



Andrew Dunlap, AIA, NCARB, LEED AP

SmithGroup, Principal

Building Technology Studio Leader

Mr. Dunlap's primary work experience is focused on the analysis and development of building enclosure systems including wall cladding assemblies, air barrier systems, roofing, skylights, fenestration systems, and waterproofing. Specializing in the Energy and Hygrothermal Evaluation and Analysis of wall, fenestration, and roof systems, Mr. Dunlap utilizes a number of advanced computerized analysis and simulation tools to perform his work. His work extends from evaluating existing buildings, investigating problem buildings, revitalizing historic structures, to the design and consultation of new and specialty facades. Mr. Dunlap received his B. Arch, B.S. in Mathematics, and M. Arch degrees from the University of Detroit Mercy. He is active participant in the design and construction community, providing presentations and publications to several industry organizations.

- American Institute of Architects (AIA) – AIA Detroit Chapter 2019 Past President
- Air Barrier Association of America (ABAA) – Board Member / Vice Chair
- Air Barrier Association of America (ABAA) – Research Committee Co-Chair
- ASTM E 06.55 Performance of Building Enclosures – Subcommittee Secretary
- ASTM E 06.41 Air Leakage and Ventilation Performance – Voting Member
- ASTM D 08 Roofing and Waterproofing - Member
- Building Enclosure Council Greater Detroit – Past Chair
- University of Detroit Mercy - Architectural Engineering Board of Advisors

Failure is Not an Option: Air Barrier Continuity Strategies for Storefront and Curtain Wall Systems

Andrew Dunlap, AIA
SmithGroup, Inc.

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Gain an understanding of how...

- ...transitions impact building enclosure performance.
- ...poor transitions can result in reduced energy efficiency.
- ...poor transitions can increase the risk of condensation.
- ...various compatibility and logistical issues impact options available to achieve proper transition details.

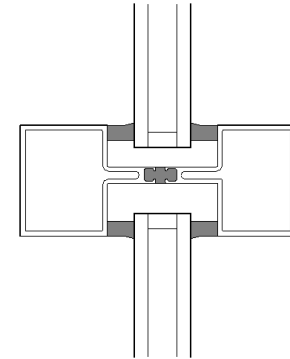
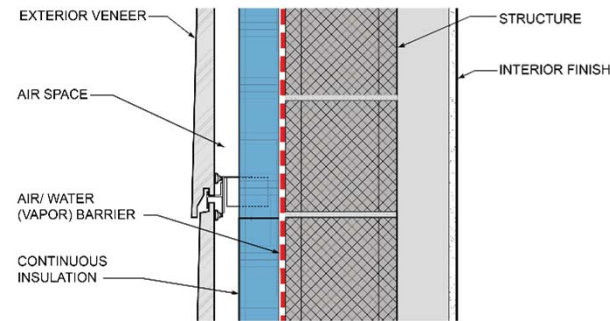
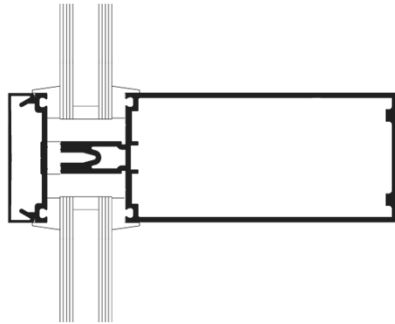


Lets Start With the Environmental Separators

They go by many names

- Control Layers
 - Planes of Performance
 - Environmental Separators
 - Barriers
 - Retarders
 - ...
- WRB
 - AWB
 - AVB
 - VB
 - VR
 - ...

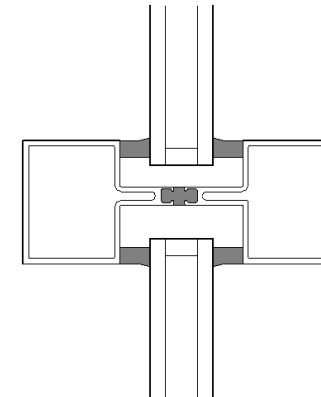
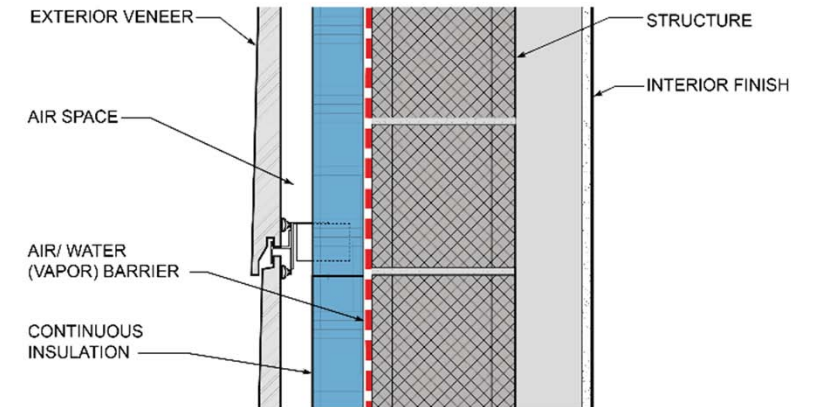
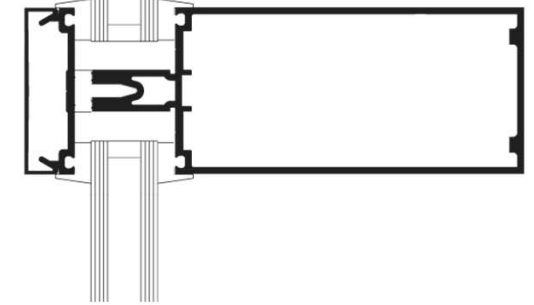
Breaking Down The Barriers



- Water
- Air
- Thermal
- Vapor

PROTECT THE STRUCTURE

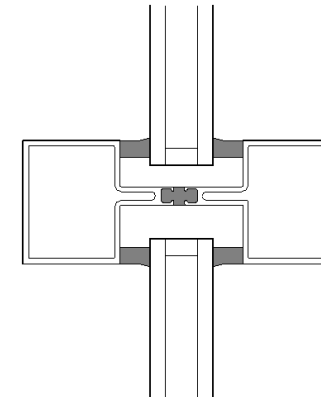
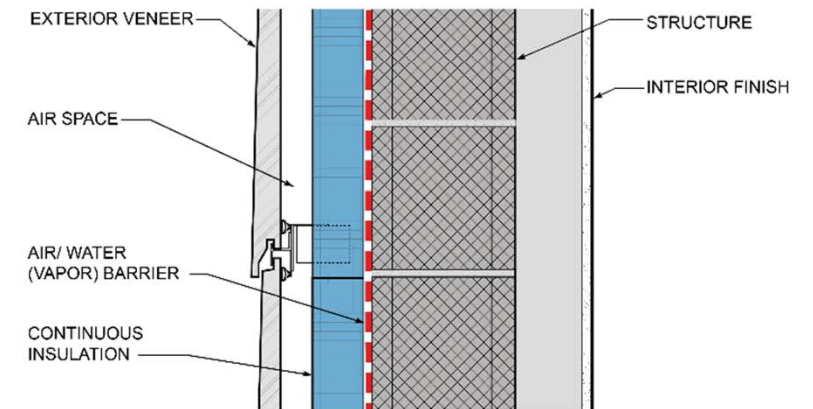
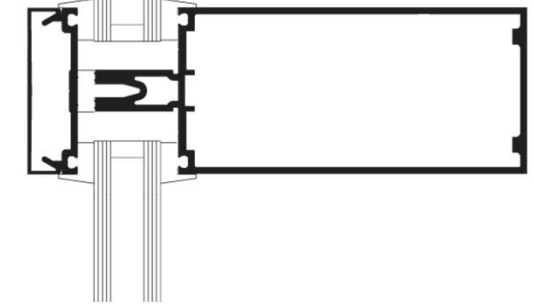
Conceptual details are for education purposes only.



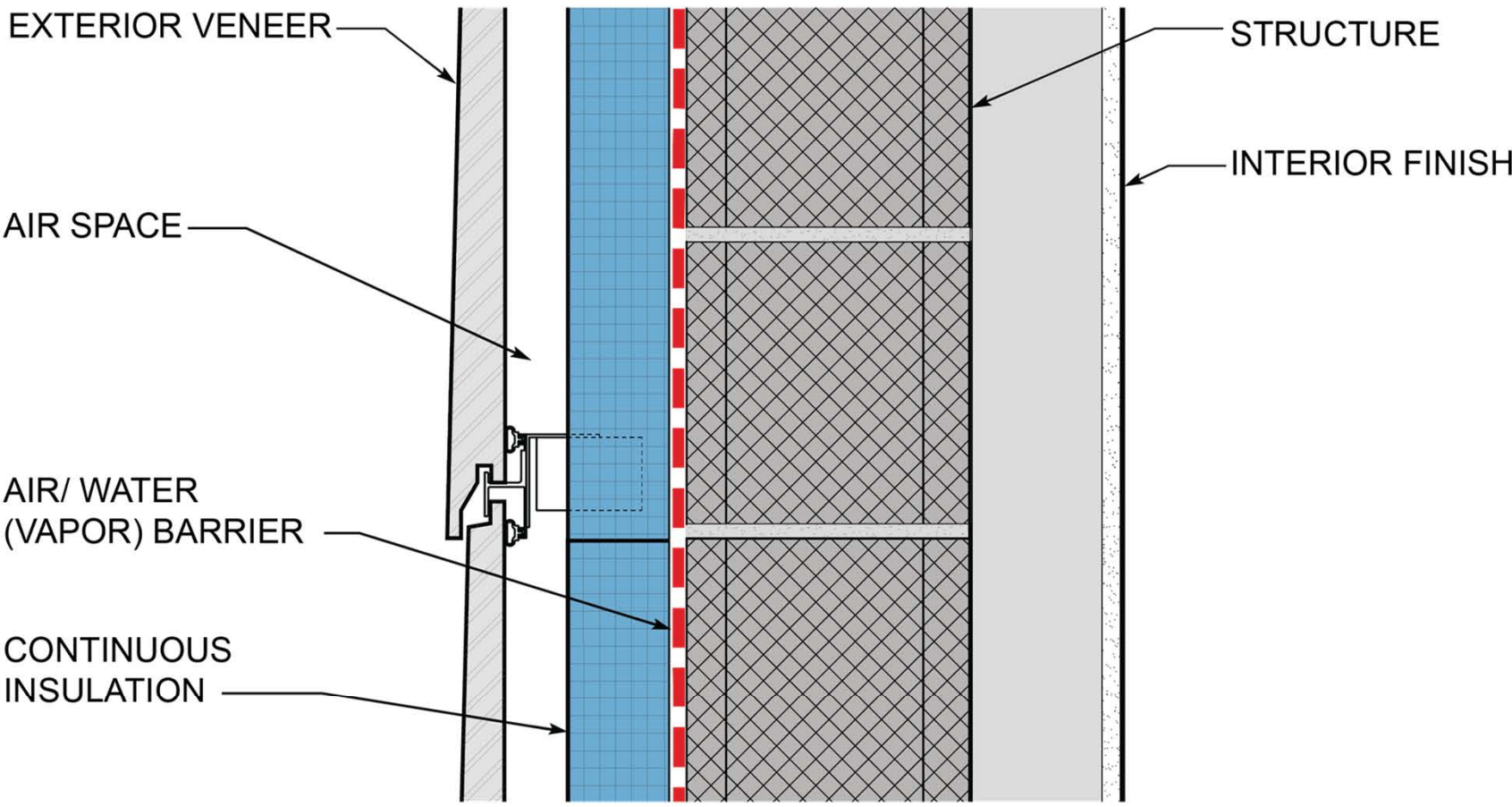
Understand that Perfection is **IMPOSSIBLE**.

Redundant Systems are **Durable** Systems.

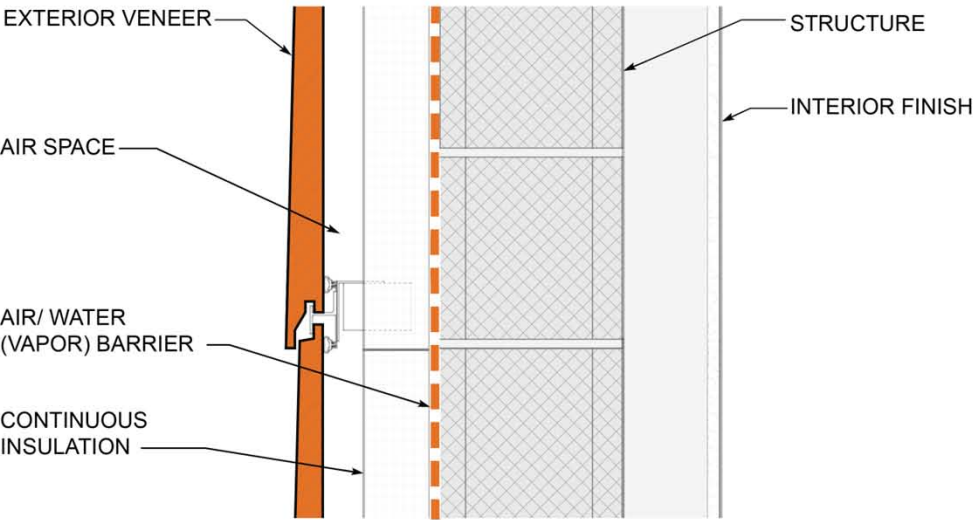
Design with **Two** Lines of Defense.



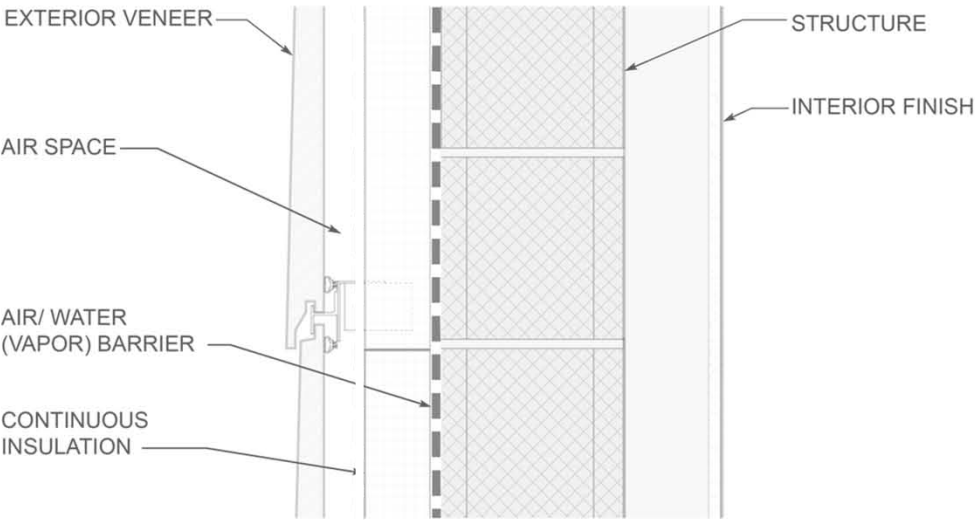
WALL



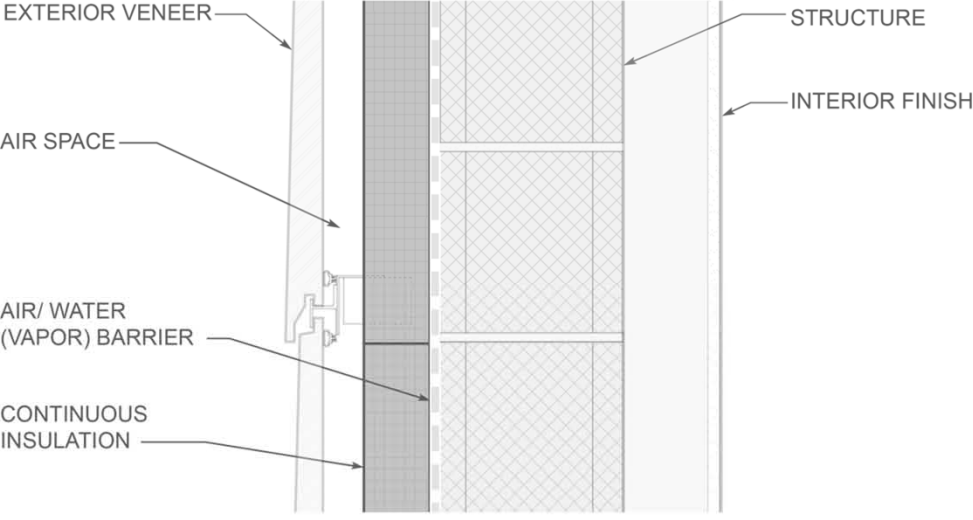
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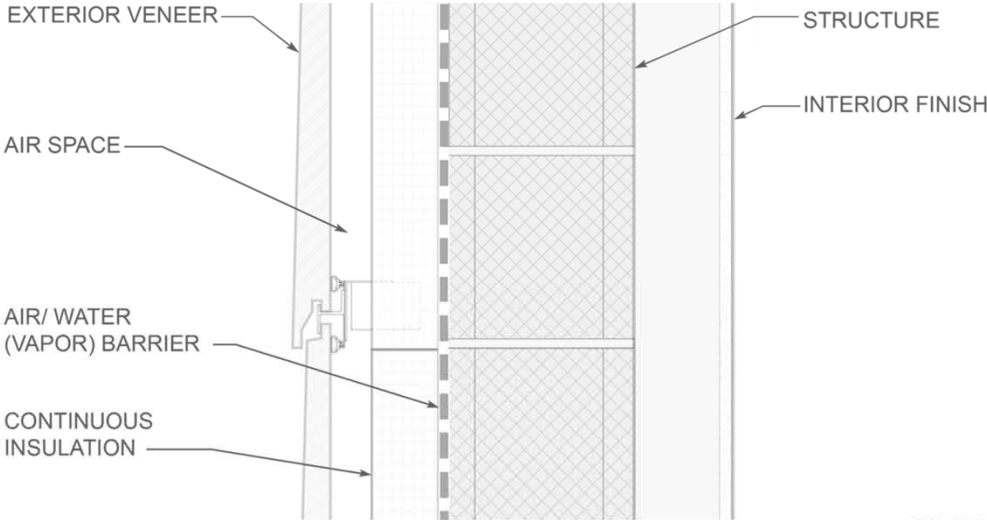
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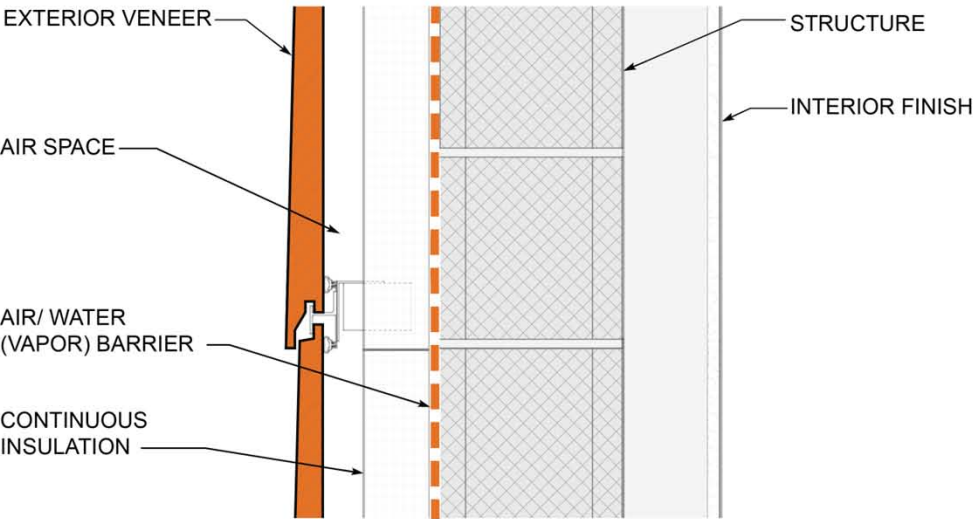
THERMAL



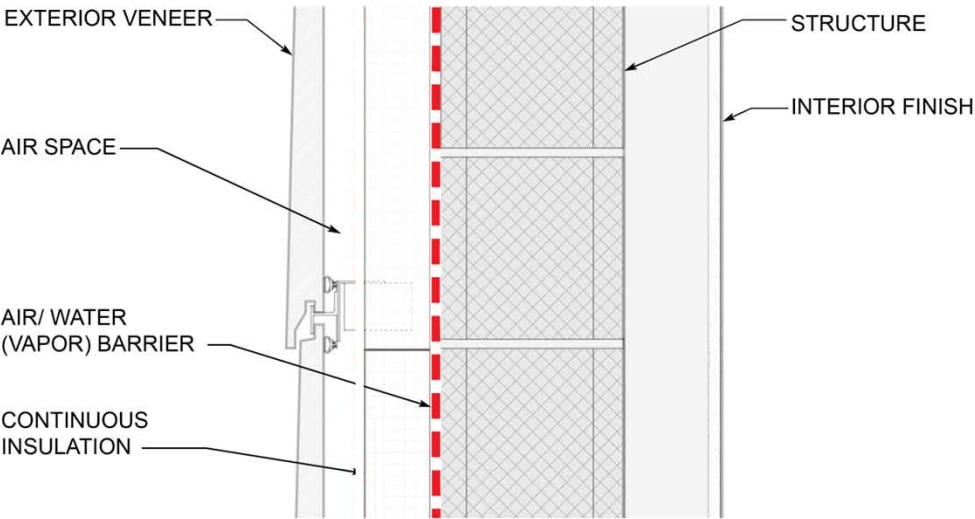
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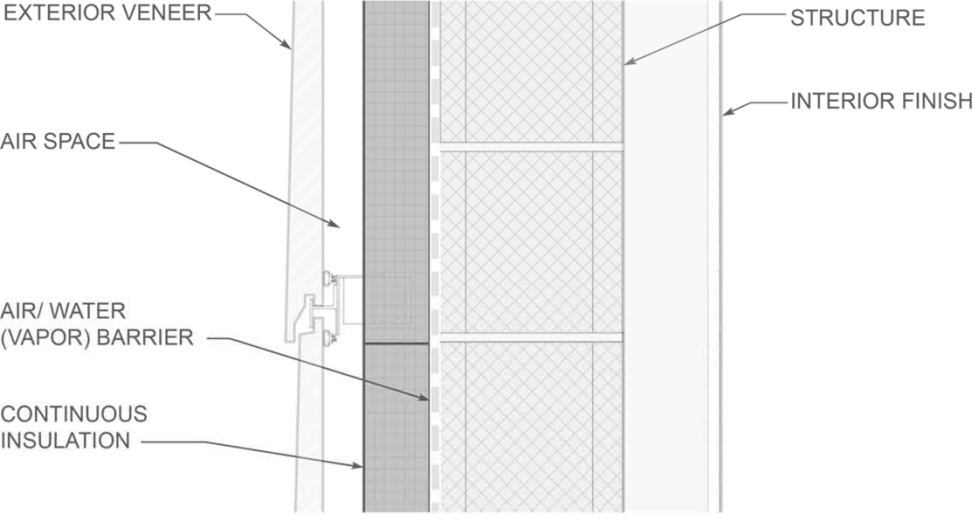
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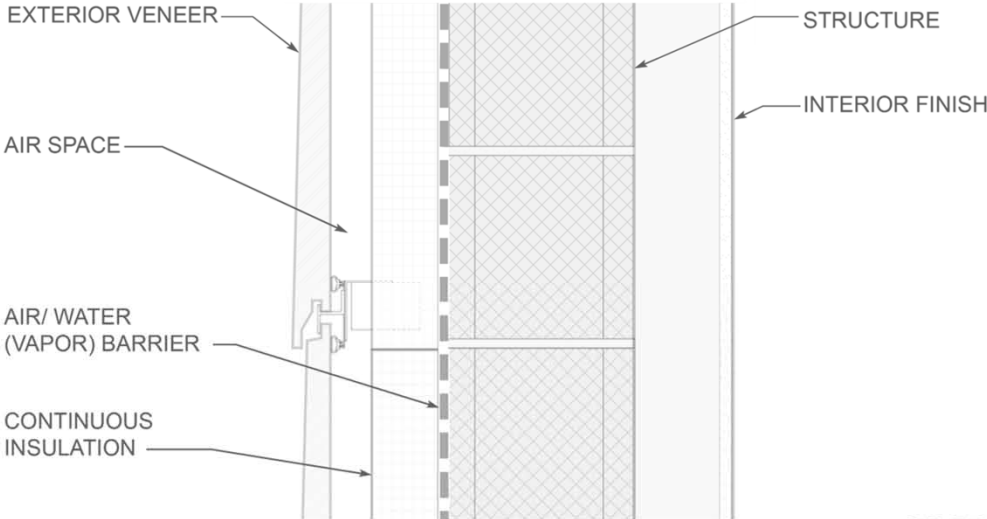
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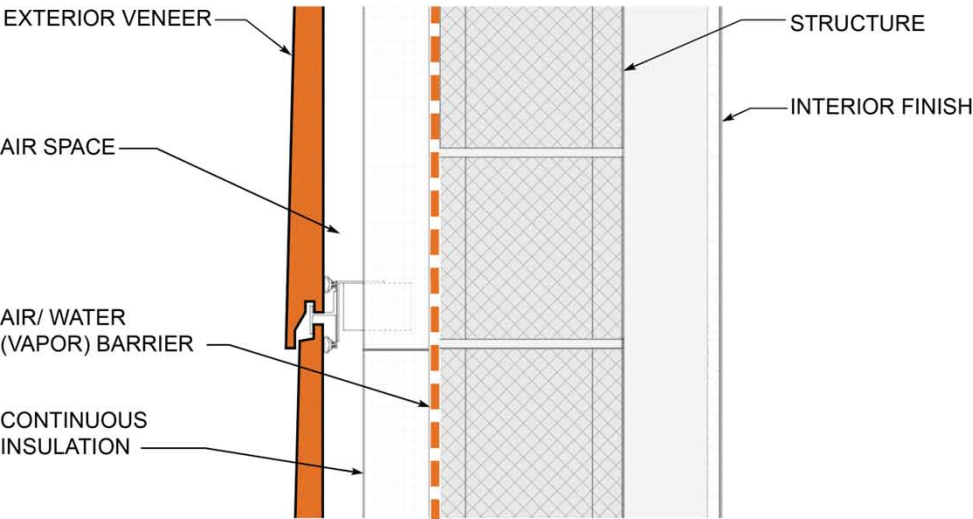
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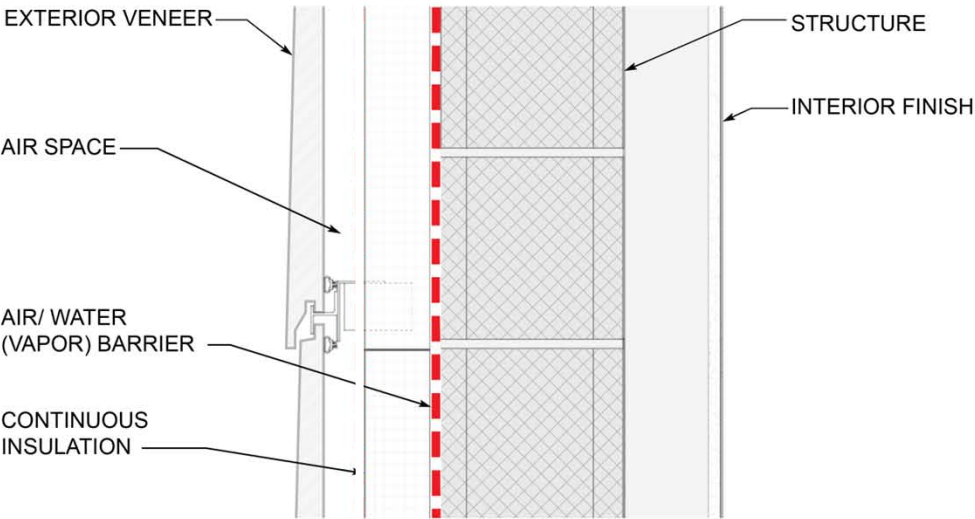
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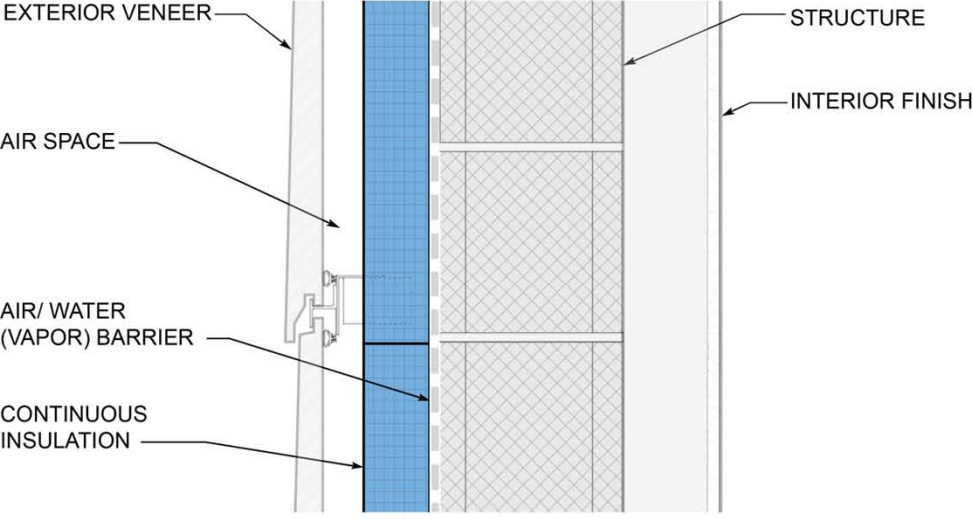
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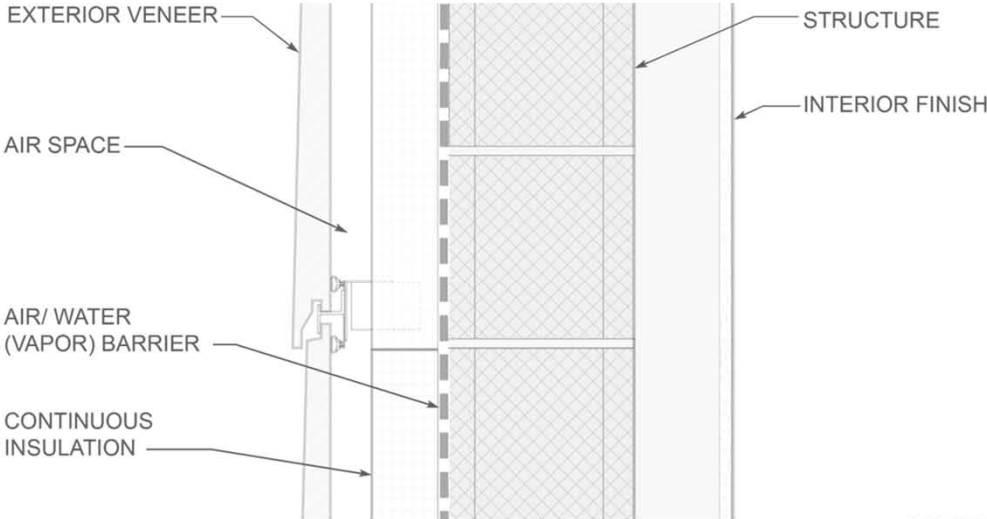
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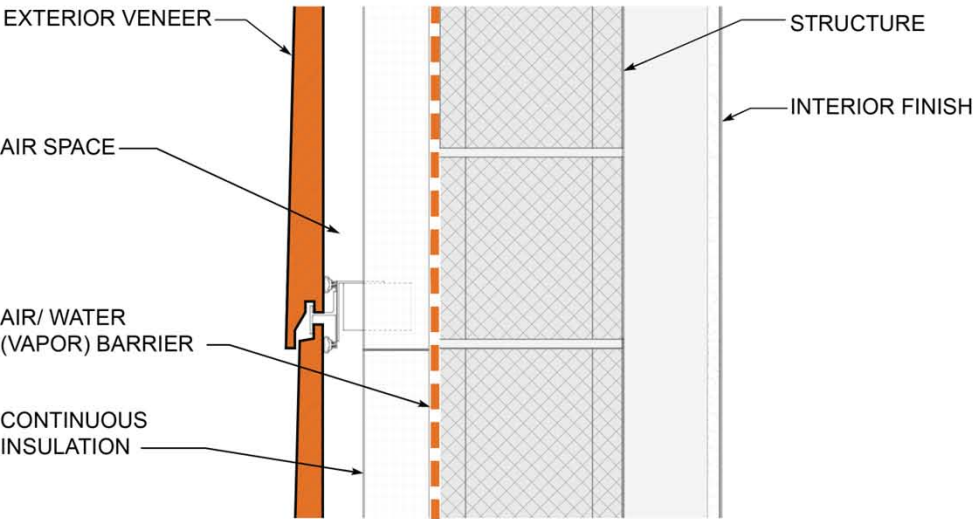
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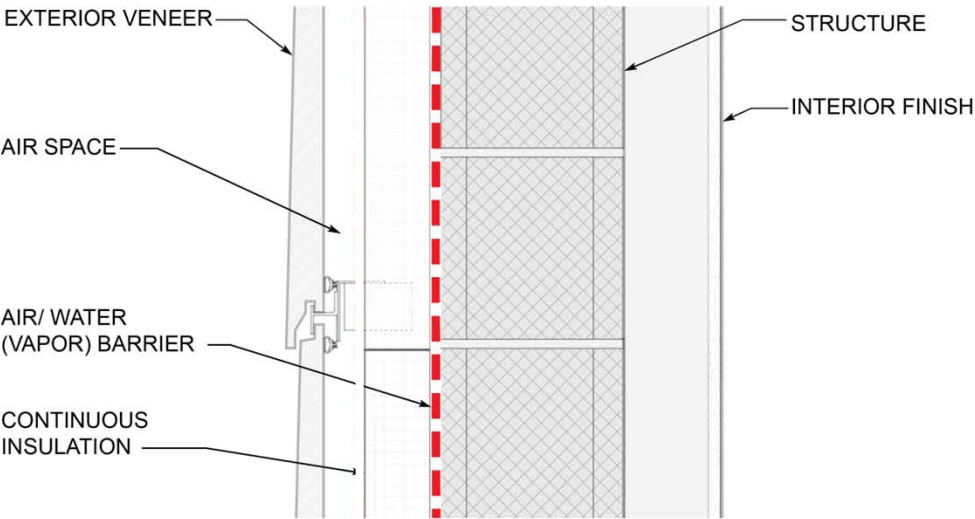
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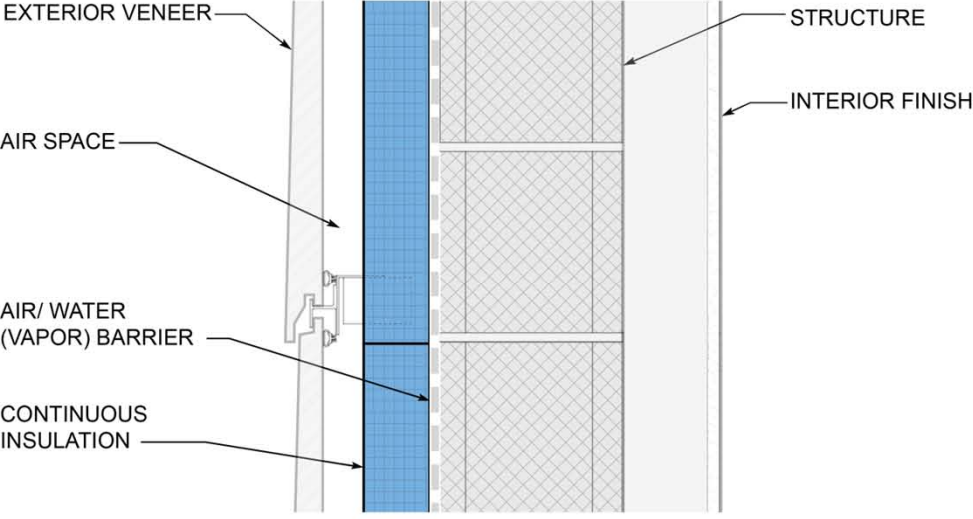
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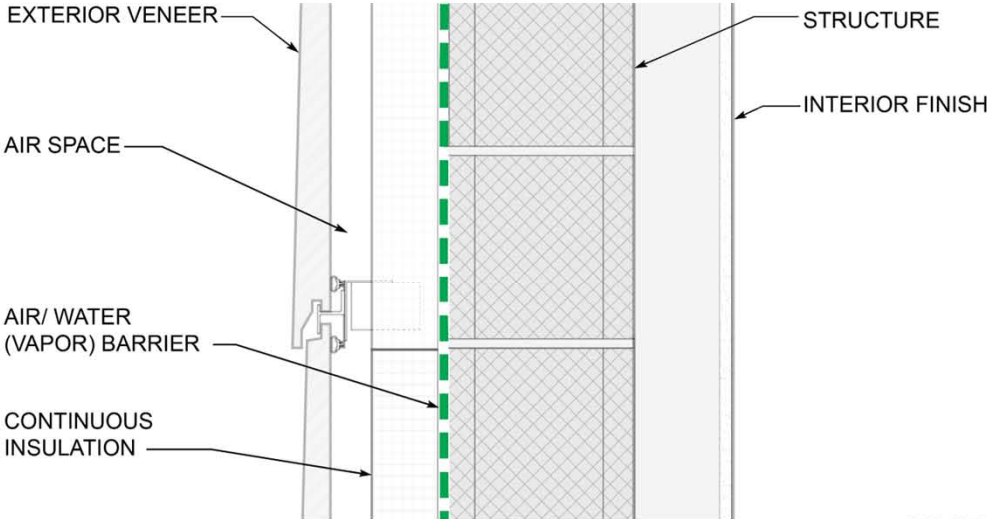
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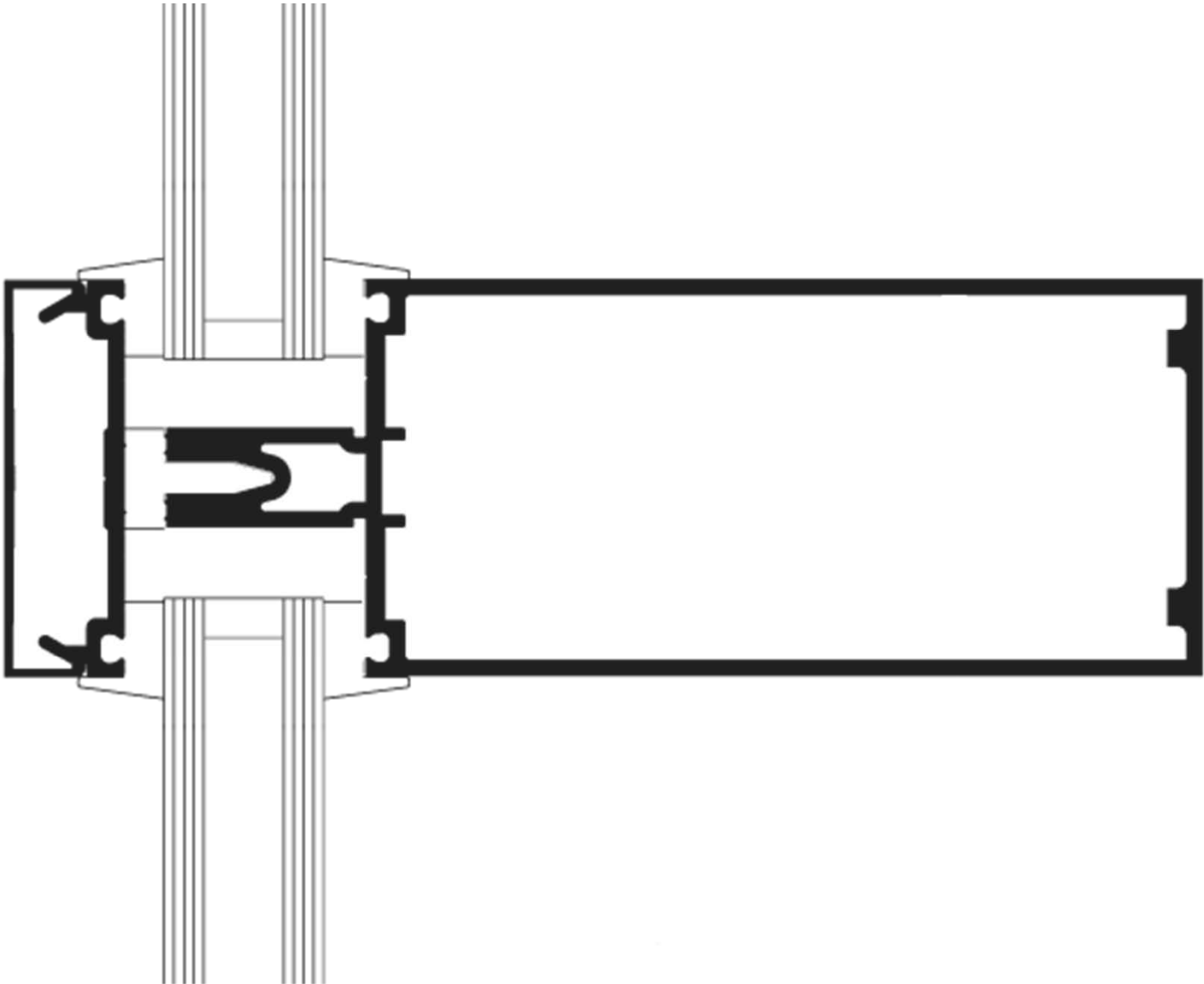
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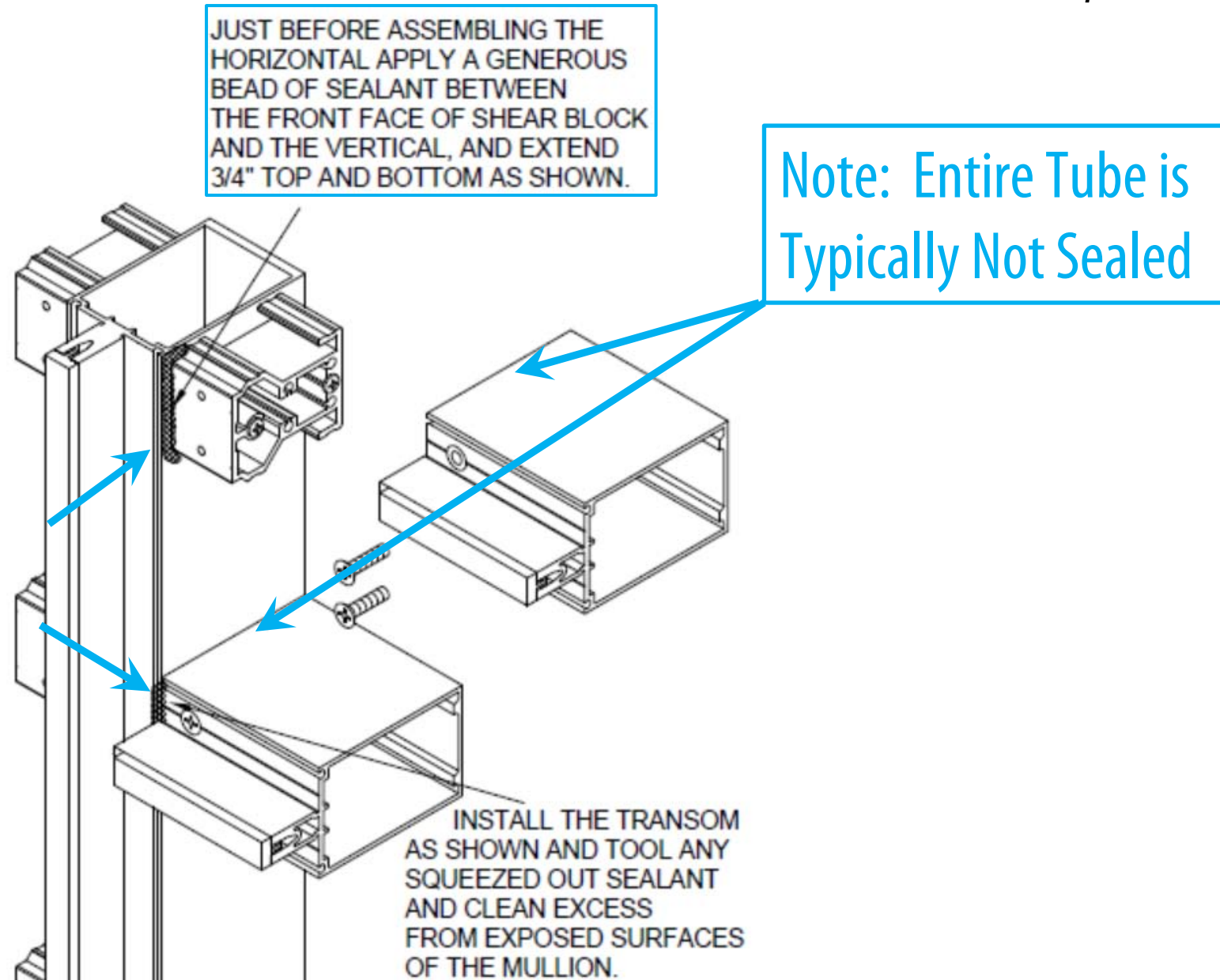


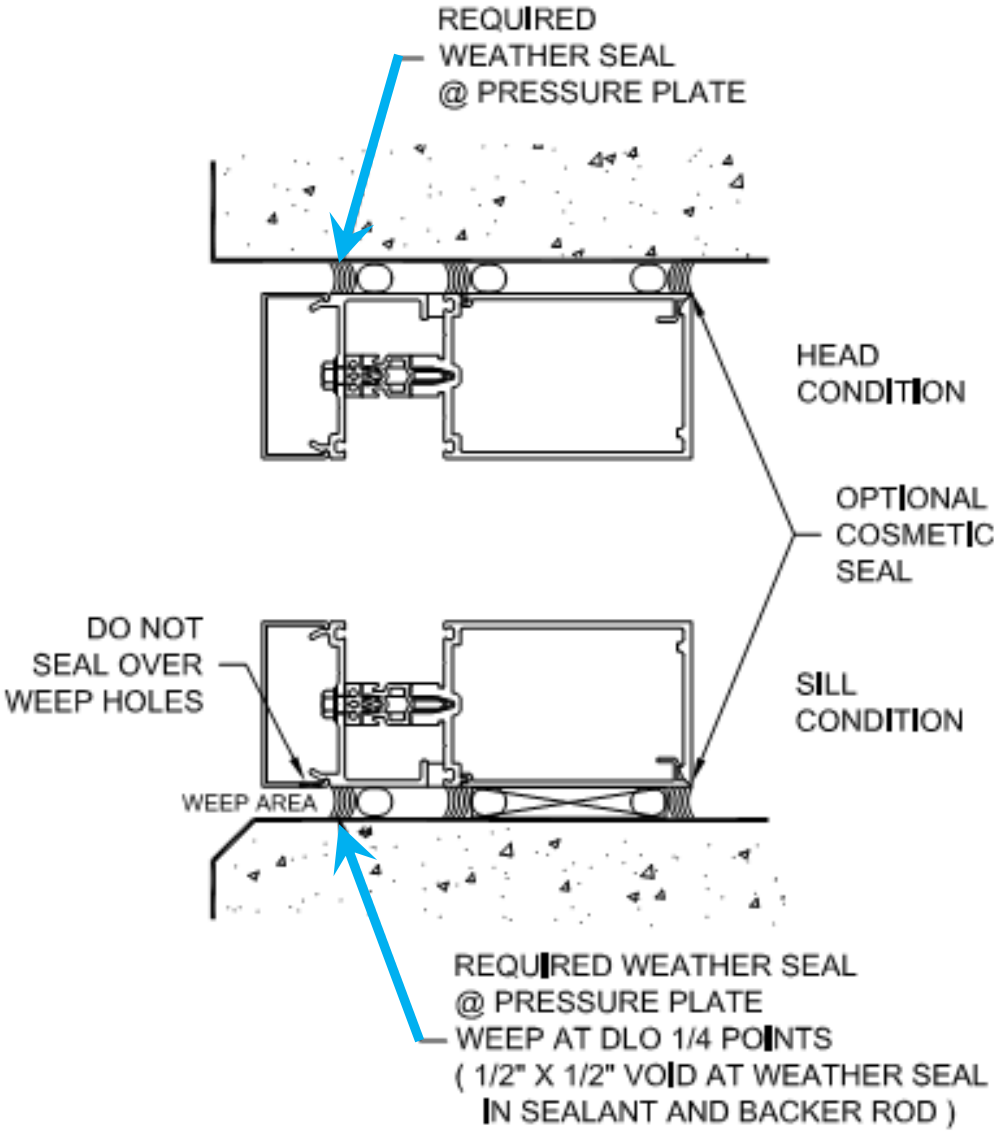
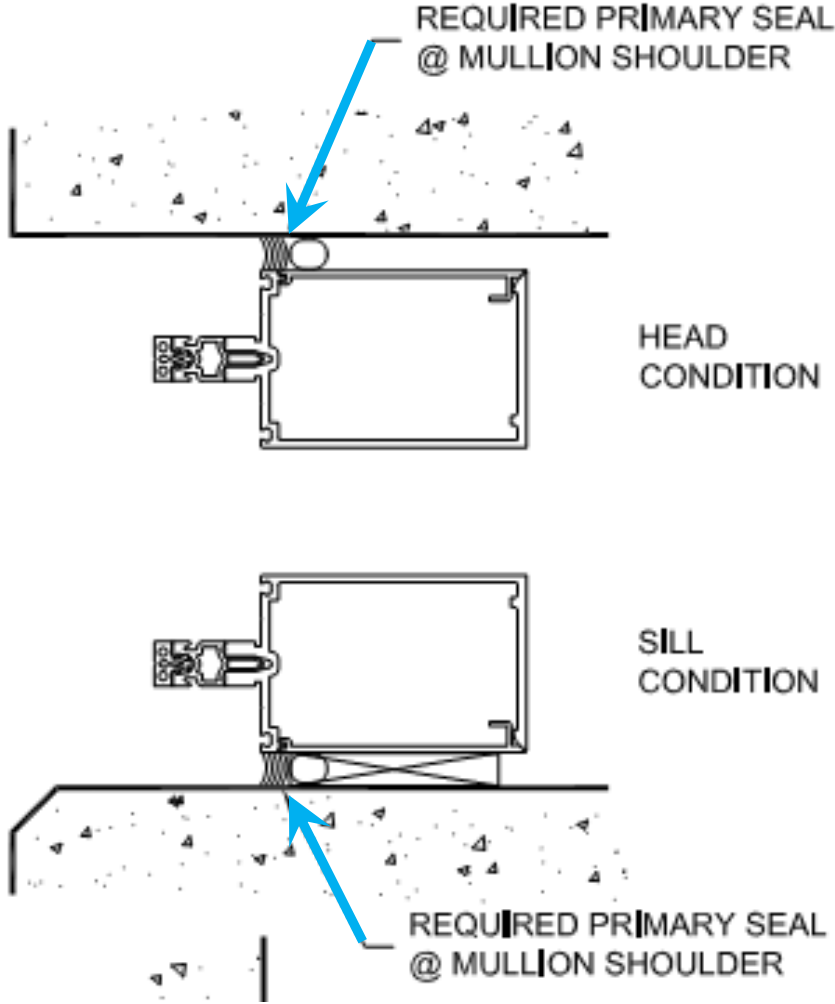
FENESTRATION

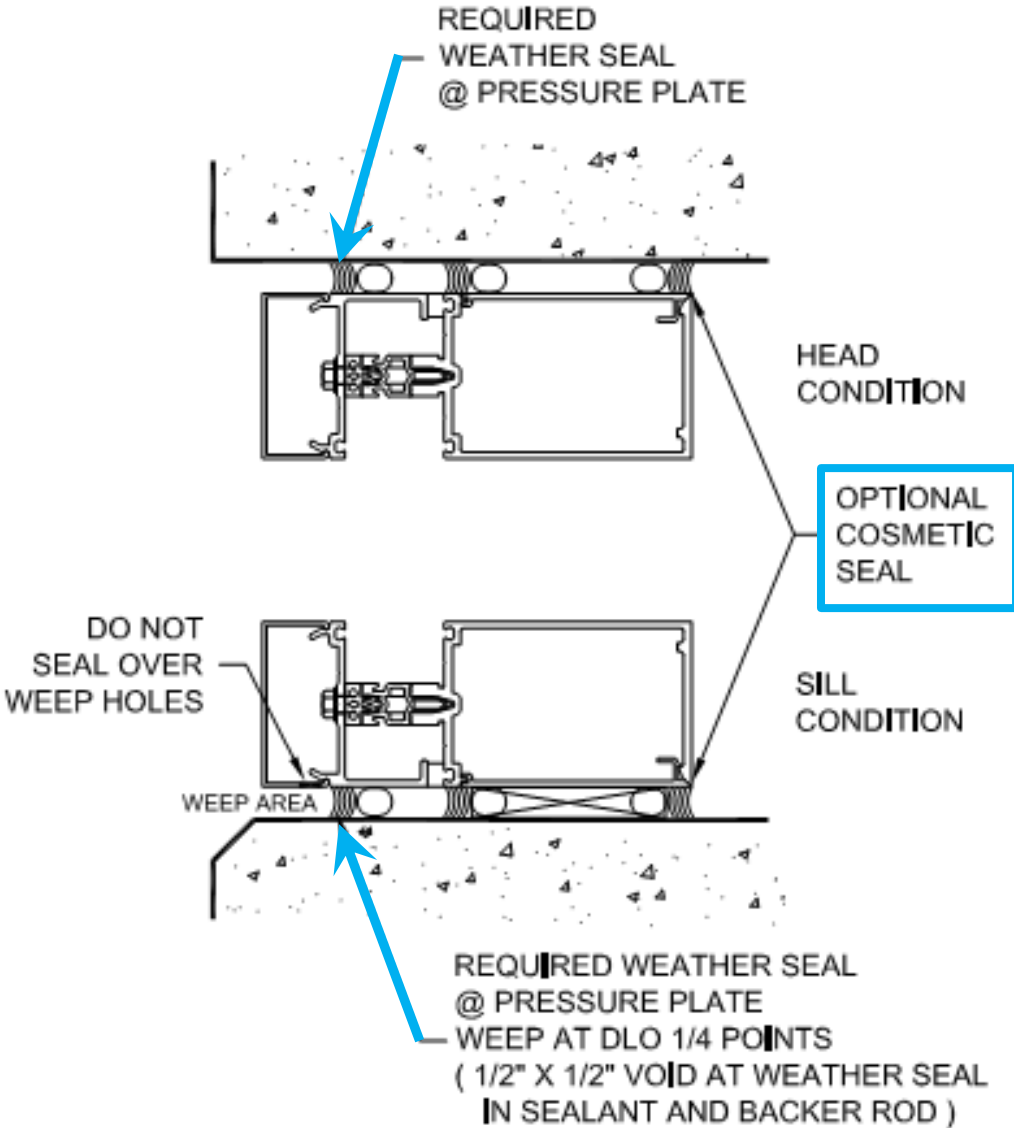
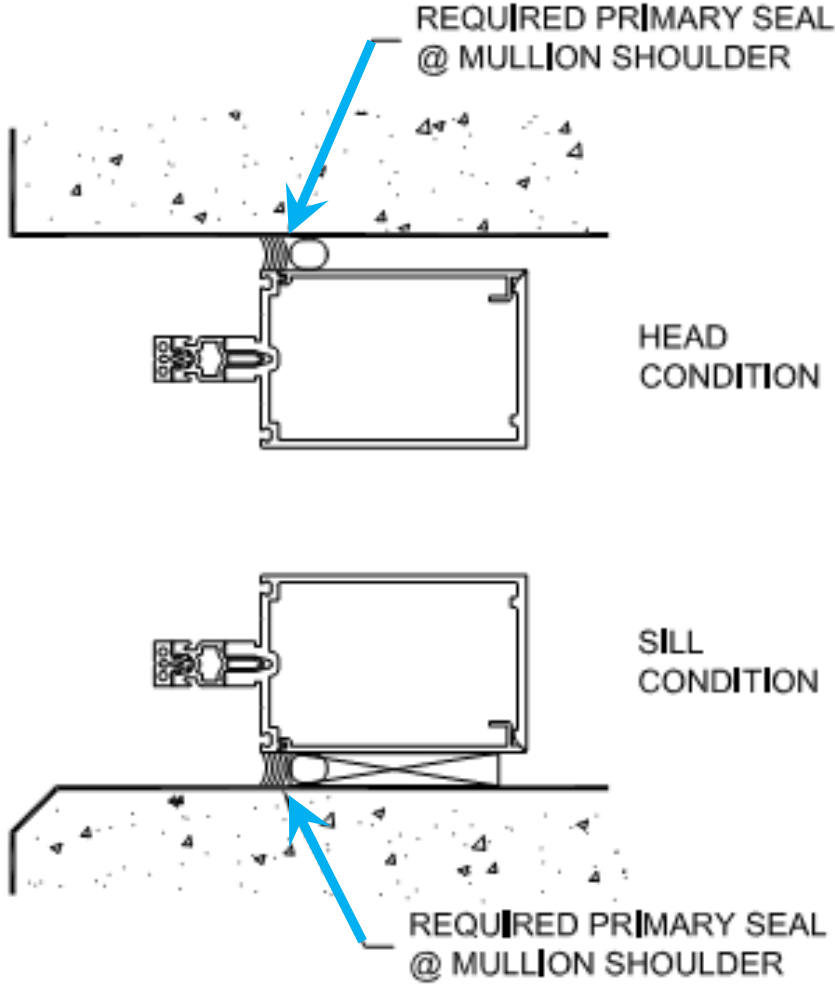
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CURTAIN WALLS

