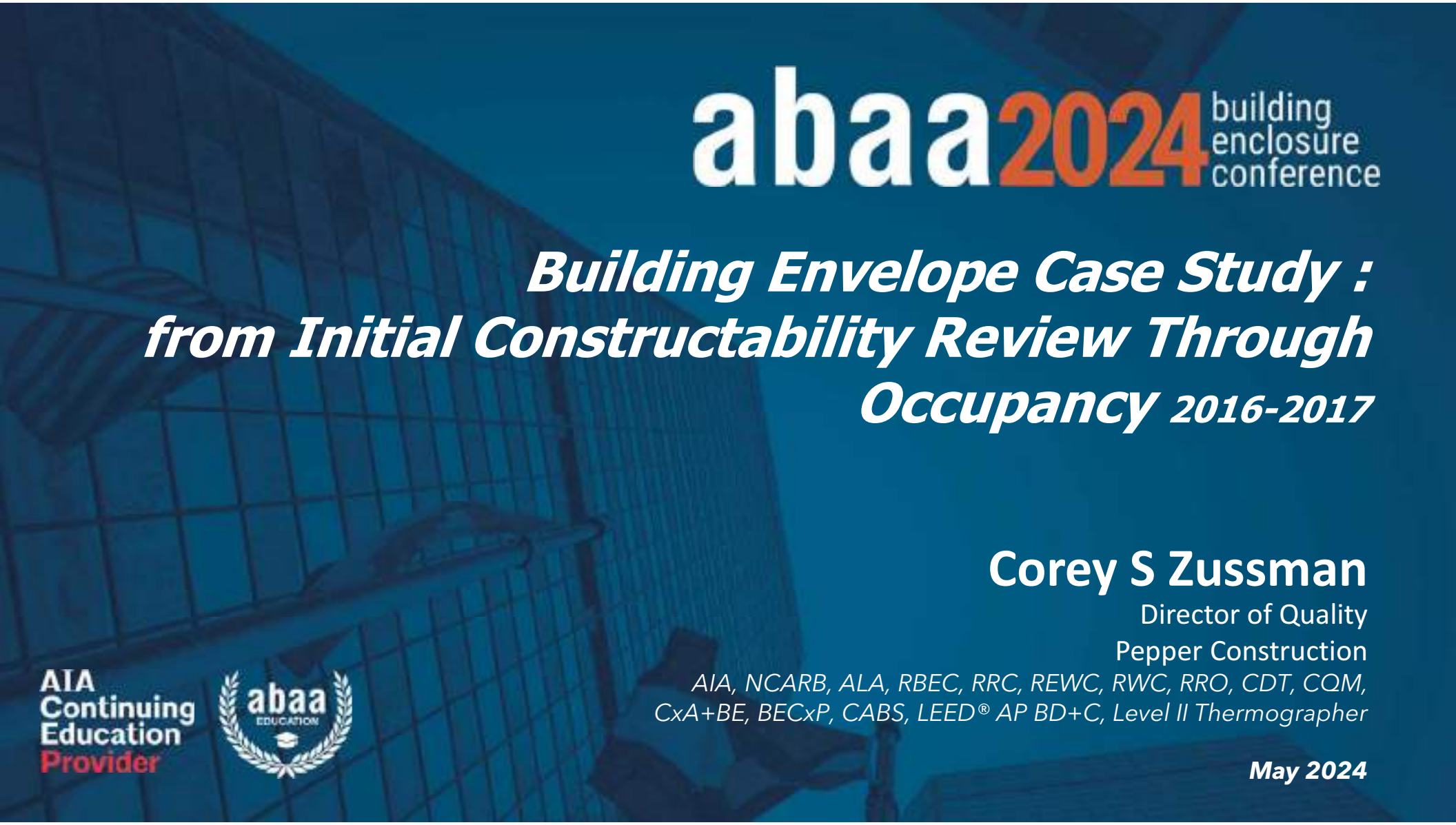

Building Envelope Case Study : from Initial Constructability Review Through Occupancy 2016-2017

Corey S Zussman
Director of Quality
Pepper Construction
AIA, NCARB, ALA, RBEC, RRC, REWC, RWC, RRO, CDT, CQM, CxA+BE, BECxP, CABS, LEED® AP BD+C, Level II Thermographer

May 2024

AIA Continuing Education Provider

abaa EDUCATION

Building Envelope Case Study : from Initial Constructability Review Through Occupancy 2016-2017

Join me as I recount my building envelope journey with a large four-story CMU and masonry higher-educational building for a large university in the Midwest. We will start with the initial pre-bid constructability review and go through construction and turnover. We will review the air/vapor barrier, masonry flashing, waterproofing, window installation, and roof transitions. We will learn what was initially missing in the Contraction Documents through mock-ups and first-work-in-place reviews. Once construction starts, we will review the building construction and perform testing throughout.

Learning Objectives

1. Review constructability concerns in the mid-stage of design.
2. Engage with a building envelope review and what modifications took place with subcontractor input.
3. Understand the building complexities with mock-ups, first-work-in-place reviews, and testing.
4. Develop a better understanding of the installation of materials and the process of installation with construction observation reviews, reporting, and verification..

abaa EDUCATION

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STOP
7000

PROJECT DESCRIPTION

Jenkins & Nanovic Halls – Notre Dame

Architect: HBRA Architects Inc

185,500 SF, 4-story, Steel frame and CMU infill construction. A pair of new conjoined buildings that together comprise an integrated ensemble for the Social Sciences and the University's community of International Institutes,

FIRST FLOOR PLAN

LONGITUDINAL SECTION B-B

TRANVERSE SECTION A-A

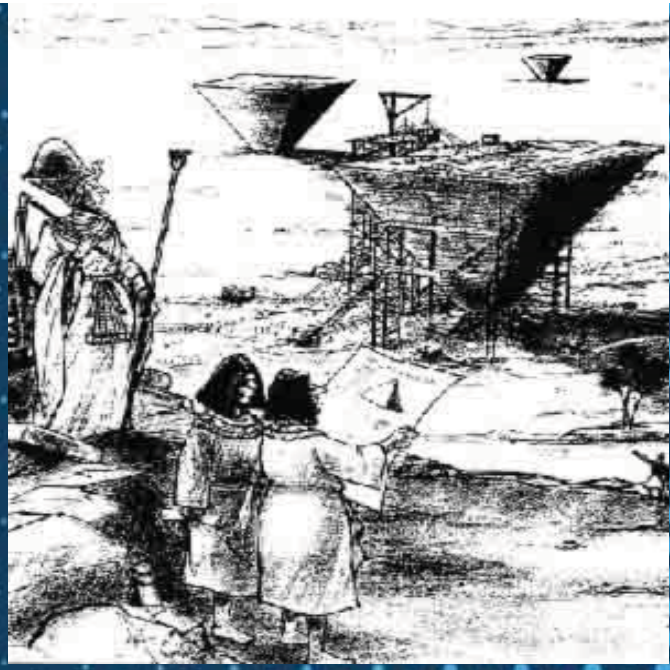
QUALITY PROGRAM

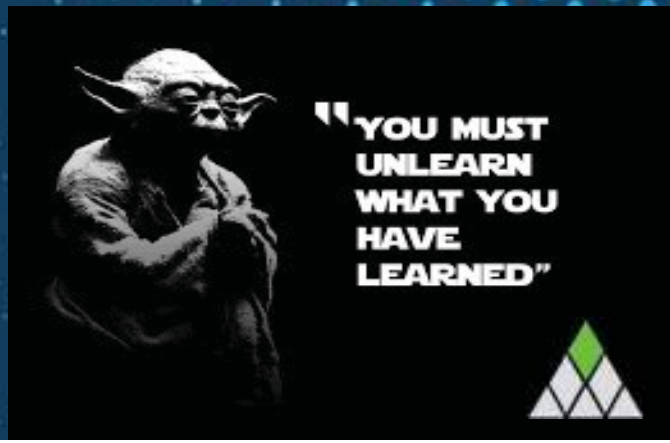
Anatomy of our Quality Program

- *The program is designed to be preventative and proactive*
- *Review drawings during several phases of design to assist the project team*
- *Use quality metric data to assist with initial project specifications*
- *Building Envelope Meeting*
- *Pre-Installation Meeting*
- *Checklists*
- *Subcontractor Job Specific Quality Plan*
- *Mock-ups*
- *1st Work in-place / Substrate Review*
- *Regular site inspections*
- *Provide proper quality metrics to identify trends and give the team an idea of progress*
- *Testing*
- *Lessons Learned & Quality Bulletins that reflect our learning throughout the project*

Setting Expectations

- Obtain clear understanding of the project goals
- Have all players in the room and review understanding of schedule, man-power, and project specific requirements
- The team must be open to understanding current requirements, sometimes new, for the exact product that is being installed or being installed adjacent to…
- Learn from mock-ups, first-work-in-place, and regular job site walk-thoughs





Reporting

	Issues	Average Issue Weight	Sum of Approx Cost	Sum of Repeat Count	Sum of Prior Talk	Sum of PCC
	72	4.10	$59,100.00	30	67	$12,150.00
	14	3.36	$10,250.00	2	6	$2,550.00
05 CFMF / SHEATHING	10	3.60	$13,100.00	1	8	$2,200.00
06 - WOOD BLOCKING	5	4.60	$4,800.00	0	4	$1,050.00
07 - AIR BARRIER	50	3.92	$32,500.00	19	44	$8,575.00
07 ROOFING	8	4.50	$7,200.00	1	7	$1,550.00
07 - ROOFING	7	3.43	$4,000.00	3	6	$1,000.00
07 - WATERPROOFING	9	2.89	$2,200.00	0	9	$1,000.00
08 WINDOWS	11	3.82	$9,000.00	0	5	$2,150.00
Grand Total	**186**	**3.90**	**$142,150.00**	**56**	**156**	**$32,225.00**

Total Est. Subcontractor Cost to Correct:	**$270,350.00**
Total Est. Subcontractor Hours to Correct:	2,704
Est. PCC Direct Quality Cost:	**$61,650.00**
Est. PCC Direct Quality Hours Spent	617

Cost of Quality/Construction Cost:			**0.6256%**
		Subcontractor	**PCC**
Cost of Repeat Items:		$58,300.00	$15,225.00
Cost of Prior talk Items:		$227,300.00	$50,900.00
Total Weeks	Week #	Percent Complete	**Cost to Date**
97	90	92.78%	**$53,072,165**

[Version 5.0]

INITIAL QUALITY-REVIEW OF CONTRACT DOCUMENTS IN DD STAGE

Pepper CONSTRUCTION

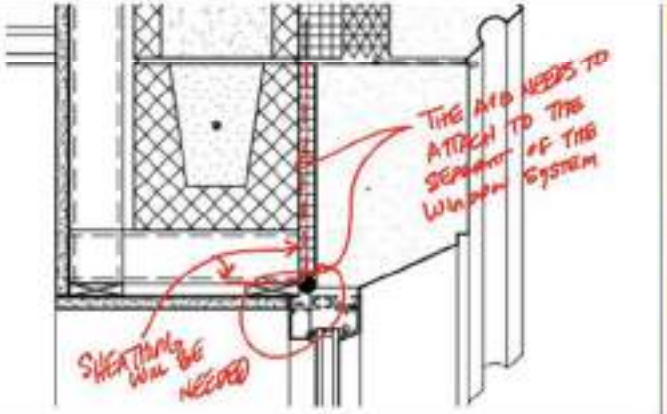
Constructability Review Report

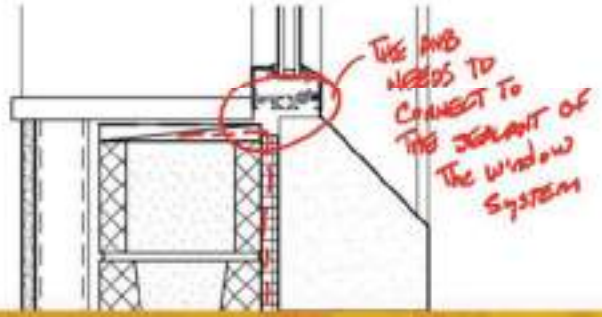
09-24-2013

BUILDING QUALITY AT EVERY LEVEL

Date of Review:	09-30-2014	Summary:	
Project Information		Exterior detail review of 100% DD set	Author: Corey S Zussman, AIA
University of Notre Dame		dated 09-17-2014	
Jenkins & Nanovic Halls			
Project:	#		

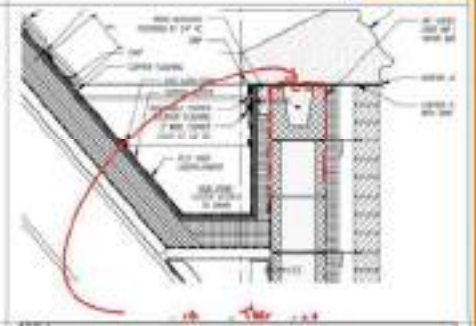
Item #	Description
26	Detail 4/A5.10 1. There needs to be an AVB attachment to the window sealant. I suggest ETA. 2. There should be sheathing on the metal framing. 3. The AVB needs to be extended.
27	Detail 4/A5.10 1. There needs to be an AVB attachment to the window sealant. I suggest ETA. 2. AVB needs to be extended.





