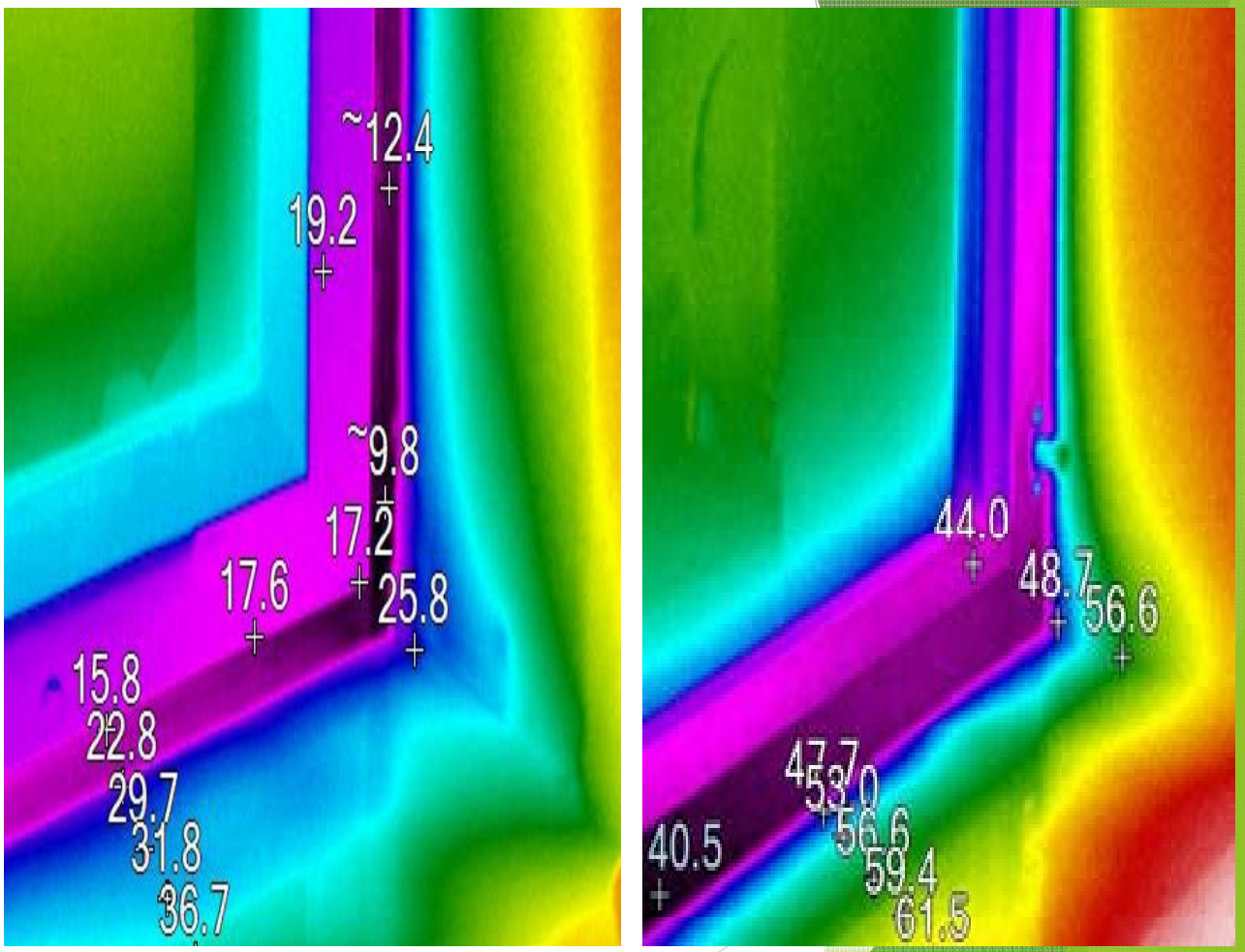




 # 9- Designers Lack of Building Science Education / Knowledge

- Details with Thermal Bridging
- Details depicting non-continuous Air Barriers
- Lack of Redundancy for Primary Barriers
- NFPA 285
- Not Spec Field Testing
- Not Spec Mock Ups



Outside -15F
Inside 73F
RH 26%

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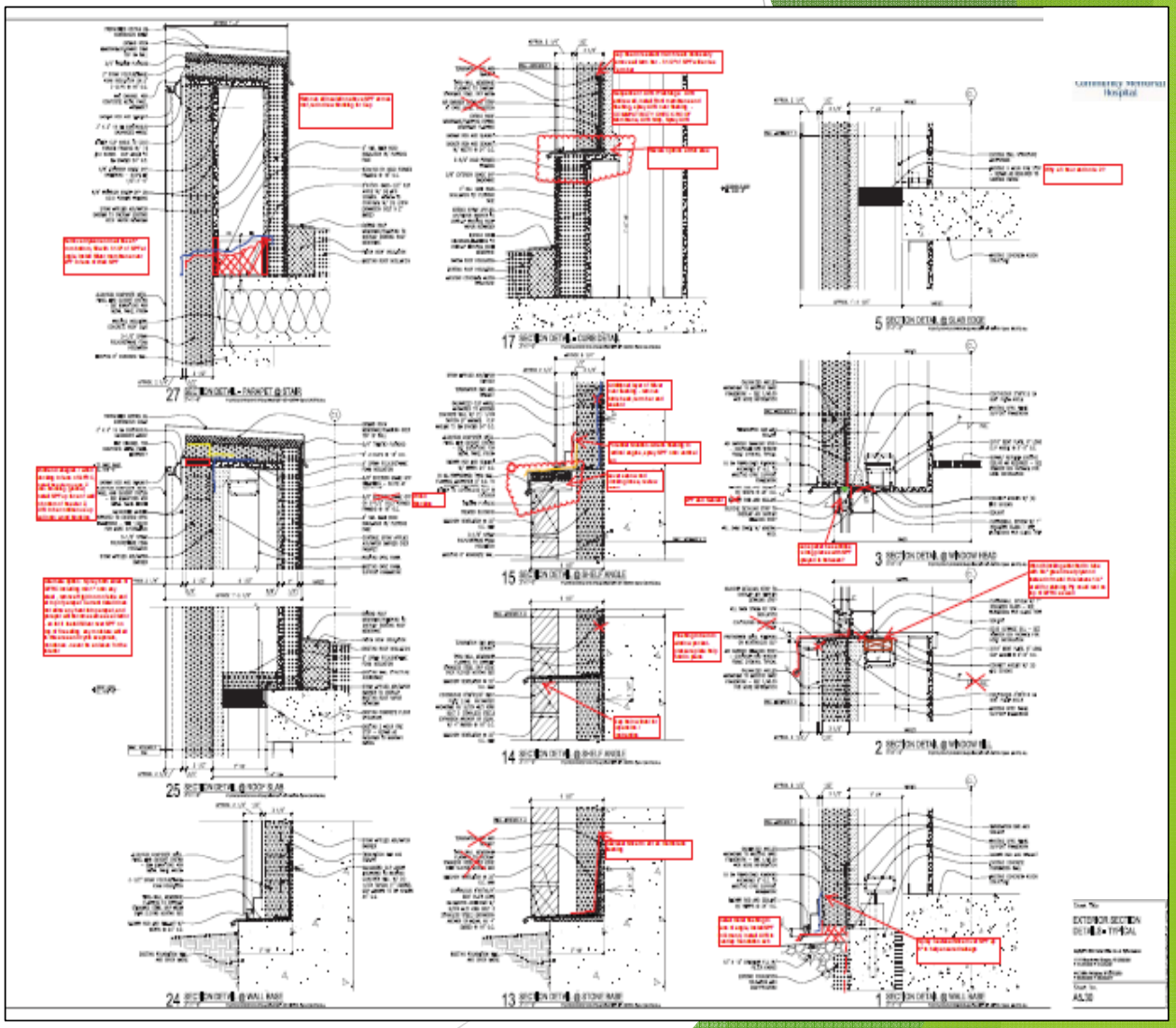

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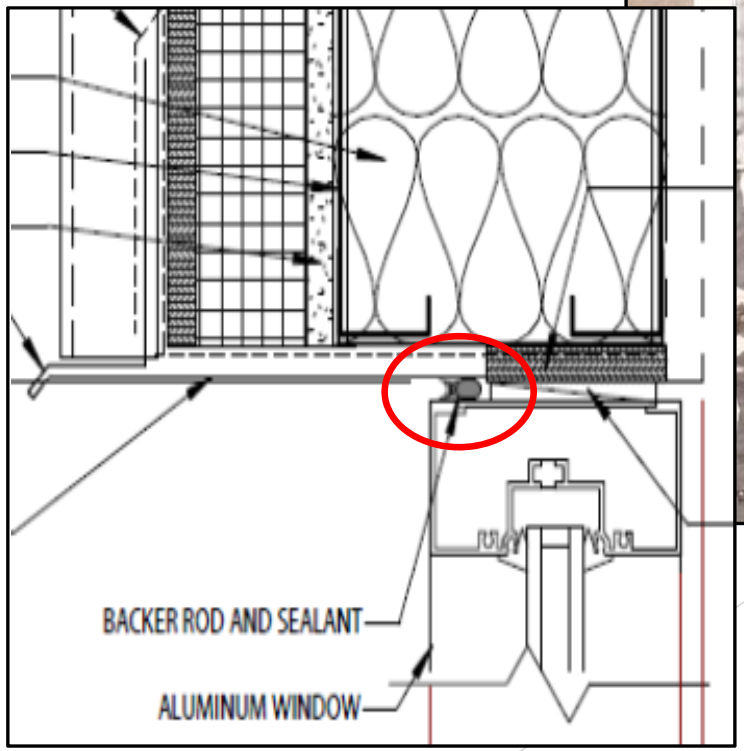

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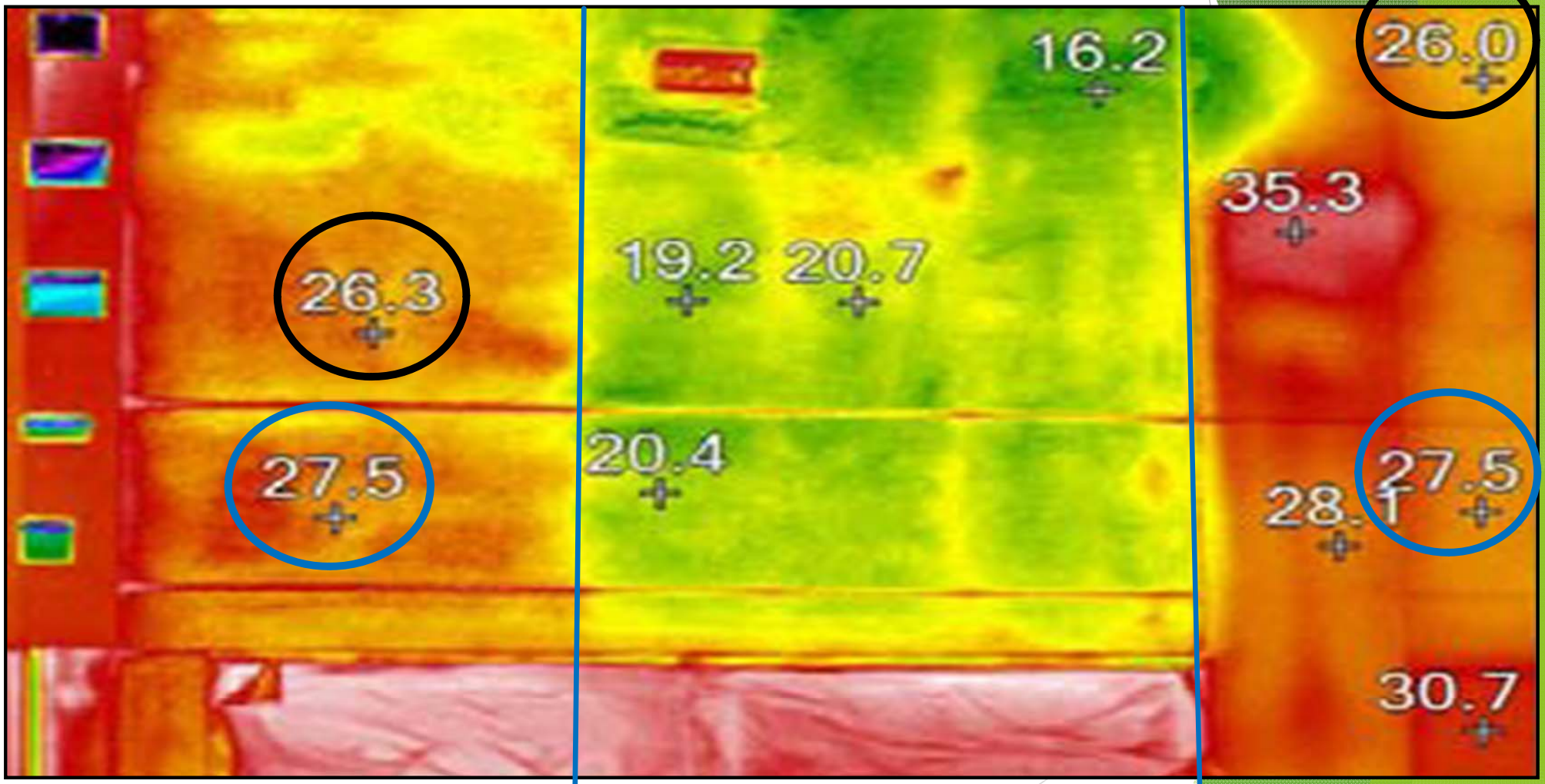
9 - Designers Lack of Building Science Knowledge

