AABC Commissioning Group

AIA Provider Number 50111116

How-to: Commissioning Design Reviews for the Building Envelope

Course Number: CXENERGY1625

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Course Description

This session provides an overview of the standards relating to BECx, from design phase activities to design reviews, providing full-wall elevation examples showing the transition from below grade to above grade and to the roof. Attendees will learn how to trace the various enclosure barriers (air, thermal, moisture, and vapor) to ensure continuity throughout the whole enclosure.

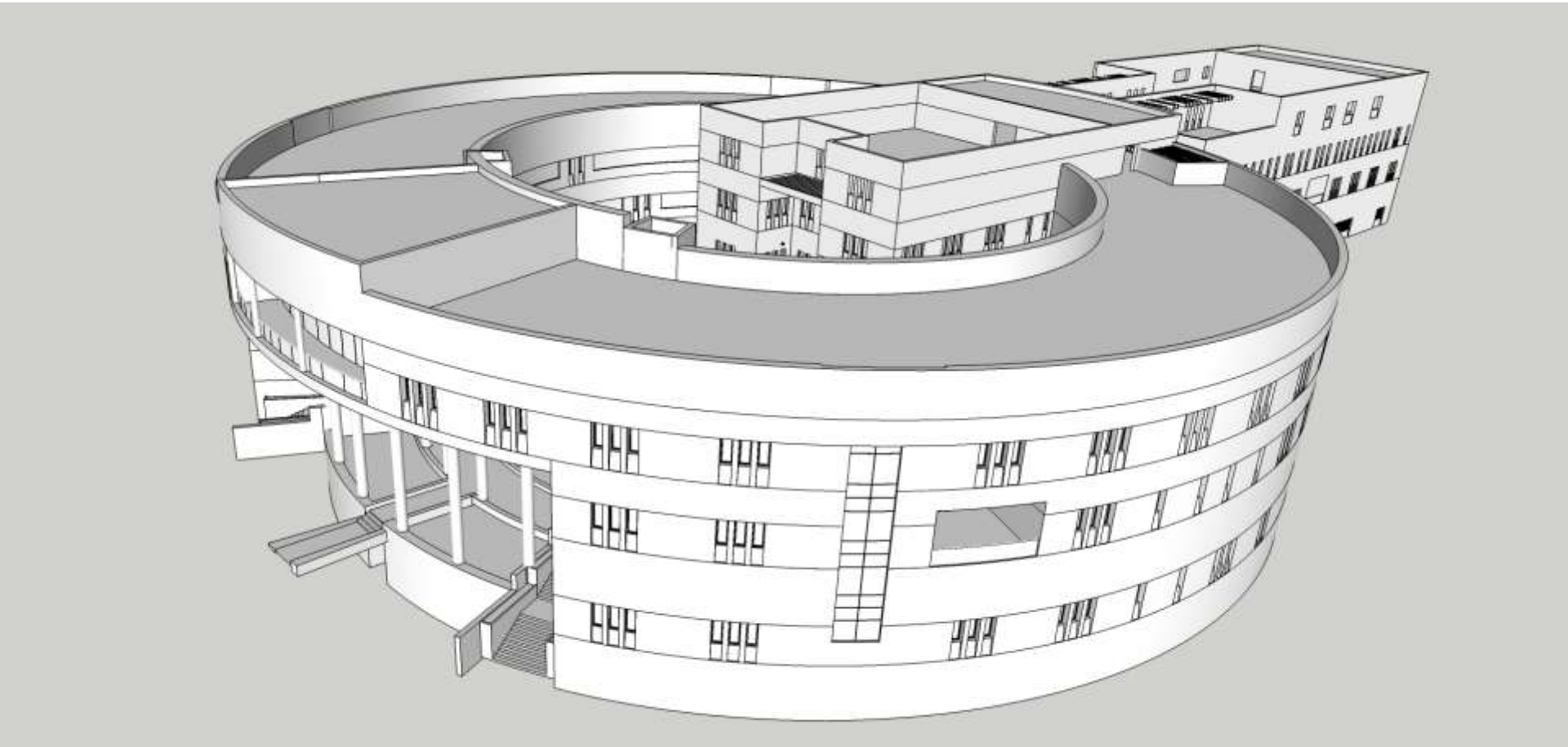
Learning Objectives

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

1. Learn how to determine the building enclosure control layers – water, thermal, air, and vapor.
2. Learn how to review the various enclosure control layers to ensure continuity.
3. Learn how to review the enclosure design against the requirements outlined in the owner's project requirements.
4. Learn some of the issues associated with some common enclosure details in various climate zones.

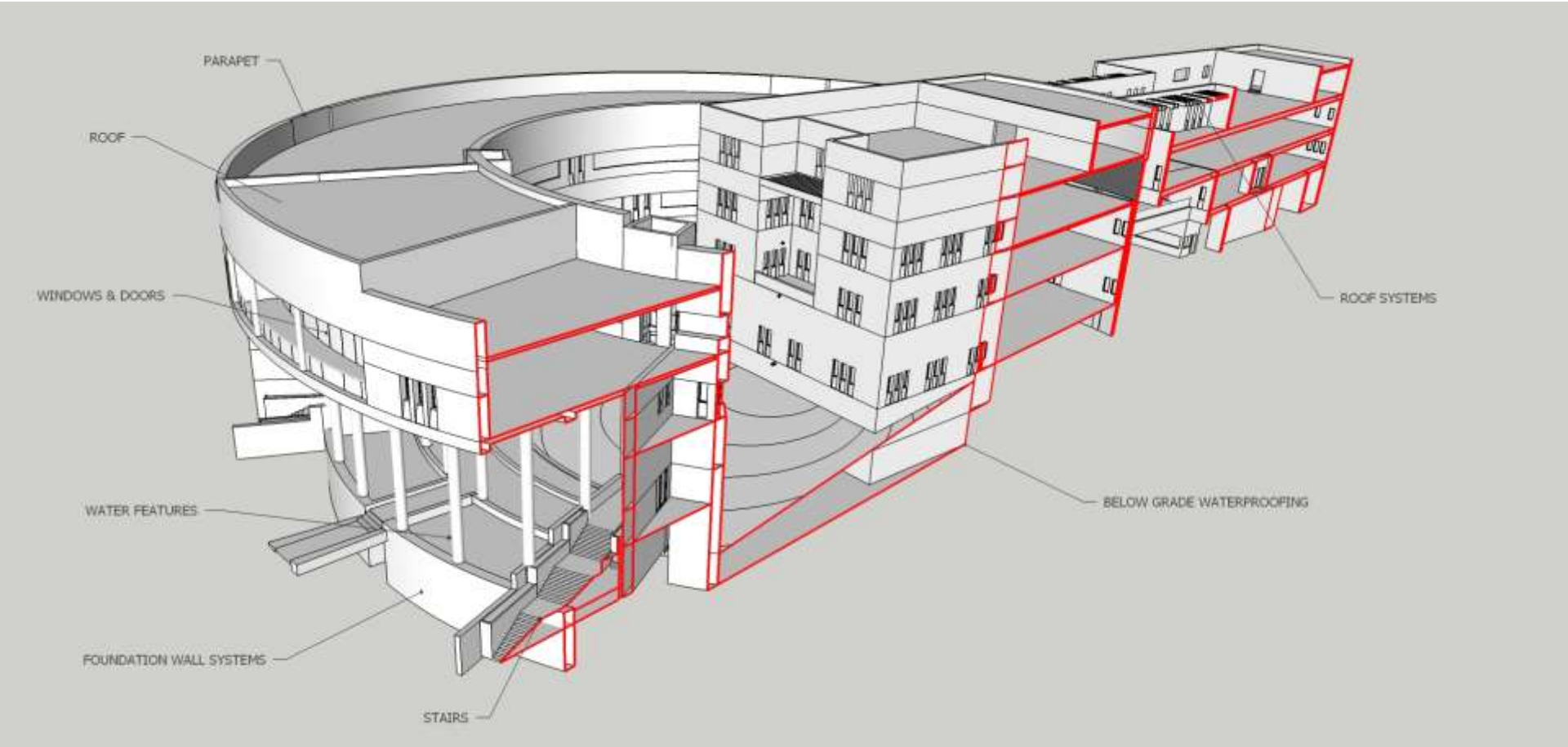
What is the Building Envelope?

The assembly of components that separates the interior and the exterior environment.



Envelope Continuity

The assembly of components that separates the interior and the exterior environment.



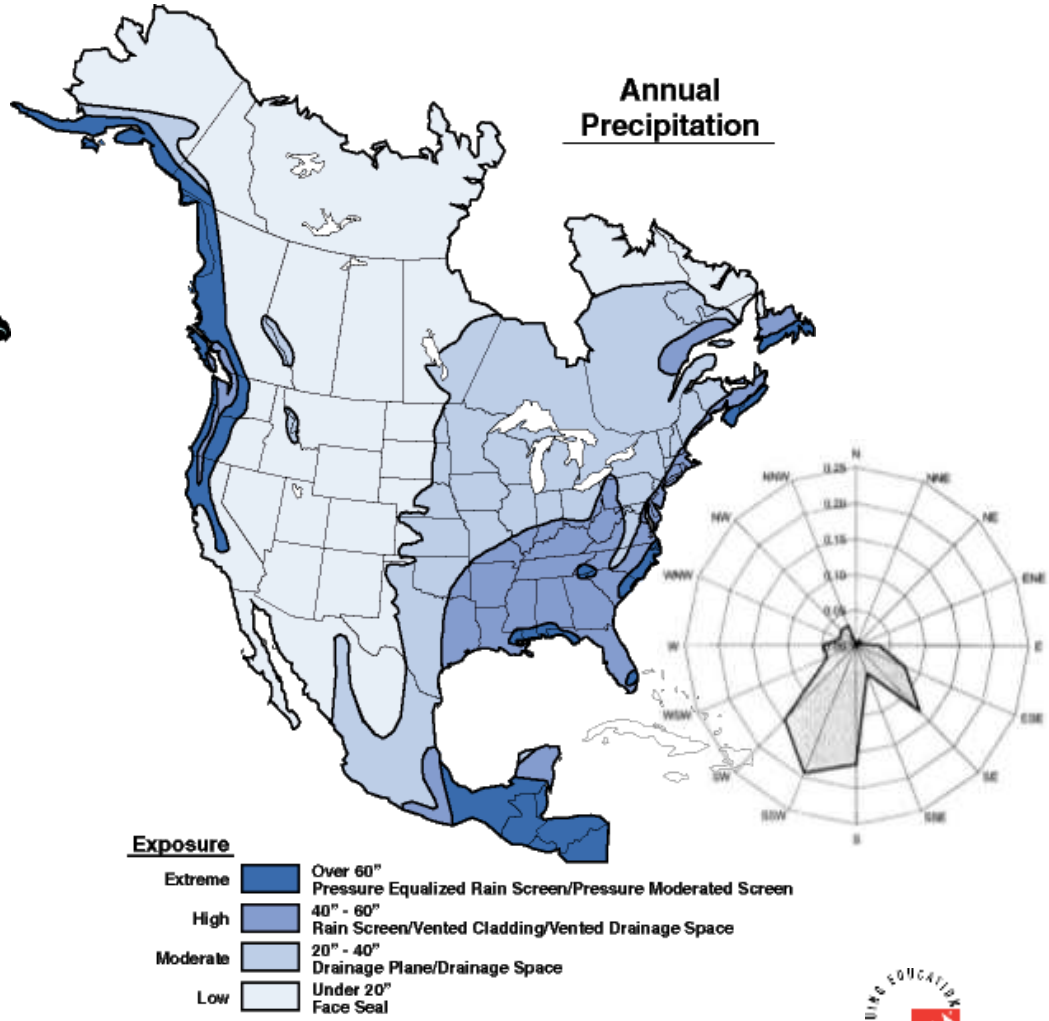
Outdoor Environment

Temperature (Extremes & Difference)
Humidity
Rainfall (peak & total)
Wind Driven Rain
Wind Blown Snow
Snow & Ice Accumulation
UV Exposure
Impact
Contaminants

Indoor Environment

- Temperature and Humidity
- Requirements determined by occupancy
- Controlled by HVAC system