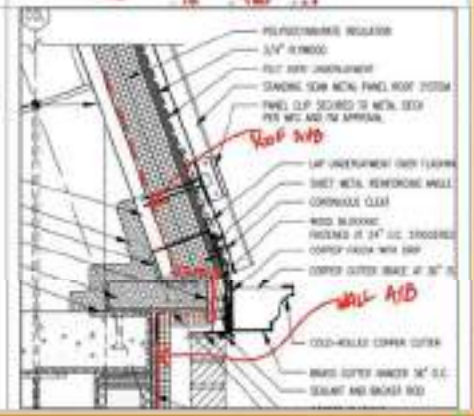
29 Detail 1/A5.51

1. The roof AVB should go up the parapet and over...and the wall AVB should go up the wall and over the roof AVB.



31 Detail 1/A5.55

1. The roof AVB should go down and on top of the wall AVB...and the wall AVB should go up the wall.



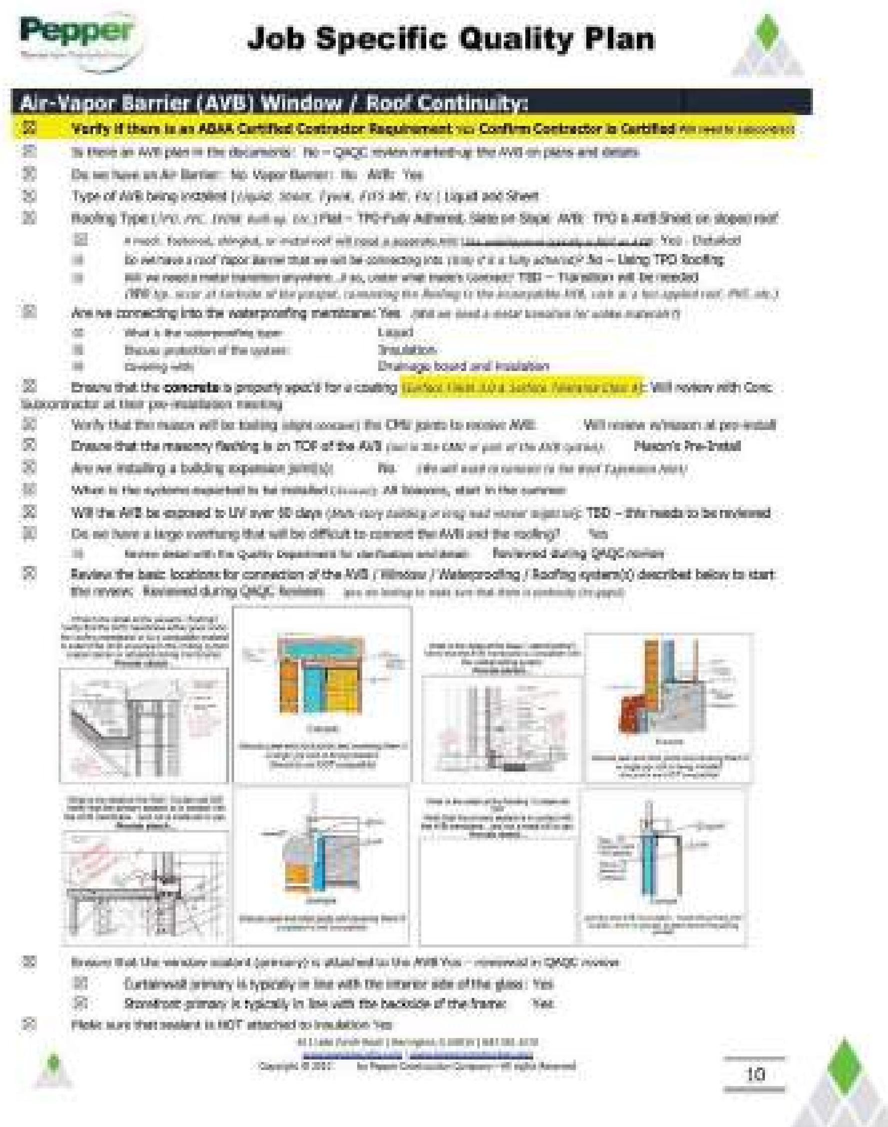
Lessons Learned

Create a building profile reviewing:

- Potential materials
- Areas of concern to review in CD phase
- List of complex detailing
- Confirmation of Air, Water, Vapor, and insulation lines

GENERAL CONTRACTOR JOB SPECIFIC QUALITY PLAN

Make sure that the General Contractor has a Job Specific Quality Plan that reviews the building envelope & current material requirements



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Job Specific Quality Plan

Air-Vapor Barrier (AVB) Window / Roof Continuity:

- ☒ Verify if there is an ABAA Certified Contractor Requirement: Yes Confirm Contractor is Certified
- ☒ Is there an AVB plan in the documents: No – QAQC review marked-up the AVB on plans and details
- ☒ Do we have an Air Barrier: No Vapor Barrier: No AVB: Yes
- ☒ Type of AVB being installed: Liquid and Sheet
- ☒ Roofing Type: Flat – TPO-Fully Adhered, Slate on Slope; AVB: TPO & AVB Sheet on sloped roof
  - ☒ Do we have a roof Vapor Barrier that we will be connecting into: No – Using TPO Roofing
  - ☒ Will we need a metal transition anywhere: TBD – Transition will be needed
- ☒ Are we connecting into the waterproofing membrane: Yes
  - ☒ What is the waterproofing type: Liquid
  - ☒ Discuss protection of the system: Insulation
  - ☒ Covering with: Drainage board and insulation
- ☒ Ensure that the **concrete** is properly spec'd for a coating: Will review with Conc. Subcontractor at their pre-installation meeting
- ☒ Verify that the mason will be tooling the CMU joints to receive AVB: Will review w/mason at pre-install
- ☒ Ensure that the masonry flashing is on TOP of the AVB: Mason's Pre-Install
- ☒ Are we installing a building expansion joint(s): No
- ☒ When is the systems expected to be installed: All Seasons, start in the summer
- ☒ Will the AVB be exposed to UV over 60 days: TBD – this needs to be reviewed
- ☒ Do we have a large overhang that will be difficult to connect the AVB and the roofing?: Yes
  - ☒ Review detail with the Quality Department for clarification and detail: Reviewed during QAQC review
- ☒ Review the basic locations for connection of the AVB / Window / Waterproofing / Roofing system(s) described below to start the review: Reviewed during QAQC Reviews

- ☒ Ensure that the window sealant (primary) is attached to the AVB: Yes – reviewed in QAQC review
  - ☒ Curtainwall primary is typically in line with the interior side of the glass: Yes
  - ☒ Storefront primary is typically in line with the backside of the frame: Yes
- ☒ Make sure that sealant is NOT attached to insulation: Yes

10

Pepper
Tomorrow Transformed

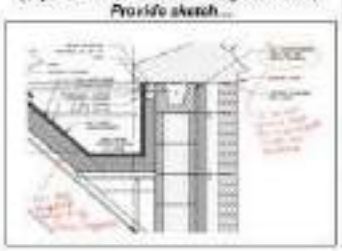
Job Specific Quality Plan

Air-Vapor Barrier (AVB) Window / Roof Continuity:

- ☒ **Verify if there is an ABAA Certified Contractor Requirement** YES **Confirm Contractor is Certified** Will need to subcontract
- ☒ Is there an AVB plan in the documents: No – QAQC review marked-up the AVB on plans and details
- ☒ Do we have an Air Barrier: No Vapor Barrier: No AVB: Yes
- ☒ Type of AVB being installed (*Liquid, Sheet, Tyvek, EIFS Mfr, Etc.*) Liquid and Sheet
- ☒ Roofing Type (*TPO, PVC, EPDM, Built-up, Etc.*) Flat – TPO-Fully Adhered, Slate on Slope AVB: TPO & AVB Sheet on sloped roof
  - ☒ A mech. fastened, shingled, or metal roof will need a separate AVB (*The underlayment typically is NOT an AVB*): Yes - Detailed
  - ☒ Do we have a roof Vapor Barrier that we will be connecting into *(Only if it is fully adhered)*? No – Using TPO Roofing
  - ☒ Will we need a metal transition anywhere...if so, under what trade's Contract? TBD – Transition will be needed
    (Will typ. occur at backside of the parapet, connecting the Roofing to the incompatible AVB, such as a hot-applied roof, PVC, etc.)
- ☒ Are we connecting into the waterproofing membrane: Yes *(Will we need a metal transition for unlike materials?)*
  - ☒ What is the waterproofing type: Liquid
  - ☒ Discuss protection of the system: Insulation
  - ☒ Covering with: Drainage board and insulation
- ☒ Ensure that the **concrete** is properly spec'd for a coating *(Surface Finish 3.0 & Surface Tolerance Class A)*: Will review with Conc Subcontractor at their pre-installation meeting
- ☒ Verify that the mason will be tooling (slight concave) the CMU joints to receive AVB: Will review w/mason at pre-install
- ☒ Ensure that the masonry flashing is on TOP of the AVB *(not in the CMU or part of the AVB system)*: Mason's Pre-Install
- ☒ Are we installing a building expansion joint(s): No *(We will need to connect to the Roof Expansion Joint)*
- ☒ When is the systems expected to be installed (*Season*): All Seasons, start in the summer
- ☒ Will the AVB be exposed to UV over 60 days (*Multi-story building or long lead vendor might be*): TBD – this needs to be reviewed
- ☒ Do we have a large overhang that will be difficult to connect the AVB and the roofing? Yes
  - ☒ Review detail with the Quality Department for clarification and detail: Reviewed during QAQC review

☒ Review the basic locations for connection of the AVB / Window / Waterproofing / Roofing system(s) described below to start the review: Reviewed during QAQC Reviews *(you are looking to make sure that there is continuity (no gaps))*

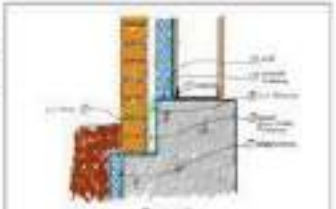
What is the detail at the parapet / flashing?
Verify that the AVB membrane either goes under the roofing membrane or to a compatible material to extend the AVB envelope to the roofing system (vapor barrier or adhered roofing membrane)
Provide sketch...



Example

Discuss peel and stick joints and covering them if a single ply roof is being installed (the joints are NOT compatible)

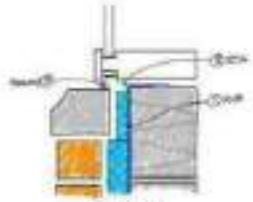
What is the detail at the base / waterproofing?
Verify that the AVB membrane is compatible with the waterproofing system...
Provide sketch...



Example

Discuss peel and stick joints and covering them if a single ply roof is being installed (the joints are NOT compatible)

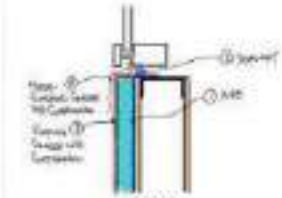
What is the detail at the Wall / Curtainwall Sill?
Verify that the primary sealant is in contact with the AVB membrane ...and not a metal sill or pan.
Provide sketch...



Example

Discuss peel and stick joints and covering them if a sealant is not compatible

What is the detail at the Roofing / Curtainwall Sill?
Verify that the primary sealant is in contact with the AVB membrane ...and not a metal sill or pan.
Provide sketch...



Example

(primary and AVB must attach - locate the primary joint location, which is typically located behind the glazing pocket)

☒ Ensure that the window sealant (primary) is attached to the AVB Yes – reviewed in QAQC review

- ☒ Curtainwall primary is typically in line with the interior side of the glass: Yes
- ☒ Storefront primary is typically in line with the backside of the frame: Yes

☒ Make sure that sealant is NOT attached to insulation Yes

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Material Season Schedule:

Discuss at each of your jobsite meetings

☐ Provide a written plan outlining the procedures that will be taken during the event of Cold / Hot Weather...Please make sure that the temperature requirements of the materials being used are clearly identified.

- ☒ Hot / Cold Weather Concrete Procedure Form Required -
- ☒ Hot / Cold Weather Masonry Procedure -
- ☐ Hot / Cold Weather EIFS Procedure -

	Winter	Spring	Summer	Fall	Temp Limitations / Notes / Precautions
Concrete Footing/Foundations	☐	☐	☒	☐	
Waterproofing	☐	☐	☒	☒	
Concrete SOG	☒	☐	☐	☒	Depends on Erection
Concrete on Metal Deck	☒	☒	☐	☐	Tarps / Heat
Concrete - Elevated	☐	☐	☐	☐	
Concrete - Roof	☐	☐	☐	☐	
Precast Concrete	☐	☐	☐	☐	
Steel	☒	☒	☐	☒	
CFMF	☐	☒	☐	☐	
Exterior Sheathing	☐	☒	☐	☐	
Masonry	☒	☒	☒	☐	
Metal Panels	☐	☐	☒	☒	
Air / Vapor Barrier	☒	☒	☒	☒	Start Summer
Spray Insulation (ext)	☐	☐	☐	☐	
EIFS	☐	☐	☐	☐	
Roofing	☐	☐	☒	☒	2016
Asphalt Roofing	☐	☐	☐	☐	
Curtainwall	☐	☐	☐	☐	
Windows	☐	☐	☒	☐	2016
Exterior Coating / Painting	☐	☐	☐	☐	
Sealant	☐	☐	☒	☐	
Pavers	☐	☐	☐	☐	
Sidewalk	☐	☒	☒	☐	
	☐	☐	☐	☐	
	☐	☐	☐	☐	

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Floor / Roof Deflection:

Discuss with your Engineer of Record and or Architect as soon as possible

☒	Floor - Typical	Deflection:	3/8" per RFI
☒	Floor - Perimeter	Deflection:	3/4" per RFI
☒	Roof	Deflection:	3/4" per RFI
☒	Other	Deflection:	3/4" up and down on CFMF Spec only

Mock-Up Requirements:

	Mock-up:	Date of Scheduled Mock-up	Date of Completed Mock-up		Mock-up:	Date of Scheduled Mock-up	Date of Completed Mock-up
☐	Sidewalk	Click here to enter a date.	Click here to enter a date.	☐	Masonry (Simple)	Click here to enter a date.	Click here to enter a date.
☐	Concrete Patch	Click here to enter a date.	Click here to enter a date.	☒	Masonry (Complex)	Click here to enter a date.	Click here to enter a date.
☐	Precast Concrete	Click here to enter a date.	Click here to enter a date.	☐	Restoration - Masonry	Click here to enter a date.	Click here to enter a date.
☐	Precast Concrete Repairs	Click here to enter a date.	Click here to enter a date.	☐	Tuckpointing	Click here to enter a date.	Click here to enter a date.
☐	Architectural Concrete	Click here to enter a date.	Click here to enter a date.	☒	Masonry Cleaning	Click here to enter a date.	Click here to enter a date.
☐	Stained Concrete	Click here to enter a date.	Click here to enter a date.	☐	Colored Concrete	Click here to enter a date.	Click here to enter a date.
☒	Waterproofing	Click here to enter a date.	Click here to enter a date.	☒	Air/Vapor Barrier	Click here to enter a date.	Click here to enter a date.
☐	Curtain Wall	Click here to enter a date.	Click here to enter a date.	☒	Sealant	Click here to enter a date.	Click here to enter a date.
☒	Window	Click here to enter a date.	Click here to enter a date.	☐	Stucco	Click here to enter a date.	Click here to enter a date.

Quality Review Hold-Point Assemblies/Items:

	Pre-Installation Meeting	Date of Scheduled Meeting	Date of Completed Meeting		Pre-Installation Meeting	Date of Scheduled Meeting	Date of Completed Meeting
☐	Pavers/Plaza	Click here to enter a date.	Click here to enter a date.	☐	Building Expansion Joint	Click here to enter a date.	Click here to enter a date.
☒	Concrete	Click here to enter a date.	Click here to enter a date.	☒	Under slab Vapor Barrier	Click here to enter a date.	Click here to enter a date.
☐	Precast Concrete	Click here to enter a date.	Click here to enter a date.	☐	Concrete Restoration	Click here to enter a date.	Click here to enter a date.
☐	GFRC	Click here to enter a date.	Click here to enter a date.	☒	Epoxy Anchors	Click here to enter a date.	Click here to enter a date.
☐	Shotcrete	Click here to enter a date.	Click here to enter a date.	☒	Masonry Flashing	Click here to enter a date.	Click here to enter a date.
☒	Masonry - CMU	Click here to enter a date.	Click here to enter a date.	☒	Masonry	Click here to enter a date.	Click here to enter a date.
☒	Spray or Sheet Air / Vapor Barrier	Click here to enter a date.	Click here to enter a date.	☐	Steel Remediation	Click here to enter a date.	Click here to enter a date.
☒	Cold Formed Metal Framing	Click here to enter a date.	Click here to enter a date.	☒	Exterior Wall Sheathing	Click here to enter a date.	Click here to enter a date.
☒	Waterproofing	Click here to enter a date.	Click here to enter a date.	☐	Tyvek Air Barrier	Click here to enter a date.	Click here to enter a date.
☒	Spray Insulation	Click here to enter a date.	Click here to enter a date.	☒	Roof Systems	Click here to enter a date.	Click here to enter a date.