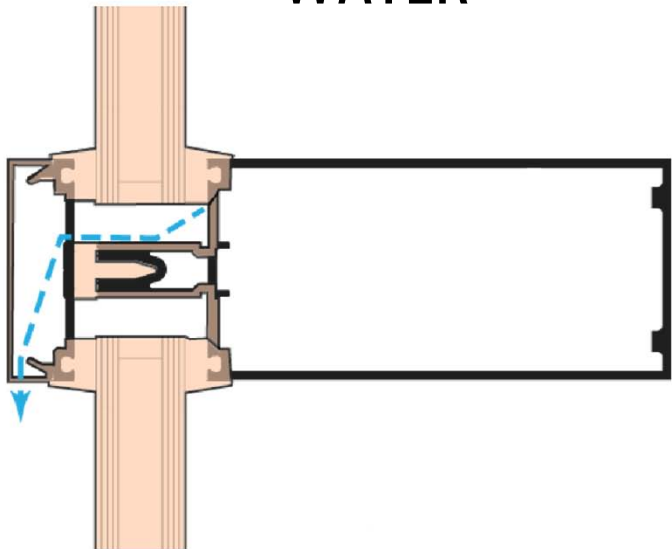




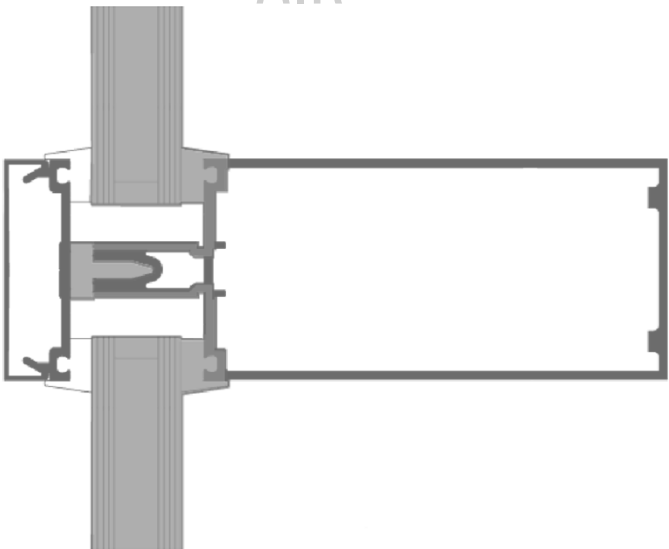




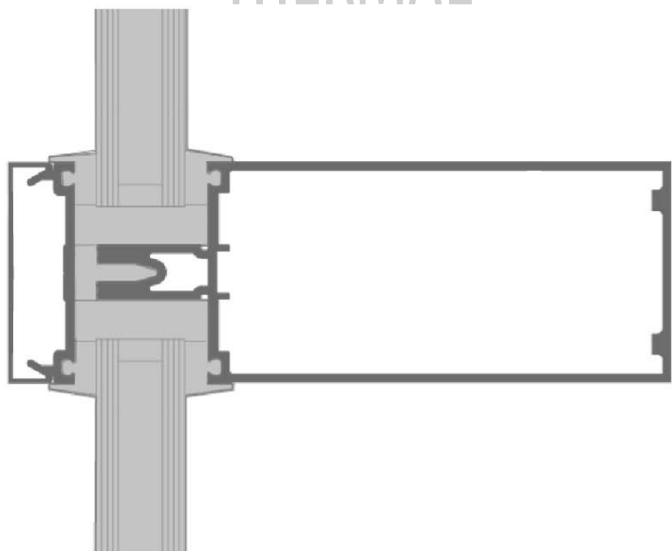
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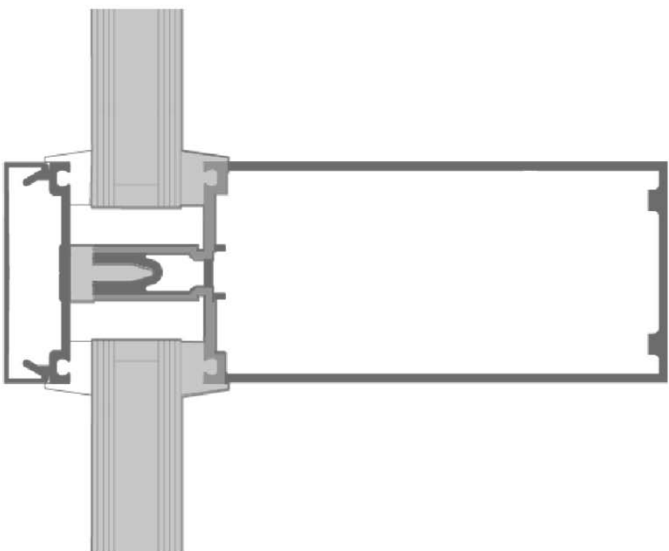
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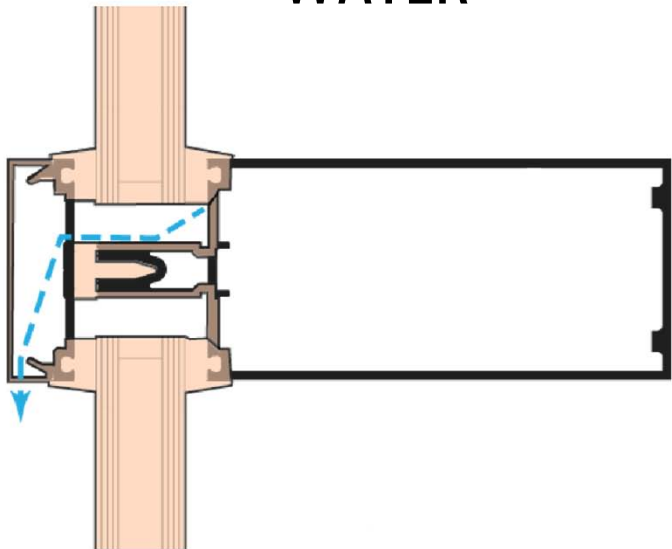
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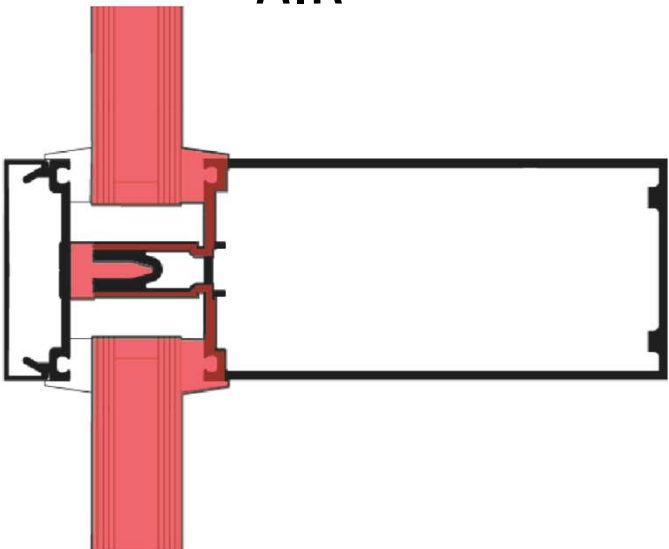
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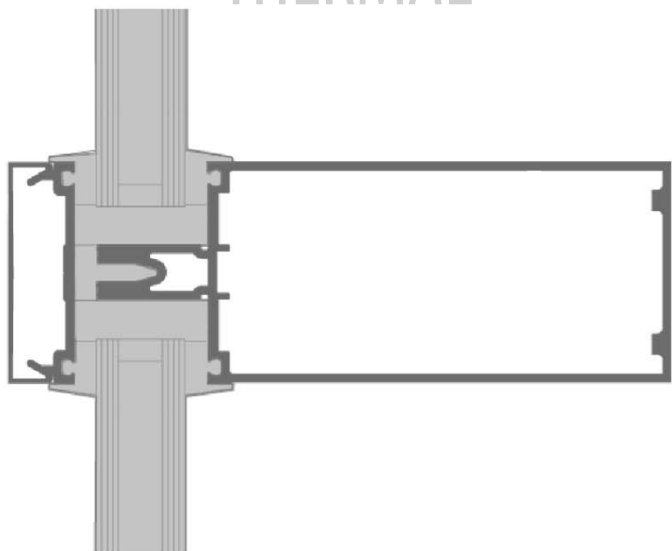
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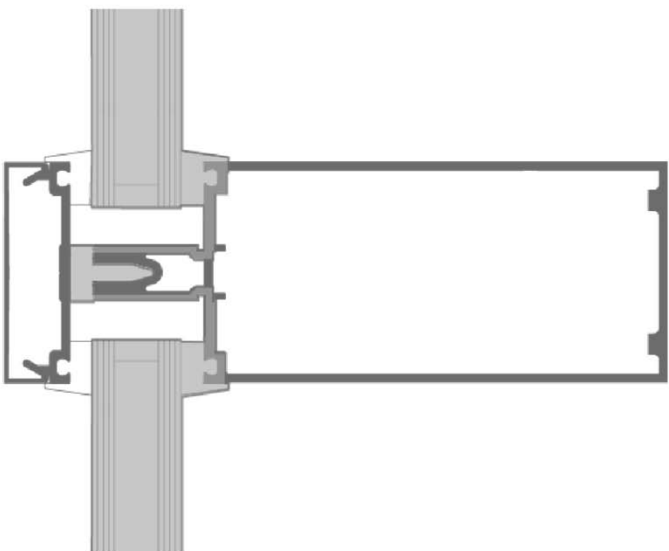
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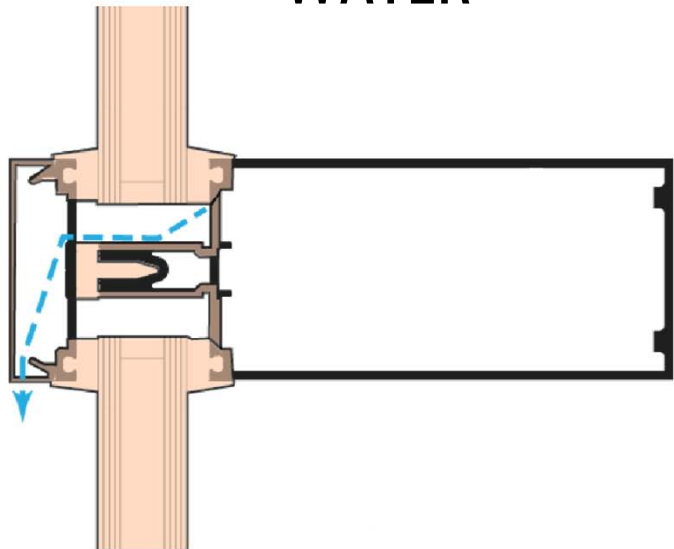
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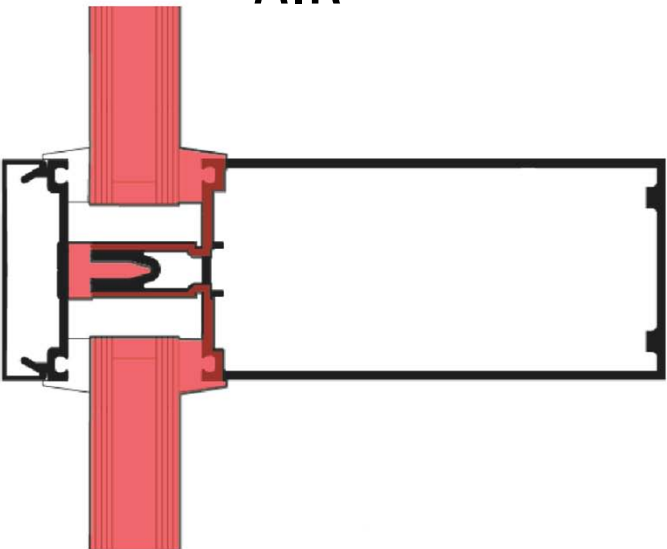
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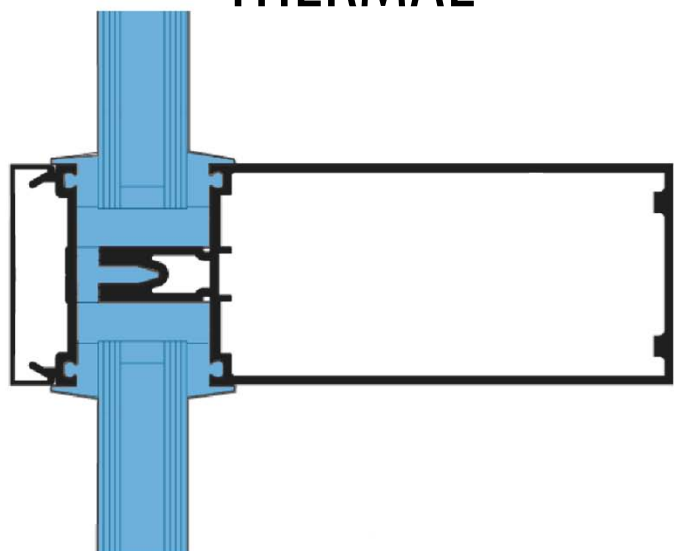
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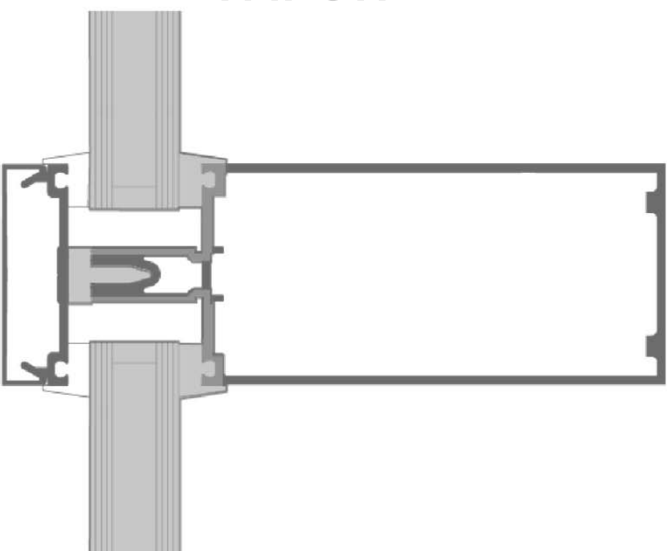
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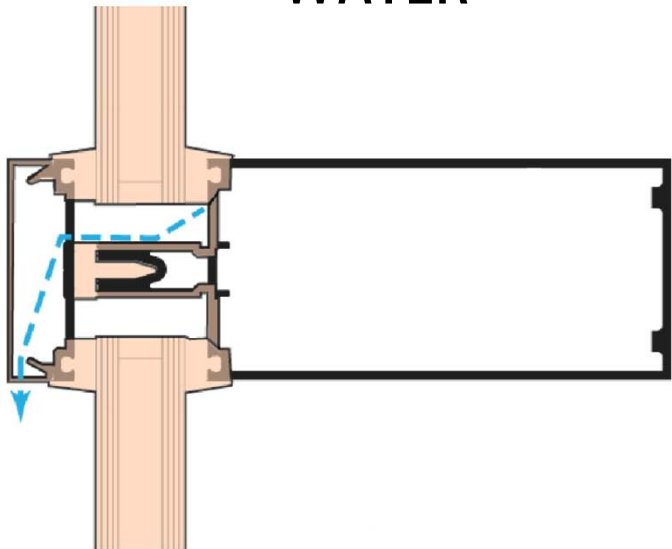
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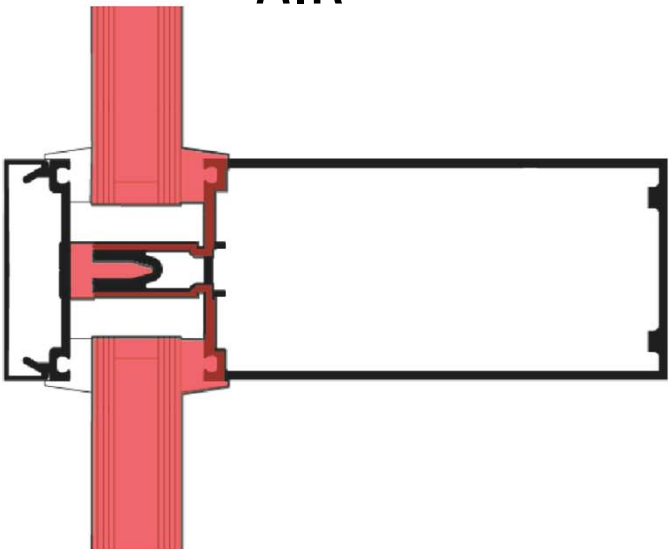
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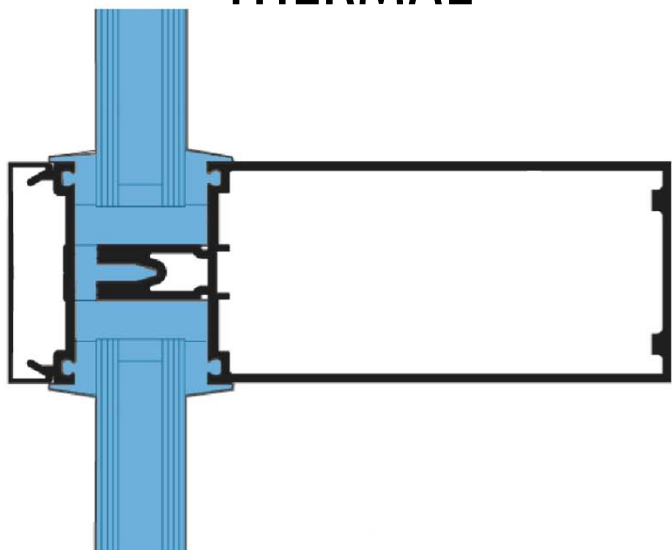
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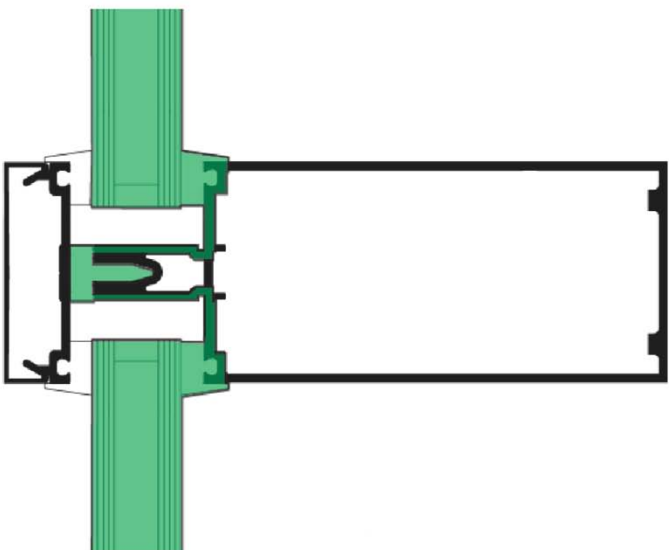
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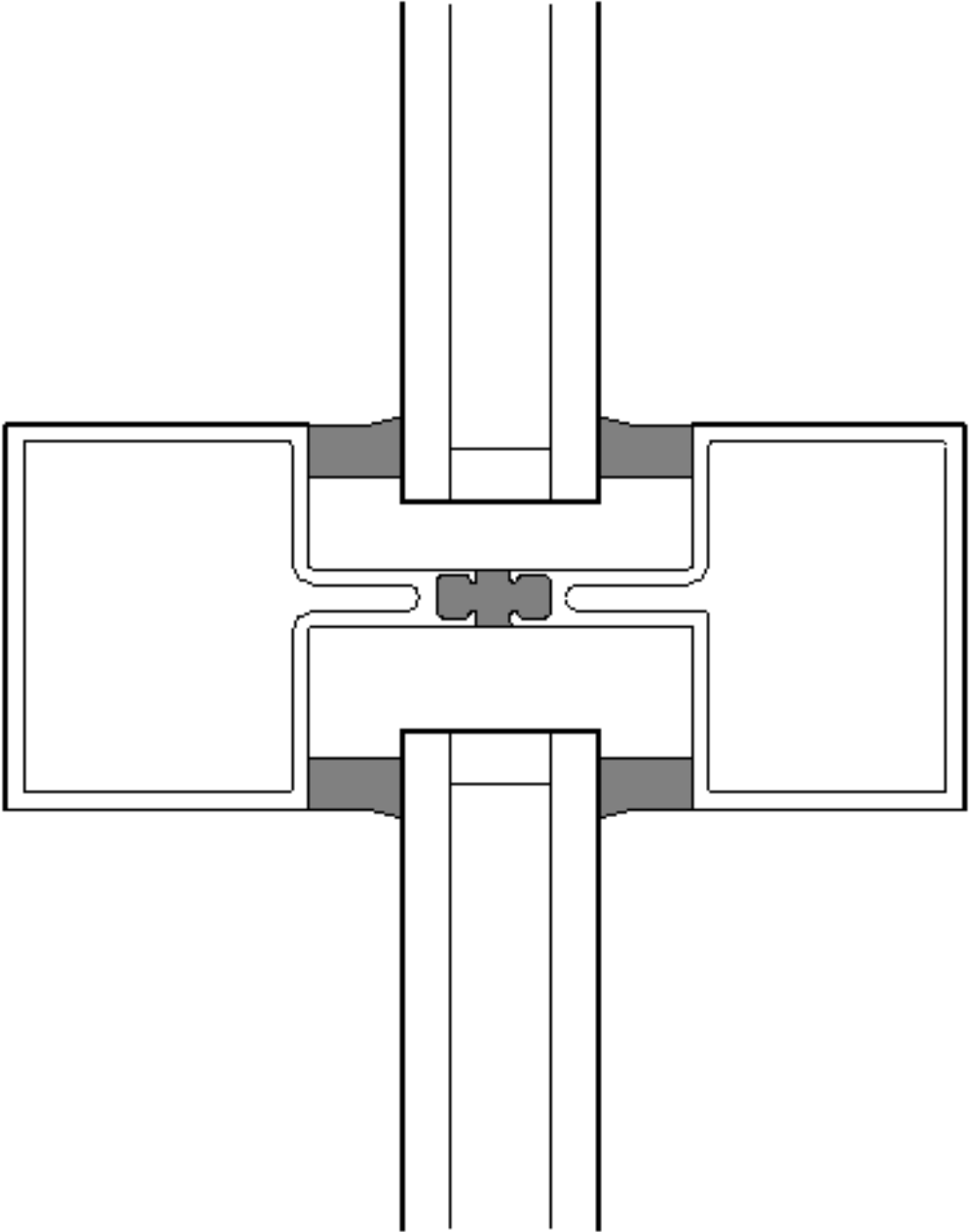


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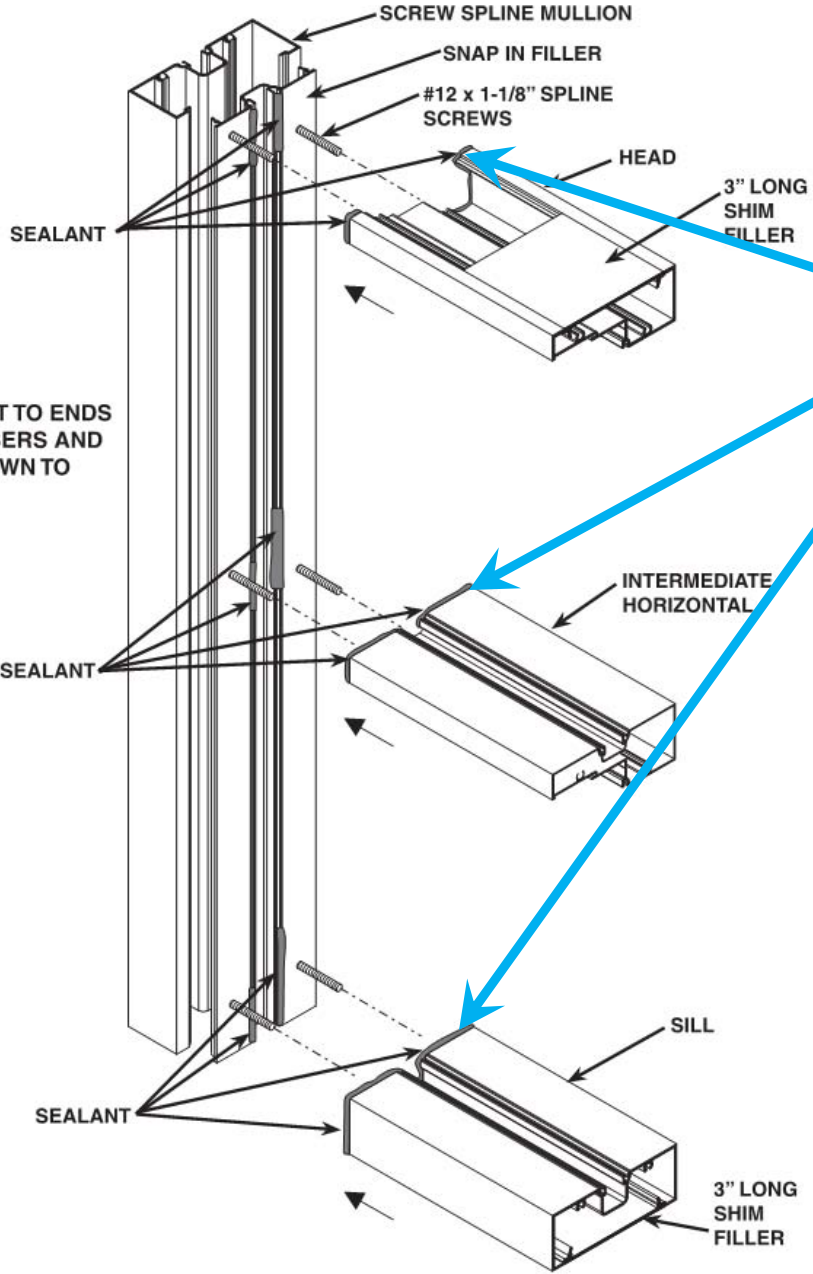


FENESTRATION

Storefronts

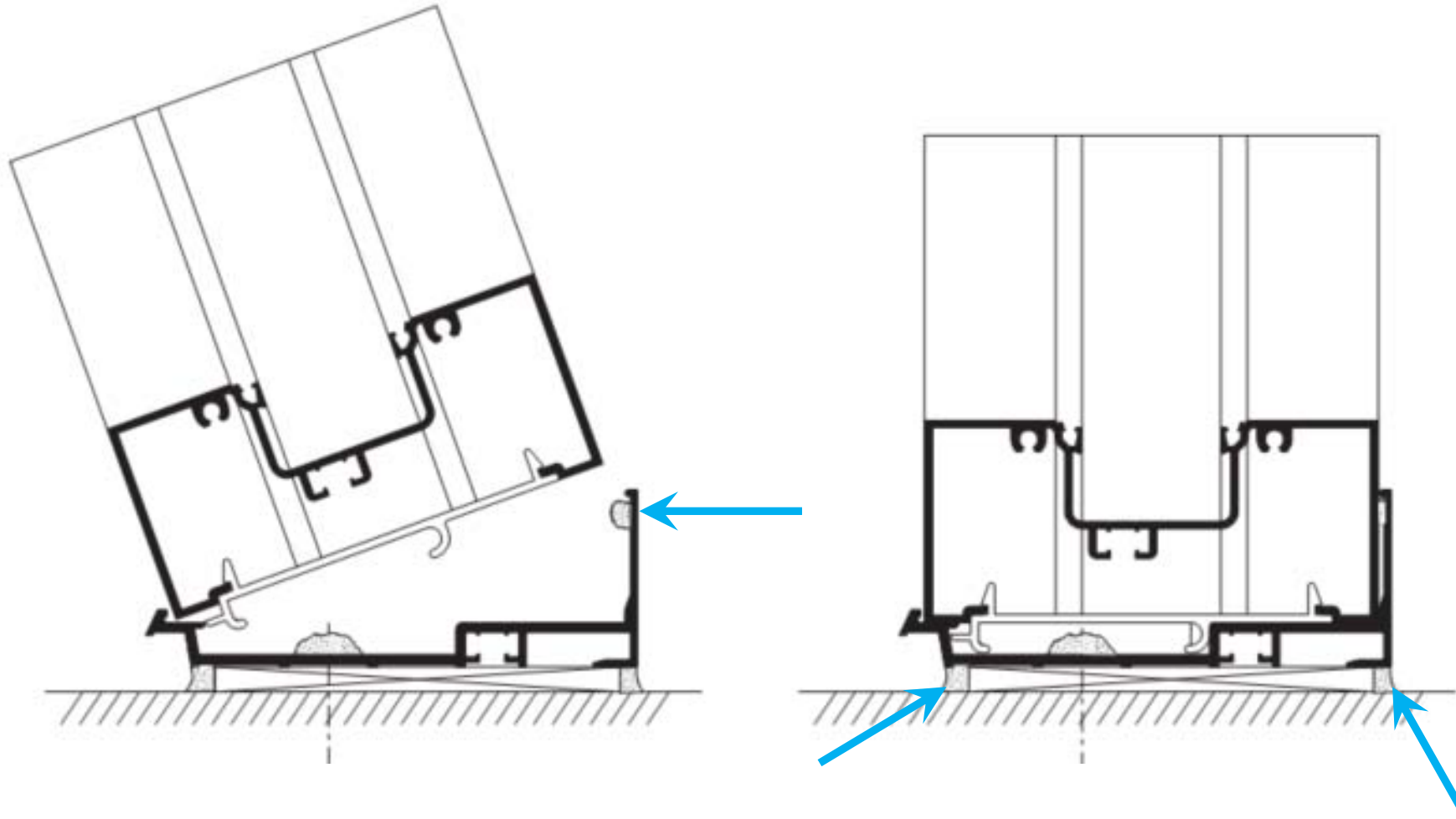


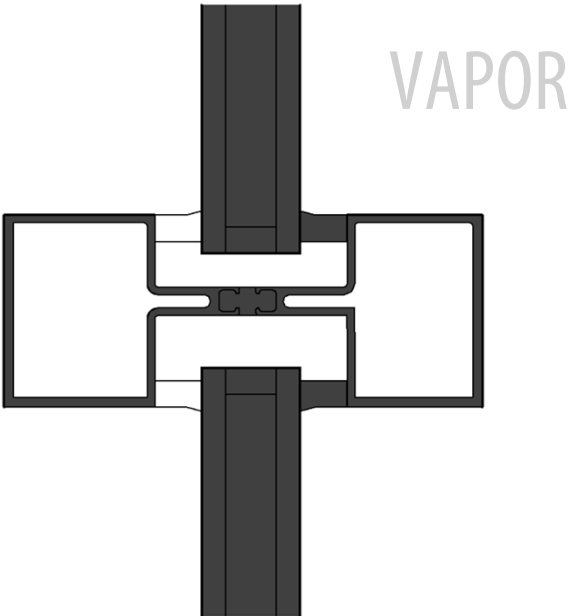
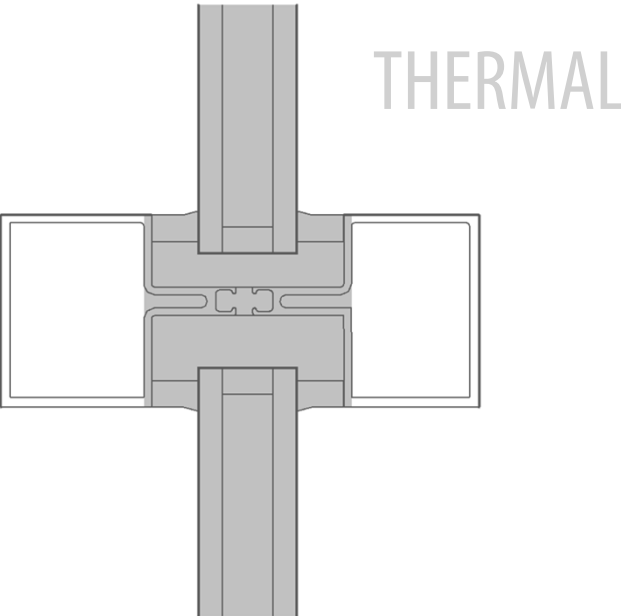
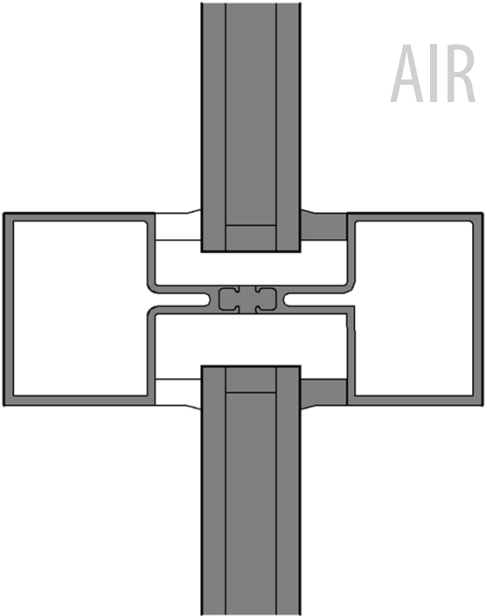
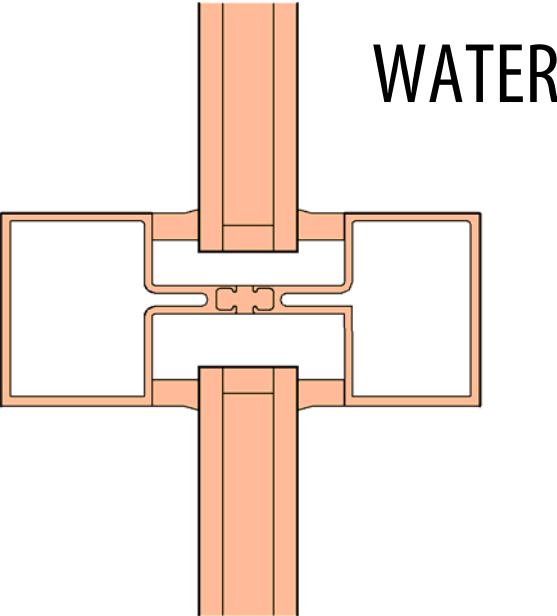
NOTE:
IT IS IMPORTANT THAT THE
INSTALLER APPLY SEALANT TO ENDS
OF ALL HORIZONTAL MEMBERS AND
GLAZING REGLETS AS SHOWN TO
ENSURE GOOD SEAL.

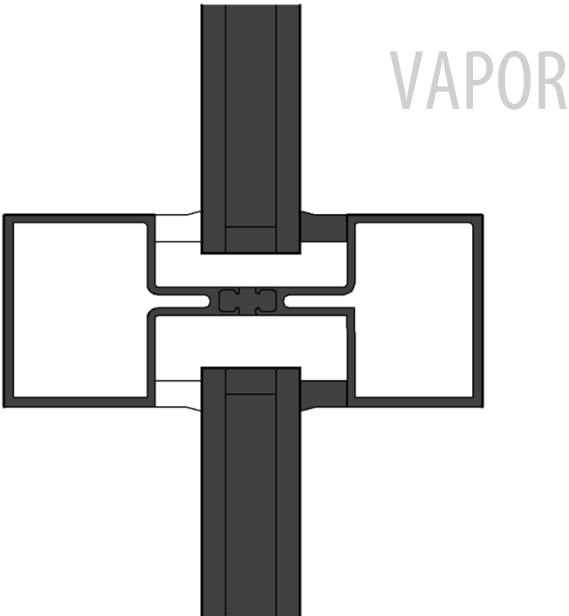
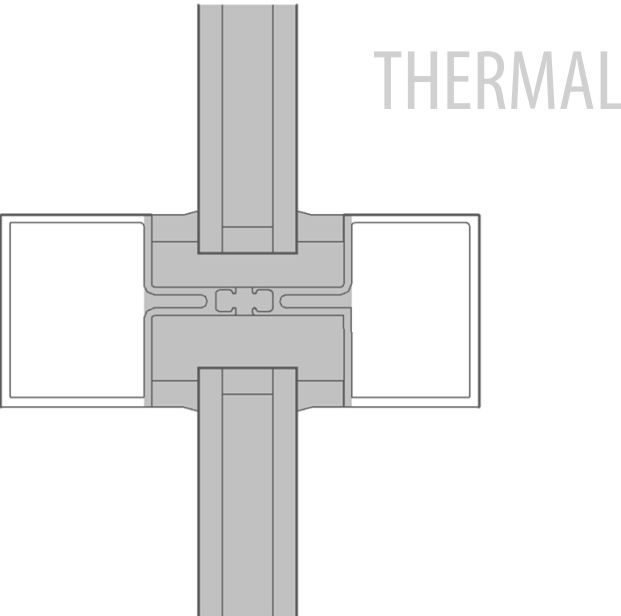
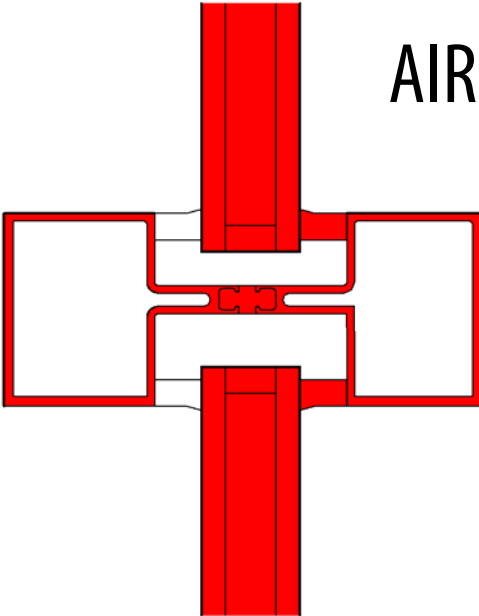
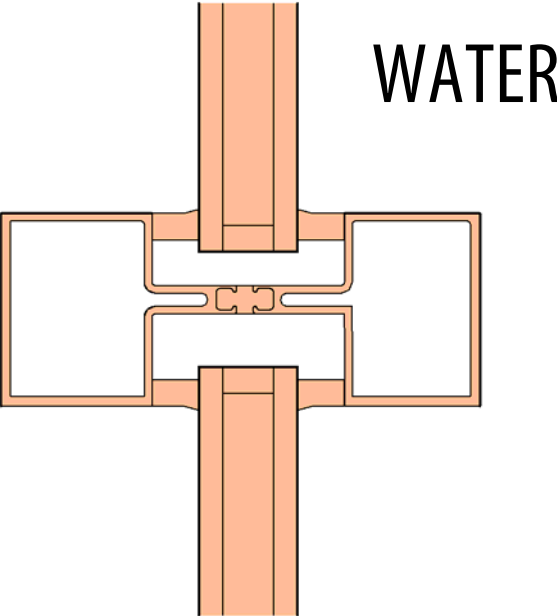


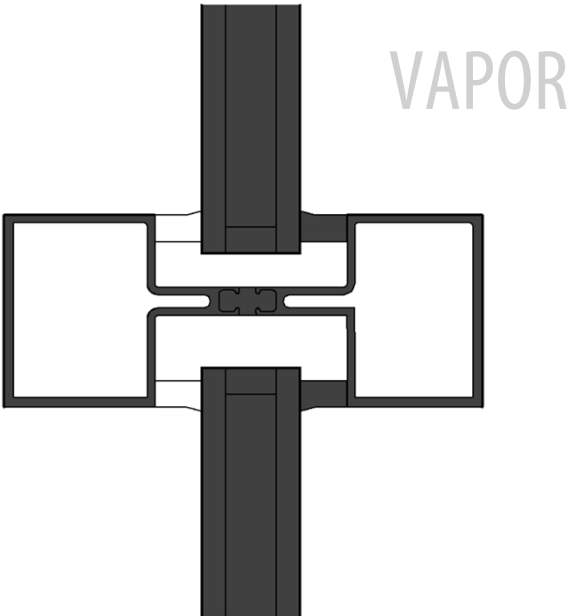
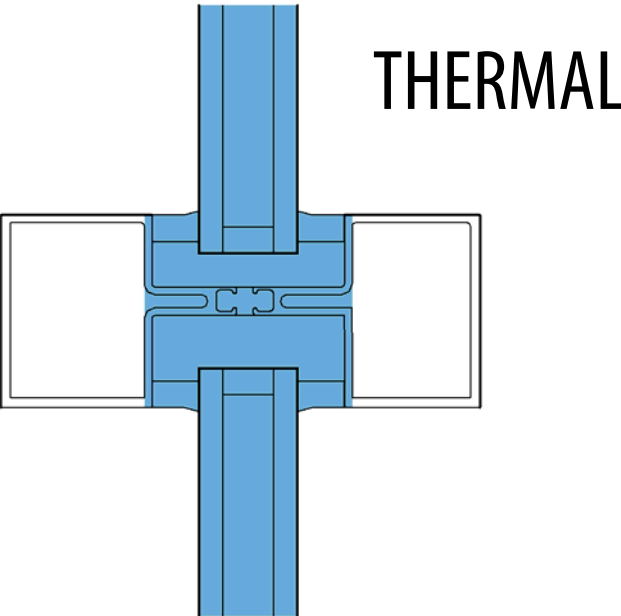
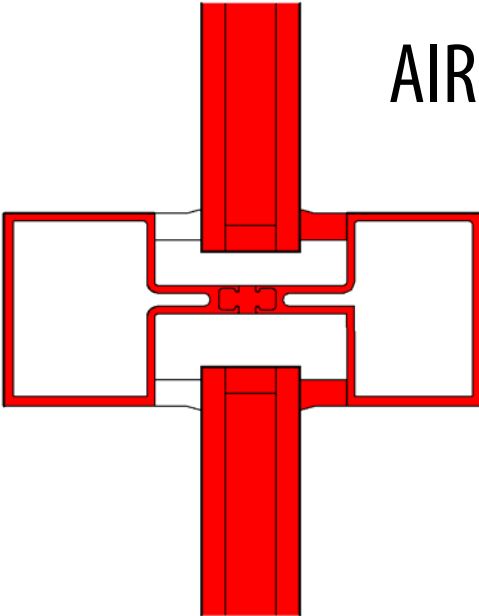
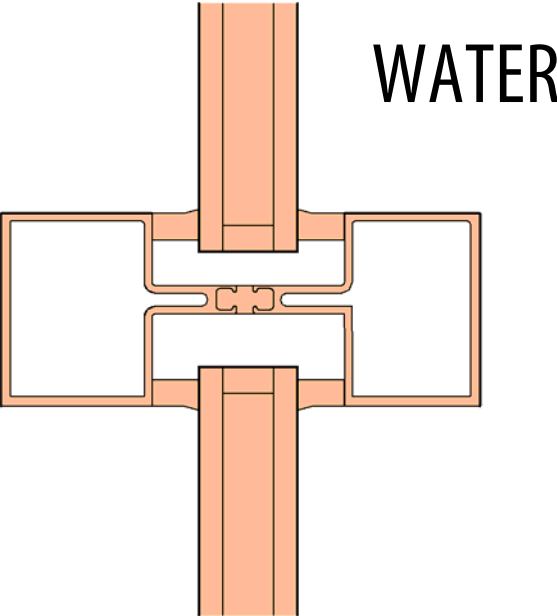
Note: Sometimes
the Entire Tube is
Sealed Full Depth

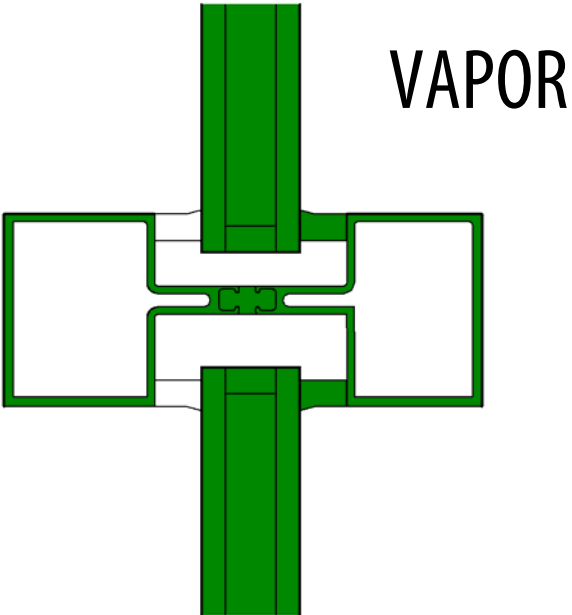
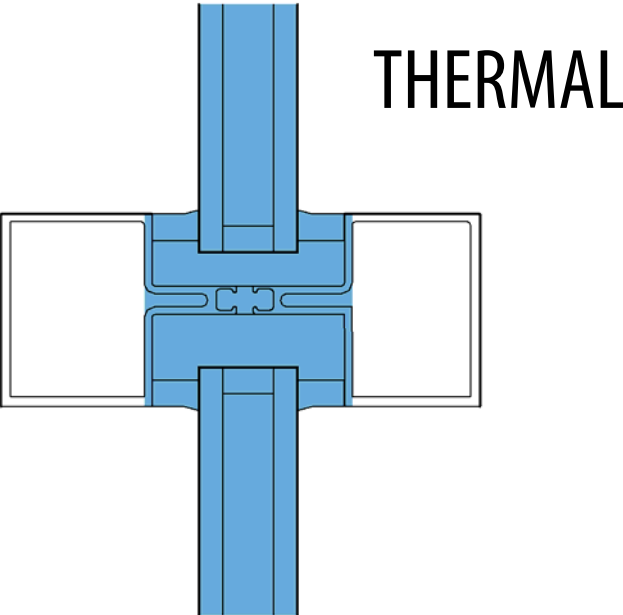
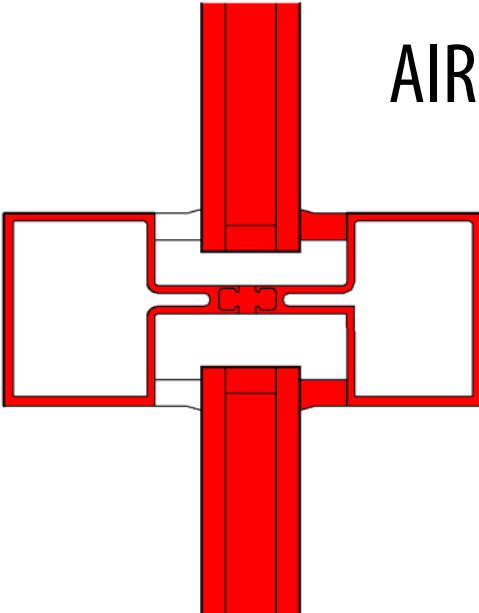
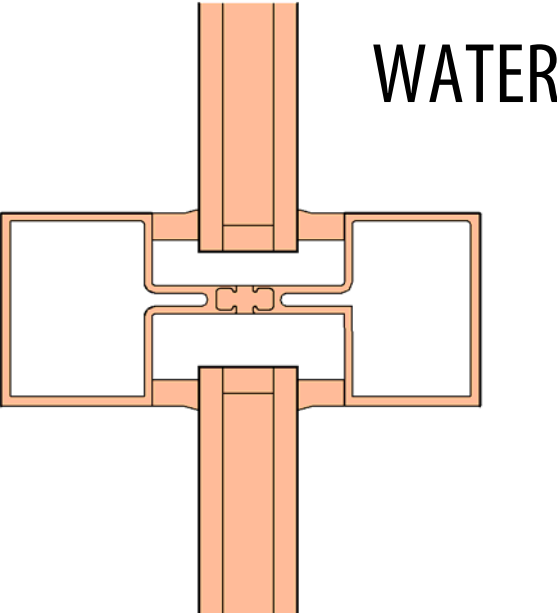
Caulk both interior and exterior at head, jamb and under sill flashing with high quality sealant. Do not block weep holes in flashing.

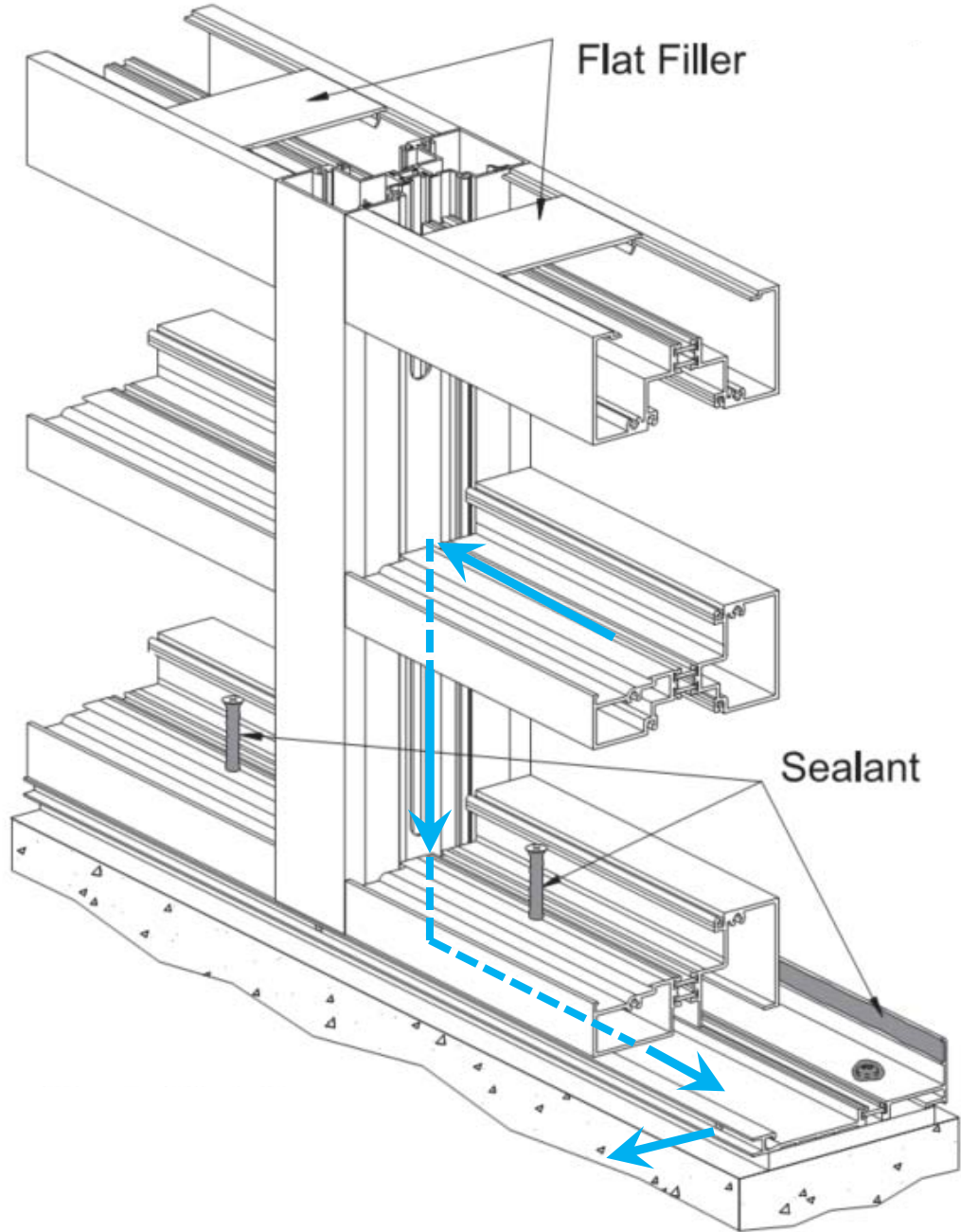












WHY DOES THIS MATTER?

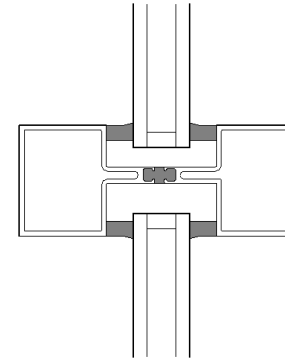
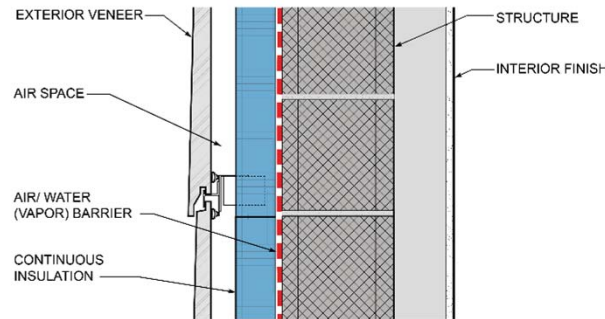
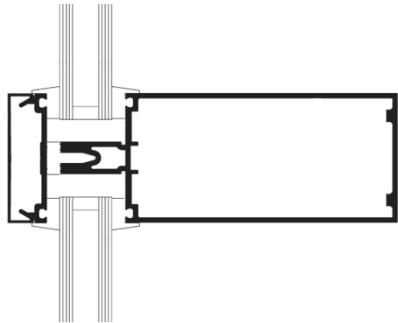
They need to Provide an
EFFECTIVE separation
between the interior and
exterior.

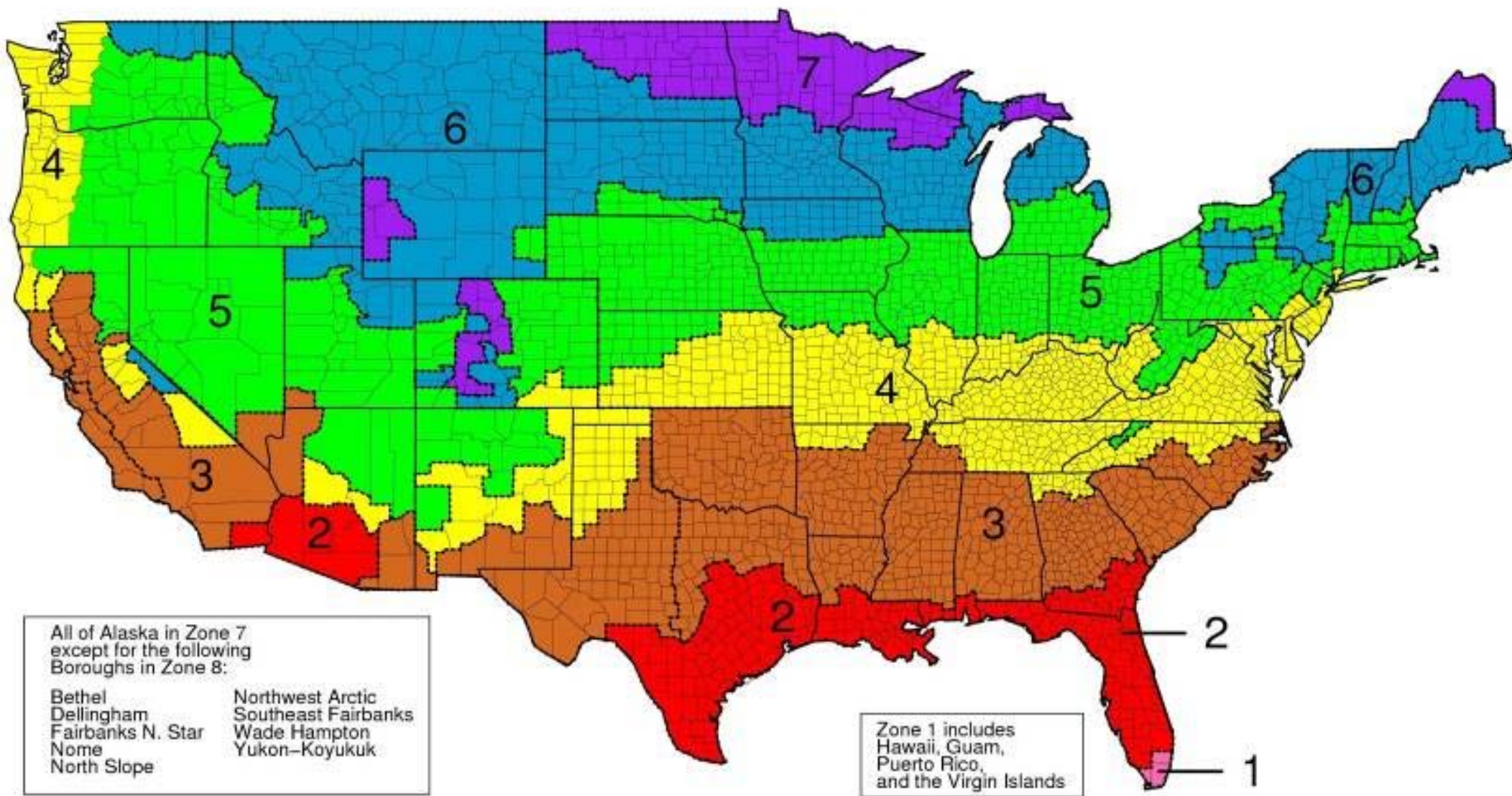
THEY MUST BE CONTINUOUS...
...TO BE EFFECTIVE

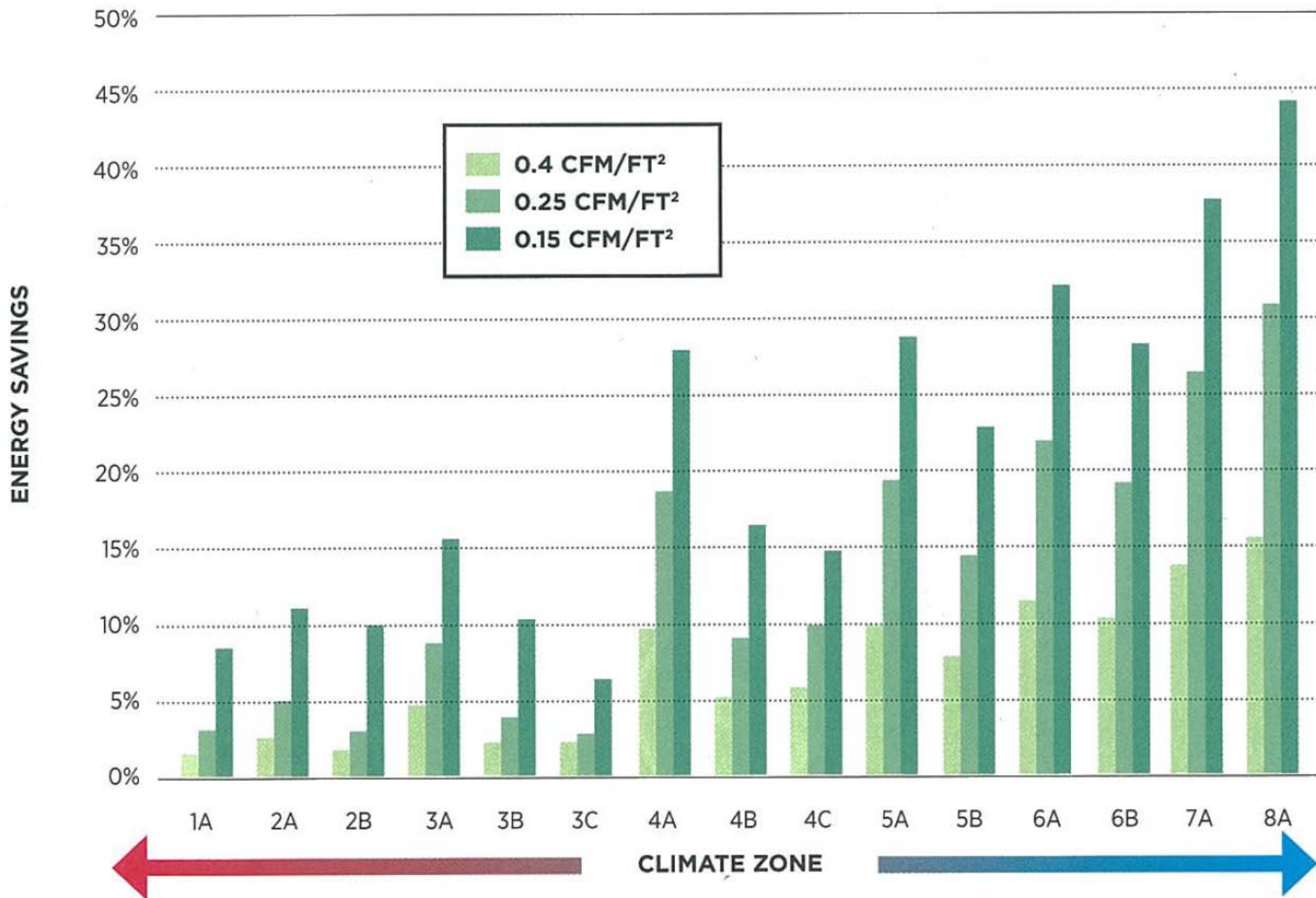
Effects of Discontinuity

Lack of Continuity may lead to...

- Water leakage
- Air leakage
- Thermal bridging
- Poor energy performance
- Condensation
- Durability problems
- Mold
- Corrosion
- Rot
- Reversion

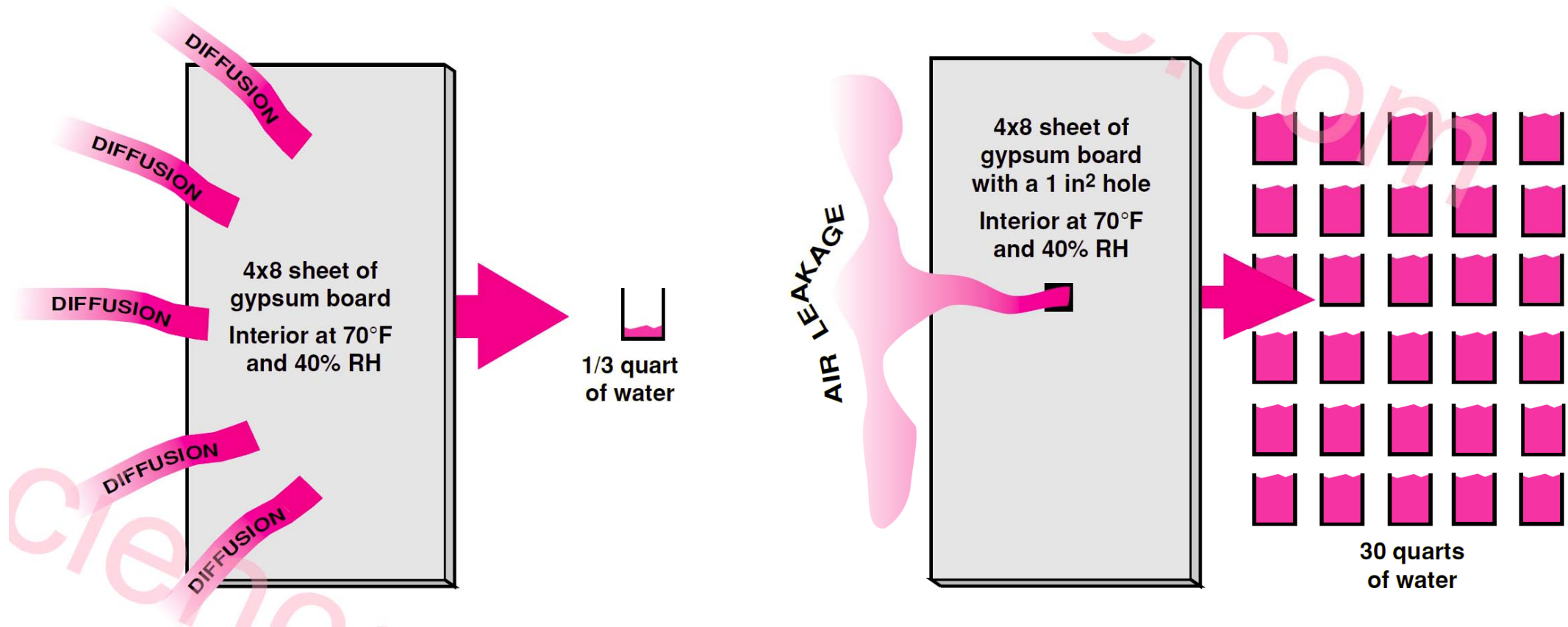






Courtesy of Buildings Magazine 8/14 and BCRA

For Vapor Control You Must First Have Air Control



Insulations, Sheathings, and Vapor Retarders: Building Science Corporation, Research Report - 0412

ENERGY SAVINGS AND MOISTURE TRANSPORT CALCULATOR

In conjunction with Oak Ridge National Laboratory (ORNL) and the National Institute of Science and Technology (NIST), we are very excited to provide this new resource to the industry to help quantify energy savings based on the use of air barriers and increasing the airtightness of buildings.