Air Barrier – No Insulation

Air Barrier w Insulation

NO Air Barrier & With Insulation

9 - Designers Lack of Building Science Knowledge



Air Barrier – No Insulation

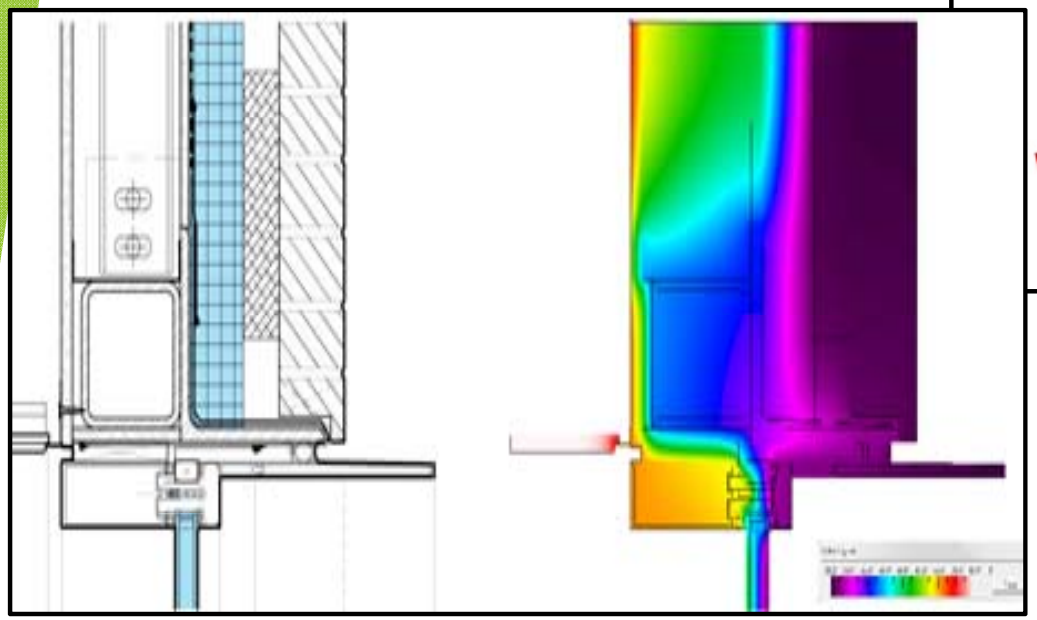
Air Barrier with Insulation

NO Air Barrier & With Insulation

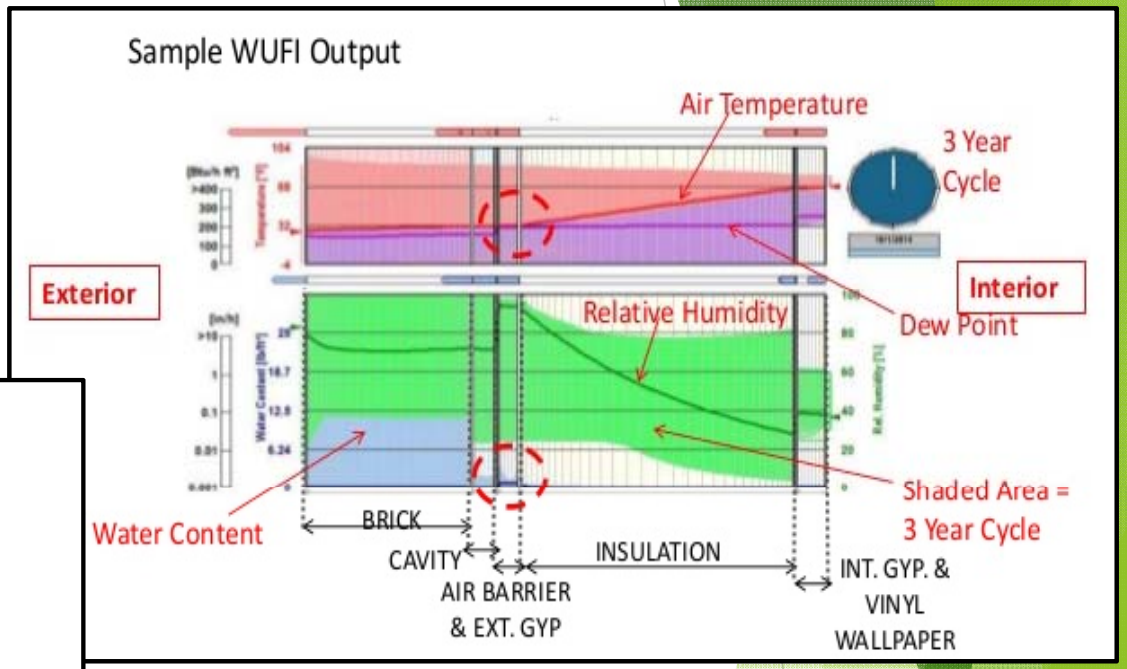
#8 - Lack of Modeling - Moisture Location

Computer Modeling Programs:

- Therm
- WUFI
- eQuest



Therm

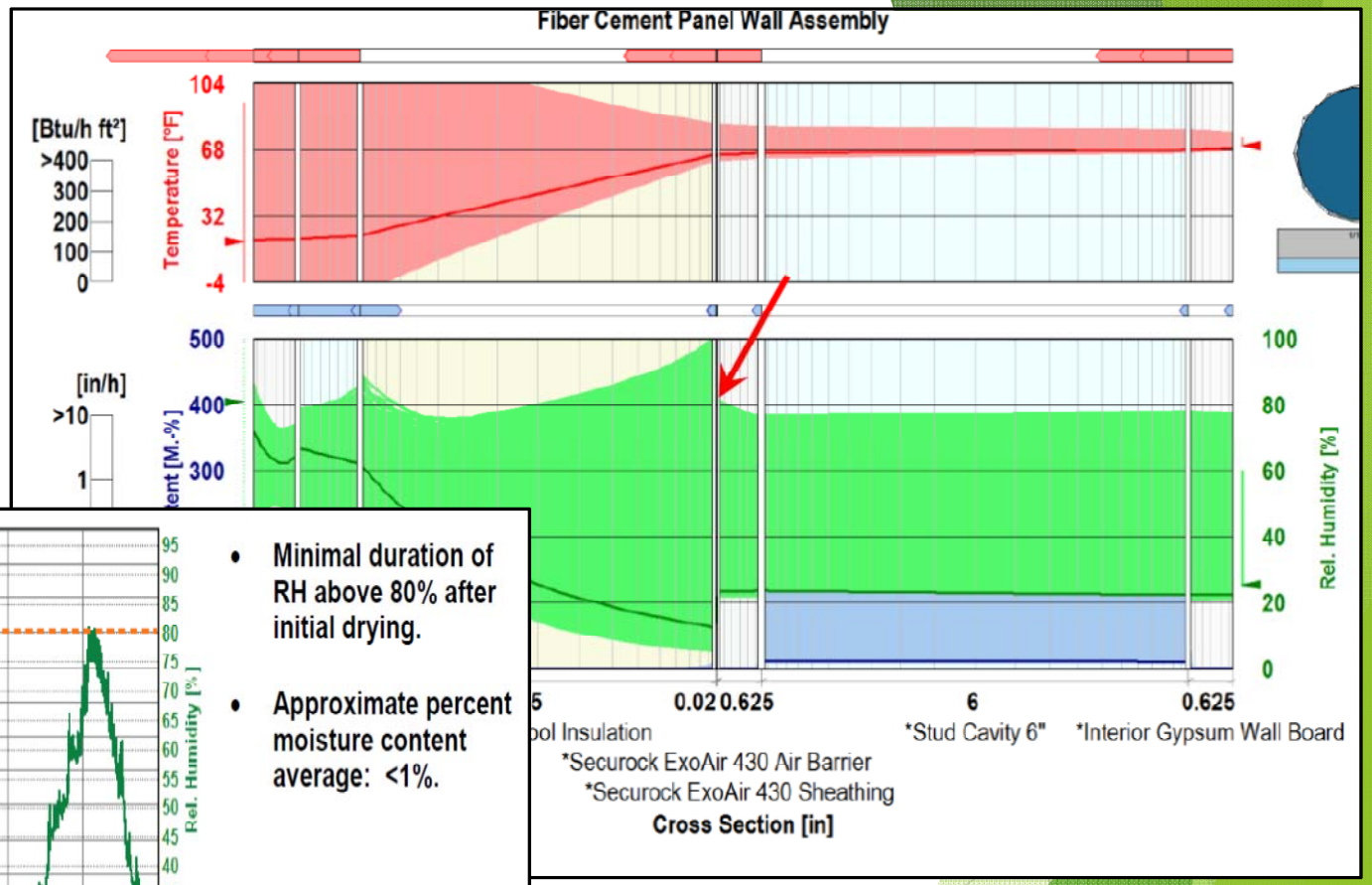


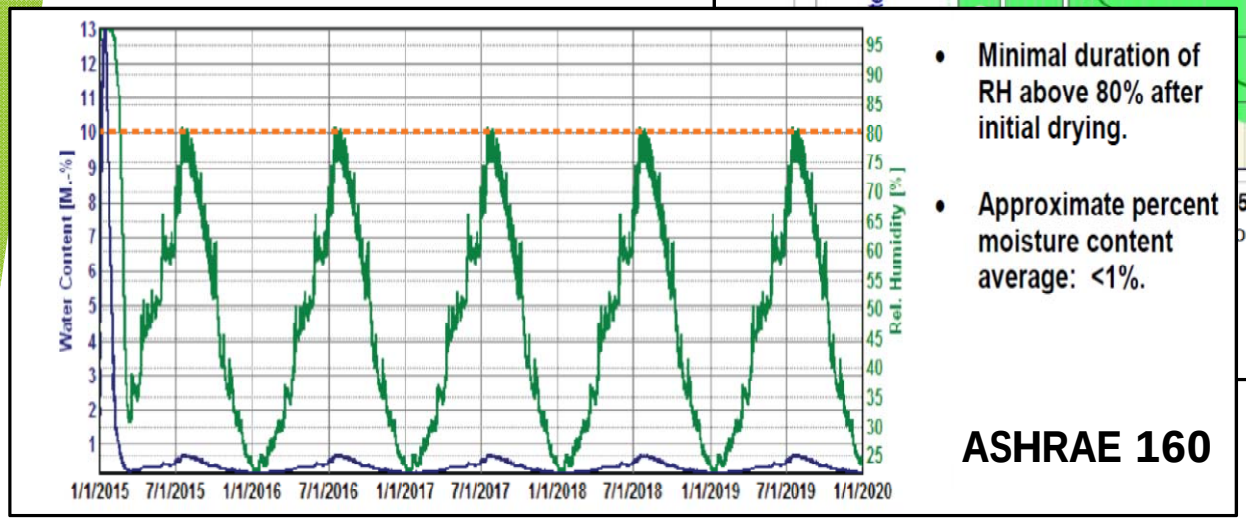
WUFI

Caution – Output is only as good as the Input!!!!!

IBC 2015

- Section 1405.3
  - Vapor Retarders as described in Section 1405.3.3 shall be provided in accordance with Section 1405.1 and 1405.3.2 **or an approved design using accepted engineering practice for hydrothermal analysis**





- Minimal duration of RH above 80% after initial drying.
- Approximate percent moisture content average: <1%.

ASHRAE 160

Caution – Output is only as good as the Input!!!!!

#8 – Lack of Modeling - Moisture Location

#7 - Lack Knowledge – Insulating Existing Buildings

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What Else Should We Do to Ensure We Re-Build It Right???

Make Sure Brick Can Handle Different Moisture / Freeze Thaw Cycles

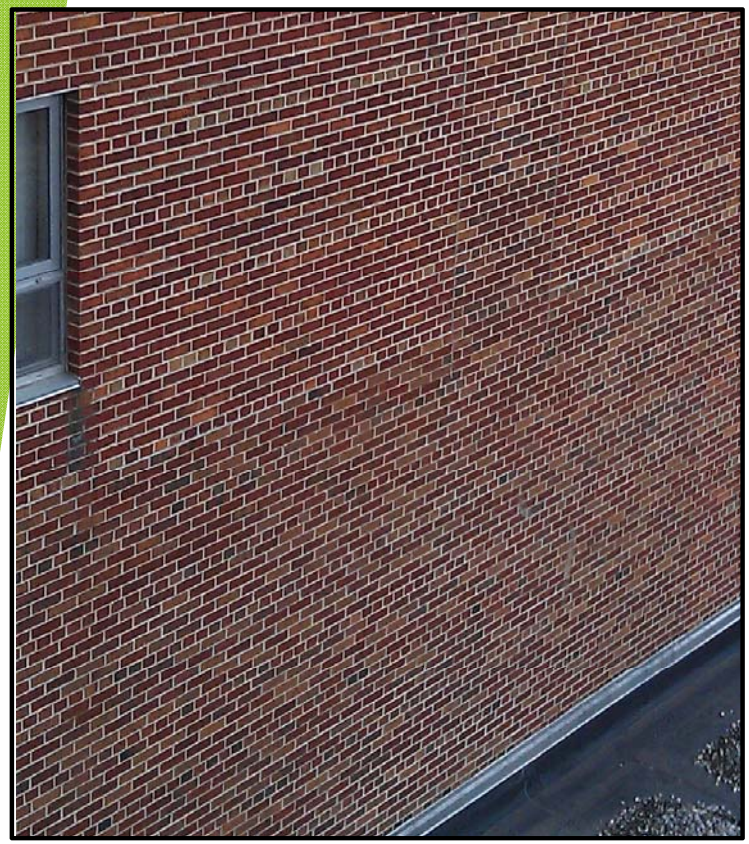


Photo by: Construction Specifier Institute

- **ASTM C67 – 14 Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile**

#7 - Lack Knowledge – Insulating Existing Buildings

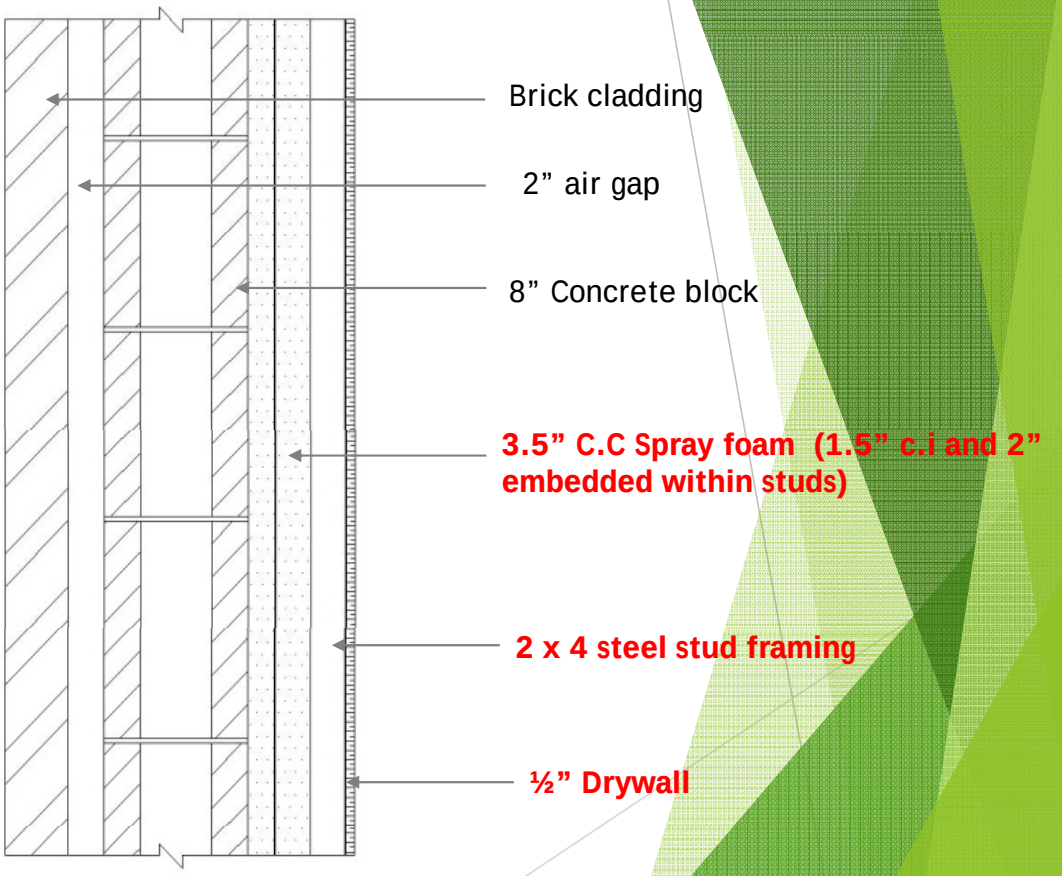
The existing fiberglass batts and steel studs will have to be taken down to spray continuous layer of foam on the inside of the CMU.