Lessons Learned

Create an action plan of typical concerns that we need to get ahead of:

- Time sensitive construction
- List of tests and mock-ups
- List of Pre-installation meetings needed
- List of complex detailing
- Confirmation of Air, Water, Vapor, and insulation lines

INITIAL QUALITY REVIEW OF CONTRACT DOCUMENTS IN CD STAGE

Pepper CONSTRUCTION

Constructability Review Report

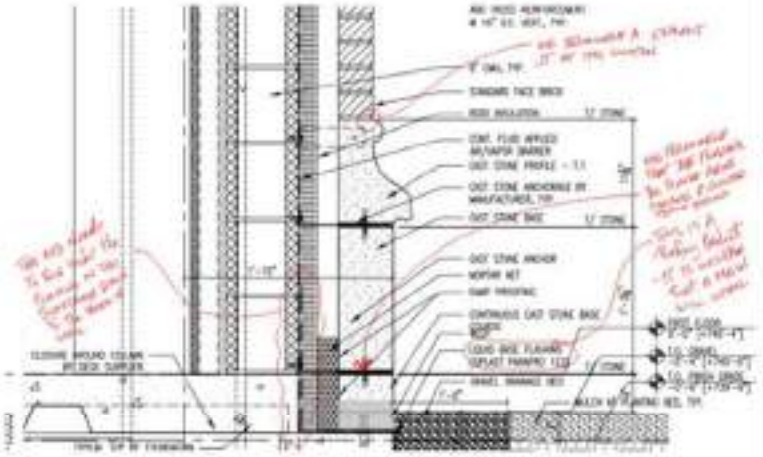
09-29-2013

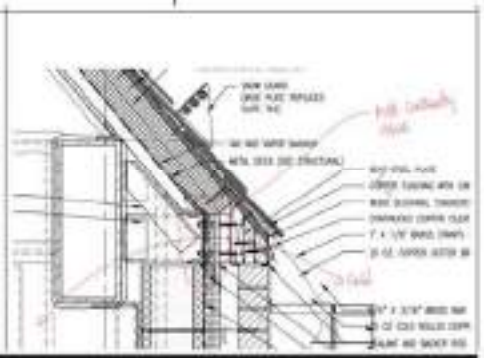
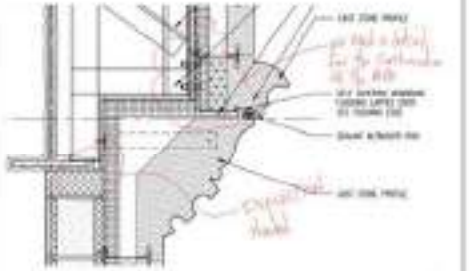
BUILDING QUALITY AT EVERY LEVEL

Date of Review:	02-24-2015	Summary:	
Project Information		Exterior detail review of 50% CD set	Author: Corey S Zussman, AIA
University of Notre Dame		dated 02-06-2015	
Jenkins & Nanovic Halls		*Please note that*	
		this is a review of details that are	
		noted, only, and not a full review of the	
Project:	#	*drawings*	

Item #	
45	

1. Pepper recommends all material changes (masonry precast) have a backer rod and sealant.
2. Pepper recommends that flashing be installed above the grade and fill solid below grade. This will prevent and clogging of the weeps below grade over time as sediment settles in the gravel drainage bed.
3. The flashing chosen at the base is a roofing flashing and is unclear about the installation procedures and who will be installing the material confidently.
4. The AVB should run down to the waterproofing and the masonry flashing should be secondary an on top of the AVB (compatibility must be reviewed.



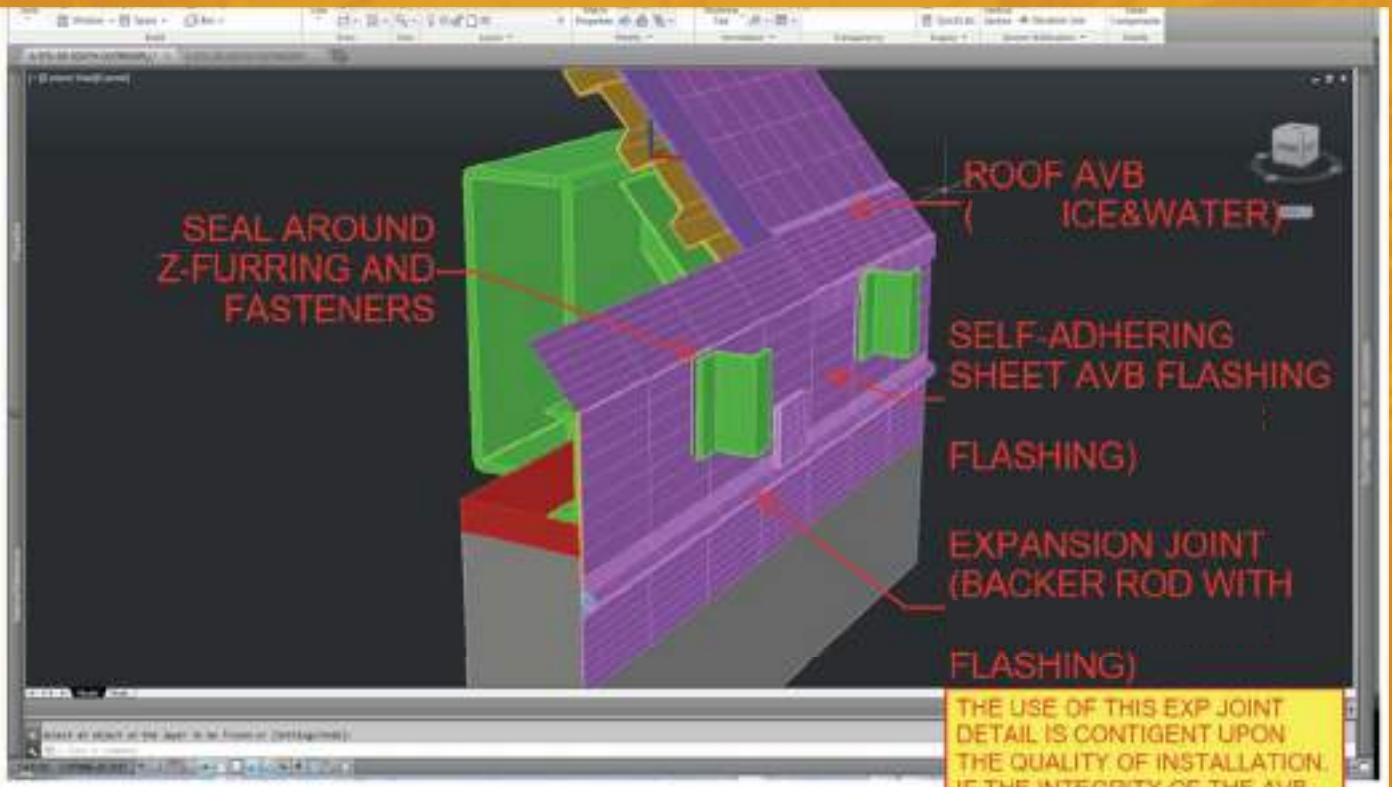
Item #	Description	Photo
52	04/A4.51 1. The shelf angle should be reviewed for AVB continuity and thermal break concerns. 2. Please provide a detail on the AVB continuity at this location and others similar. 3. There appears to be a thermal break at the roof edge connection...please review.	
49	01/A5.11 1. I believe that a deflection joint is needed at the bottom of the beam for the CMU, sheathing, and AVB. 2. The shelf angle should be reviewed for AVB continuity and thermal break concerns. 3. Please provide a detail on the AVB continuity at this location and others similar.	

Lessons Learned

Confirm initial DD concerns:

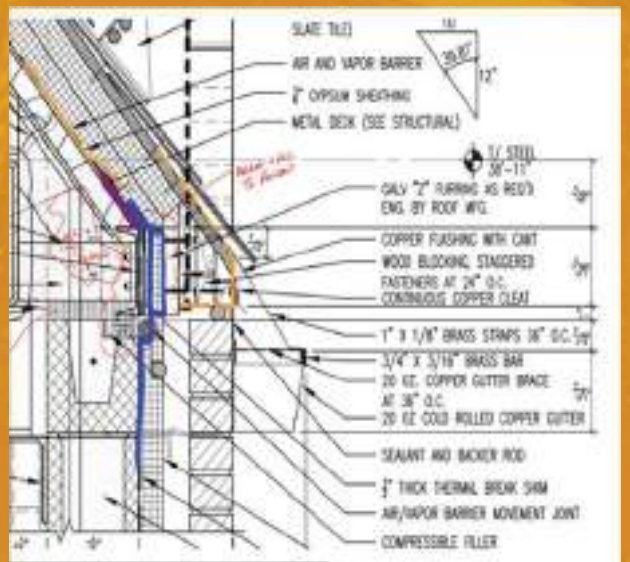
- DD drawing comments resolved
- Confirm list of JSQP assumptions and follow-up
- Confirmation of Air, Water, Vapor, and insulation lines
- Set up early RFI list
- List of details that need further developement

Thinking through the details…before bidding



THE USE OF THIS EXP JOINT DETAIL IS CONTIGENT UPON THE QUALITY OF INSTALLATION. IF THE INTEGRITY OF THE AVB CANNOT BE MAINTAINED THEN THE USE OF AN EXTRUDED SILICONE ETA IS TO BE USED.