[LEARN MORE](#)






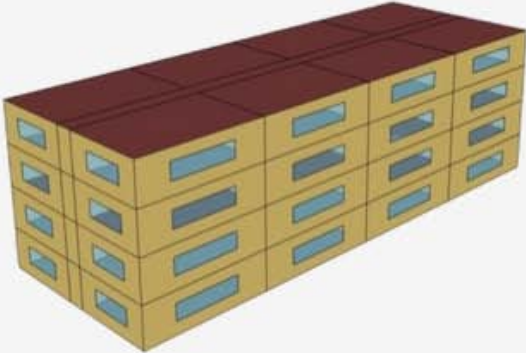
Energy Savings and Moisture Transport Calculator







Energy Savings and Moisture Transport Calculator


Location:  United States  Pennsylvania  Pittsburgh 


Building Type:  Mid-Rise Apartment  **Floor Area:**  ft² 33700




Leakage Rates:  CFM/ft² 

Base case: 1.318895  **Retrofitted building:** 0.0492125 

Energy Costs: 

Electricity: (\$/kWh) 0.09 **Natural Gas: \$/1000 ft³**  10.13

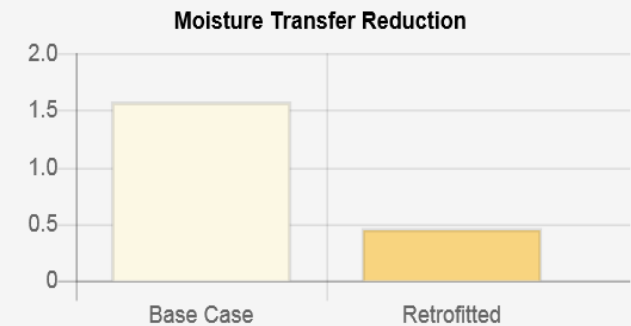
Calculate >> 

Results Display

Leakage Rate		Equivalent Leakage Area	
Base Case	Retrofitted Building	Base Case	Retrofitted Building
5.40 L/s/m ² at 75 Pa	2.00 L/s/m ² at 75 Pa	19.34 ft ²	7.16 ft ²

Predicted Savings	Electricity	Natural Gas
Energy	9,502 kWh	329,947 ft ³
Cost	\$ 855.21	\$ 2,397.77
Total Cost Savings	\$ 3,252.98	

Moisture Transfer Into the space Due to the Air Leakage	
Base Case	Retrofitted Building
1.57 gal/ft ² /year	0.46 gal/ft ² /year







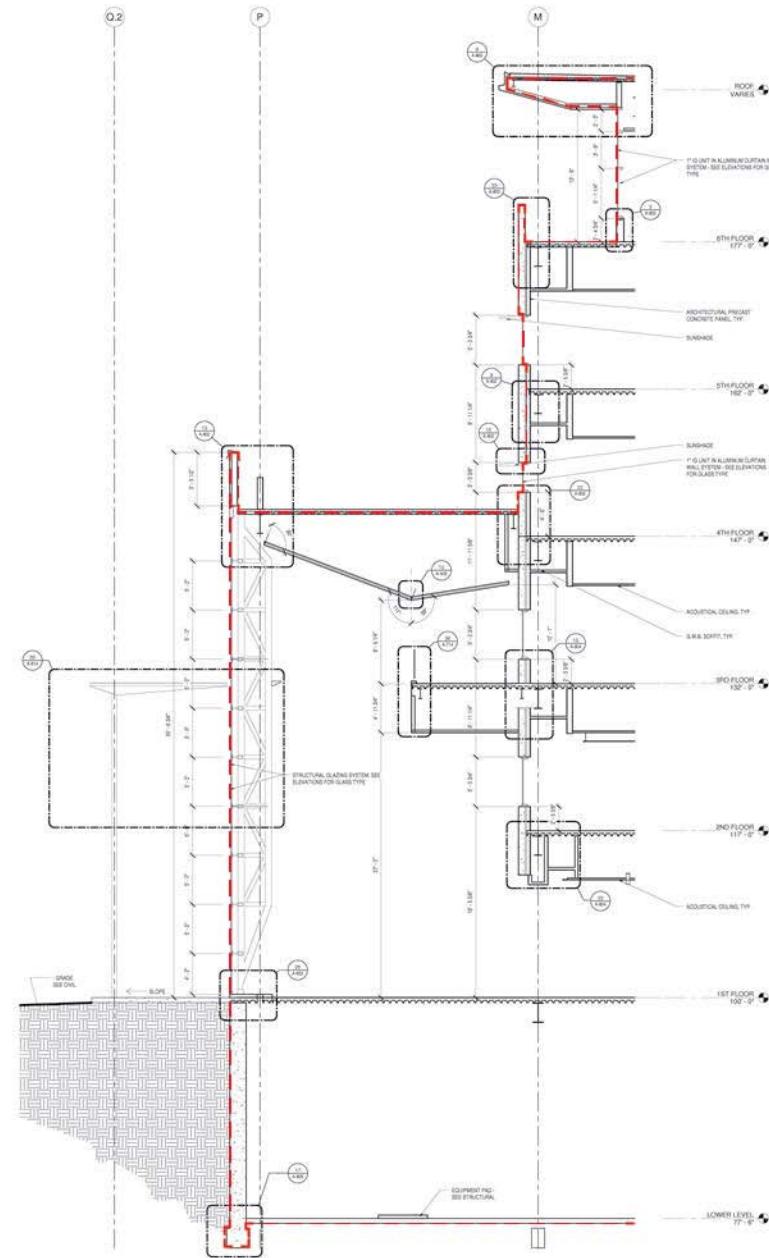




Avoid Discontinuity

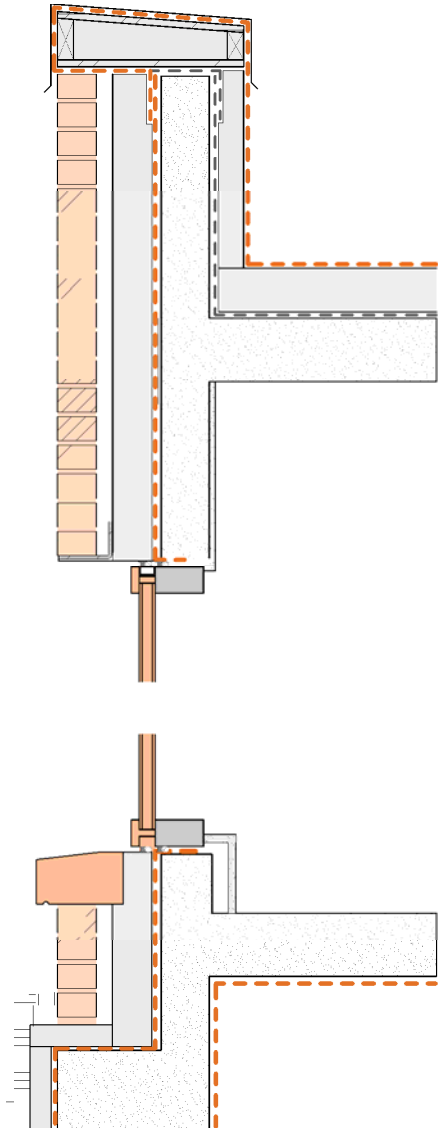
Avoid Discontinuity

- Roofs
- Walls
- Fenestration
- Below Grade Walls
- Soffits
- Transitions

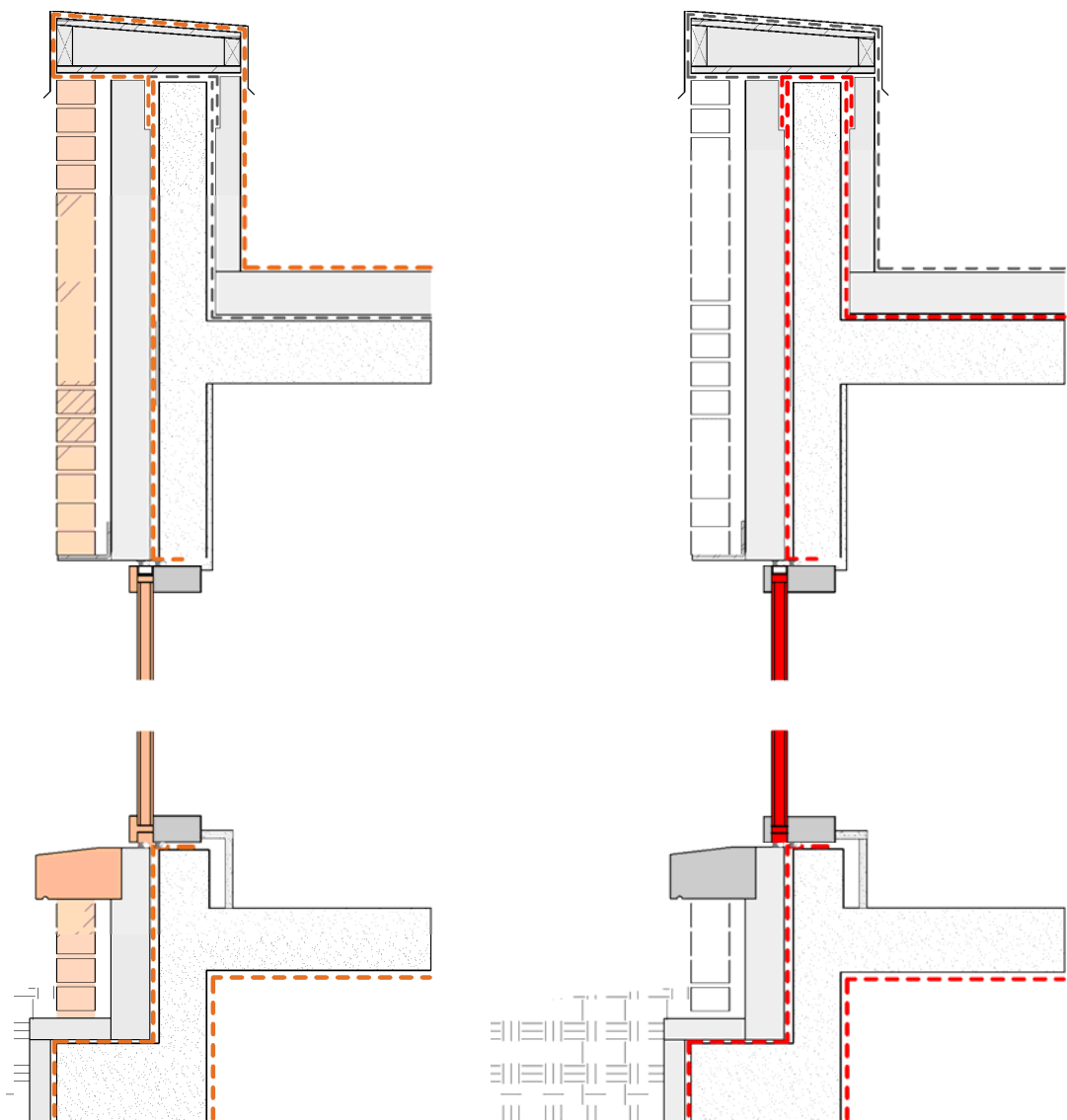


TRACE THE LAYERS

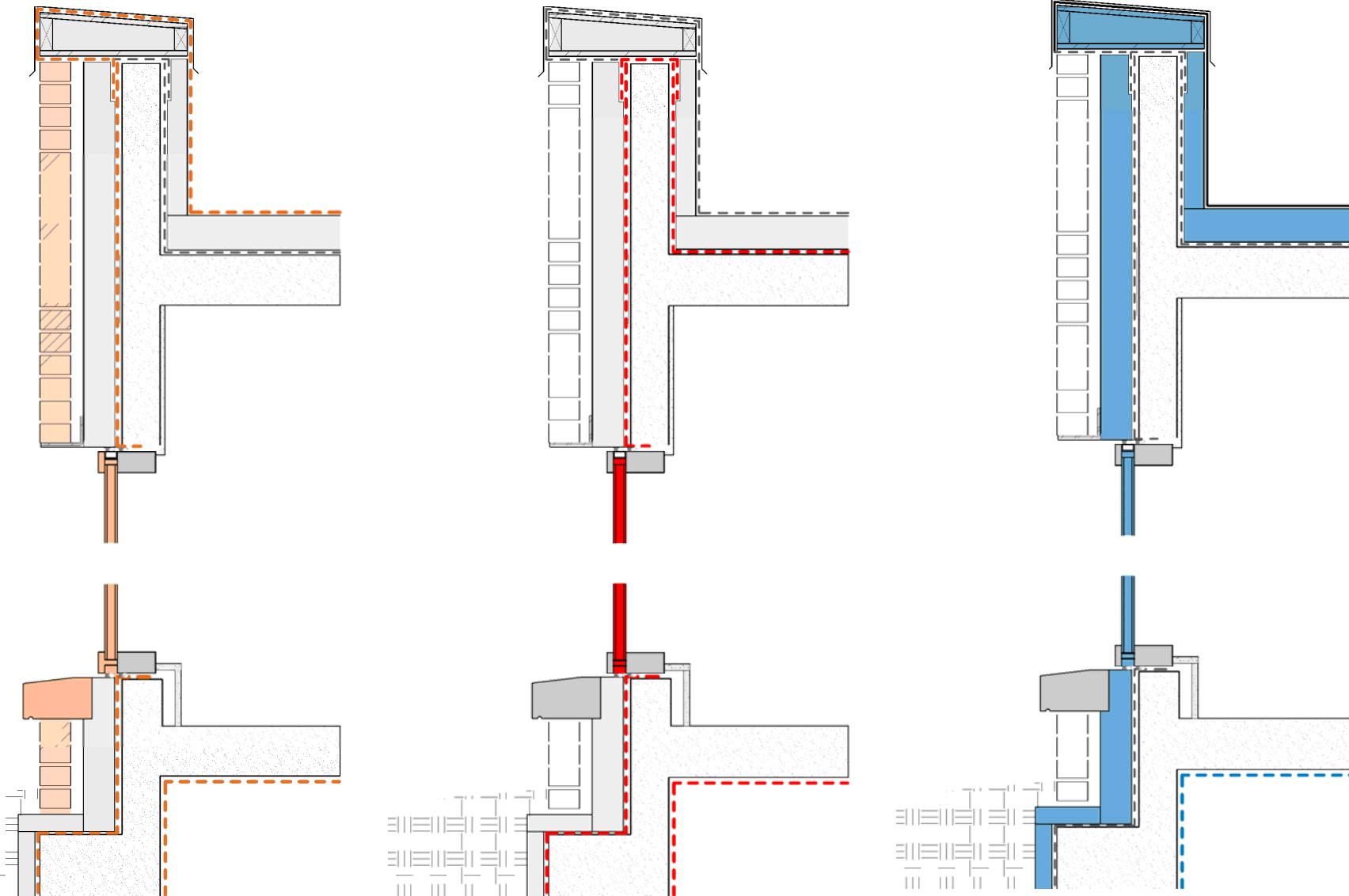
TRACE THE LAYERS



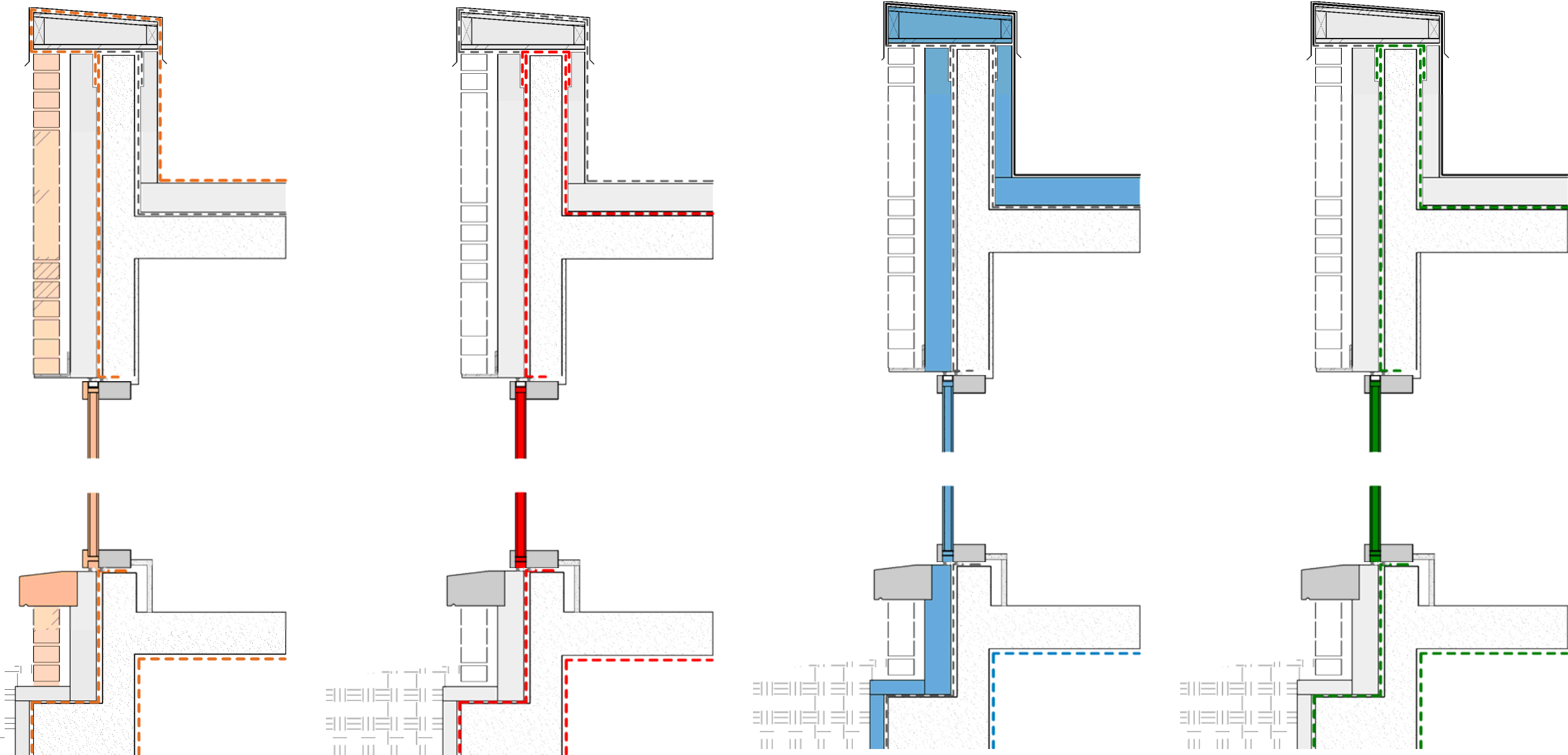
TRACE THE LAYERS



TRACE THE LAYERS

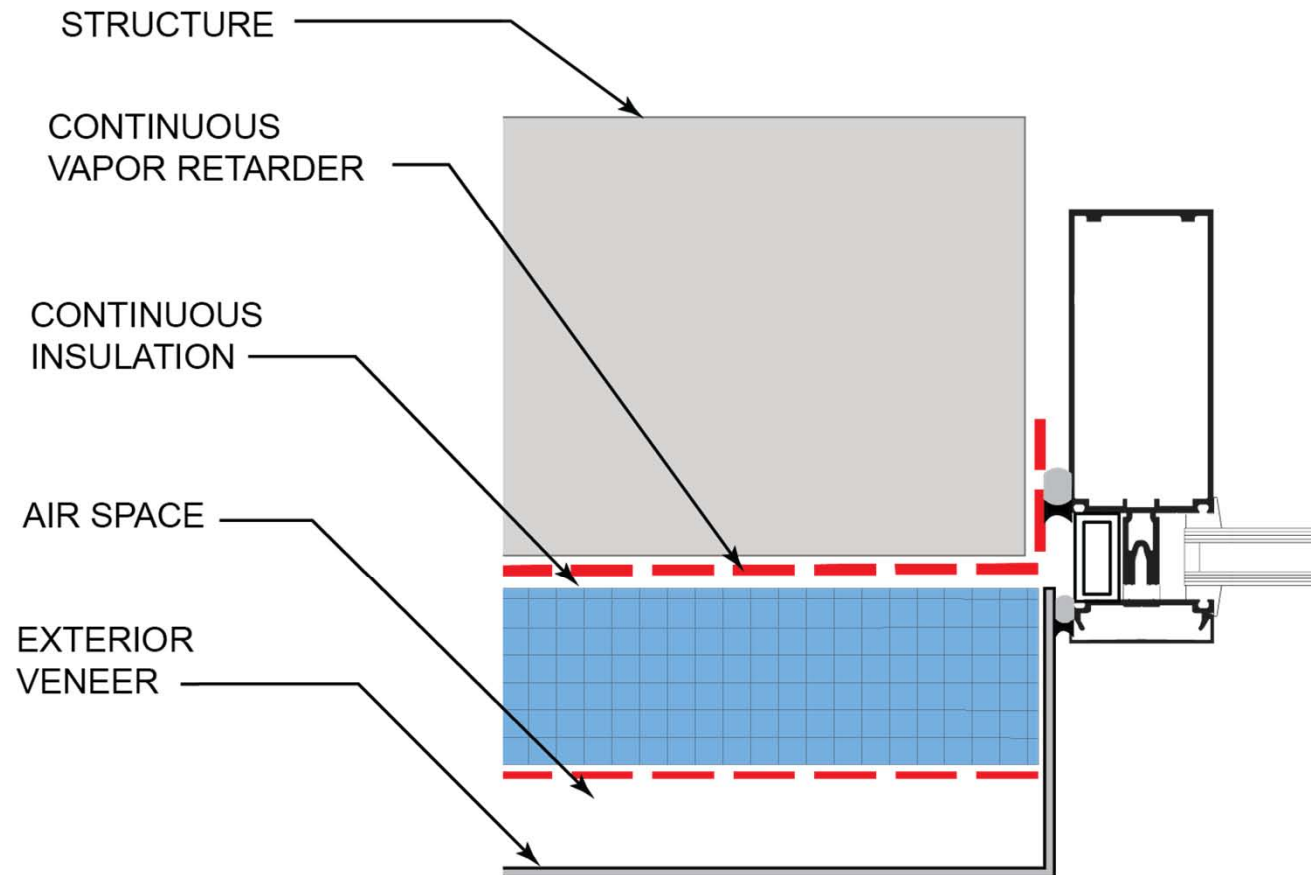


TRACE THE LAYERS



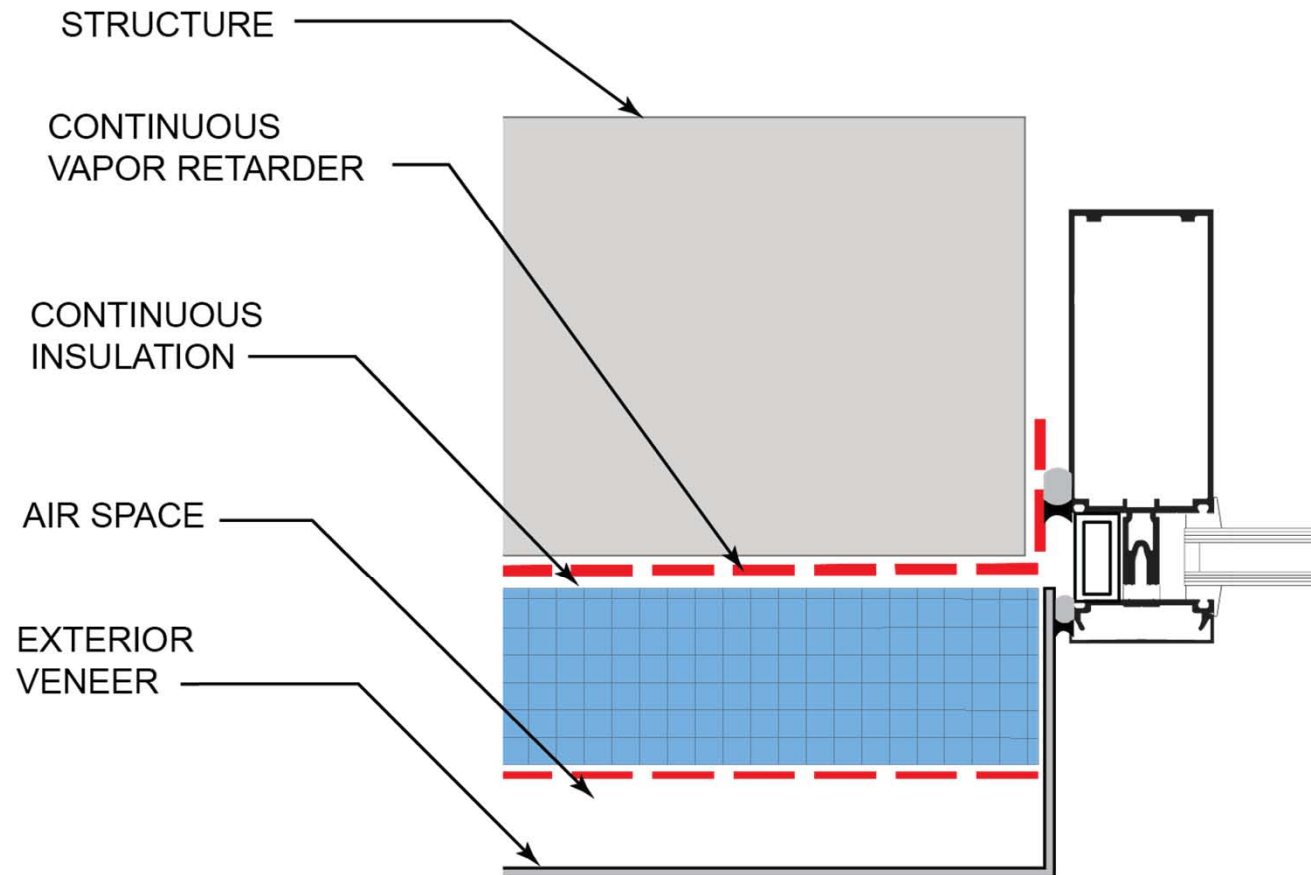
SYSTEM TRANSITIONS

Window – To – Wall

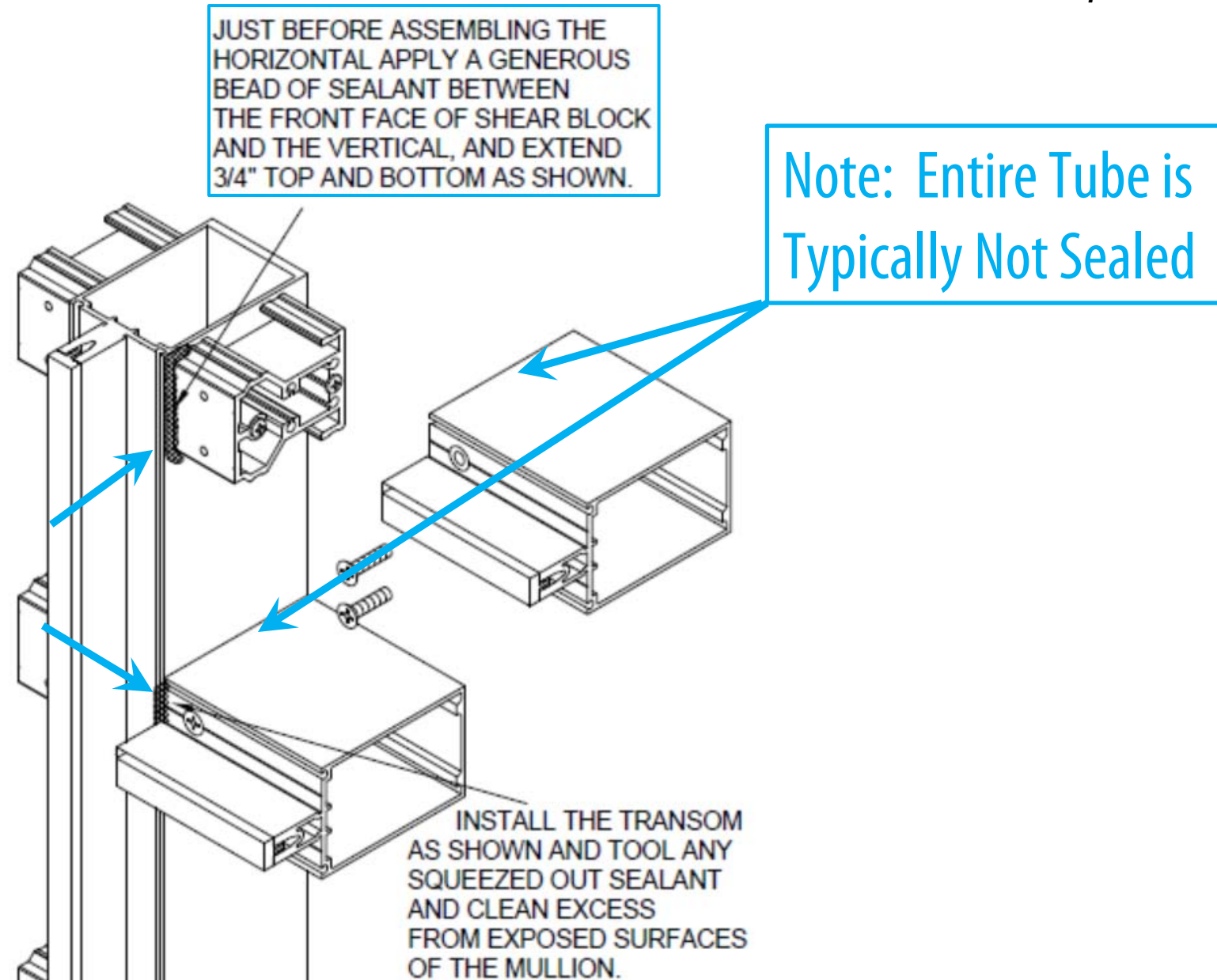


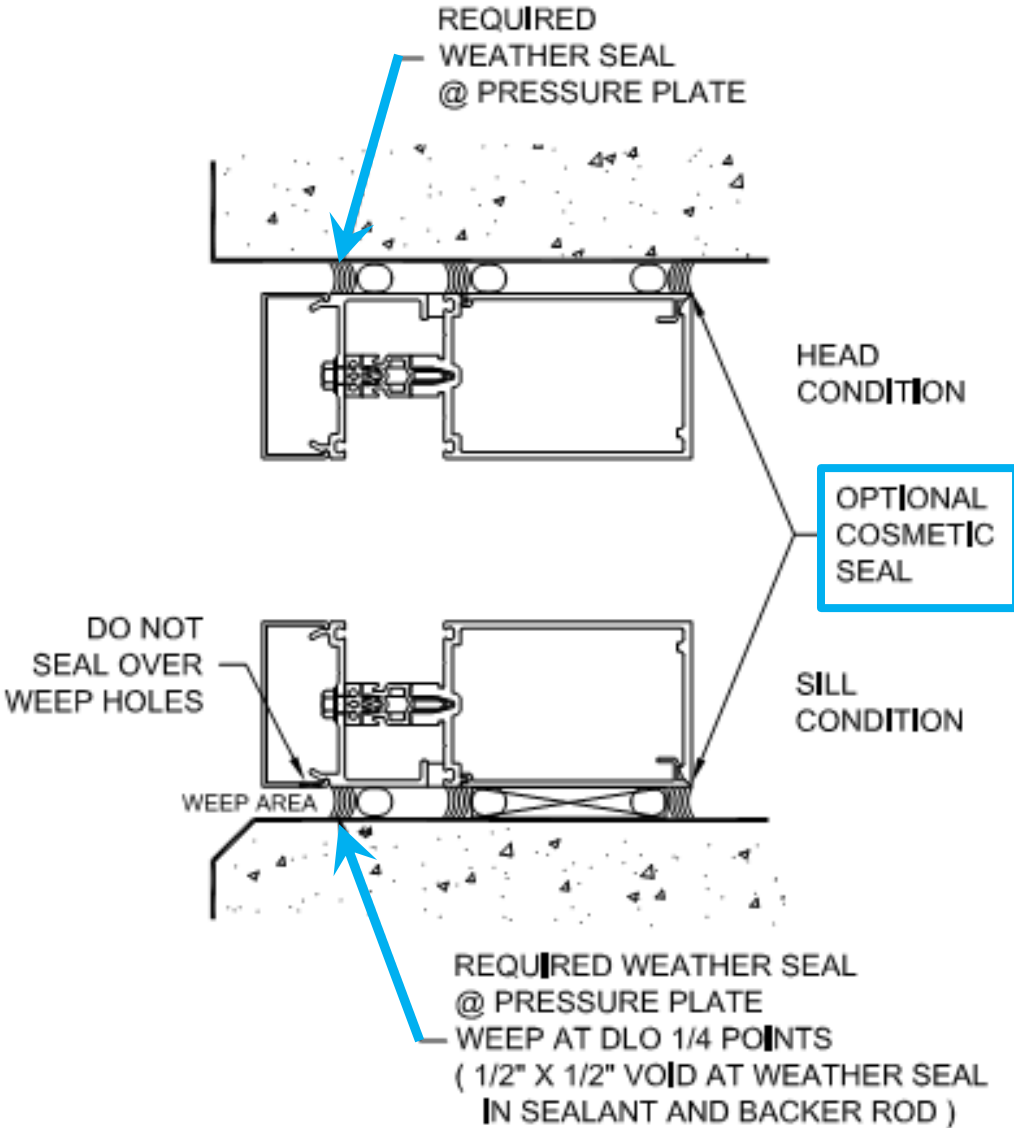
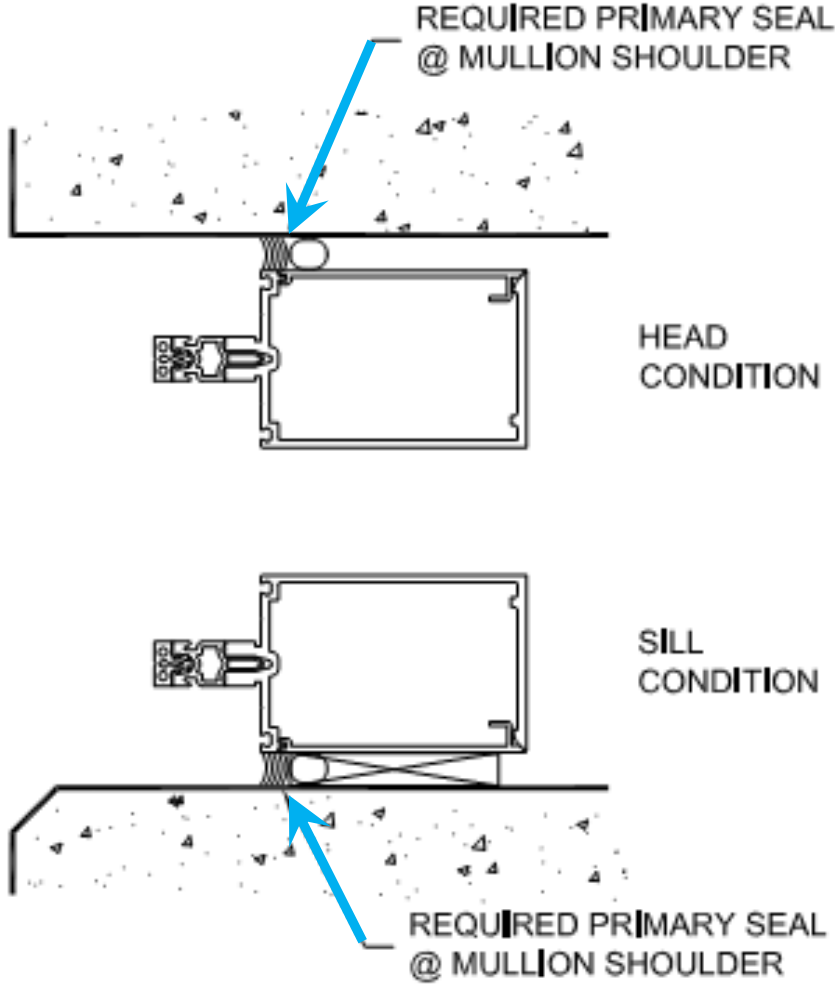
Window – To – Wall

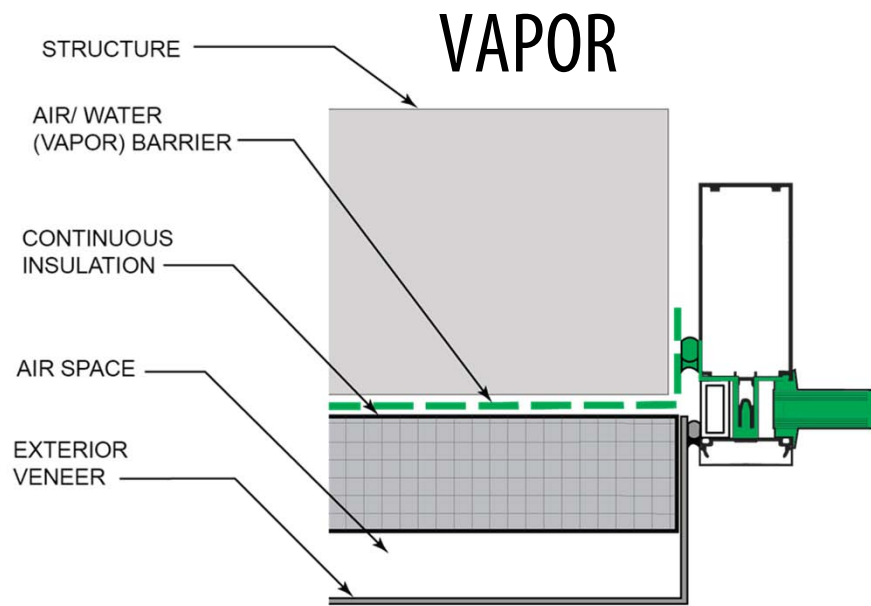
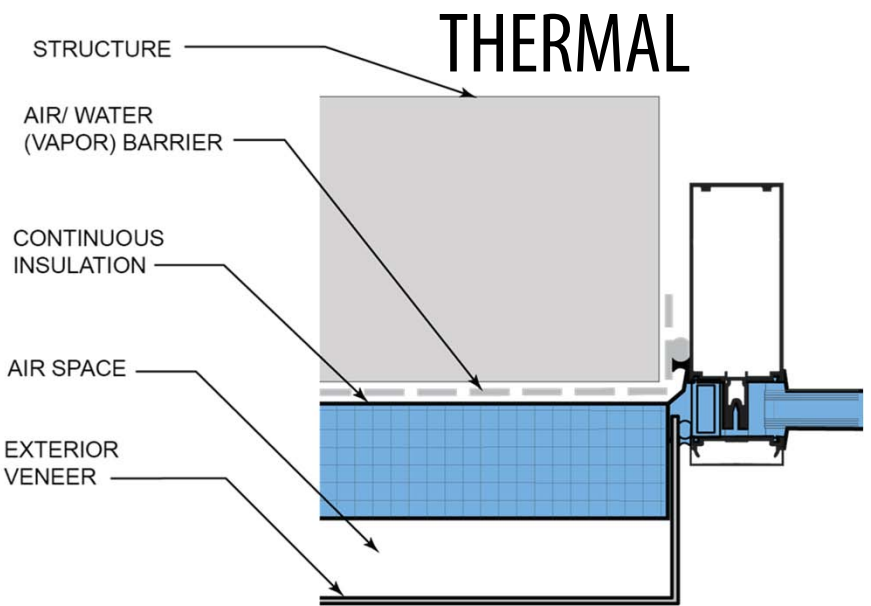
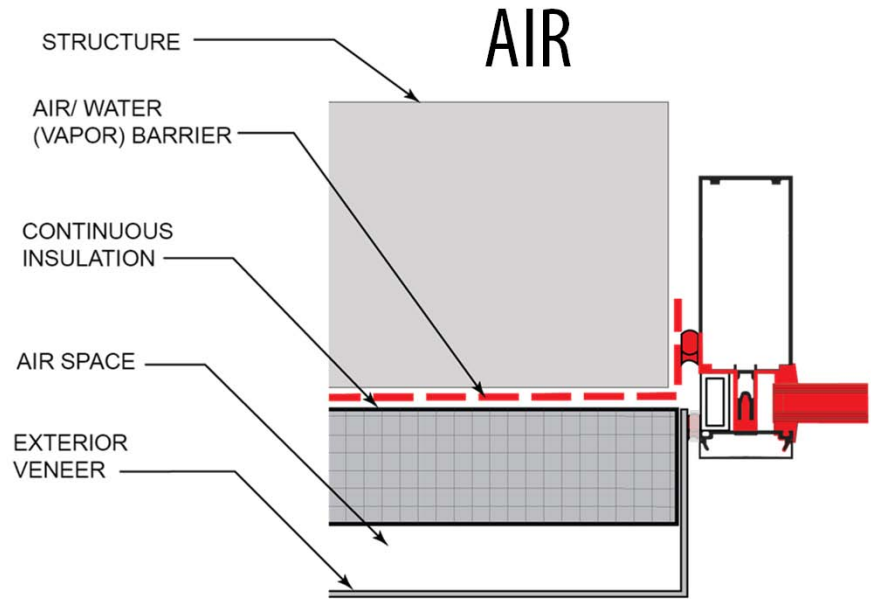
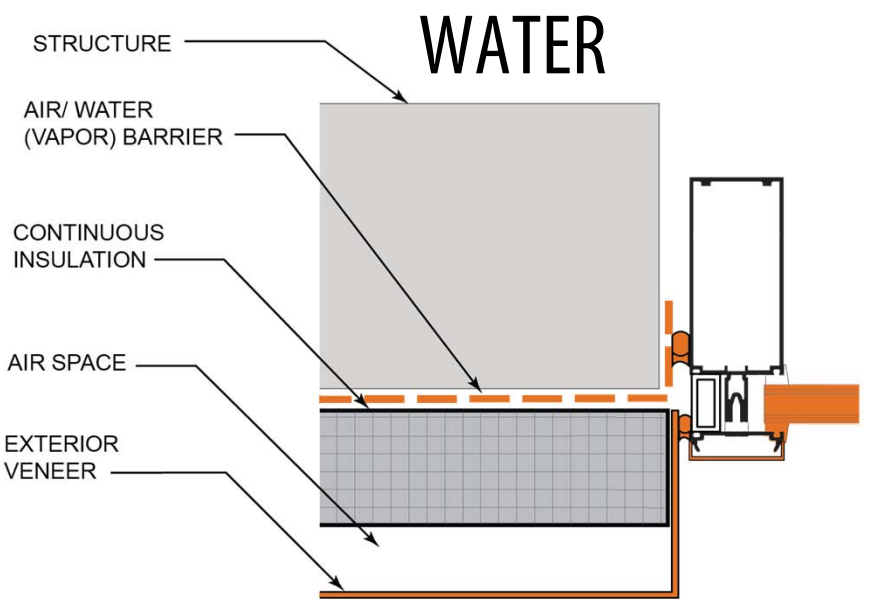
(curtain wall)