Closed-cell Spray foam insulation:

- 3.5” Spray foam applied onto the existing wall
- 2 x 4” steel stud framing at 16” o.c
- ½” Drywall

* *1.5” Spray foam as continuous insulation while the remaining 2” embedded within the steel stud framing*

***Being Tested At Oak Ridge National Labs Test Platform**



Wall Designs Courtesy of:

CBEI CONSORTIUM for BUILDING ENERGY INNOVATION

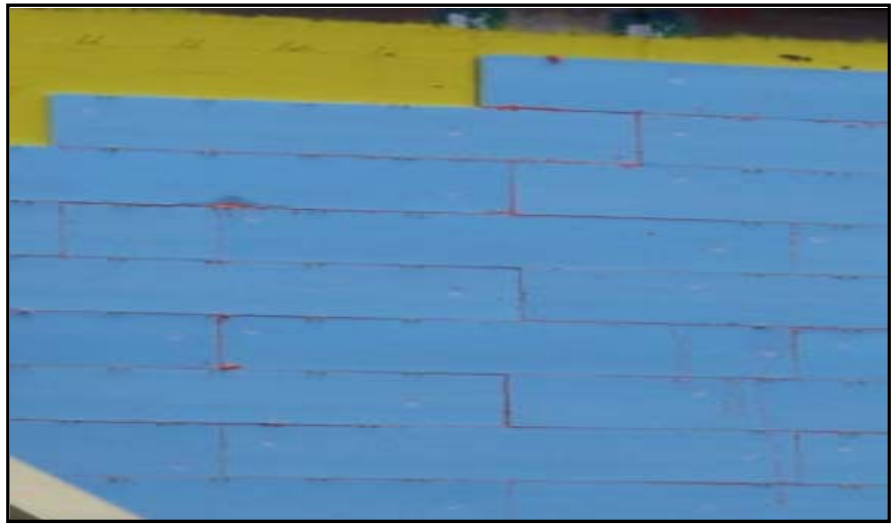
Project 1.3 – Wall Retrofit Solutions

#6 - Thermal Insulation Expectations / Understanding

Insulation

"Insulation should be installed so that **there is a continuous layer** between the conditioned inside space of the building and the outside environment. **Breaks in this layer will form thermal bridges** and will **lead to excessive energy loss or gain** into the building."

Andre Desjarlais, Program Manager for Oak Ridge (Tenn.) National Laboratory's Building Envelope Program



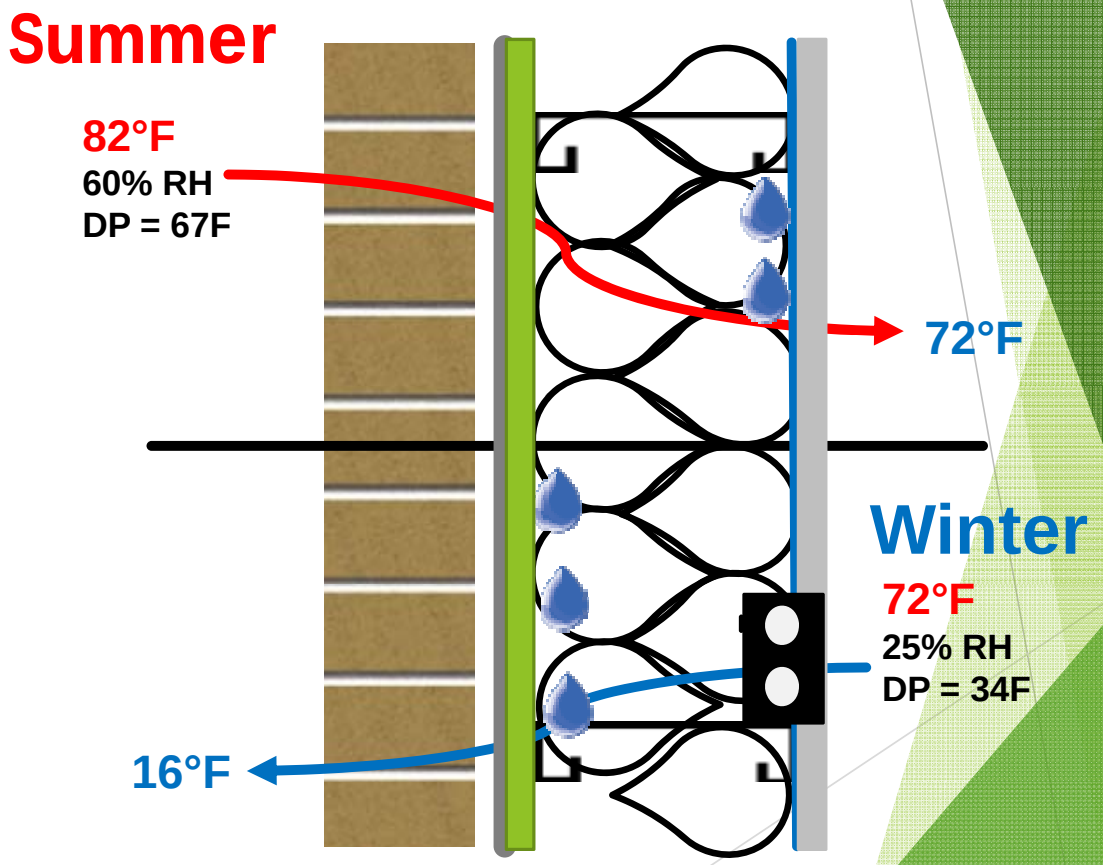
#6 - Thermal Insulation Expectations / Understanding

Wall:
2”x6” with R19 Batt

Milwaukee

July:
Hi Temperature = **82°F**
Low Temperature = **65°F**
85F with 70%RH = 74F DP

January:
Temperature = **27°F**
Low Temperature = **16° F**



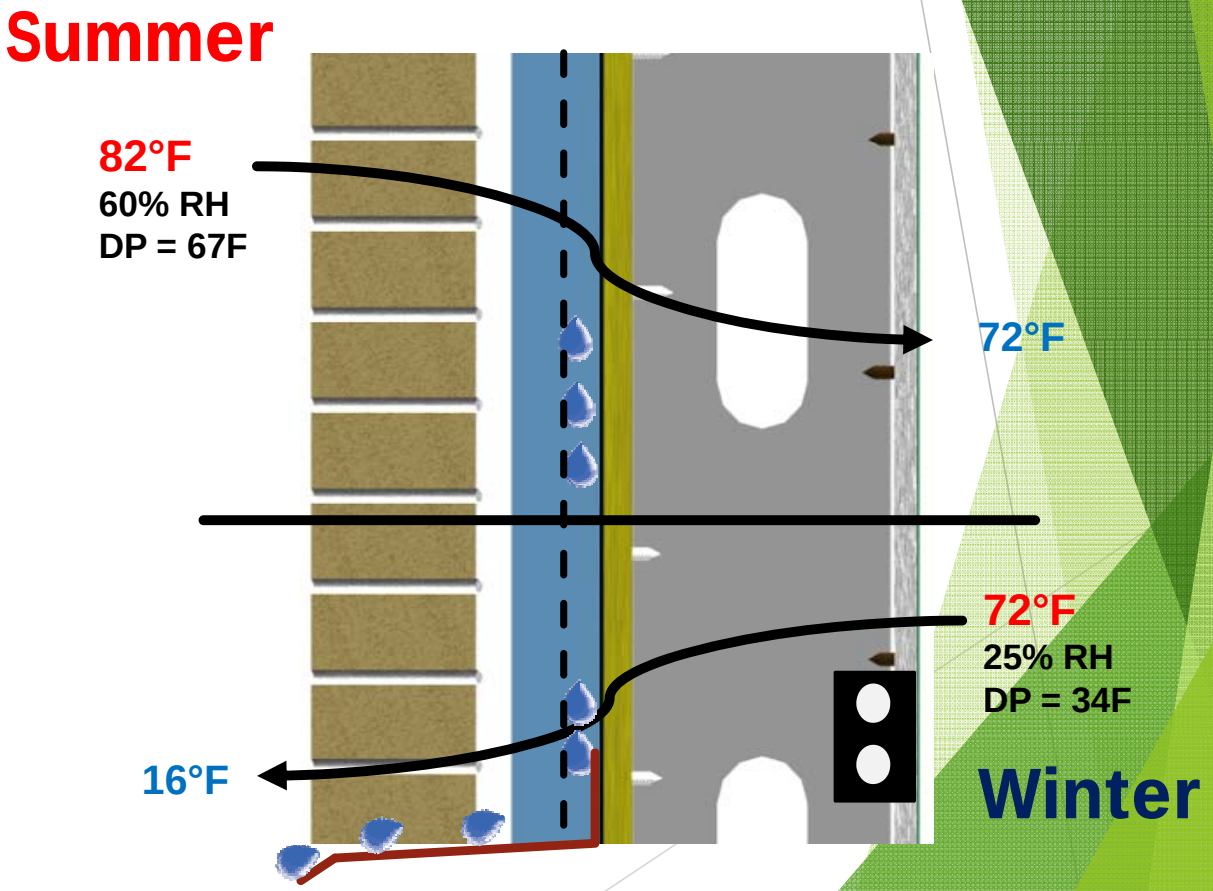
#6 - Thermal Insulation Expectations / Understanding

Wall:
2” Exterior Insulation

Milwaukee

July:
Hi Temperature = **82°F**
Low Temperature = **65°F**
90F with 60%RH = 74F DP

January:
Temperature = **27°F**
Low Temperature = **16° F**

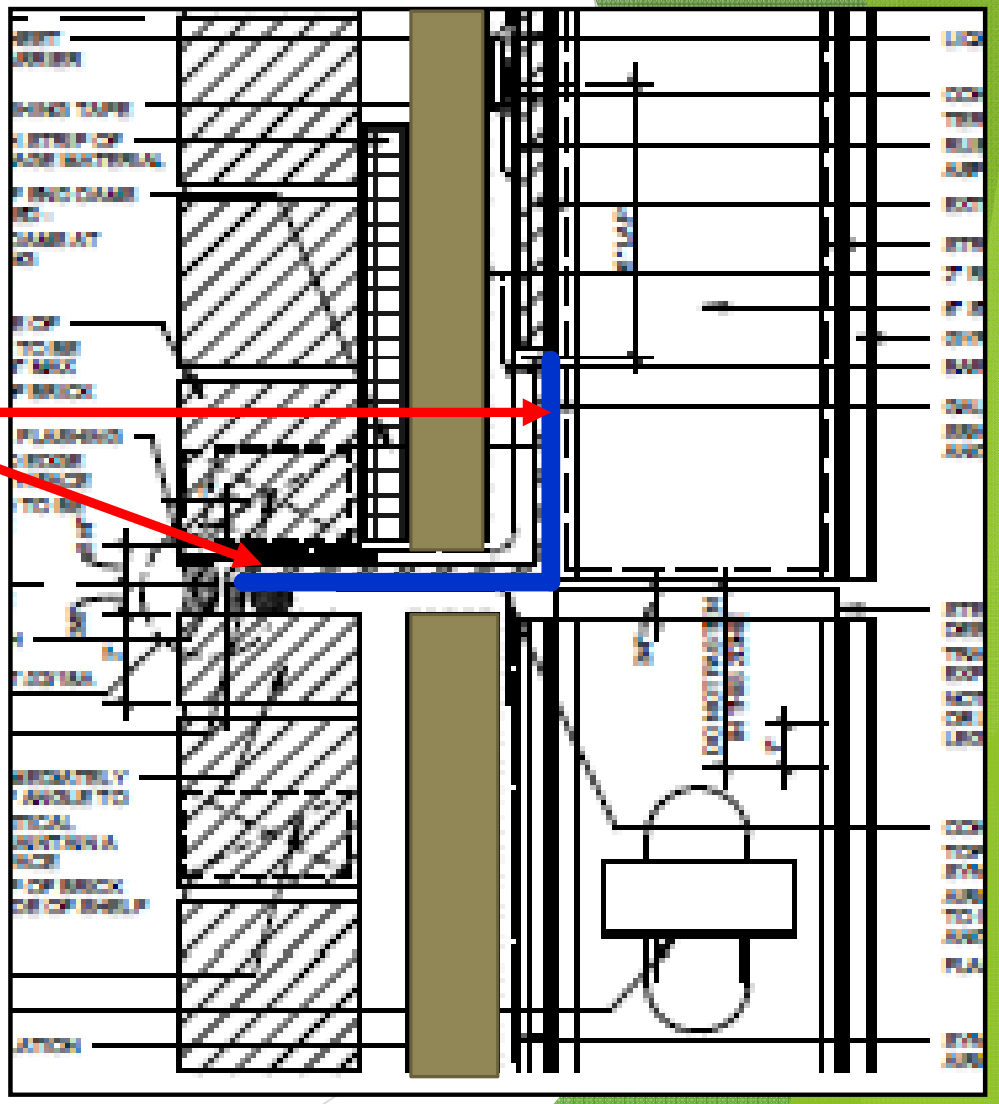


#6 - Thermal Insulation Expectations / Understanding

What Do We Mean by Continuous???

#6 - Thermal Insulation Expectations / Understanding

Thermal Bridging from Steel Lintels / Relieving Angles reduces the nominal R value of the Insulation by approximately 30% – 50%



Dr. John Straube – BEC Austin Annual Symposium May 2016

The use of “Standoffs” reduce the Thermal bridging effect to lee than 10%

#6 - Thermal Insulation Expectations / Understanding

2015 IECC

- Table C402.1.3 Opaque Thermal Envelope insulation Component Minimum Requirements, R-Value Method
  - **All Above Grade Walls / All Climate Zones**
    - **Require CI – Continuous Insulation**

5 - SPF Installation Issues

- **Thickness per Pass**
- Overall Thickness
- Installed when Temperature is Too Cold
- Improper Mix / Temperature / Density
- Bad Cell Structure
- Improper Substrate Prep

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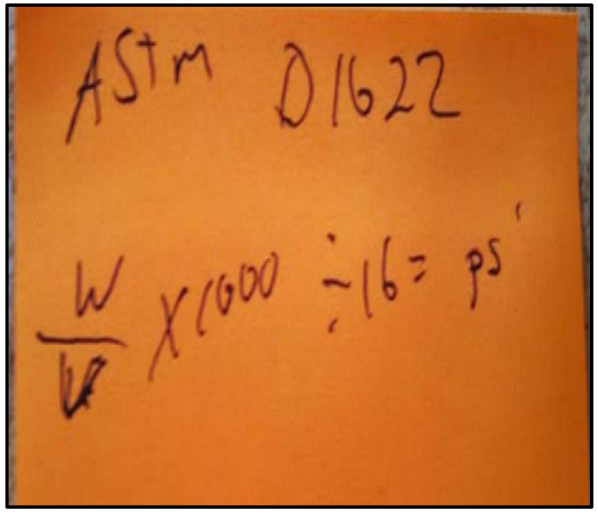

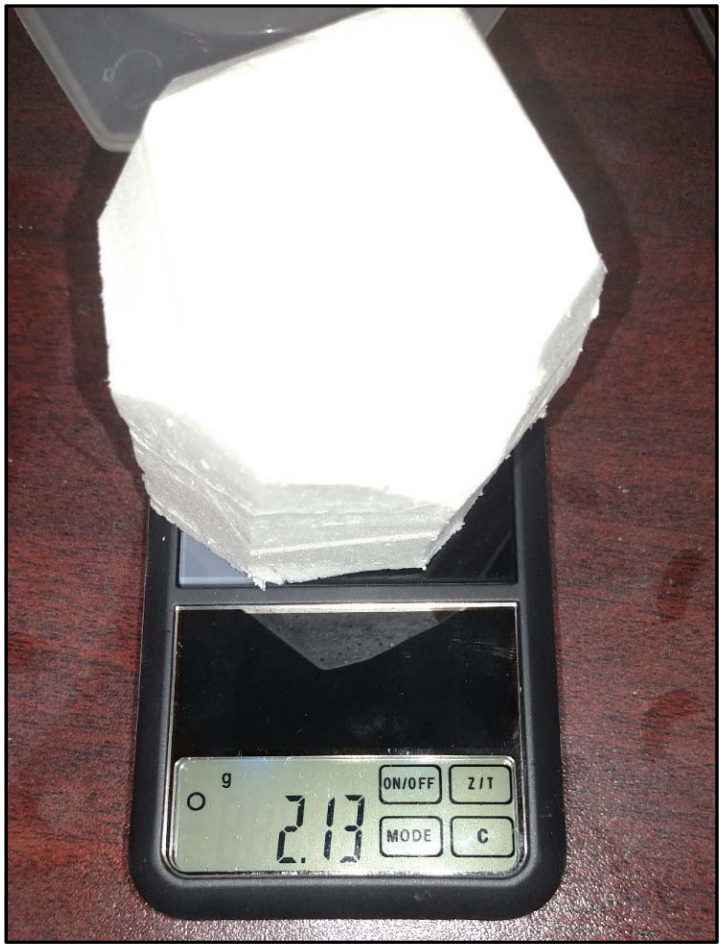

ASTM D 1622 – Provides method for Density Testing

5 - SPF Installation Issues

- Thickness per Pass
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SPF Installation Issues