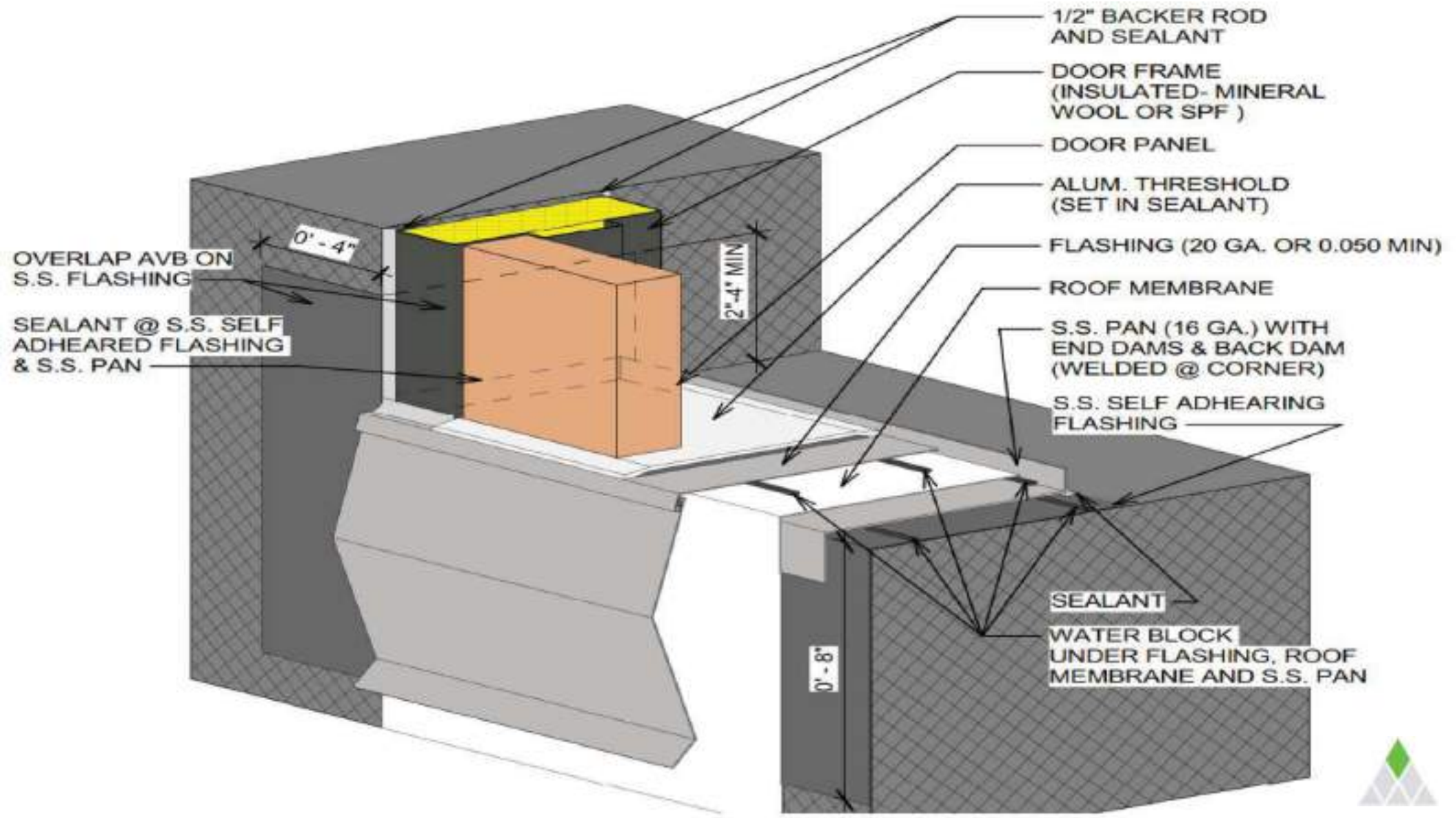
PROVIDE MOCKUP FOR REVIEW BY ARCHITECT



Detail 13/A5.51

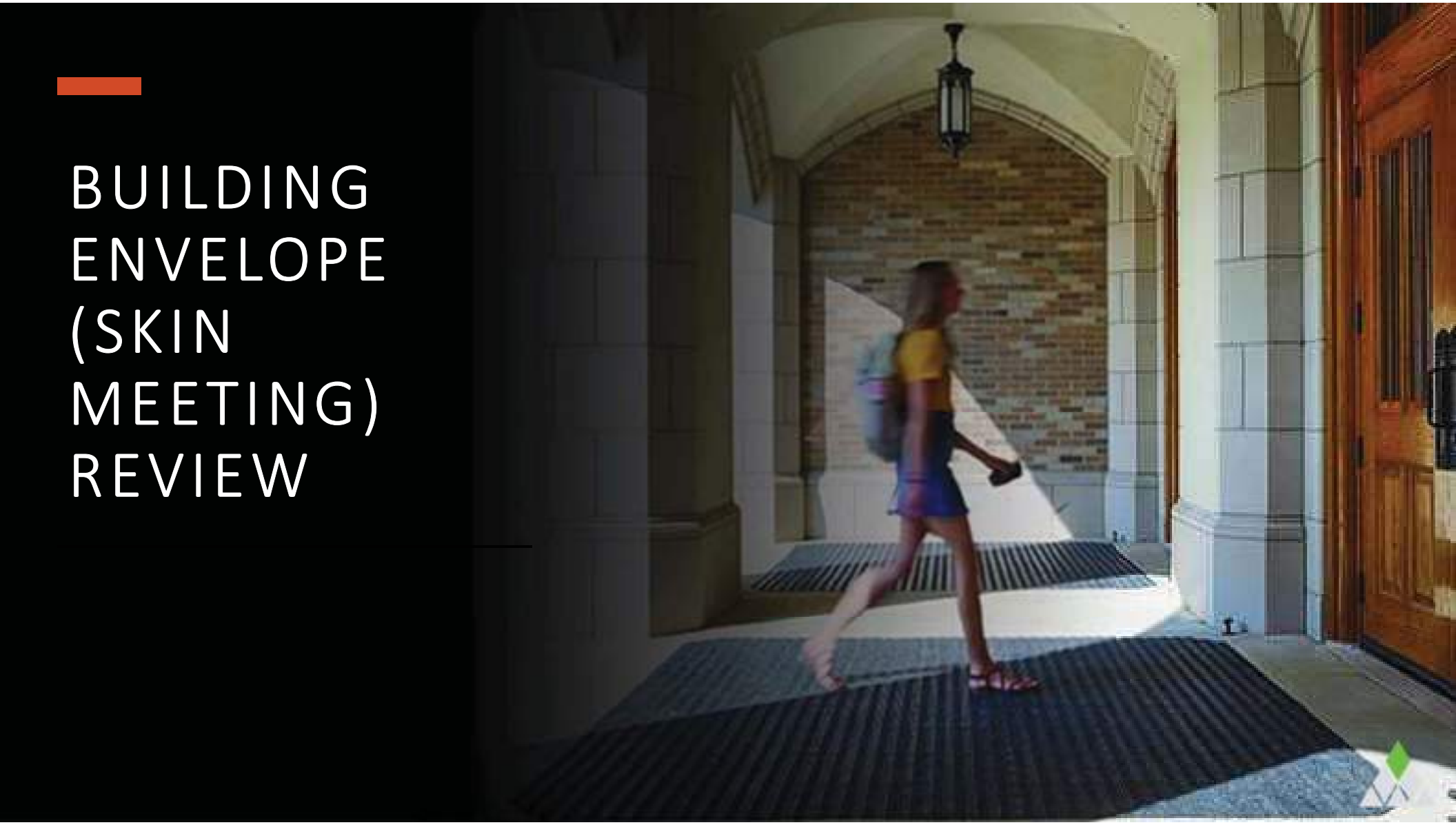
constructability & VB location and issue a revised sketch. We need to
VB is not in between steel elements and still make a connection.
eral wool will need to be installed prior to the SPF.

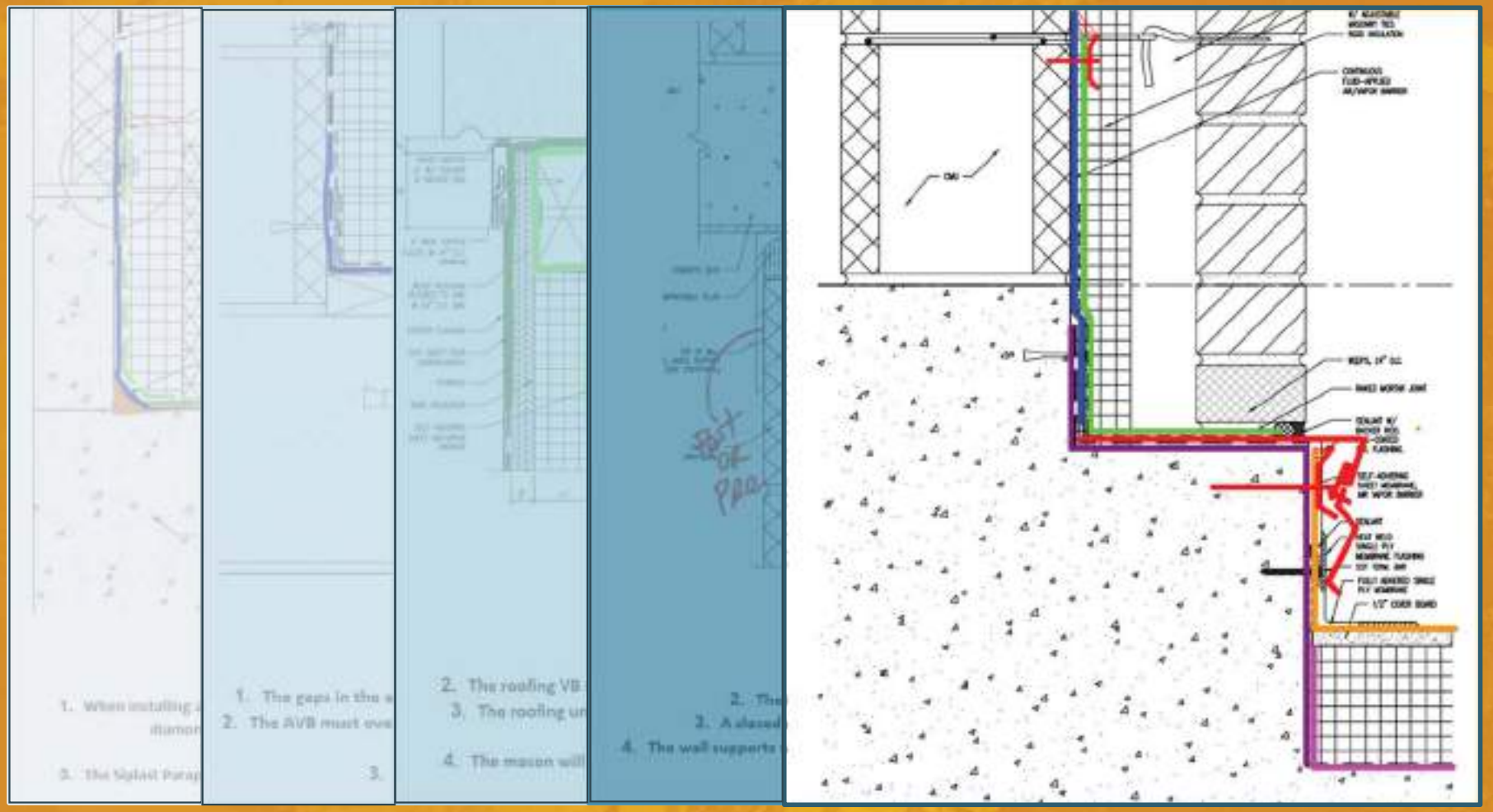
Installed detail as designed


1/2" BACKER ROD
AND SEALANT
DOOR FRAME
(INSULATED- MINERAL
WOOL OR SPF)
DOOR PANEL
ALUM. THRESHOLD
(SET IN SEALANT)
FLASHING (20 GA. OR 0.050 MIN)
ROOF MEMBRANE
S.S. PAN (16 GA.) WITH
END DAMS & BACK DAM
(WELDED @ CORNER)
S.S. SELF ADHEARING
FLASHING
SEALANT
WATER BLOCK
UNDER FLASHING, ROOF
MEMBRANE AND S.S. PAN
OVERLAP AVB ON
S.S. FLASHING
SEALANT @ S.S. SELF
ADHEARED FLASHING
& S.S. PAN
0' - 4"
2"-4" MIN
0' - 8"

The roof deck flutes under the curb should be filled with SPF (closed cell) in order to prevent air from getting under the roofing system

BUILDING ENVELOPE (SKIN MEETING) REVIEW




CMU
CONTINUOUS FLUID-APPLIED AIR/VAPOR BARRIER
WEEPS, 24" O.C.
RAKED MORTAR JOINT
SEALANT W/ BACKER ROD
SELF-ADHERING SHEET MEMBRANE, AIR/VAPOR BARRIER
SEALANT
SHEET METAL SINGLE PLY MEMBRANE FLASHING
SELF-ADHERED SINGLE PLY MEMBRANE
1/2" COVER BOARD

Lessons Learned

Skin Meeting

- Confirm compatibility of actual materials being used
- Confirm detailing of actual systems being installed
- Confirm sequencing
- Confirm all components are assigned

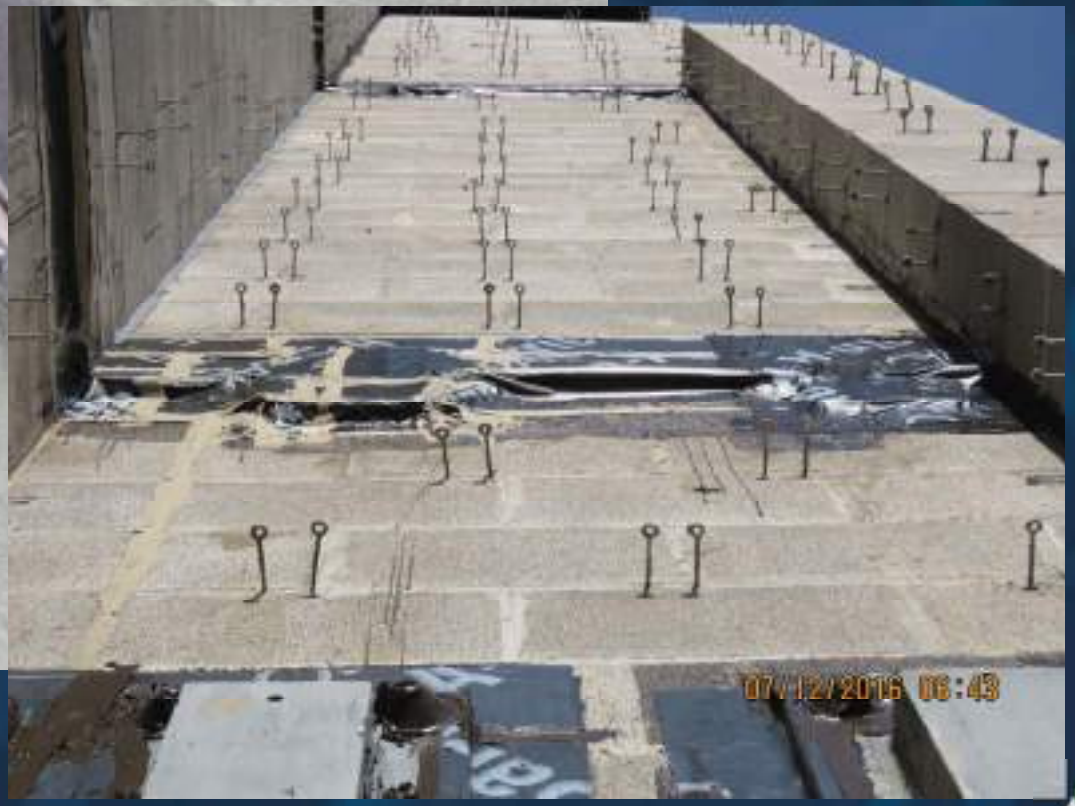
CONTRACTOR VALUE ENGINEERING CONVERSATIONS

VE attempt

Exchange pre-cured silicone for peel and stick at the exterior horizontal CMU joints

The detail included horizontal and vertical movement components

We did a First Work in Place to determine if the proposed VE would be efficient…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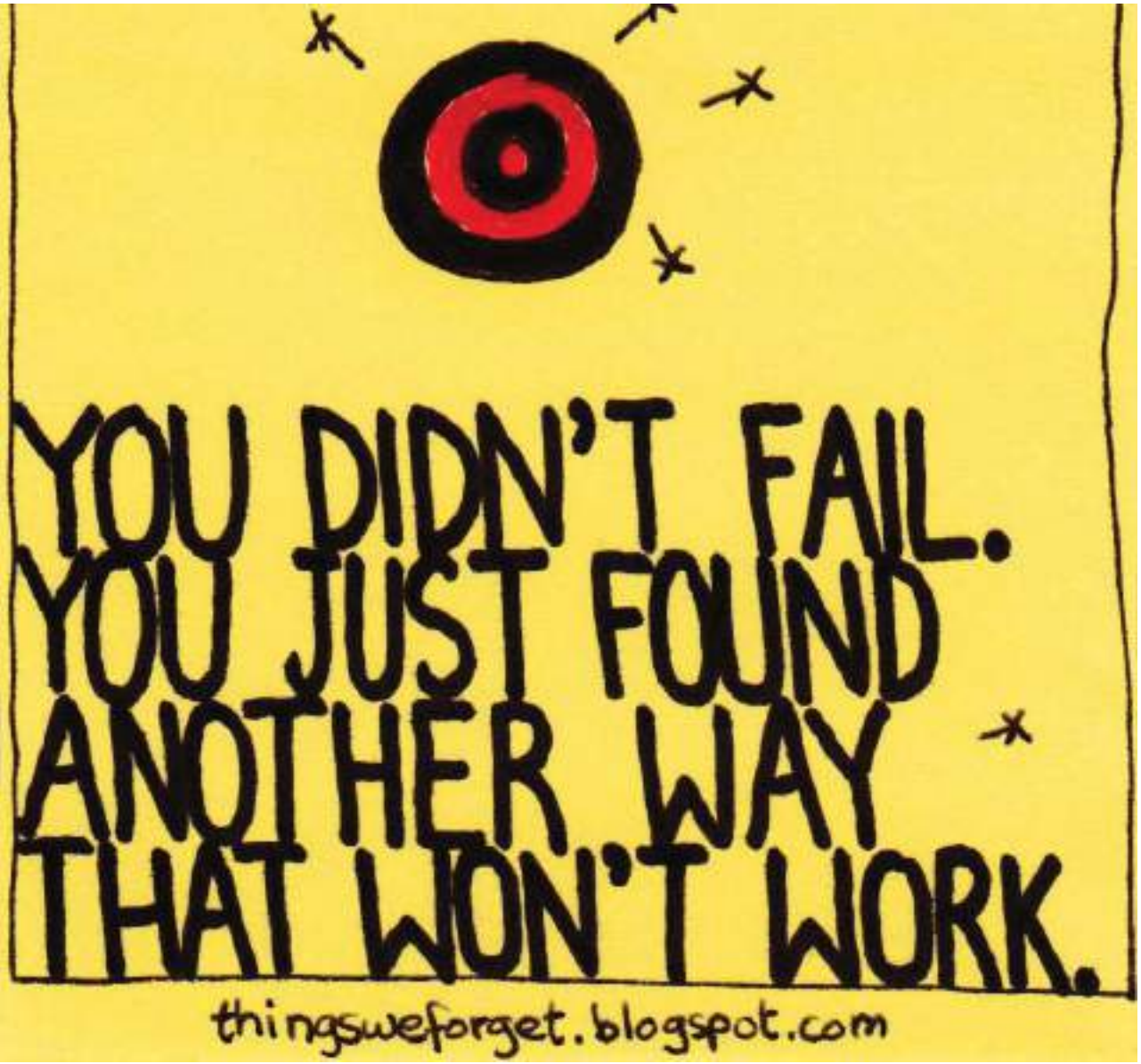

Understand the limitations of the materials:

Construction Tolerance

Installation Limitations

Movement


08/09/2016 06:40

Lessons Learned

Is it worth it:

- Perfom a proper Value Engineering evaluation, making sure that the product or system suggested works as intended and is fit for use

AIR / VAPOR BARRIER + COORDINATING TRADE PRE-INSTALLATION MEETING

Submittals should be Job Specific!