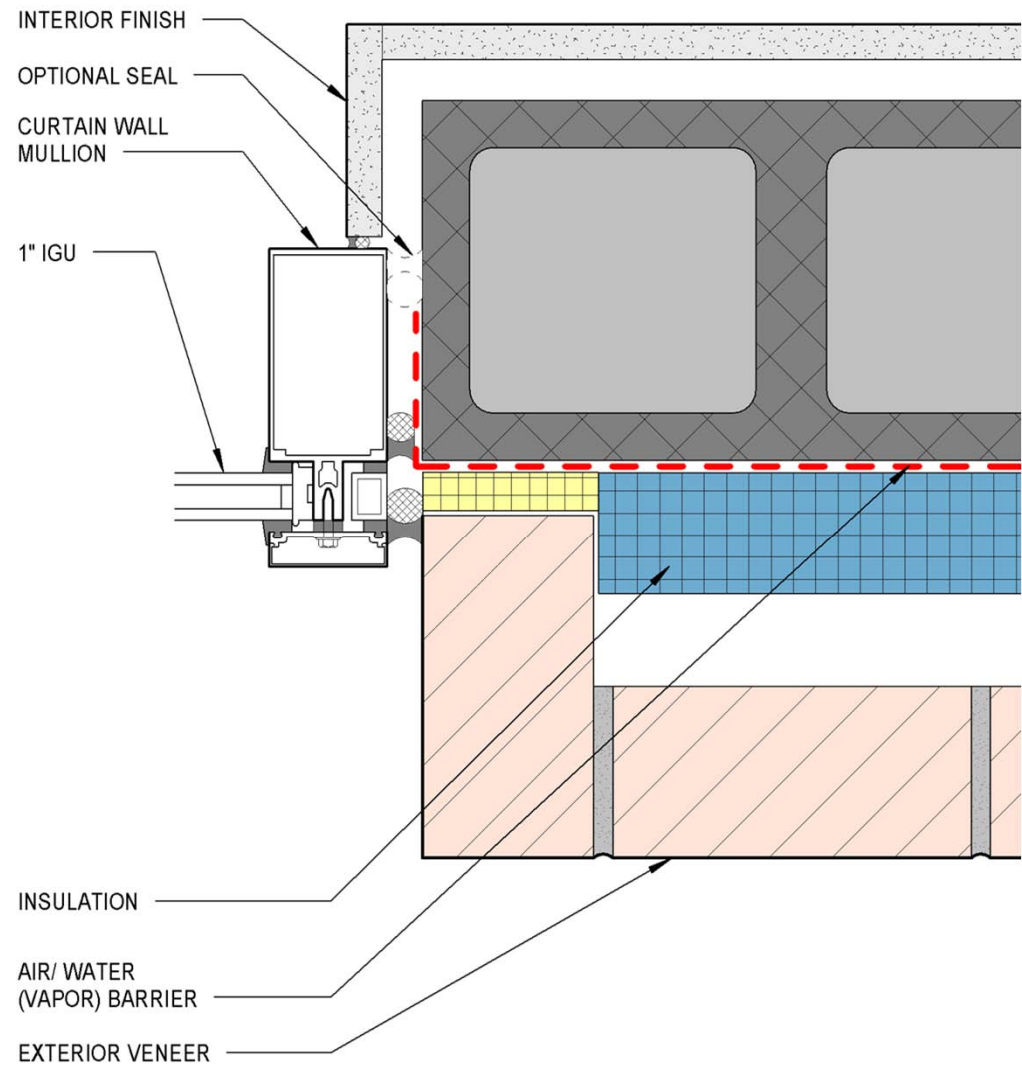
Remember First...
Understand the System



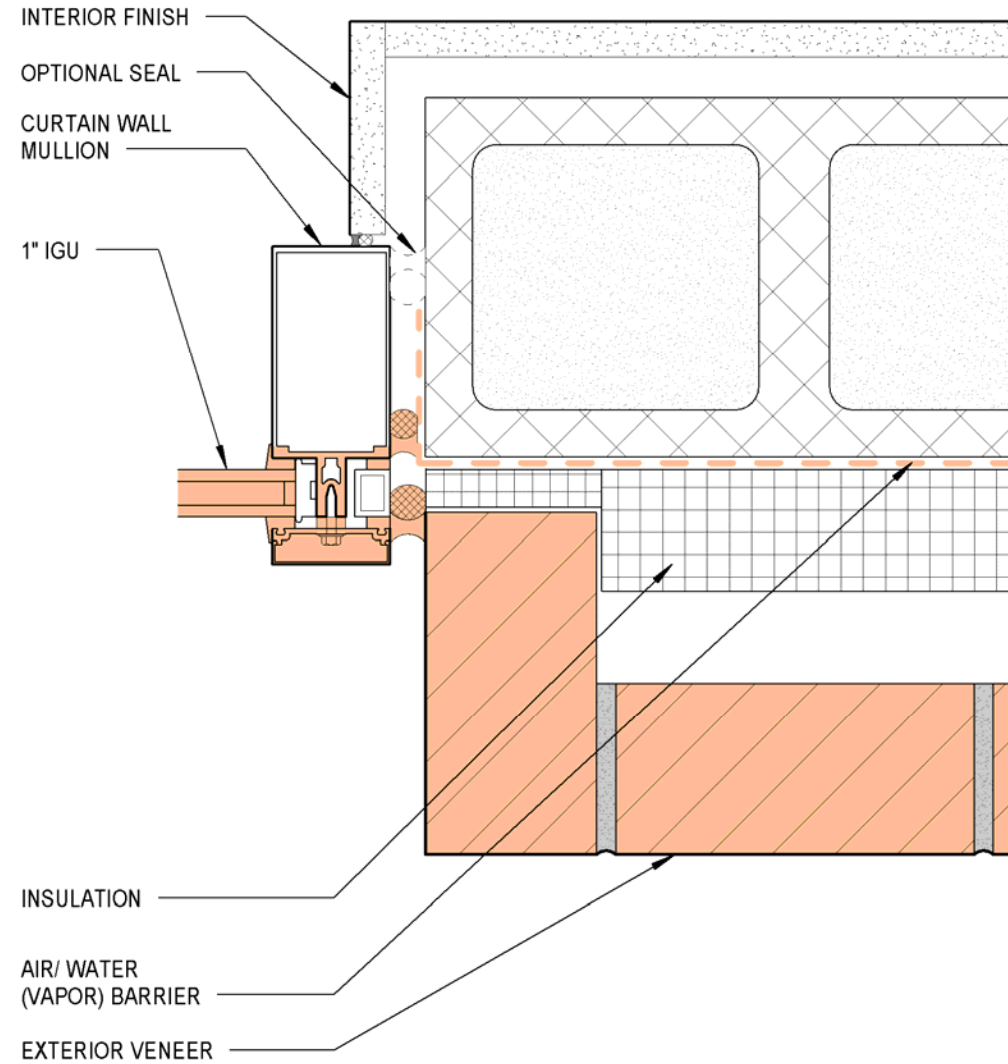




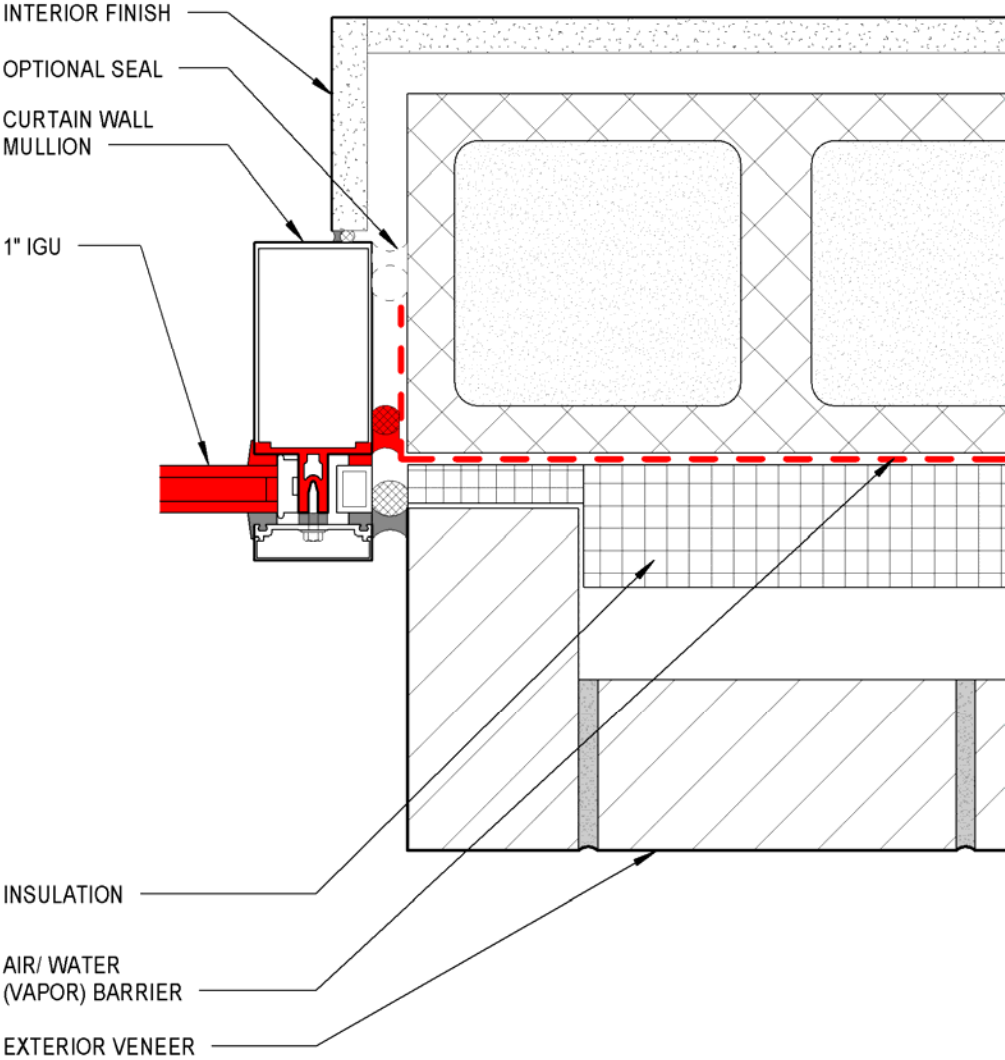
Curtain Wall Jamb



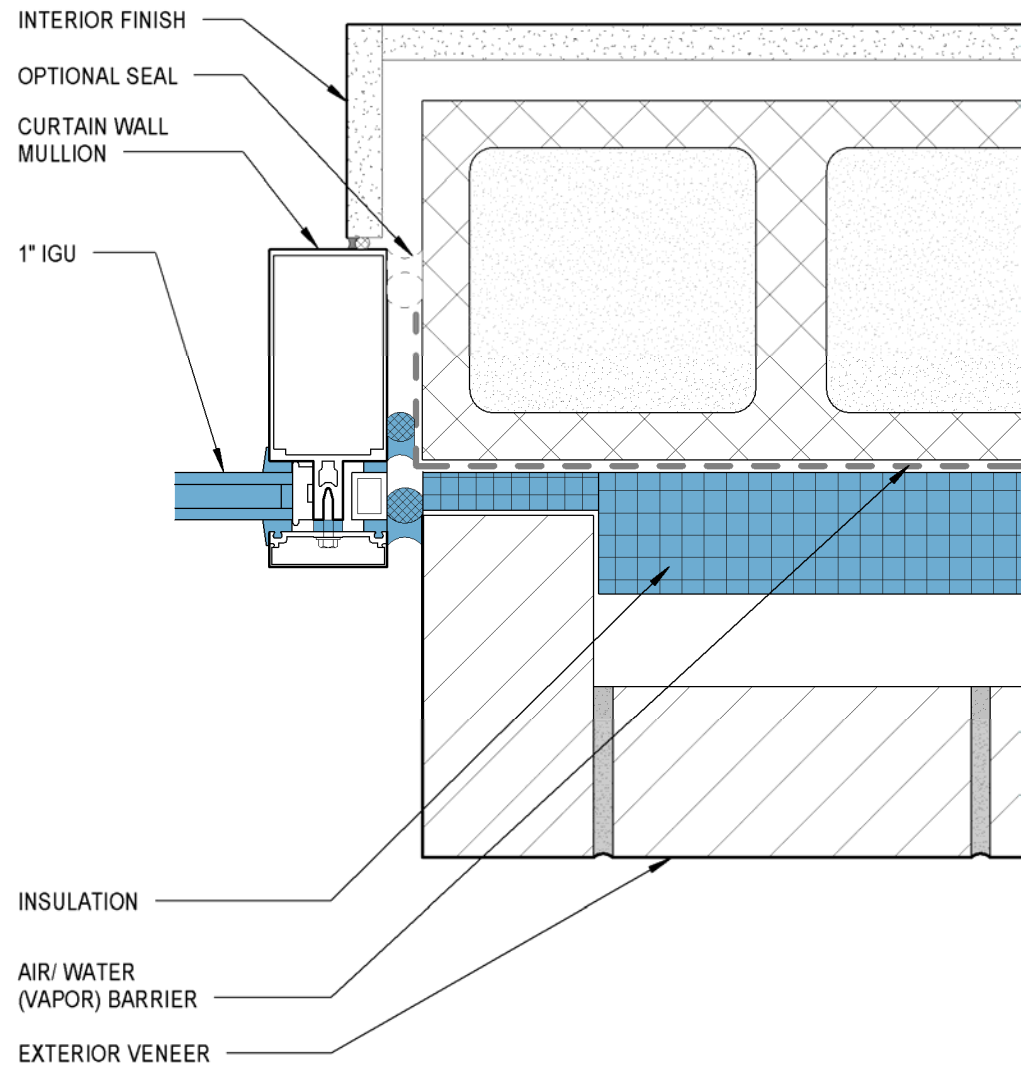
Water



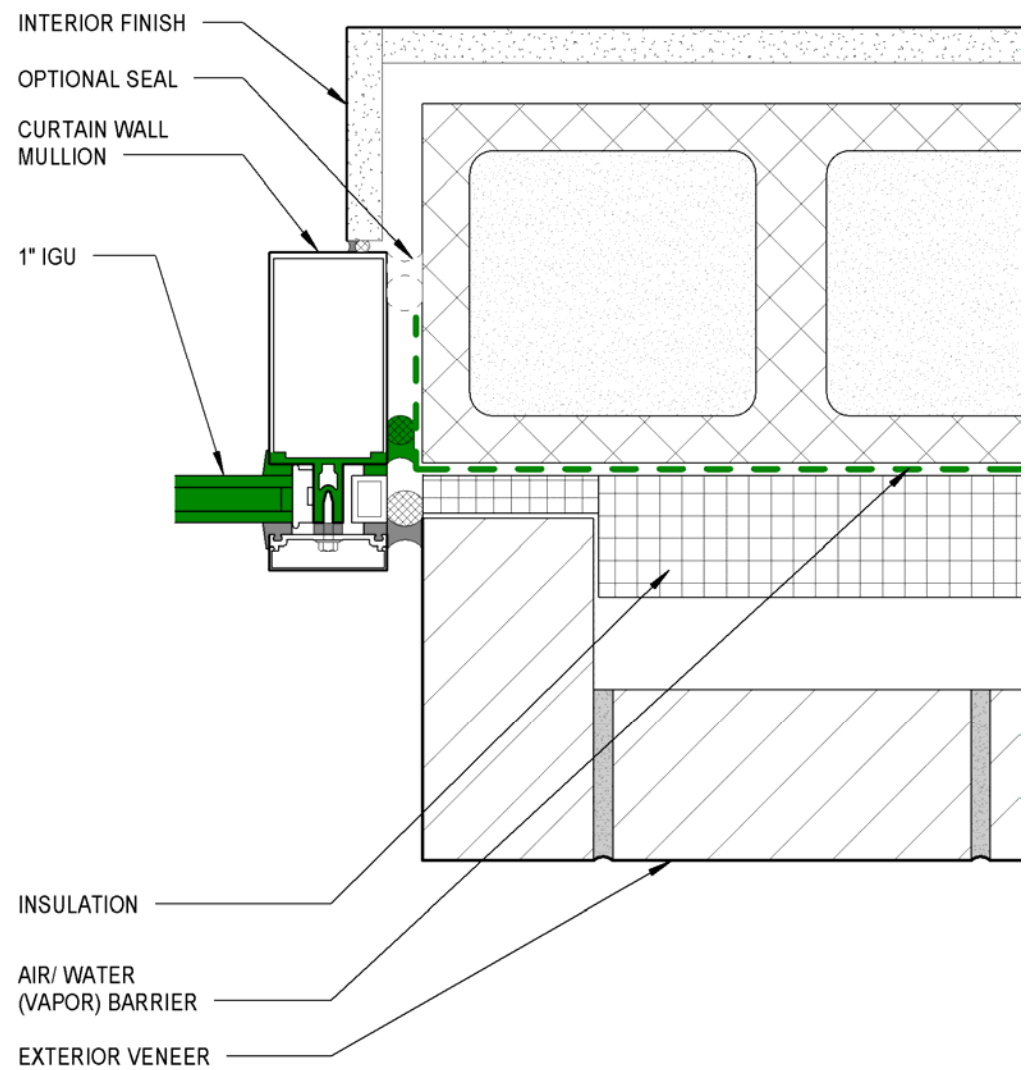
Air



Thermal

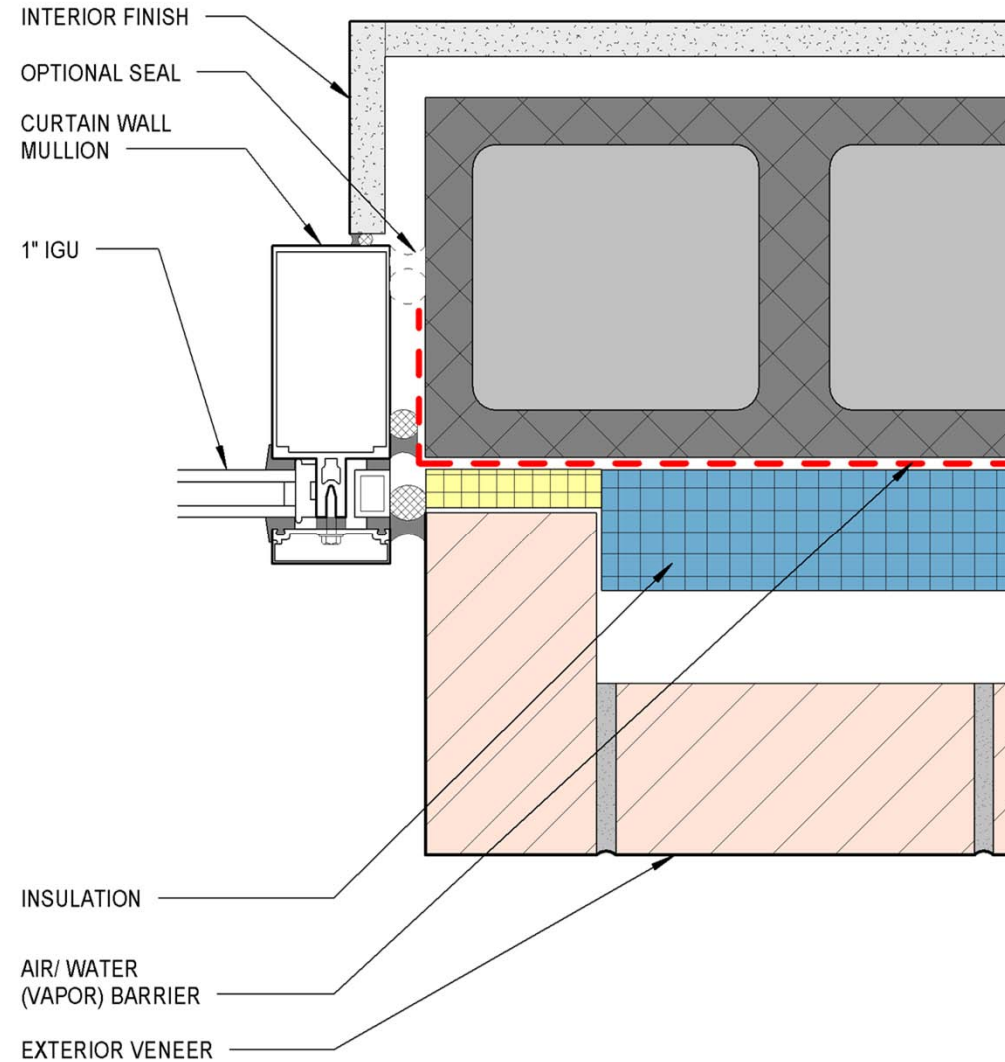


Vapor

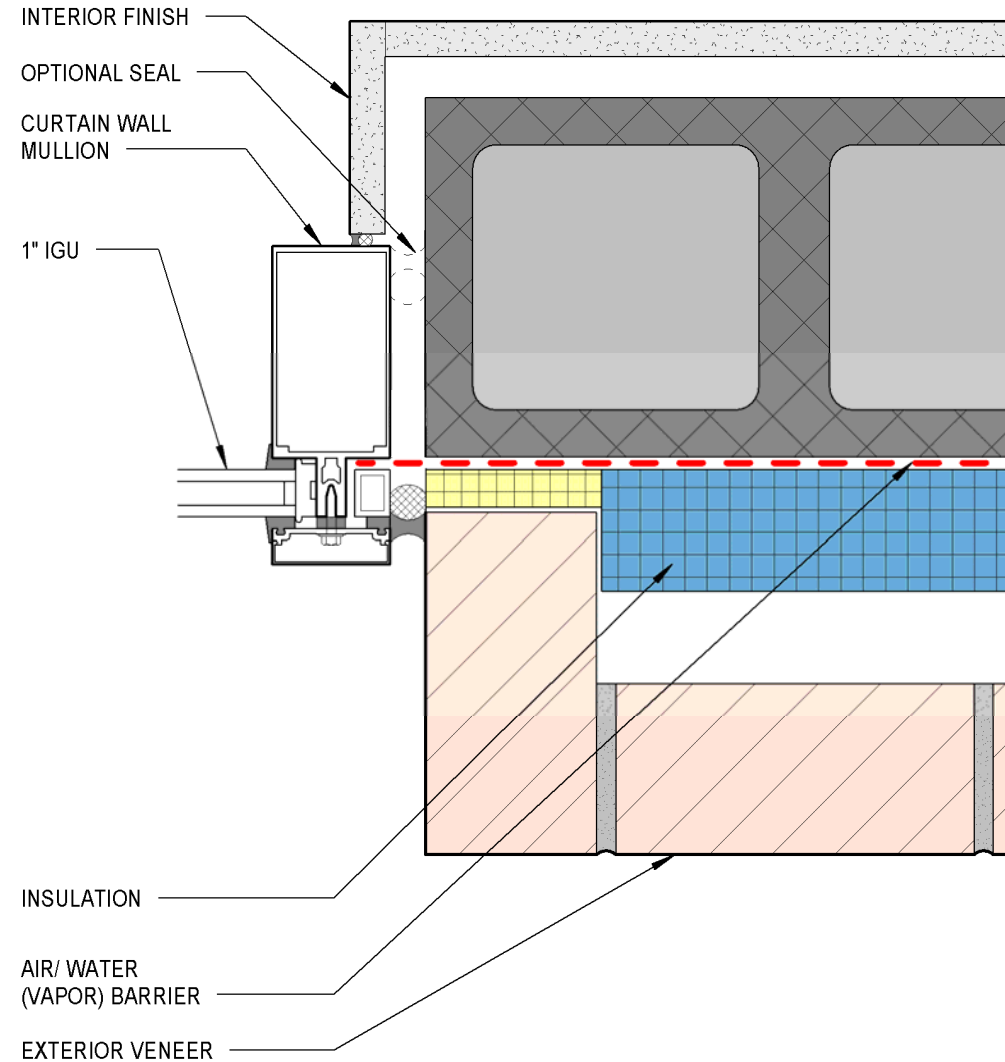


Two Methods to Achieve Continuity

Sealant Transition

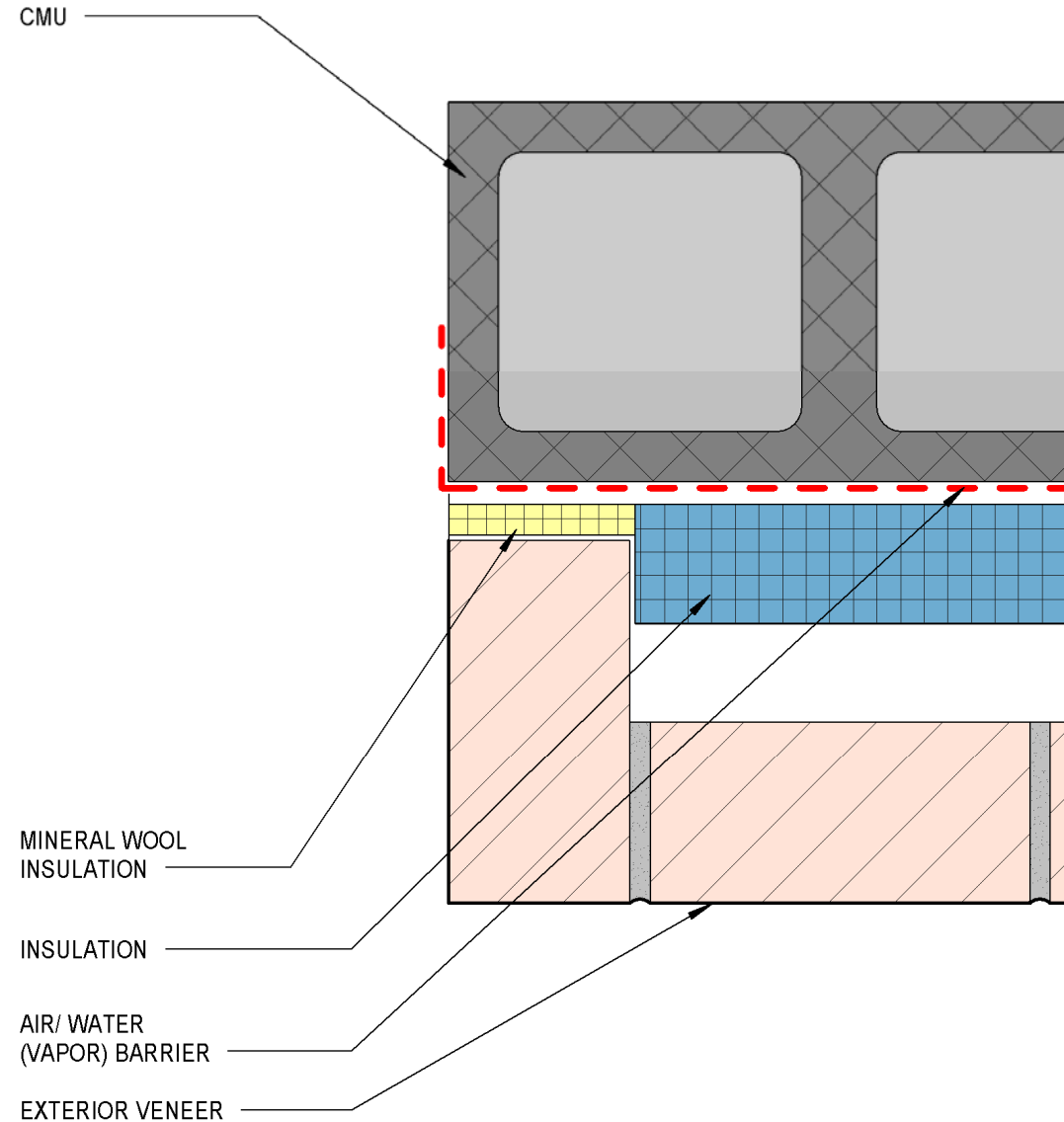


Membrane Transition

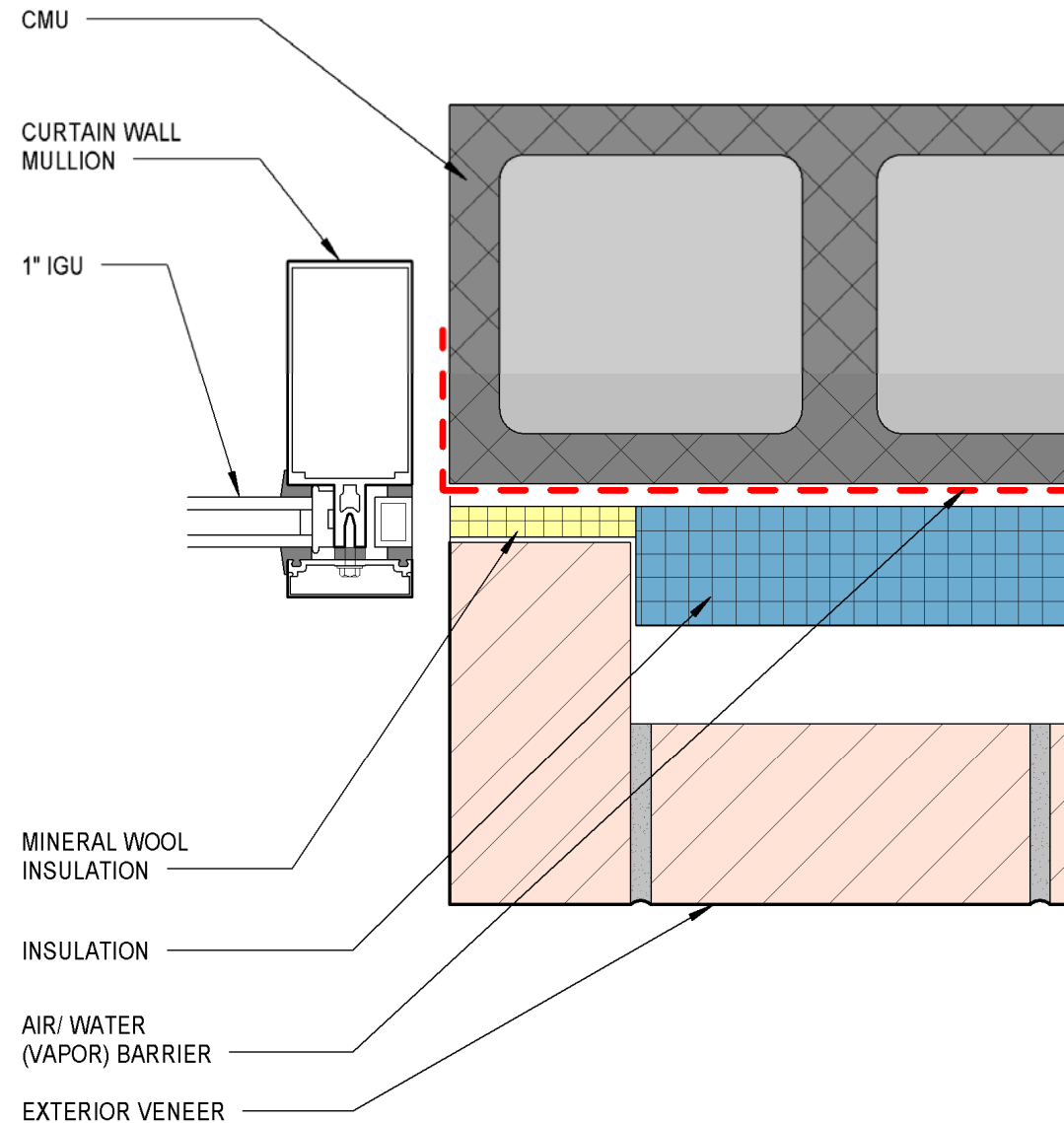


Sequence of Installation

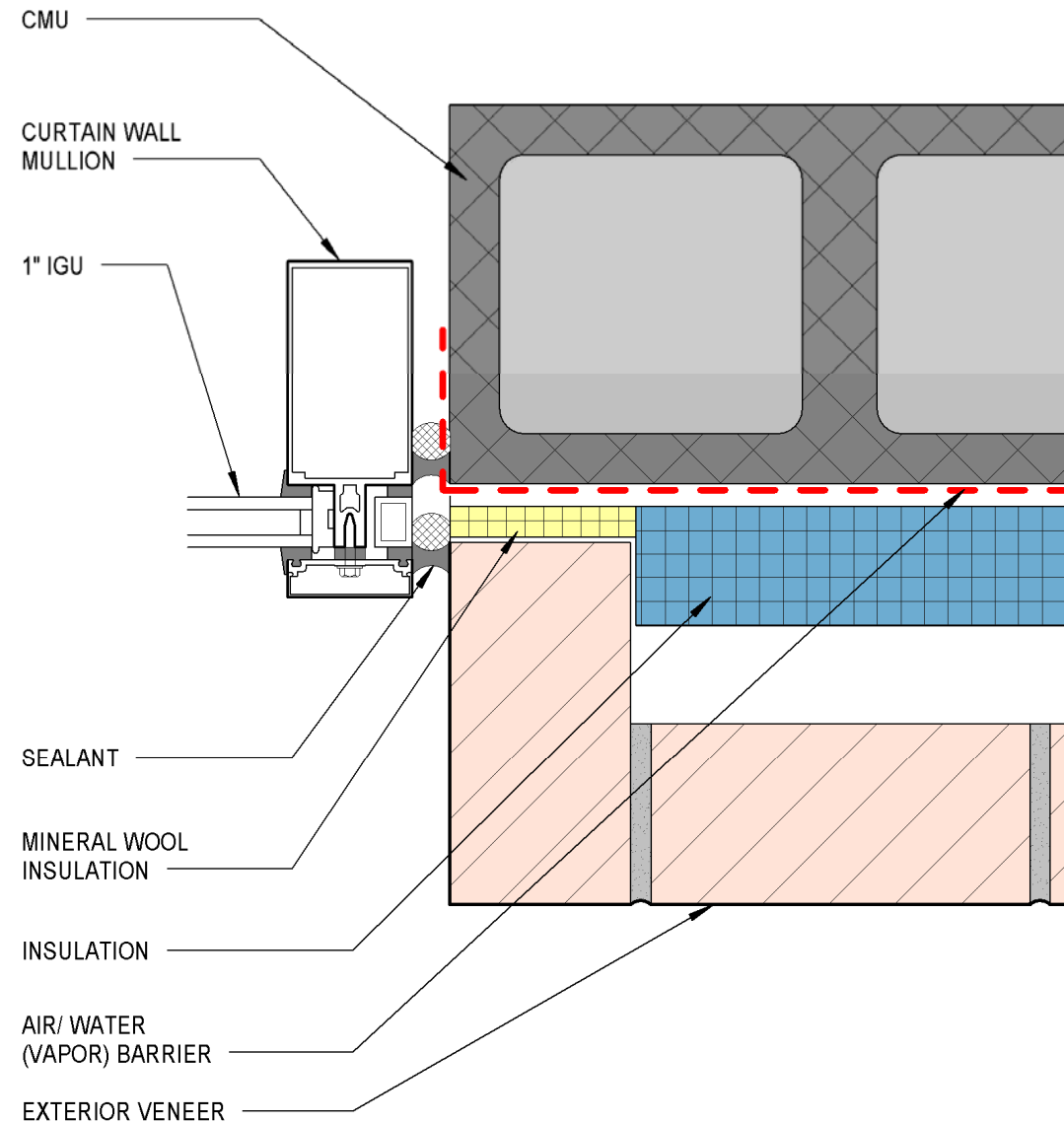
Sealant Transition



Sealant Transition

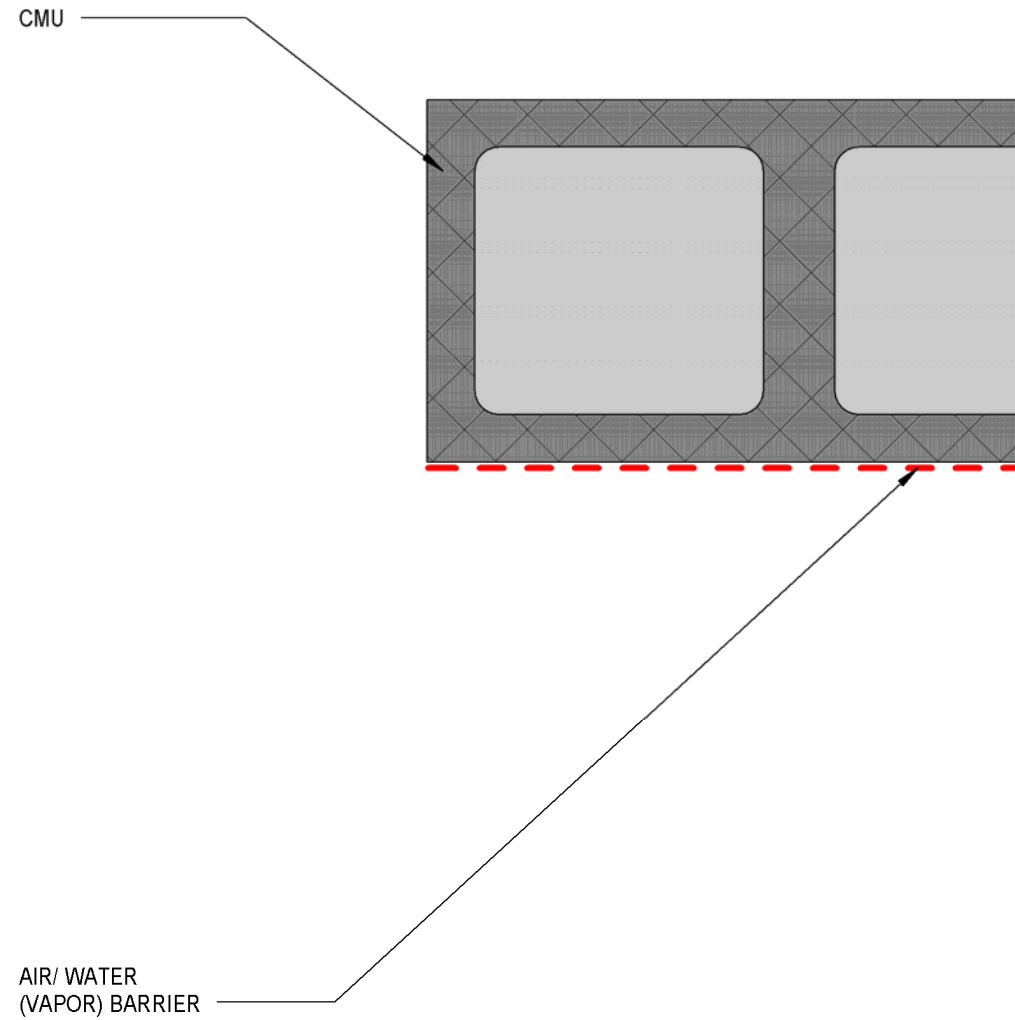


Sealant Transition

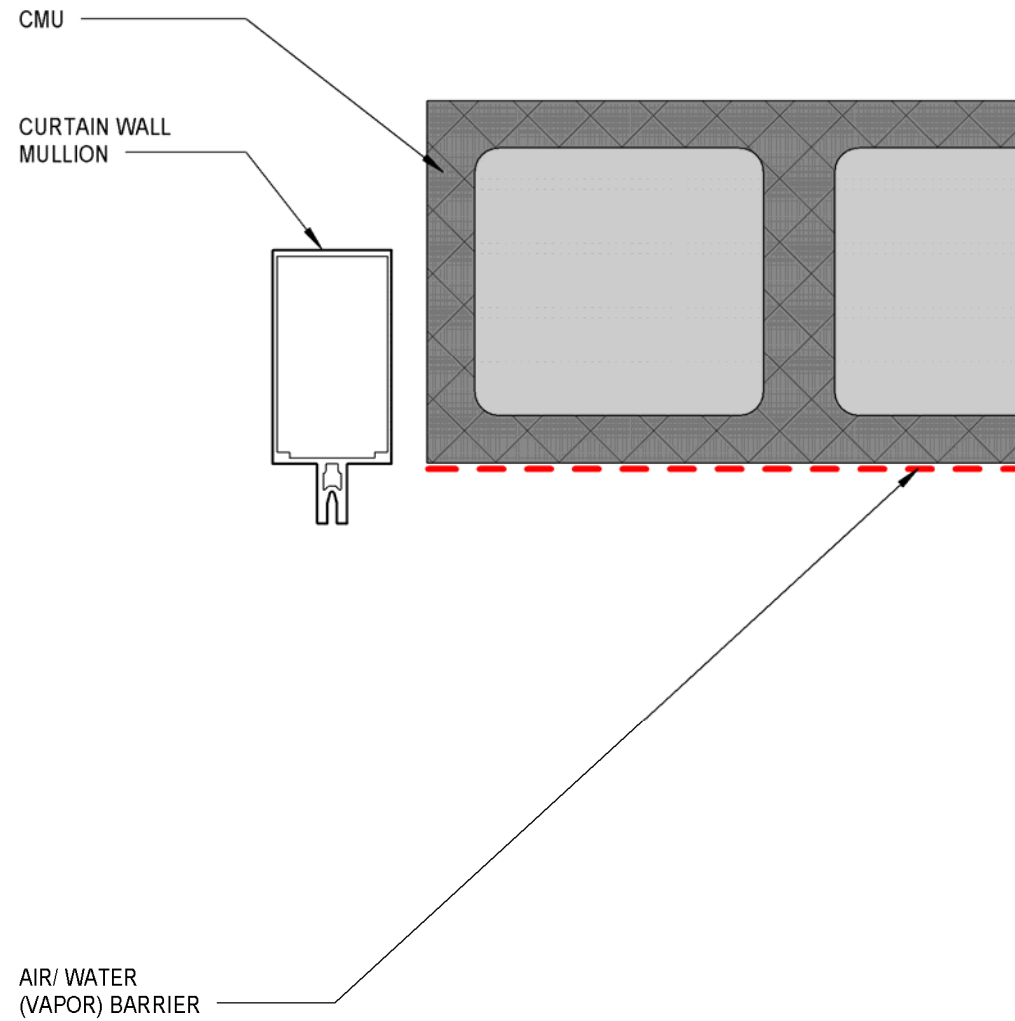


Membrane Transition 1

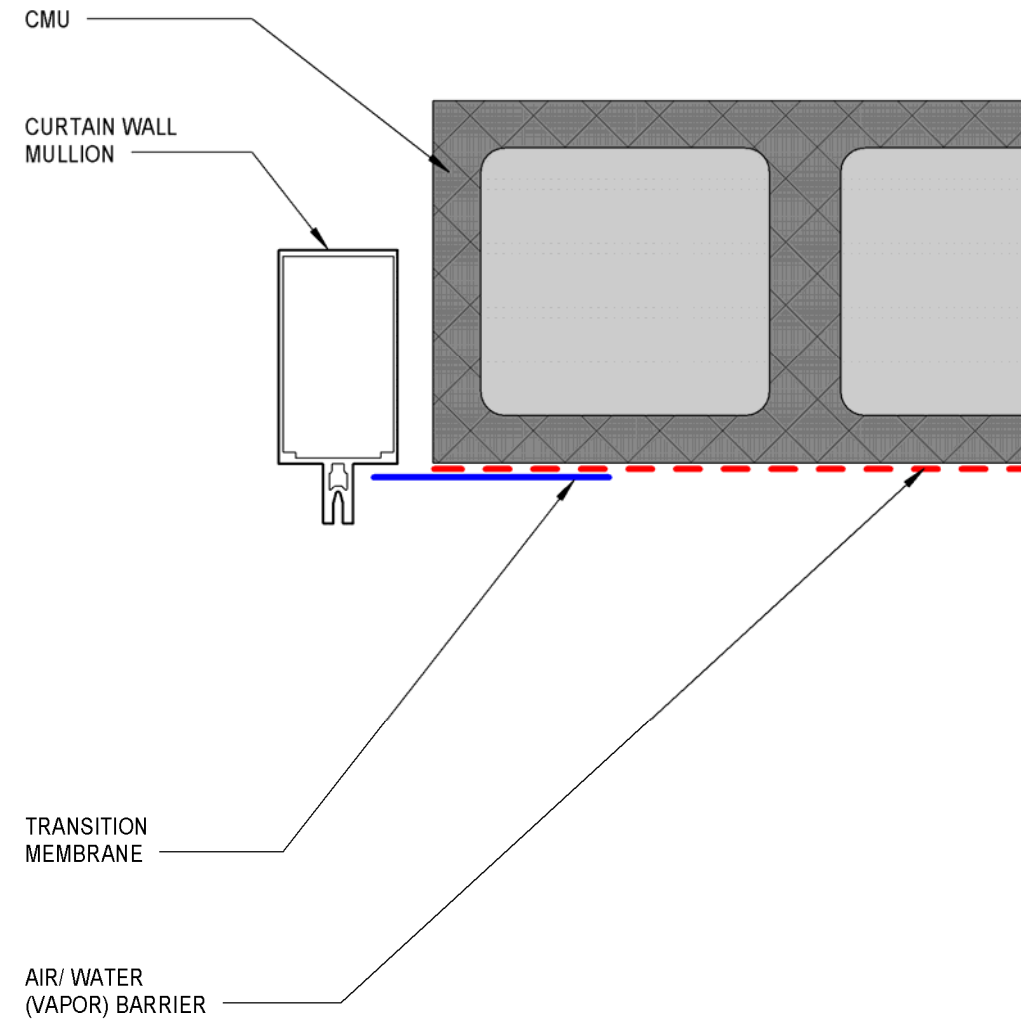
Membrane Transition 1



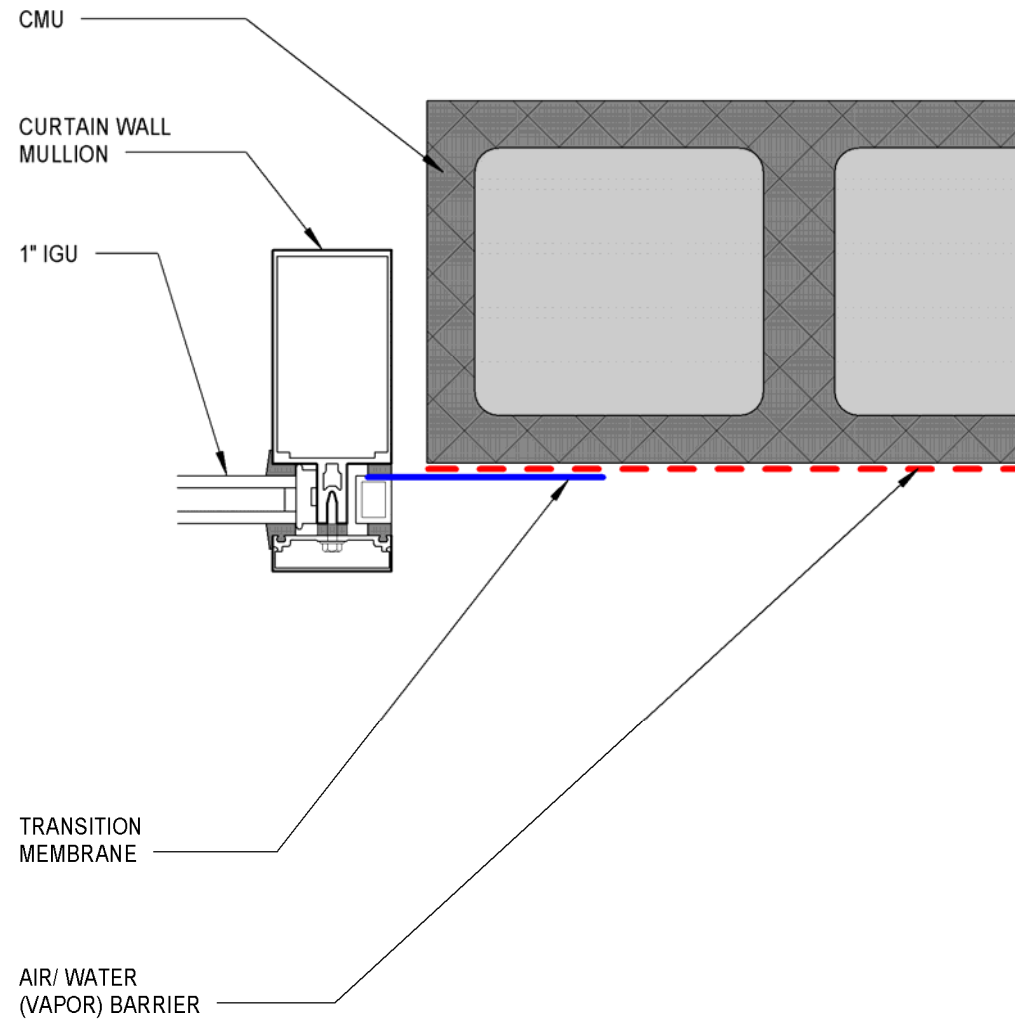
Membrane Transition 1



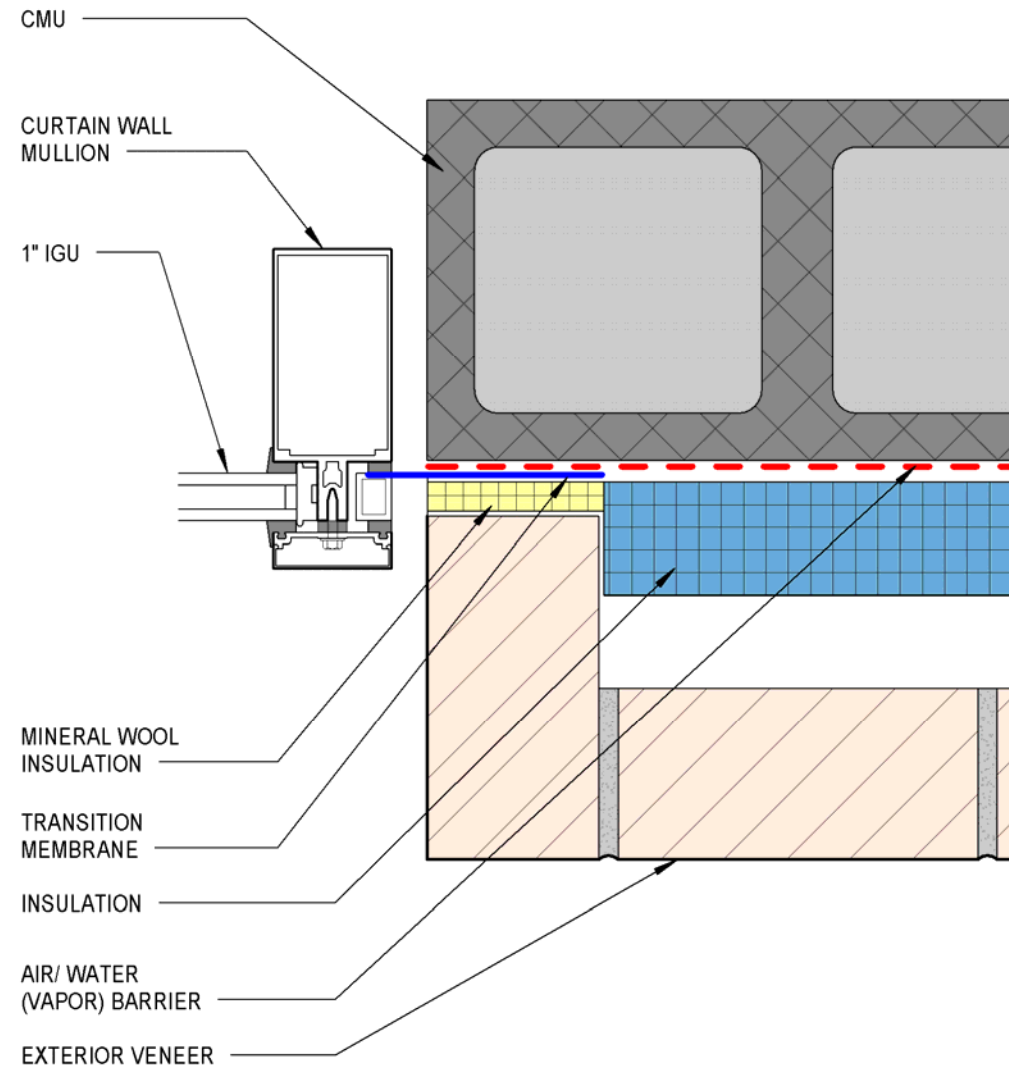
Membrane Transition 1



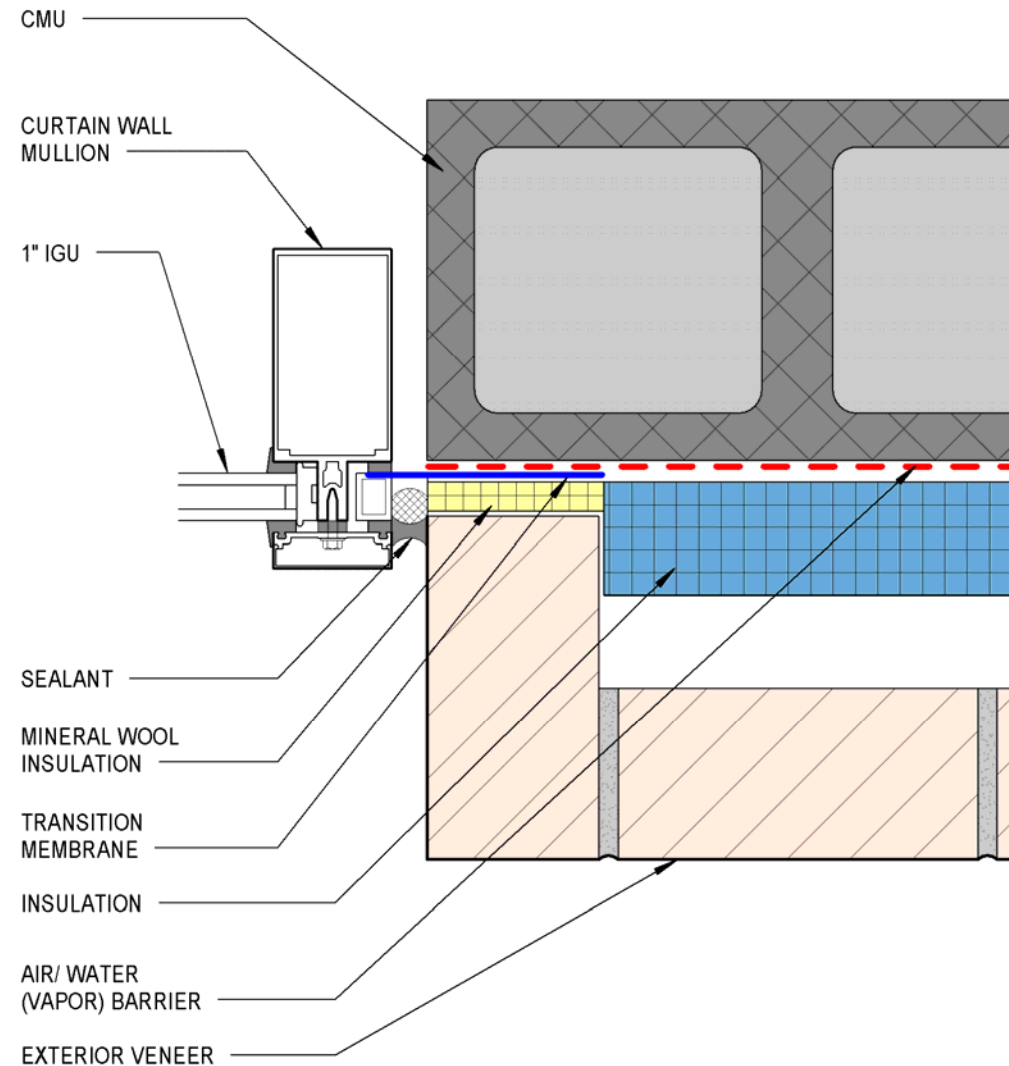
Membrane Transition 1



Membrane Transition 1

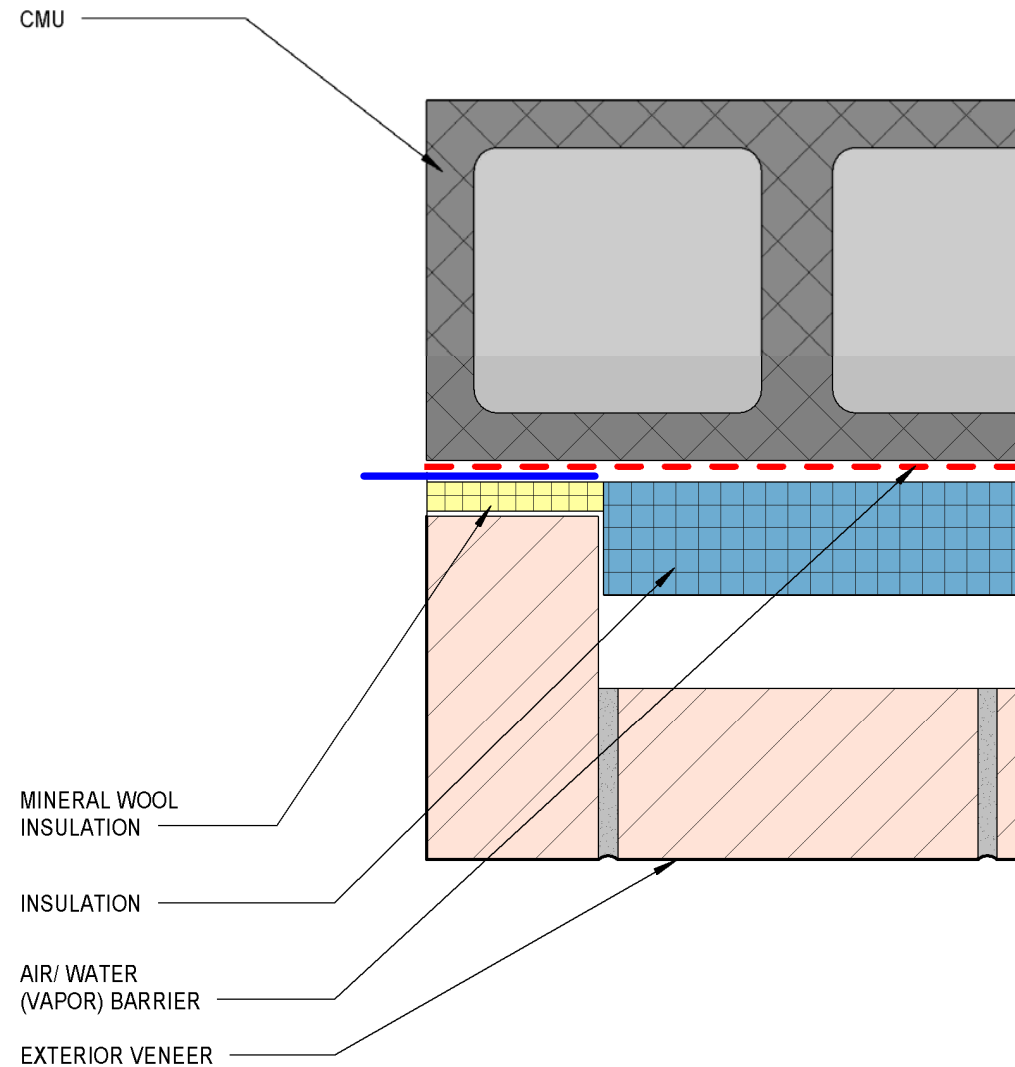


Membrane Transition 1

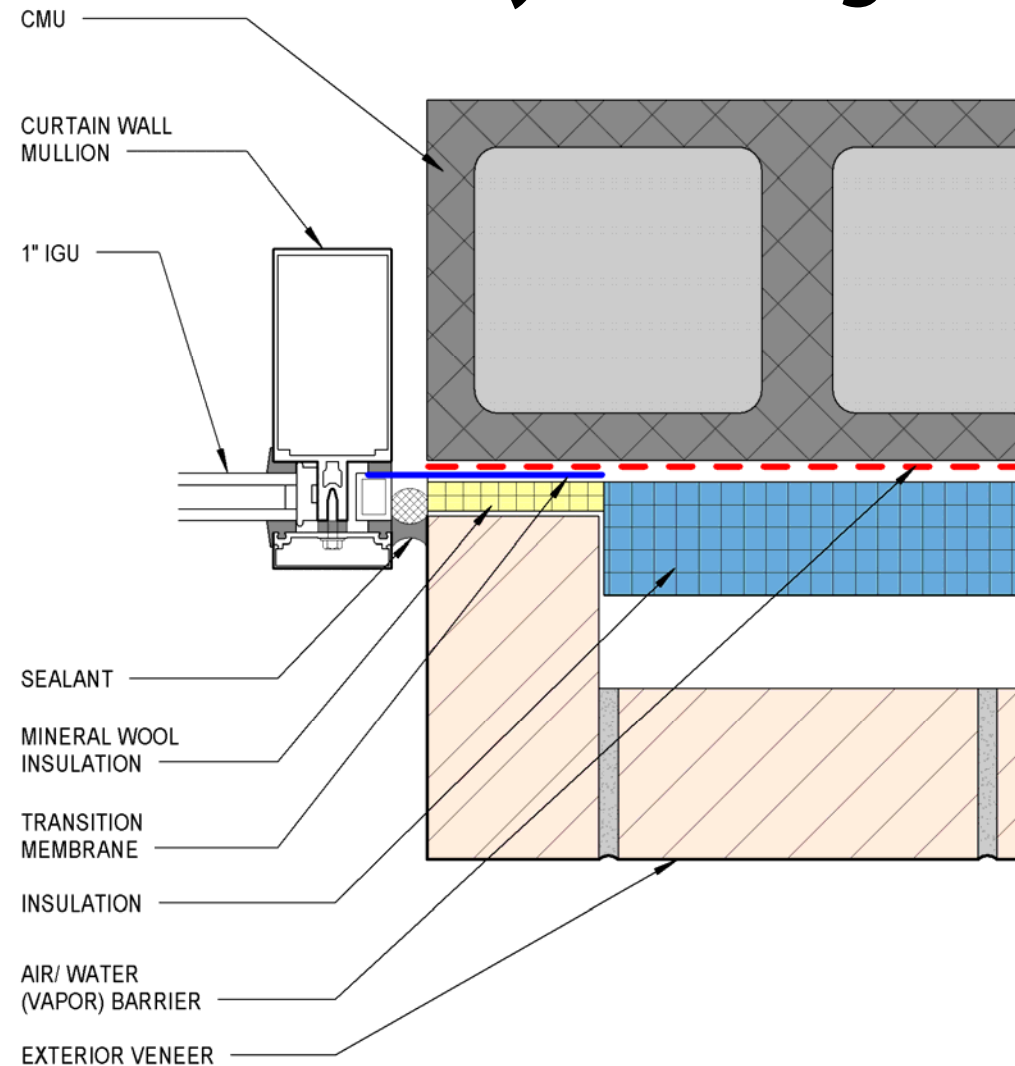


Membrane Transition 2

Membrane Transition 2



Membrane Transition 2 (yeah, right...)



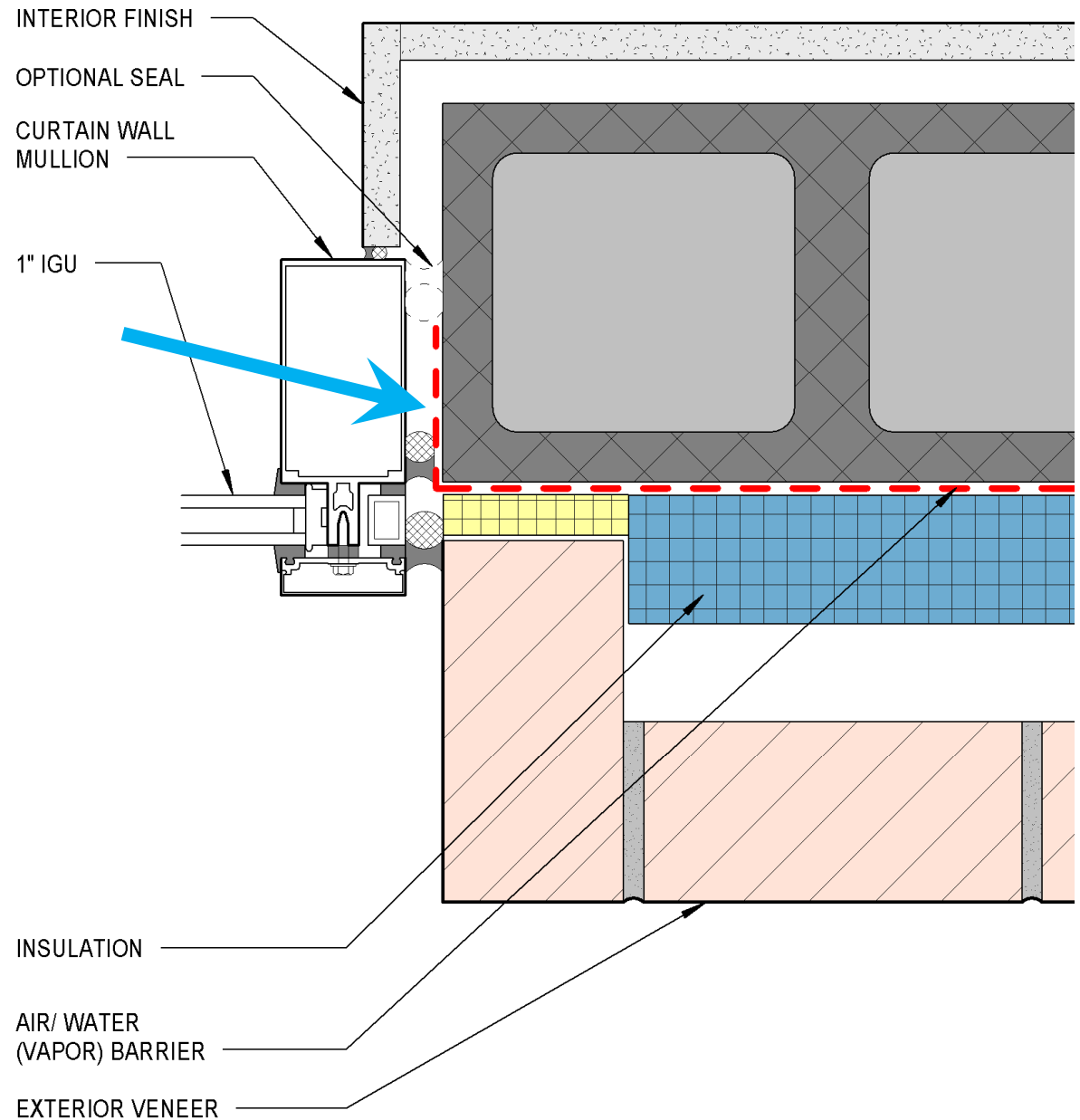
Materials/Method

Benefits/Limitations

Sealant Transition

Flashing Materials

- Fluid Applied Flashing
 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

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 - Silicone
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 - Rubberized Asphalt
 - Foil Faced
 - Butyl
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Sealant Transition

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2017/10/12 16:58

Sealant Transition

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Sealant Transition

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Sealant Transition

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Sealant Transition

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Sealant Transition

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Sealant Transition

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Sealant Transition

Flashing Materials

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2016/09/12 11:20

Sealant Transition

Flashing Materials

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 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

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 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

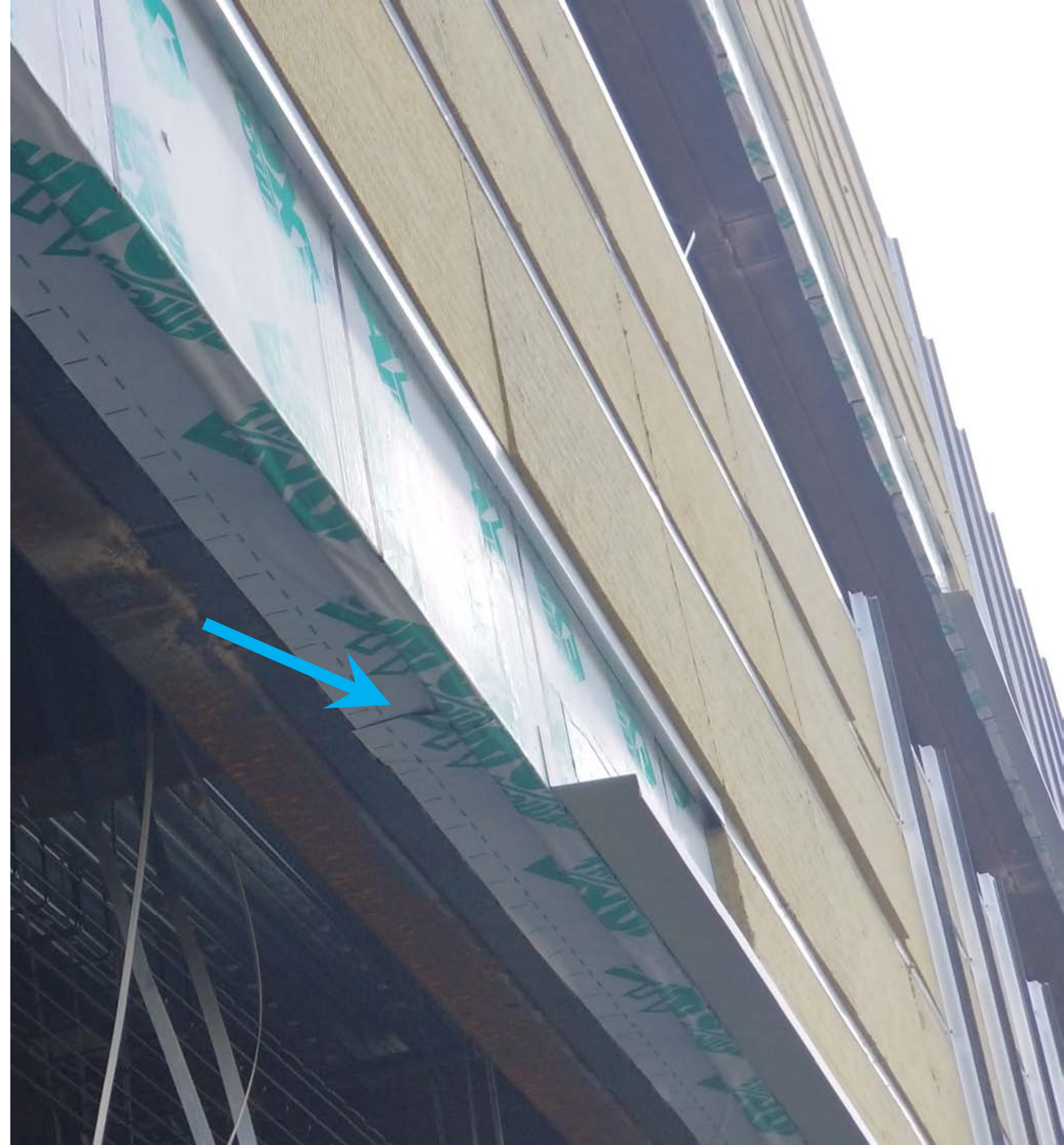
- Fluid Applied Flashing
 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

- Fluid Applied Flashing
 - STPE
 - Silicone
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 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

- Fluid Applied Flashing
 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - Stainless Steel



2016/09/12 10:00

Sealant Transition

Flashing Materials

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 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

- Fluid Applied Flashing
 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

- Fluid Applied Flashing
 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - **Foil Faced**
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

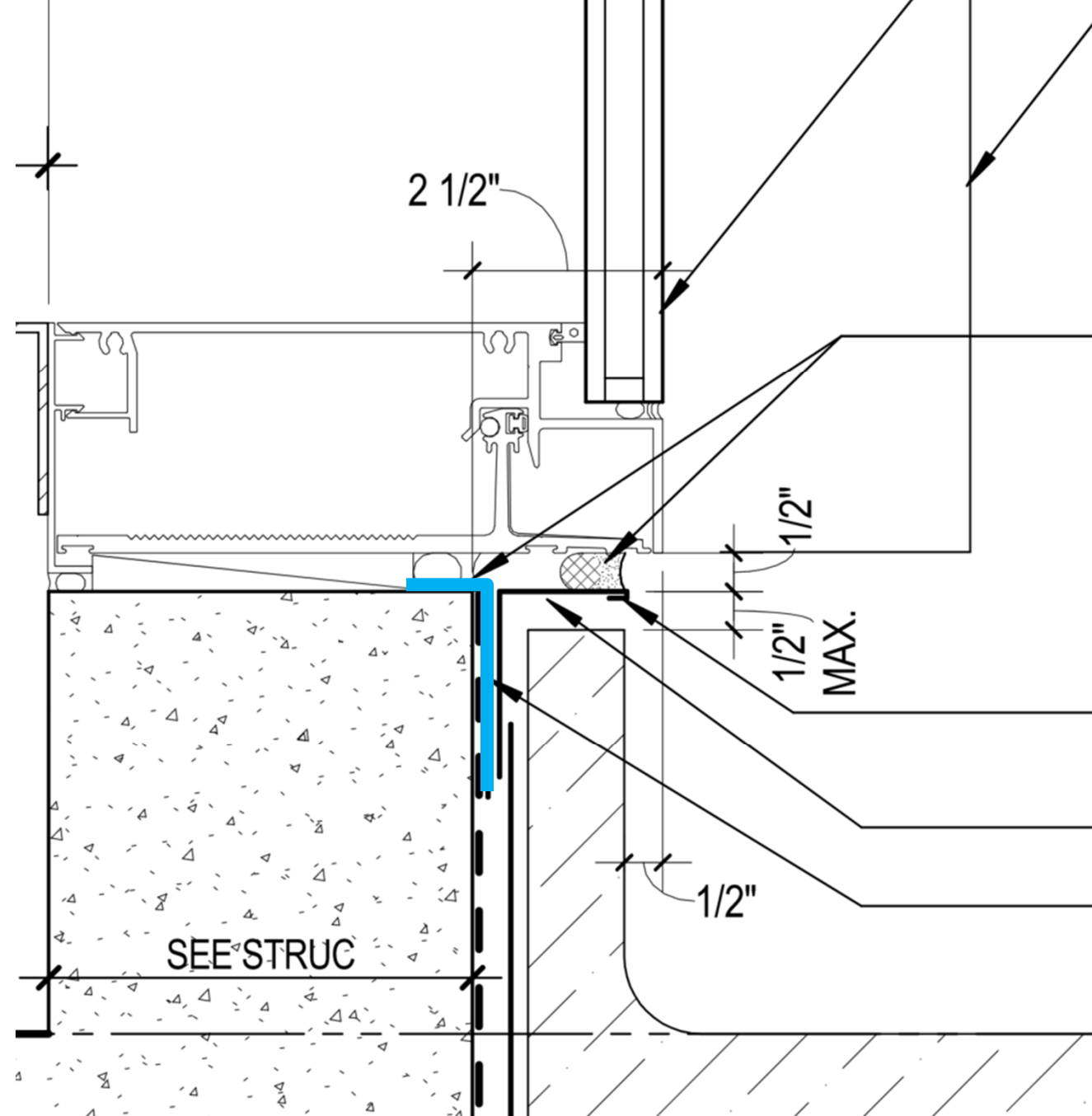
- Fluid Applied Flashing
 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - **Foil Faced**
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

- Fluid Applied Flashing
 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - **Stainless Steel**



Sealant Transition

Flashing Materials

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 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

- Fluid Applied Flashing
 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - Stainless Steel



Sealant Transition

Flashing Materials

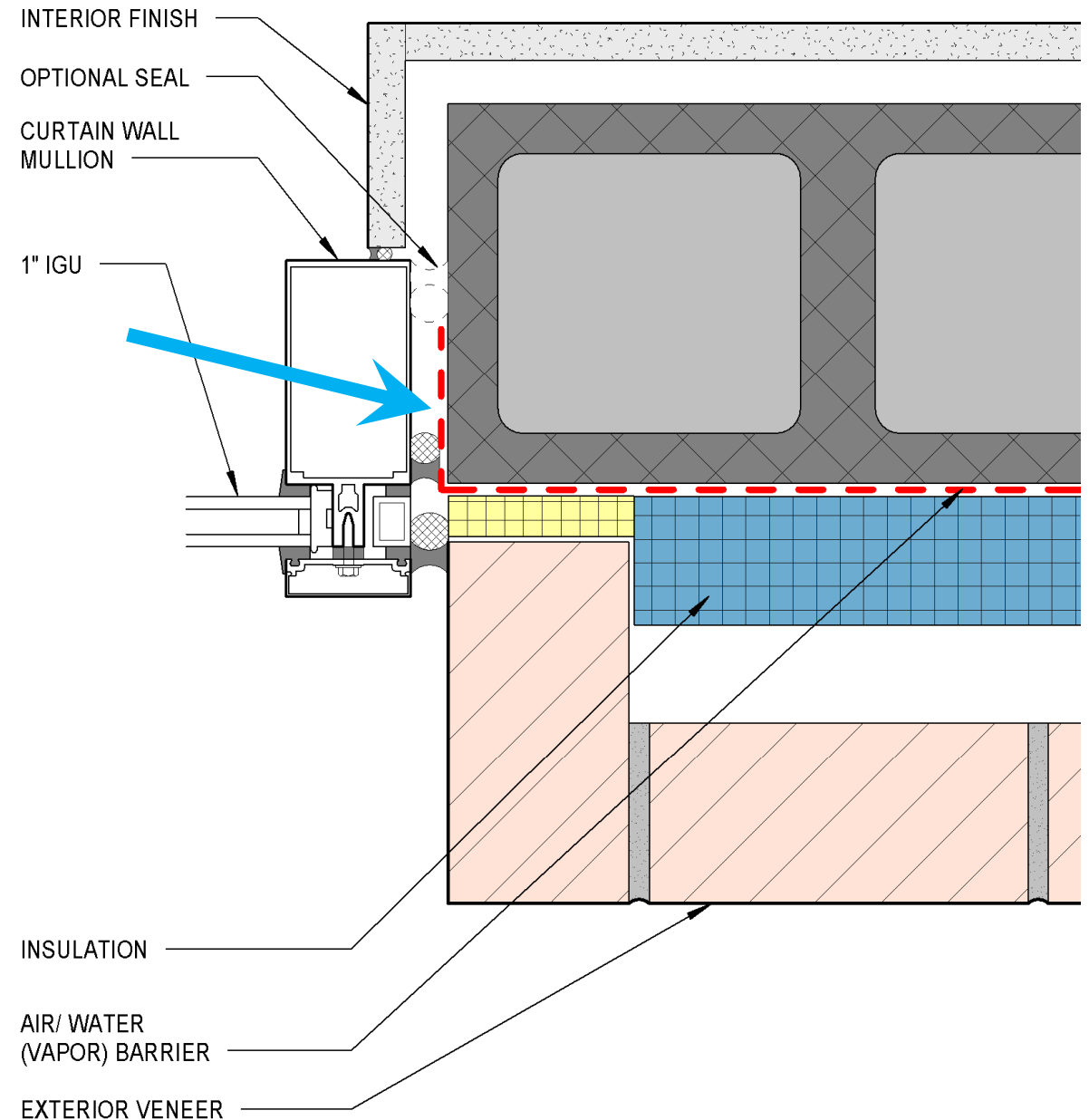
- Fluid Applied Flashing
 - STPE
 - Silicone
- Self Adhered
 - Rubberized Asphalt
 - Foil Faced
 - Butyl
 - **Stainless Steel**



Sealant Transition

Flashing Materials

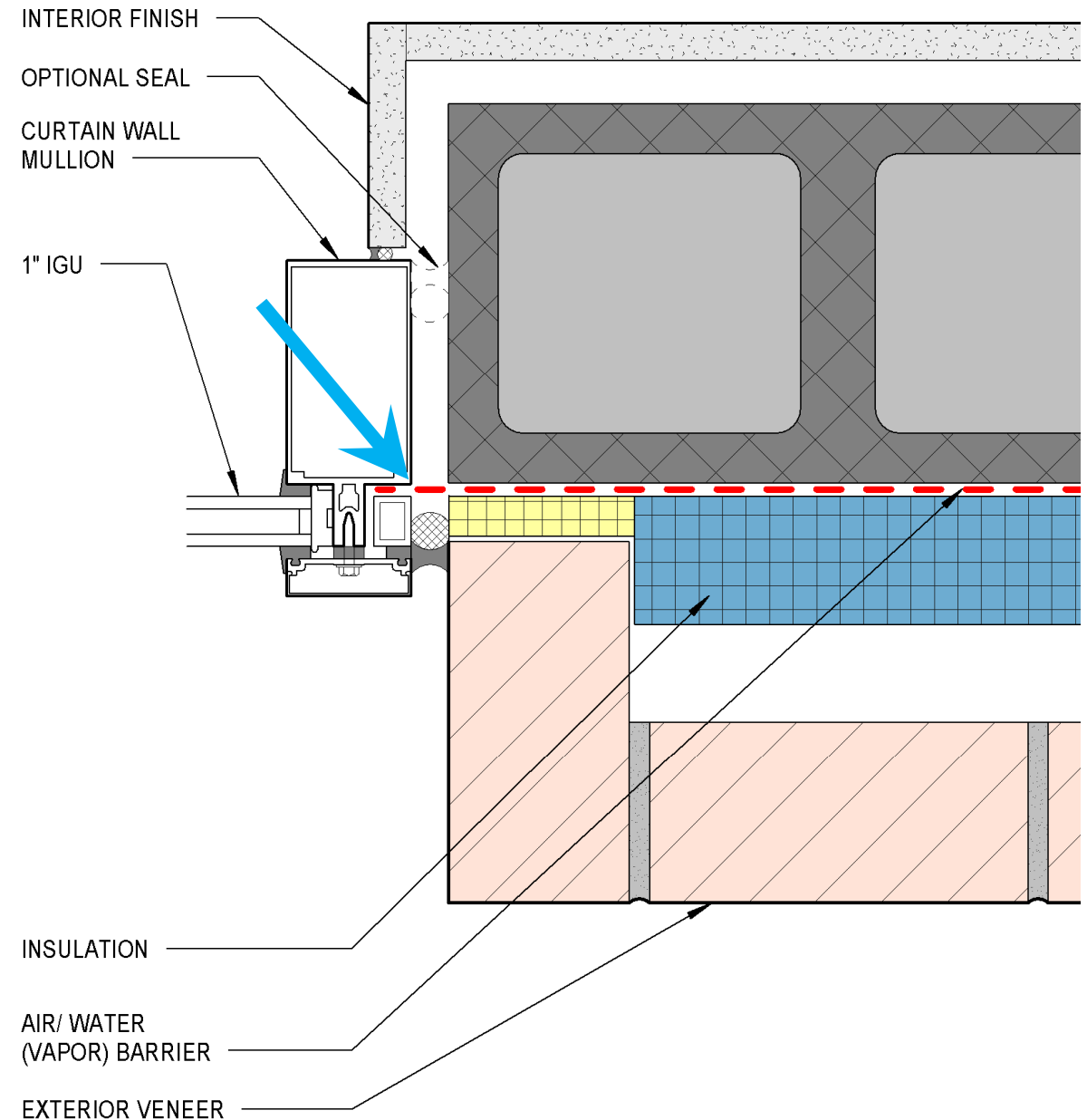
- Fluid Applied Flashing
 - Seamless
 - Thickness variability
 - Curing
 - Good Adhesion Compatibility
 - Possible Water Absorption
- Self Adhered
 - Seams
 - Buildup of Layers
 - Adhesion
 - Sealant Compatibility



Membrane Transition

Flashing Materials

- Self Adhered Rubberized Asphalts
 - Risk of Compatibility
 - Span Limits
- Self Adhered Stainless Steel
 - Risk of Compatibility
 - Span Limits
- Sheet Metal
 - Lack of movement capability
- Pre-cured Silicone



Membrane Transition

Flashing Materials

- Self Adhered Rubberized Asphalts
 - Risk of Compatibility
 - Span Limits
- Sheet Metal
 - Lack of movement capability
- Pre-cured Silicone











Membrane Transition

Flashing Materials

- Self Adhered Rubberized Asphalts
 - Risk of Compatibility
 - Span Limits
- Sheet Metal
 - Lack of movement capability
- Pre-cured Silicone



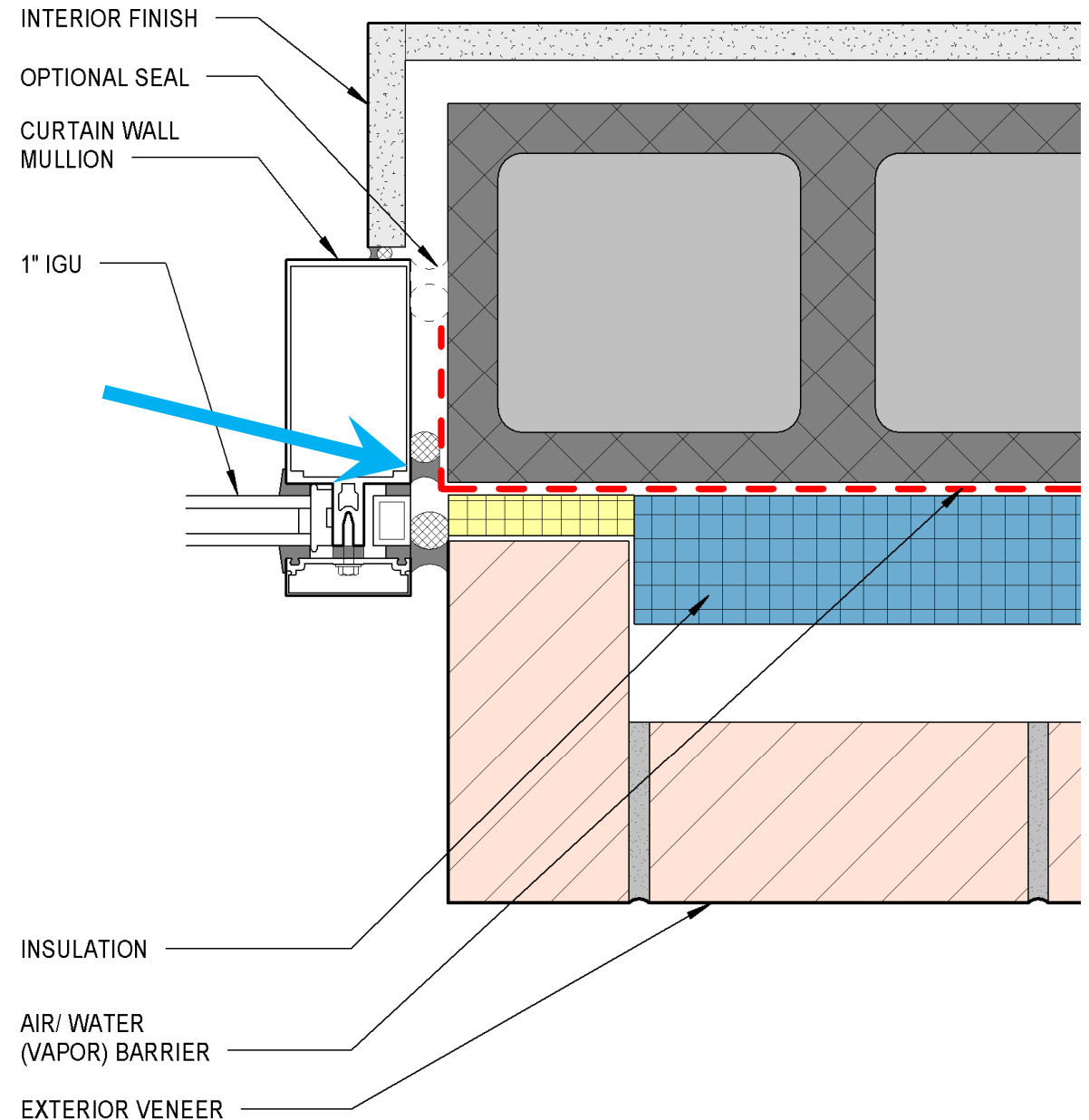
Sealant Transition

BENEFITS

- Future Sealant Repair
- Perimeter Sealant is Compatible with Curtain Wall Sealants
- Constructability / Sequence

LIMITATIONS

- Perimeter Sealant Alignment
- Sealant width tolerance
- Sealant/Membrane Compatibility



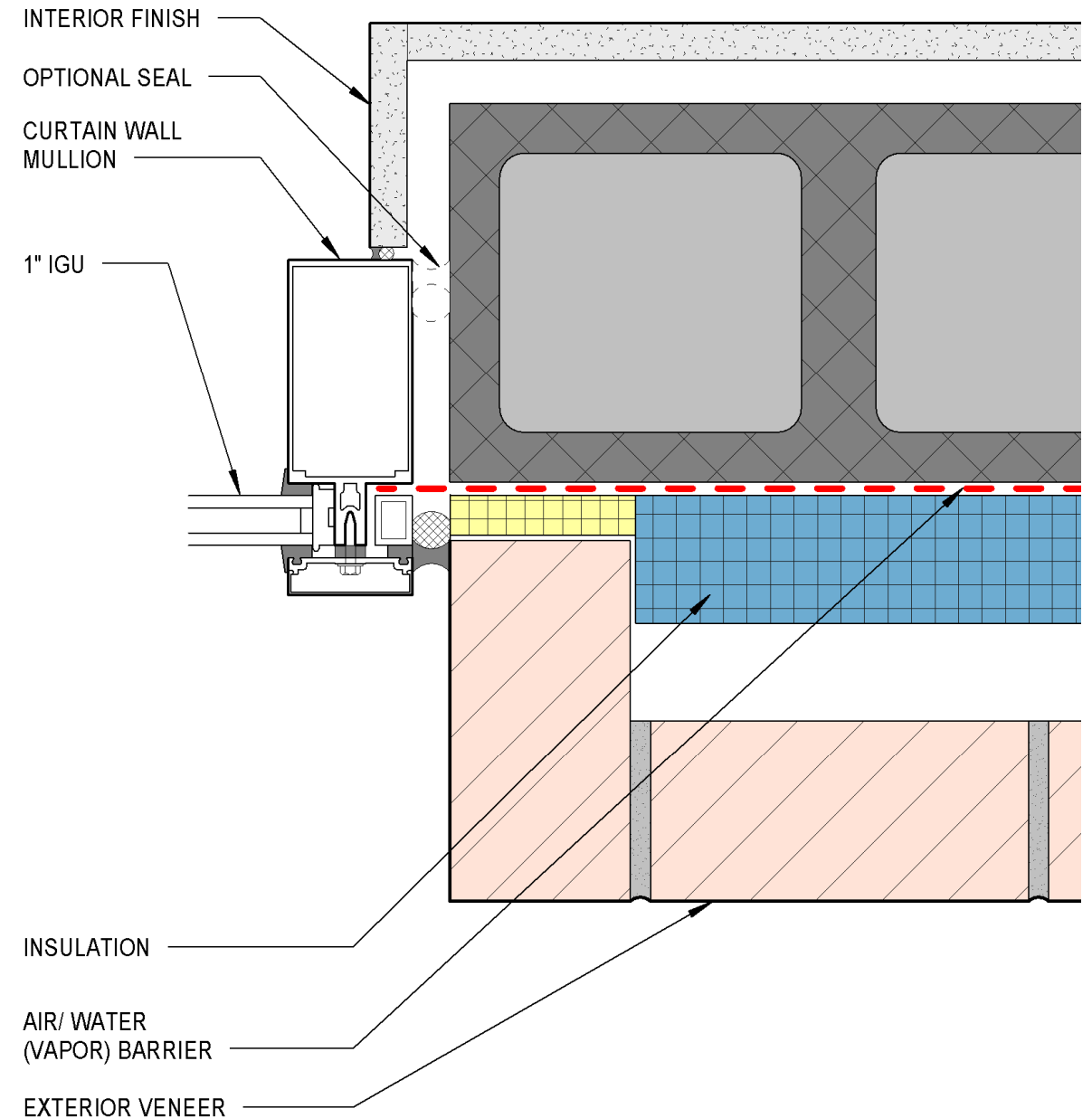
Membrane Transition

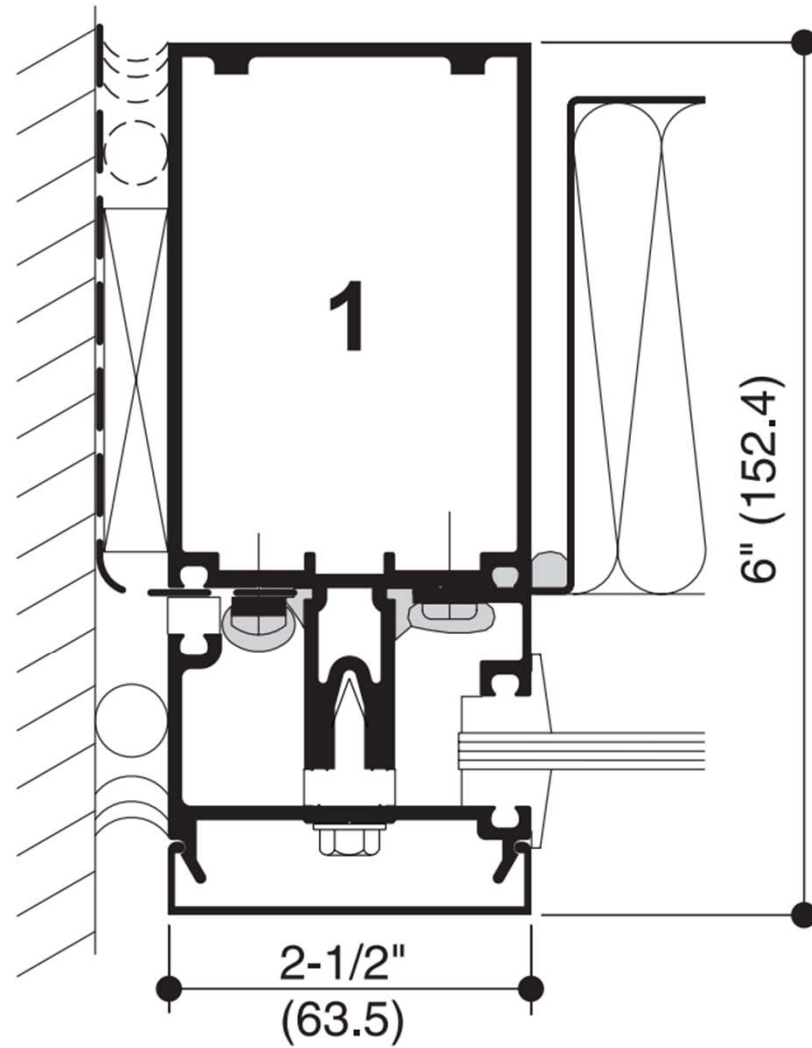
BENEFITS

- Eliminates Sealant/Membrane Compatibility Issue
- Can span narrow gaps

LIMITATIONS

- Constructability / Sequencing
- Seams
- Certain Membrane Span Limits
- Future Repair Issues
- Requires Change of Gaskets
- Internal Curtain Wall Sealant Compatibility with Membrane
- 3D Terminations are Difficult





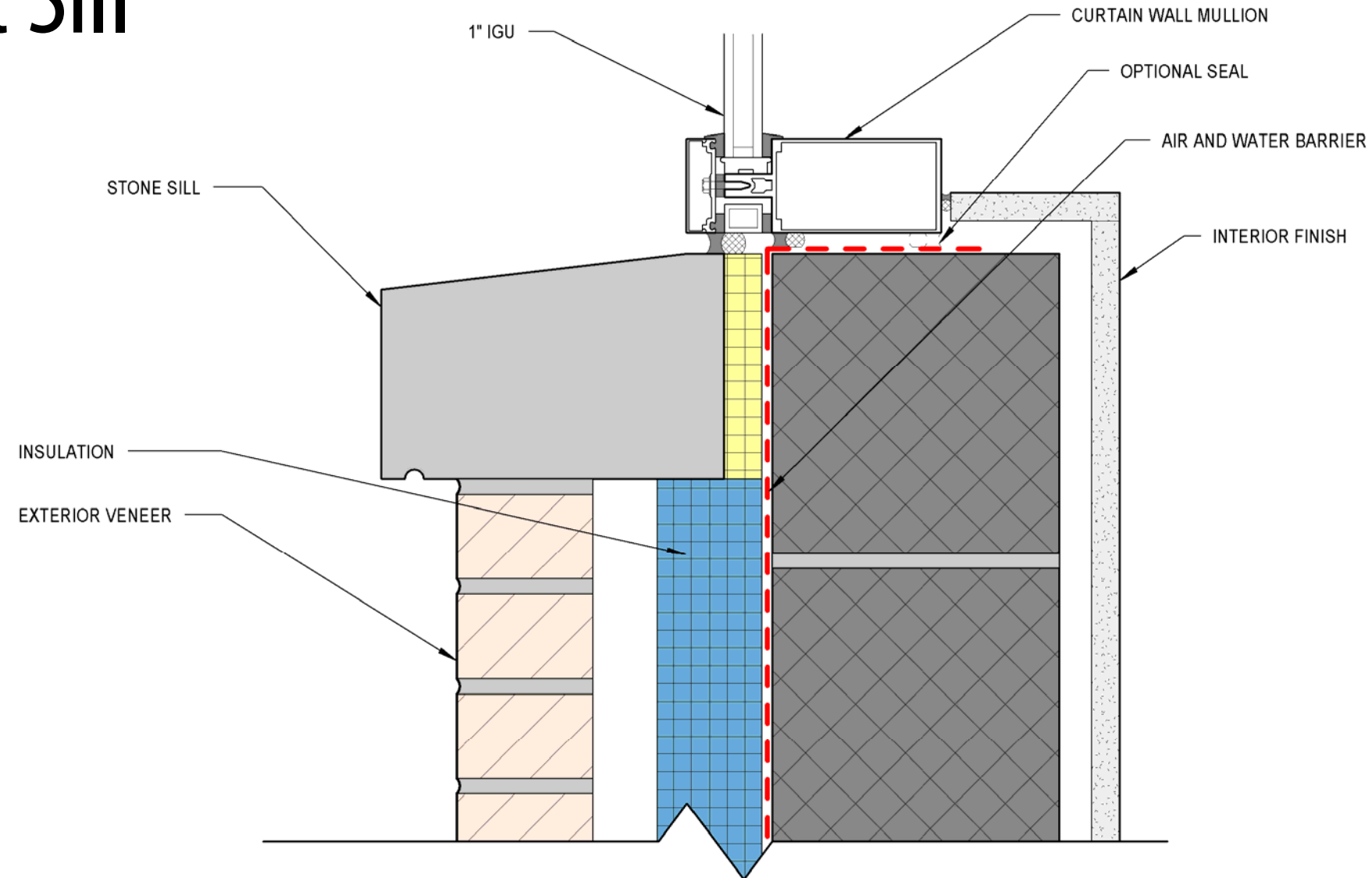
**JAMB MULLION
AT SPANDREL**
(With vapor barrier tie-in)

Continuity Around the Perimeter

Critical Seals must align at...