- Thickness per Pass
- Overall Thickness
- Installed when Temperature is Too Cold
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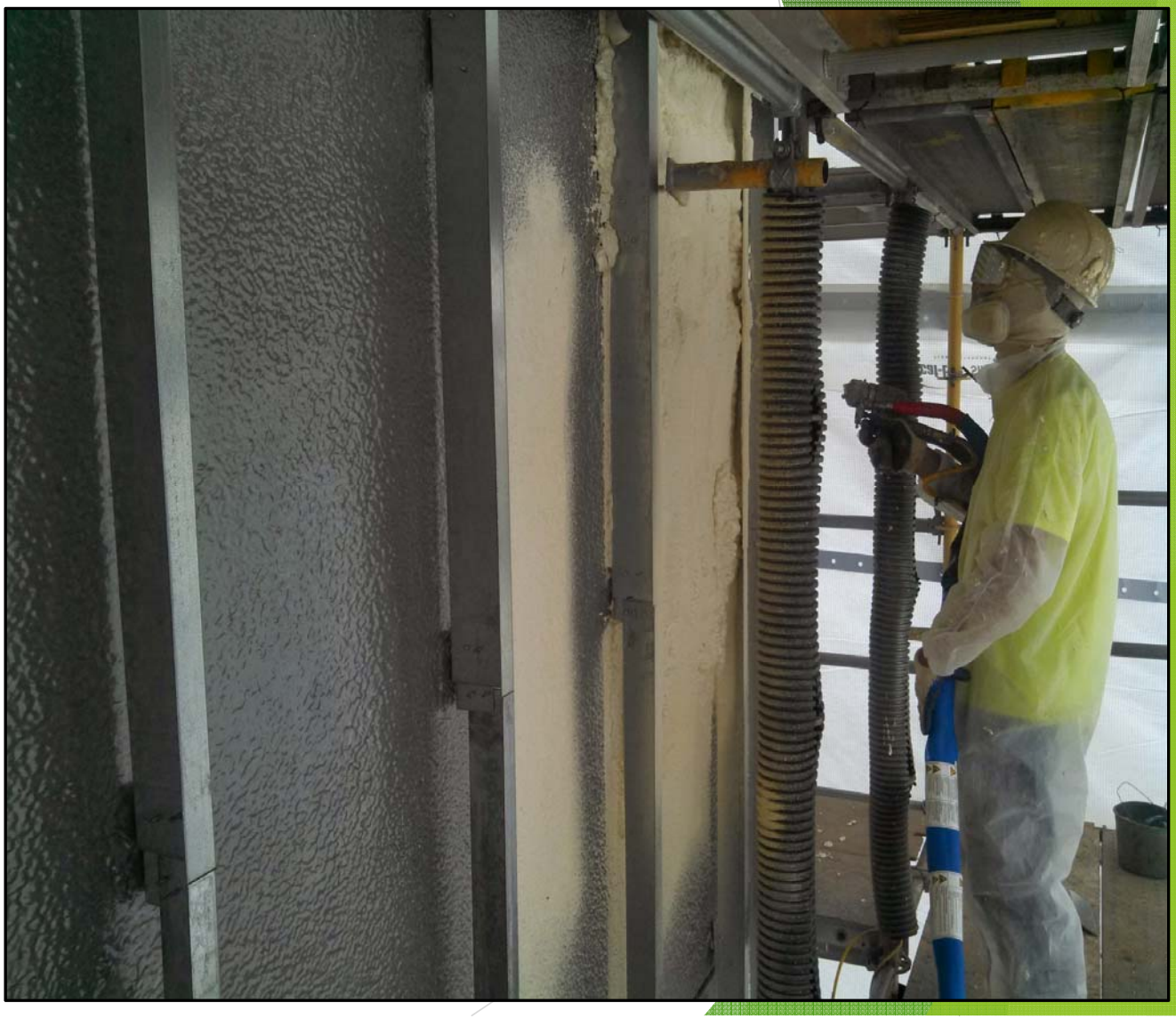
- Bad Cell Structure
- Improper Substrate Prep
- **PPE - Clearance**



 # 4 - Improper Installation of AVB Materials

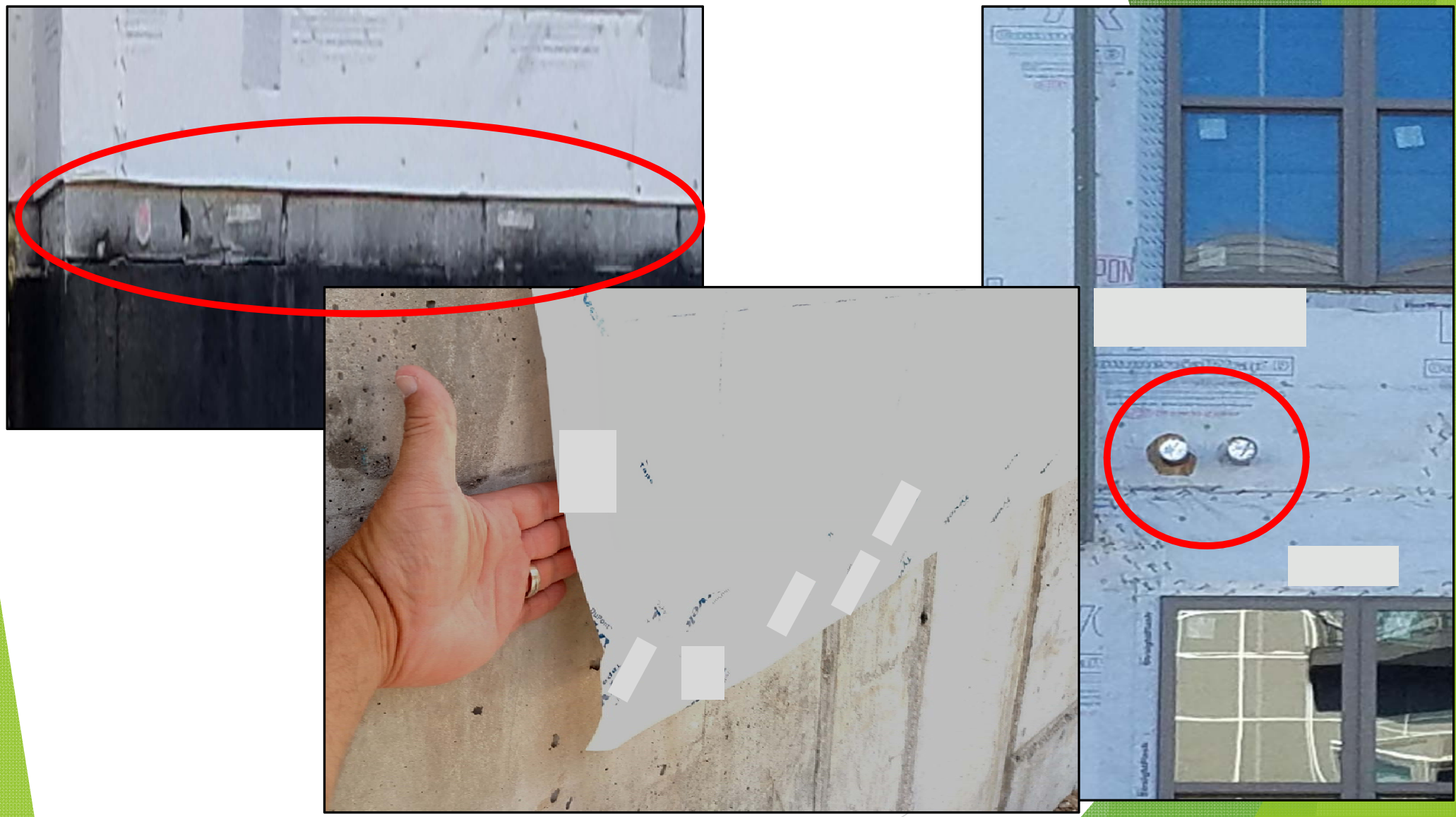
- **Sheet Membranes**
  - **Improper Fastening / Sealing**
  - Fish Mouths
  - Wrong Shingle
  - Not Properly Rolled
  - Incompatible Materials

How Many Sides to a Building?

 # 4 - Improper Installation of AVB Materials

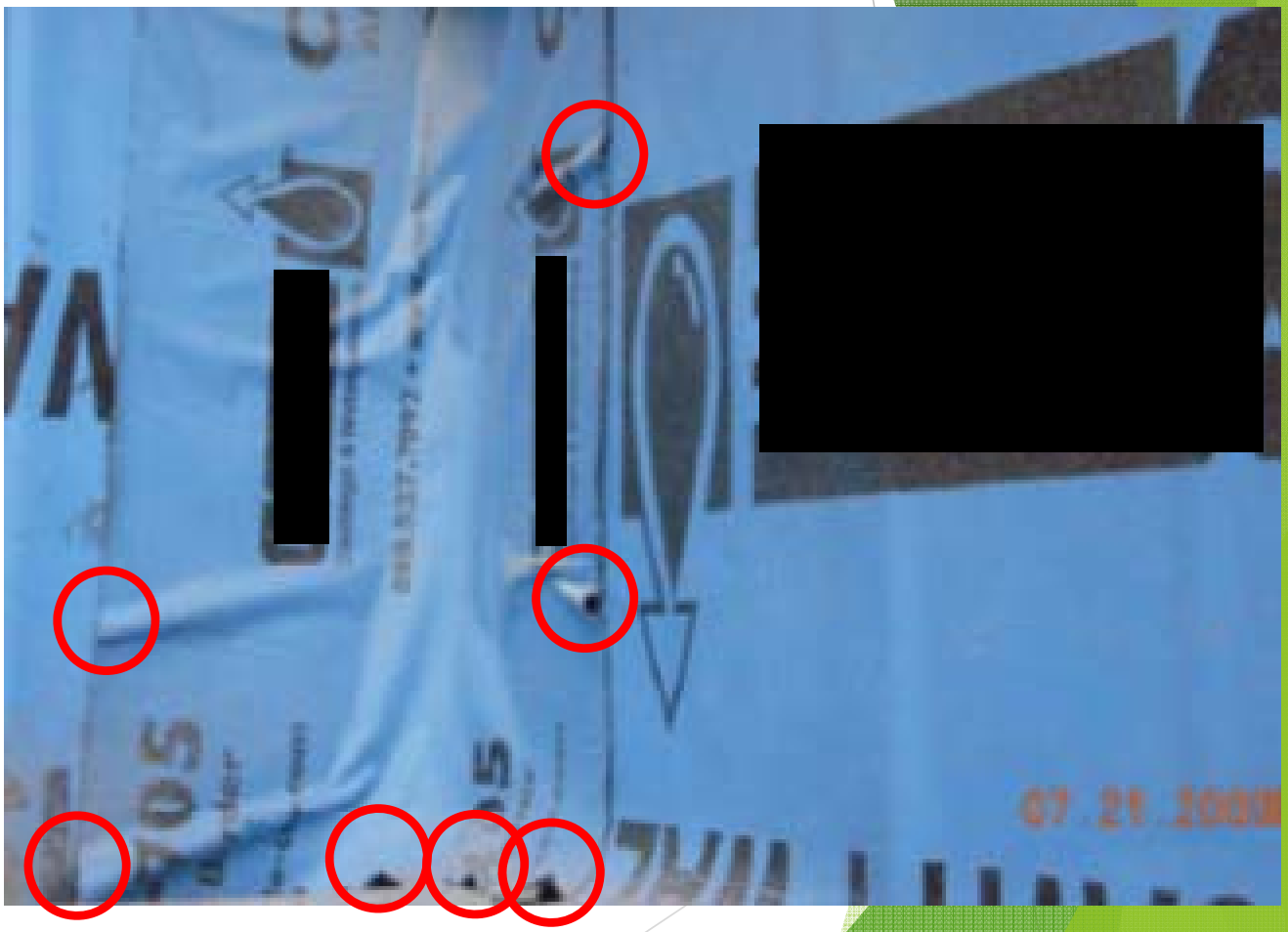
- **Sheet Membranes**
  - **Improper Fastening / Sealing**
  - Fish Mouths
  - Wrong Shingle
  - Not Properly Rolled
  - Incompatible Materials

46 Staples



4 - Improper Installation of AVB Materials

- **Self Adhered**
  - Improper Fastening / Sealing
  - **Fish Mouths**
  - Wrong Shingle
  - Not Properly Rolled
  - Incompatible Materials



4 - Improper Installation of AVB Materials

- **Self Adhered**
  - **Improper Fastening / Sealing**
  - Fish Mouths
  - Wrong Shingle
  - Not Properly Rolled
  - Incompatible Materials

4 - Improper Installation of AVB Materials

- **Self Adhered**
  - Improper Fastening / Sealing
  - Fish Mouths
  - **Wrong Shingle / No Termination Bar**
  - Not Properly Rolled
  - Incompatible Materials

Construction Cautions with Air Barriers and Enclosures

 # 4 - Improper Installation of AVB Materials

- **Self Adhered**
  - Improper Fastening / Sealing
  - Fish Mouths
  - Wrong Shingle
  - **Not Properly Rolled**
  - Incompatible Materials

Rolling Should Start in the Middle and Work to the Edges

 # 4 - Improper Installation of AVB Materials

- **Self Adhered**
  - Improper Fastening / Sealing
  - Fish Mouths
  - Wrong Shingle
  - Not Properly Rolled
  - **Incompatible Materials**

4 - Improper Installation of AVB Materials

- **Fluid Applied**
  - **Substrate Prep**
  - Mil Thickness / Slumping
  - Material Compatibility / Transitions
  - Adhesion
  - Cure Time