The Importance of Updated Data Sheets

Limitations

- eXP Sheathing is not a finished surface, nor is it a substrate for the direct application of joint compound, stucco, paint or textures in exterior wall applications. Placement of vapor retarders within the wall assembly is the responsibility of the design professional.
- Do not use eXP Sheathing as a nailing base. Mechanical fasteners should pass through the sheathing and engage the framing member behind the panel.
- Install materials used in conjunction with eXP Sheathing per the respective manufacturer's recommendations.
- eXP Sheathing is resistant to weather, but it is not intended for immersion in water and should not be subjected to ponding or to cascading water conditions.
- Do not apply eXP Sheathing below grade. Comply with building code grade clearance requirements.
- Do not laminate eXP Sheathing directly to masonry surfaces; fasten panels to furring strips or framing.
- eXP Sheathing is not intended for tile applications. For tile applications, Gold Bond® brand eXP® Tile Backer or PermaBase® brand Cement Board is recommended.
- Gypsum sheathing is not a replacement for specific structurally engineered sheathing in shear wall designs.
- Adhesive-only application of eXP Sheathing to framing is not recommended.
- Framing supports must not exceed 24 in. (610 mm) o.c.
- Design details, including fasteners, sealants and control joints, must be properly installed per system specifications. Openings and penetrations must be properly flashed and sealed according to code, building design and weather-resistive barrier manufacturer's instructions. Failure to do so will void the warranty; refer to eXP Sheathing warranty for terms, conditions and limitations.
- Avoid conditions that will create moisture in the air and condensation on eXP Sheathing. The use of unvented or improperly vented forced air heaters in the building creates water vapor volumes which can condense on the exterior sheathing. The use of these heaters and any resulting damage is not the responsibility of National Gypsum. Please consult heater manufacturer for proper use and ventilation.

111046 Rev. 3/19

So, can you spot the difference?

We have an extra paragraph under limitations. This is extremely important for the entire team to understand…including the subcontractor!

The Manufacturer determined an issue and placed that issue under the limitations section, telling us that there might be a new problem that we need to understand.

Limitations

- eXP Sheathing is not a finished surface, nor is it a substrate for the direct application of joint compound, stucco, paint or textures in exterior wall applications. Placement of vapor retarders within the wall assembly is the responsibility of the design professional.
- Do not use eXP Sheathing as a nailing base. Mechanical fasteners should pass through the sheathing and engage the framing member behind the panel.
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111046 Rev. 6/17

030000 Concrete

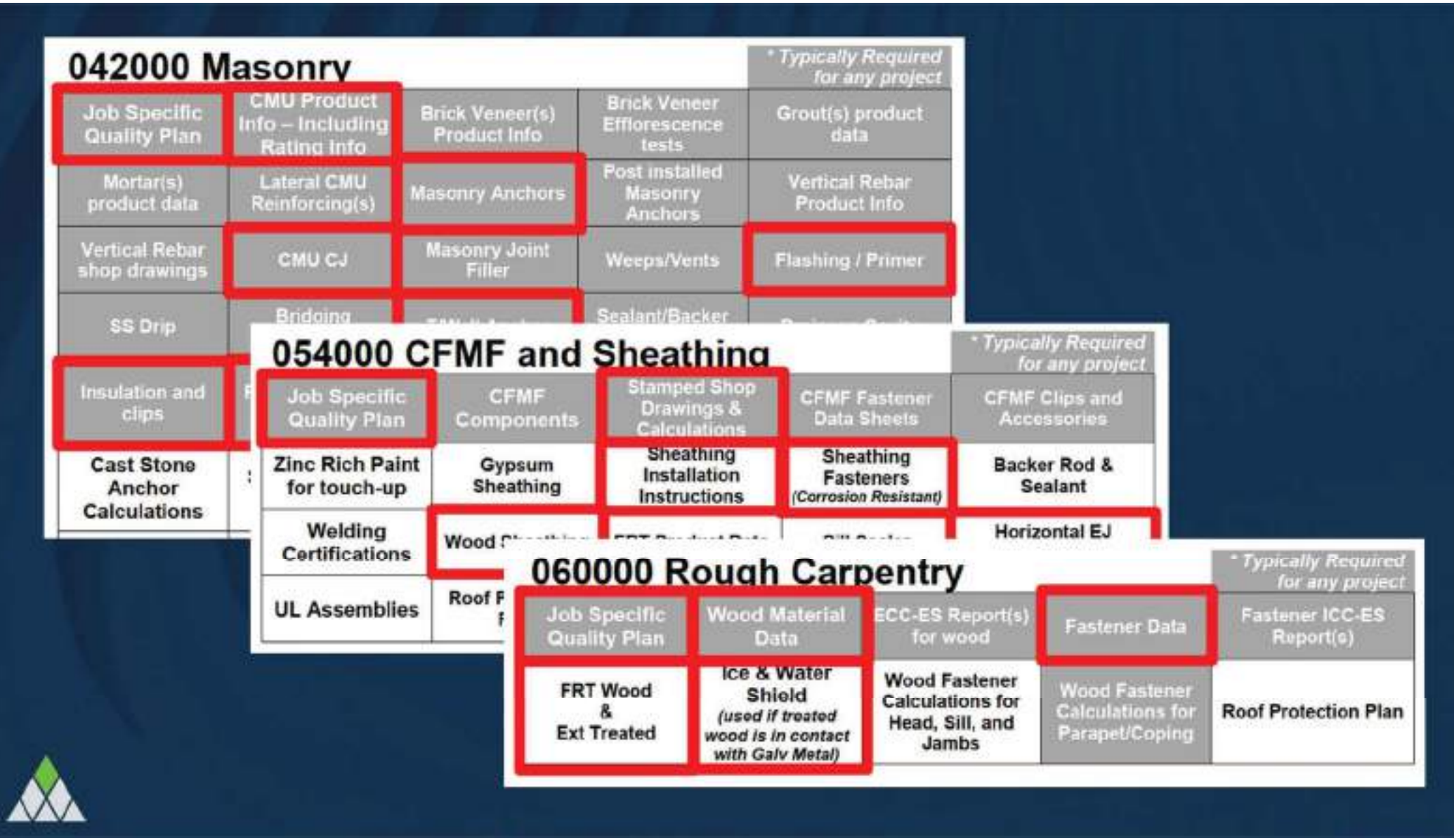
				* Typically Required for any project
Job Specific Quality Plan	Roof Protection Plan	Existing Flooring Protection Plan	Depressed Slab Procedure Plan	Architecturally Exposed Concrete Procedures
Formwork Shop Drawings and Calculations	Shoring and Calculations	Hot Weather Plan	Cold Weather Plan	Mass Concrete Procedure Plan
Flatwork Description Procedure	Slab Opening Coordination	Slab Edge Coordination	High FF (+50) Procedure	Pre/Post Tensioning Procedures
Mix Designs with identification	Concrete and Additive Material Product Data	Mix Design for Stair	Color Pigments	Floor Treatments
Fiber Reinforcement	Floor slab Treatments	Bonding Agents		Concrete Tolerance Acceptance
Rebar Shop Drawings	Rebar (and epoxy) Product Data	WWF Product Data	Epoxy Coated Rebar paint	Rebar Couplers
Diamond Dowels or Similar	Rebar Chairs	Dovetail Anchors	Embed Items	
Form Material(s) and locations	Form release (Will need to Waterproofing and AVB Compatible)	Form Liner(s)	Form Rustication Strips	Special Forms
Chamfer & Reveal Strips	Insulation	Curing Material		
Construction Joint Layout - Horizontal	Construction Joint Layout - Vertical	Control Joint Layout - Horizontal	Control Joint Layout - Vertical	Joint Filler
Vapor Retarders & Accessories and Installation Instructions	Waterstop and Installation Instructions	Epoxy and Installation Instructions	Grout and Installation Instructions	Sealant for joints
Vapor Barrier	Vapor Barrier Mastic	Vapor Barrier Tape	Vapor Barrier Concrete Tape	Vapor Barrier Installation Instructions

The following is a list of typical submittals that we should be requesting for each project regarding the specific trades.

Make sure that the specifications regarding what to submit are followed. Some of these submittals are above what is required; however, it is what's needed for our proper review and Checklist records.

Discuss with the Architect if they want to receive the extra submittals.

The list is not a complete listing of submittals for your project, and not all listed submittals may pertain to your project.

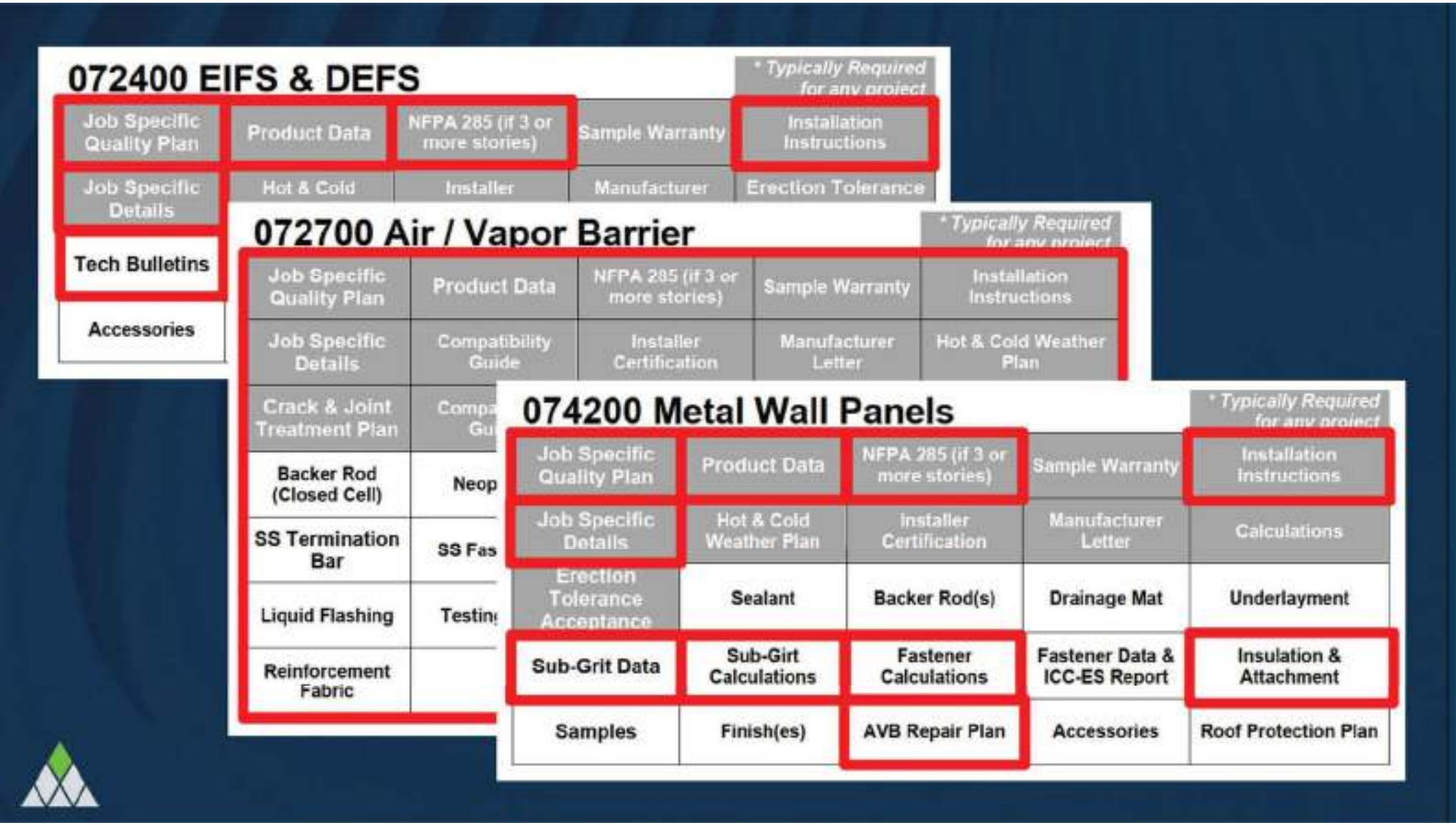

042000 Masonry
* Typically Required for any project
Job Specific Quality Plan
CMU Product Info – Including Rating Info
Brick Veneer(s) Product Info
Brick Veneer Efflorescence tests
Grout(s) product data
Mortar(s) product data
Lateral CMU Reinforcing(s)
Masonry Anchors
Post installed Masonry Anchors
Vertical Rebar Product Info
Vertical Rebar shop drawings
CMU CJ
Masonry Joint Filler
Weeps/Vents
Flashing / Primer
SS Drip
Bridging
Sealant/Backer
Insulation and clips
054000 CFMF and Sheathing
* Typically Required for any project
Job Specific Quality Plan
CFMF Components
Stamped Shop Drawings & Calculations
CFMF Fastener Data Sheets
CFMF Clips and Accessories
Cast Stone Anchor Calculations
Zinc Rich Paint for touch-up
Gypsum Sheathing
Sheathing Installation Instructions
Sheathing Fasteners (Corrosion Resistant)
Backer Rod & Sealant
Welding Certifications
Horizontal EJ
UL Assemblies
060000 Rough Carpentry
* Typically Required for any project
Job Specific Quality Plan
Wood Material Data
ECC-ES Report(s) for wood
Fastener Data
Fastener ICC-ES Report(s)
FRT Wood & Ext Treated
Ice & Water Shield (used if treated wood is in contact with Galv Metal)
Wood Fastener Calculations for Head, Sill, and Jambs
Wood Fastener Calculations for Parapet/Coping
Roof Protection Plan