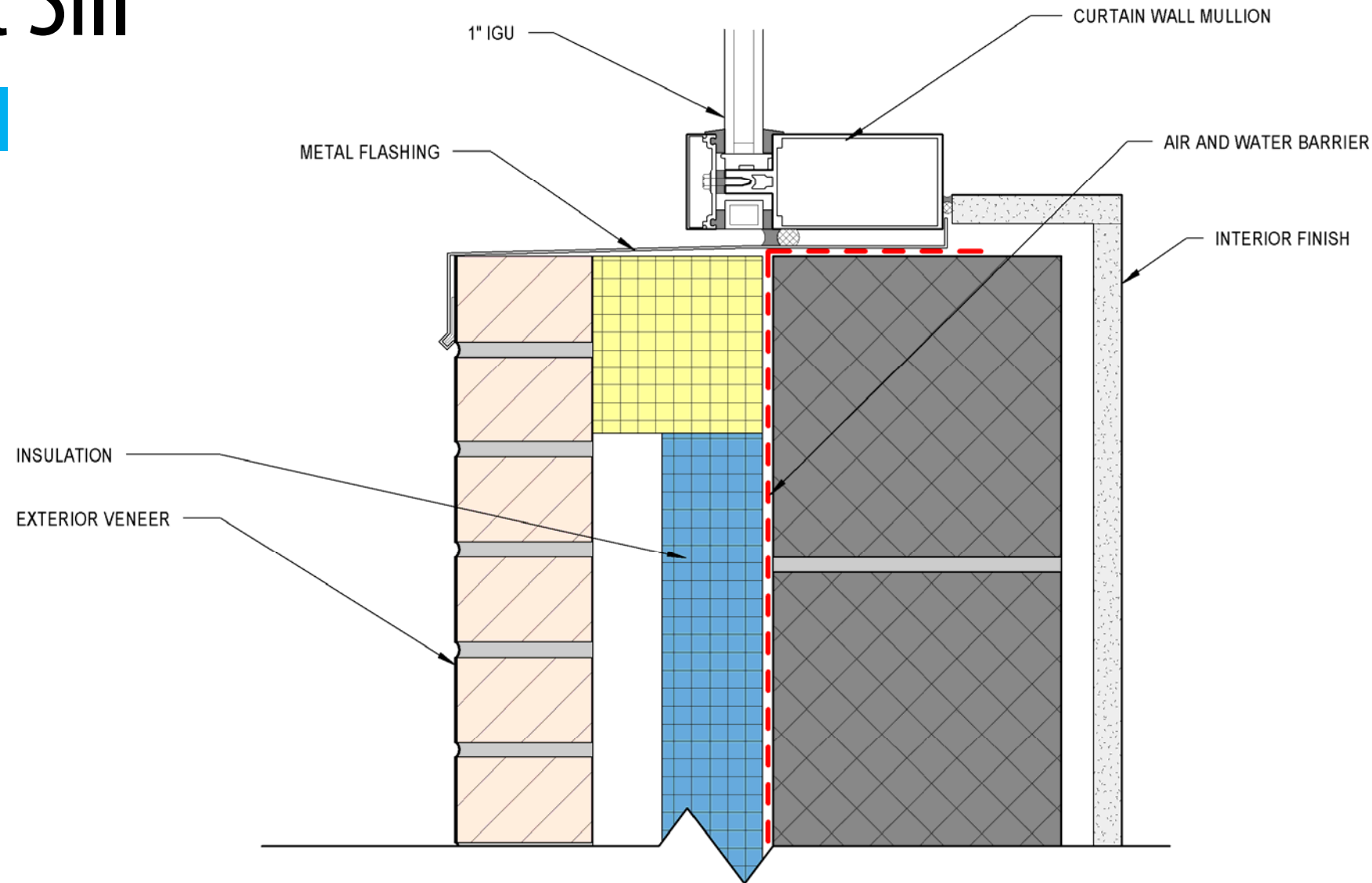
- Head
- Jamb
- Sill

Curtain Wall at Sill



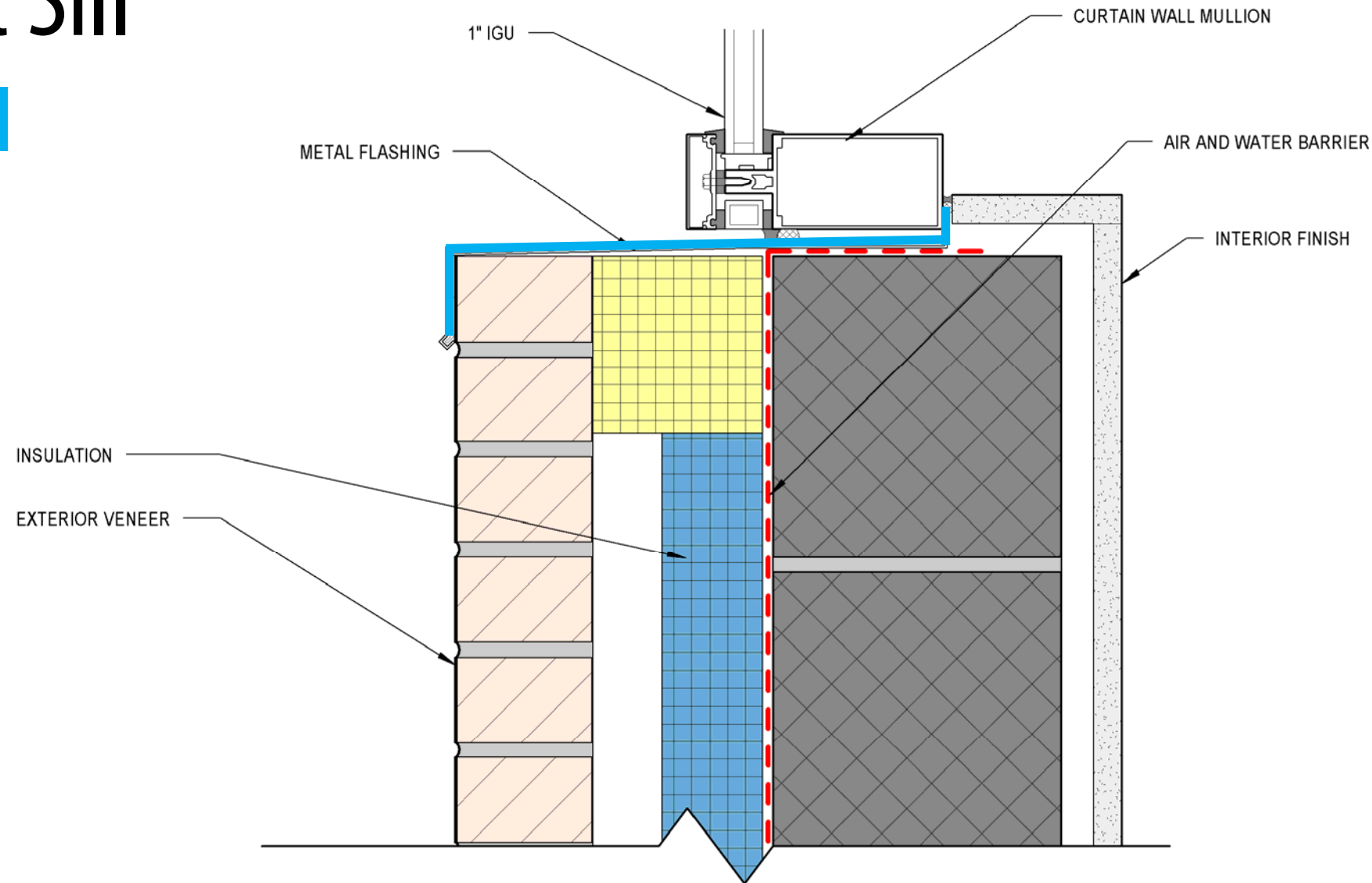
Curtain Wall at Sill

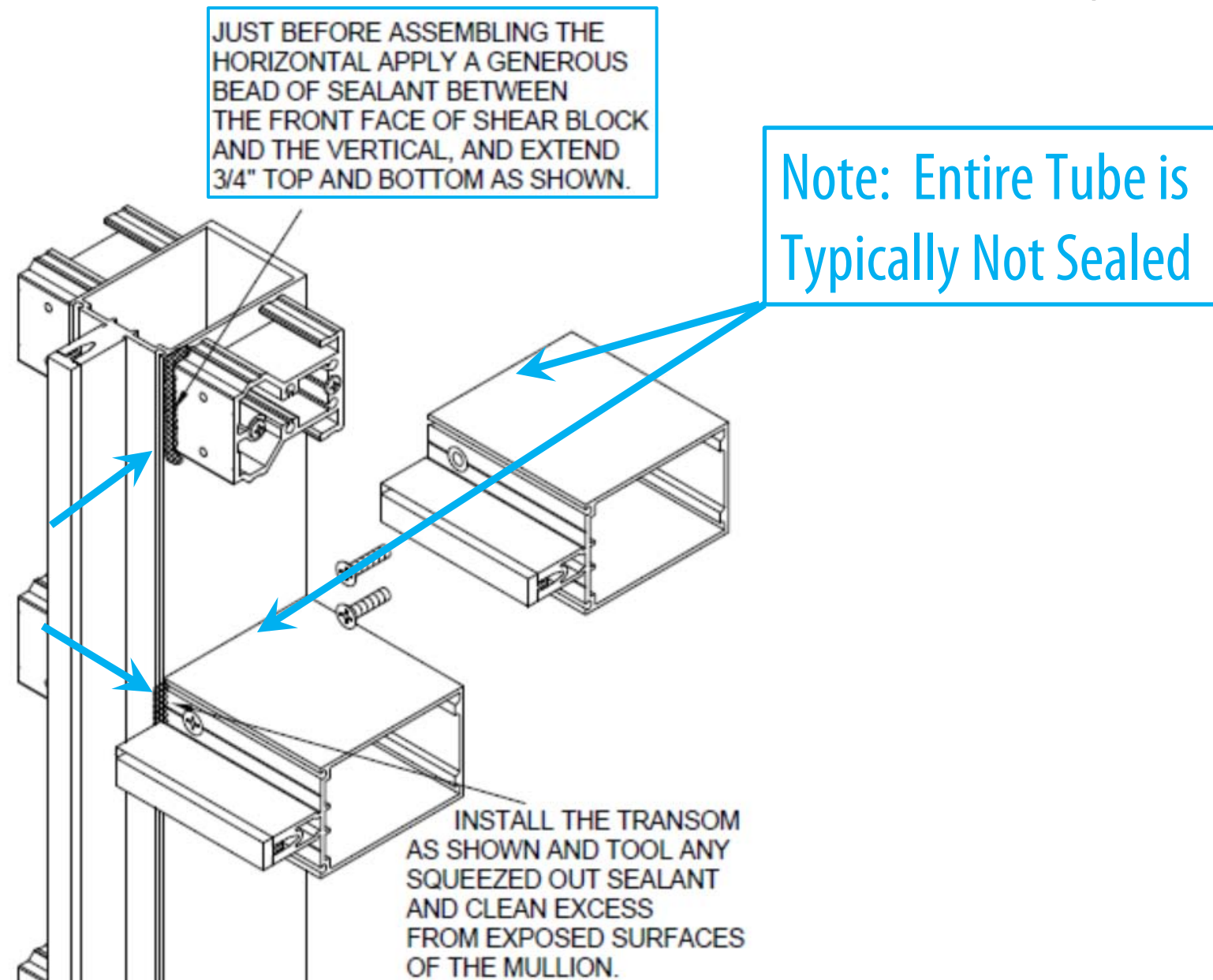
Challenging Detail



Curtain Wall at Sill

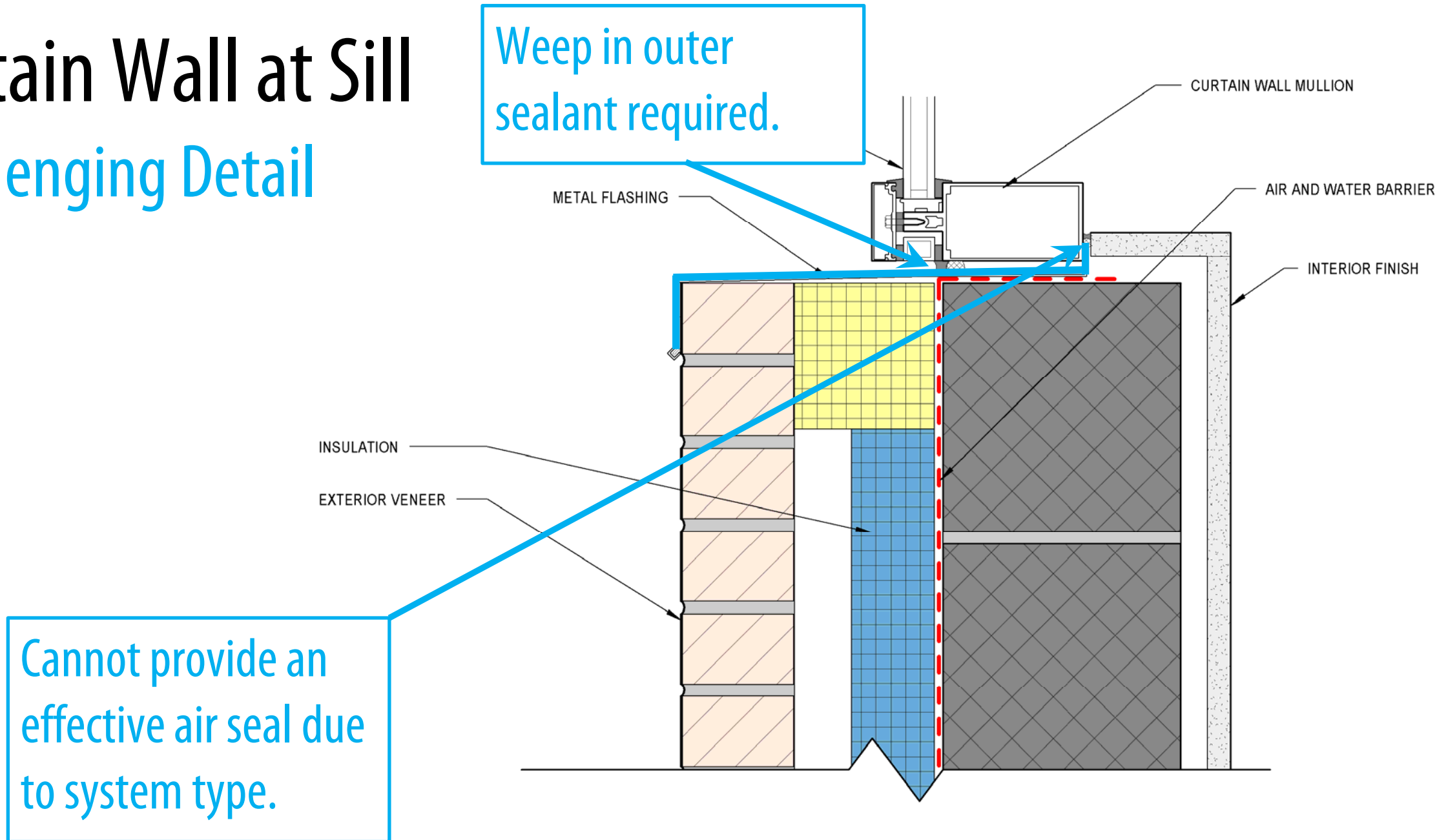
Challenging Detail





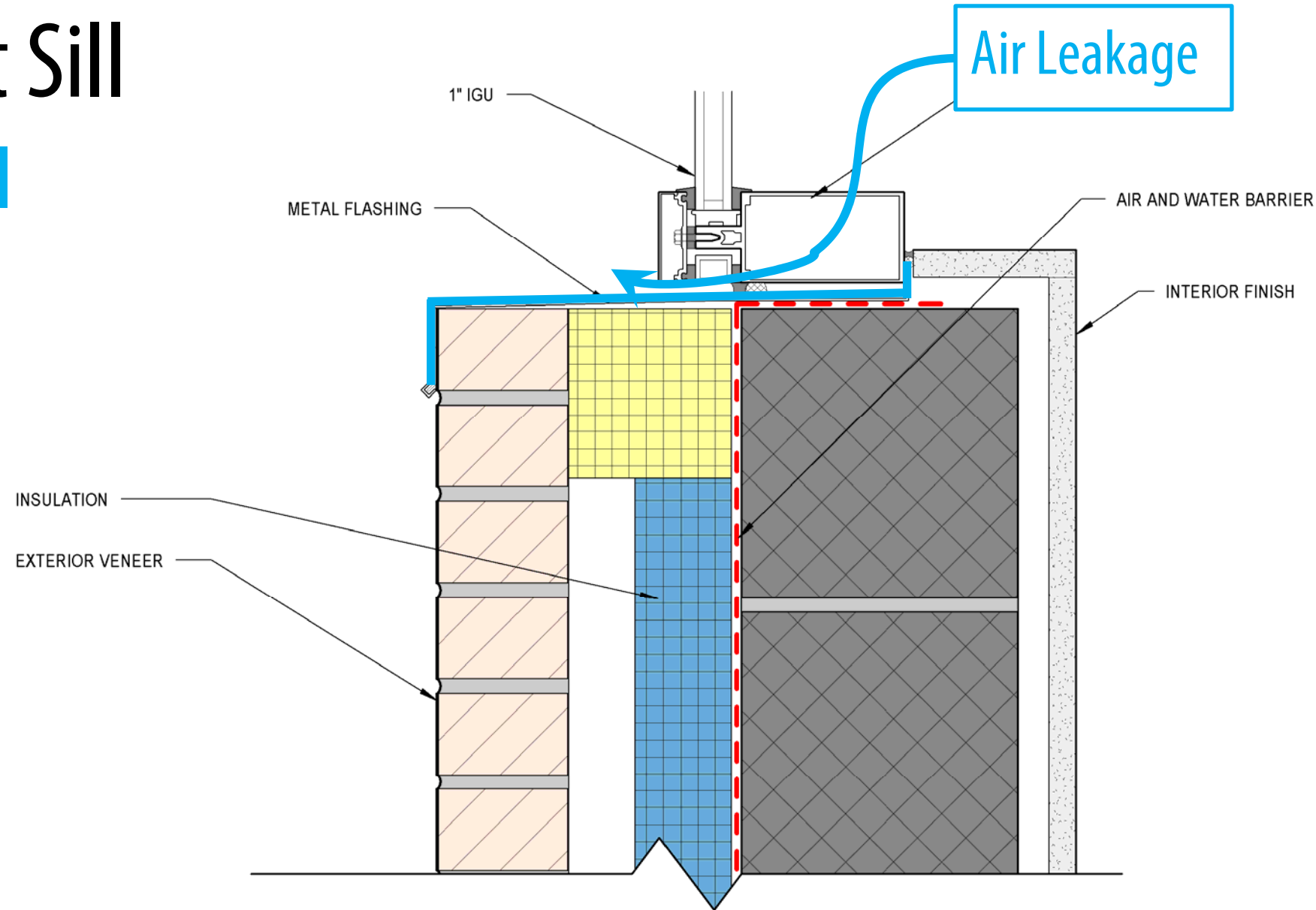
Curtain Wall at Sill

Challenging Detail



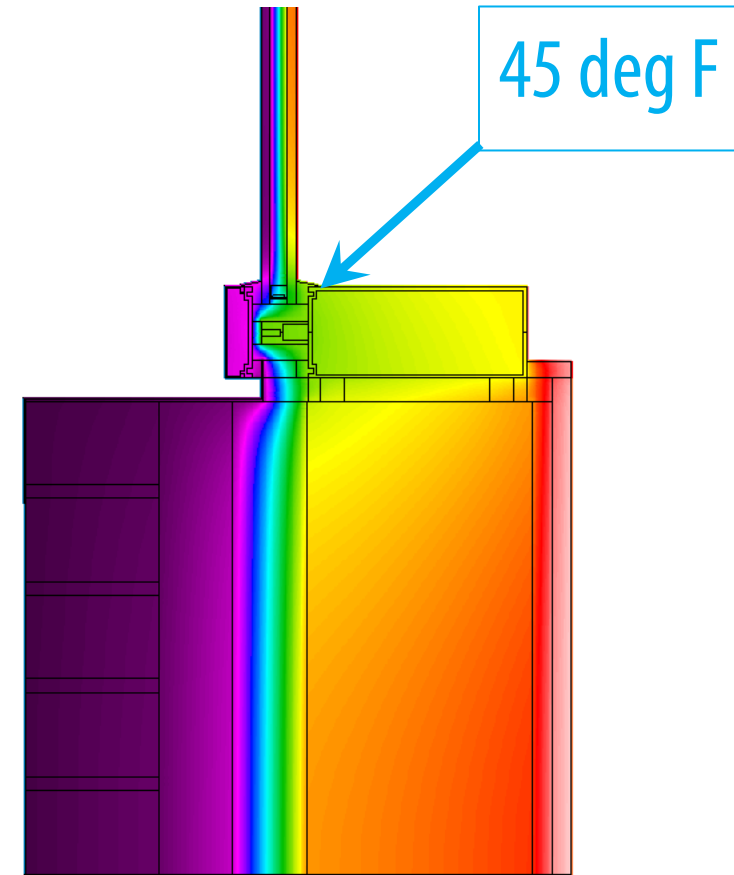
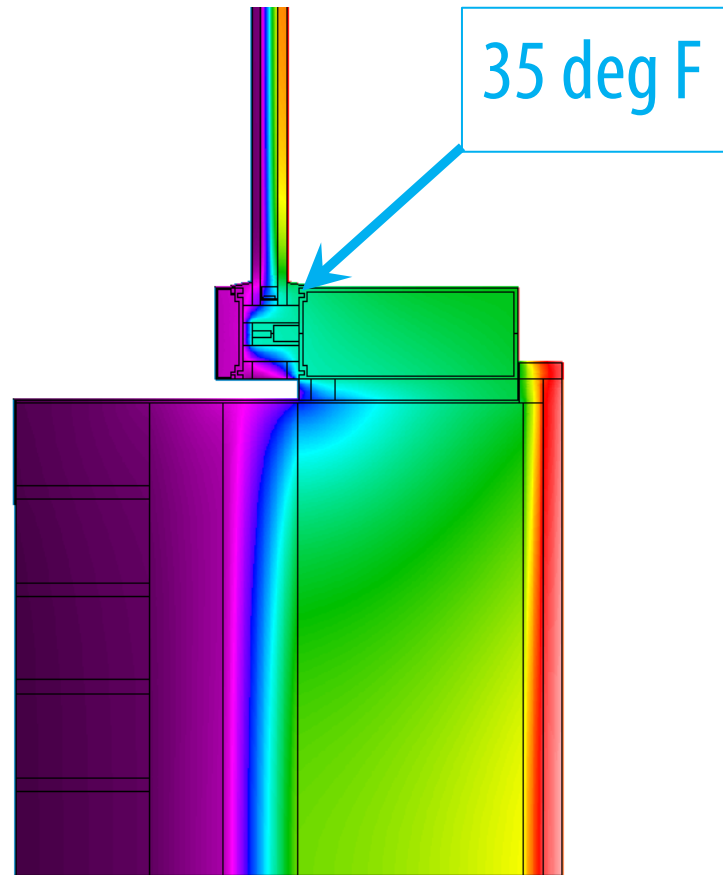
Curtain Wall at Sill

Challenging Detail



Curtain Wall at Sill

Challenging Detail











2016/09/15 17:40



Protecto Wrap
1-800-753-9727
www.protectowrap.com
Meets ASTM 2112

2016/09/15 18:08



2016/10/06 18:53



2016/10/06 18:53





2016/08/10 16:05



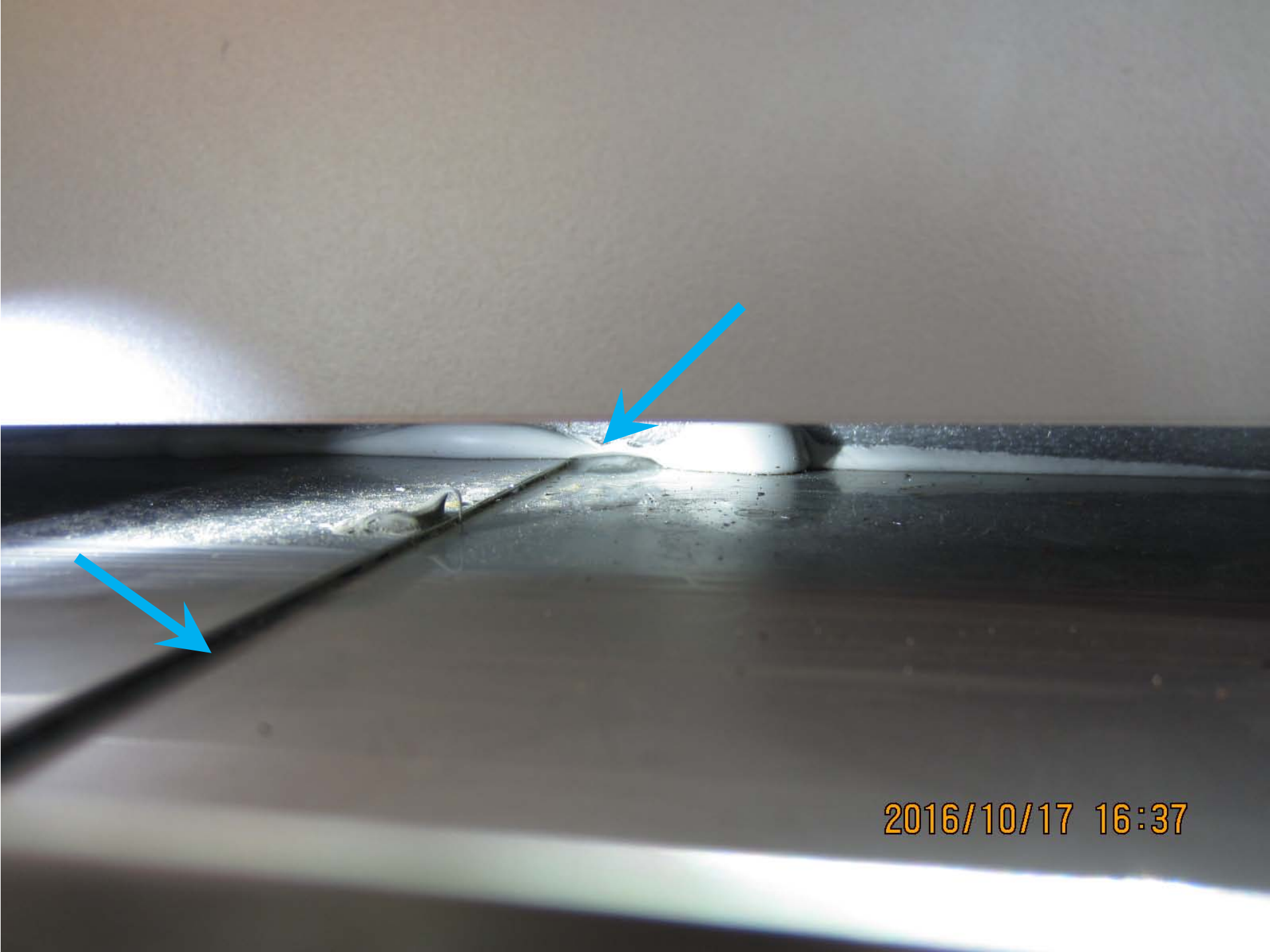
2016/08/10 16:04



2016/08/10 16:05



2016/08/10 15:34



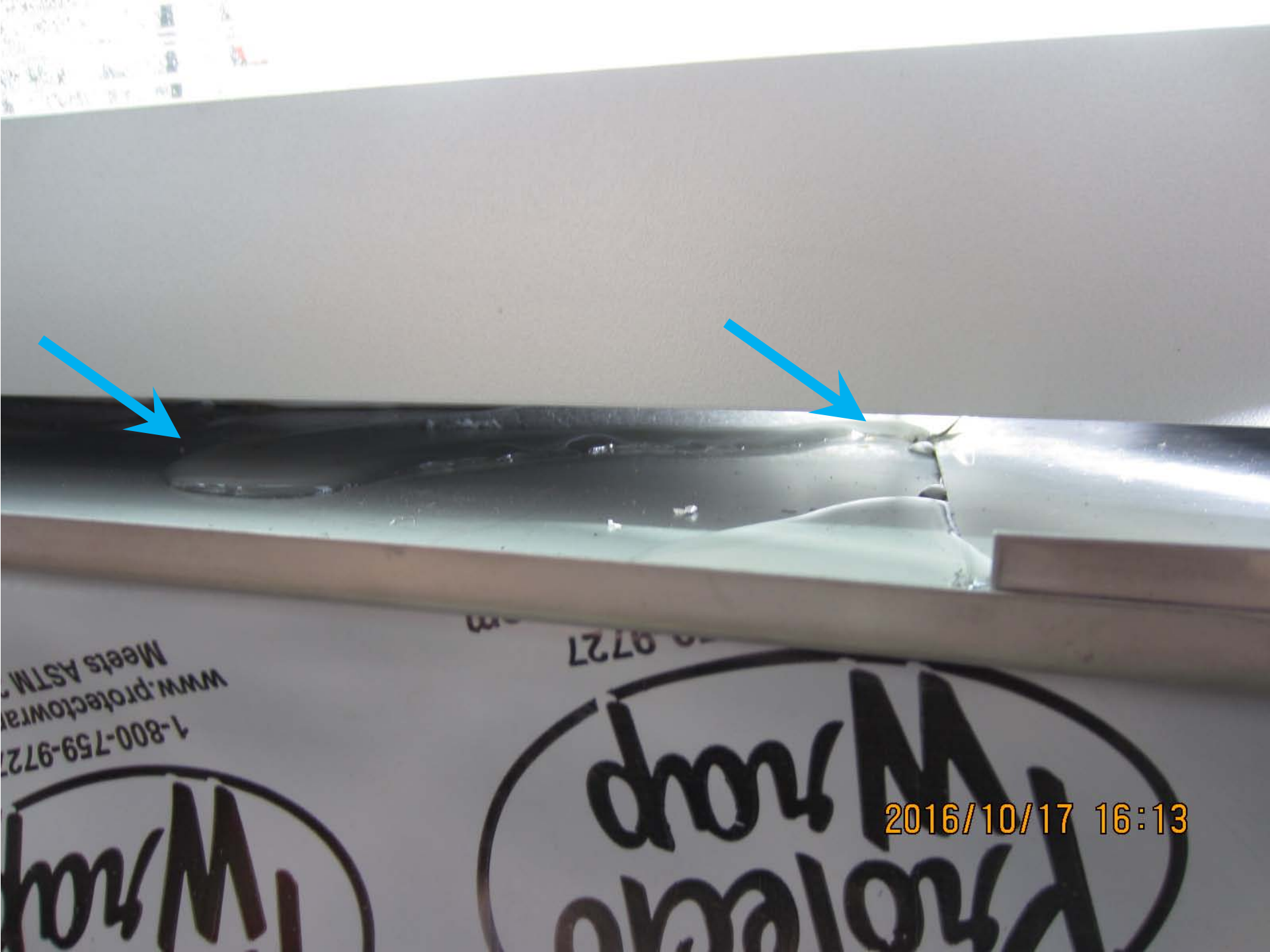
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2016/10/17 16:08



2016/10/17 16:13



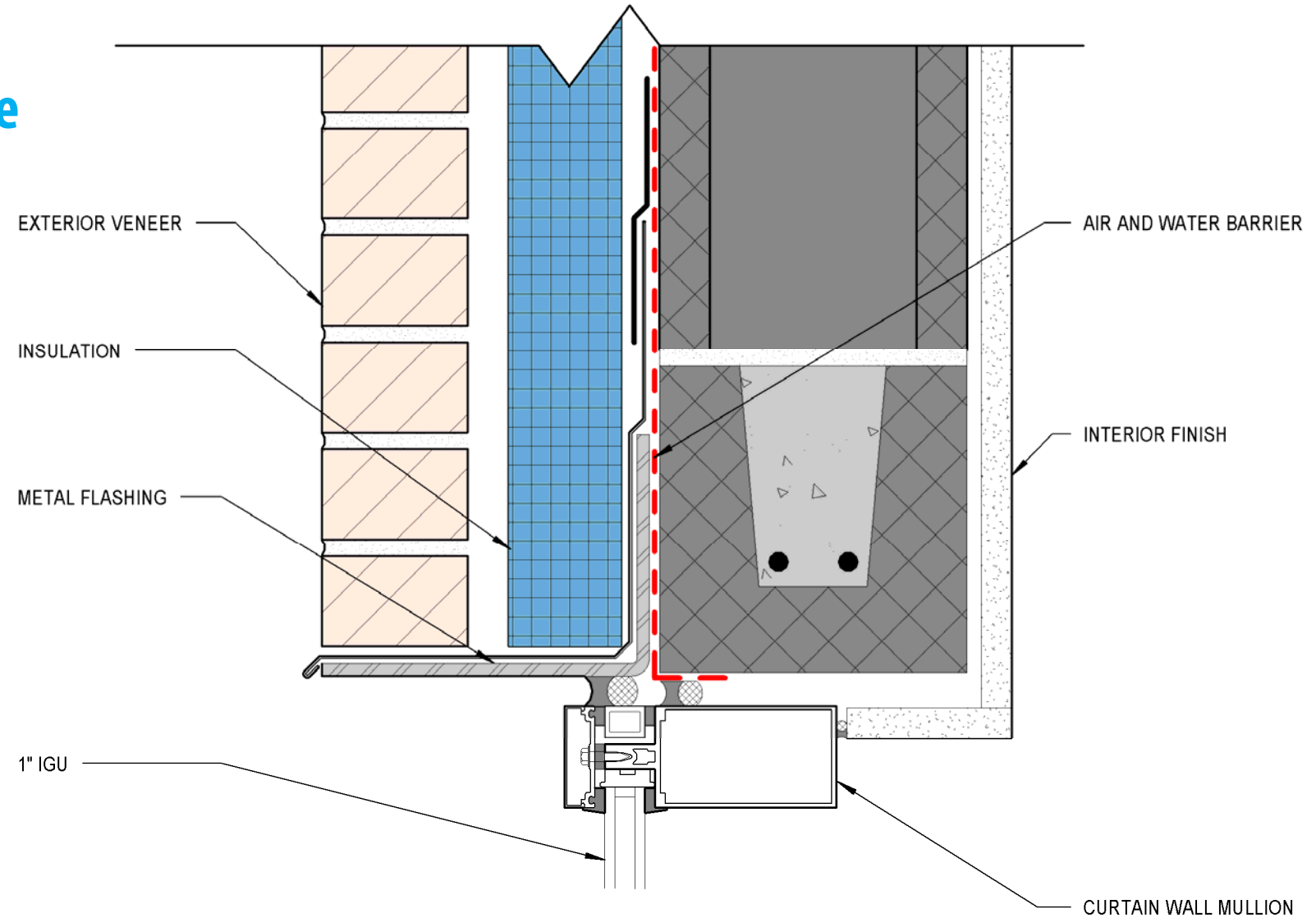
2017/02/24 13:56

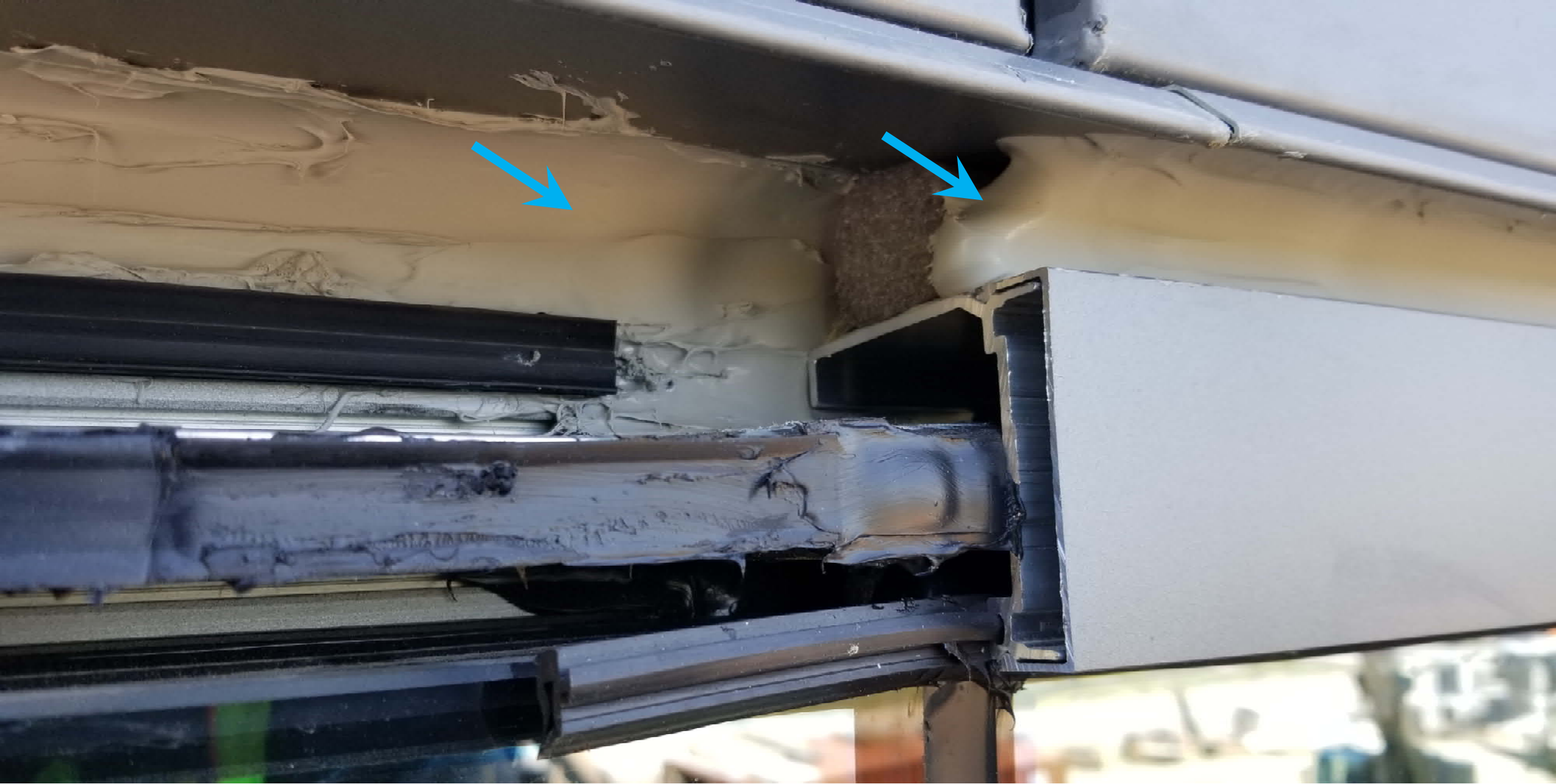


Curtain Wall at Head

Curtain Wall at Head

Limited Thermal Performance



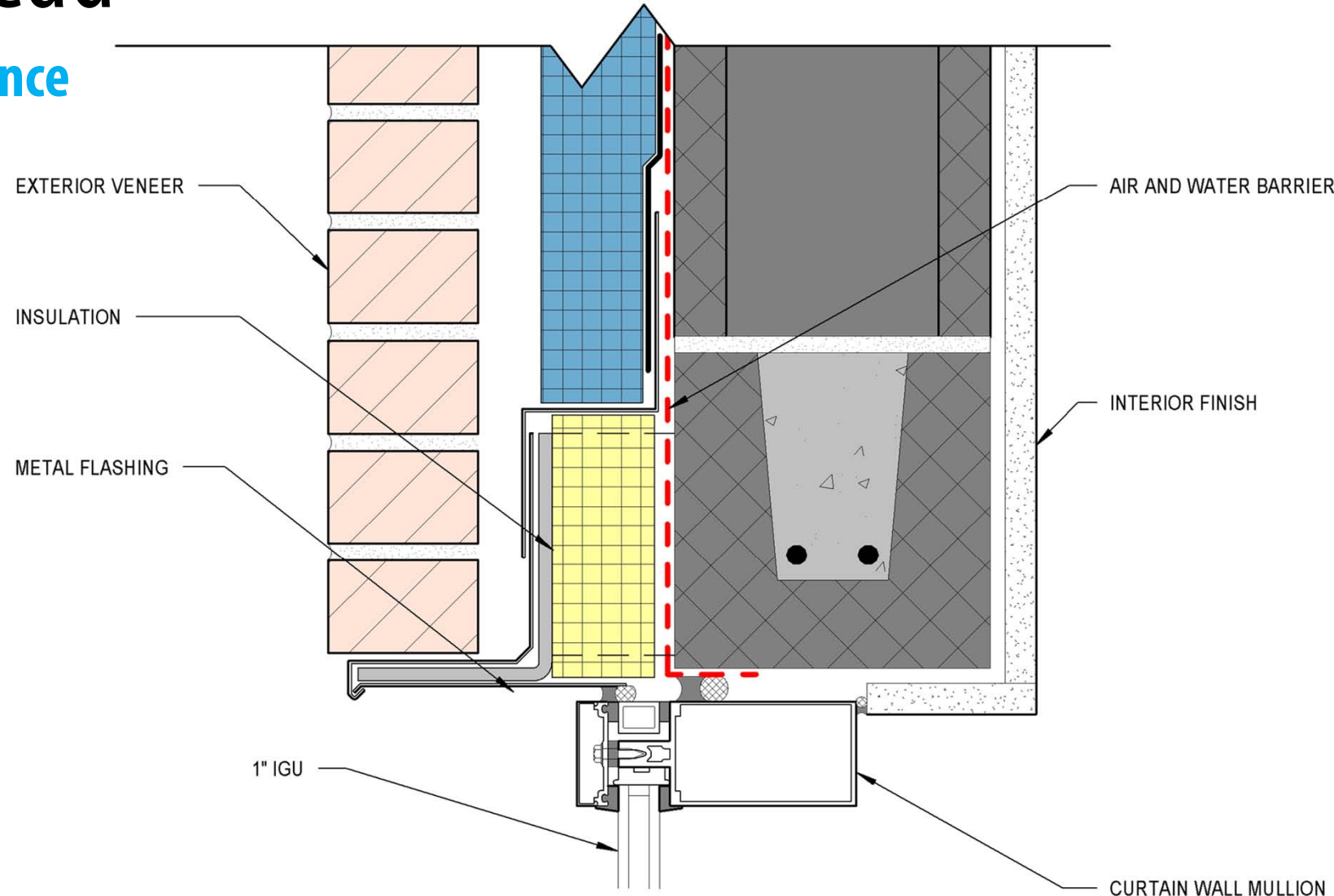


Curtain Wall at Head

Enhanced Thermal Performance

Limitations

- Detailing of Air/Water/Vapor Barrier around clips

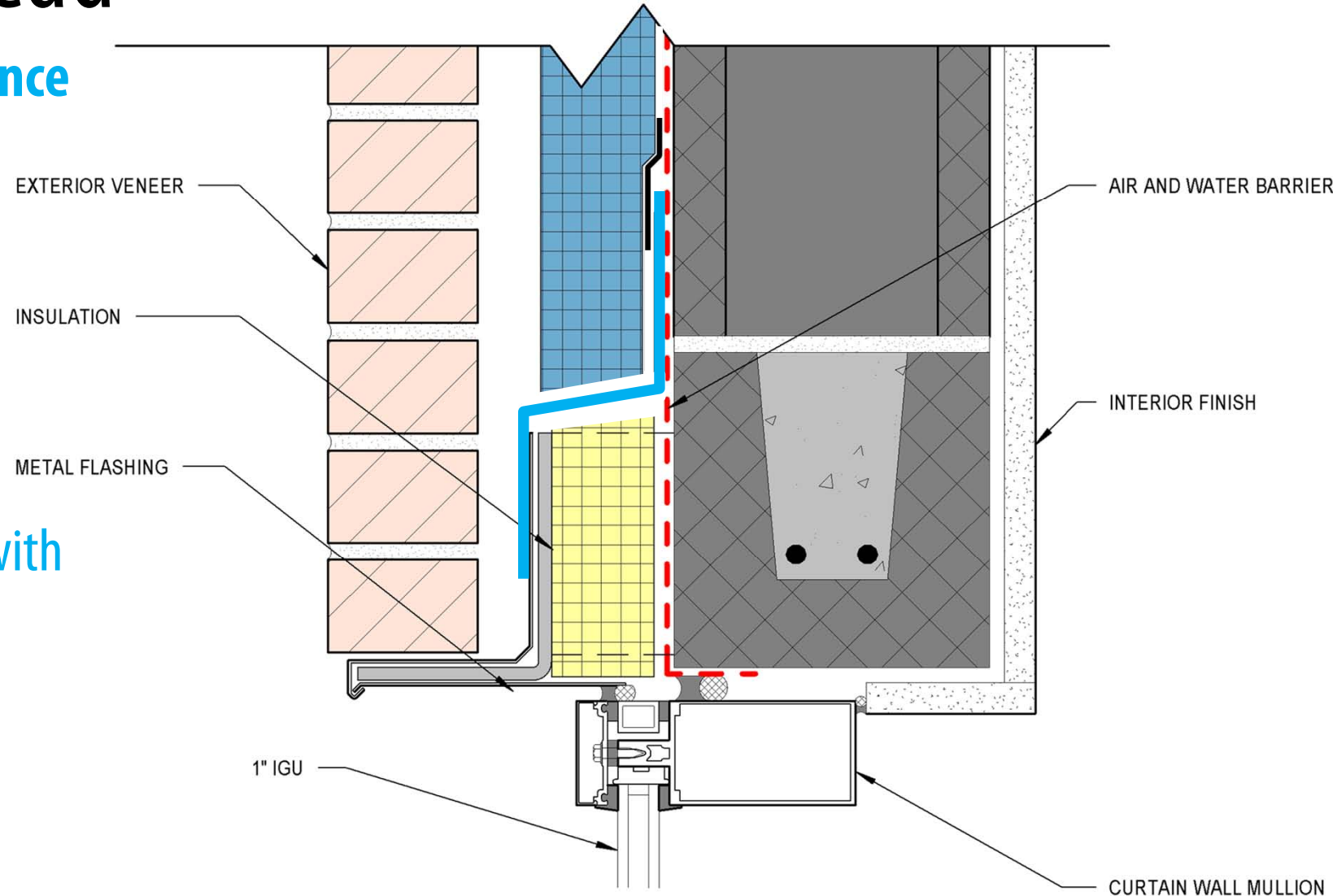


Curtain Wall at Head

Enhanced Thermal Performance

Limitations

- How to support the Flexible with Mineral wool?
- Detailing of Air/Water/Vapor Barrier around clips





2015/12/04 13:27



2015/12/04 13:27



National Gypsum

Sheathing

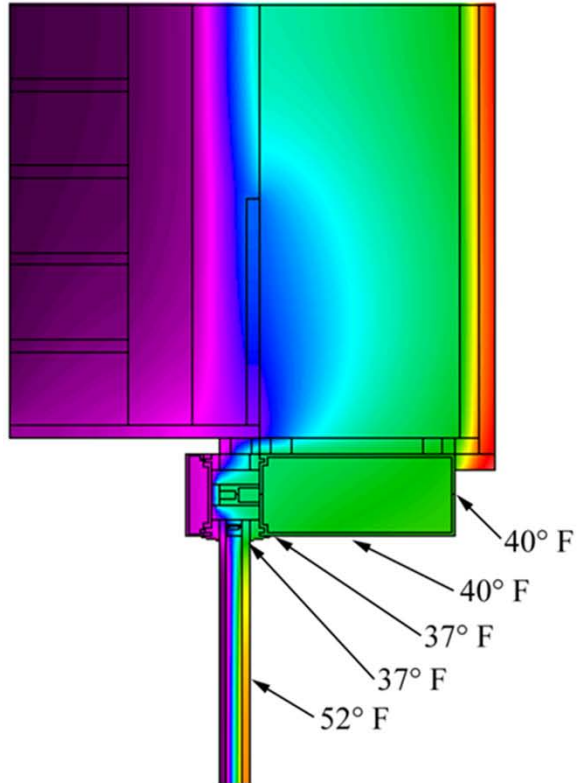
Nat

2015/12/04 13:28

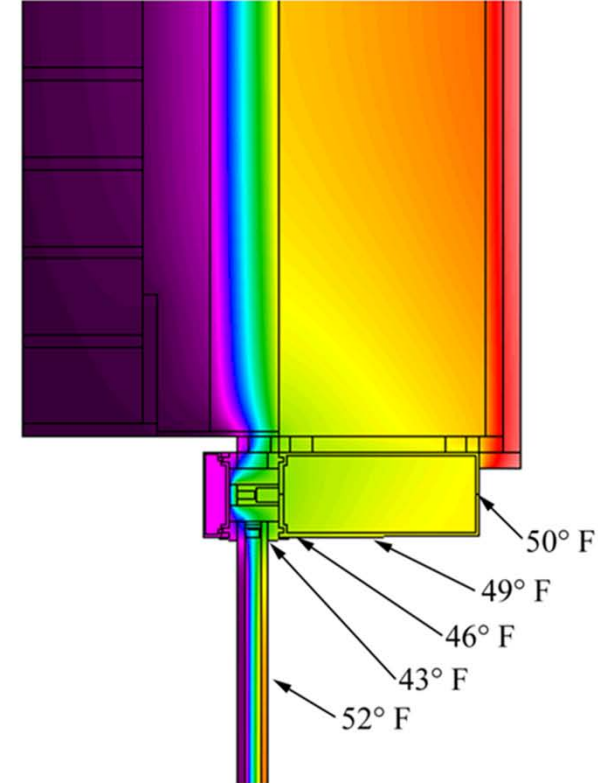


2015/12/04 13:28

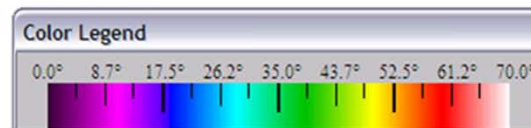
Curtain Wall at Head - Comparison



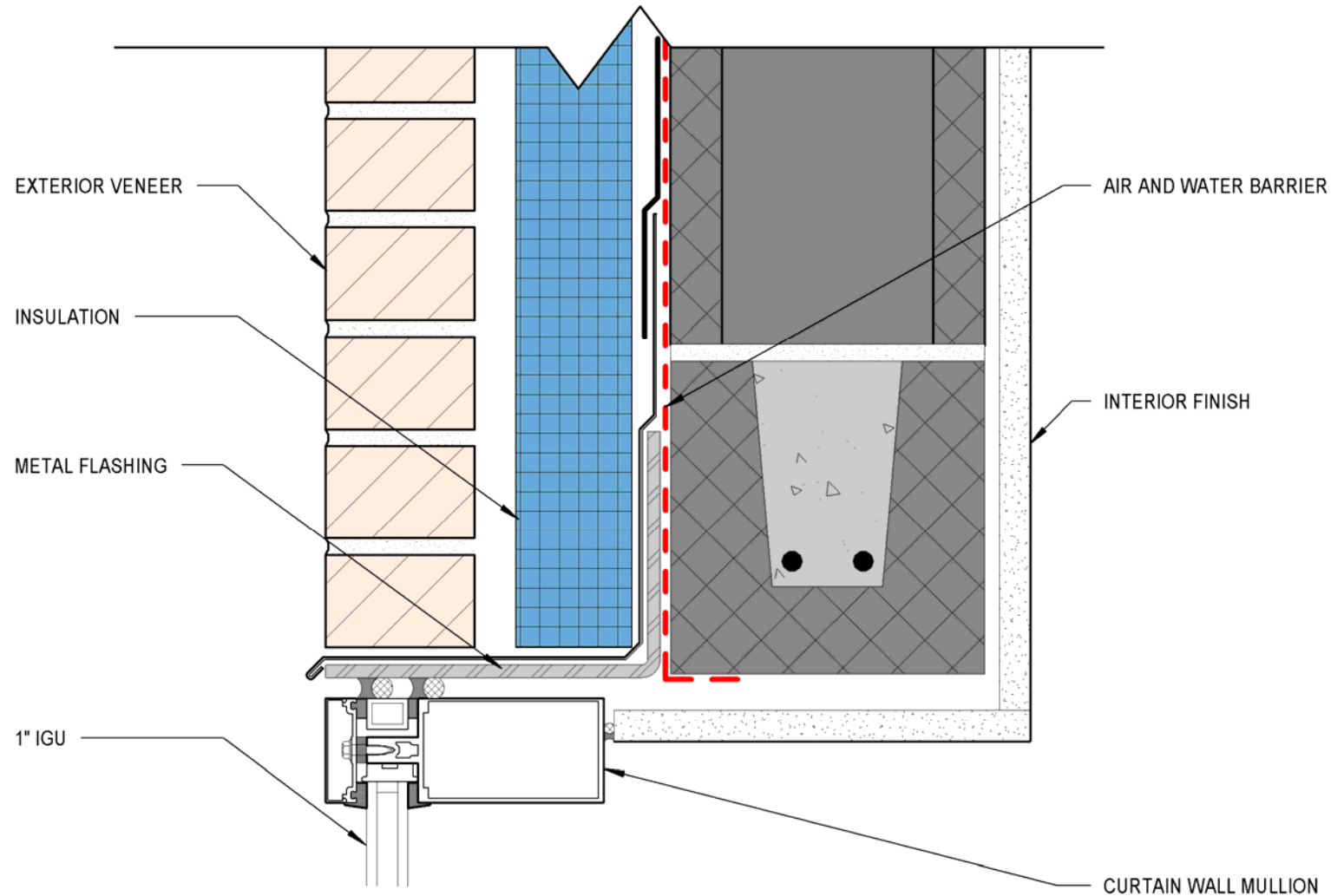
System Installed at Typical Lintel Condition
- Head Condition at Transition between Brick Cavity Wall and Enhanced Glazed Wall System



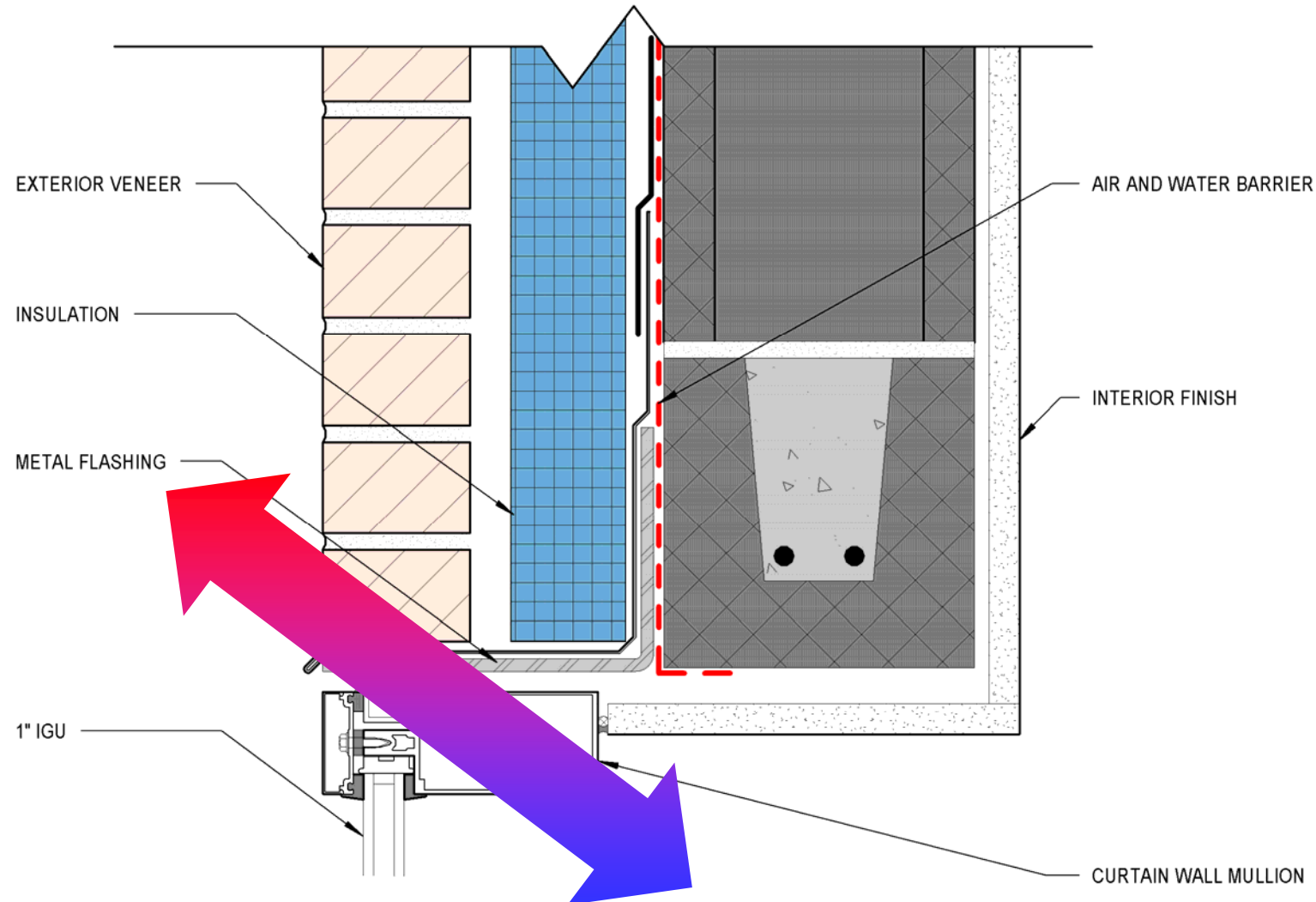
System Installed at Thermally Broken Lintel Condition
- Head Condition at Transition between Brick Cavity Wall and Enhanced Glazed Wall System



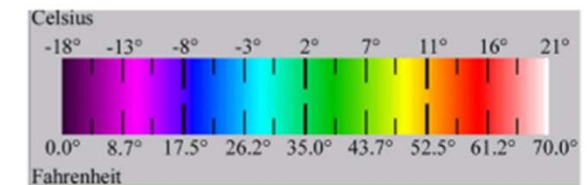
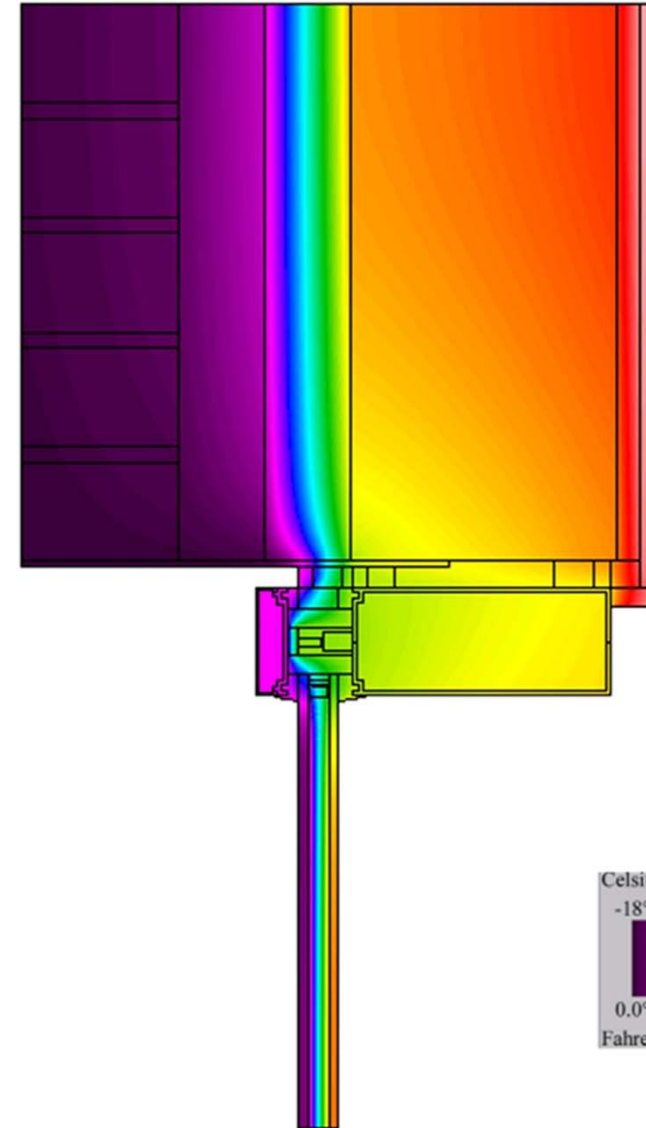
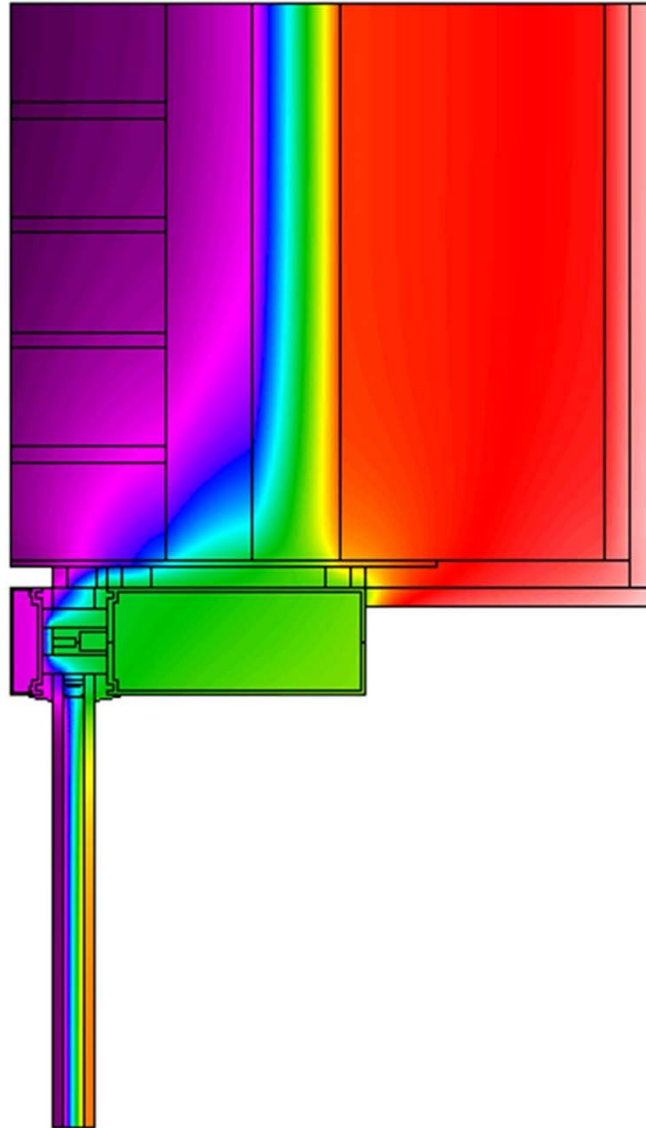
Curtain Wall at Head – Poor Detail