Climatic Conditions



Building Envelope Design Factors

Resist imposed loads

Accommodate movement

Control rain penetration

Control heat flow

Control air flow

Control vapour diffusion

Provide security

Control fire

Control radiation

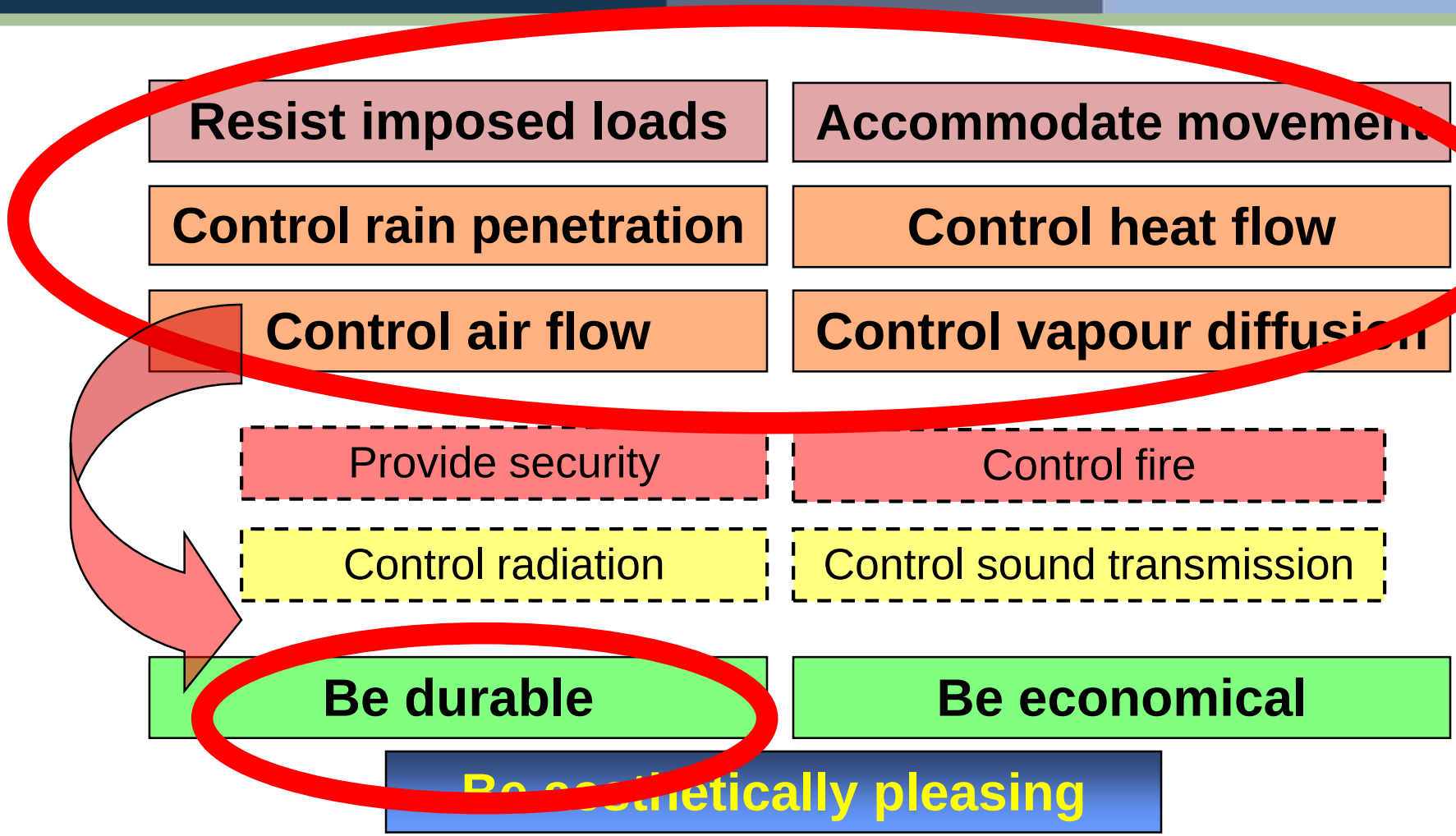
Control sound transmission

Be durable

Be economical

Be aesthetically pleasing

Building Envelope Design Factors



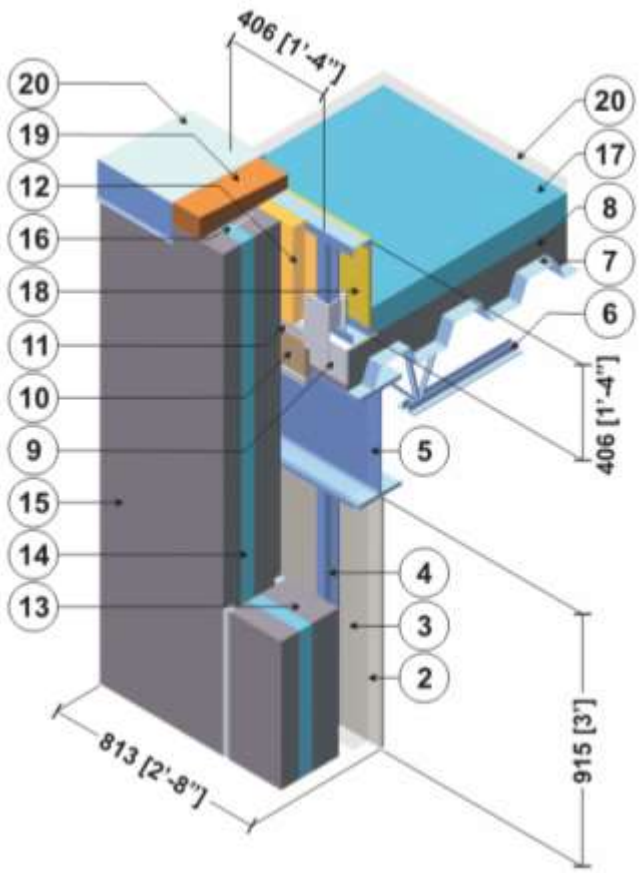
Control layers or barriers

- Water Barrier (most important)

  Rain Shedding Surface
  - Lapping of element
  - Drips directing water off walls
  - How does water run off horizontal elements

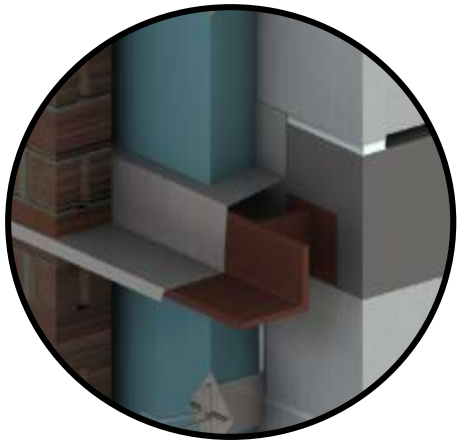
  Internal moisture barrier
  - Drain path to outside
  - Lapping of elements
  - Venting of cavities

- Air barrier
  - Continuous
  - Structurally supported
  - Provision for relative movement



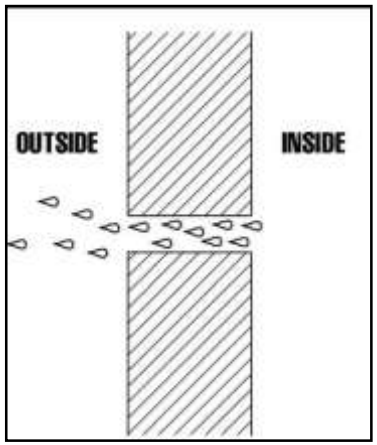
Control layers or barriers

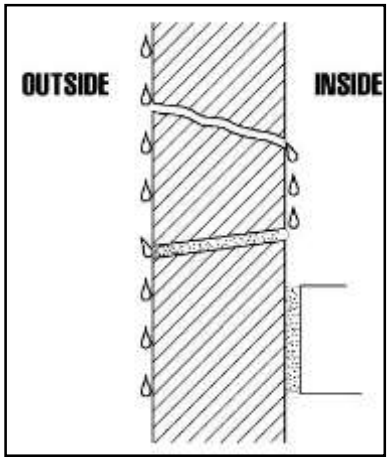
- Thermal Barrier (Insulation)
  - Continuity/thermal bridges
  - Keeping interior surfaces above dew point
  - Outside of structure if possible
- Vapor Barrier (Humidity Control)
  - On warm side of insulation

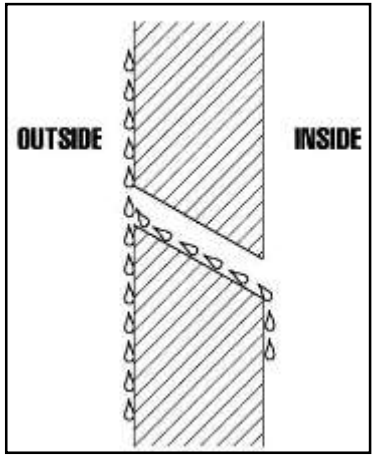


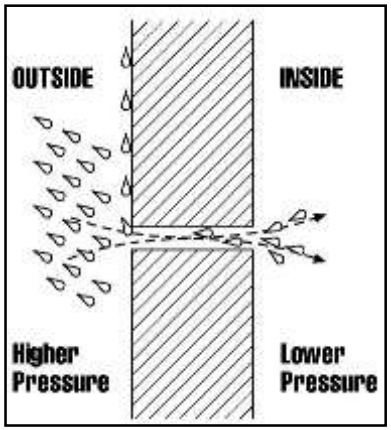
Water Barrier - Rain Penetration Control

- Driving forces:
  - momentum
  - capillarity
  - gravity
  - air pressure
- Resistance
  - diversion
  - drainage
  - drying









Water Penetration Failures

Wall Failure

Window Failure

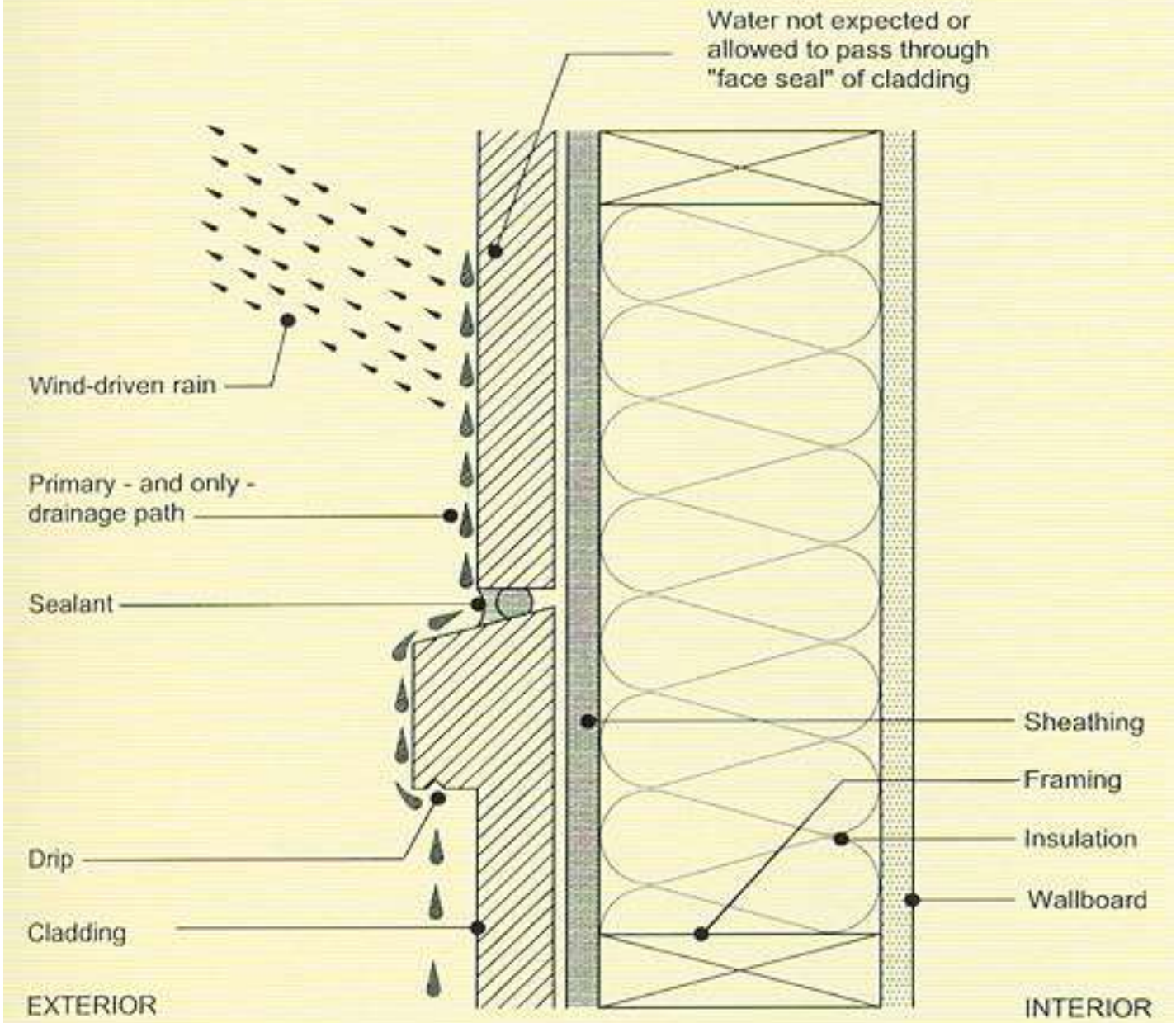
Steel Stud Wall Failures

Not limited to a wood frame construction

Water Barrier Types - Face Sealed Water Barrier

- Cladding is only barrier
- First and only line of defense
- Examples:
  - EIFS
  - Precast panels
  - Masonry mass wall