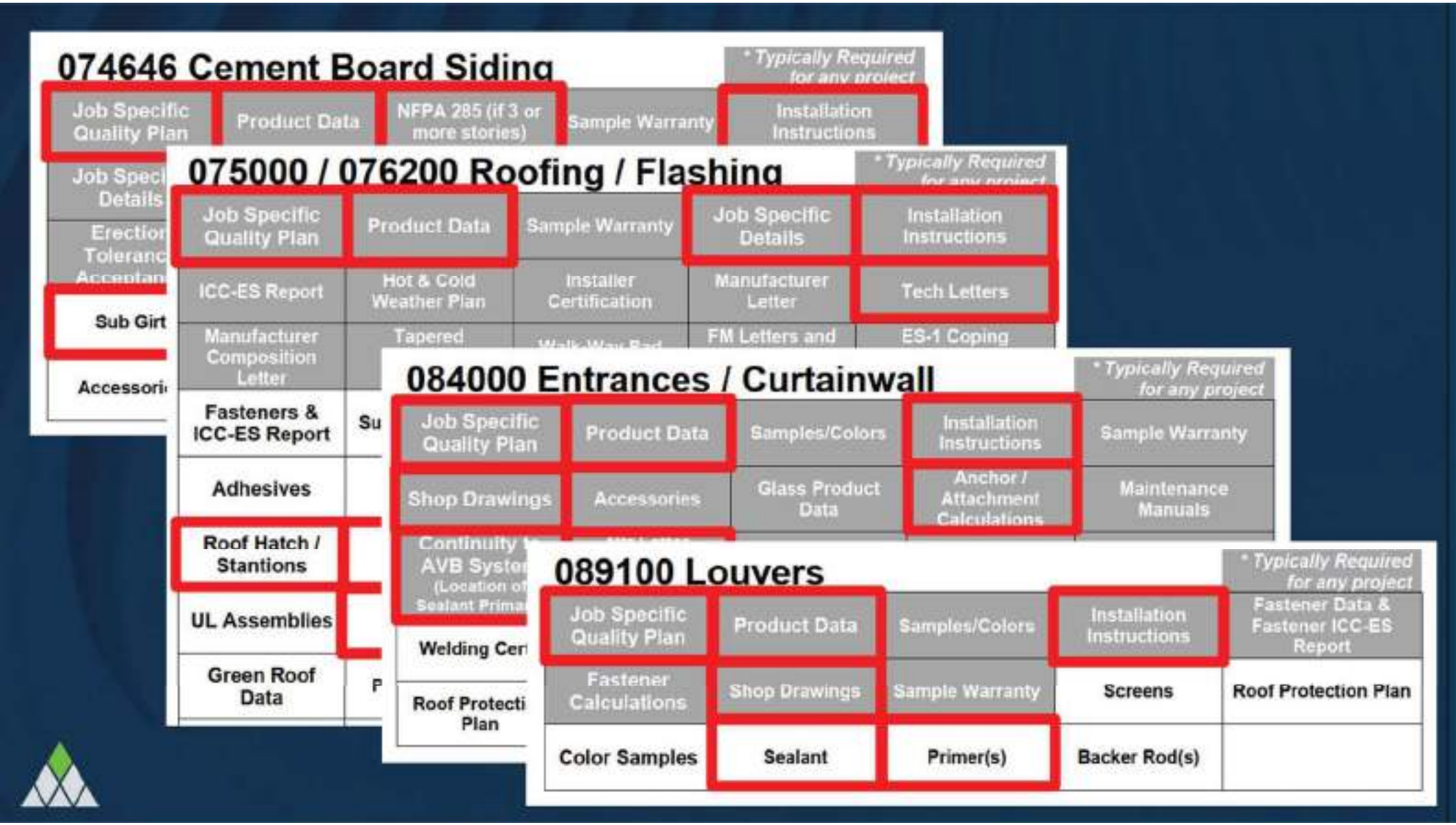
071000 Waterproofing

				* Typically Required for any project
Job Specific Quality Plan	Job Specific Details	Waterproofing Installation Instructions	Installer Certification	Manufacturer Letter
Product Data	ICC-ES Report(s)	Hot & Cold Weather Plan	Sample Warranty	Repair Plan
Crack & Joint Treatment Plan	Compatibility Guide	Mfr Tech Bulletins	Protection Board	Drainage Panels
Sealant (under and or over)	Neoprene	Mastic	Aggerate / Sand	Reinforcement Fabric
SS Termination Bar	SS Fasteners	Backer R (Closed C		
Root Barrier	Water Stopping and sealant or primer	Transiti Membra		
EFMD (Testing)	Testing Plan	Tie-Back C Etc.		
Samples	Liquid Flashing	Roof Prote Plan		

071800 Traffic Coating

				* Typically Required for any project
Job Specific Quality Plan	Job Specific Details	Traffic Coating Installation Instructions	Installer Certification	Manufacturer Letter
Product Data	ICC-ES Report(s)	Hot Weather Plan	Cold Weather Plan	Repair Plan
Sample Warranty	Maintenance Manuals	Crack & Joint Treatment Plan	Compatibility Guide	Mfr Tech Bulletins
Sealant (under and or over)	Concrete Patch Material(s) and installation Instructions	Samples	Aggerate / Sand	Neoprene Sheet
Reinforcing Fabric	Flashing Tape	Liquid Flashing	Roof Protection Plan	Primer


072400 EIFS & DEFS
* Typically Required for any project
Job Specific Quality Plan
Product Data
NFPA 285 (if 3 or more stories)
Sample Warranty
Installation Instructions
Job Specific Details
Hot & Cold
Installer
Manufacturer
Erection Tolerance
Tech Bulletins
Accessories
072700 Air / Vapor Barrier
* Typically Required for any project
Job Specific Quality Plan
Product Data
NFPA 285 (if 3 or more stories)
Sample Warranty
Installation Instructions
Job Specific Details
Compatibility Guide
Installer Certification
Manufacturer Letter
Hot & Cold Weather Plan
Crack & Joint Treatment Plan
Backer Rod (Closed Cell)
SS Termination Bar
Liquid Flashing
Reinforcement Fabric
074200 Metal Wall Panels
* Typically Required for any project
Job Specific Quality Plan
Product Data
NFPA 285 (if 3 or more stories)
Sample Warranty
Installation Instructions
Job Specific Details
Hot & Cold Weather Plan
Installer Certification
Manufacturer Letter
Calculations
Erection Tolerance Acceptance
Sealant
Backer Rod(s)
Drainage Mat
Underlayment
Sub-Grit Data
Sub-Girt Calculations
Fastener Calculations
Fastener Data & ICC-ES Report
Insulation & Attachment
Samples
Finish(es)
AVB Repair Plan
Accessories
Roof Protection Plan

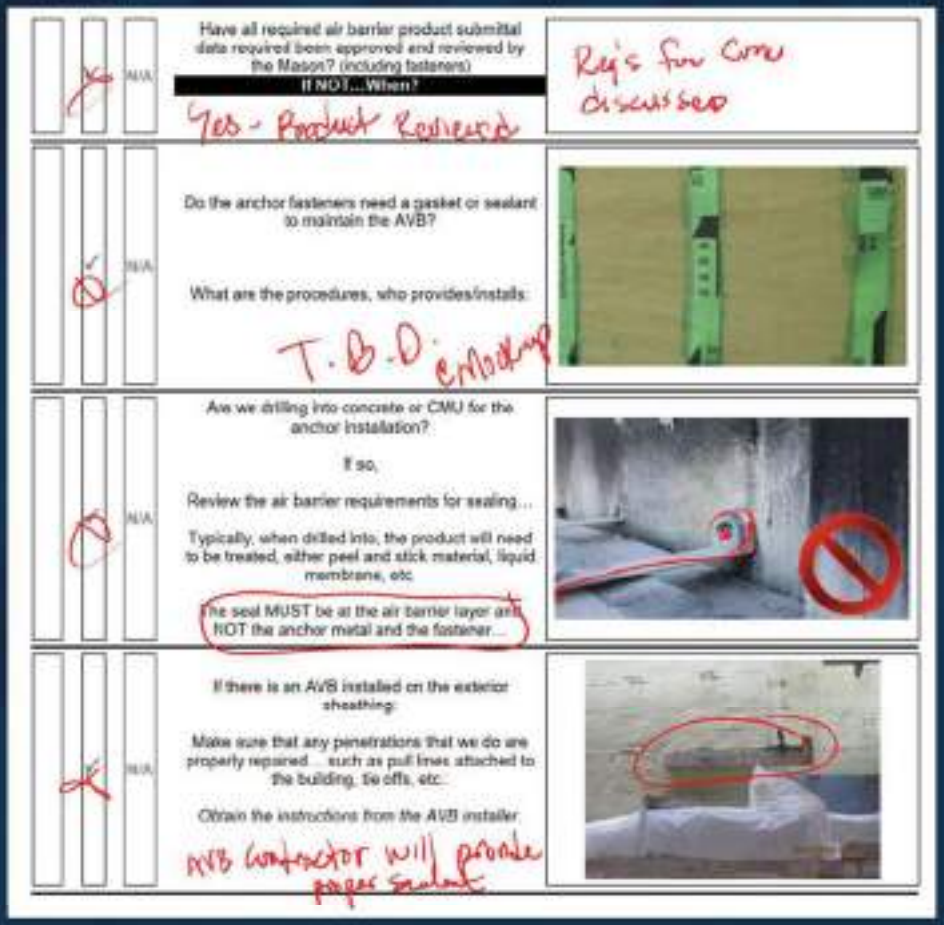

074646 Cement Board Siding
* Typically Required for any project
Job Specific Quality Plan
Product Data
NFPA 285 (if 3 or more stories)
Sample Warranty
Installation Instructions
075000 / 076200 Roofing / Flashing
* Typically Required for any project
Job Specific Quality Plan
Product Data
Sample Warranty
Job Specific Details
Installation Instructions
ICC-ES Report
Hot & Cold Weather Plan
Installer Certification
Manufacturer Letter
Tech Letters
Manufacturer Composition Letter
Tapered
FM Letters and
ES-1 Coping
Fasteners & ICC-ES Report
Adhesives
Roof Hatch / Stantions
UL Assemblies
Green Roof Data
084000 Entrances / Curtainwall
* Typically Required for any project
Job Specific Quality Plan
Product Data
Samples/Colors
Installation Instructions
Sample Warranty
Shop Drawings
Accessories
Glass Product Data
Anchor / Attachment Calculations
Maintenance Manuals
Welding Cer
Roof Protecti Plan
089100 Louvers
* Typically Required for any project
Job Specific Quality Plan
Product Data
Samples/Colors
Installation Instructions
Fastener Data & Fastener ICC-ES Report
Fastener Calculations
Shop Drawings
Sample Warranty
Screens
Roof Protection Plan
Color Samples
Sealant
Primer(s)
Backer Rod(s)

Lessons Learned

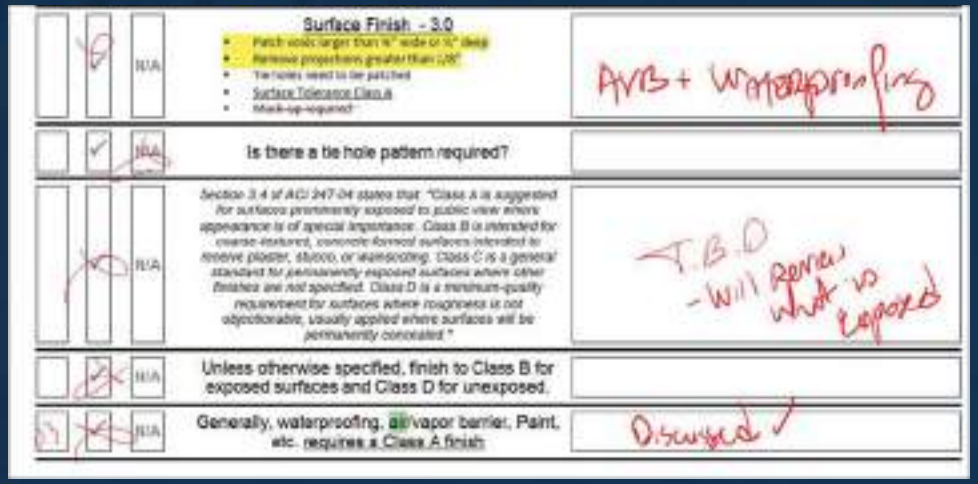
What is important to who

- In general, the team needs more submittals to review and confirm, at least the Contractor needs more
- Early identification of the required submittals are key to keep things on track