4
Improper Installation of AVB Materials

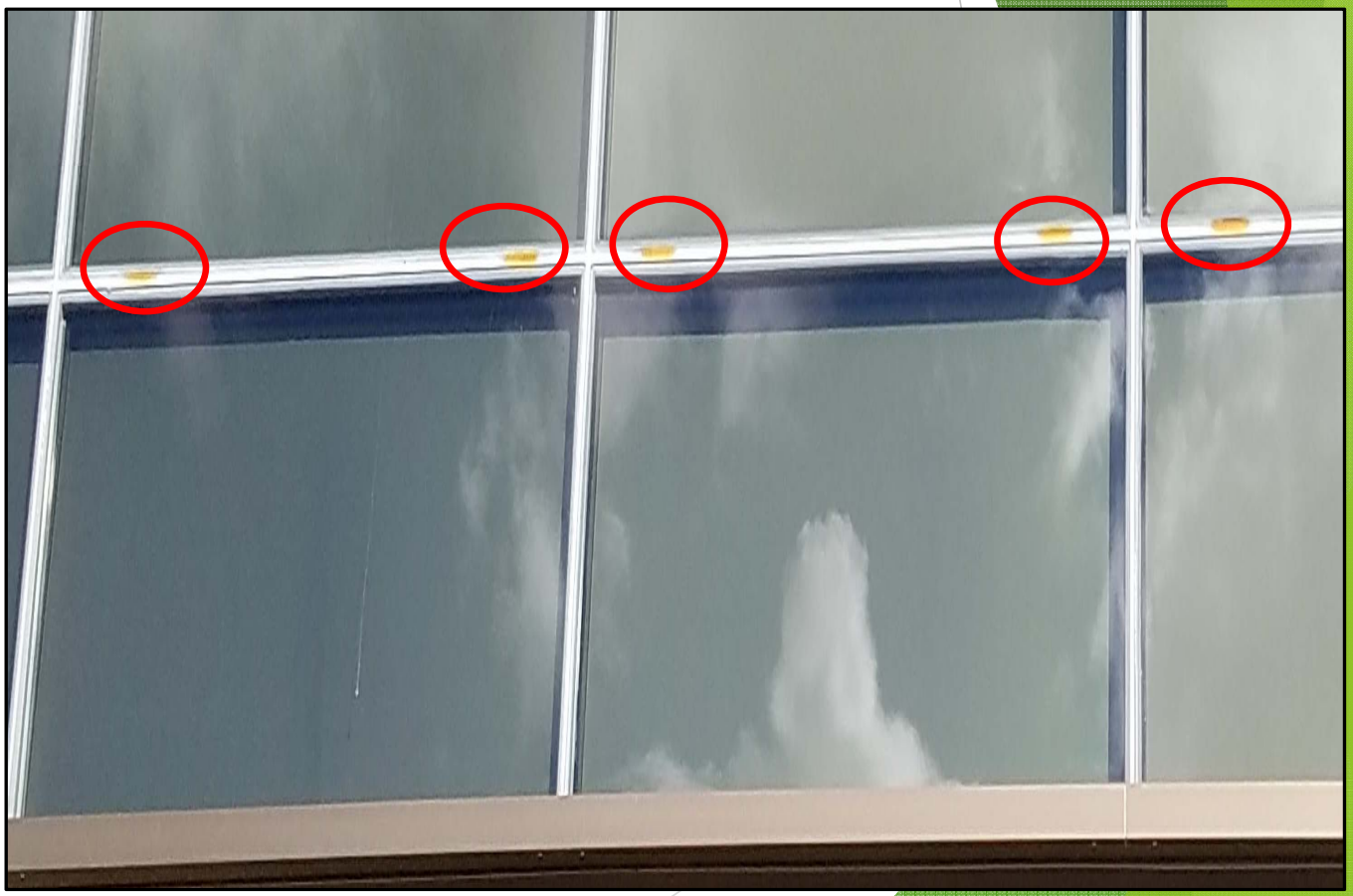
- **Fluid Applied**
  - Substrate Prep
  - **Mil Thickness / Slumping**
  - Material Compatibility / Transitions
  - Adhesion
  - Cure Time

4 Improper Installation of AVB Materials

- **Fluid Applied**
  - Mil Thickness / Slumping
  - UV Exposure
  - Material Compatibility / Transitions
  - **Adhesion**
  - **Cure Time**

4 Improper Installation of AVB Materials

- **Fluid Applied**
  - Mil Thickness / Slumping
  - UV Exposure
  - **Material Compatibility** / Transitions
  - Adhesion
  - Cure Time

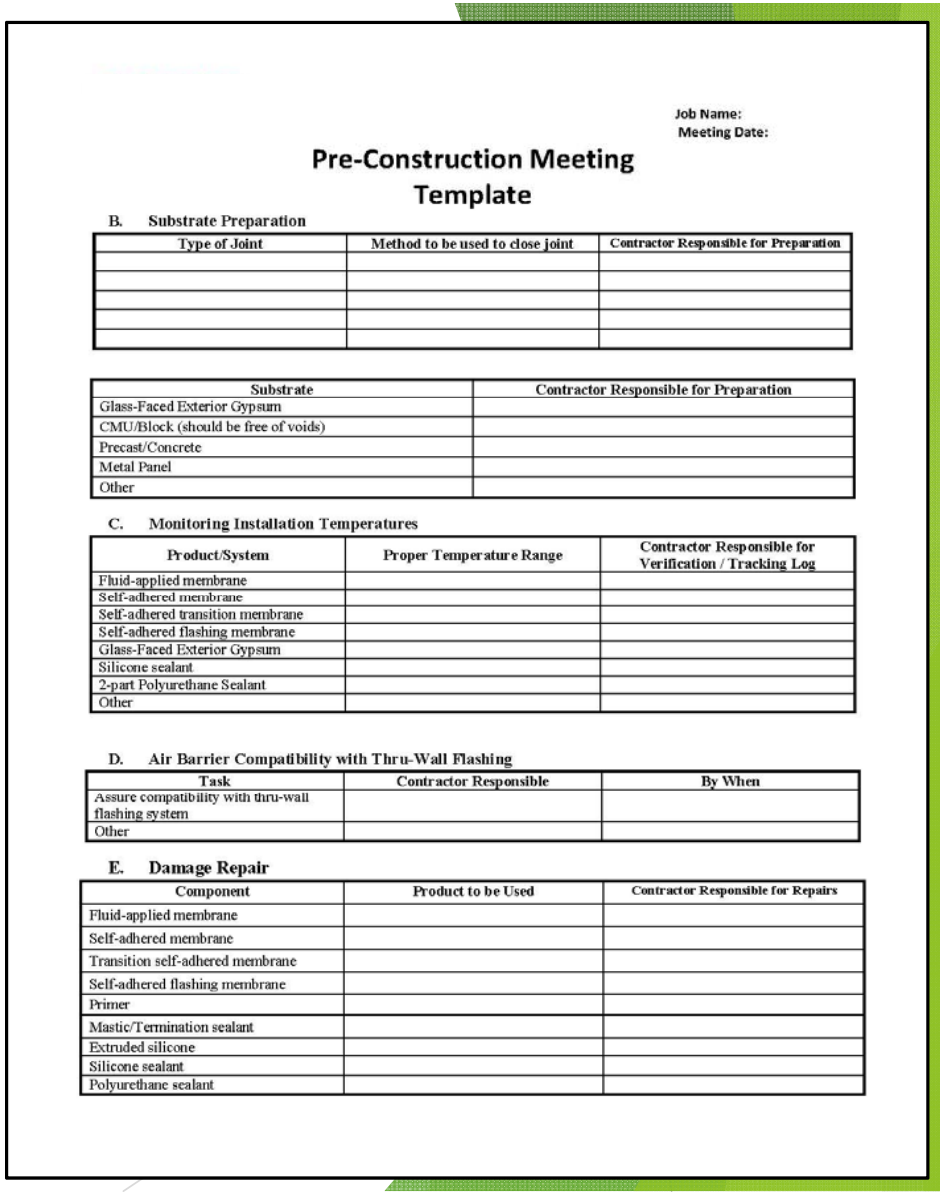


3 - No Pre Installation Team Meeting

- **Review Details**
- Review Sequence of Construction
- Review Acceptable “Hand Offs” Between Trades

3 - No Pre Installation Team Meeting

- Discuss Expectations for Project
  - Owners Intent
  - Specifications, Material Selection
  - Inspections and Testing Requirements
  - Structural Requirements for Supporting various Systems
  - Team Effort



Job Name:
Meeting Date:

Pre-Construction Meeting Template

B. Substrate Preparation

Type of Joint	Method to be used to close joint	Contractor Responsible for Preparation

Substrate	Contractor Responsible for Preparation
Glass-Faced Exterior Gypsum	
CMU/Block (should be free of voids)	
Precast/Concrete	
Metal Panel	
Other	

C. Monitoring Installation Temperatures

Product/System	Proper Temperature Range	Contractor Responsible for Verification / Tracking Log
Fluid-applied membrane		
Self-adhered membrane		
Self-adhered transition membrane		
Self-adhered flashing membrane		
Glass-Faced Exterior Gypsum		
Silicone sealant		
2-part Polyurethane Sealant		
Other		

D. Air Barrier Compatibility with Thru-Wall Flashing

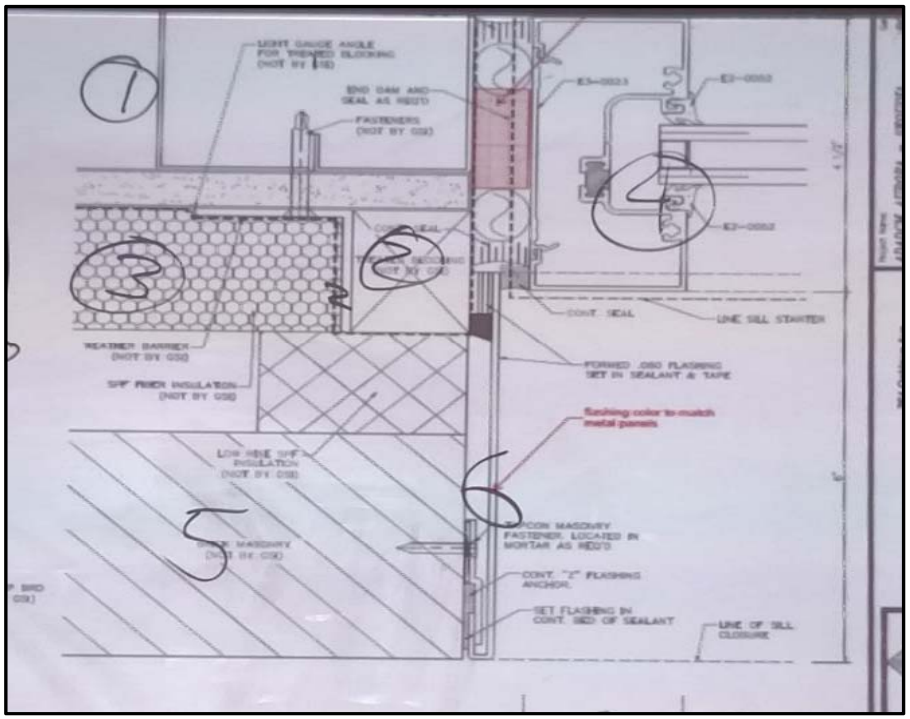
Task	Contractor Responsible	By When
Assure compatibility with thru-wall flashing system		
Other		

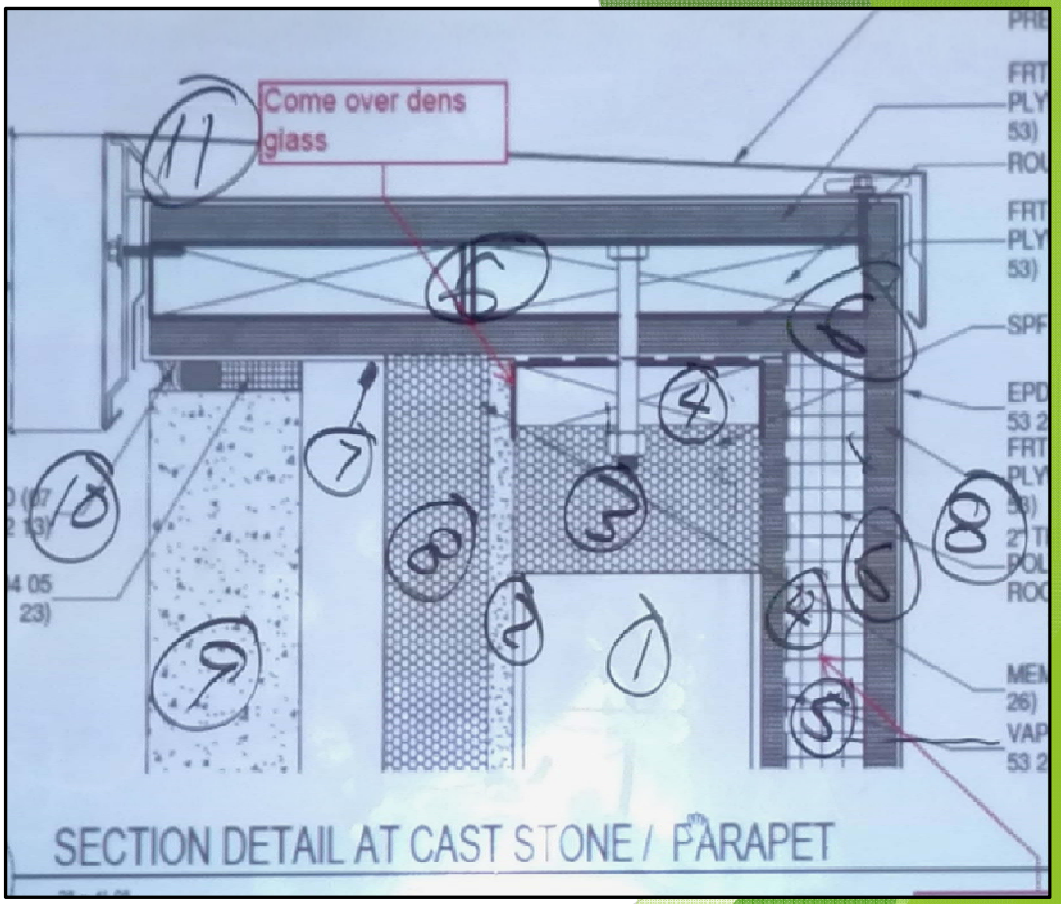
E. Damage Repair

Component	Product to be Used	Contractor Responsible for Repairs
Fluid-applied membrane		
Self-adhered membrane		
Transition self-adhered membrane		
Self-adhered flashing membrane		
Primer		
Mastic/Termination sealant		
Extruded silicone		
Silicone sealant		
Polyurethane sealant		

3 - No Pre Installation Team Meeting

- **Review Details**
- **Review Acceptable "Hand Offs" Between Trades**
- Review Sequence of Construction





3 - No Pre Installation Team Meeting

- **Review Sequence of Construction**
- Review Details
- **Review Acceptable “Hand Offs” Between Trades**

2 No Mock Up / In Situ Testing

 # 2 - No Mock Up / In Situ Testing

"Mock Ups are the MOST VALUE DOLLAR SPENT on this Stuff."