FIGURE 11: Face Seal Wall Assembly



Face Sealed Water Barrier

Face-Sealed Exterior Walls: least water resistant assembly

- Relies on sealant joints
- Unforgiving when water penetration occurs
- Reliable only in very dry climates/locations.

Low Slope Roofs: ultimate example of barrier design

- Minimum joints
- Layered approach
- Limited penetration
- Slope pitched toward drain

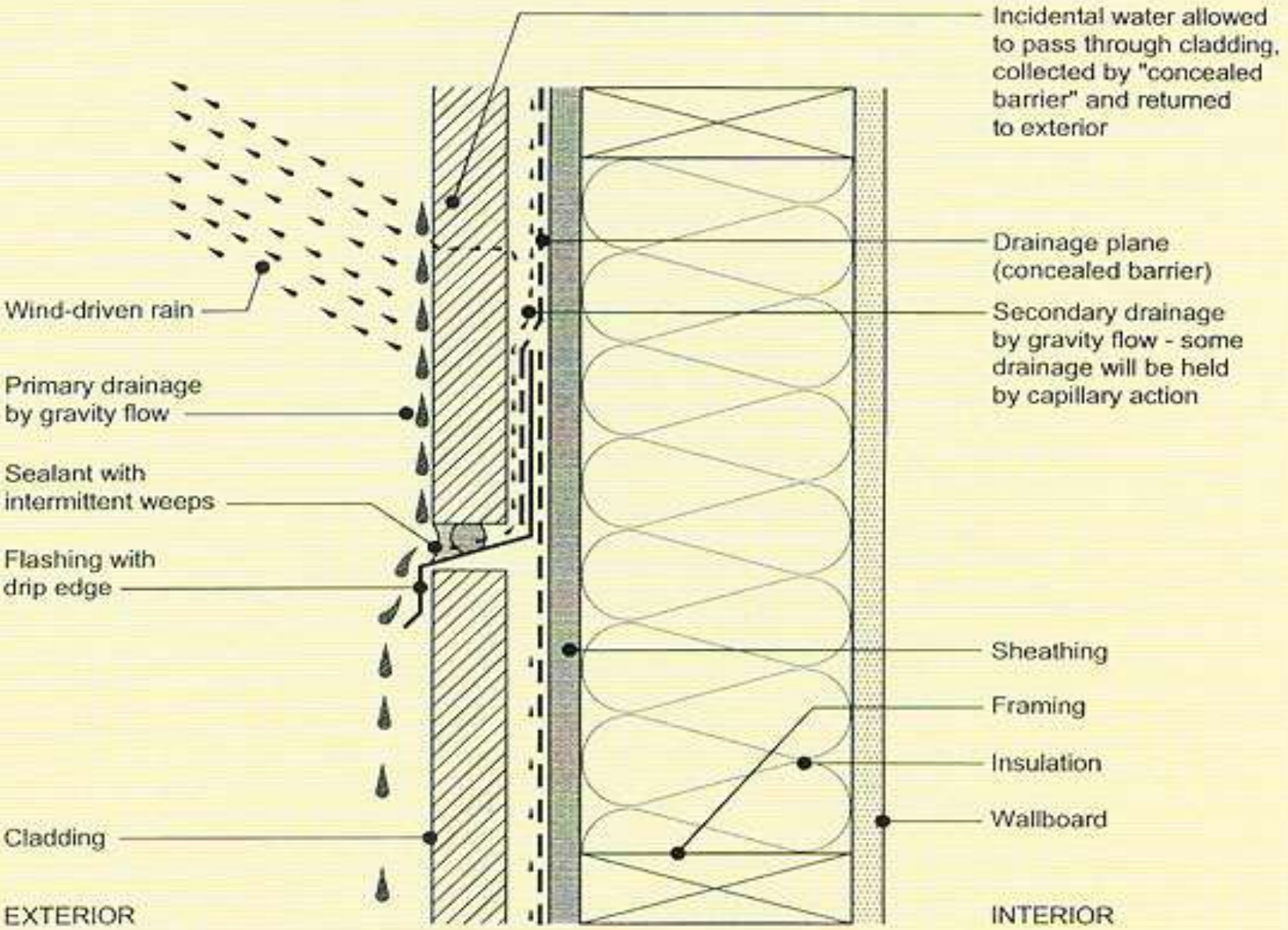
Storage or Mass Wall:

- Oldest strategy
- Relies on absorption and evaporation
- Can be suitable for all climates or locations
- Main limitation is joints and interfaces.

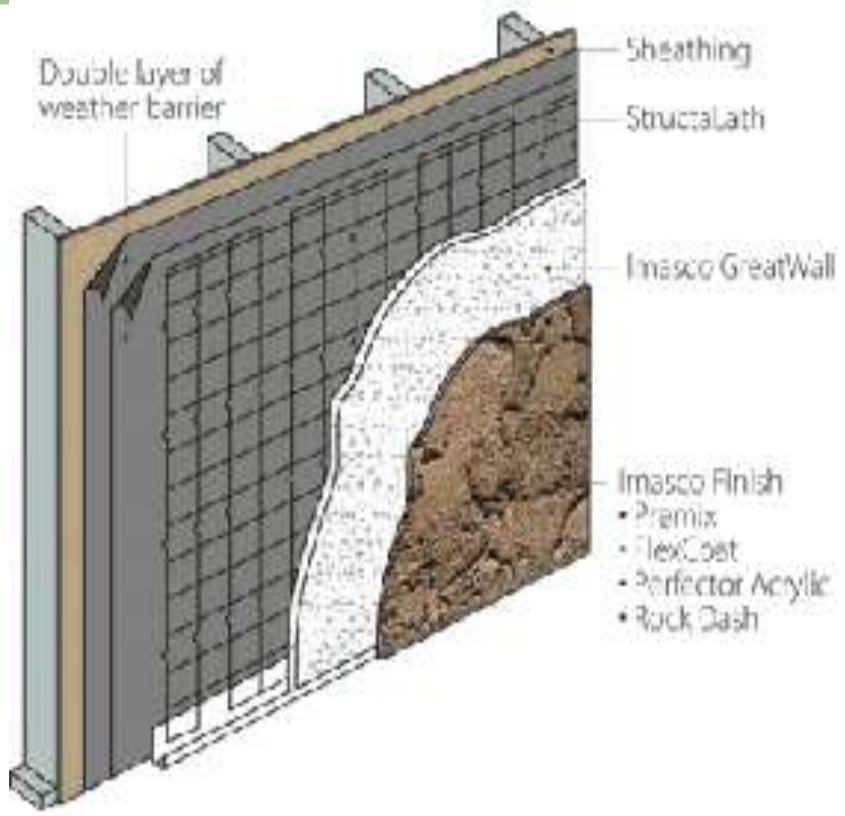
2. Concealed Water Barrier

- Uses a WRB membrane touching cladding
  - Weather Resistive Barrier
- Non-absorbent claddings:
  - Vinyl siding, metal siding
  - Use at walls with low or medium exposure
- Absorbent claddings:
  - Cladding in contact with WRB
  - stucco, wood, fiber-cement siding
  - Use at walls with low exposure only