AIR / VAPOR BARRIER + ADJACENT TRADE SUBMITTALS



Masonry Pre-Installation Meeting

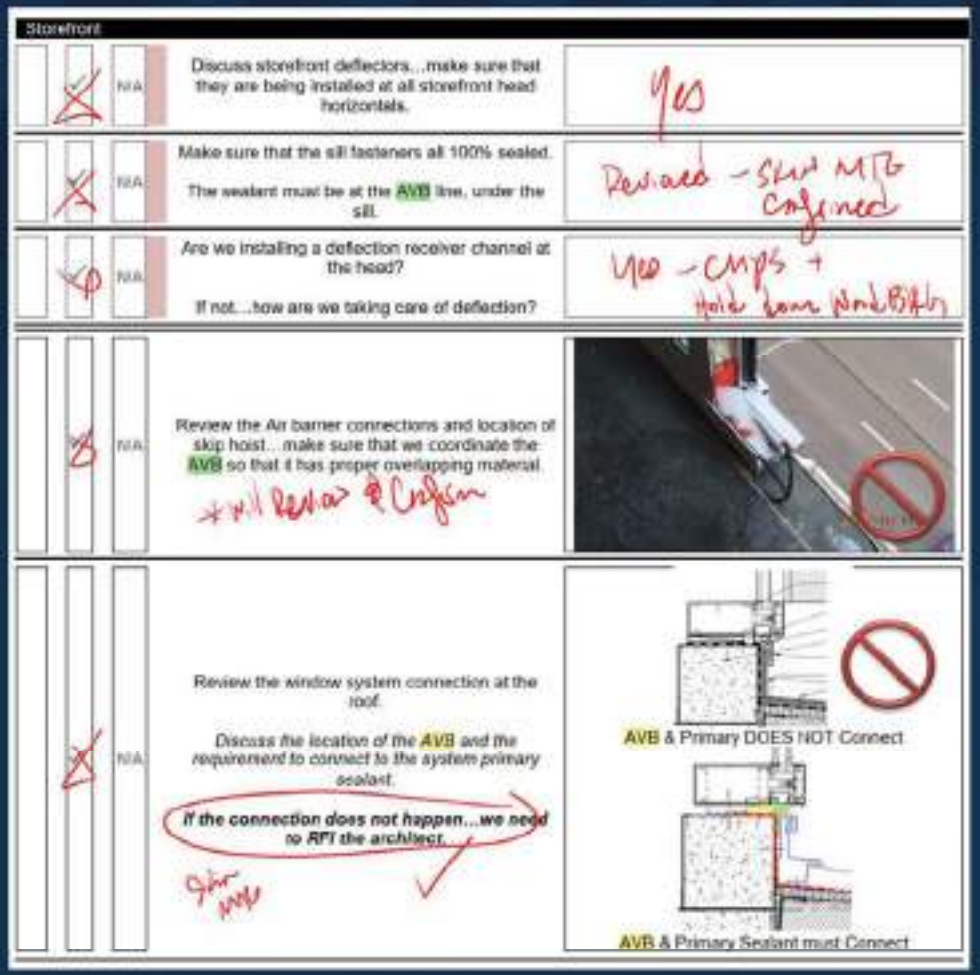


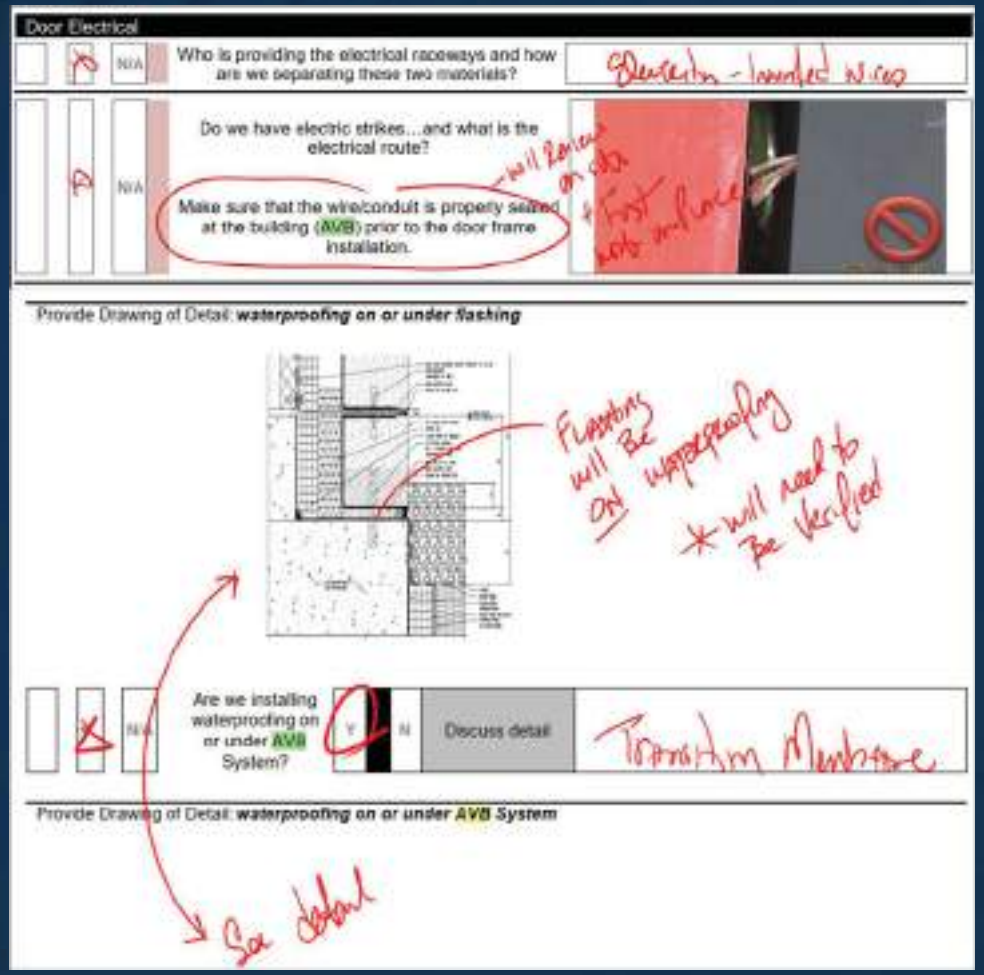
Concrete Pre-Installation Meeting

Typical for all Pre-Installation Meetings

		N/A	Mastic on peel and stick seams are to be 1/8"-1/4" in thickness, tooled, and 1"-1 ½" wide.	
		N/A	What is the minimum overlap required for the Self-adhered sheet Overlap Required: 4"	
		N/A	Review the overlap and make sure that the proper overlap is maintained at end of construction areas…i.e.: Expansion joints, corners, etc. 3"	
		N/A	Always verify installation for pin holes, blisters, or other voids…	✓
		N/A	What is the repair patching requirements/procedures: will provide letter from Carlisle	
		N/A	How are penetrations detailed?	Overlap 3" w/ Sealant @ Ft See Details

Air/Vapor Barrier Pre-Installation Meeting

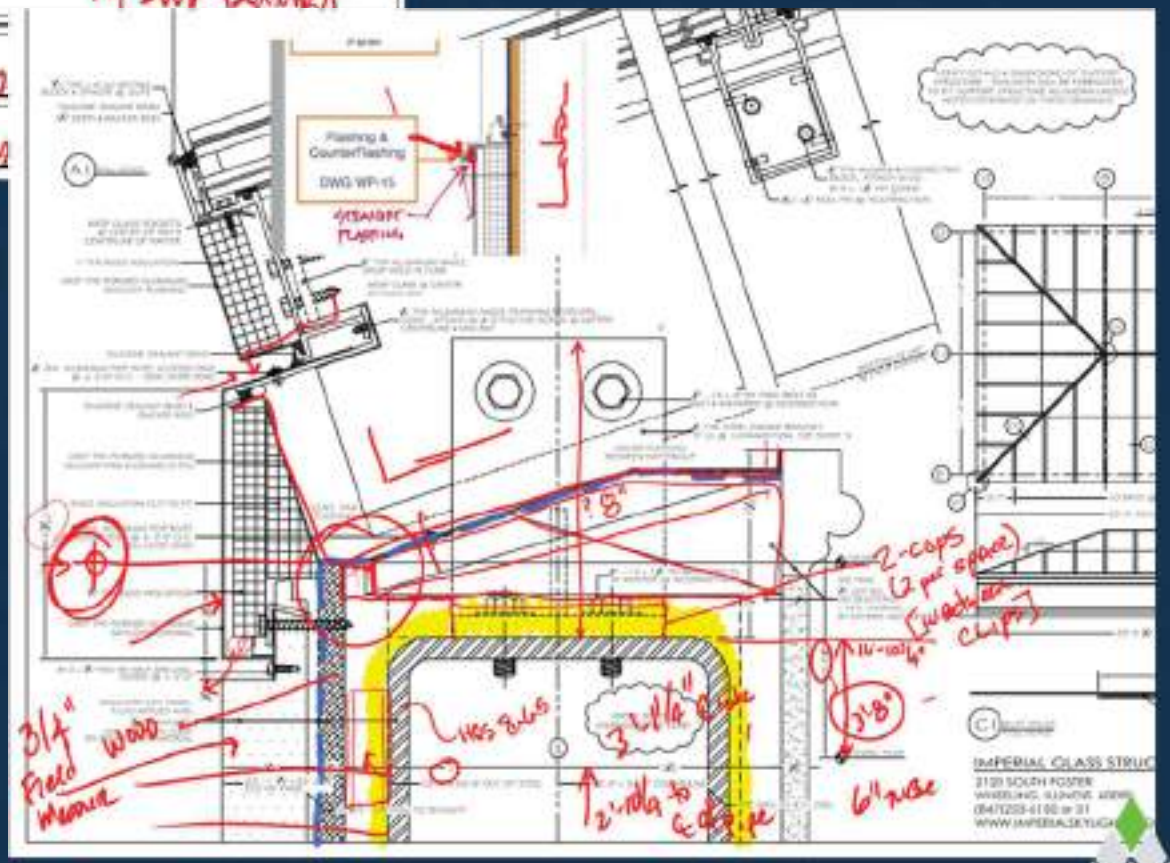




Window Pre-Installation Meeting

Waterproofing Pre-Installation Meeting

Skylights				
	X	N/A	Skylight curbs must have an R-5 minimum curb or system to be NFRC 100 Labeled.	Yes
	✓	N/A	Review the AVB connection and continuity. Make sure that there is not a weep interrupting the connection – might need to locate behind the weep system.	Yes - will Confirm w/ Shop Drawings
	X	N/A	Make sure that there is a condensation pan that extends past the end of the glass.	Yes
	✓	N/A	Always install a pan flashing	Yes



Skylight Pre-Installation Meeting

How does the vapor barrier go up the parapet?

Identify path of Vapor Barrier and Air Barrier in all conditions and proper transitions between materials:

See Shops

What is the detail at the parapet / Roofing? Verify that the AVB membrane either goes under the roofing membrane or to a compatible material to extend the AVB envelope to the roofing system (vapor barrier or adhered roofing membrane).

Provide sketch...

Example

Discuss peel and stick joints and covering them if a single ply roof is being installed (the joints are NOT compatible)

Review what material will be making the AVB / Roofing connection.

Self-Adhered Stainless Steel with a butyl tape is a good option.

See Sketched

Discuss Vapor Barrier termination details and attachment to A/V barrier as required.

Verify Compatibility and Sequencing...

Discuss Vapor Barrier, Roof Membrane, and AVB compatibility and sequencing.

Need to discus and detail the roofing and the curtainwall.

Make sure that the materials are compatible, sequence of installation is clear, and there is attachment to the curtainwall primary sealant and the roofing or roofing extension (such as stainless steel)

[Curtainwall sealant will not bond to most roofing materials]

(Review SKIN Meeting Notes)

Review what material will be making the AVB / Window or Door / Roofing connection.

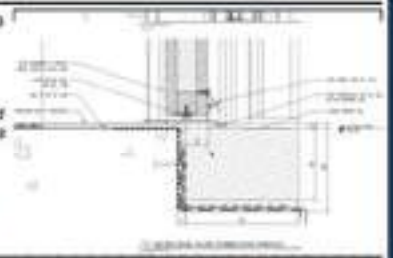
Self-Adhered Stainless Steel with a butyl tape is a good option.

Need to discus and detail the roofing and the door threshold.

Make sure that the materials are compatible, sequence of installation is clear, and there is attachment to the curtainwall primary sealant and the roofing or roofing extension (such as stainless steel)

[sealant will typically not bond to most roofing materials]

(Review SKIN Meeting Notes)



Discuss the **sequence** of installation with time required for cure at each step....

SEQUENCE of Vapor Barrier / Roof Membrane / AVB	

Discuss the scuppers and how we are tying the roofing / scupper flashing with the AVB?

Discuss a transition piece or similar to make sure that all are compatible

Roofing Pre-Installation Meeting

Lessons Learned

Can we do better next time?

- Evaluate current preinstall meetings for completeness and usefulness – constantly improve
- Update as new materials or new procedures are discovered

CHECKLIST

Fluid/Sheet Applied A/V Barrier Construction Checklist

Date of Initial Review:		Location of Work Performed:	Day	Initial	Weather	Beg Temp / End Temp
			Monday			
			Tuesday			
			Wednesday			
			Thursday			
Project:			Friday			

Always review existing conditions PRIOR to the start of work EACH DAY and discuss with A/E as required

N/A	Mon	Tue	Wed	Thur	Fri		Comments
N/A	✓	✓	✓	✓	✓	Verify the temperature will be above 40°F at time of application and during cure.	
N/A	✓	✓	✓	✓	✓	Air barrier is backed with something solid... **DO NOT ALLOW THE AIR BARRIER TO SPAN OVER MATERIALS UNSUPPORTED.**	
N/A	✓	✓	✓	✓	✓	Make sure ALL material is lifted off the ground and is properly covered to protect from water and sun.	
N/A	✓	✓	✓	✓	✓	CMU shall have struck flush or made flush joints.	
N/A	✓	✓	✓	✓	✓	CMU shall have mortar accumulation removed prior to installation.	
N/A	✓	✓	✓	✓	✓	Sheathing and wood blocking is continuous and complete.	
N/A	✓	✓	✓	✓	✓	Cementitious surfaces must be clean and smooth.	
N/A	✓	✓	✓	✓	✓	Tape off area above the waterproofing at the base of the wall prior to installing membrane to avoid overspray onto the waterproofing.	
N/A	✓	✓	✓	✓	✓	Voids in CMU greater than ½" shall be pre-treated with LM, S100, or a fast setting concrete mortar.	
N/A	✓	✓	✓	✓	✓	Gaps greater than ¼" should be pre-filled with a S100 and allowed to skin over.	
N/A	✓	✓	✓	✓	✓	Install primer IVB on all surfaces. Allow to dry to the touch prior to installation of detail membrane. (40°F min at 70°F or 50% relative humidity)	
N/A	✓	✓	✓	✓	✓	Detail membrane should be installed over skimmed over S100 only.	
N/A	✓	✓	✓	✓	✓	S100 at sheathing joints & detail membrane at corners (underlayment)	
N/A	✓	✓	✓	✓	✓	Install "football" membrane at the inside corner of the window openings.	
N/A	✓	✓	✓	✓	✓	Verify that the membrane is installed with shingle style lapping.	
N/A	✓	✓	✓	✓	✓	Detail membrane to detail membrane should overlap a minimum 2"	

AIR BARRIER PROJECT

Type of Air Barrier System:	☐ Fluid- Applied Membrane		☐ Self-Adhered Membrane		☐ Spray-Foam	
Manufacturer:	☐ Carlisle	☐ Henry	☐ Prosoco	☐ Polyguard	☐ W.R. Grace	☐ Meadows	☐ Other
Substrate:	☐ Gypsum	☐ CMU	☐ Concrete	Substrate Temp: (°F)		Ambient Temp: (°F)	

Installation Area:		Elevation:	☐ North	☐ South	☐ East	☐ West	☐ Other
From Level:		To Level:		Between CL:		To CL:	

- ☐ Verify that materials are properly stored in material storage areas.
- ☐ Verify both ambient and substrate temperatures are within the limitations for material installation.
- ☐ Review adjacent materials (windows, doors, ducts, penetrations) for conformance to details and instructions.
- ☐ Verify that all penetrations are securely installed.
- ☐ Verify that a continuous air barrier system is capable of being achieved before beginning installation.
- ☐ Verify that substrate(s) are installed per manufacturer's instructions and are flat, free of fins and irregularities.
- ☐ Verify that substrate is properly cured, dry, clean, sound, and free of dust, dirt, residue, and all other contaminants.
- ☐ Verify that all gaps exceeding ¼-inch are treated with approved sealant.
- ☐ Verify that any surrounding areas and surfaces are protected from damage and staining during application of air barrier.
- ☐ Verify spray equipment, hoses, and spray tips are clean and in proper working condition.
- ☐ Verify that proper wet mil thickness is achieved during spray and/or roller application.
- ☐ Verify that application is free of voids and pinholes.
- ☐ Verify that details have been installed correctly according to details and instructions.
- ☐ Protect finished work at the end of each day as necessary.
- ☐ Note any physical damage to completed areas that may have occurred during construction and repair as needed.
- ☐ Clean equipment and material areas per instructions and as required.
- ☐ Verify proper removal of construction materials, equipment, and waste materials.

AIR BARRIER CONTRACTOR JOB SPECIFIC QUALITY PLAN

d. Review of Architectural and Manufacturer's Details

   i. During Daily Tool Box Talks, the Quality Champion is to review the most current approved details and installation instructions for the upcoming installation.

   ii. Weather concerns must be addressed as needed prior to beginning work for the day.

e. Installer Quality Assurance – **Self-Adhering Sheet Air & Vapor Barrier**

   i. Quality Champion will review the product application daily with the installation team to verify the field membrane is properly installed.