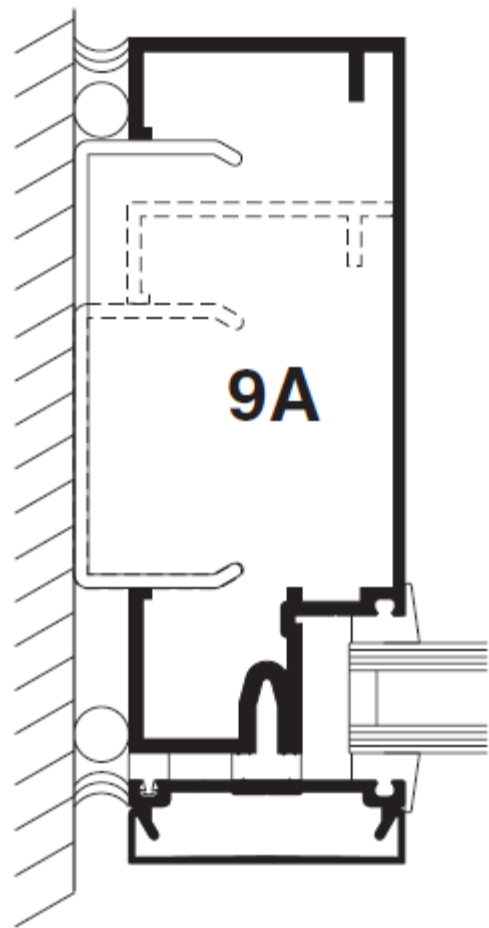
Curtain Wall at Head – Poor Detail



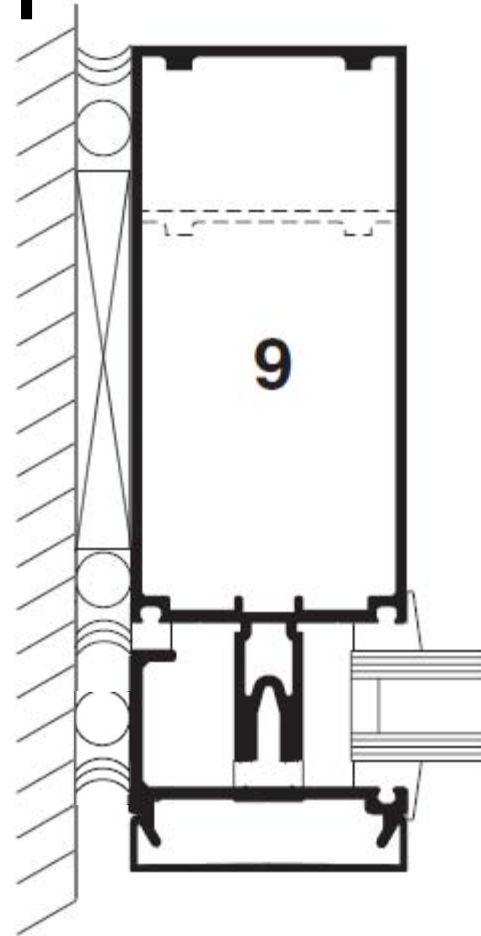
Curtain Wall at Head – Poor Detail



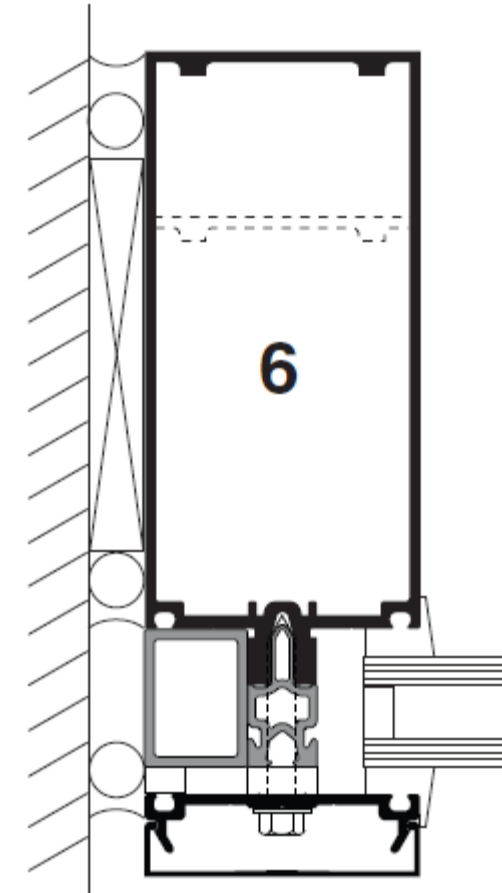
Perimeter Mullion Options



Lowest Thermal Performance



Low Humidity Only

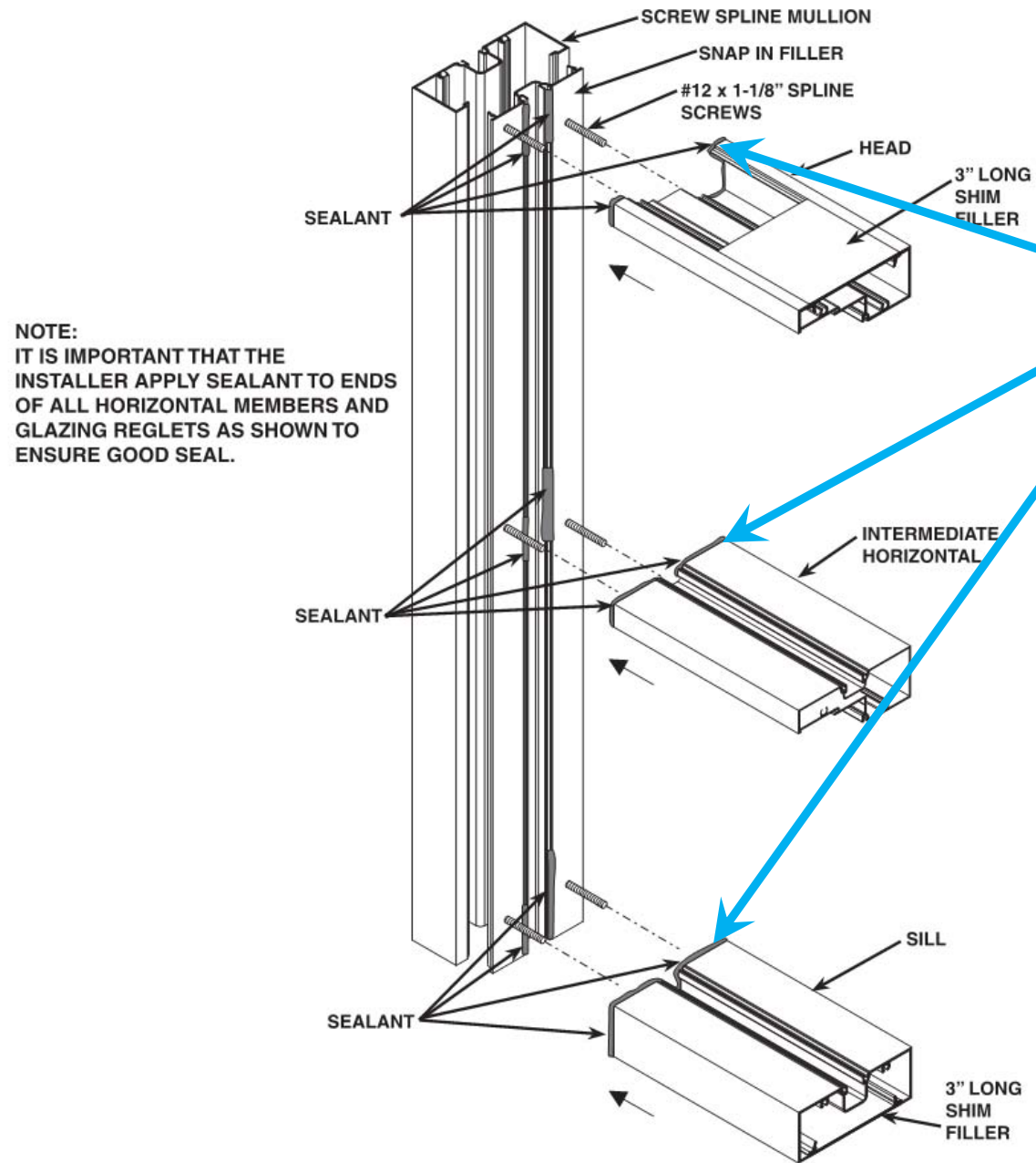


Better For Humidified Environments

Window – To – Wall

(storefront)

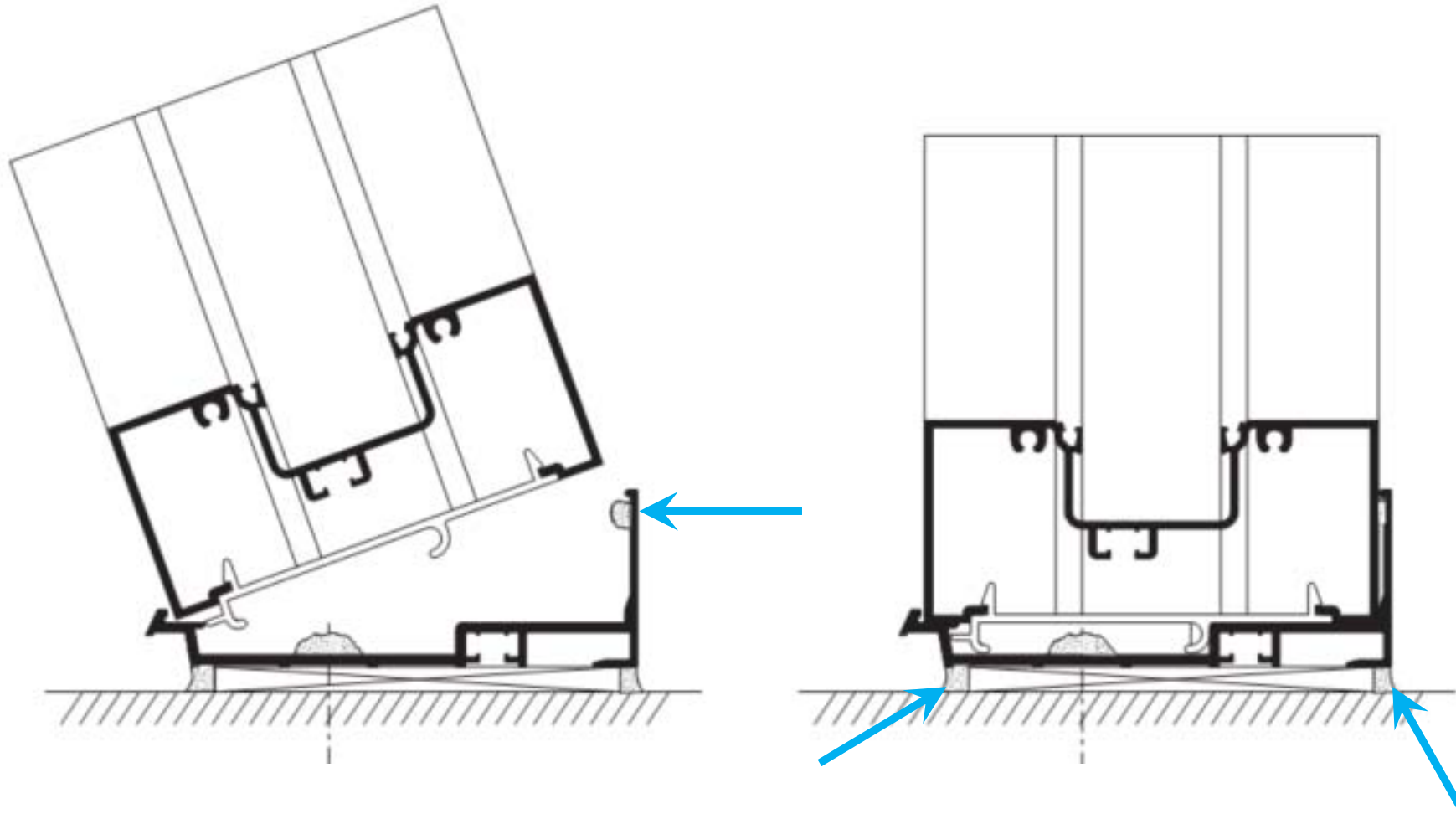
Remember First...
Understand the System

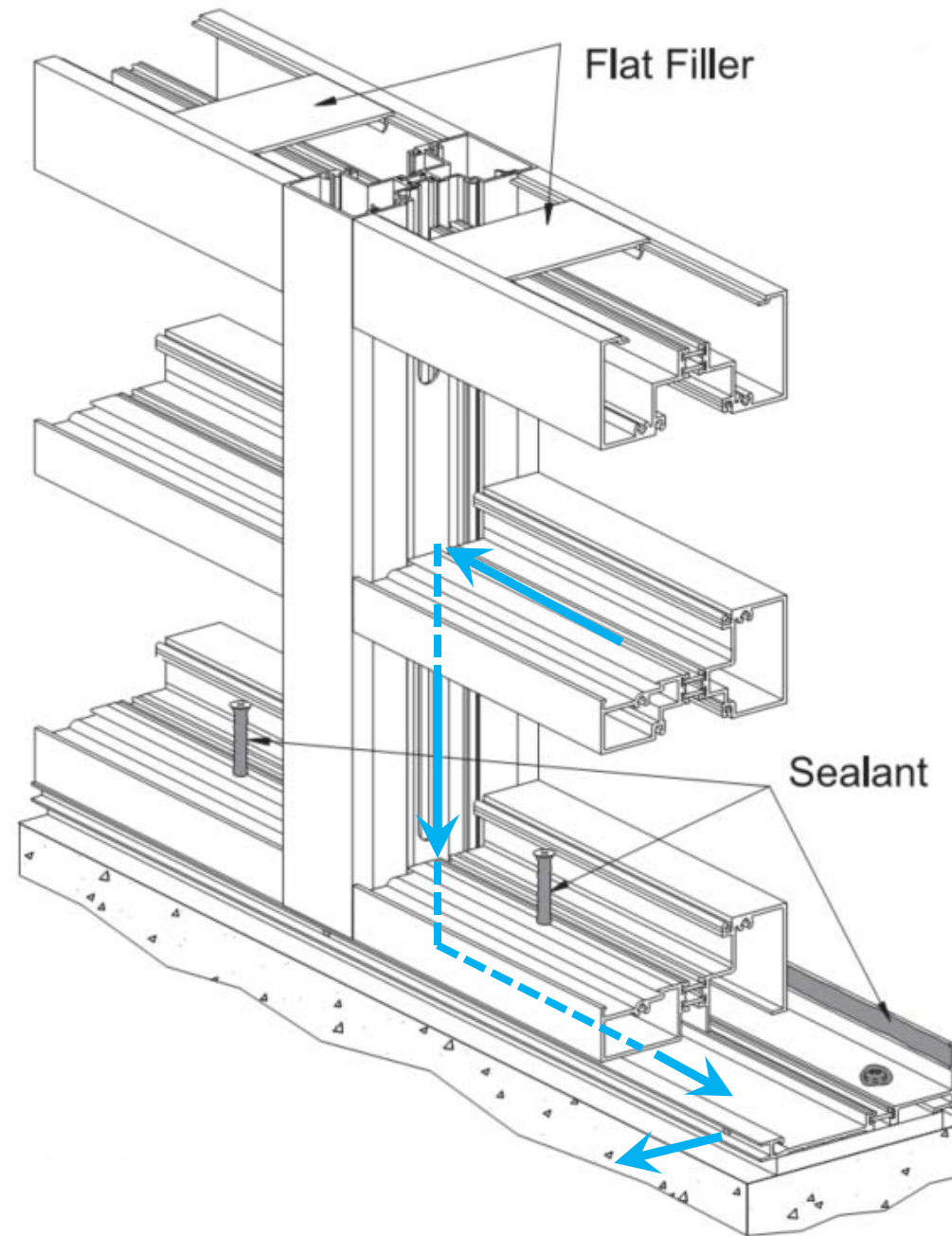


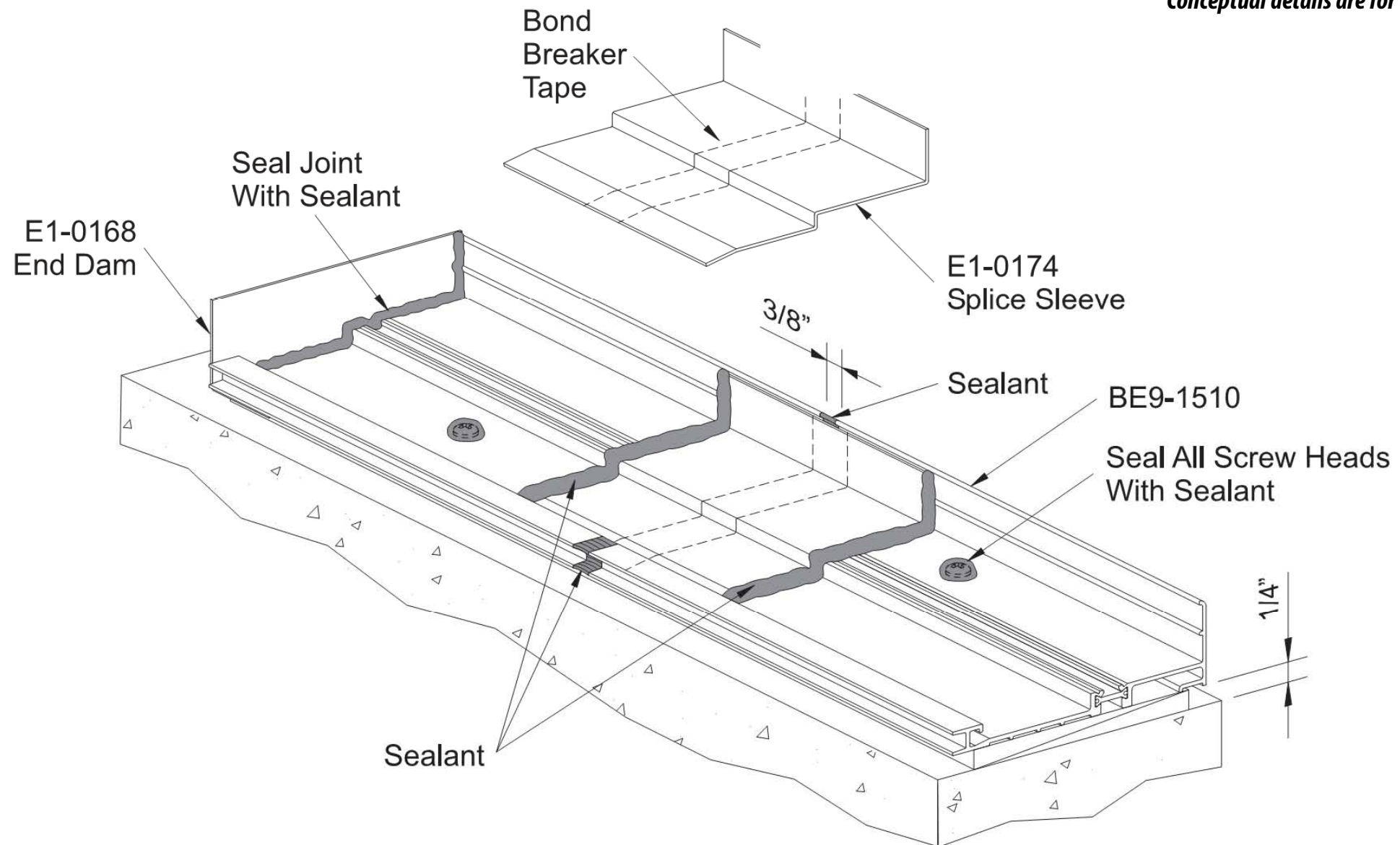
Note: Entire Tube is Sealed Full Depth

NOTE:
IT IS IMPORTANT THAT THE
INSTALLER APPLY SEALANT TO ENDS
OF ALL HORIZONTAL MEMBERS AND
GLAZING REGLETS AS SHOWN TO
ENSURE GOOD SEAL.

Caulk both interior and exterior at head, jamb and under sill flashing with high quality sealant. Do not block weep holes in flashing.







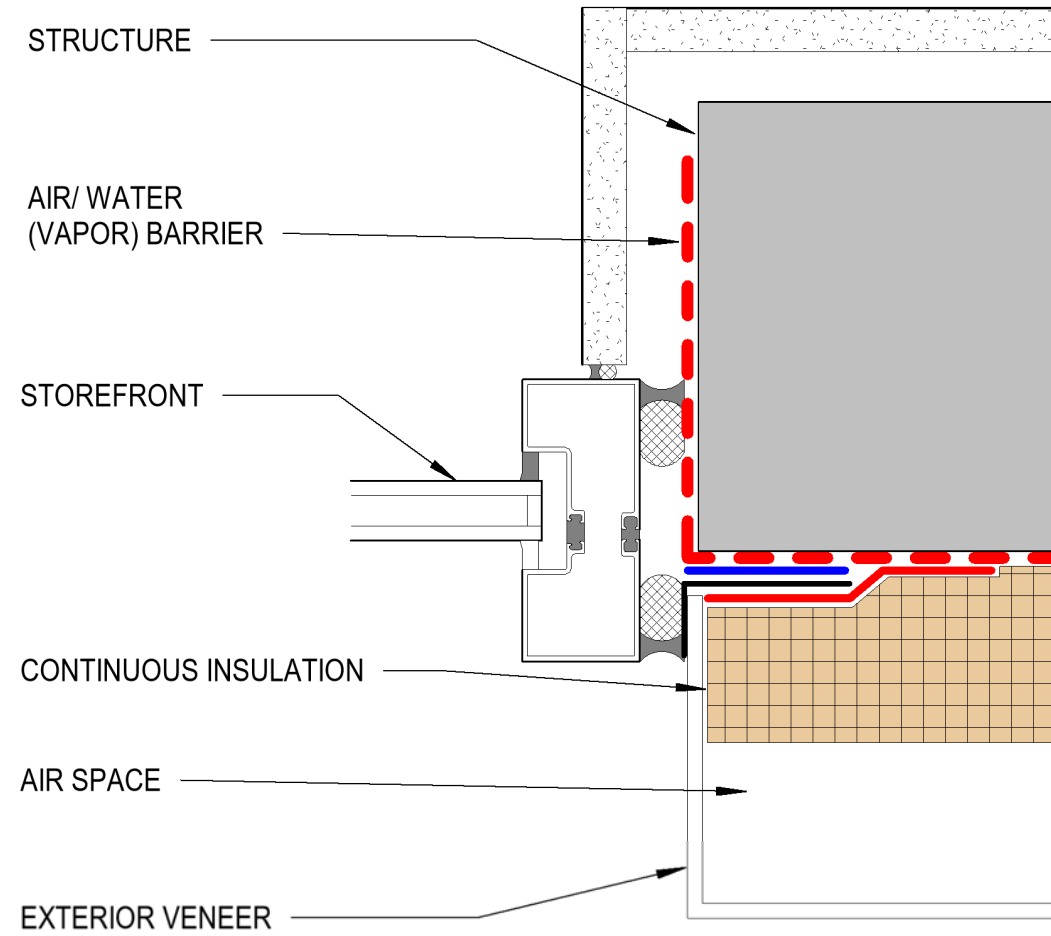
so many options...

(storefront)

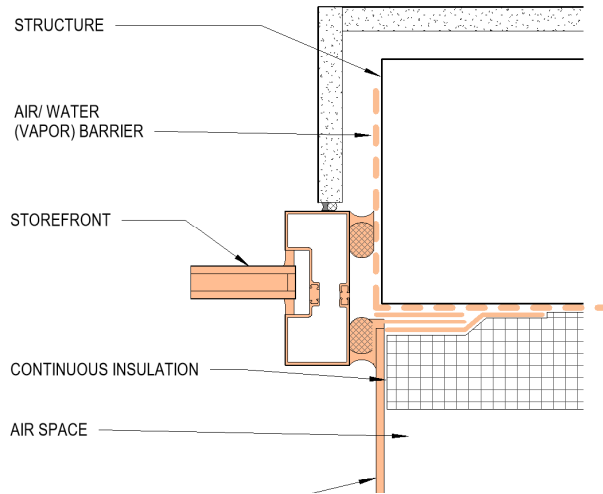
so many options...

(storefront)

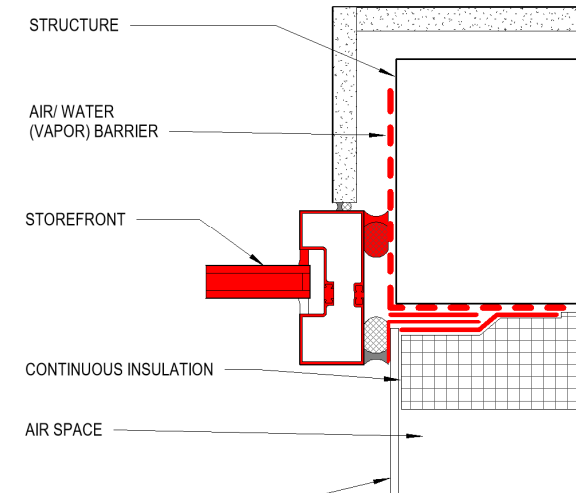
and it depends...



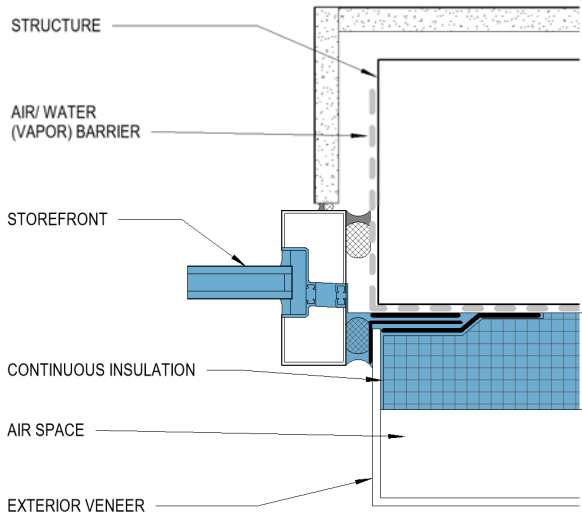
WATER



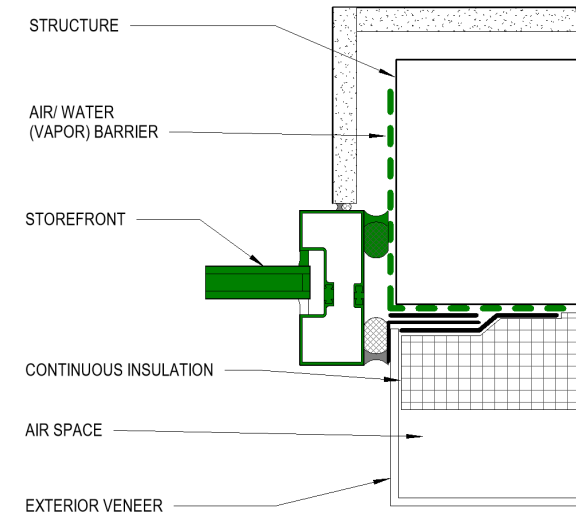
AIR



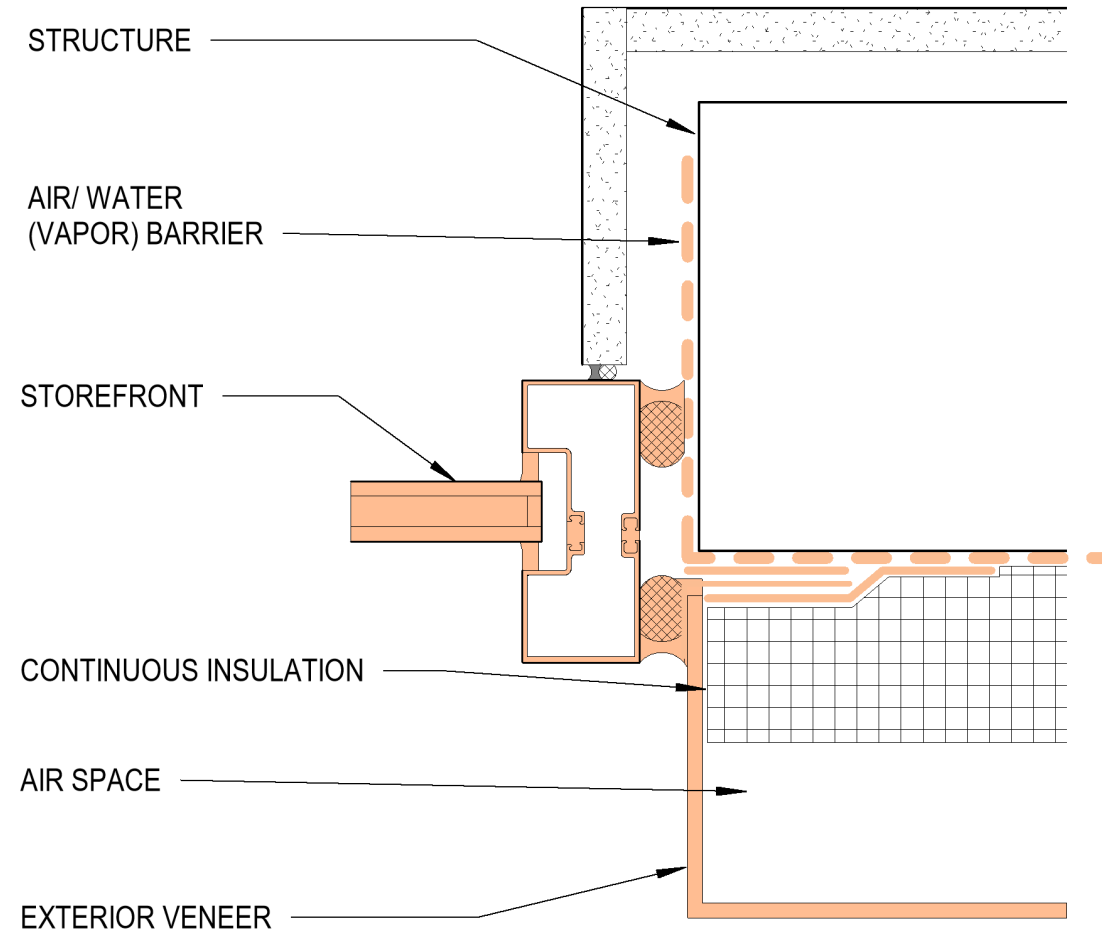
THERMAL



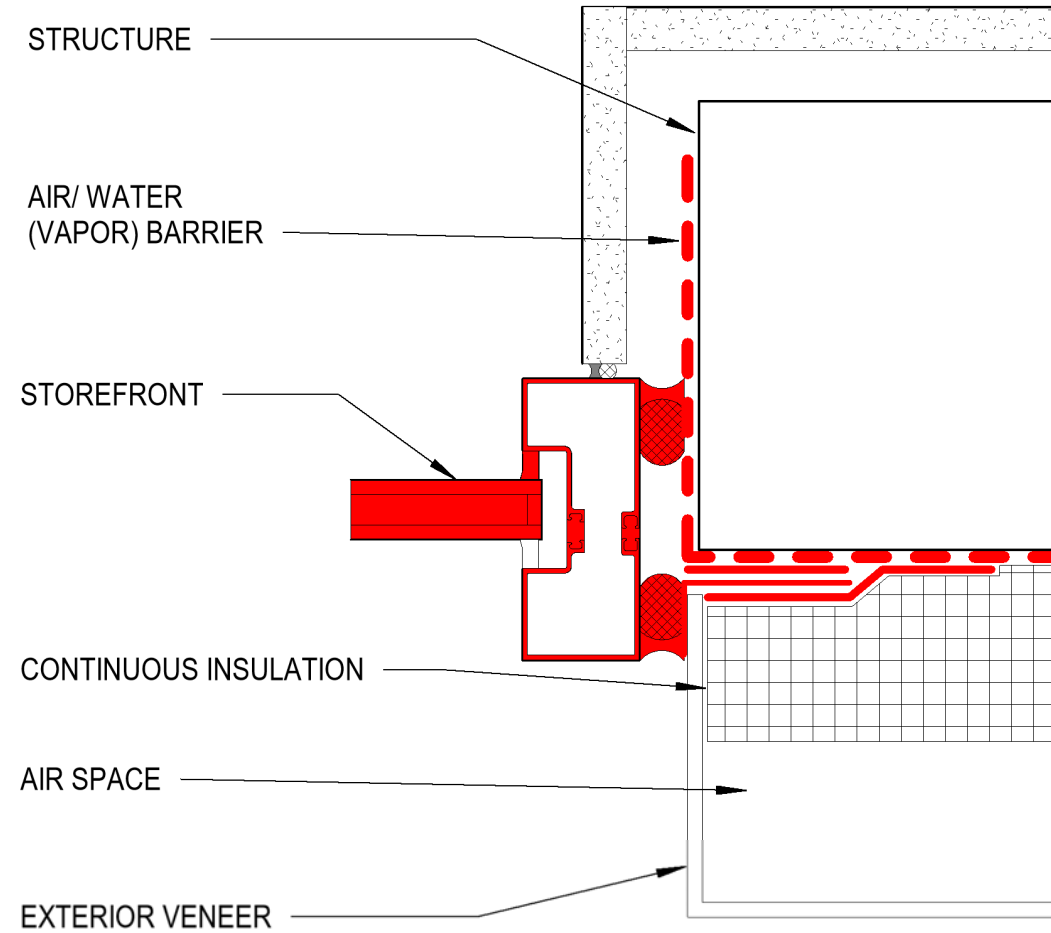
VAPOR



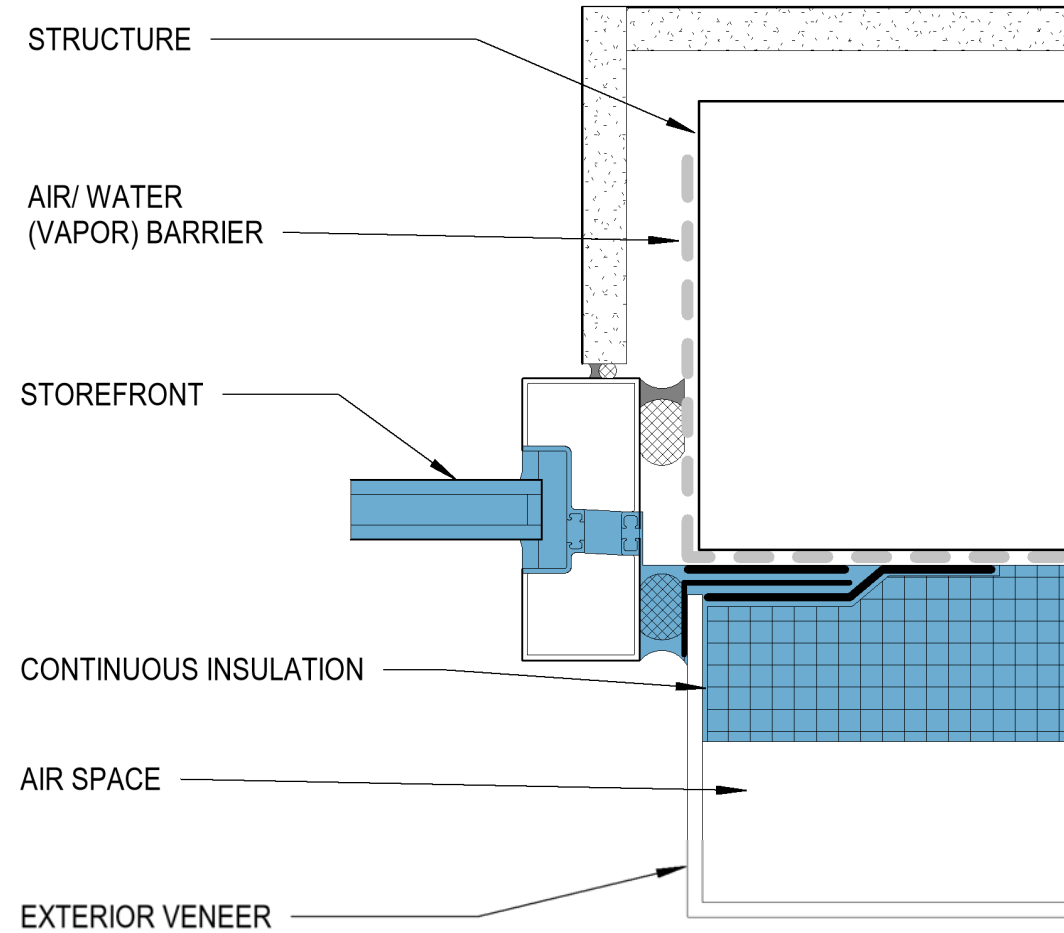
Water



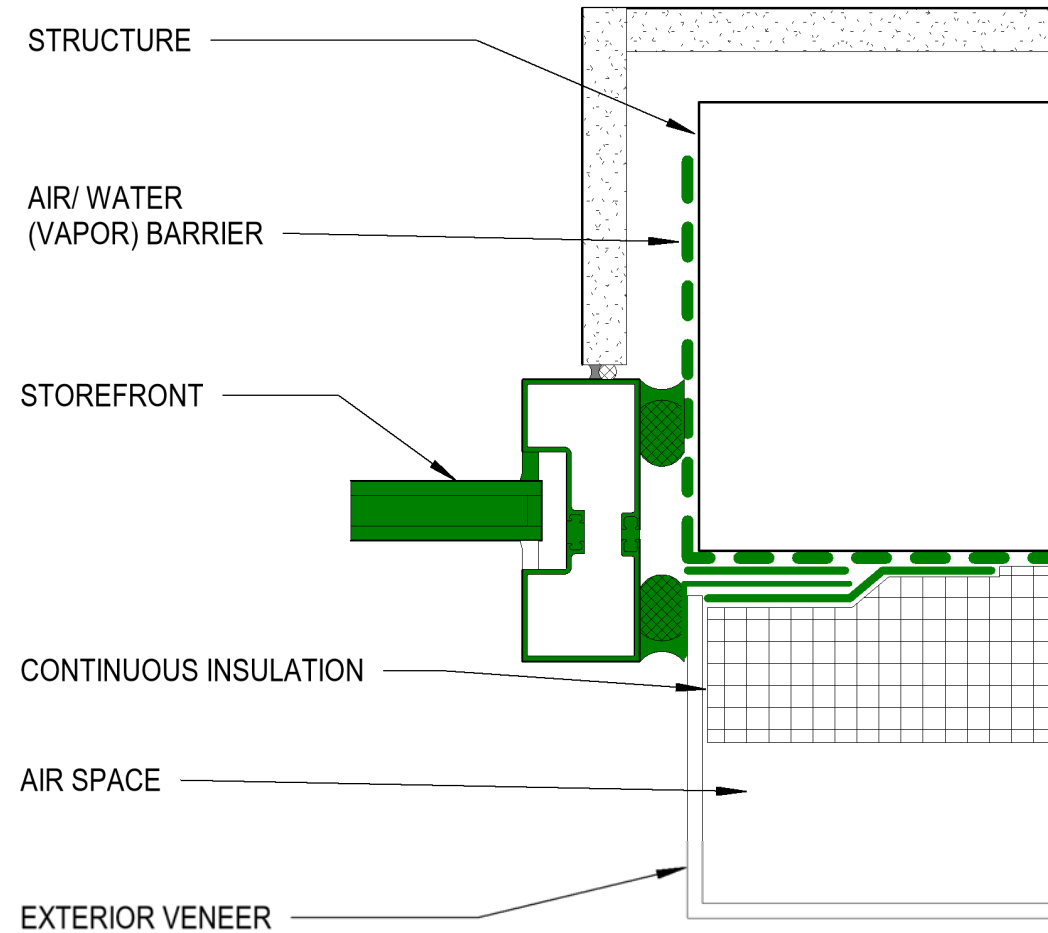
Air



Thermal



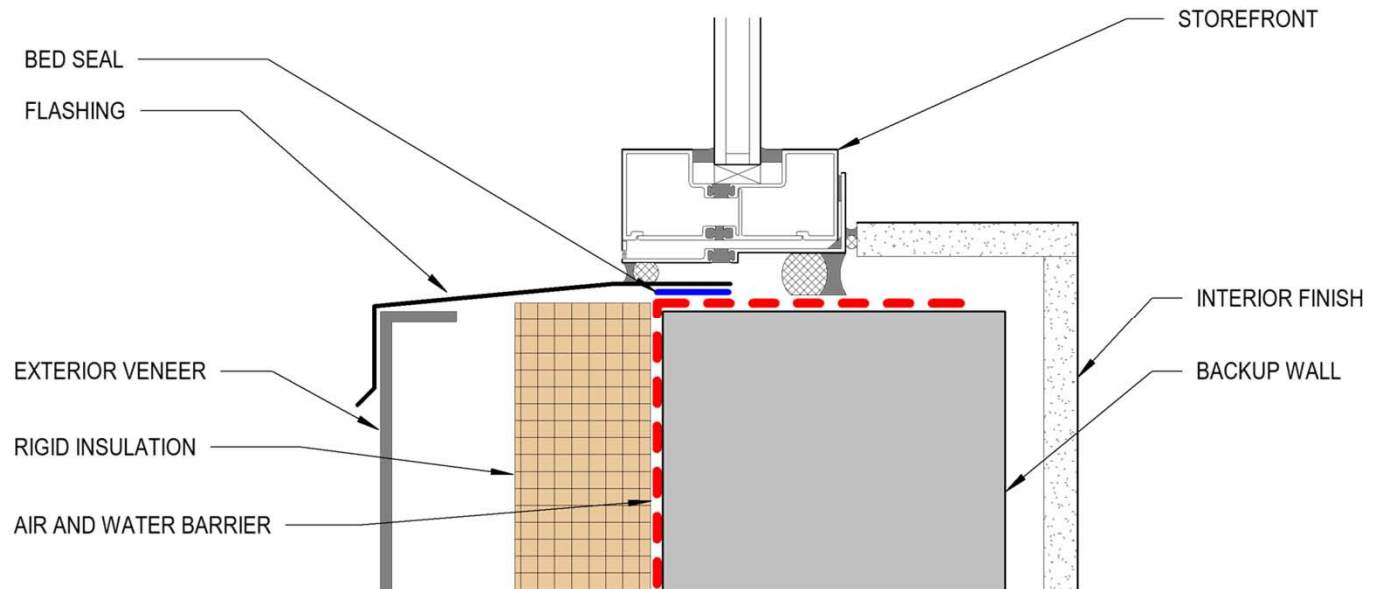
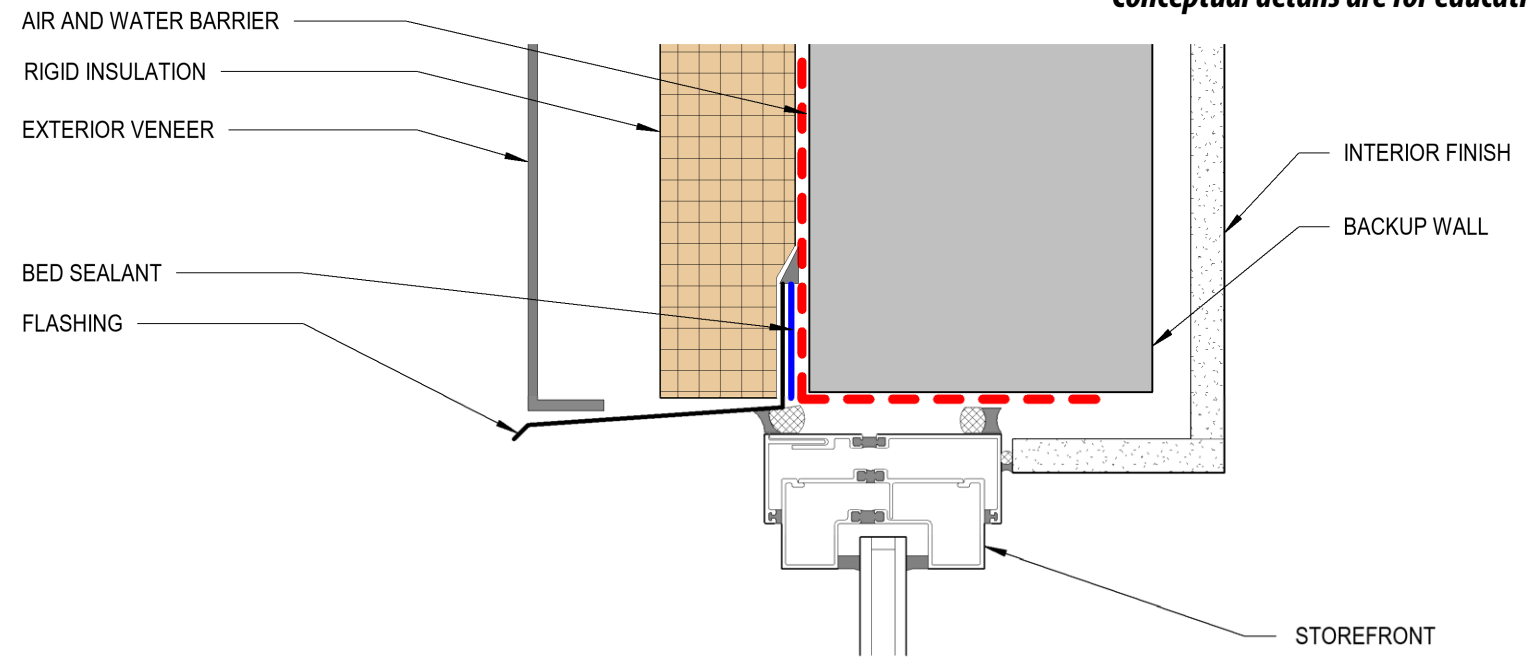
Vapor

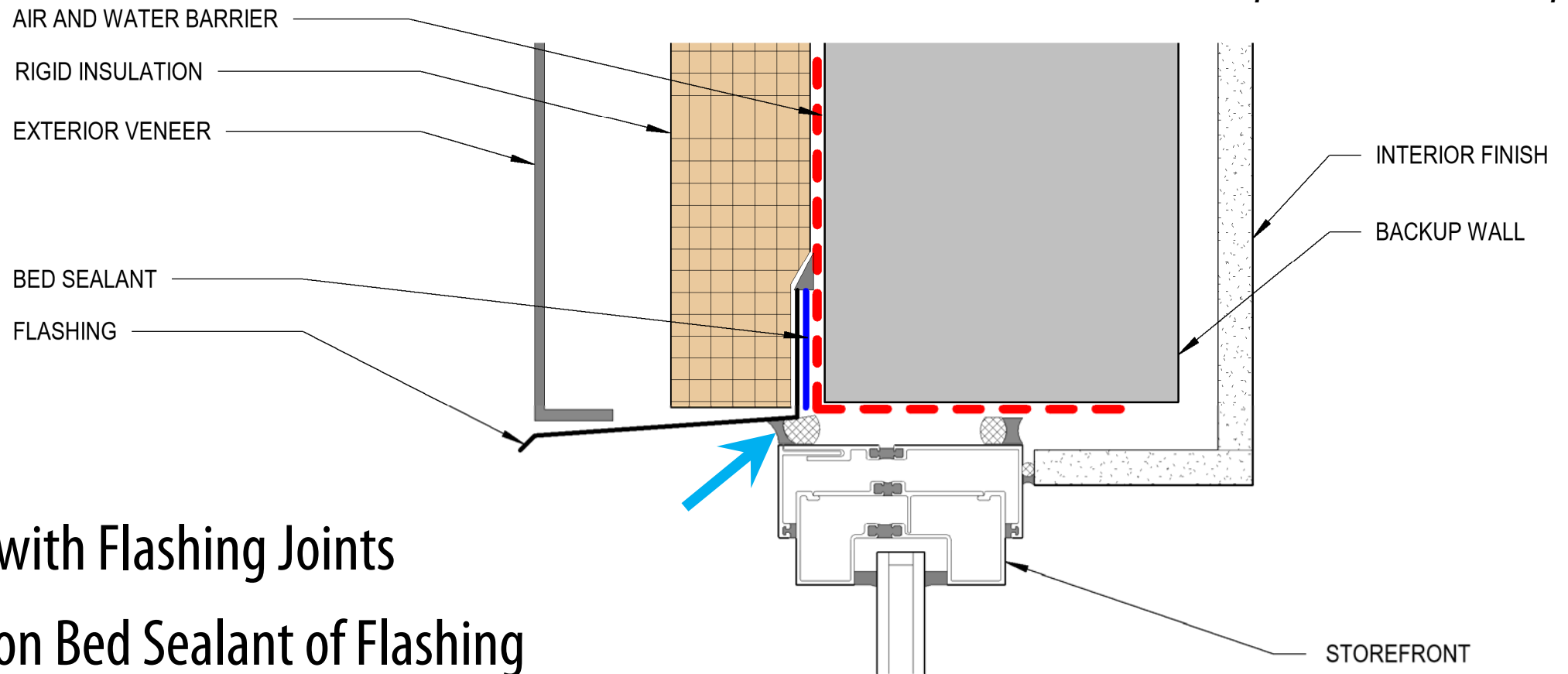


StoreFront

Common

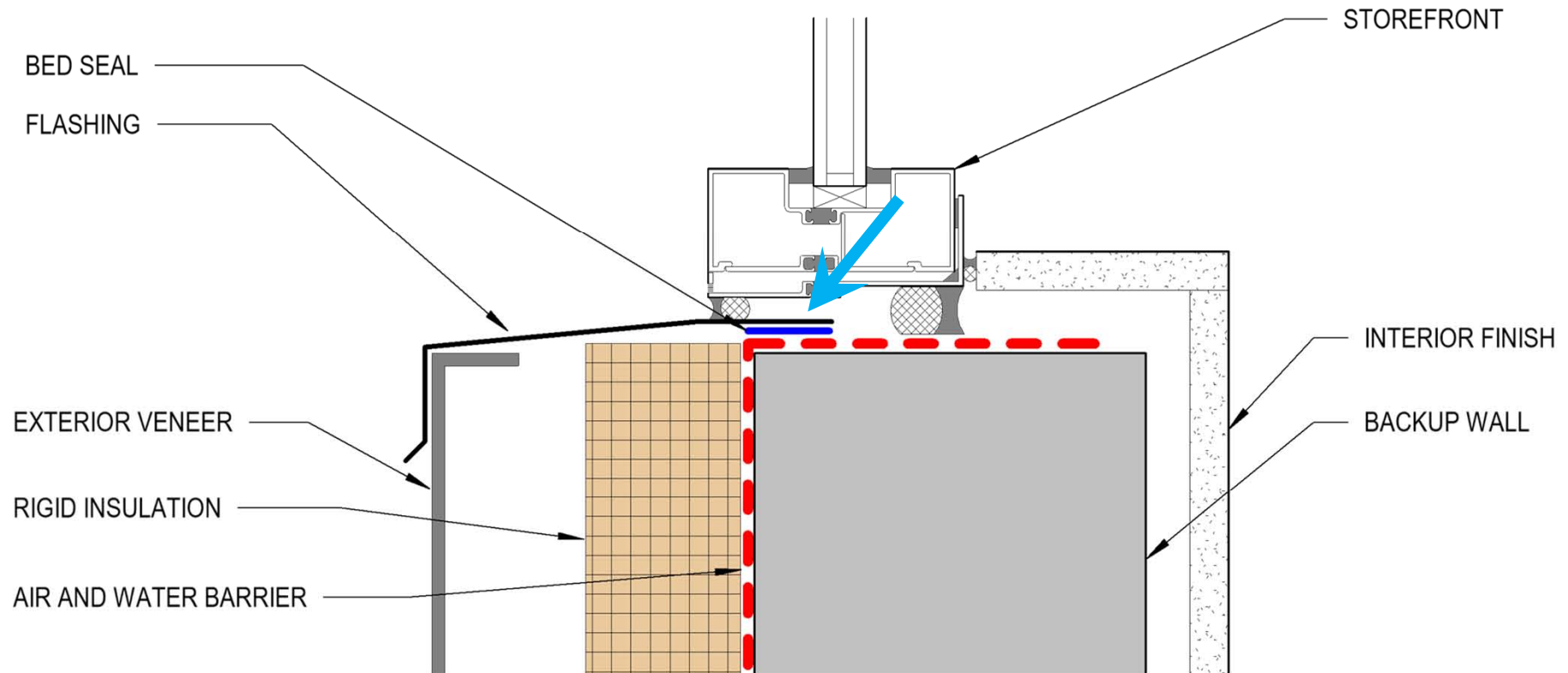
- Flashing Bed Sealed
- Flashing extended into opening at Sill





- Issues with Flashing Joints
- Relies on Bed Sealant of Flashing
- Minimal Installation Tolerance for Sealant

- Issues with Flashing Joints
- Relies on Bed Sealant of Flashing
- Reduced Thermal Performance





2017/04/27 15:50



2017/04/27 15:50



2017/04/27 15:53



2017/04/27 15:52



2017/04/27 18:07



2015/10/30 11:26



2015/10/30 11:25



2015/10/30 11:26



2015/10/28 13:49







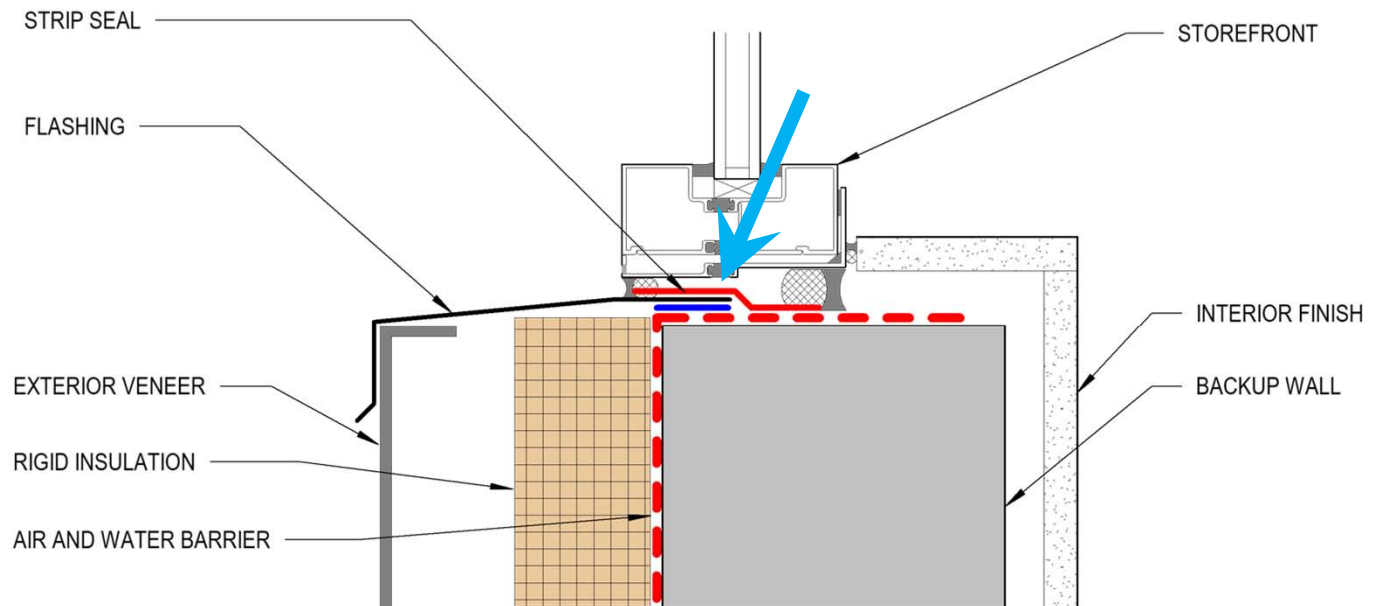
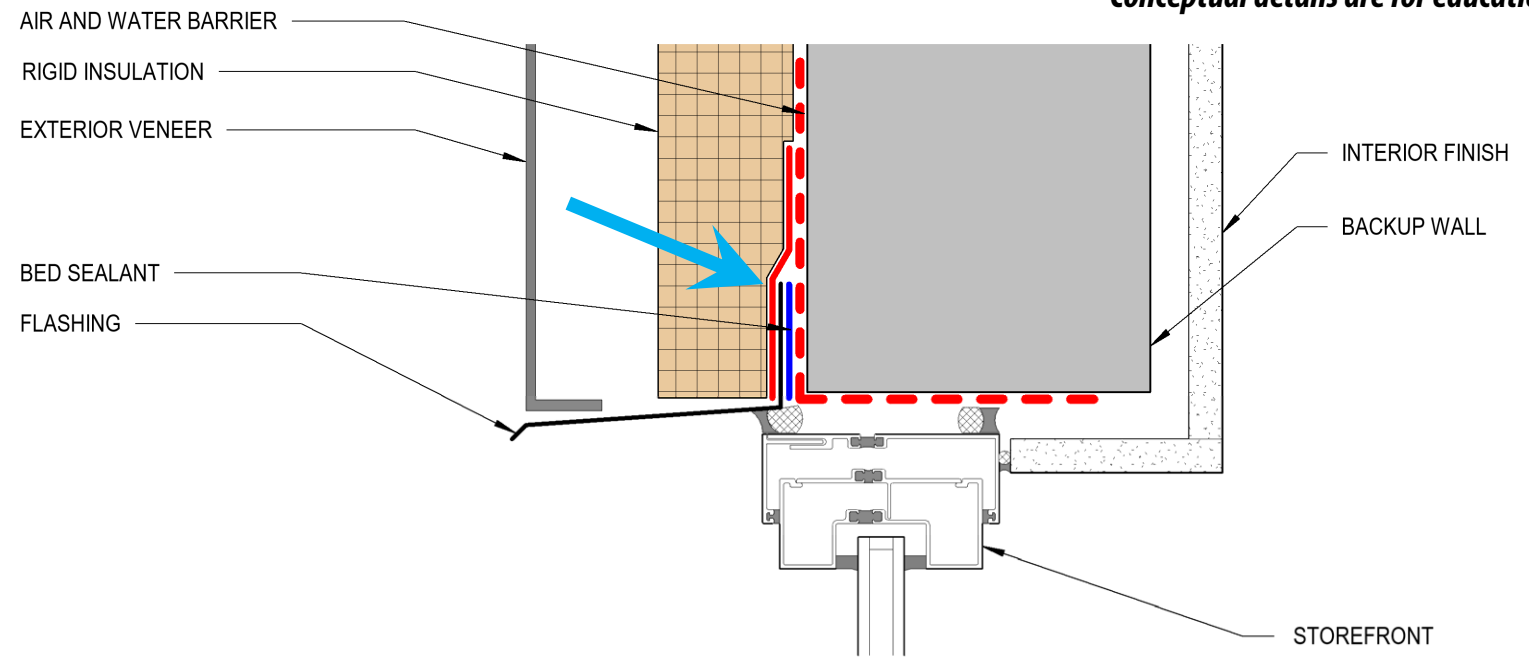


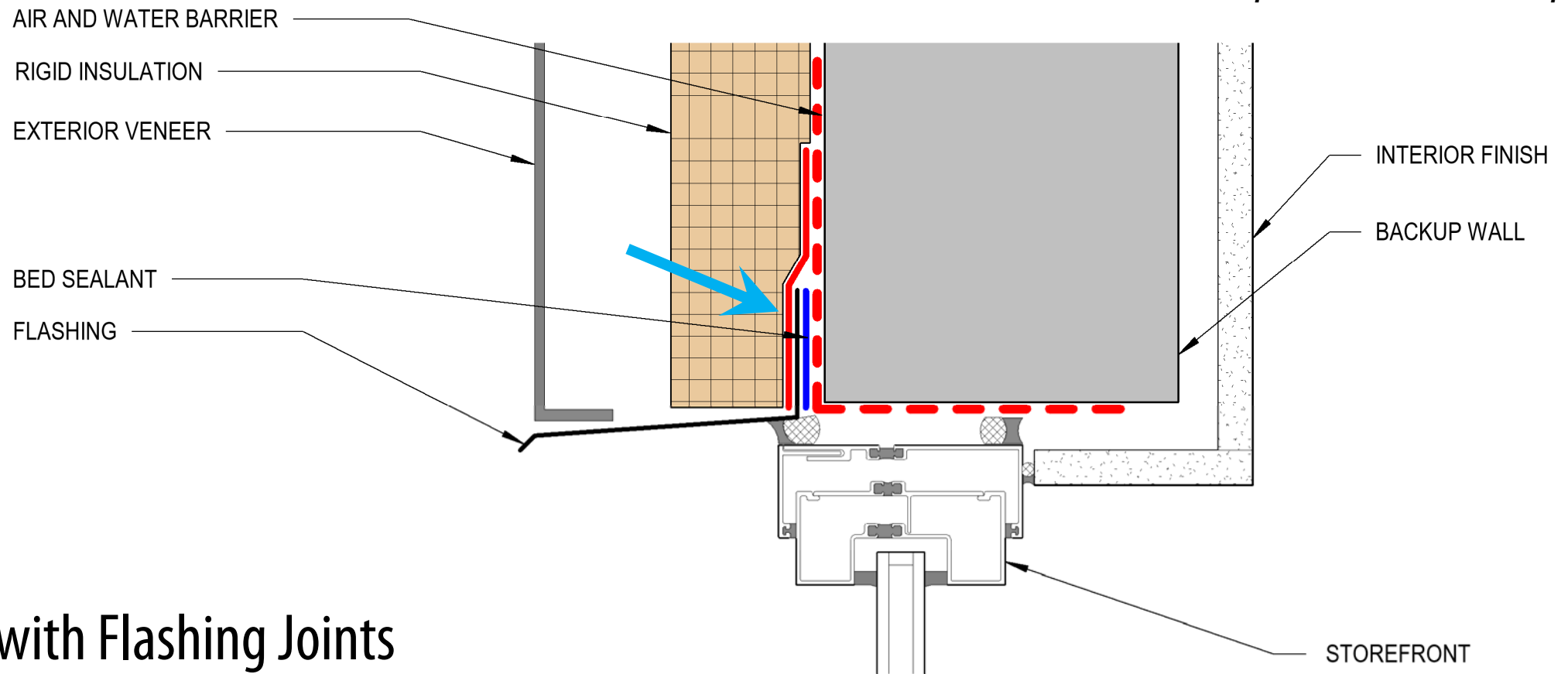
2017/10/05 19:53

StoreFront

Common+

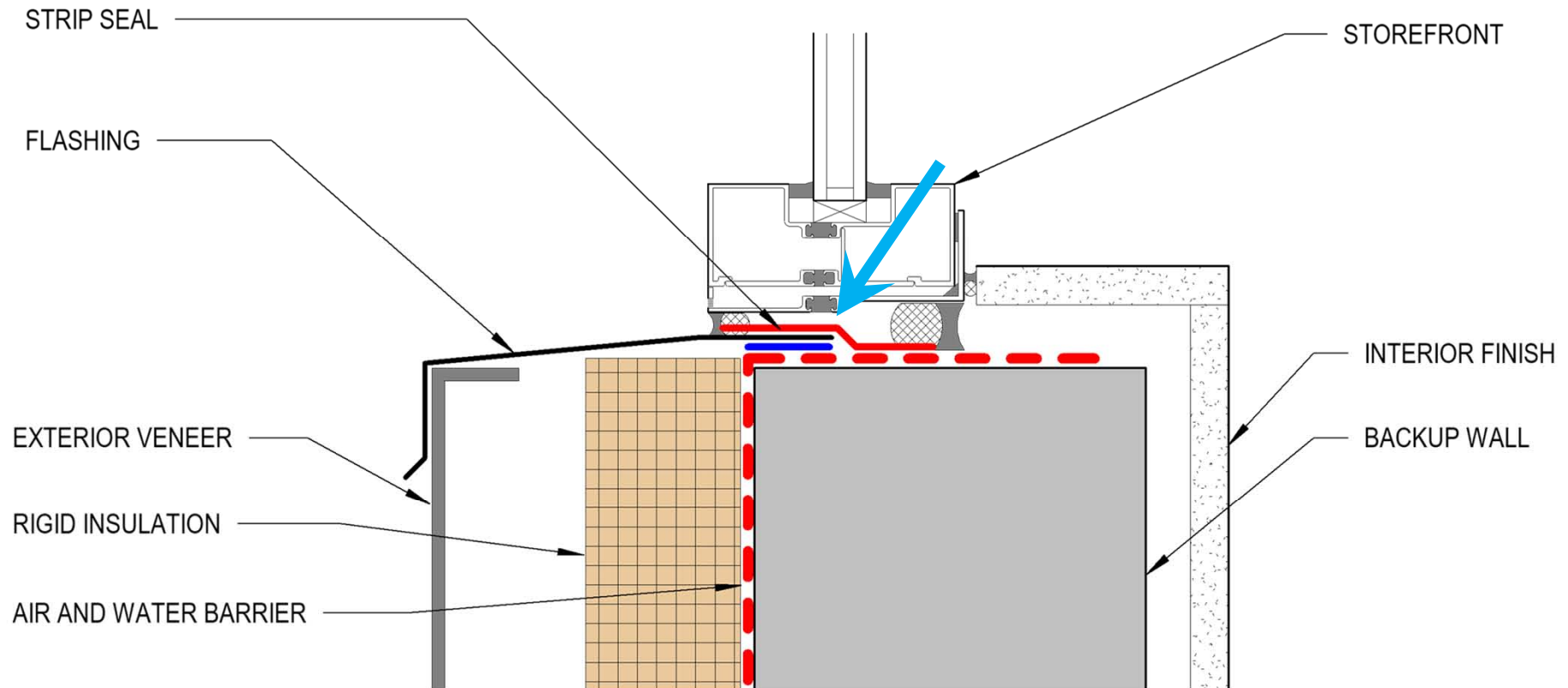
- Flashing Bed Sealed
- Flashing “stripped-in”
- Flashing extended into opening at Sill





- Issues with Flashing Joints
- **Less** Reliant on Bed Sealant of Flashing
- Minimal Installation Tolerance for Seal

- Issues with Flashing Joints
- Less Reliant on Bed Sealant of Flashing
- Reduced Thermal Performance