FIGURE 12: Concealed Barrier Wall Assembly



Concealed Water Barrier

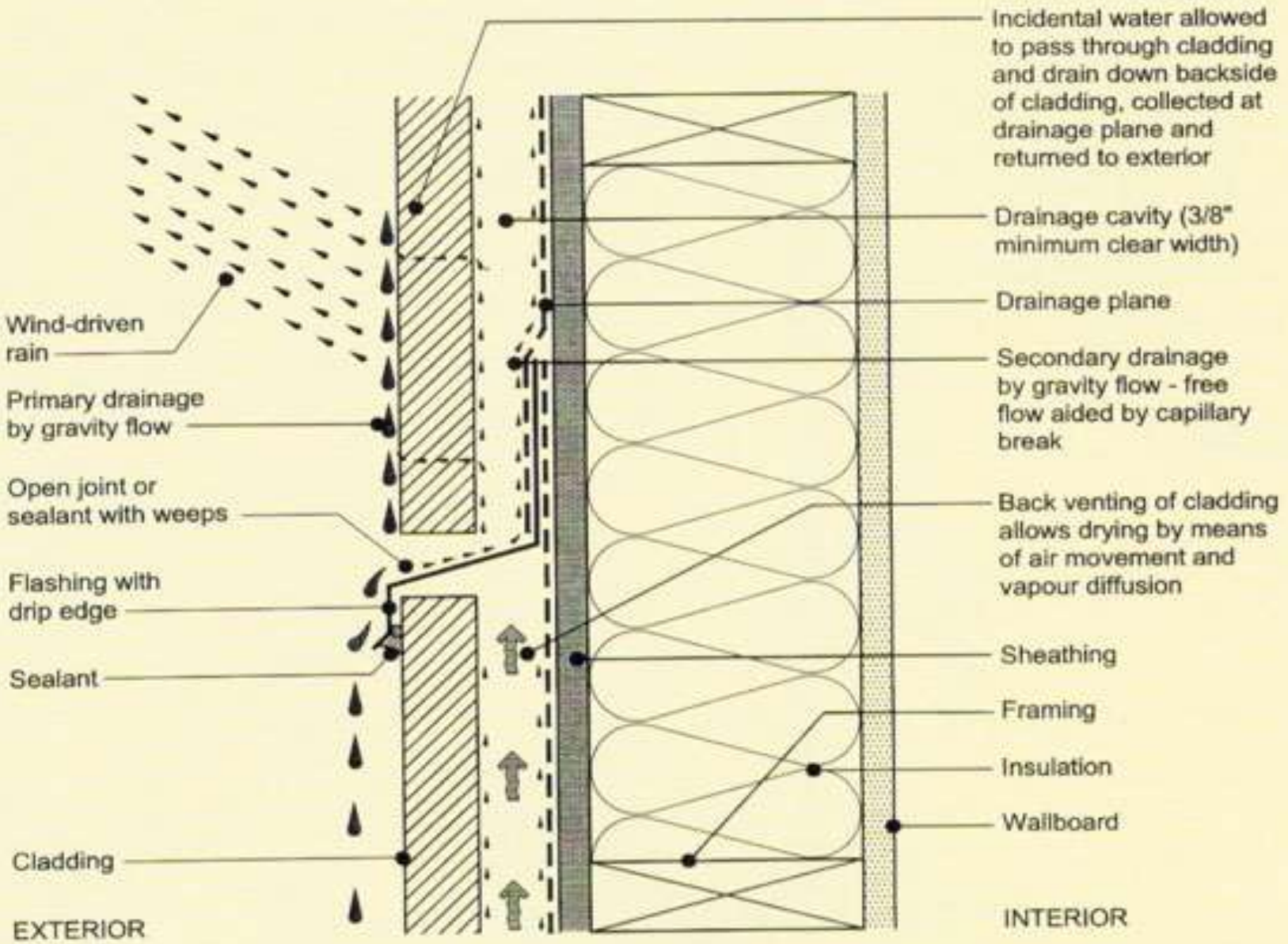


Moisture damage resulting in corrosion and failure of attachments

3. Ventilated Concealed Water Barrier

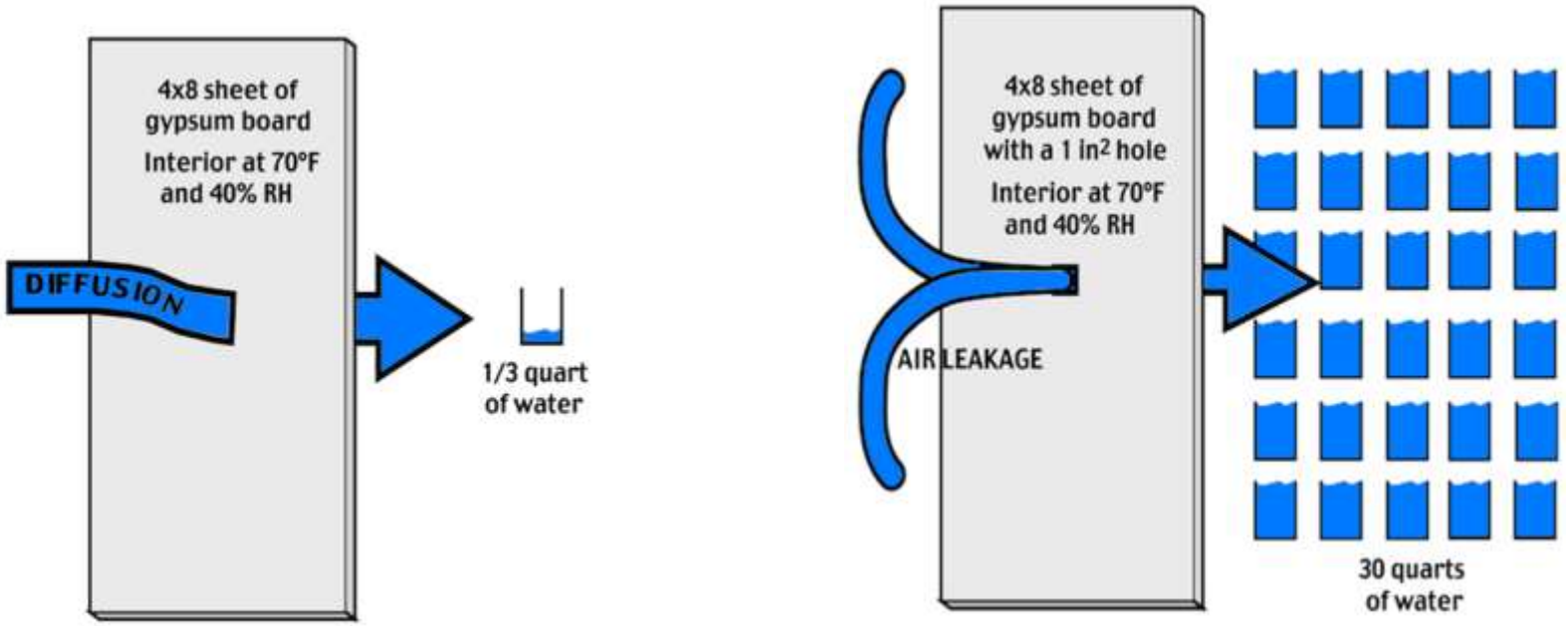
- Include drainage cavity (airspace) between cladding and drainage plane
- Airspace should be 3/8” for drainage, 1/2” or more for ventilation
- aka – Rainscreen Wall

FIGURE 13: Rainscreen Wall Assembly



Air Leakage Control

Vapor Diffusion vs. Air Leakage



Air Leakage Problems

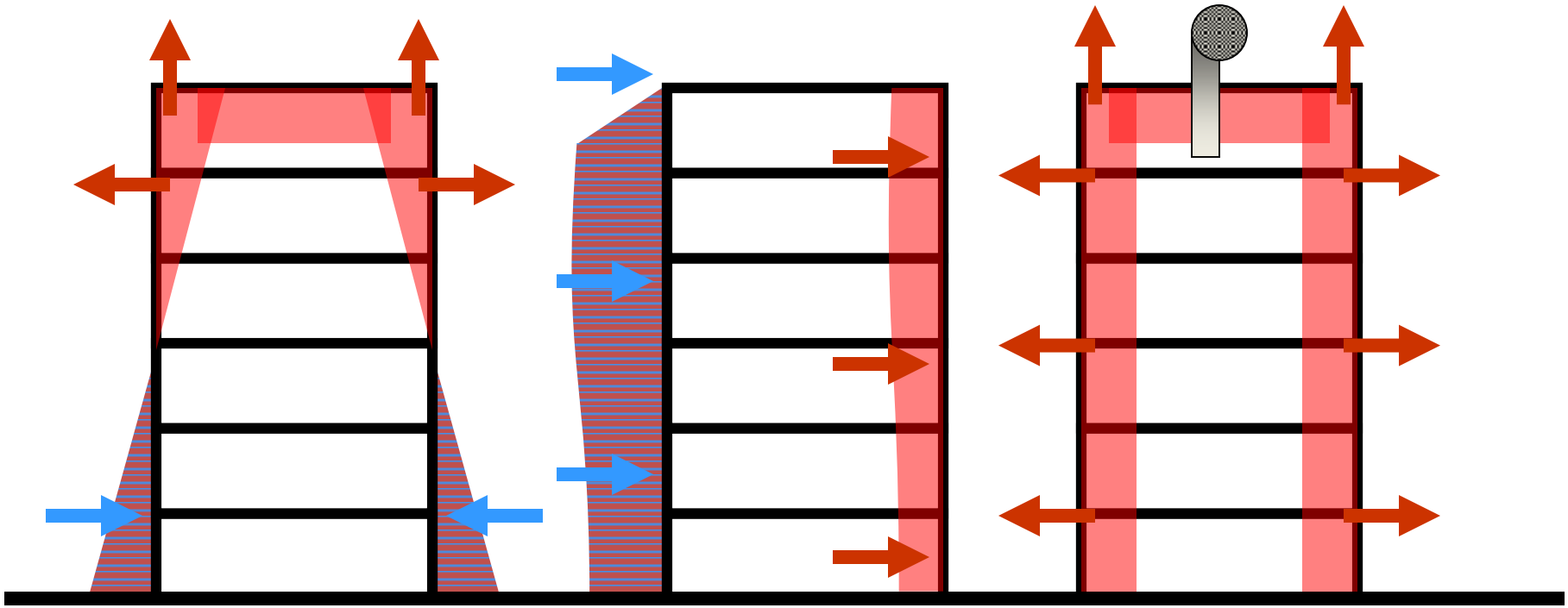
Wood Framed Party Wall Air Exfiltration

Wood Rot & Moisture-Induced Deterioration

Air Leakage Problems

Failure at Seams of Air Barrier

Air Pressure Difference



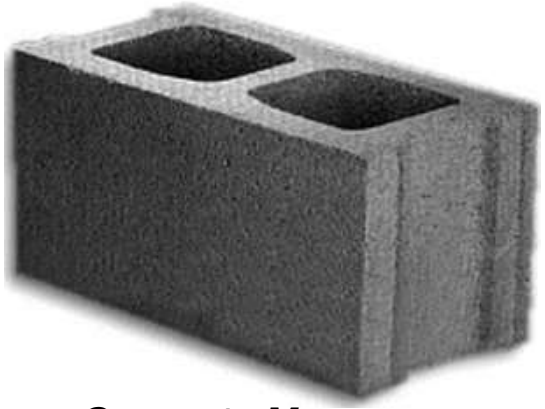
Stack Effect **Wind** **Mechanical Pressurization**

Thermal Barrier

- *R-value measures resistance*
- *Rarely includes thermal bridging or three dimensional heat flow*

Polyisocyanurate

R5.5-7.0



Concrete Masonry Units

R0.12-0.40

Mineral Wool

R4.2

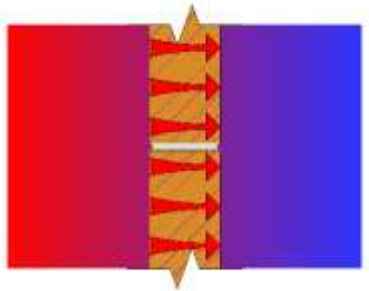
Gypsum Wallboard

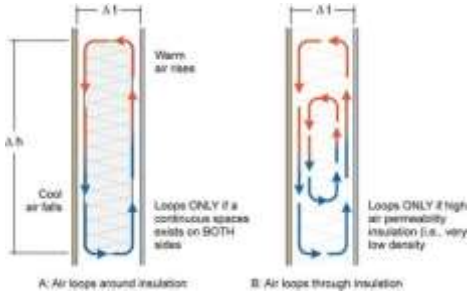
R0.32-0.56

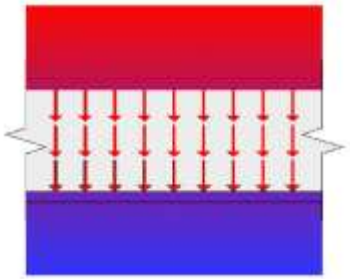
Heat Transfer

Heat travels into a building through three methods.

- Conduction (thermal bridge)
- Convection (air leakage)
- Radiation







Thermal Problems

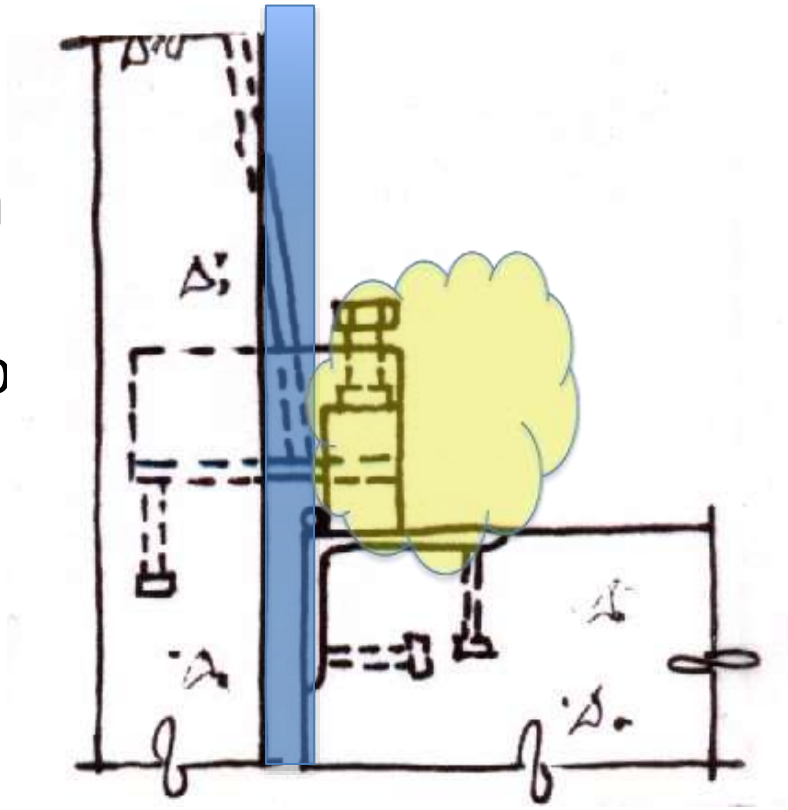
- Stud shadowing on inner and outer faces

Thermal Problems

- **Surface Mold Growth**

Isolating Thermal Bridges

- Some thermal bridges cannot be avoided
- Three options
  - Encapsulate in airtight insulation i.e. spray foam
  - Insulate with airtight insulation to a point beyond likely dew point
  - Increase heat flow to thermal bridge to minimize risk of condensation



Vapor Barrier (Retarder)

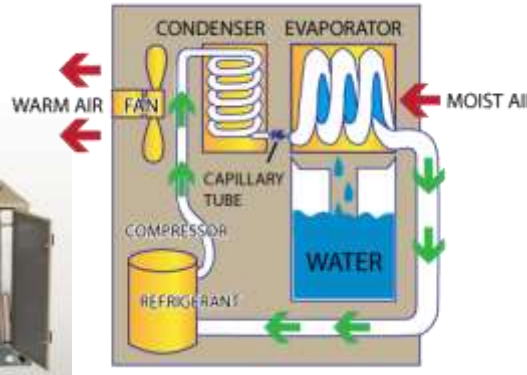
Internal Humidity Source

Purpose of Vapor Retarder: Prevent humidity (water vapor) from reaching cold surfaces and condensing inside the wall

Humidity Removal

Mechanical

- Spot Ventilation
- Dehumidification
- Air Conditioning



Passive

- Occurs when air contacts a surface colder than the dew point
- Occurs on a cold interior surface and interstitial surface (within an envelope assembly) just as it does on your car at night

Consequence of Poor Control

- Vapor diffusion leading to condensation behind vinyl wall paper in air conditioned interiors in a hot humid climate.