Dr. John Straube
Building Science Corporation / RDH
BEC Austin Annual Symposium – May 2016
BECx Round Table Discussion

2 - No Mock Up / In Situ Testing

Create Miniature Mock Ups

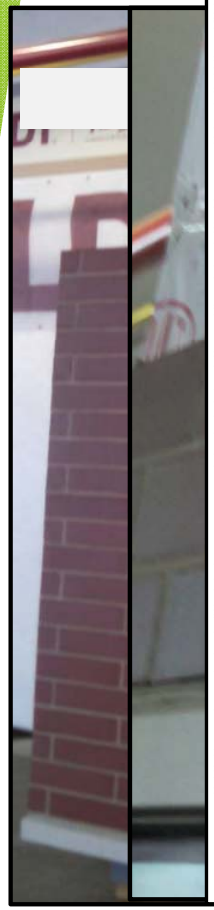
NOT ALL MOCK UPS NEED TO BE TESTED

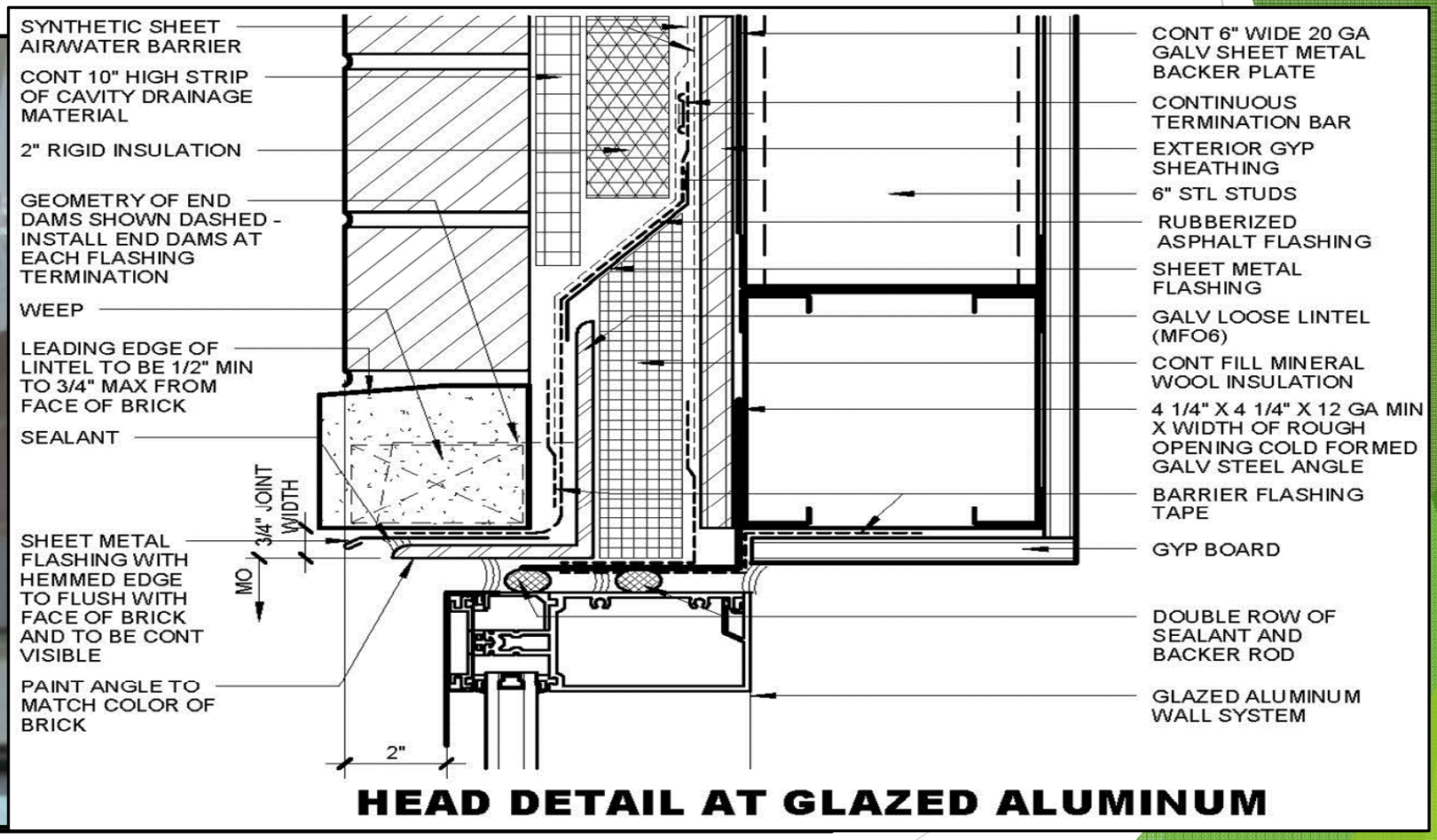
These are used to verify:

- Types of materials
- How different materials interface
- Sequence of Construction
- Acceptable Installation Expectations

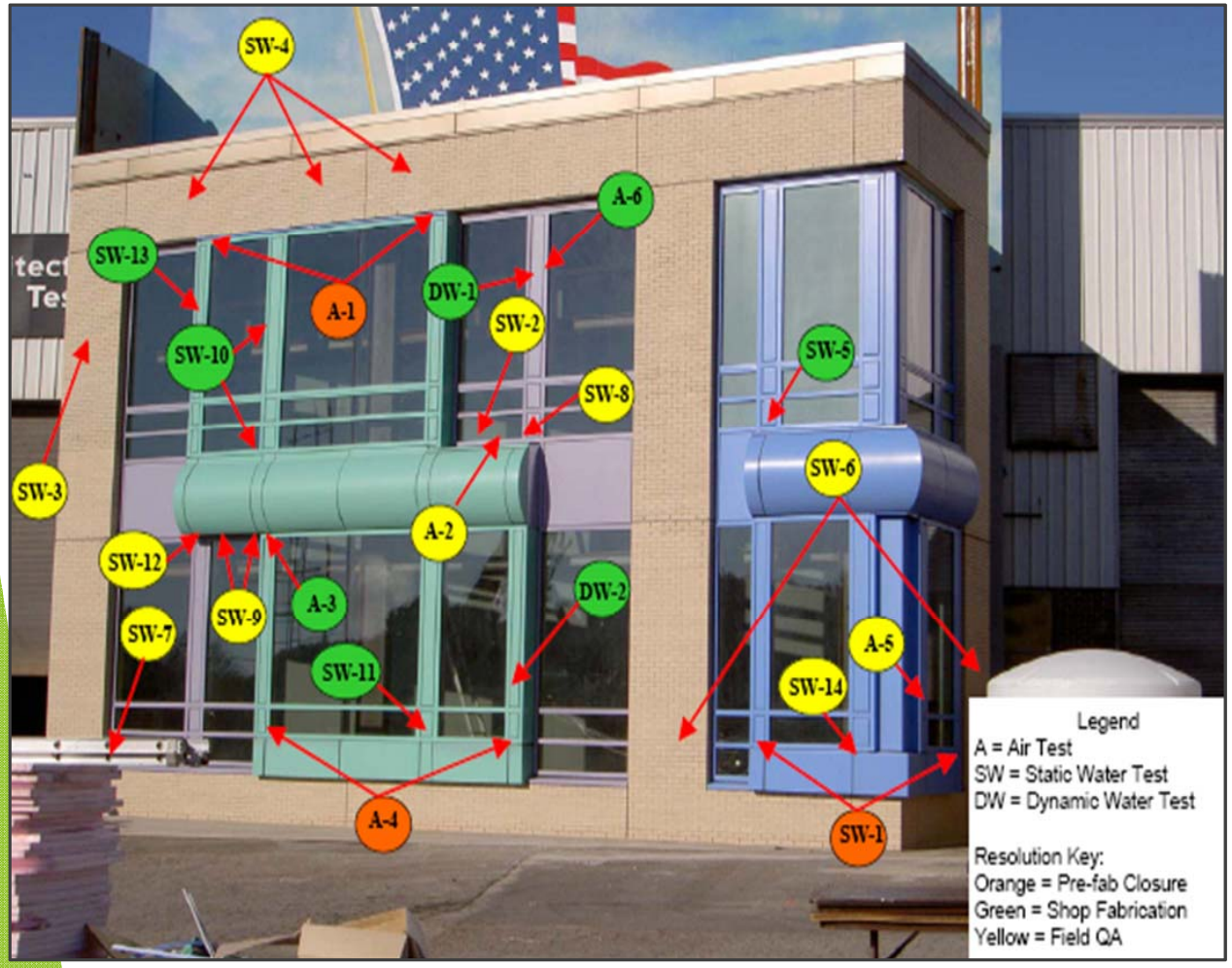
2 - No Mock Up / In Situ Testing

Not Tested Wall Mock Ups





Common Tests Performed



- Air Leakage Windows - ASTM E 283 / ASTM E 783
- Uniform Load Deflection - ASTM E 330
- Static Water - ASTM E 331 / ASTM E1105
- Smoke or Bubble Gun - ASTM E 1186
- Dynamic Water - AAMA 501.1
- Hose Test - AAMA 501.2
- Thermal Cycling - AAMA 501.5
  - Used to Determine Condensation Resistance
- Thermograph - ASTM C 1060
- Sealant Pull Test - ASTM C 1193
- Horizontal Flood Testing (Roof Test) ASTM D 5957
- Air Barrier Adhesion Tests ASTM D 4541
- Lab Mock Up – E 2099
- ASTM Work Standard – Spec and Test Field Mock Ups

2 - No Mock Up / In Situ Testing

In Place Testing:

- ASTM E 283 - Static Air
- AAMA 501.2 – Hose Test
- **ASTM E 1105 - Static Water**
- **AAMA 501.1 - Dynamic Water**
- ASTM E1186 – Smoke Test / Bubble gun / IR
- **ASTM D 4541 - Adhesion**

ASTM D 4541 - **Adhesion**

AAMA 501.1 - **Dynamic Water**

ASTM E 1105 - Static Water

2 - No Mock Up / Stand Alone Mock Ups

2 - No Mock Up / Stand Alone Mock Ups

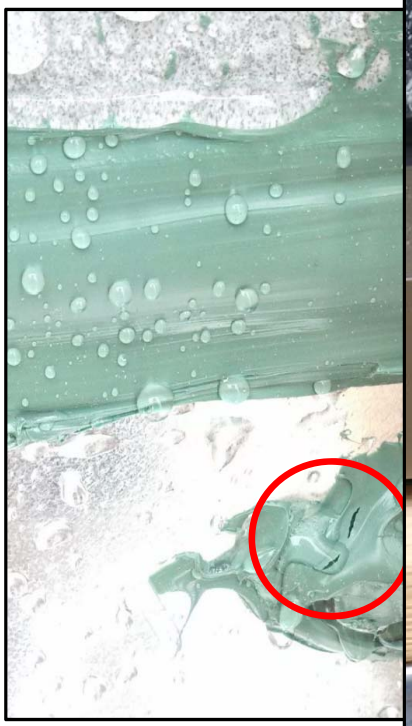
On Site 8’-0” x 8’-0” Wall Mock Up

ASTM E 1105 / Water
&
ASTM E 283 / Air

2 - No Mock Up / Stand Alone Mock Ups

Does Air Tight = Water Tight

Does Water Tight = Air Tight

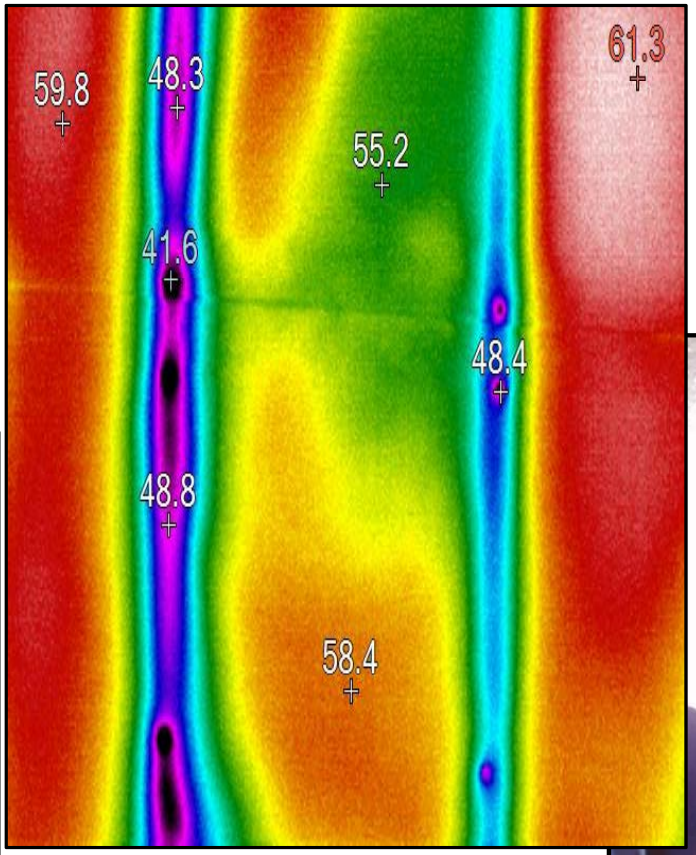


2 - No Mock Up / Stand Alone Mock Ups

Stand Alone Testing:

- ASTM E 283 - Static Air
- AAMA 501.2 – Hose Test
- ASTM E 1105 - Static Water
- AAMA 501.1 - Dynamic Water
- **ASTM E1186 – Smoke Test / Bubble gun / IR**
- ASTM D 4541 - Adhesion

ASTM E1186 – **Smoke Test** / Bubble gun / IR



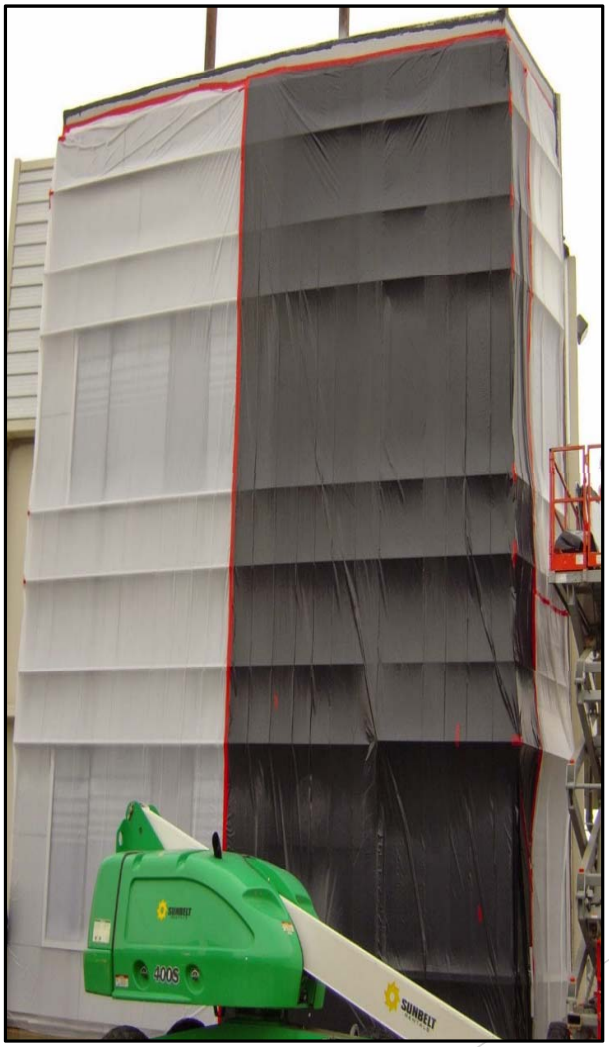
ASTM E1186 – Smoke Test / Bubble gun / **IR**

ASTM E1186 – Smoke Test / **Bubble gun** / IR

2 - No Mock Up / Test lab

Test Lab Testing:

- **ASTM E 283 - Static Air**
- ASTM E 331 - Static Water
- AAMA 501.1 - Dynamic Water
- ASTM E 330 - Uniform Load Deflection
- AAMA 501.2 - Hose Test
- AAMA 501.5 - Thermal Cycling
- ASTM C 1060 - Thermography
- ASTM E1186 – Smoke Test / Bubble gun / IR
- ASTM D 4541 – Adhesion