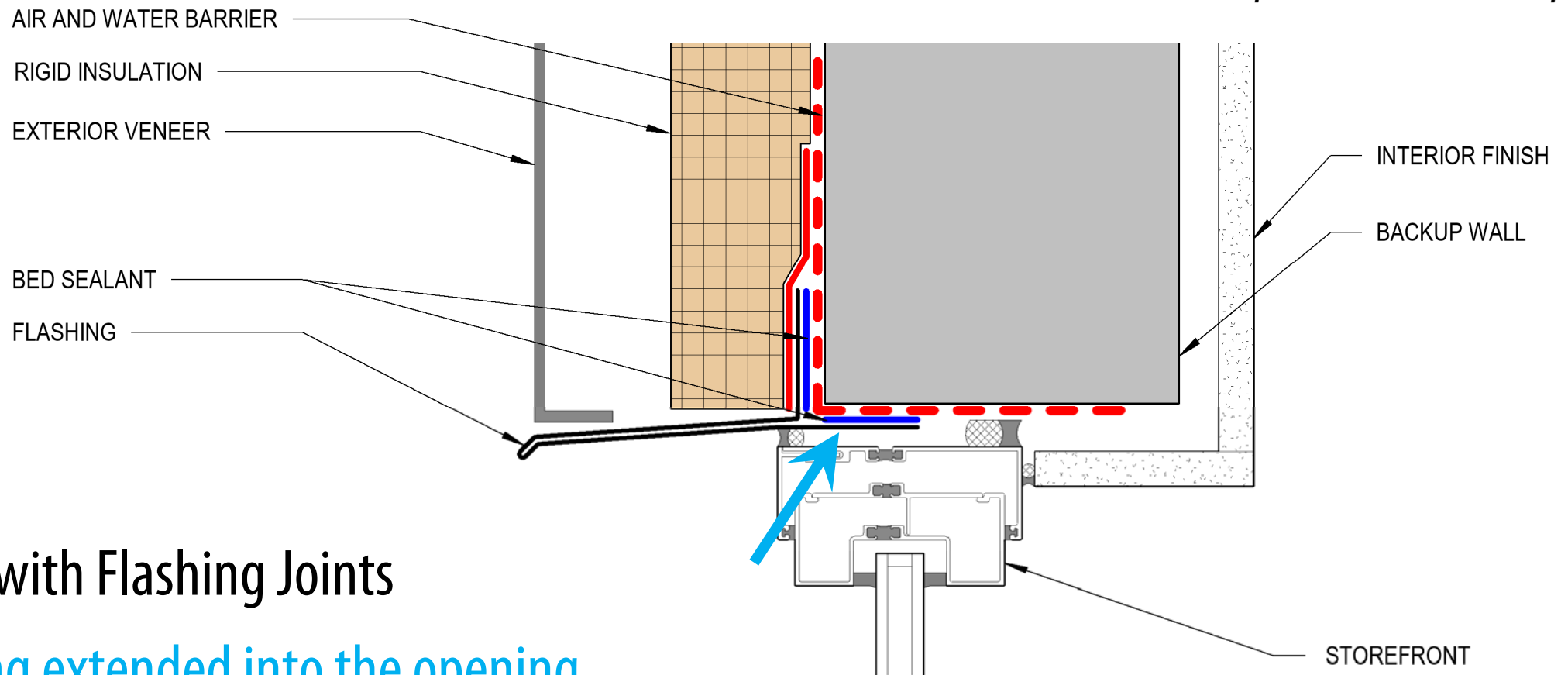
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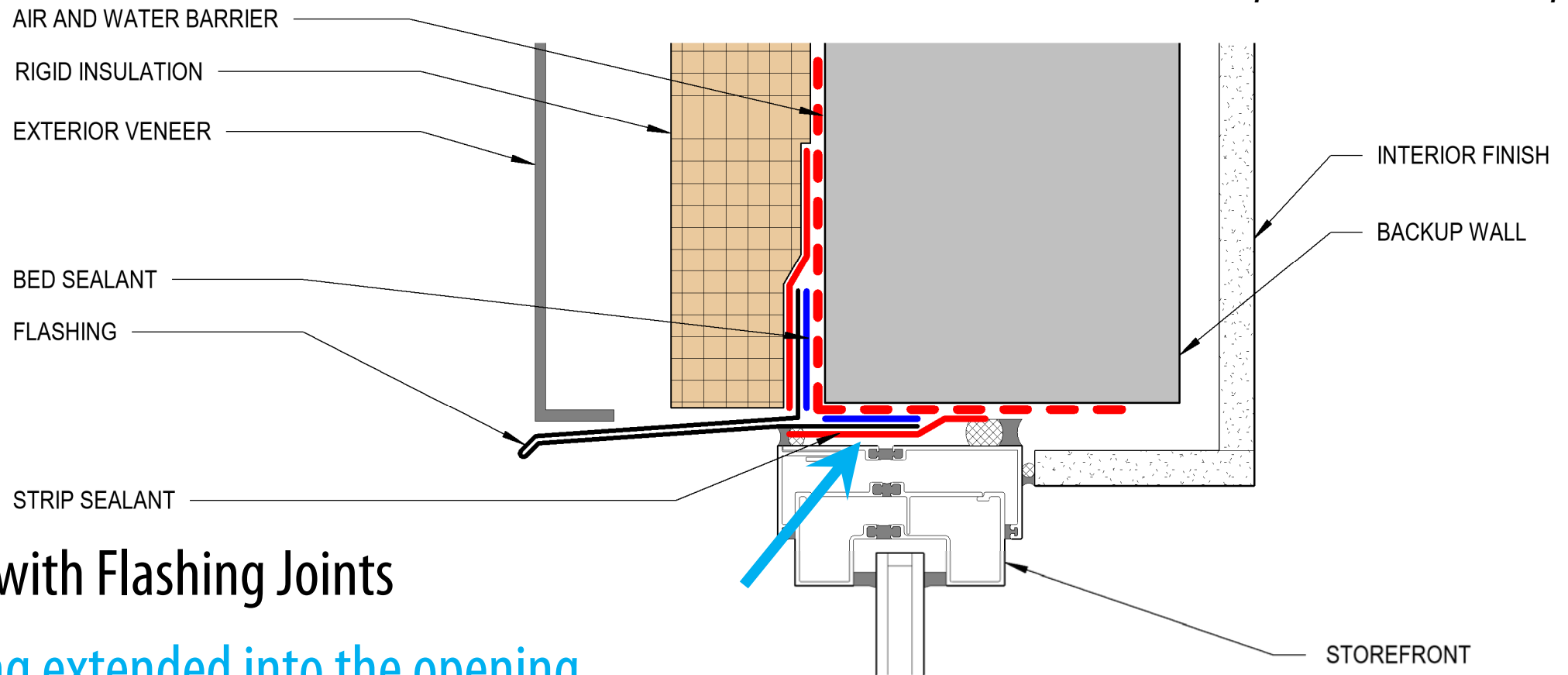
2015/10/28 14:17



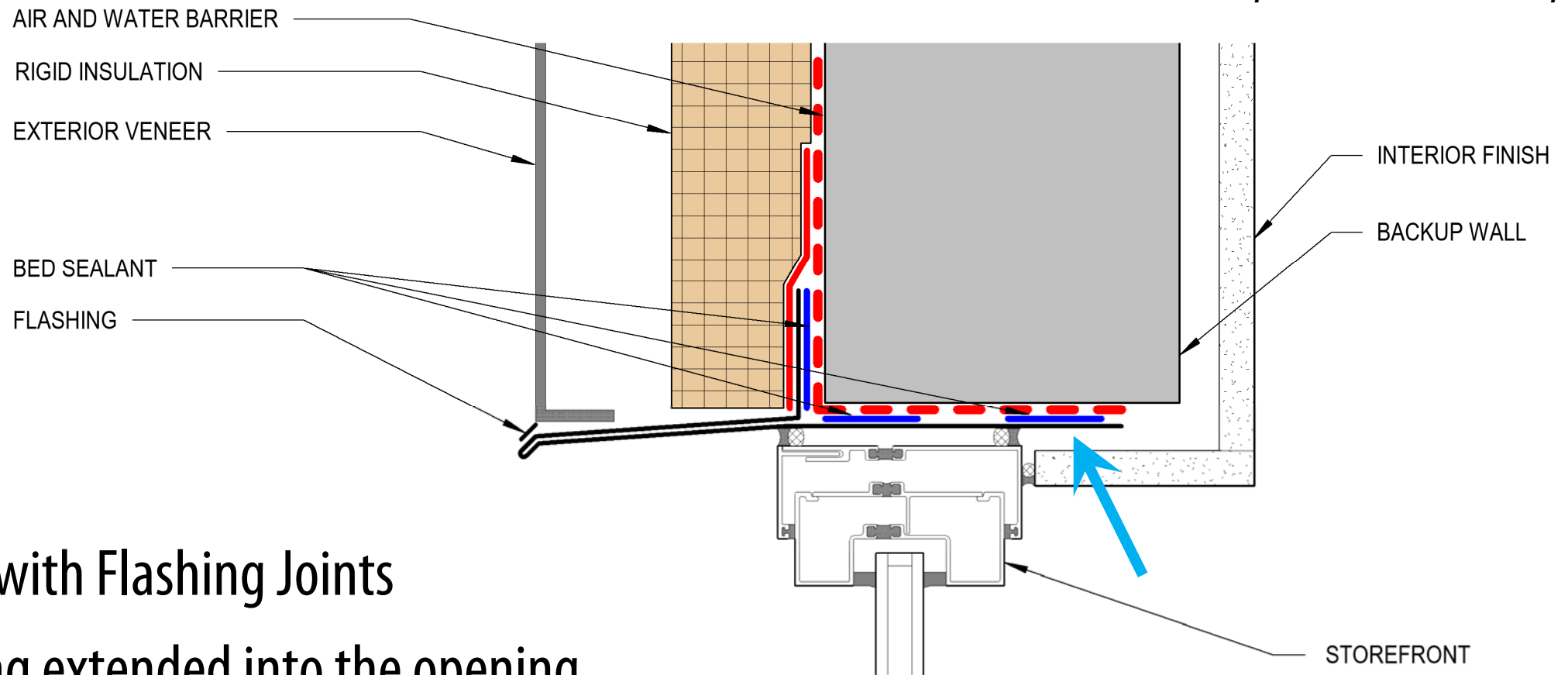
2015/10/28 14:17



- Issues with Flashing Joints
- Flashing extended into the opening
- Reliant on Bed Sealant of Flashing
- Installation Tolerance available for Sealant Joint
- Reduced Thermal Performance



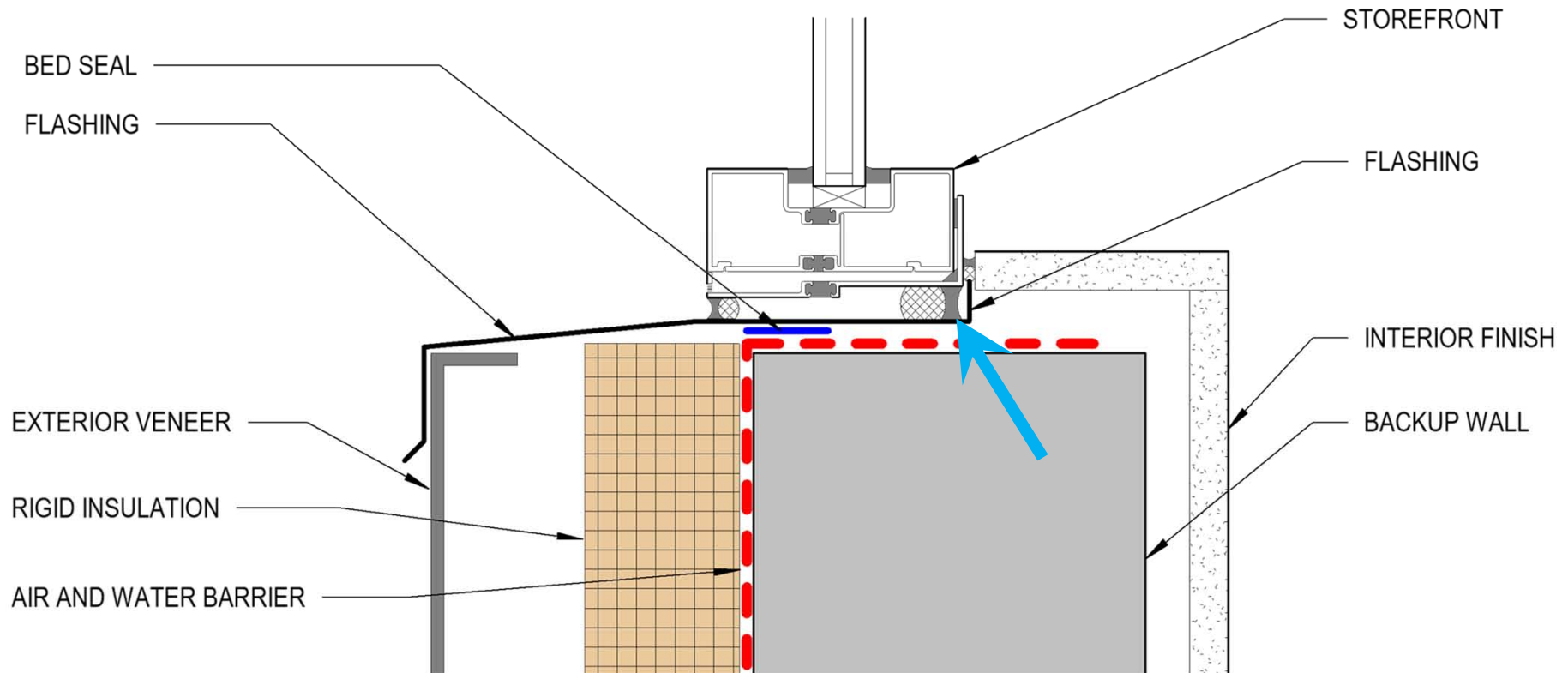
- Issues with Flashing Joints
- Flashing extended into the opening
- Less Reliant on Bed Sealant of Flashing
- Installation Tolerance available for Sealant Joint
- Reduced Thermal Performance



- Issues with Flashing Joints
- Flashing extended into the opening
- **Reliant** on Bed Sealant of Flashing
- Installation Tolerance available for Sealant Joint
- **Very Reduced Thermal Performance**

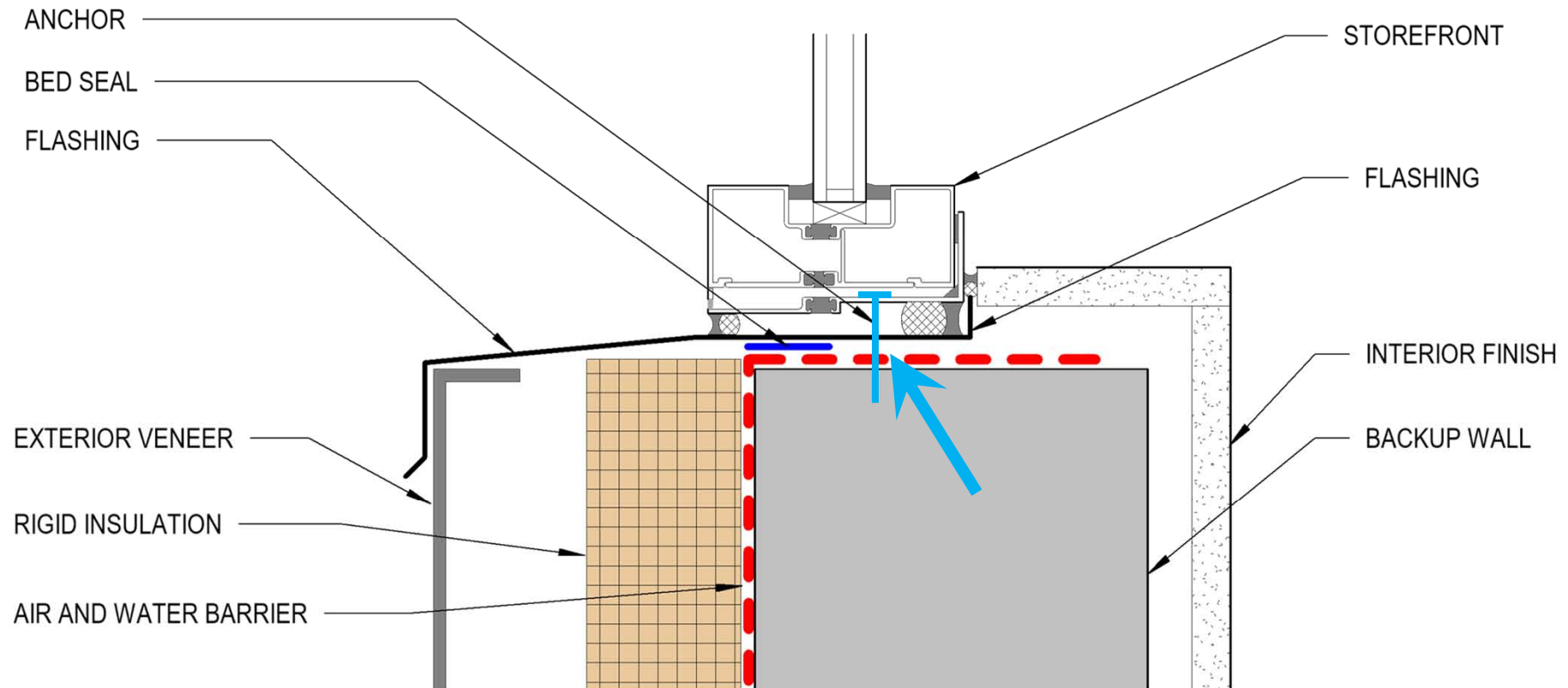
- Issues with Flashing Joints
- Reliant on Bed Sealant of Flashing
- Very Reduced Thermal Performance

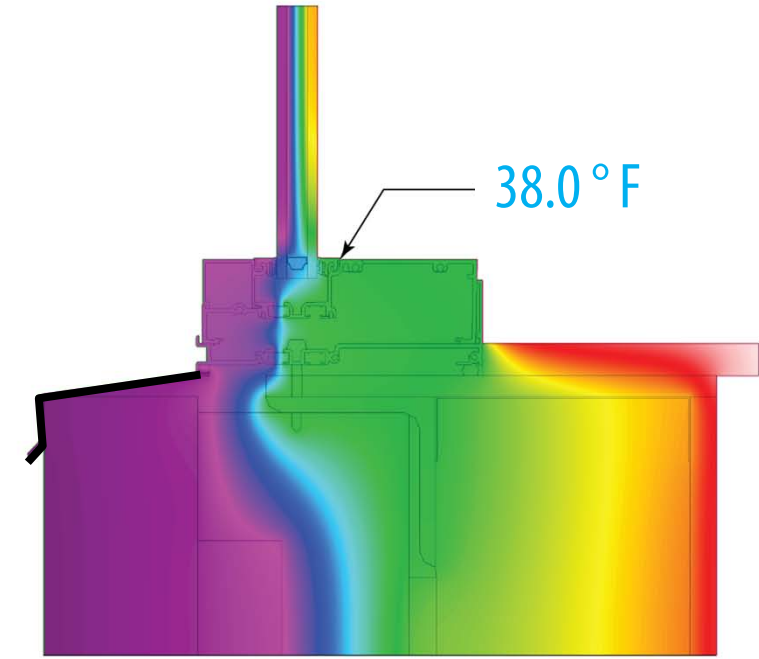
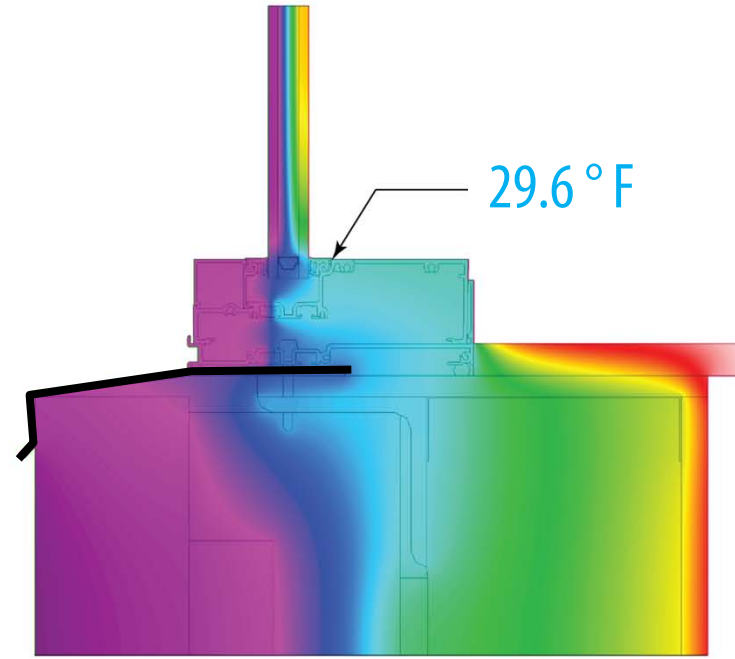
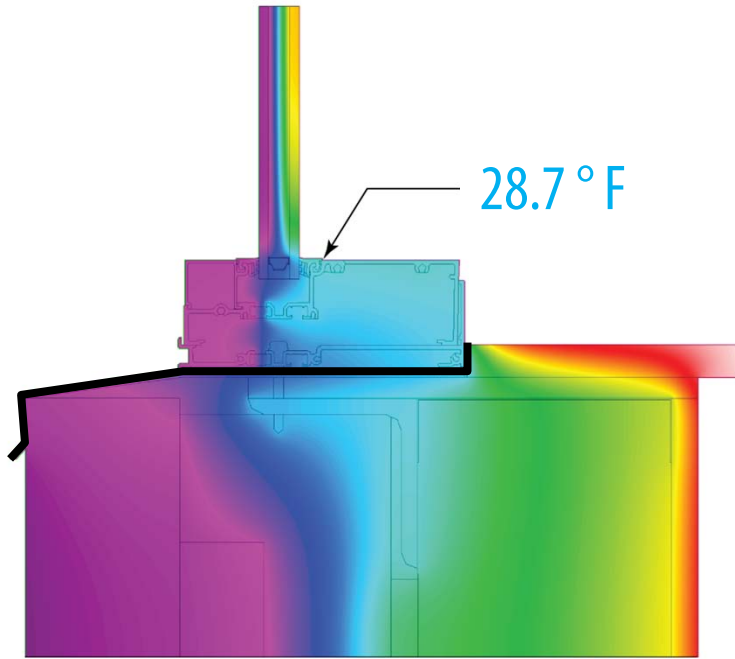
- Weep required to drain
- Introduces air infiltration which can lead to condensation.

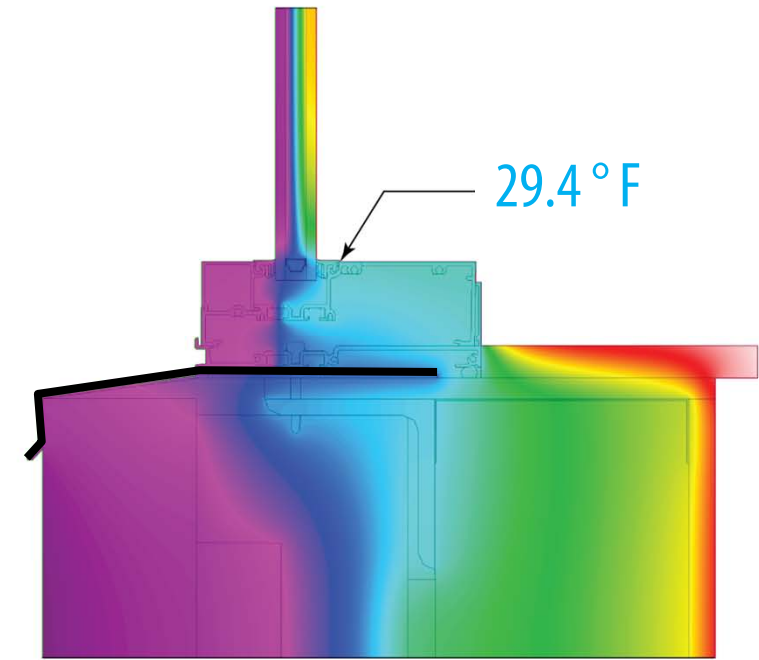
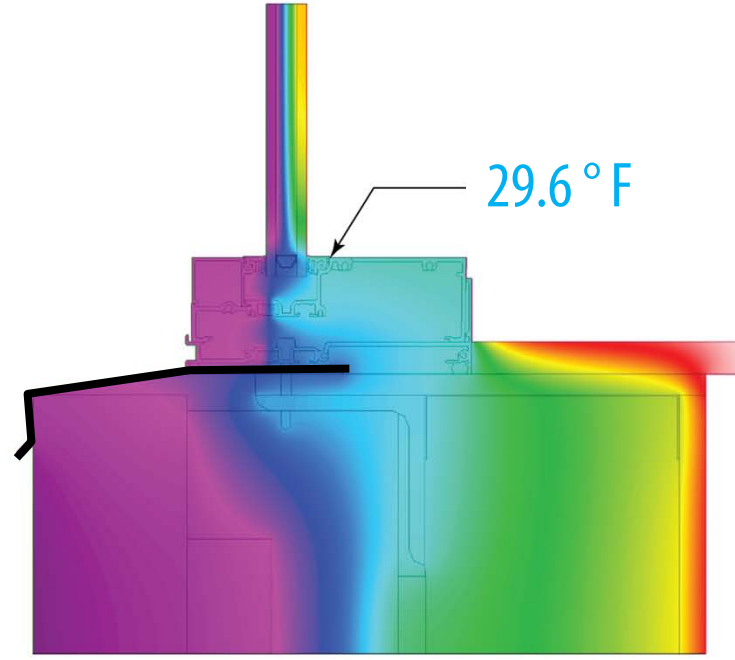
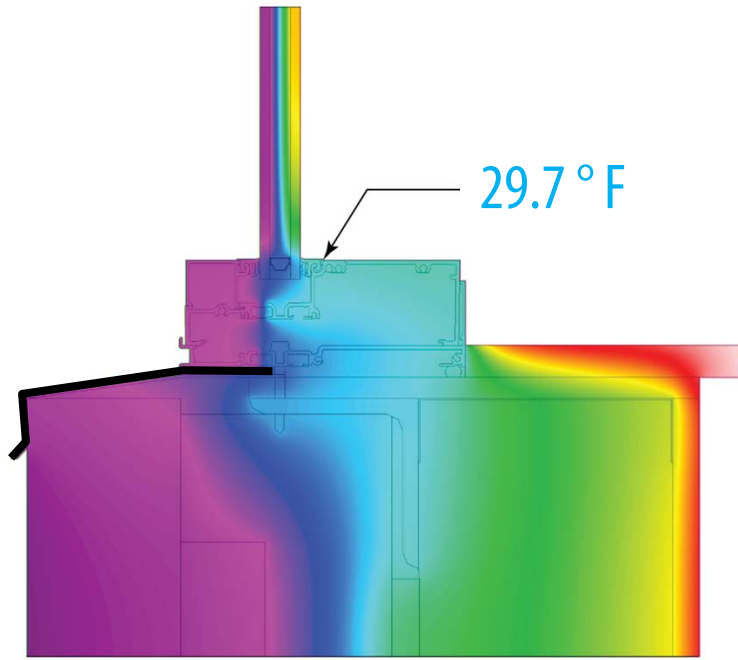


- Issues with Flashing Joints
- Reliant on Bed Sealant of Flashing
- Very Reduced Thermal Performance

- Weep required to drain
- Introduces air infiltration which can lead to condensation
- Not able to seal fastener



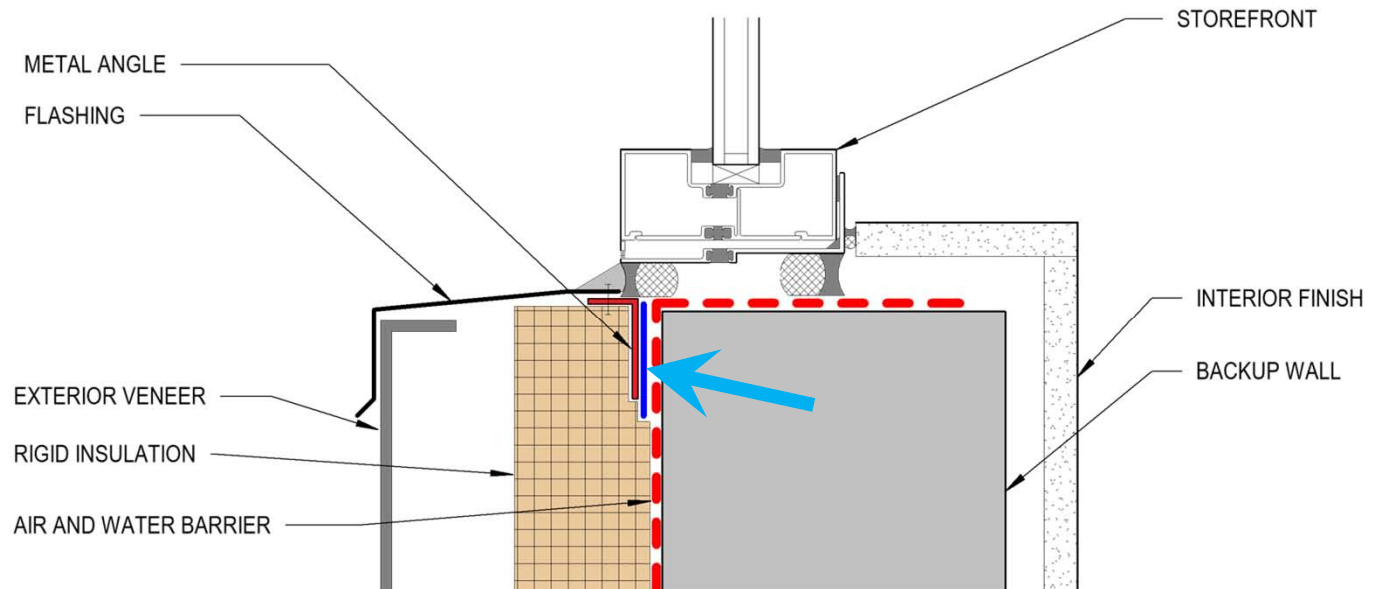
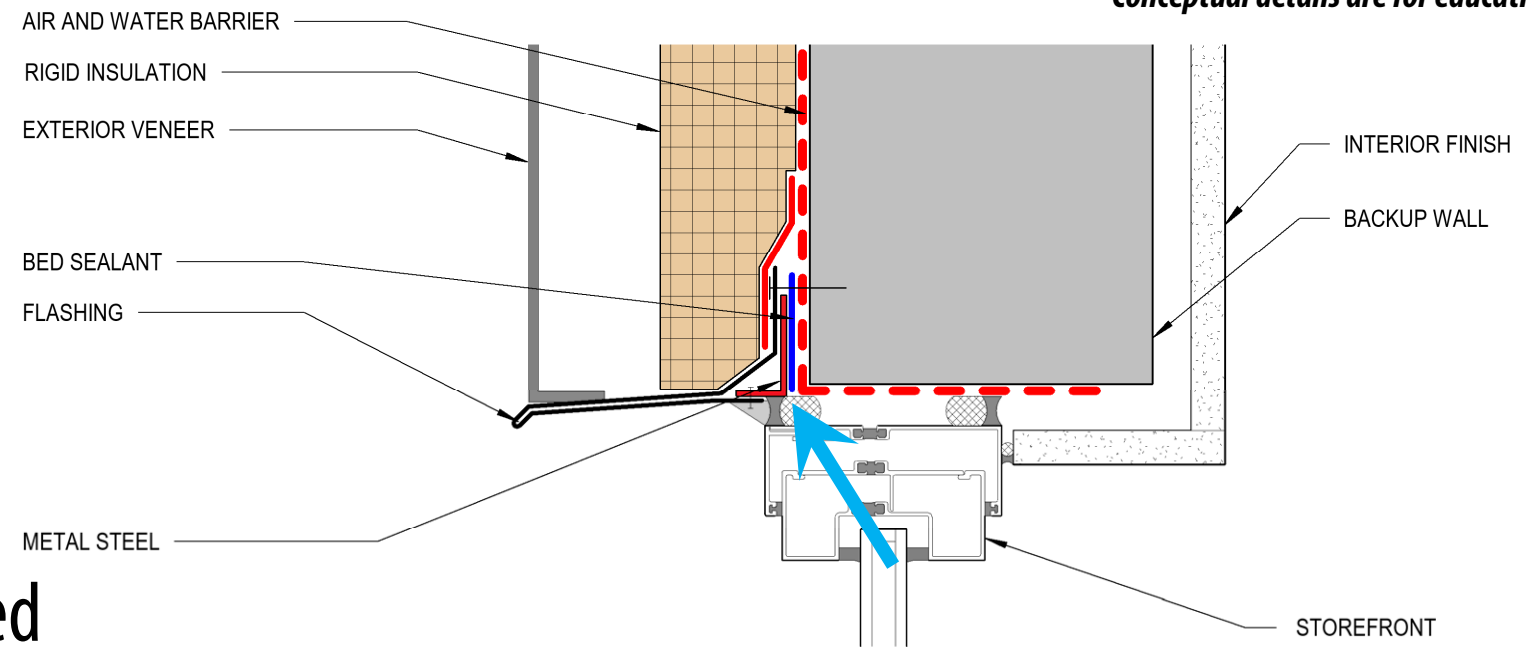


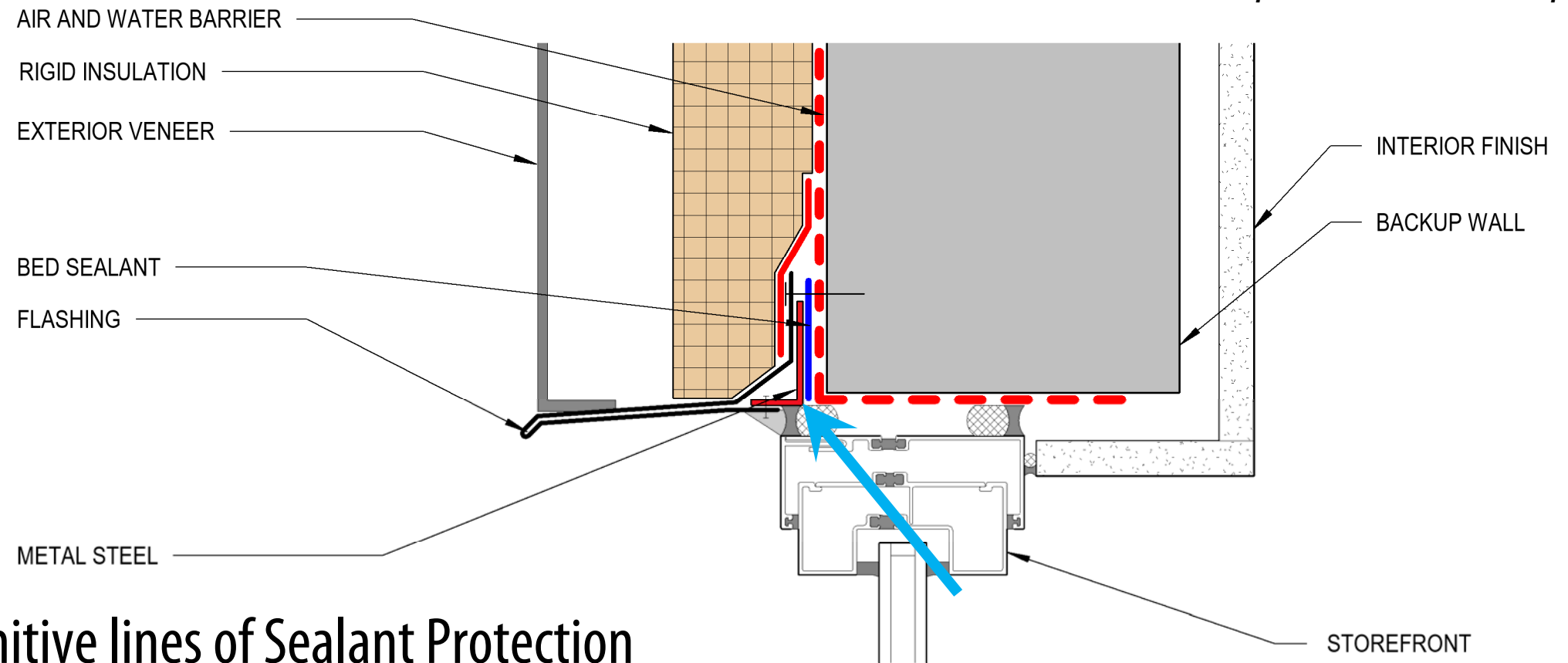


StoreFront

Alt-1

- Flashing is not extended into the opening
- Metal Angle For Transition to Air/Water Barrier

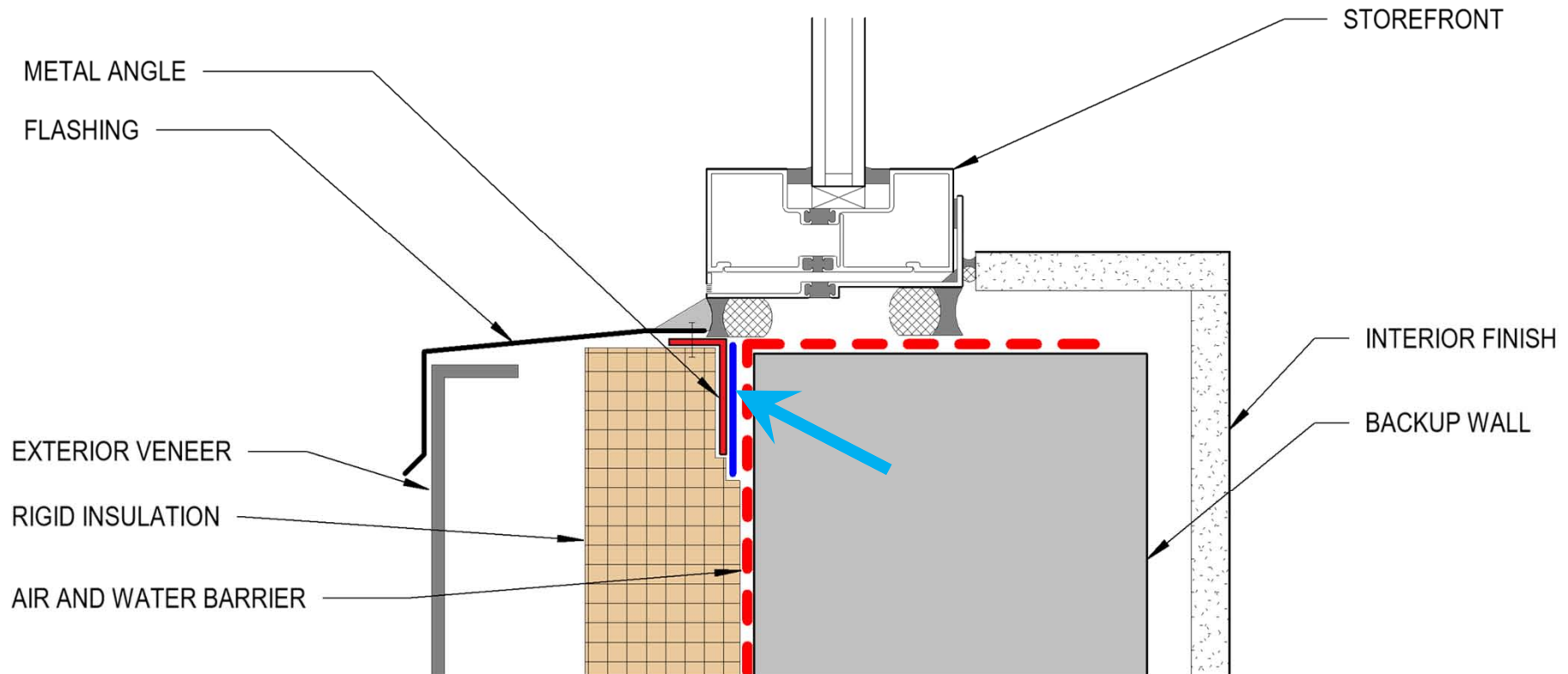




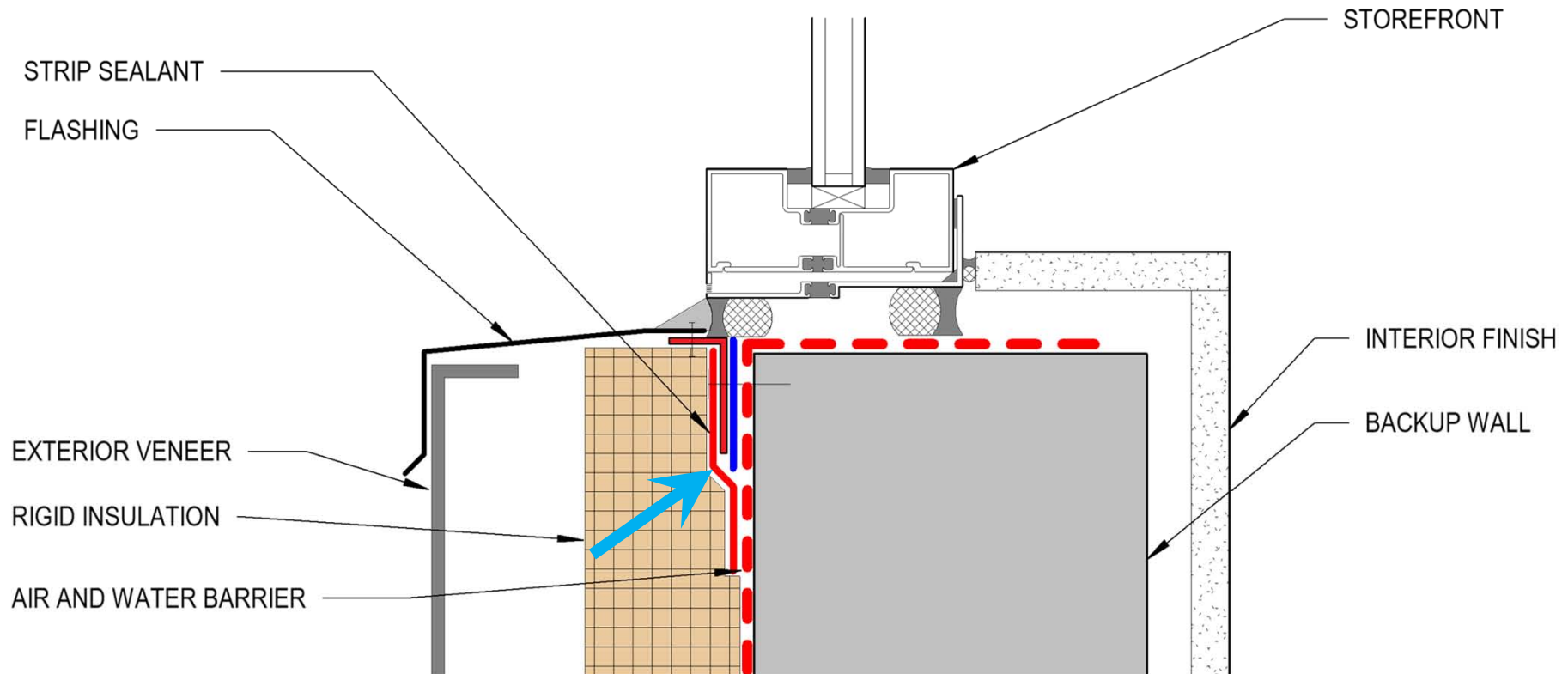
- 2 Definitive lines of Sealant Protection
- 1 added Aesthetic Sealant
- Increased Installation Tolerance
- Better Flashing Joint Appearance

Many More Pieces

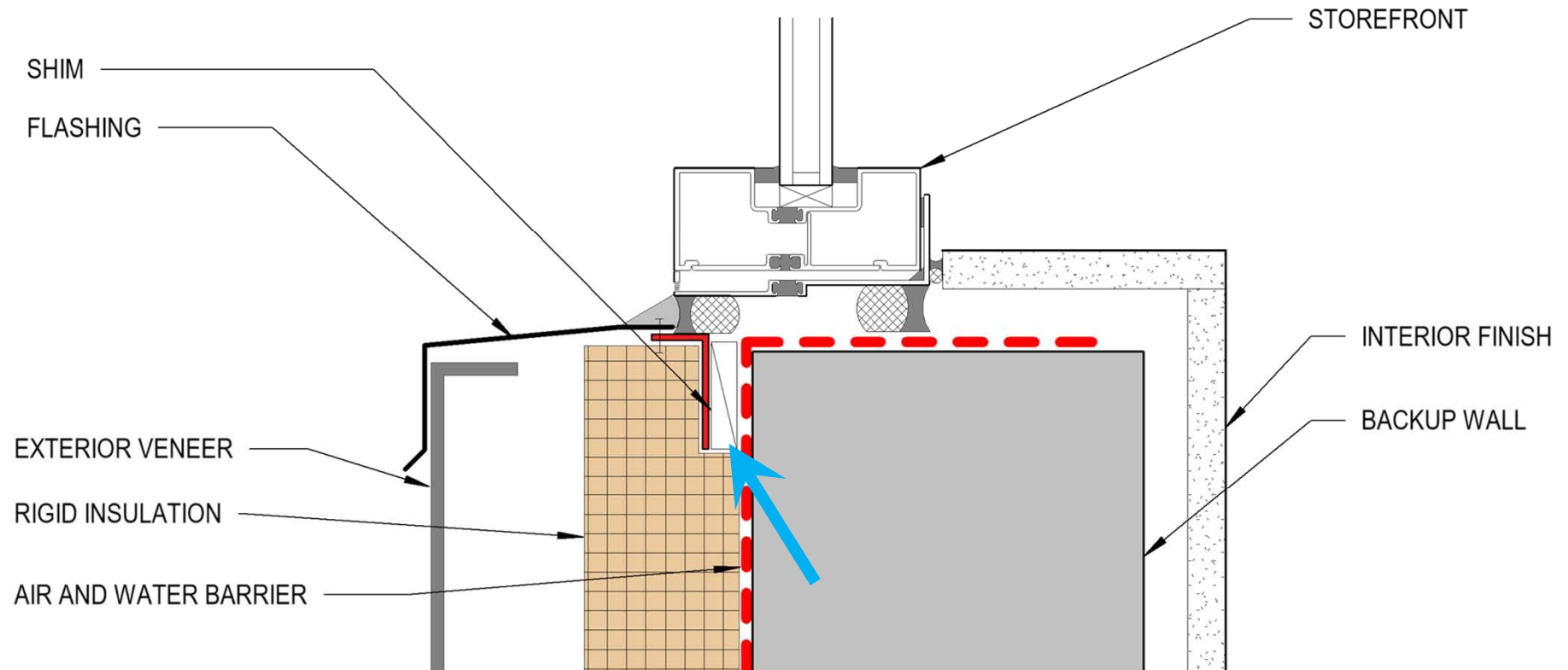
- 2 Definitive lines of Sealant Protection
- 1 added Aesthetic Sealant
- Increased Installation Tolerance
- Better Flashing Joint Appearance
- Many More Pieces
- Reliant on Bed Sealant at Sill



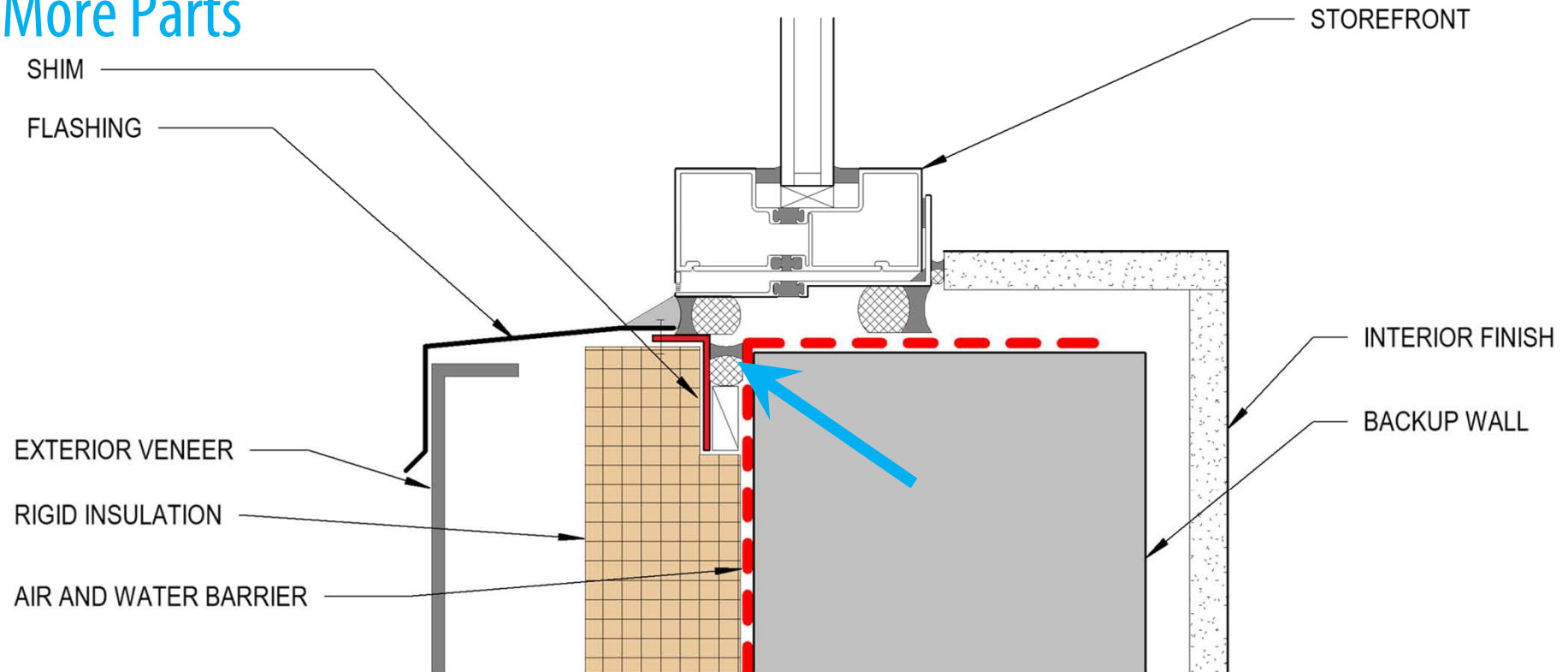
- 2 Definitive lines of Sealant Protection
- 1 added Aesthetic Sealant
- Increased Installation Tolerance
- Better Flashing Joint Appearance
- Many More Pieces
- **NOT** Reliant on Bed Sealant at Sill

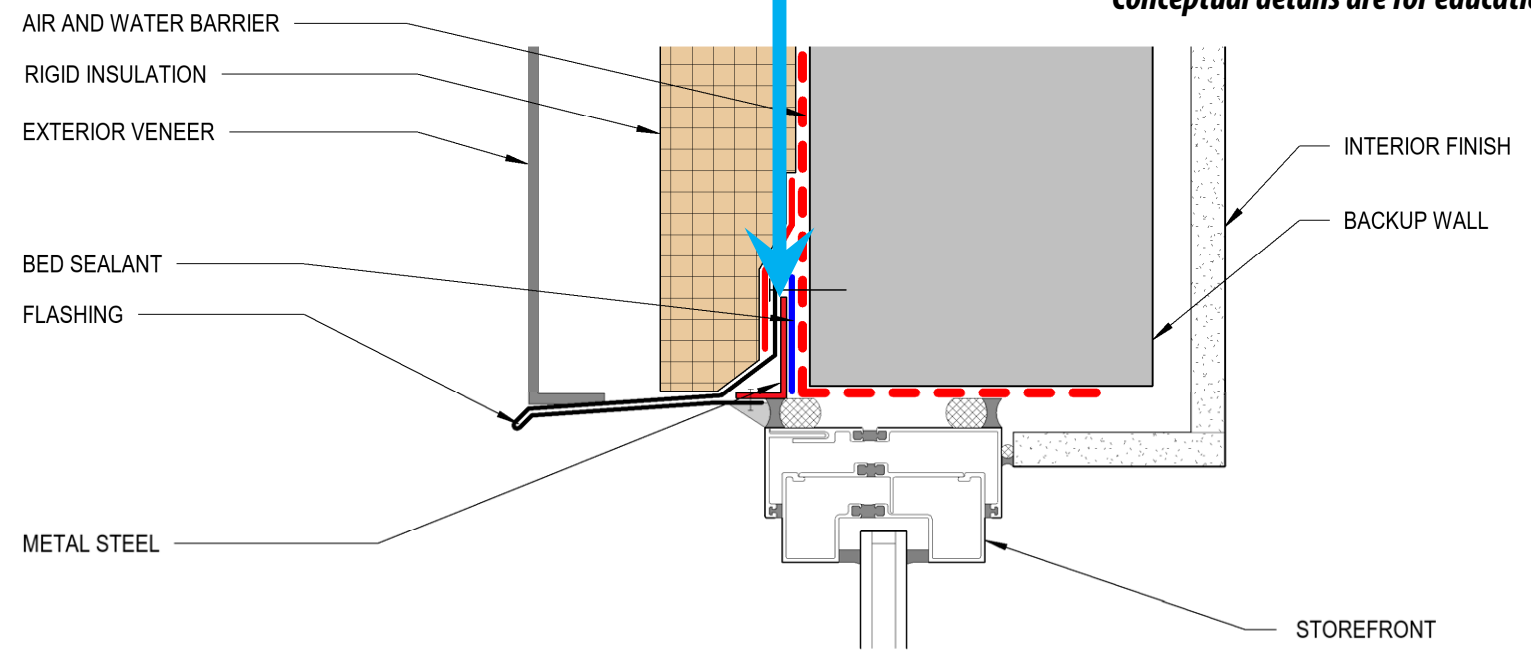


- Metal Angle with Shim
- Allows for Drainage under Sill
- Creates air infiltration path past Thermal Break
- Metal Angle does not align with Head

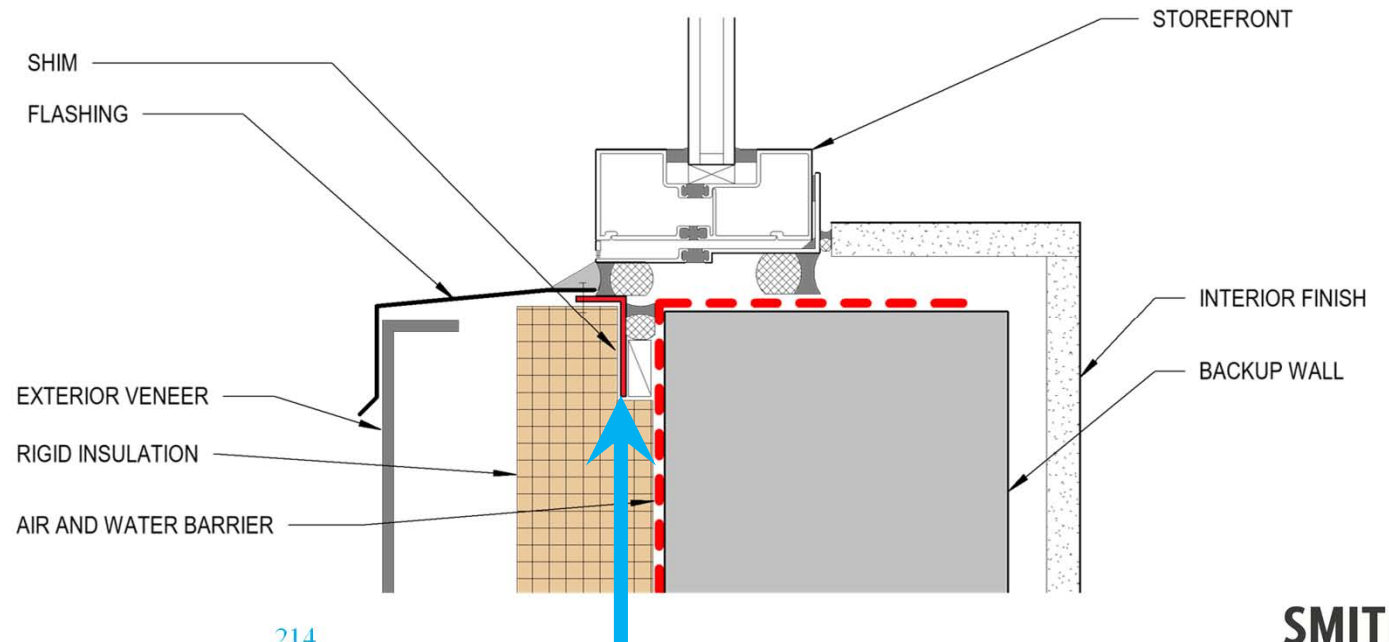


- Metal Angle with Shim and **Weeped Sealant**
- Allows for Drainage under Sill
- **Reduces** air infiltration path past Thermal Break
- Metal Angle does not align with Head
- **Many Many More Parts**

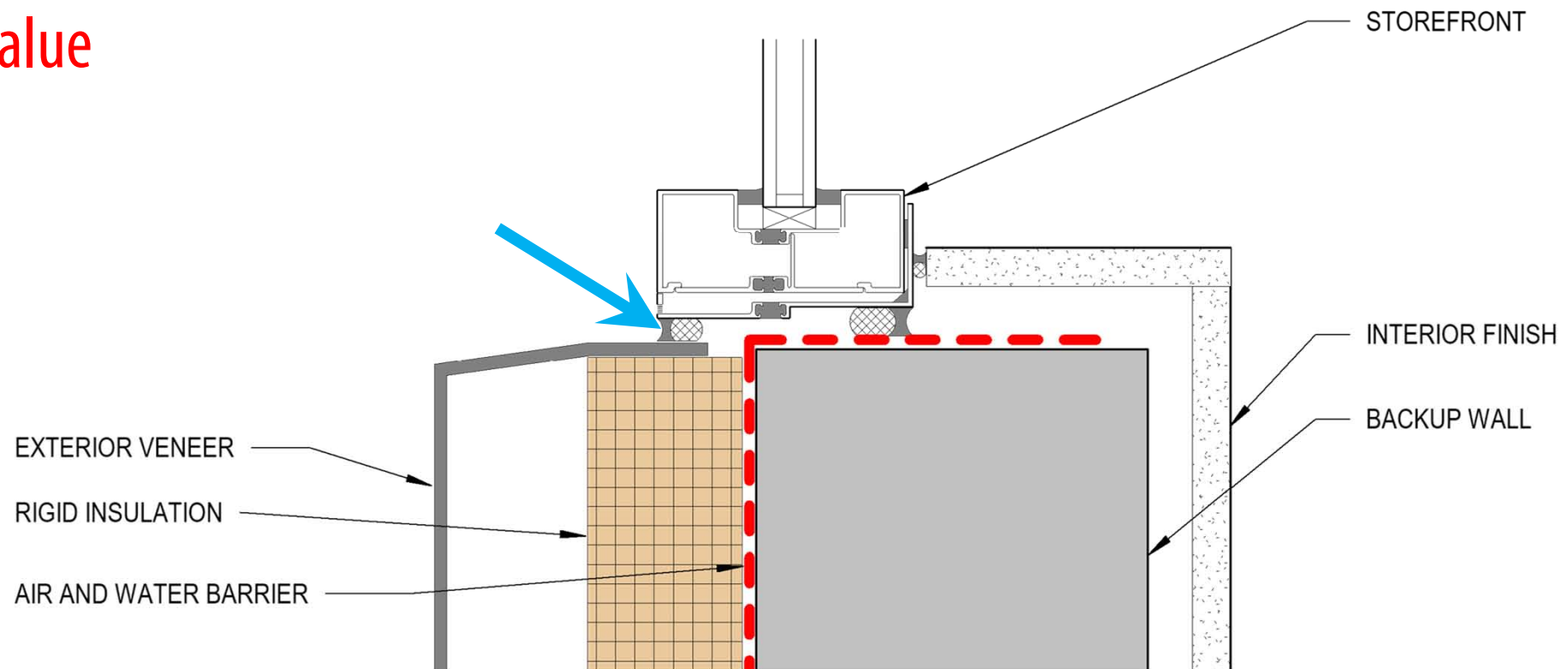




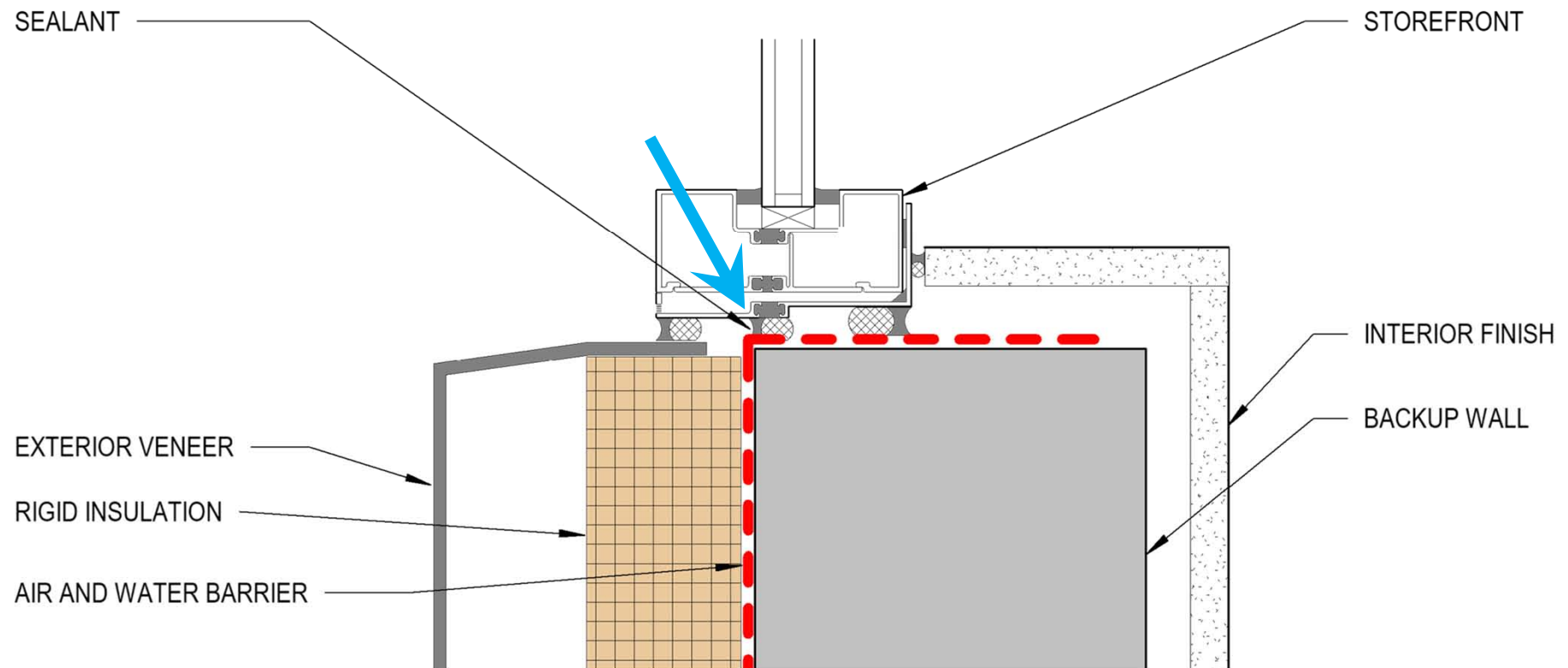
Metal angle is not in the same plane.