      1. All substrates should be smooth, sound, dry, and free of contaminants.

      2. Fluid-applied products should be applied in a continuous film free of pinholes, filling all cracks, voids, reveals, crevices, etc. with a total wet mil thickness meeting the manufacturer's guidelines. Mil thickness is to be verified using a wet mil gauge at regular intervals.

      3. When using rollers to install the product, crew members may need to apply the membrane in two coats allowing the first coat to reach initial set prior to application of second coat in order to avoid slumping.

      4. Self-adhering stainless steel detail transition strips should be placed in position and applied using positive pressure using a hand roller. Product should be wrinkle free and void of fishmouths.

Lessons Learned

Why require?

- Proves a clear line of responsibility for installation and quality
- It’s about procedure and quality of content
- Produces ownership of the work

MOCK-UP REVIEW


05/10/2016 07:48


05/10/2016 07:50

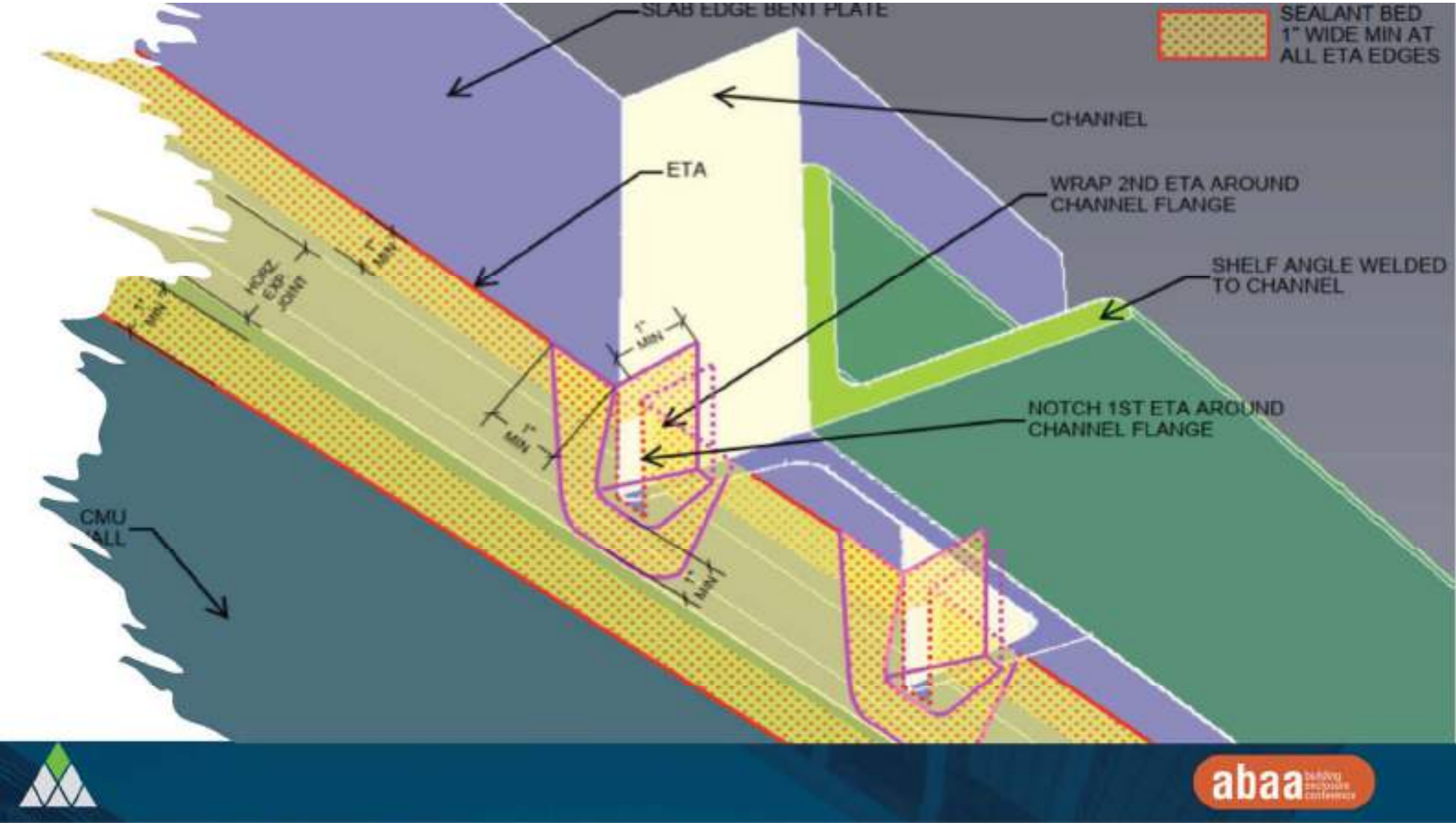
Each roof condition was reviewed for sequence, material compatibility, AVB continuity

Each Detail needs to be reviewed, with specific comments


SURFACE NOT PROPERLY PREPARED NAILS NOT REMOVED
NEED TO SEAL
NOT PROPERLY INSTALLED
OPENINGS @ Detail Strip Tape


05/10/2016 07:44

FIRST WORK IN PLACE


SLAB EDGE BENT PLATE
SEALANT BED
1" WIDE MIN AT
ALL ETA EDGES
CHANNEL
ETA
WRAP 2ND ETA AROUND
CHANNEL FLANGE
SHELF ANGLE WELDED
TO CHANNEL
NOTCH 1ST ETA AROUND
CHANNEL FLANGE
CMU
WALL
HORZ
EXP
JOINT
1" MIN
1" MIN
1" MIN
1" MIN
1" MIN

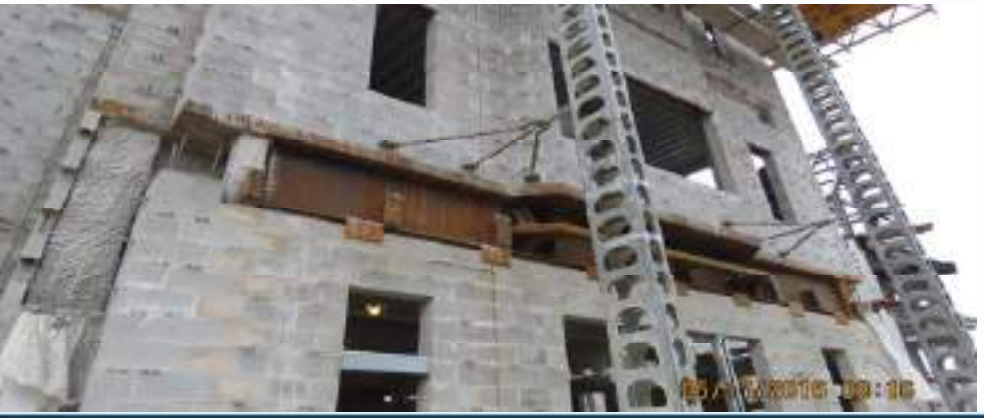

08/23/2016 07:03

Lessons Learned

What was learned and changed:

- Sequence was modified
- Material choices were changed
- Confirmed product selection and assumptions
- Understanding of products and installation
- Modifications to the pre-installation meeting and checklists

SUBSTRATE REVIEW




Sheathing
GP
08/16/2016 08 06


06/21/2016 07

Lessons Learned

What was changed:

- How we approached substrate review before AVB installation – protection and verification / testing
- Manufacturer reviews

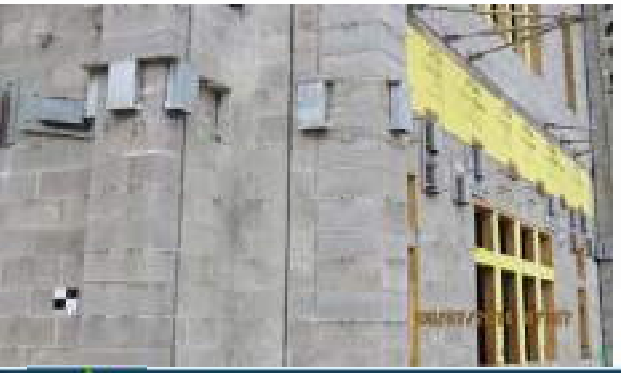
JOB SITE REVIEWS

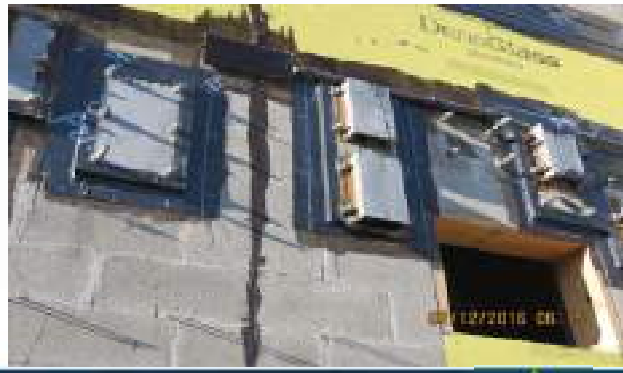

08/23


07/12/2015 05:15


03/07/2017 09:0


12/13/2016 09:21






PERM-A-BARRIER


PERM-A-BA
Wall Flashing
PERM-A-BARRIER
GRACE


307086


12/13/2016 09:26

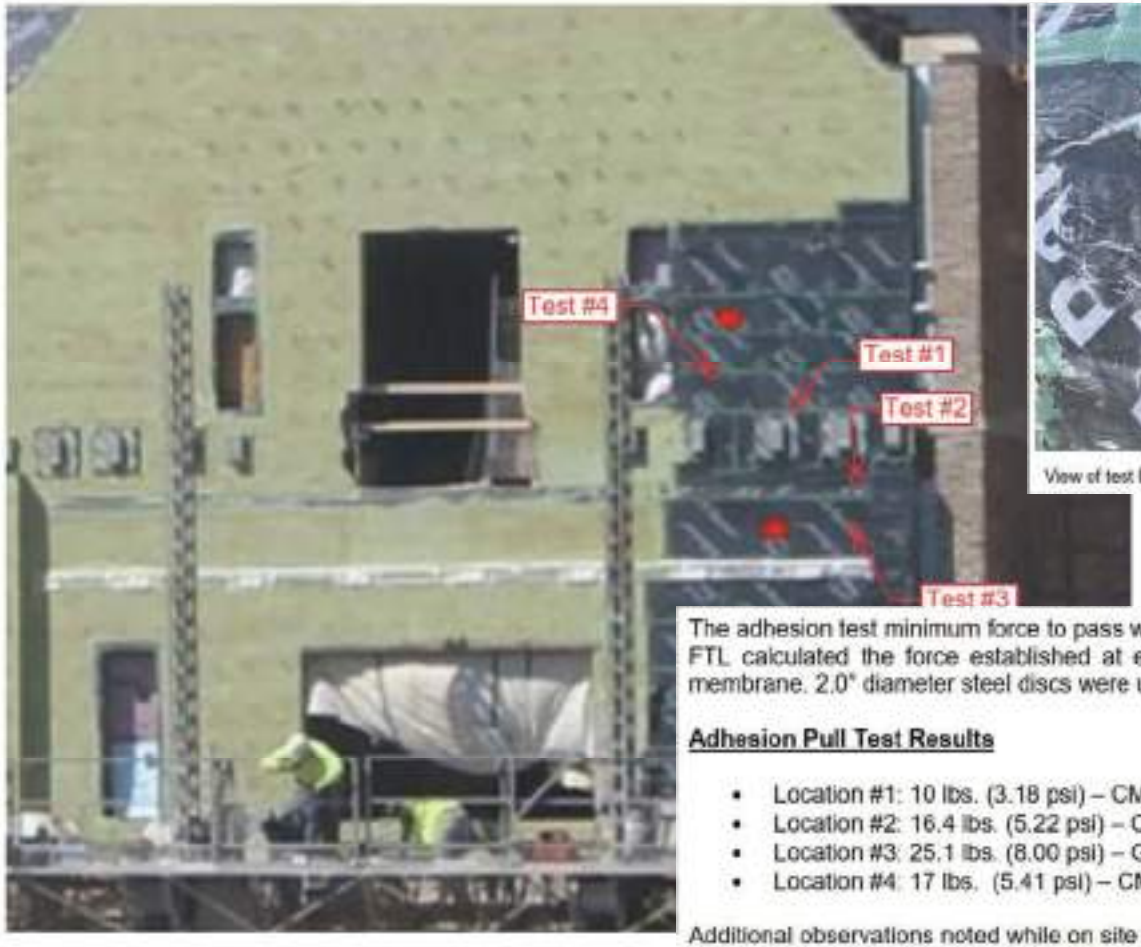
Lessons Learned

Create a building profile reviewing:

- Modifications to the pre-installation meeting and checklists
- The need to re-review the pre-installation meeting on long projects that span multiple seasons
- Periodic group re-education

TESTING


07/05/2016 08:07



View of test location #1

View of test location #2

Photo/Report: Flood Labs - Chicago

The adhesion test minimum force to pass was indicated to be 16 lbs. In order to convert the results to psi, FTL calculated the force established at each location by the area of the steel discs adhered to the membrane. 2.0" diameter steel discs were used at each location.

Adhesion Pull Test Results

- Location #1: 10 lbs. (3.18 psi) – CMU substrate
- Location #2: 16.4 lbs. (5.22 psi) – CMU substrate
- Location #3: 25.1 lbs. (8.00 psi) – Gypsum Board substrate
- Location #4: 17 lbs. (5.41 psi) – CMU substrate

Additional observations noted while on site were that the membrane did not appear to have been properly rolled in at the time of application. Several areas appeared loose and/or not adhered. The substrate beneath the membrane appeared to have been primed but it is not known if the primer was properly applied or what conditions were present at the time of application. At the time of testing, the membrane had been exposed to the sun for some time and was warm. This may have had an effect on the adhesion of the membrane when the tests were performed. Test locations and photos are attached on the following pages. Please do not hesitate to contact me with any questions or concerns.

GENERAL LESSONS LEARNED

Lessons learned

- Transition Membrane

capabilities & limitations

- Sloped roof

materials & coordination

- Deflection Joints

Locations, materials and detailing

- Preinstallation Mtgs

having several meetings that include all installers for large projects

Preplanning

- Are we spending the time to allow the team to review and plan the project?
- Are we creating a Job Specific Quality/Safety Plan?
- Are we understanding / modeling the logistics…
- Are we properly training?
- Are we expecting/overworking our teams?

Communication

- Are we properly expressing what we expect?
- Are we talking to each other?
- Are we purposely leaving something out of the conversation?
- Are we getting the right players at the meetings?
- Are we talking enough?
- Are we sending the correct information over?
- Do we have the same agenda?

Pepper

Tomorrow Transformed

Corey S Zussman, *AIA, NCARB, ALA, RBEC, RRC, REWC, RWC, RRO, CDT, CQM, CxA+BE, BECxP, CABS, LEED® AP BD+C, Level II Thermographer*

Director of Quality Management – Illinois & Wisconsin

Pepper Construction Company /// **BREAKING GROUND**

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building
enclosure
conference