Controlling Movement of Humidity

Vapor Retarder

Impermeable (no drying)

- Class I: Permeance ≤ 0.1 Perms

Polyethylene films, Aluminum foil & sheet metal, Elastomeric membranes, Bituminous or rubber membranes, Extruded polystyrene, Oil based paints, Glass

Semi-Impermeable (minimal drying)

- Class II: Permeance 0.1 ≤ 1.0 Perms

Semi-Permeable

- Permeance ≤ 10 Perms

Plywood & OSB sheathing, Expanded polystyrene (bead board), Fiber-faced isocyanurate insulation, Heavy asphalt impregnated papers, Latex based paints

Permeable

- Permeance > 10 Perms

Unpainted gypsum wallboard, Un-faced fiberglass insulation, Unpainted stucco or cement sheathing, Lightweight asphalt impregnated paper, Spun bonded polyolefin house wraps

Questions?

BECx Design Review

- Purpose
  - To identify performance, durability of constructability concerns in the design stage as well as meeting the Owner's Project Requirements.
- Contractual Clients
  - Owners
  - Architects
  - Contractors
- Other Clients
  - Future owners
  - Authorities Having Jurisdiction
  - Insurers/Warranty Providers

BECx Design Review

- Typical Scope
  - Environmental Separations
    - Roofs and decks over conditioned space
    - Opaque Walls
    - Glazing
    - At grade waterproofing
    - Below grade walls
    - Slabs on Grade
  - Other Waterproofing
    - Balconies
    - Canopies
    - Suspended slabs on underground parking areas

Considerations

- Elements proving control of Heat, Air and Moisture flows
- Allowance for relative movement of structure and enclosure element
- Durability
- Constructability
- Understanding structural attachment

Process

- Understand the design intent(s) of space and each enclosure system
- Understand the geometry of the building and use of each enclosure system
- Review all transition details thinking in 2D then 3D
- Identify missing details
- Transmit Information to Design Team on behalf of the Owner

Understanding the Intent

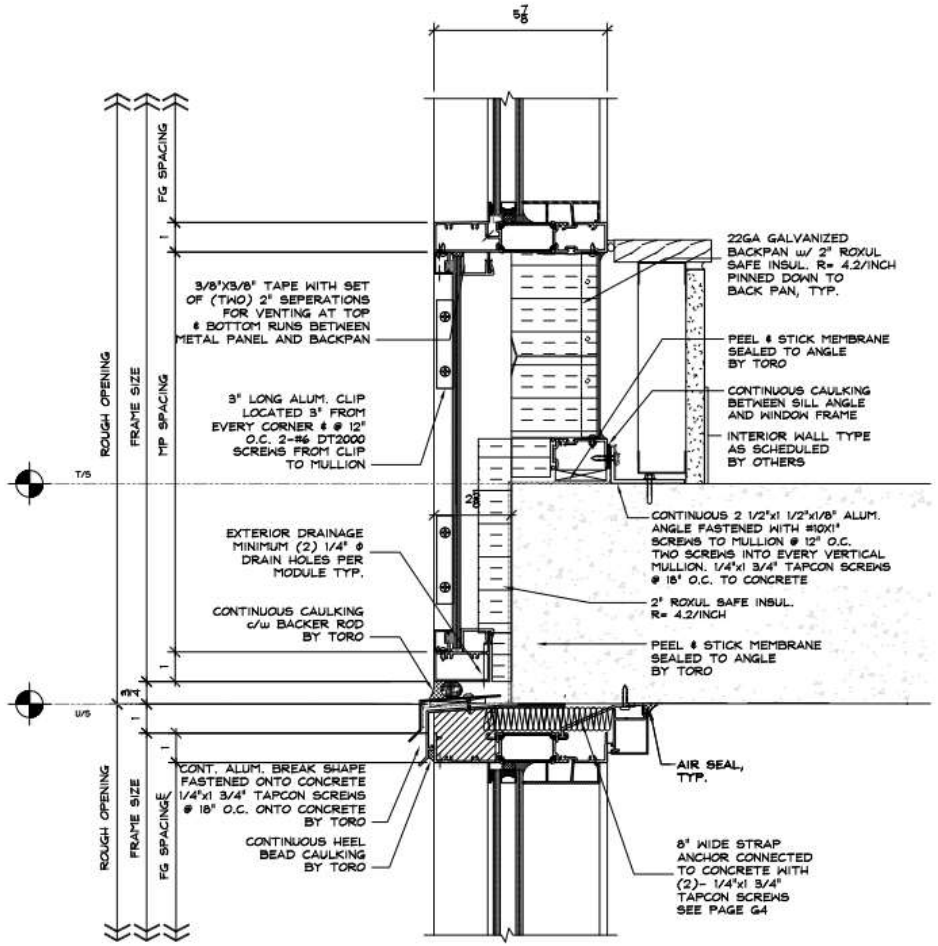
- Of the Building
  - Understand the interior and exterior environmental conditions and exposures
  - Be aware of any special requirements

- Of the Enclosure Assemblies
  - Plane of air tightness
  - Rain shedding approach
  - Last line of defense against moisture entry
  - Mechanism for removal of incidental moisture

Initial Drawing Review:

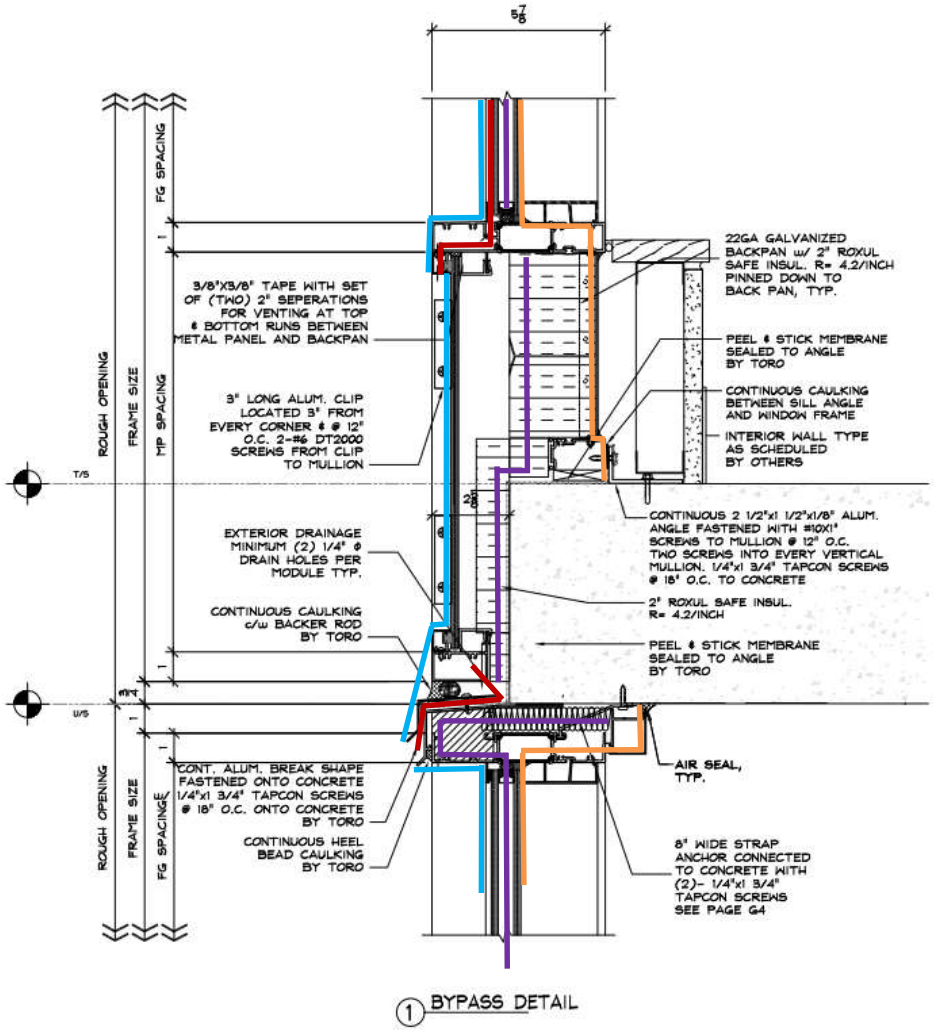
- Review plans, elevations and sections to understand geometry
  - Conditioned and unconditioned spaces
  - Changes in floor plan creating horizontal enclosure elements
  - Changes in systems used
  - Slopes on all horizontal surfaces
  - Location of drains, scuppers, and weep holes
  - Unprotected doors
  - Problematic details
    - Balcony edges
    - Curbs into walls
    - Through wall flashing and shelf-angles
    - Expansion and control joints