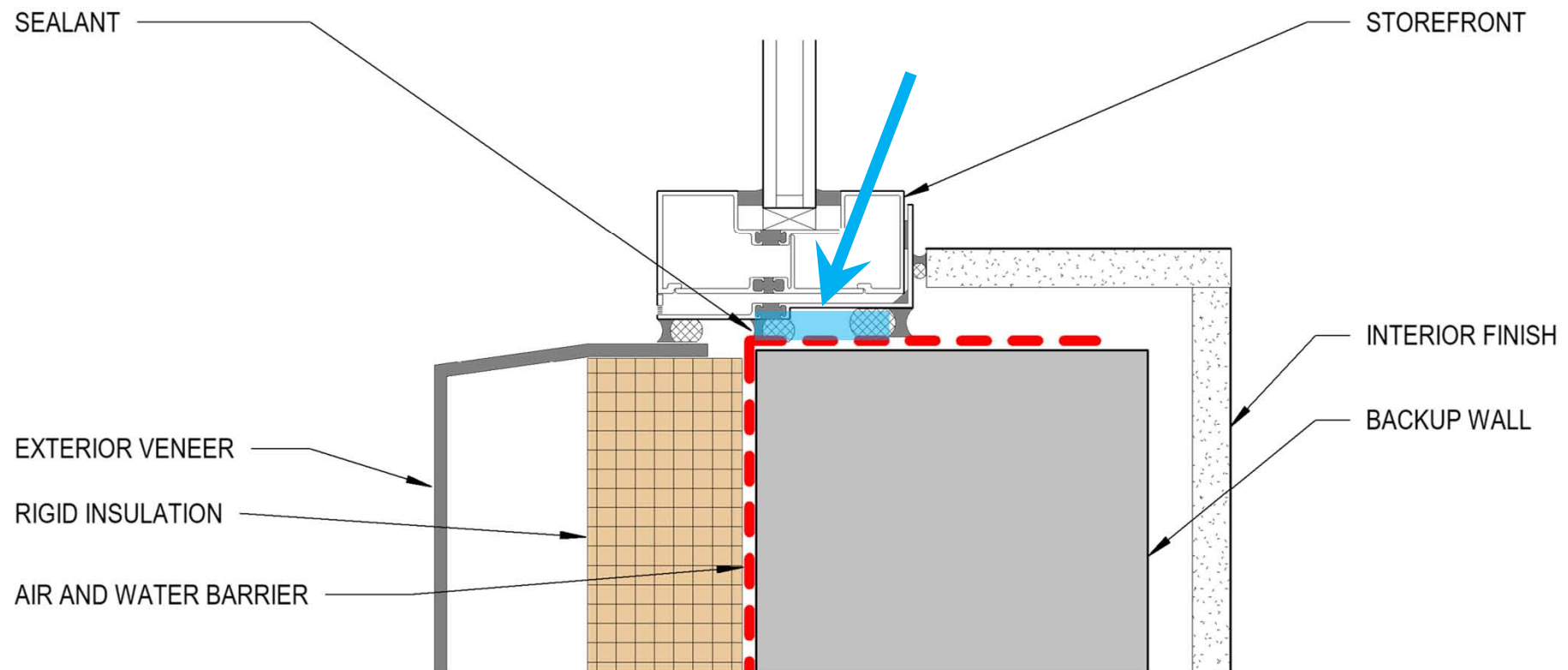
- Outer Seal to Veneer
- 1 line of Protection
- Allows for Drainage under Sill
- Creates air infiltration path past Thermal Break
- Limited Value



- Outer Seal to Veneer
- 2 lines of Protection
- Reduces air infiltration path past Thermal Break



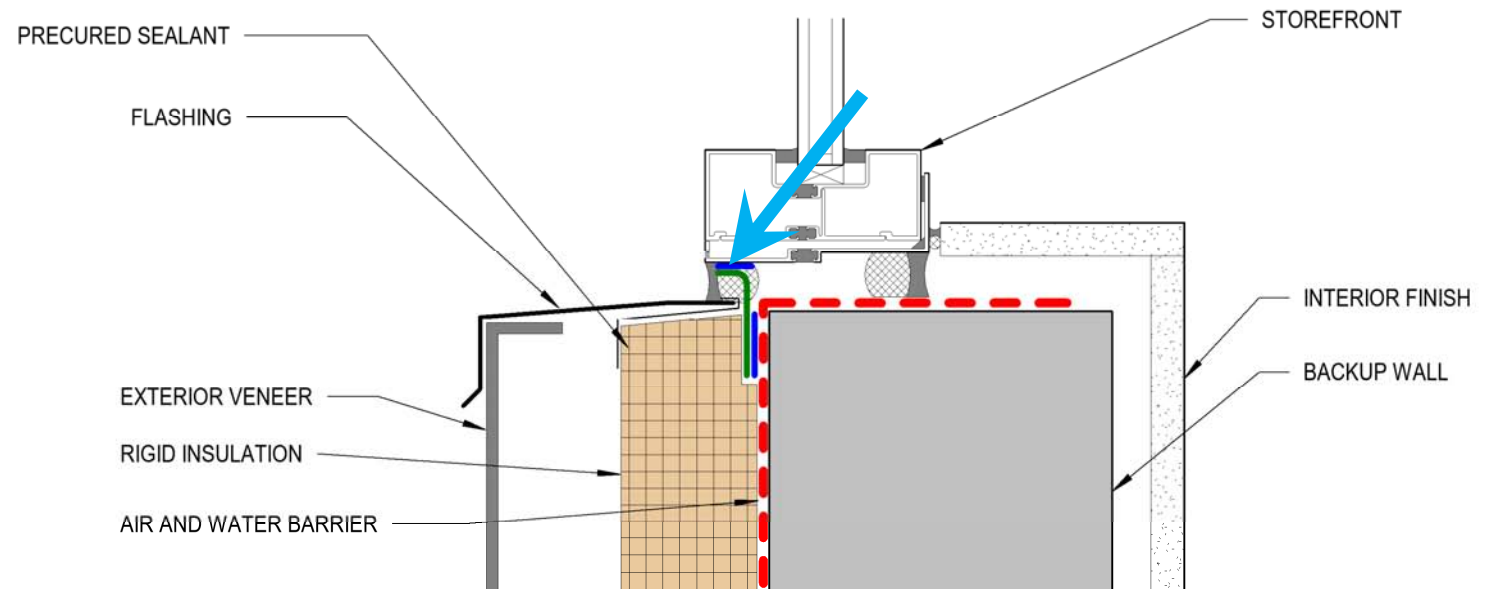
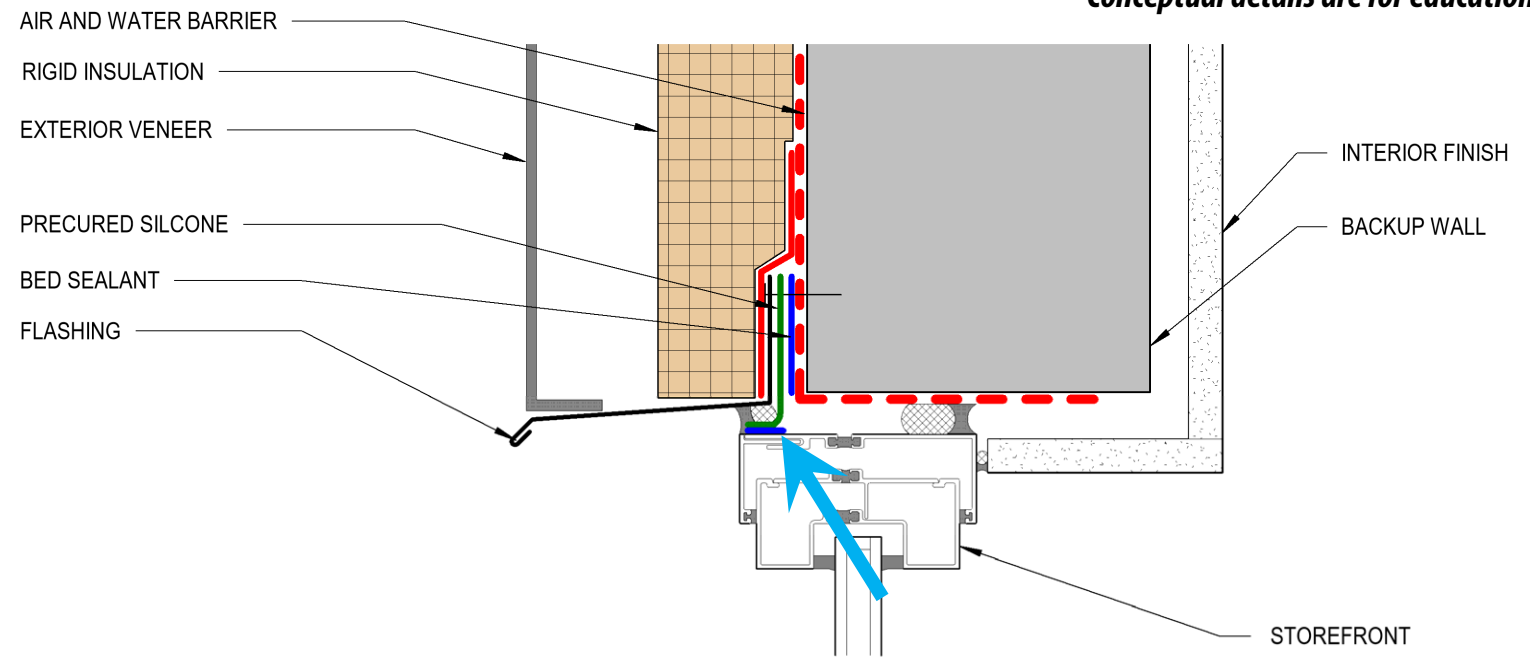
- Outer Seal to Veneer
- 2 lines of Protection
- Reduces air infiltration path past Thermal Break
- Sealant may conflict with shims

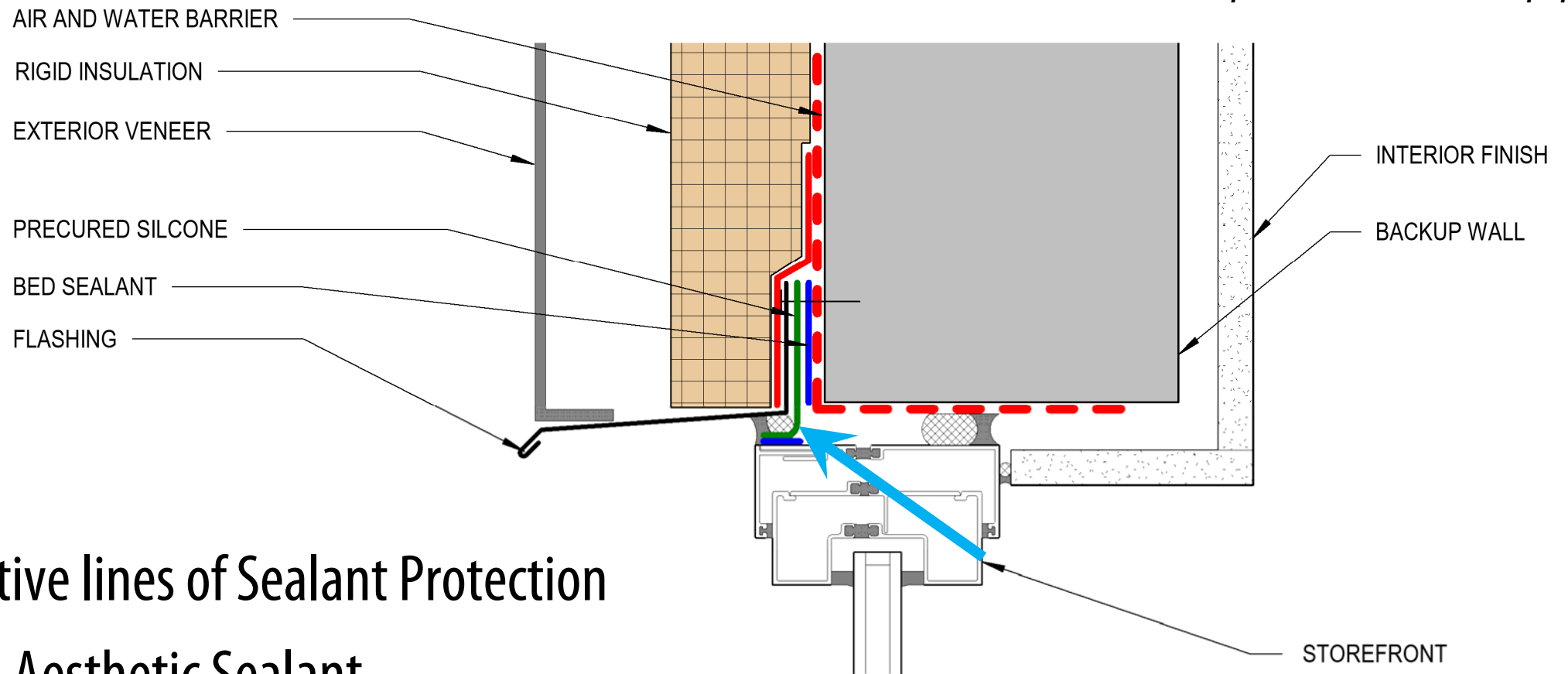


StoreFront

Alt-2

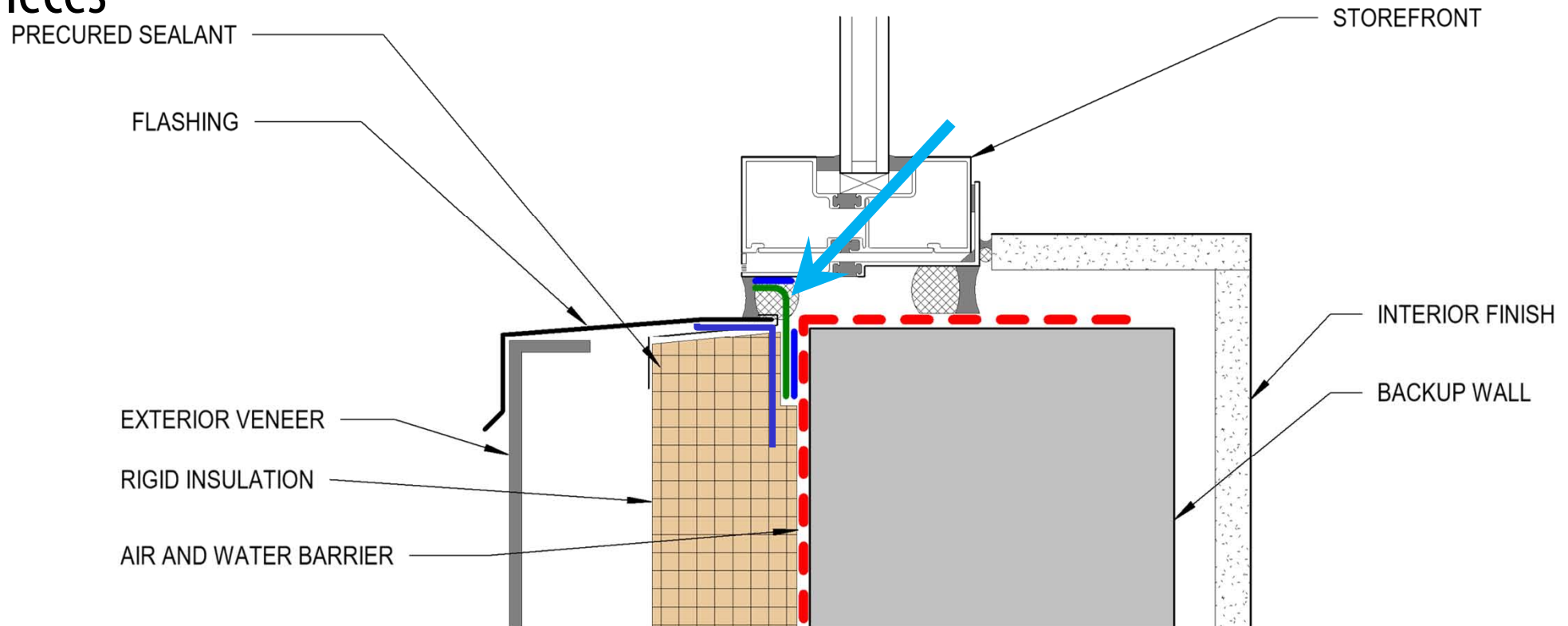
- Flashing not extended into opening
- Membrane transition to Storefront frame.



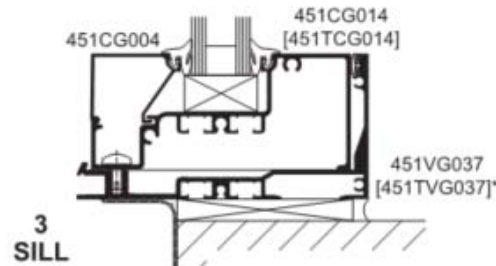
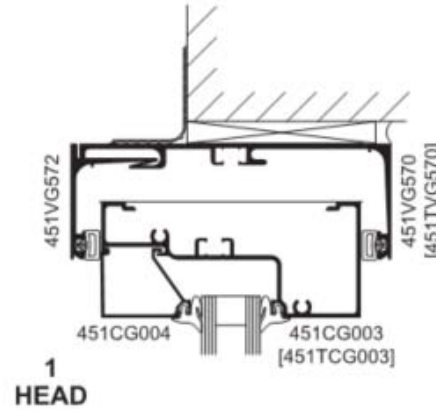
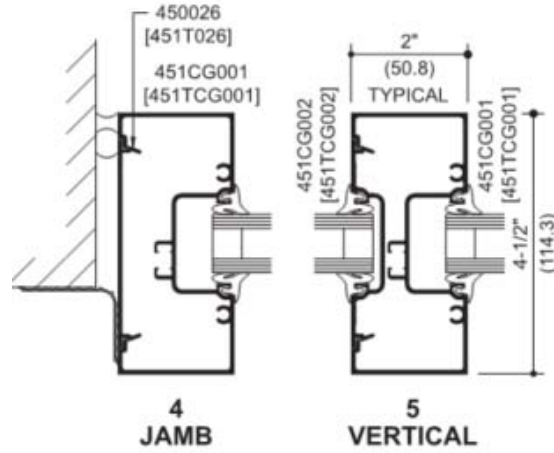


- 2 Definitive lines of Sealant Protection
- 1 added Aesthetic Sealant
- Increased Installation Tolerance
- Better Flashing Joint Appearance
- More Pieces

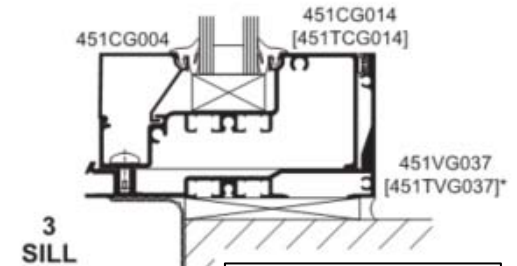
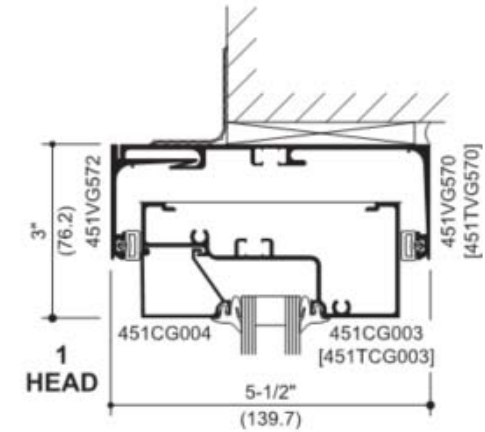
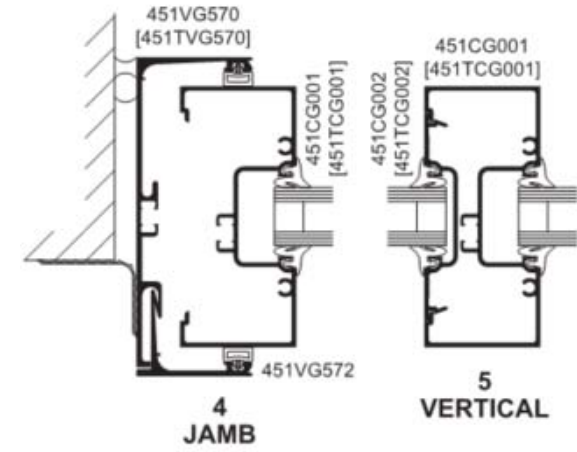
- 2 Definitive lines of Sealant Protection
- 1 added Aesthetic Sealant
- Increased Installation Tolerance
- Better Flashing Joint Appearance
- More Pieces



HEAD RECEPTOR WITH CONTINUOUS JAMB FILLERS (EXTERIOR INSTALLED)



HEAD AND JAMB RECEPTORS (EXTERIOR INSTALLED)



Courtesy of Kawneer

MITHGROUP

So what is the Right Answer?

It Depends...

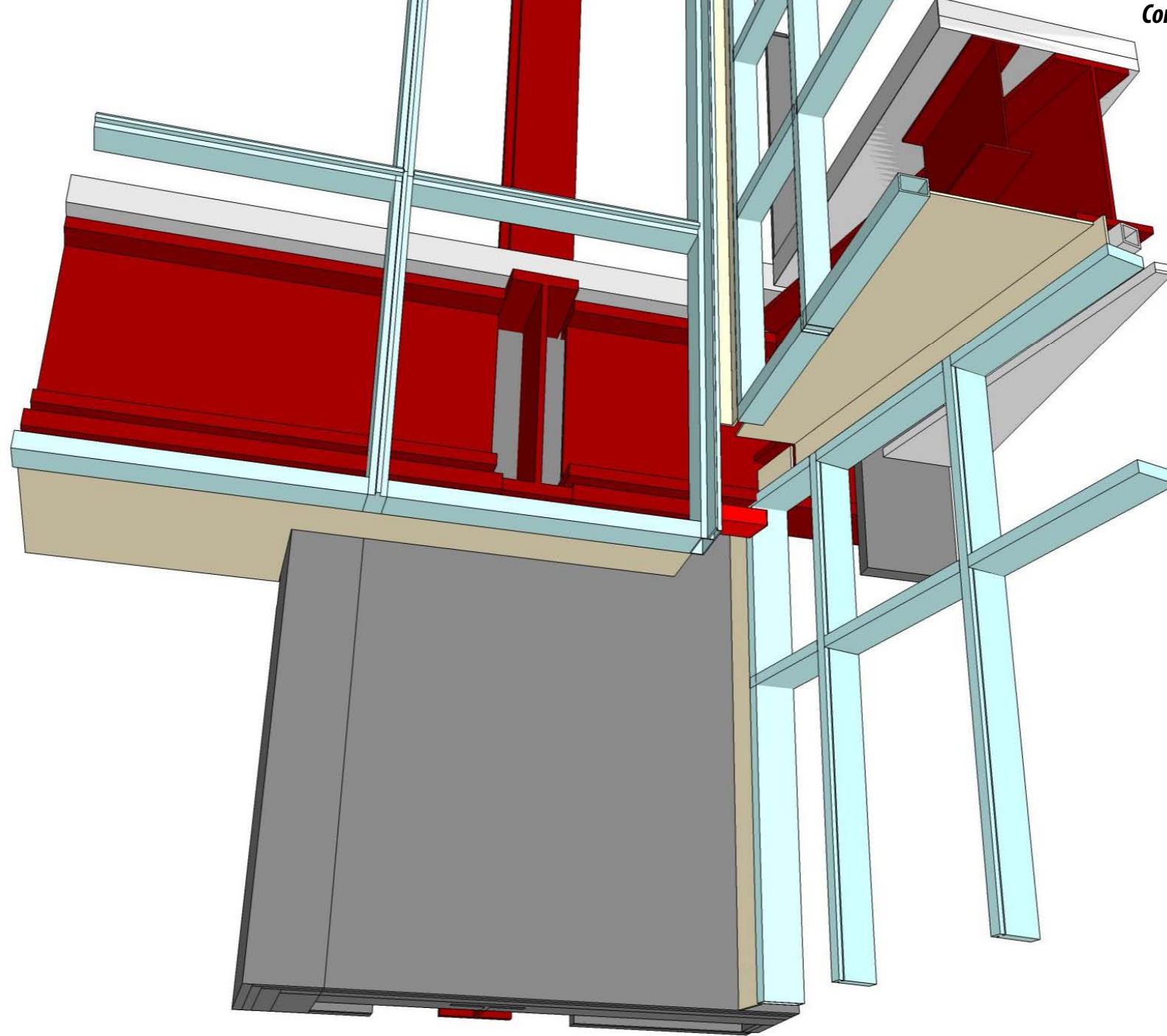
but maybe, Curtain Wall?

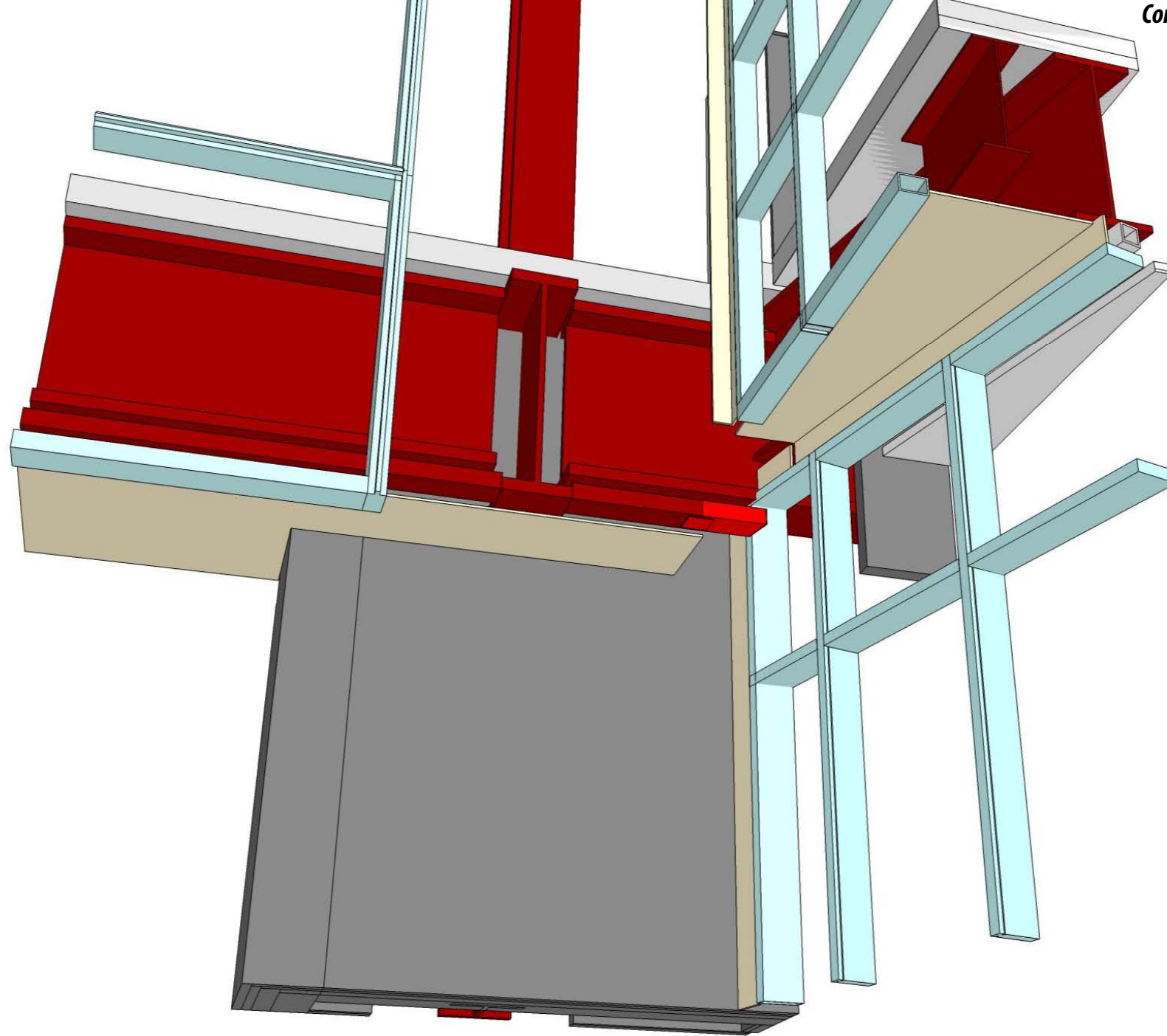
3D Detailing

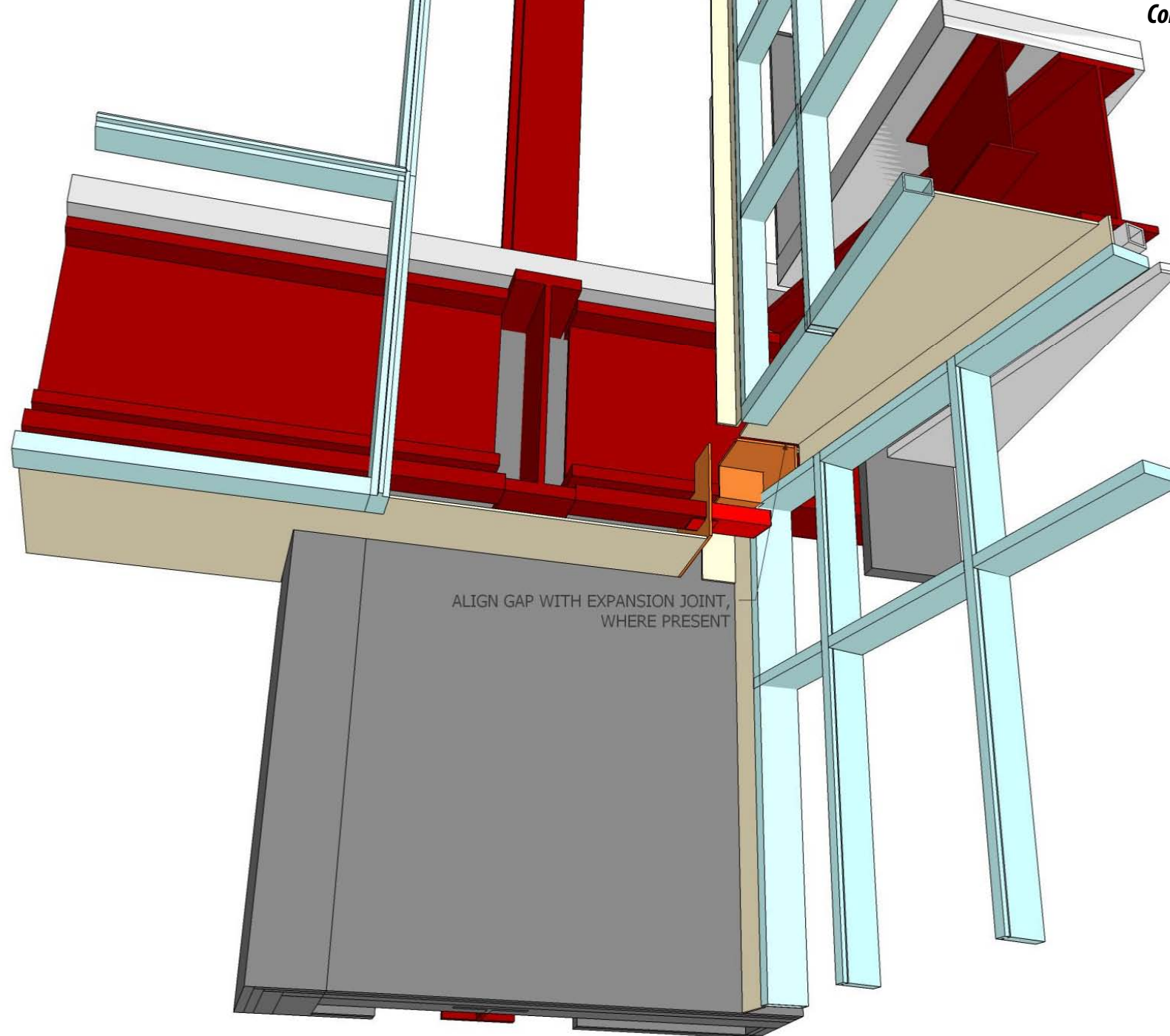


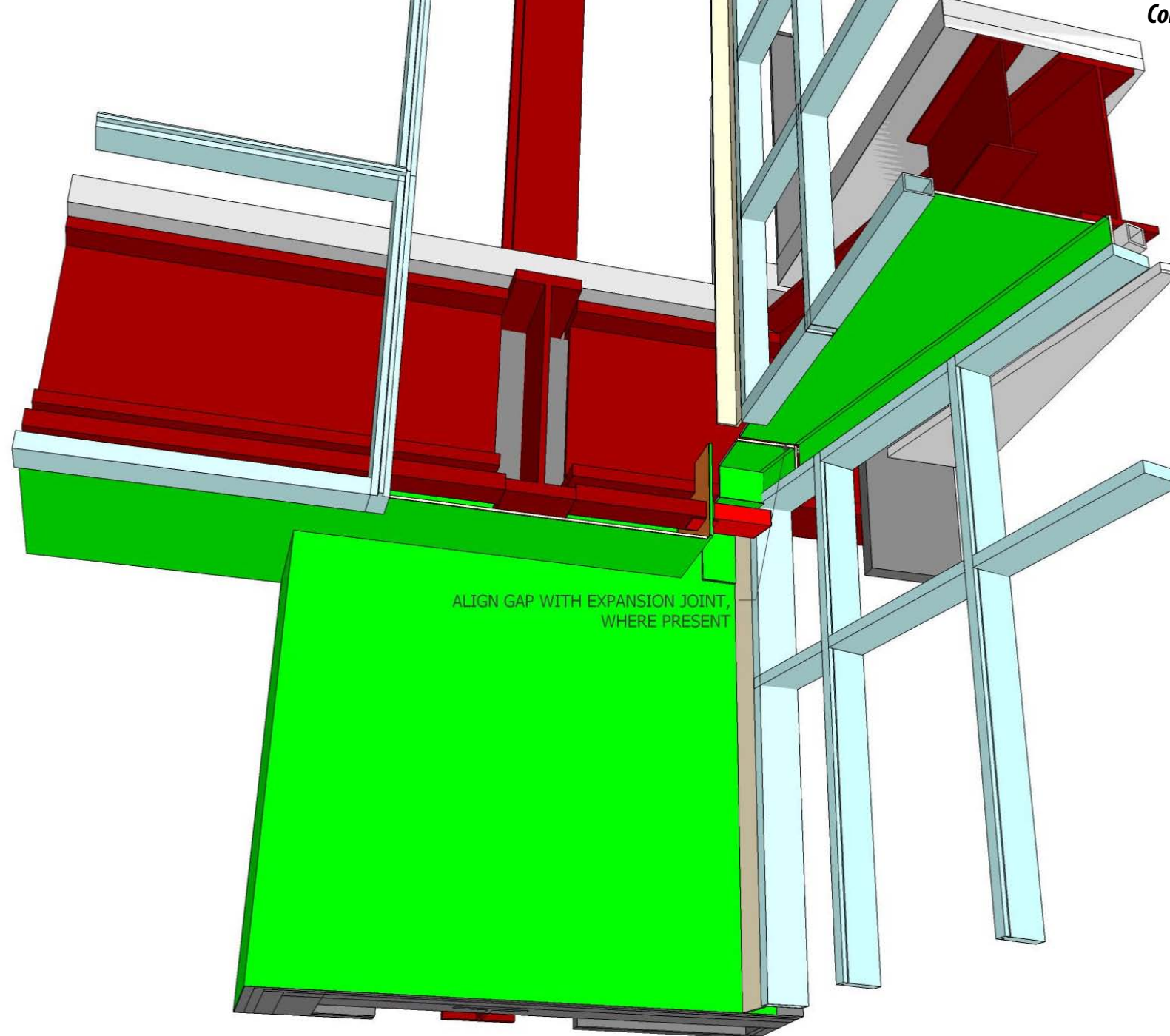


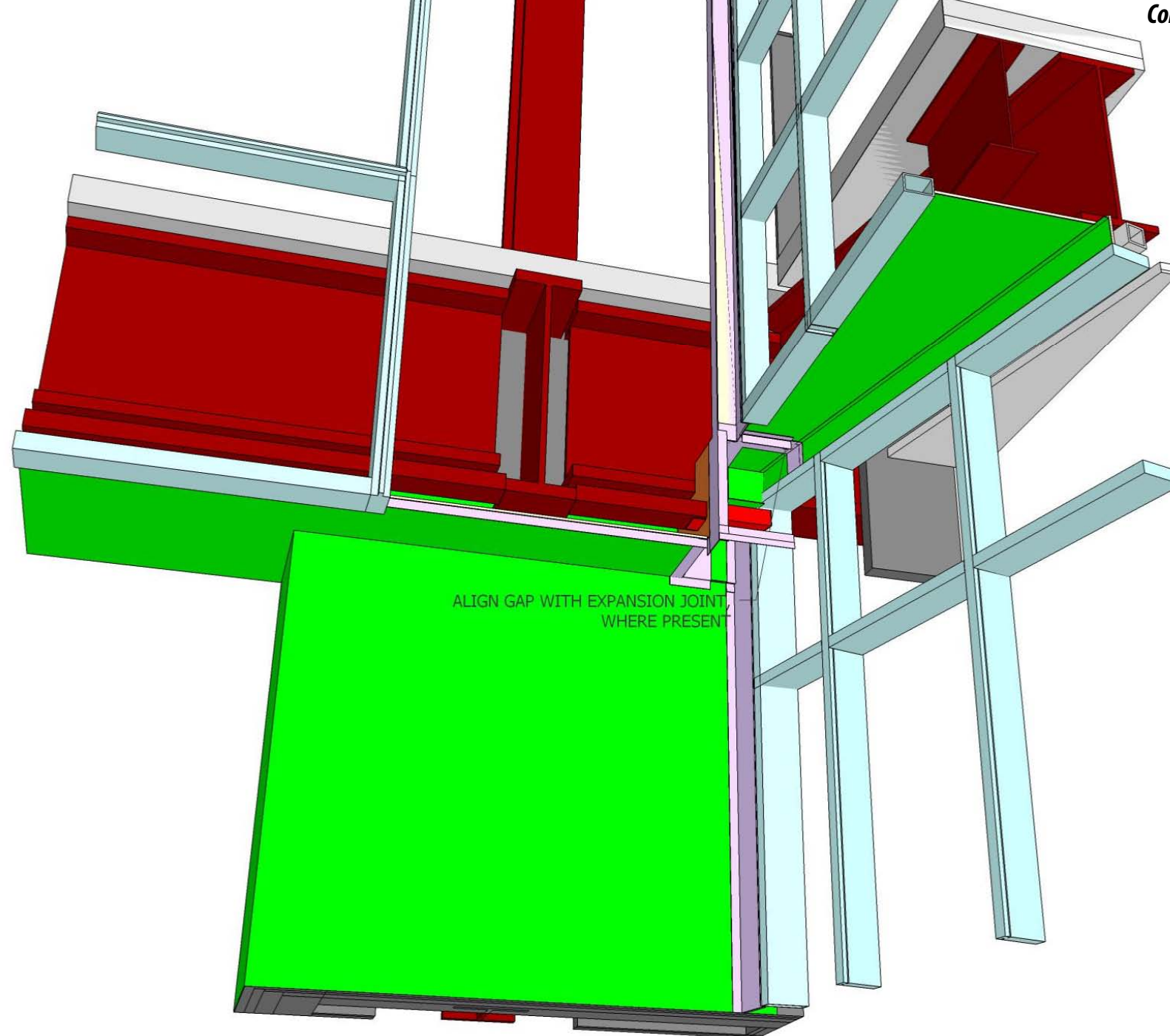
2017/05/02 15:39

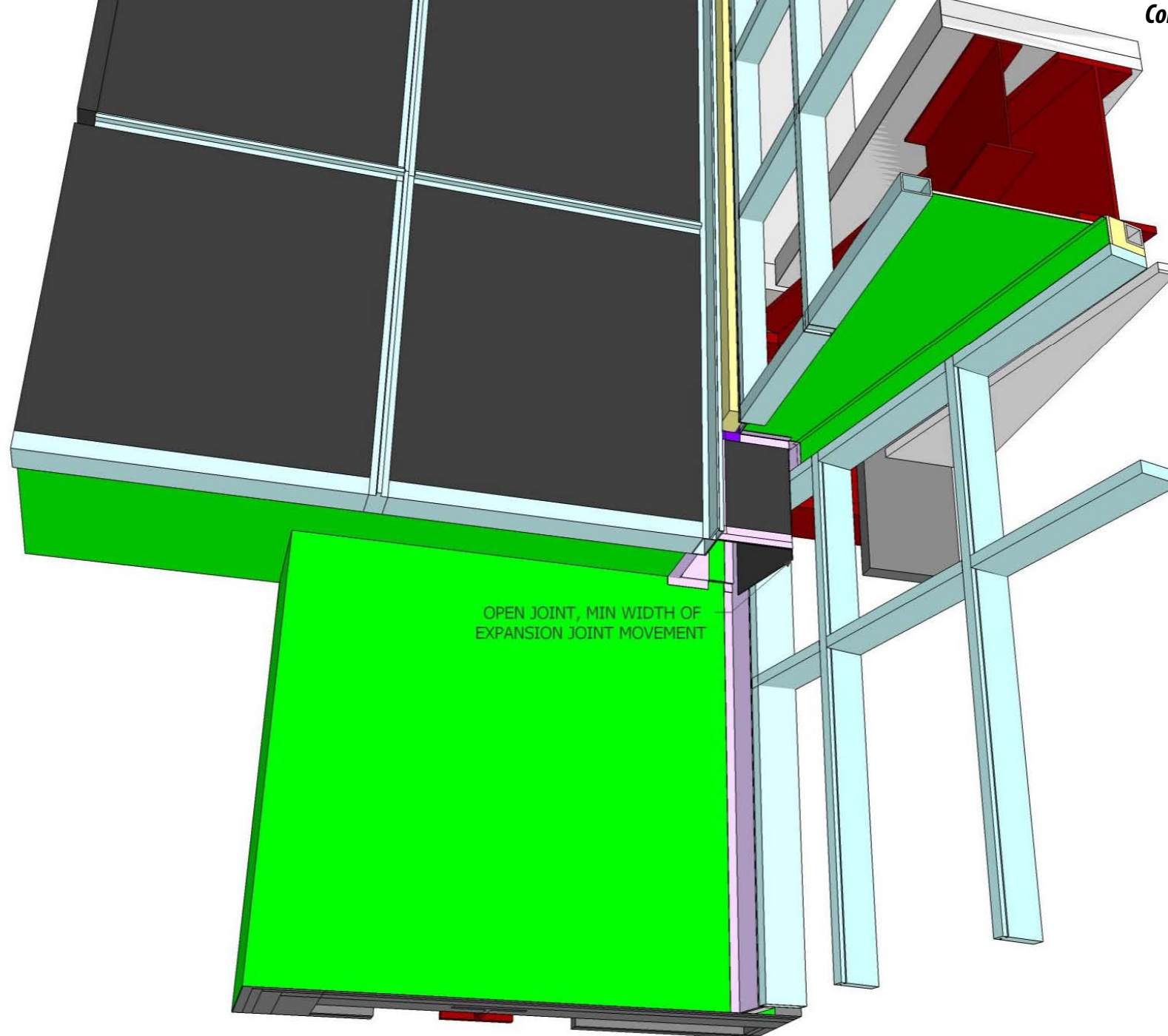


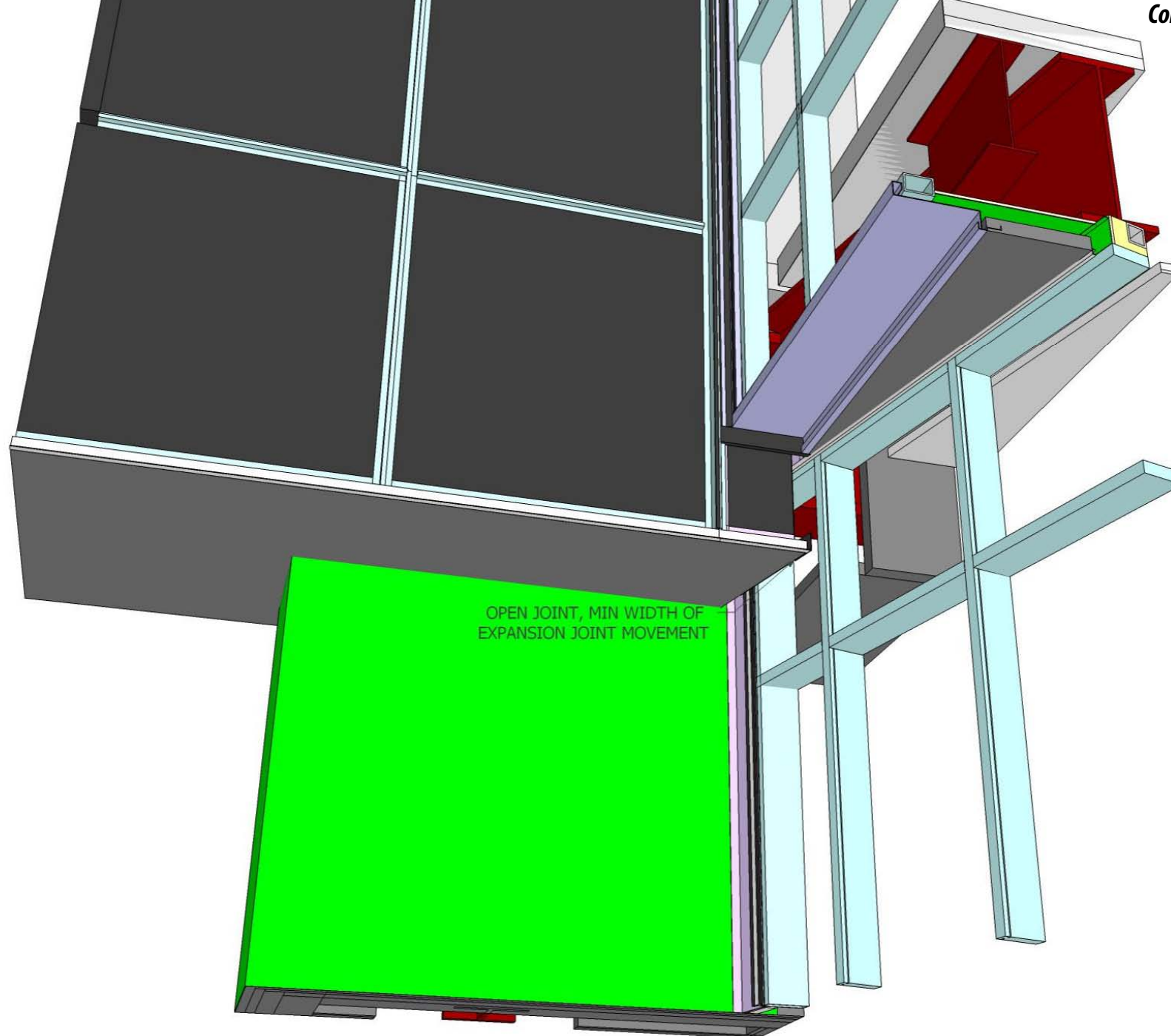


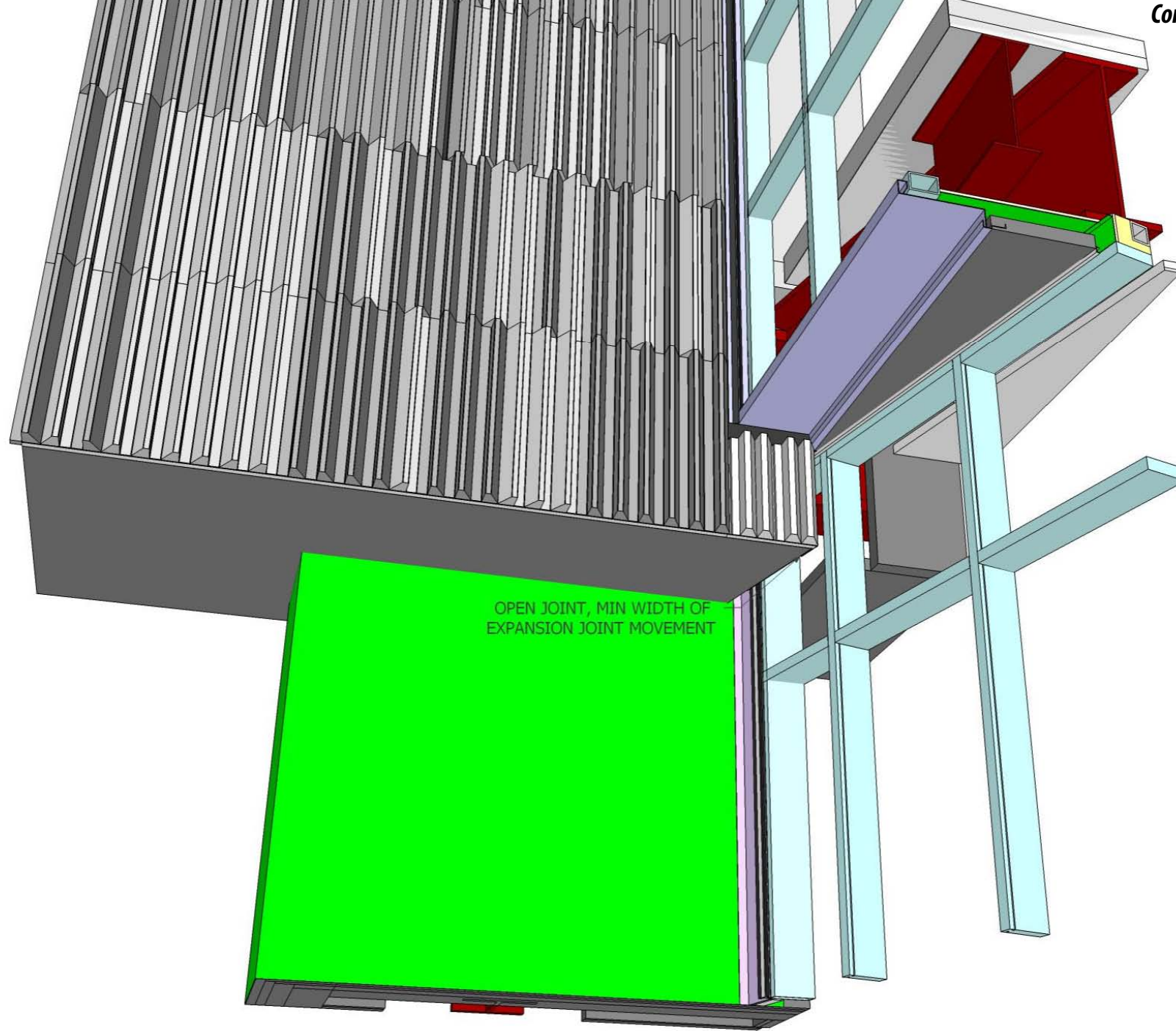


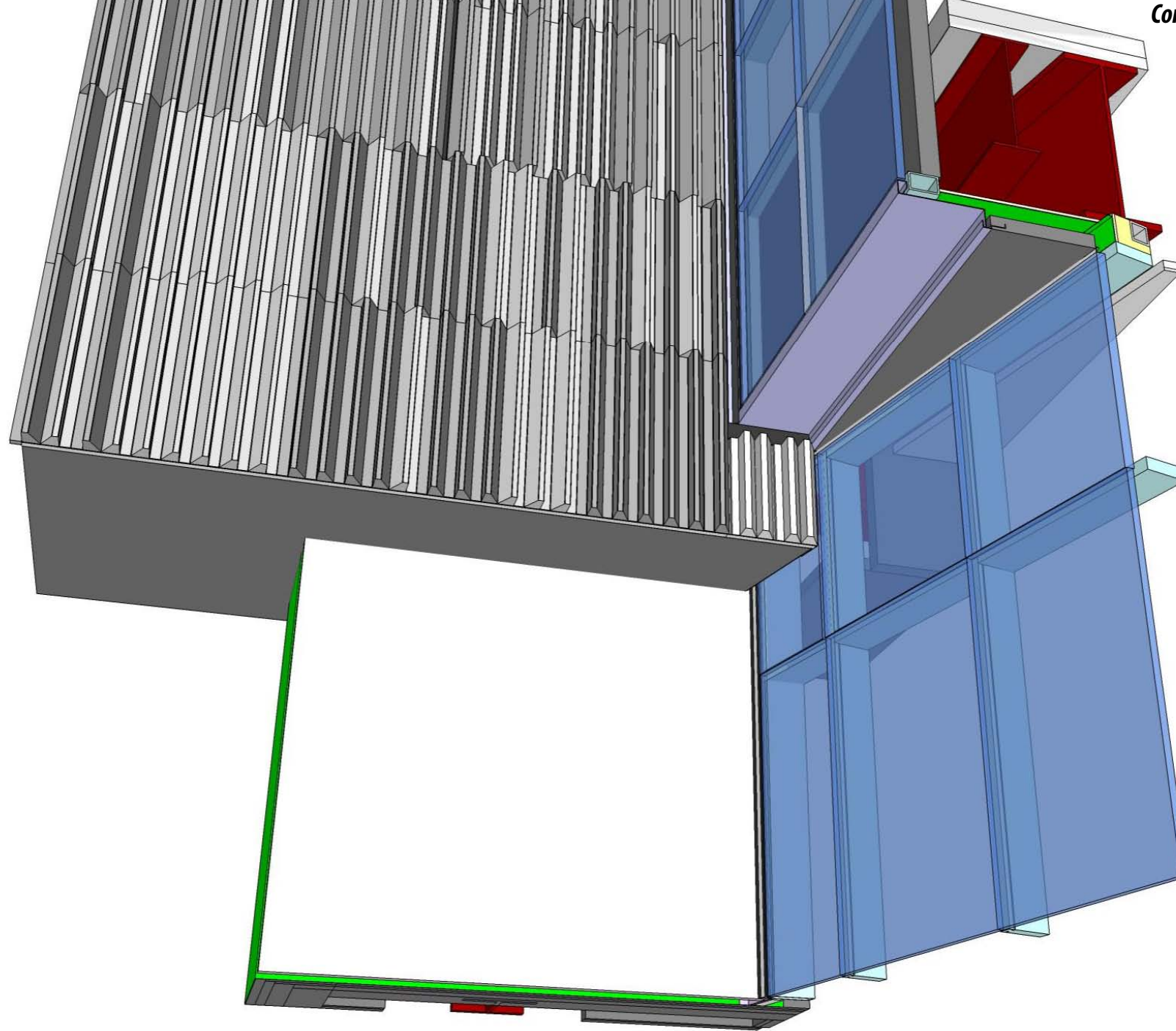














2017/10/25 15:28

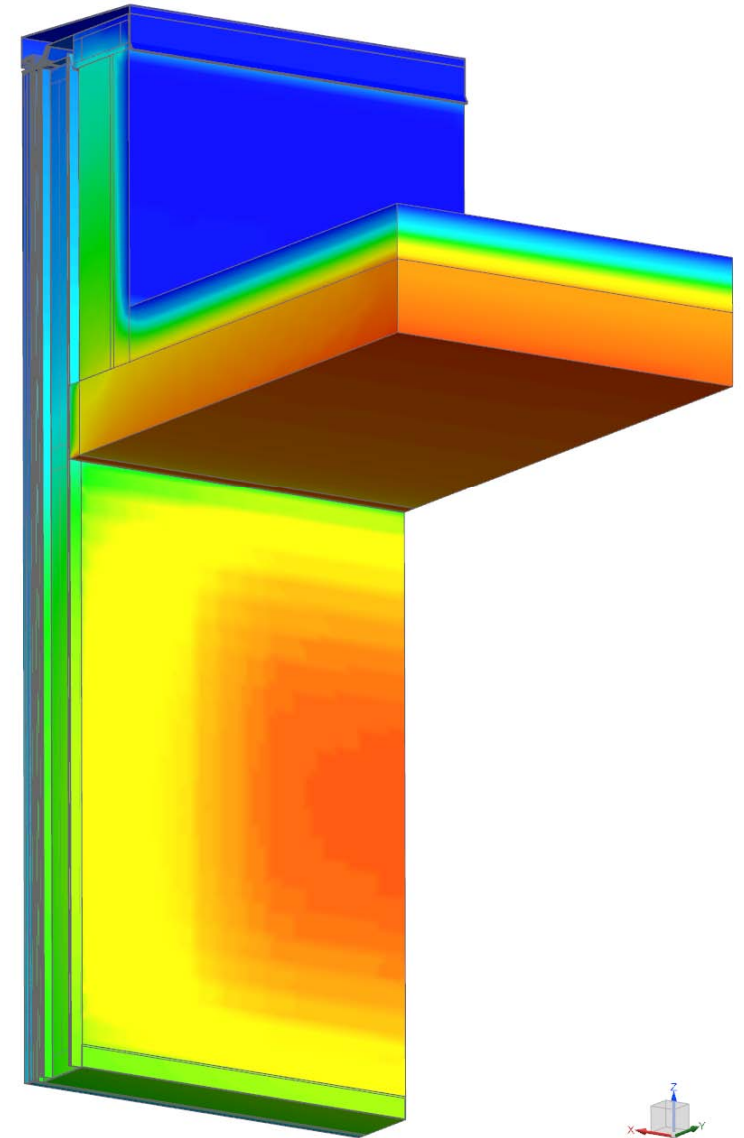
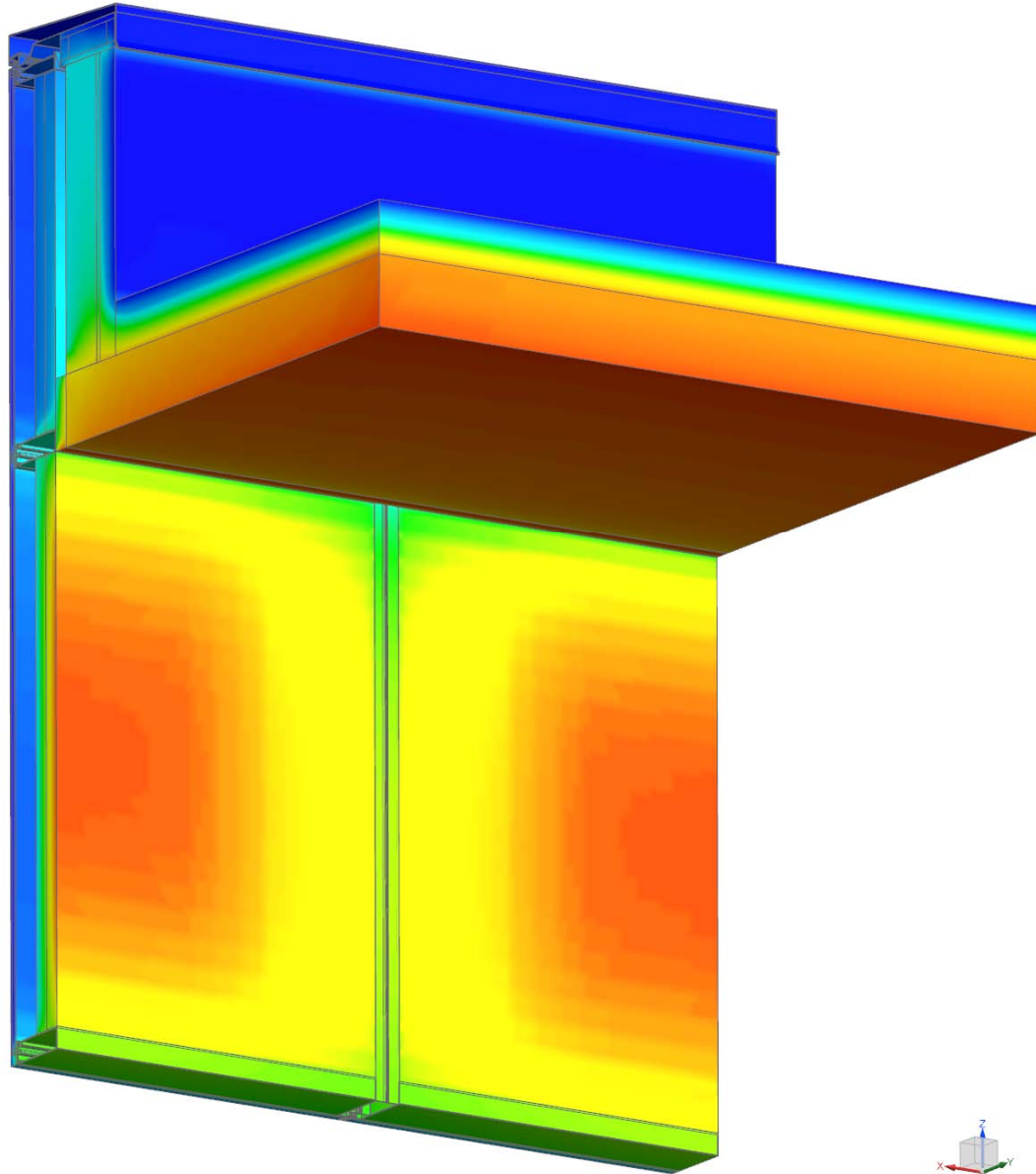


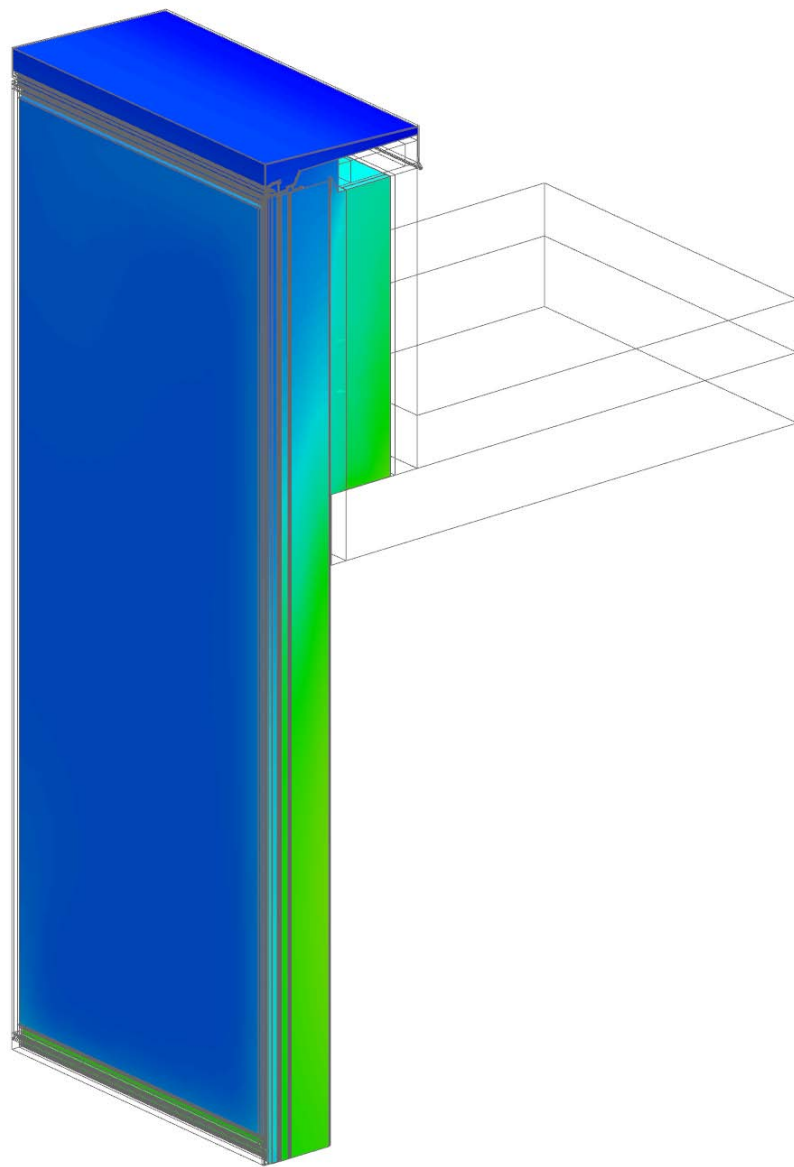
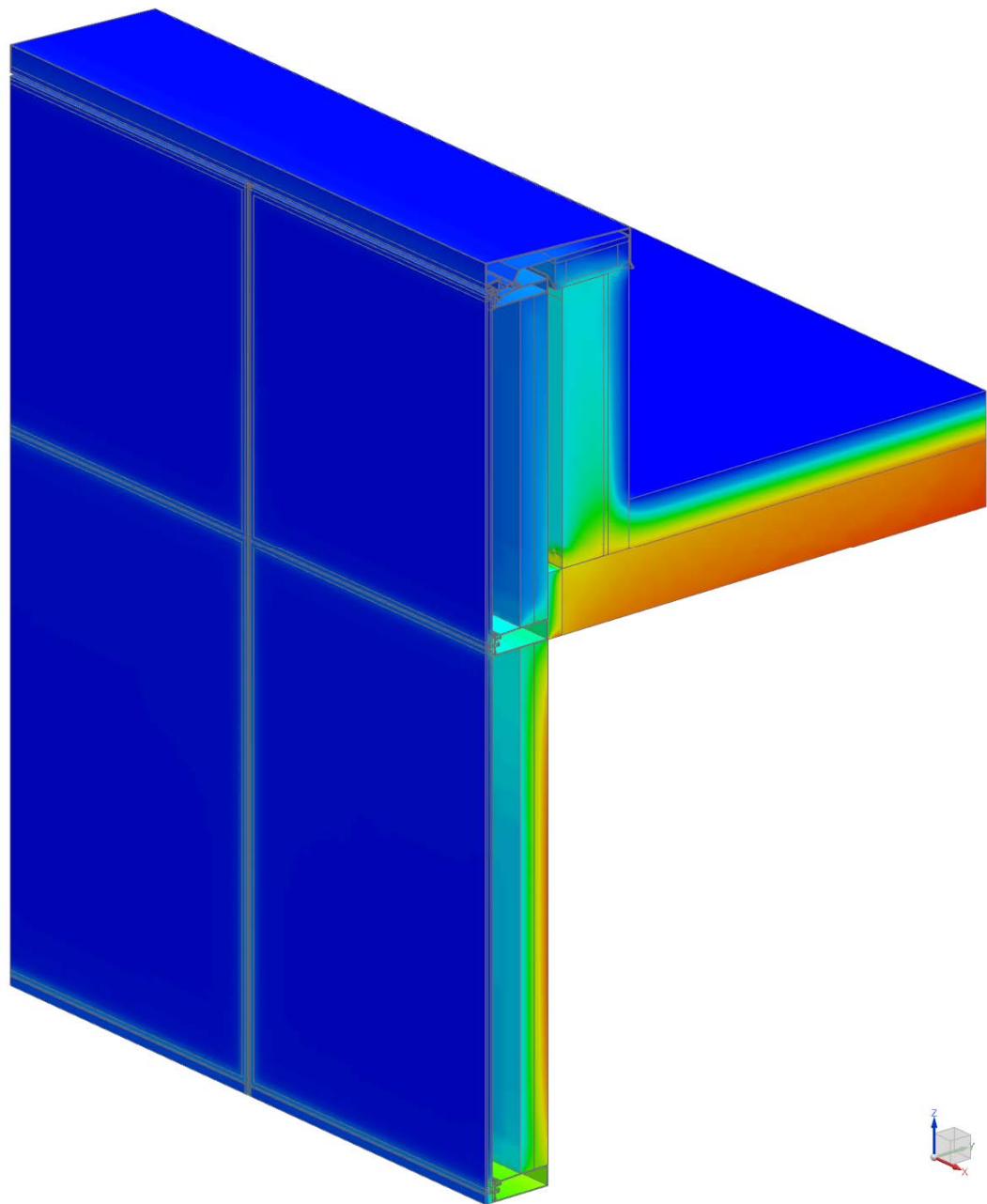
So What's Next?











Andrew A. Dunlap, AIA, NCARB

andrew.dunlap@smithgroup.com

313-442-8186



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