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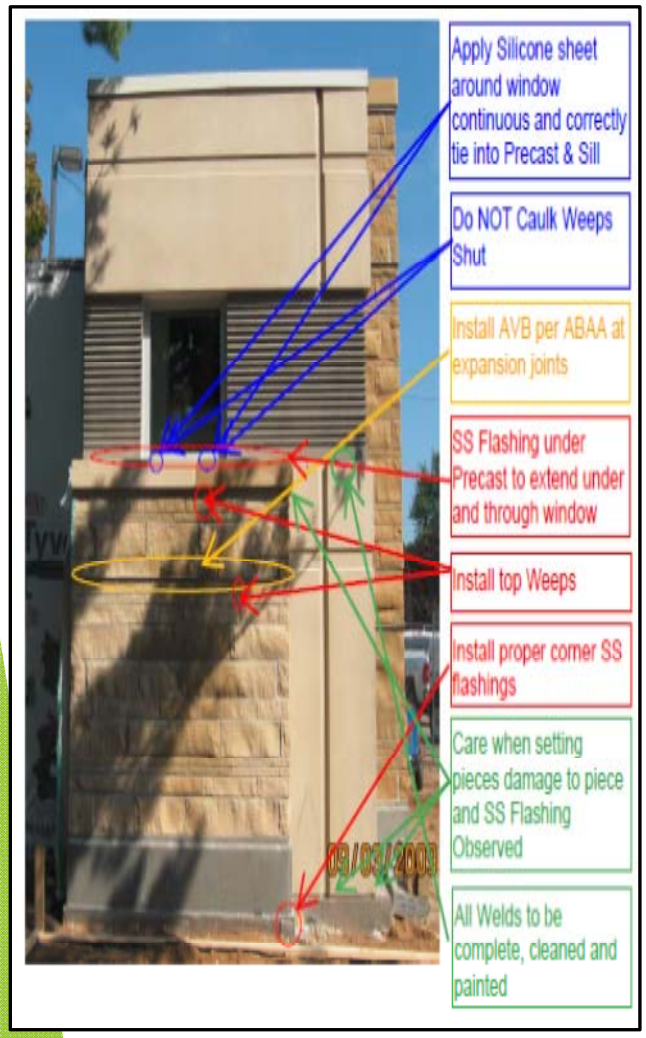
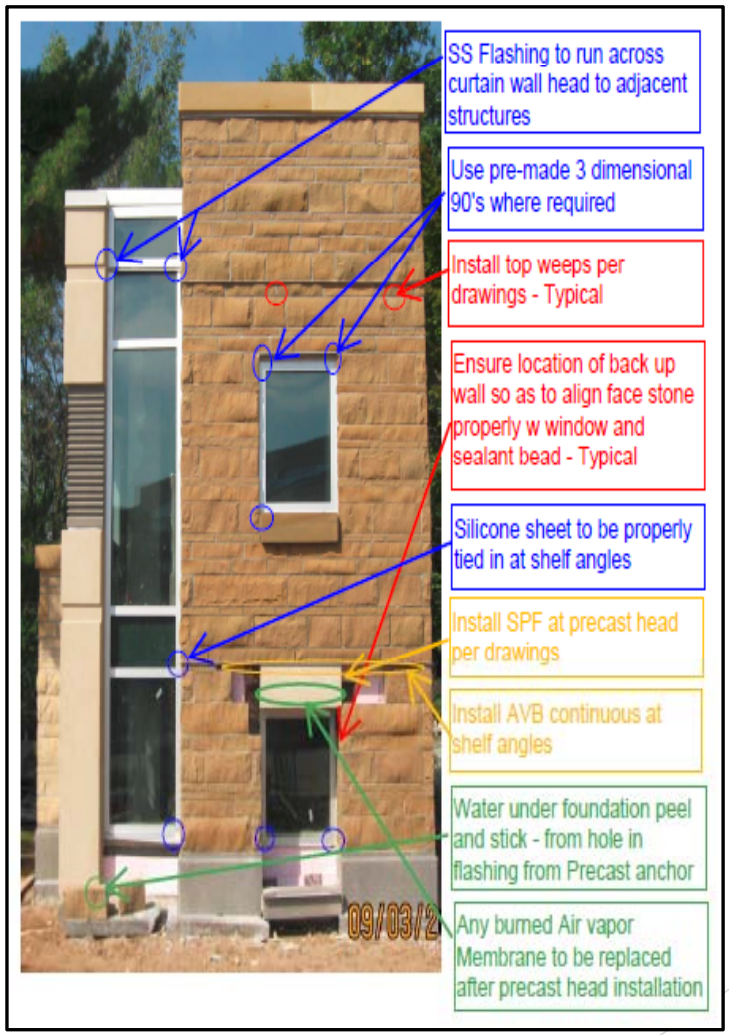
2 - No Mock Up

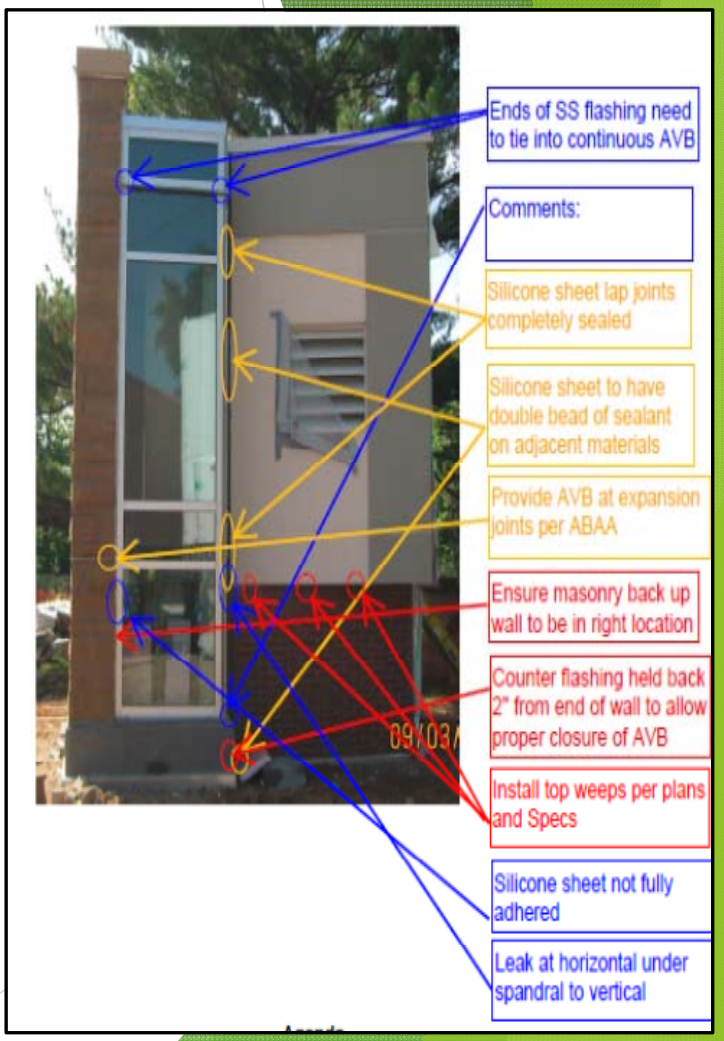
When Should We Test???

AAMA 501.1 -
Dynamic Water Test

2 - No Mock Up


Apply Silicone sheet around window continuous and correctly tie into Precast & Sill
Do NOT Caulk Weeps Shut
Install AVB per ABAA at expansion joints
SS Flashing under Precast to extend under and through window
Install top Weeps
Install proper corner SS flashings
Care when setting pieces damage to piece and SS Flashing Observed
All Welds to be complete, cleaned and painted

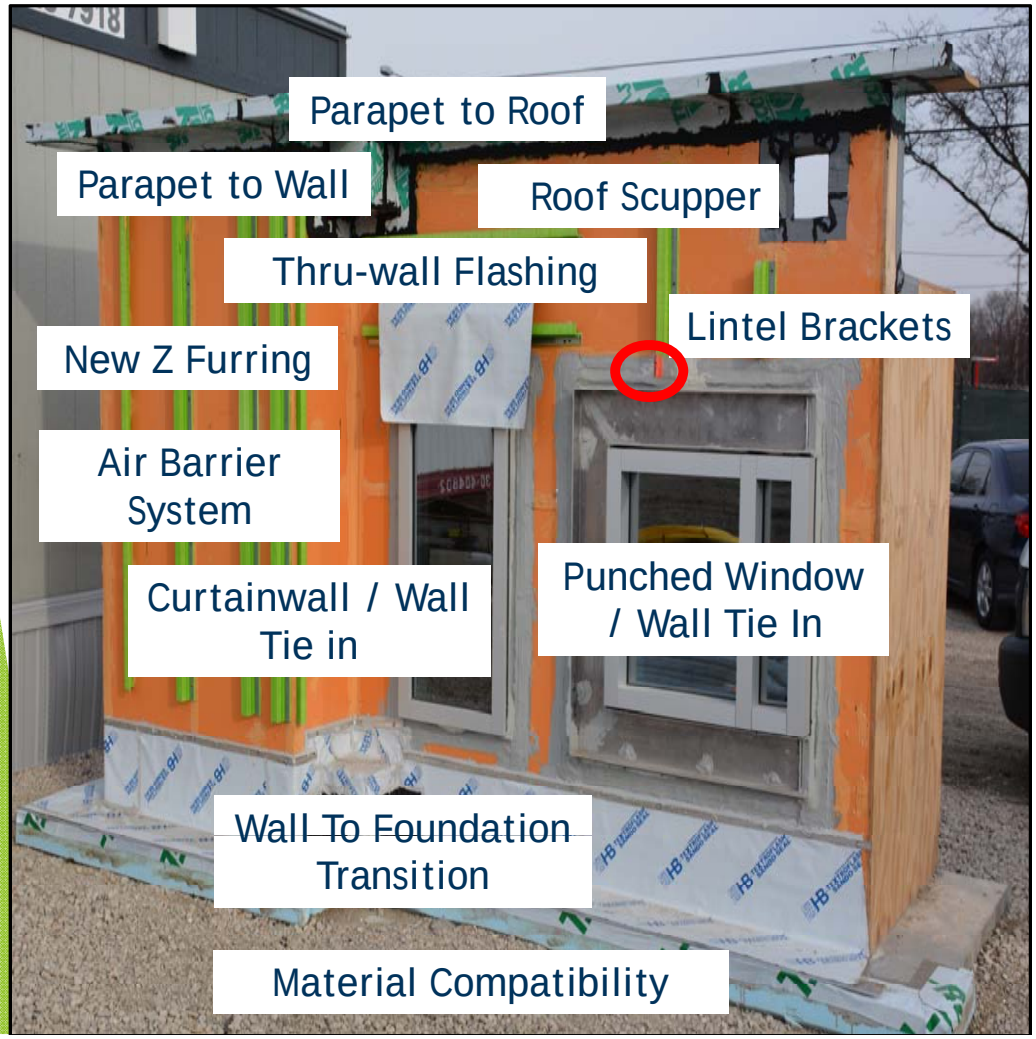

SS Flashing to run across curtain wall head to adjacent structures
Use pre-made 3 dimensional 90's where required
Install top weeps per drawings - Typical
Ensure location of back up wall so as to align face stone properly w window and sealant bead - Typical
Silicone sheet to be properly tied in at shelf angles
Install SPF at precast head per drawings
Install AVB continuous at shelf angles
Water under foundation peel and stick - from hole in flashing from Precast anchor
Any burned Air vapor Membrane to be replaced after precast head installation


Ends of SS flashing need to tie into continuous AVB
Comments:
Silicone sheet lap joints completely sealed
Silicone sheet to have double bead of sealant on adjacent materials
Provide AVB at expansion joints per ABAA
Ensure masonry back up wall to be in right location
Counter flashing held back 2" from end of wall to allow proper closure of AVB
Install top weeps per plans and Specs
Silicone sheet not fully adhered
Leak at horizontal under spandral to vertical

2 - No Mock Up

At PRIMARY BARRIER!!!!

Let's Do Some "Brian" Math – Simple #'s



Let's Say you have a $14 M Project
On Site Simple Wall Mock Up = $12,500.

Mock Up = 0.09% of Construction Costs

SO…Less than 0.1% of Construction Costs

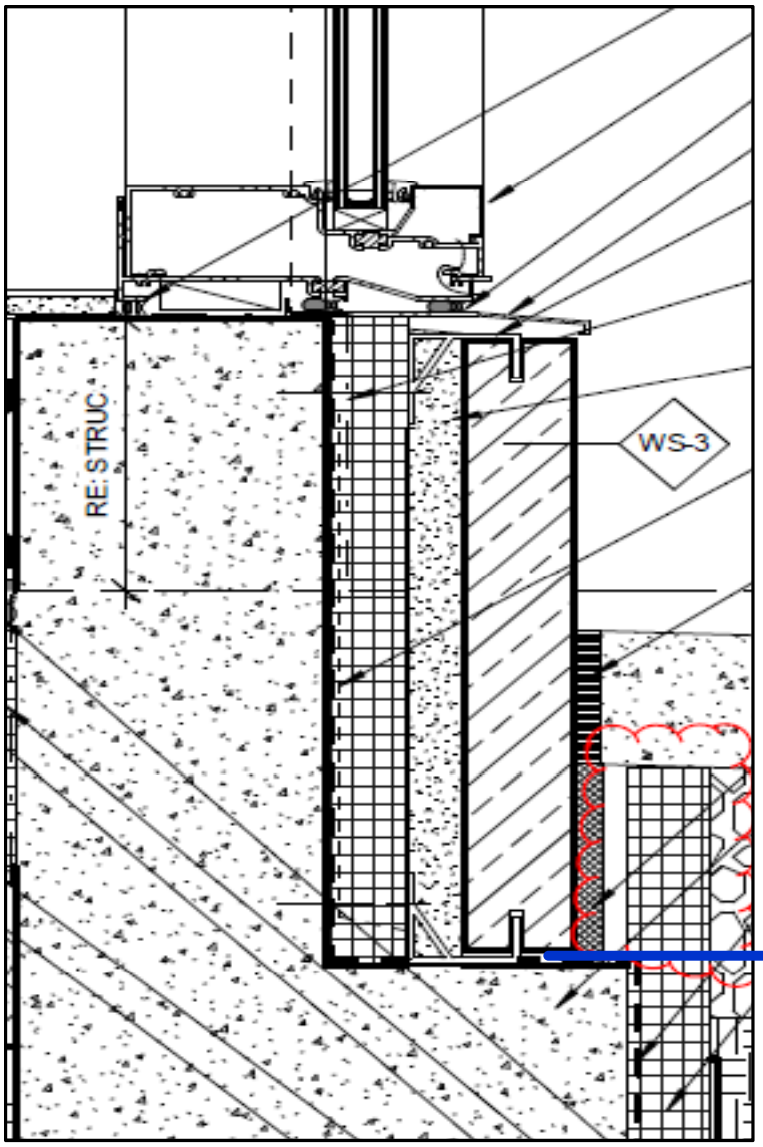
To:

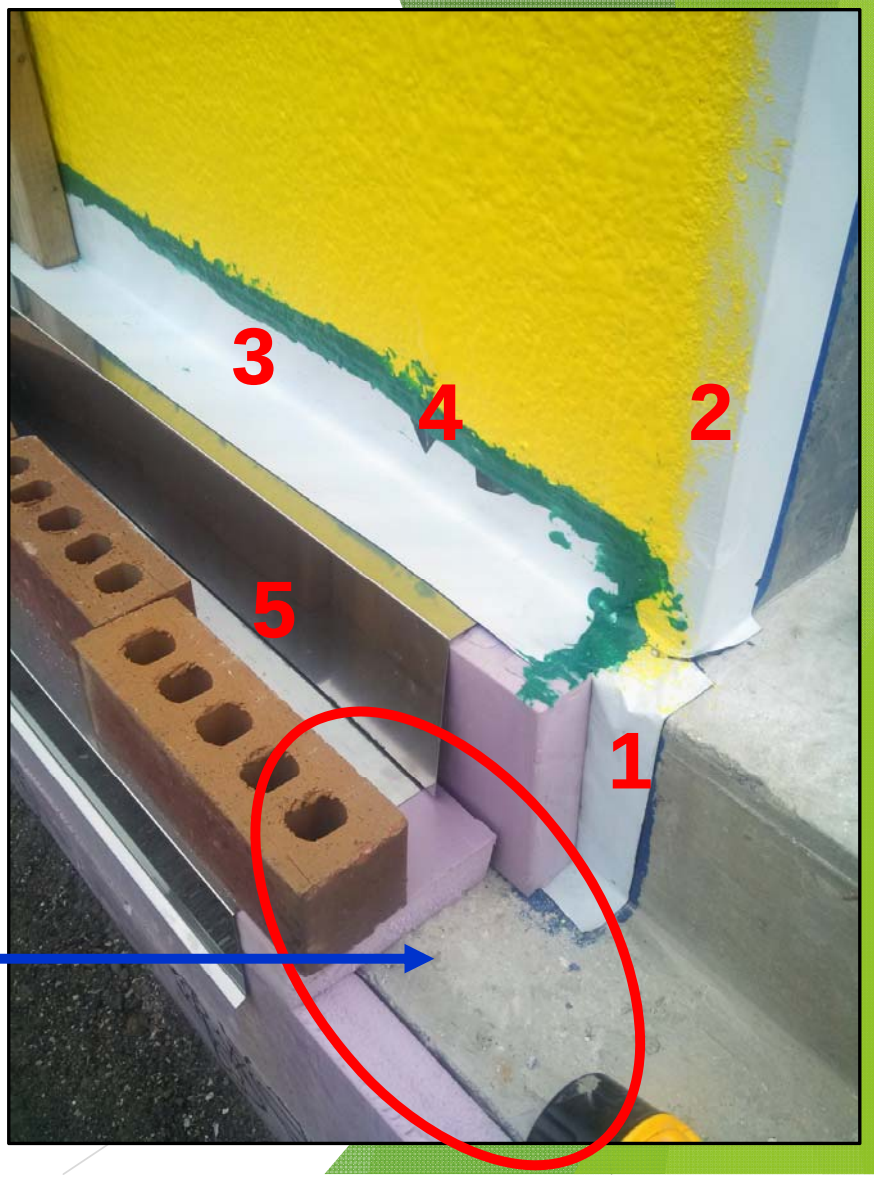
- **Validate Design**
- **Assist Construction Sequencing**
- **Validate Materials to be Used**
- **Validate Performance**
- **Discover Potential Installation Issues**
- **Provide Custom Training Program for Installers**

#1 = Transitions

#1 - Transitions

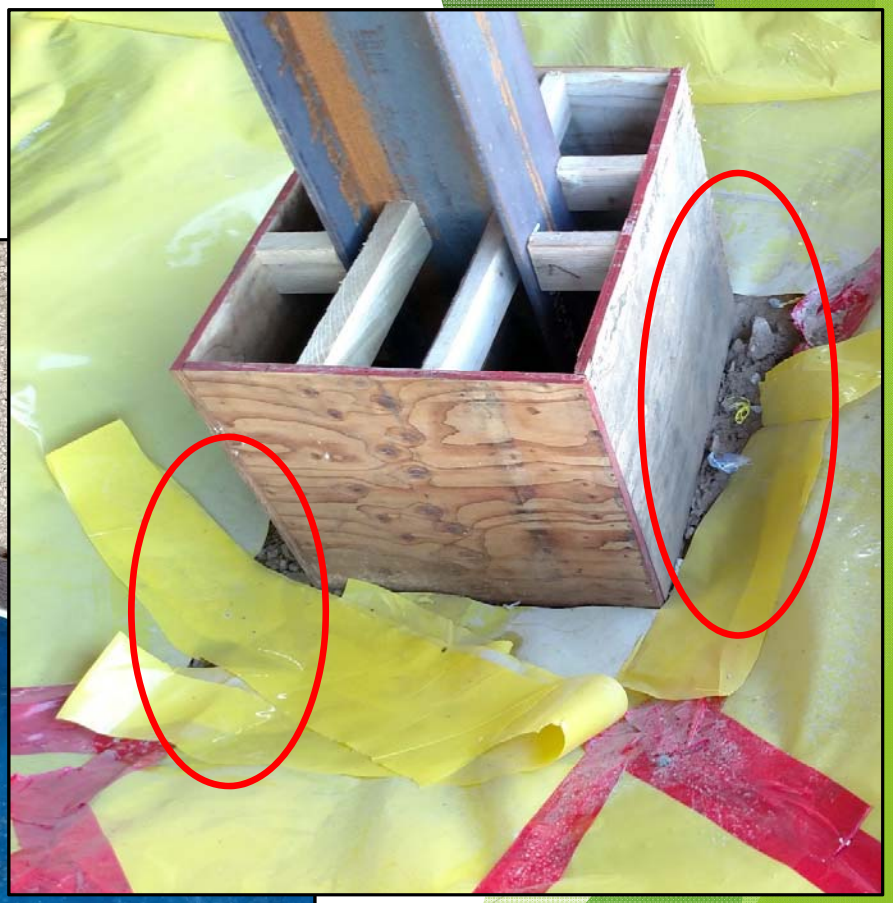
Do the Details AND Actual Construction match???





#1 - Transitions

- Below Grade to Above Grade



#1 - Transitions

- Below Grade to Above Grade

#1 - Transitions

- Below Grade to Above Grade

#1 - Transitions

- Windows to Walls

#1 - Transitions

- Windows to Walls

#1 - Transitions

- Penetrations

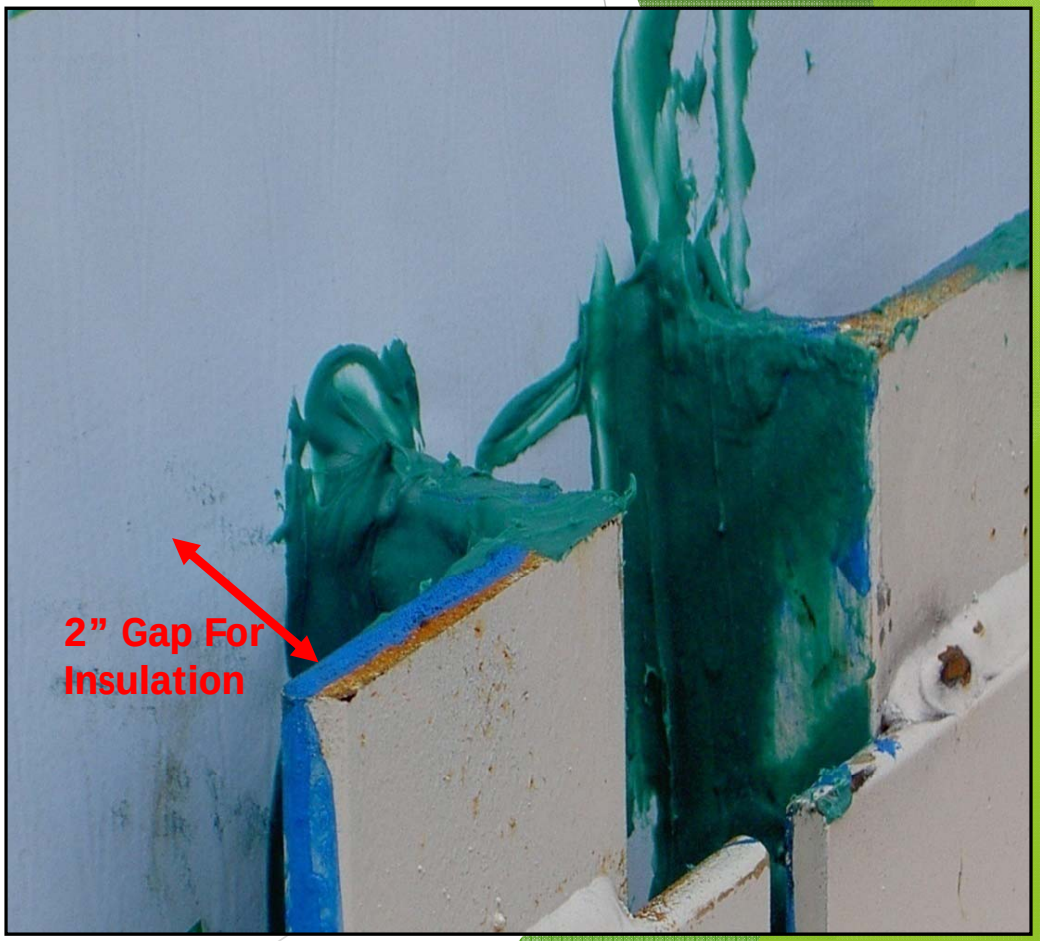
1 - Transitions

- Penetrations

#1 - Transitions

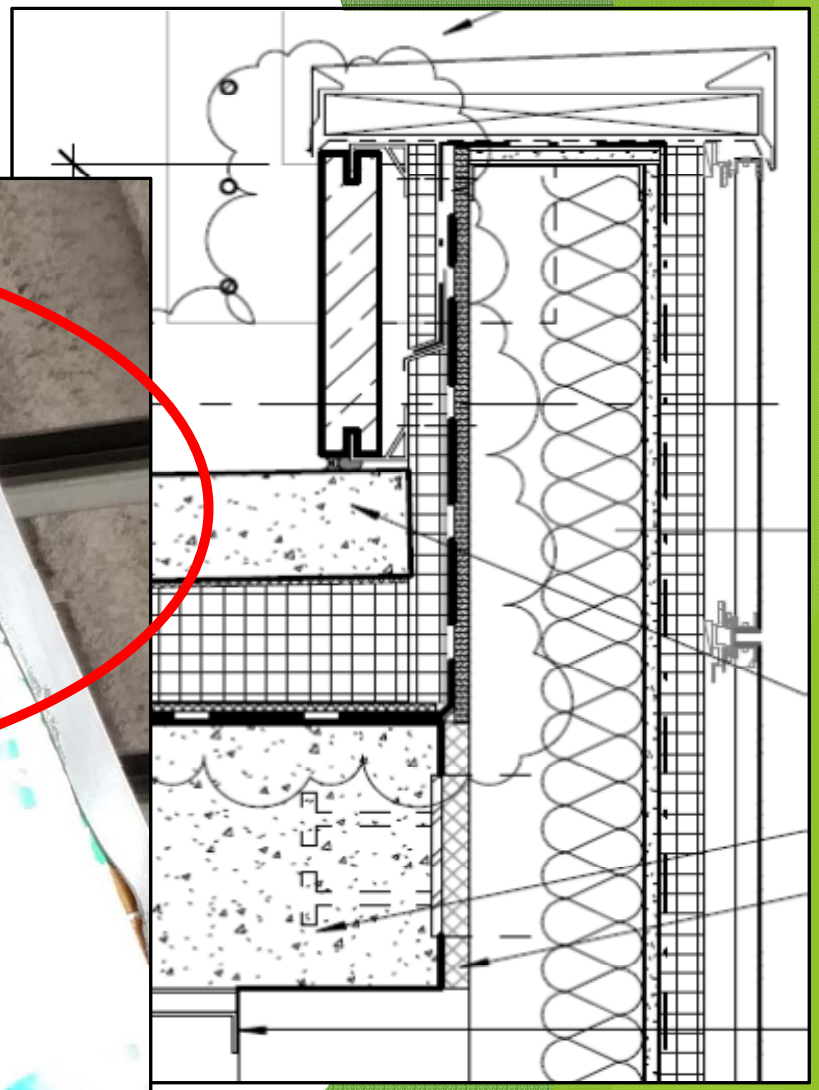
- Penetrations

Project Completed in 2005



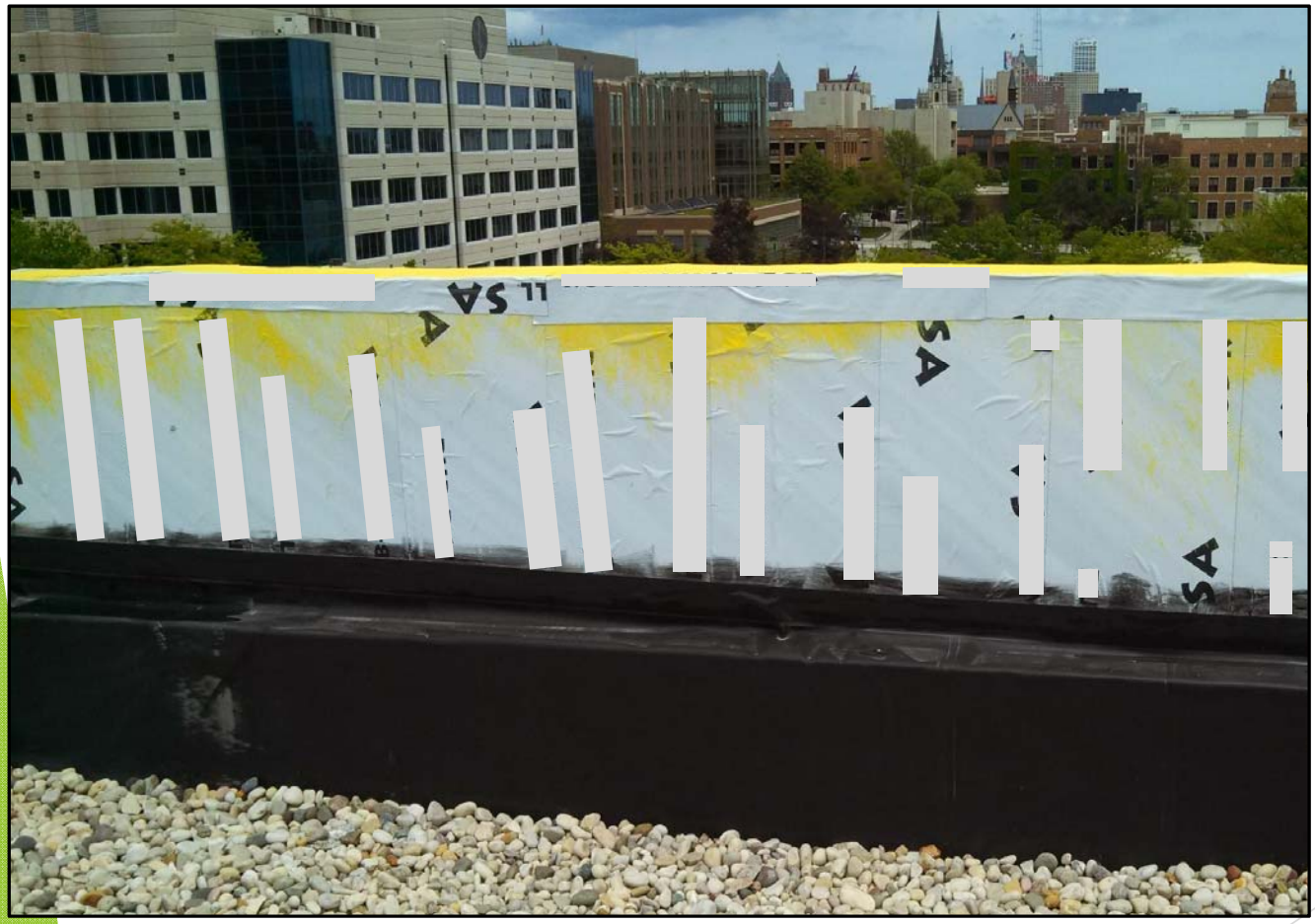
#1 - Transitions

- Wall to Roof



#1 - Transitions

- Wall to Roof



"Rework Costs — including labor, materials, equipment and subcontractors—can run from 2% to 20% of a project's total contract amount."

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

Let's Do Some "Brian" Math – Simple #'s

$50M= @ 2% = $1M
$50M = @20% = $10M

$20M = @ 2% = $400,00K
$20M = @20% = $4M

In Rework

In Rework

= WASTE = Lost Income

You put that in your Bid, Right????

Construction Cautions and Top 10 Concerns With Enclosures

- Per Zurich Insurance:
  - “We pay out Hundreds of Millions of Dollars every year in Construction Claims –
  - 70% of those are due to Water and Moisture Issues in the Enclosure”

Construction Cautions and Top 10 Concerns With Enclosures

Thank you For Your Time!!!

Brian Stroik
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Vice Chair Air Barrier Association of America
Past Chair BEC National
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