Window-wall head/sill detail A



1 BYPASS DETAIL

Window-wall head/sill detail A



1 BYPASS DETAIL

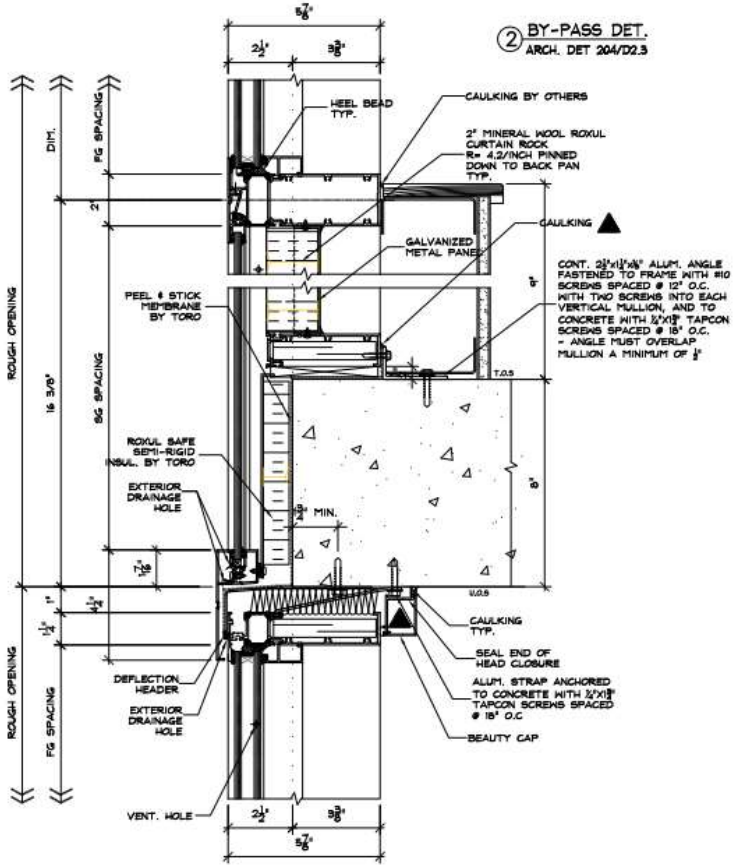
Primary water

Secondary water

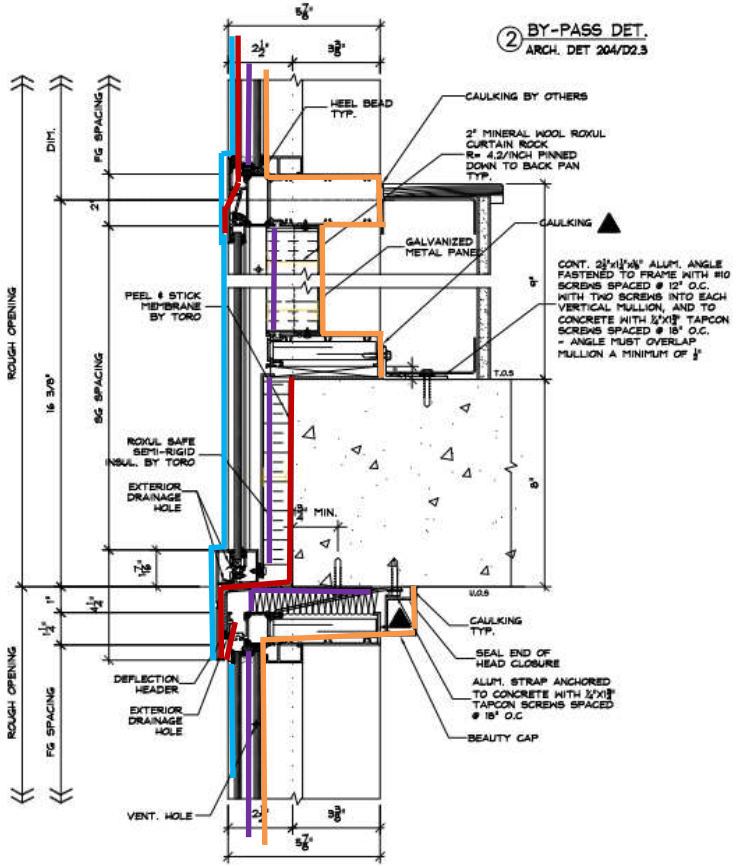
Air

Thermal

Window-wall head/sill detail B



Window-wall head/sill detail B



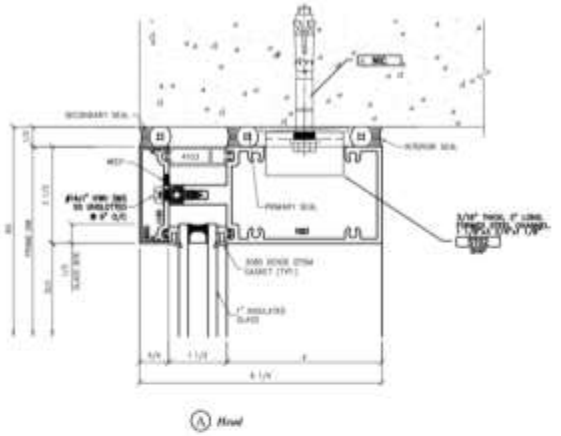
Primary water

Secondary water

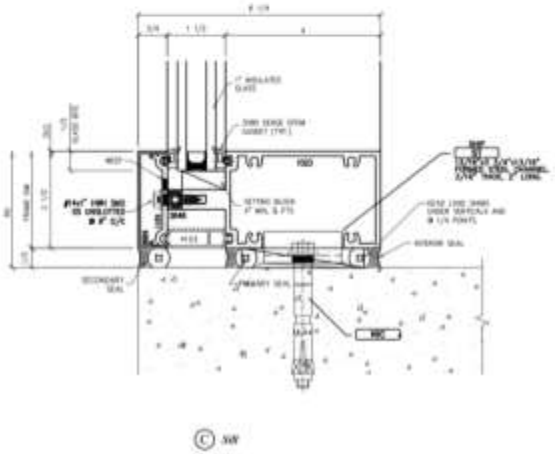
Air

Thermal

Window-wall head/sill detail C

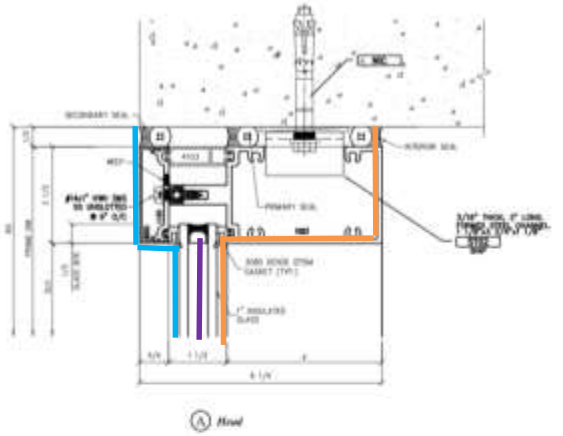


Ⓐ Head



Ⓒ Sill

Window-wall head/sill detail C



Primary water

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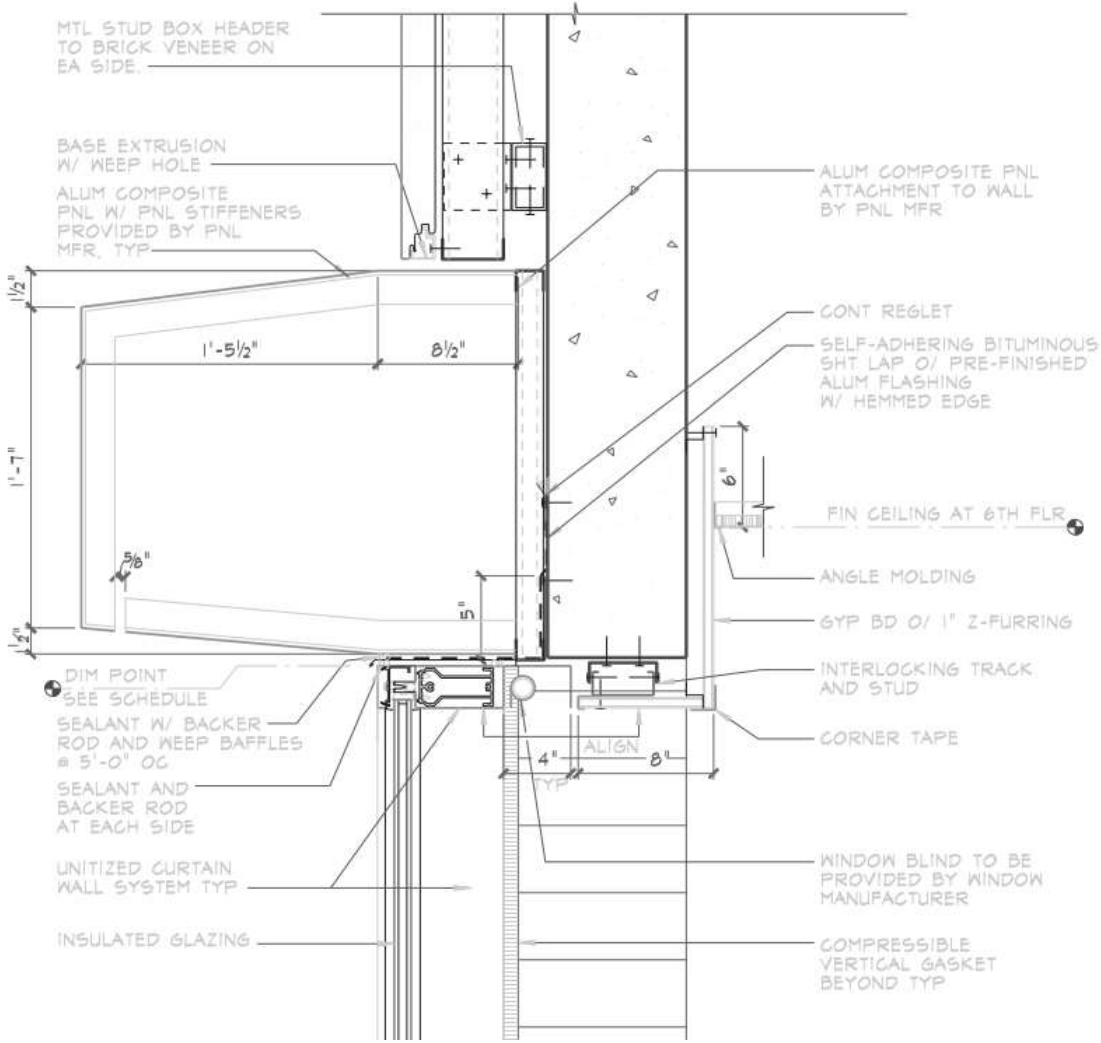
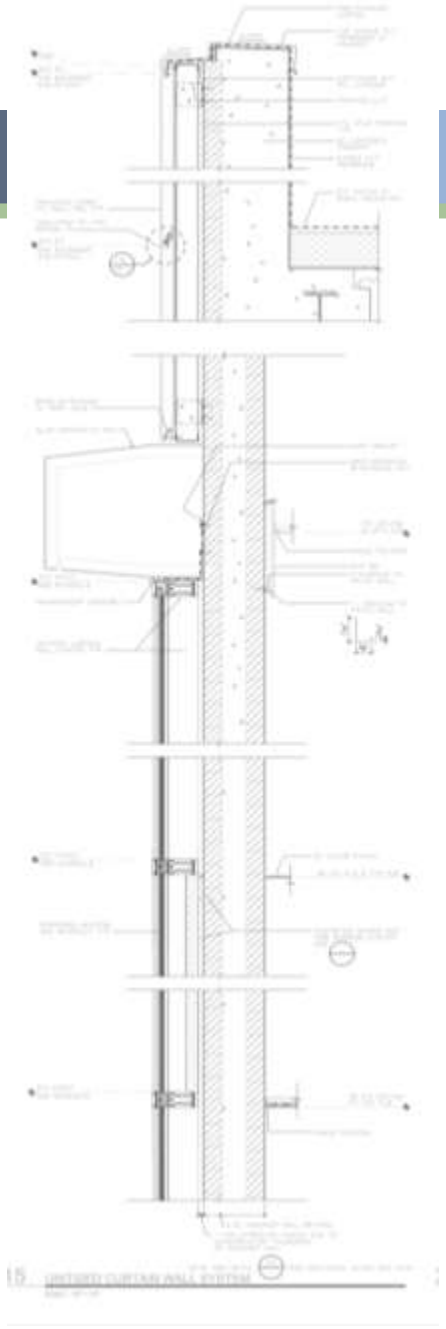
Thermal

Barrier Continuity





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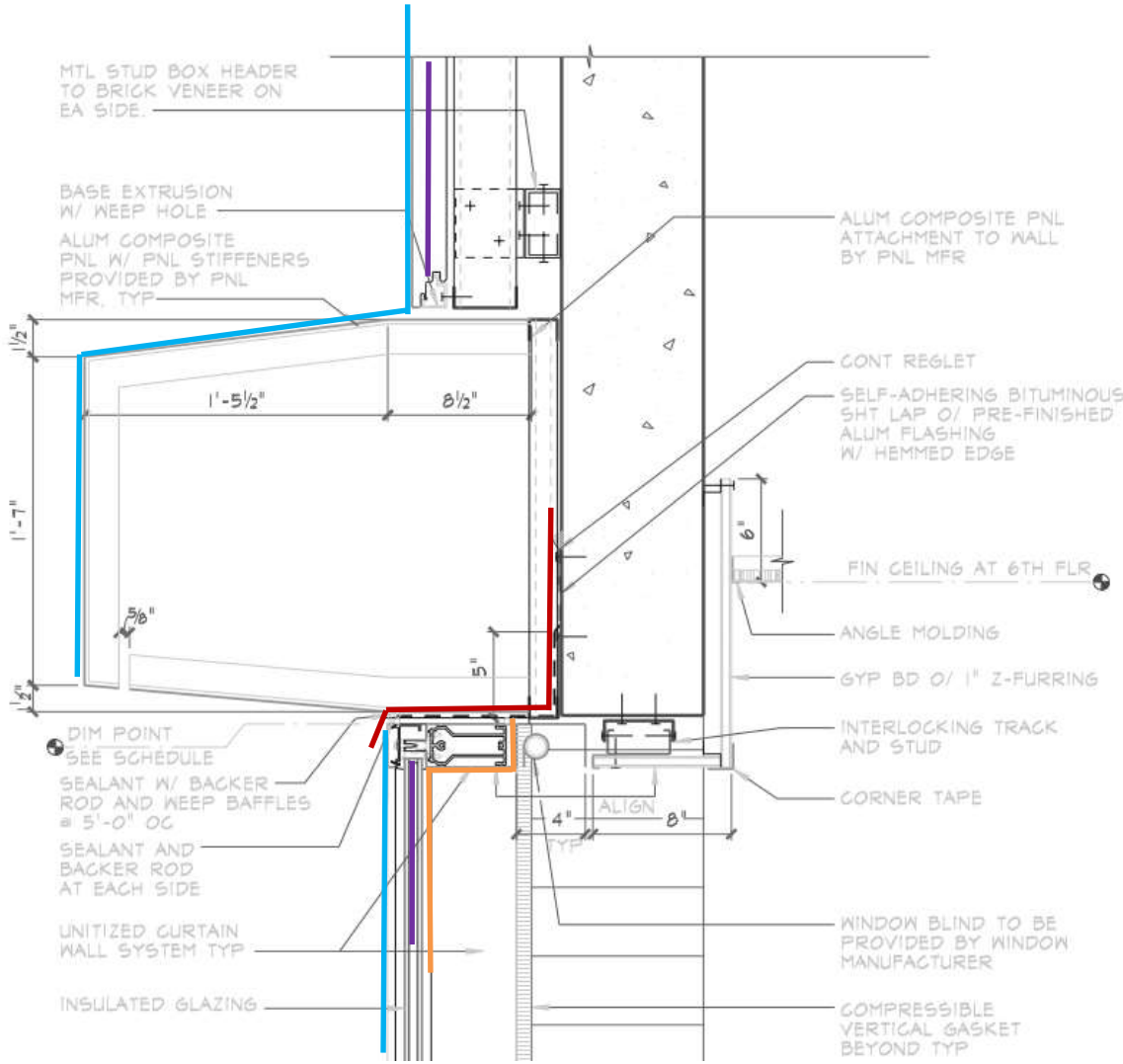

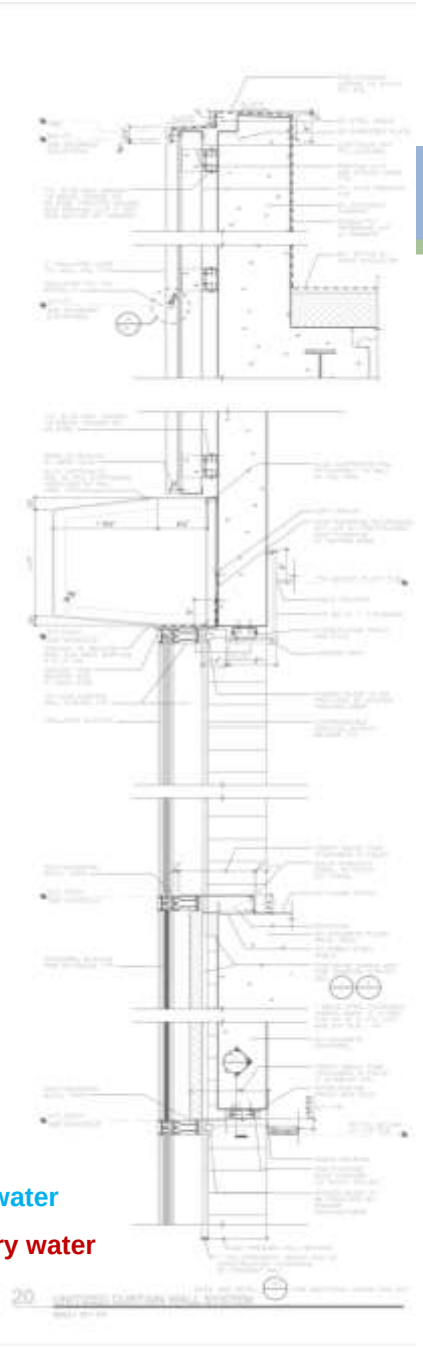

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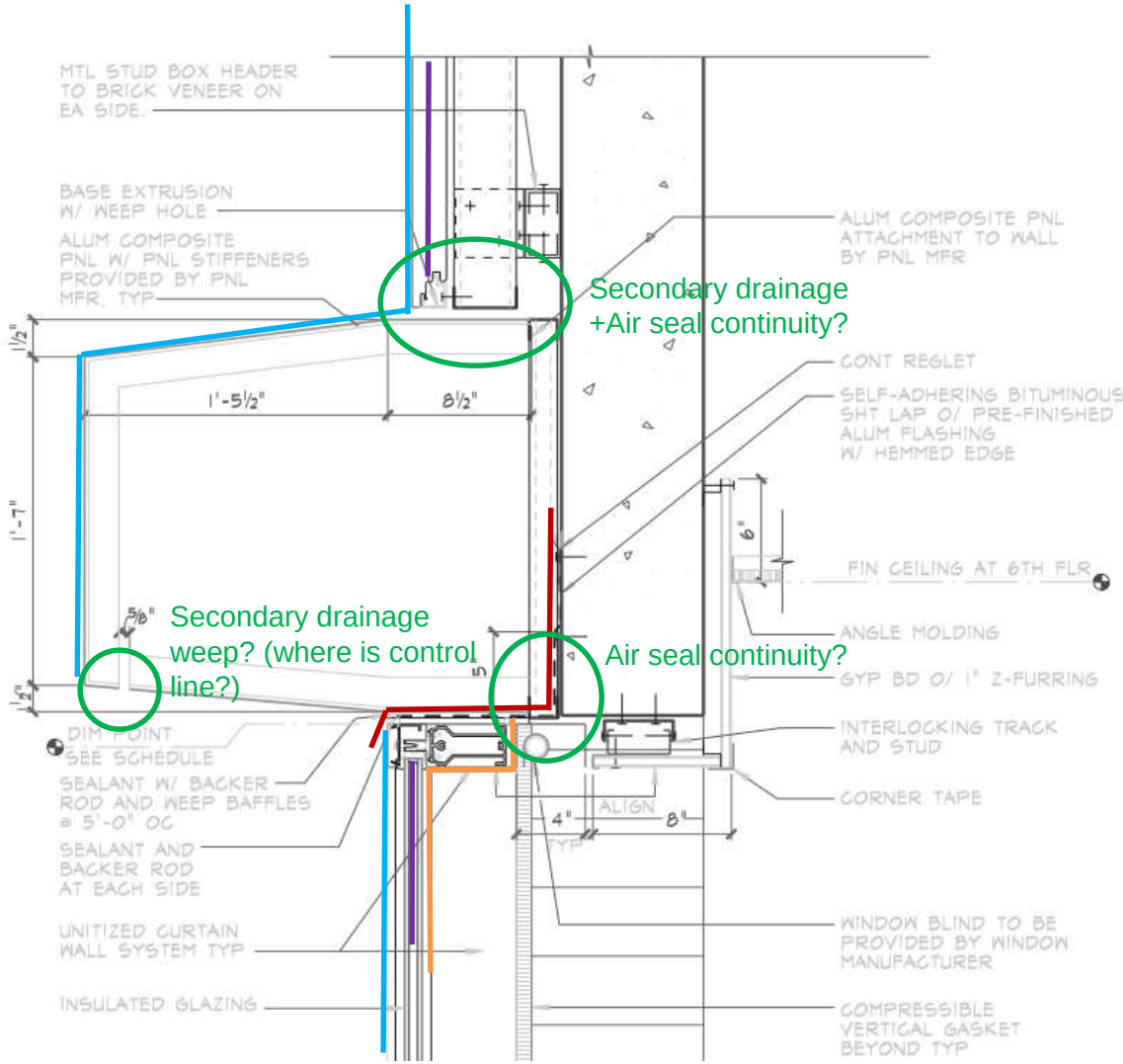

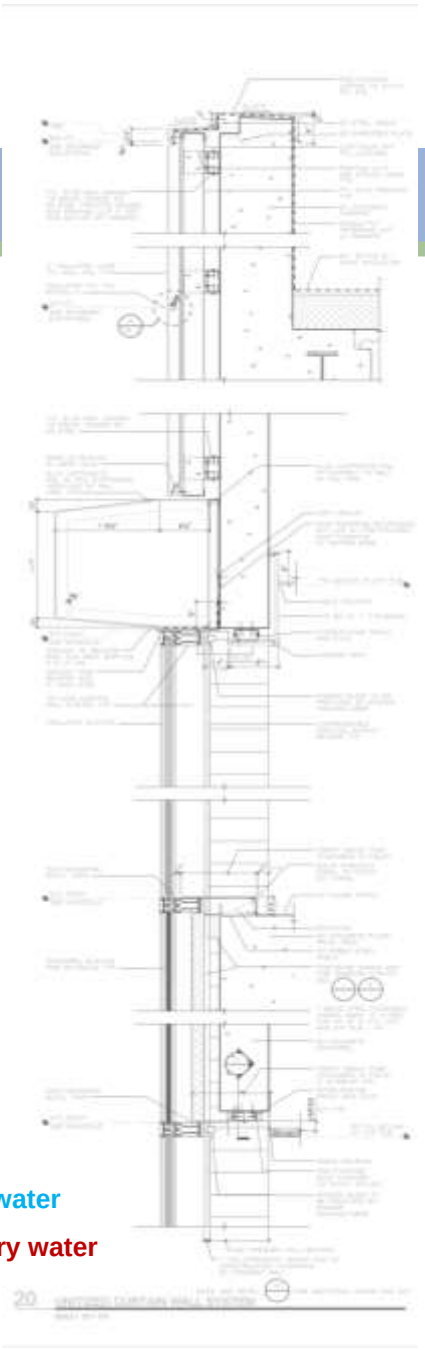

Primary water

Secondary water

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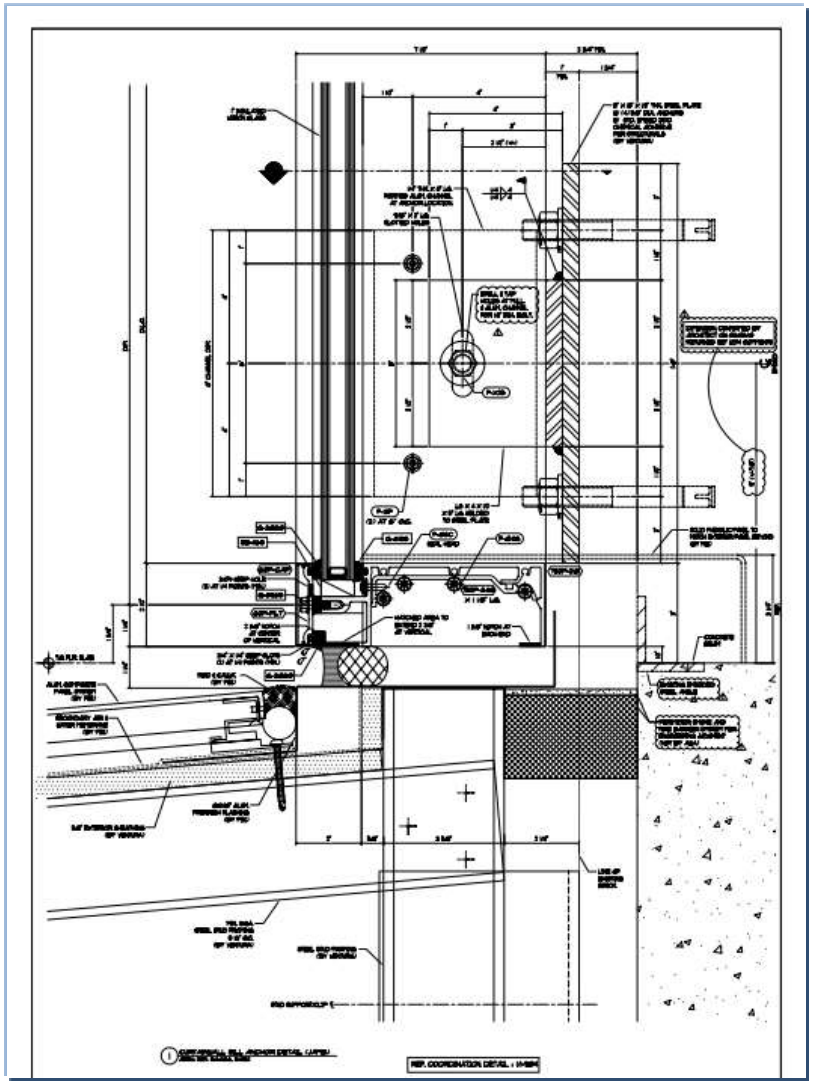
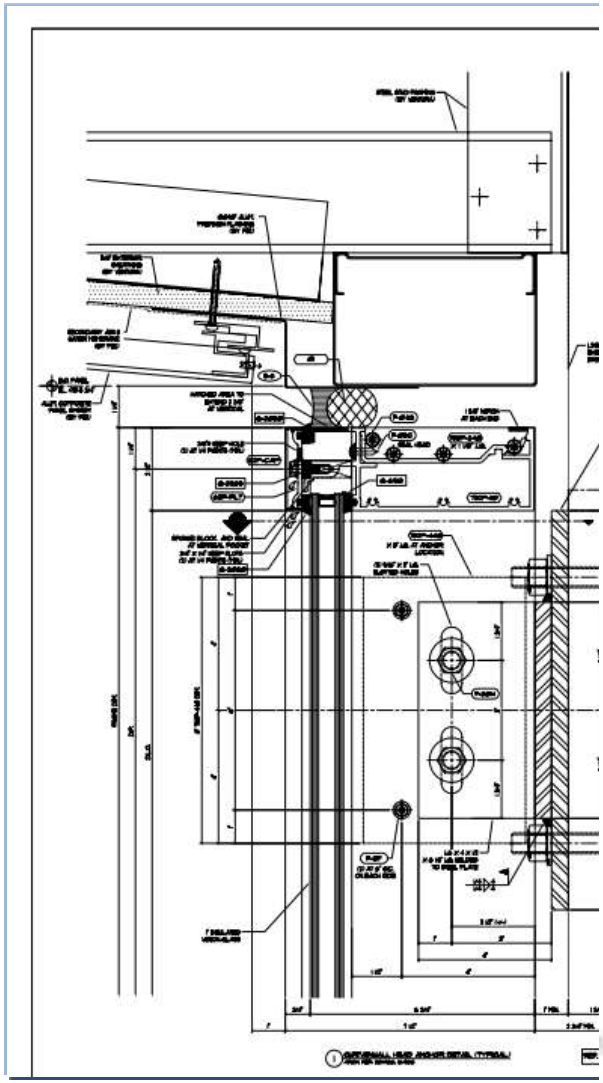
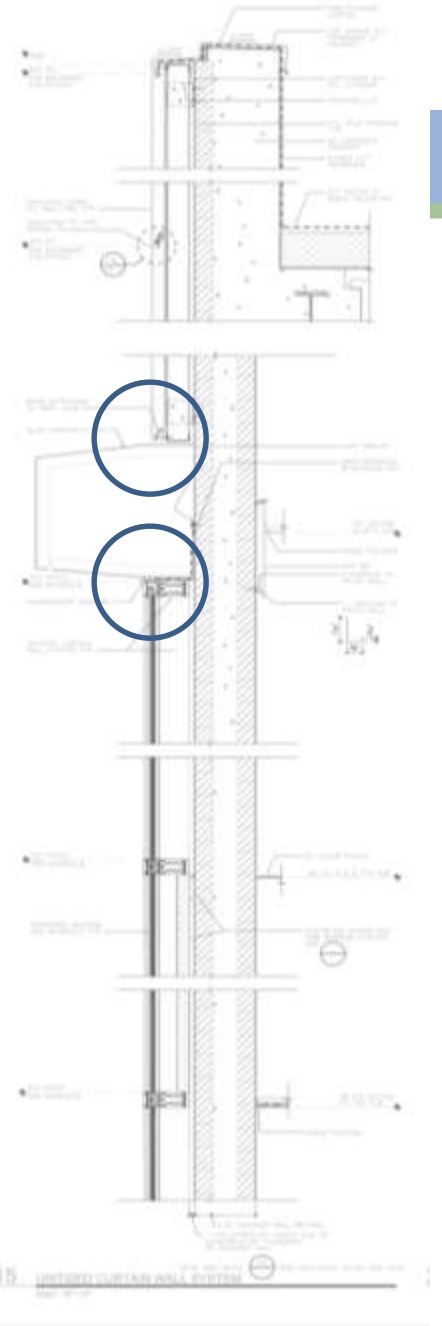
Thermal

Shop Drawings







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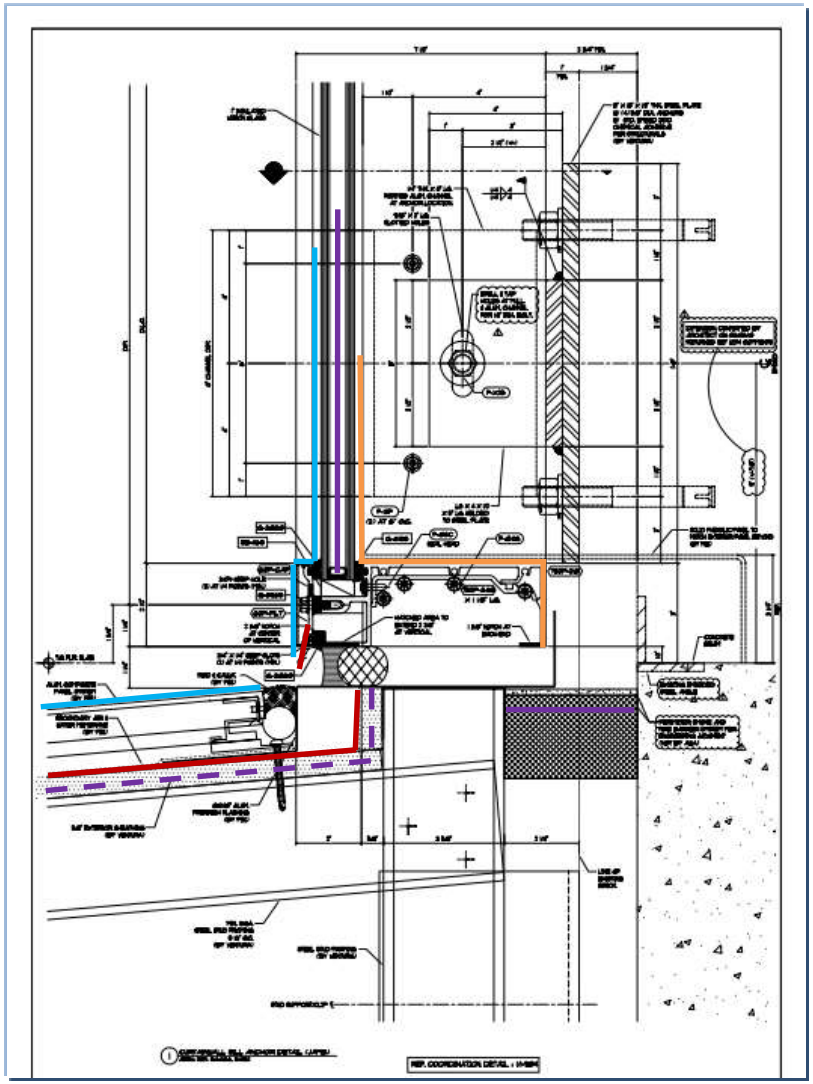

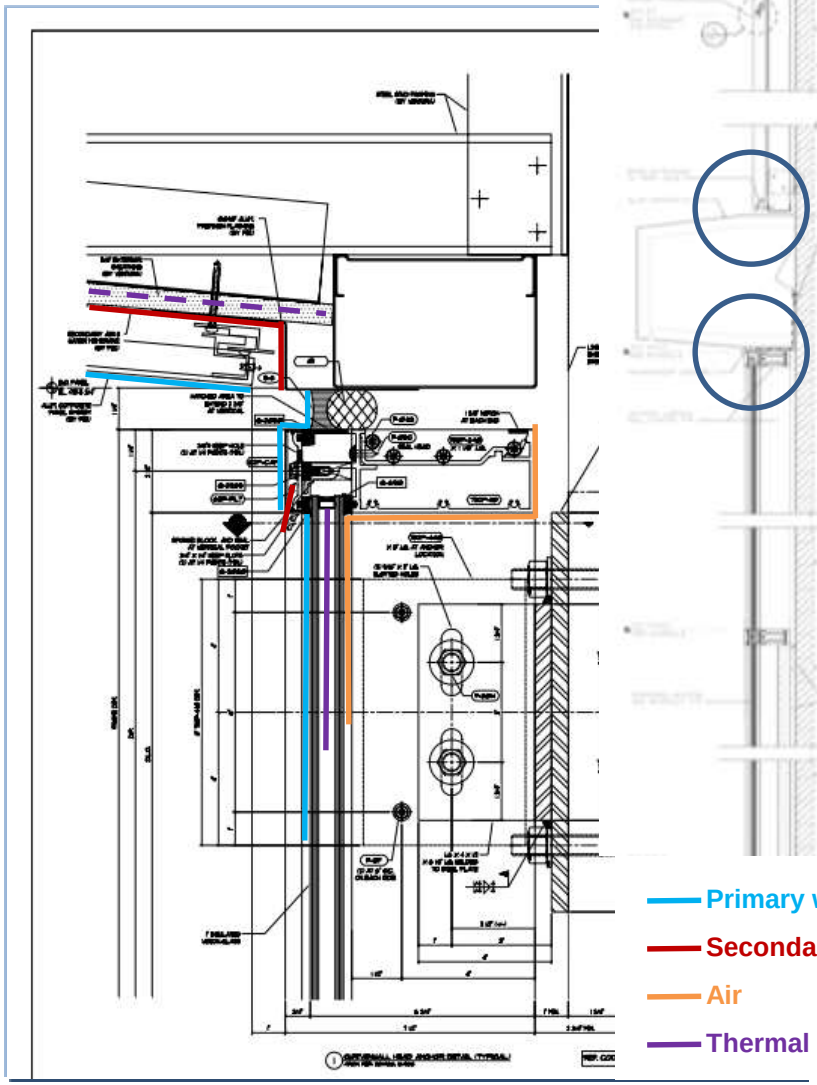

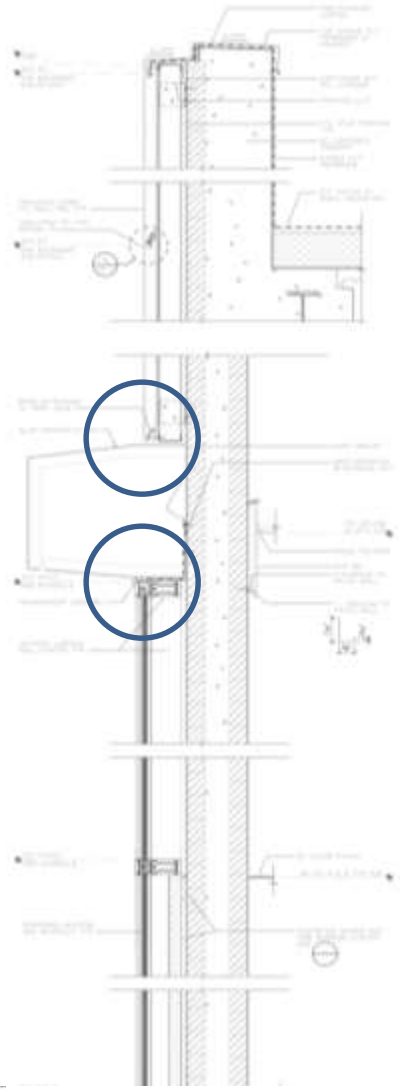

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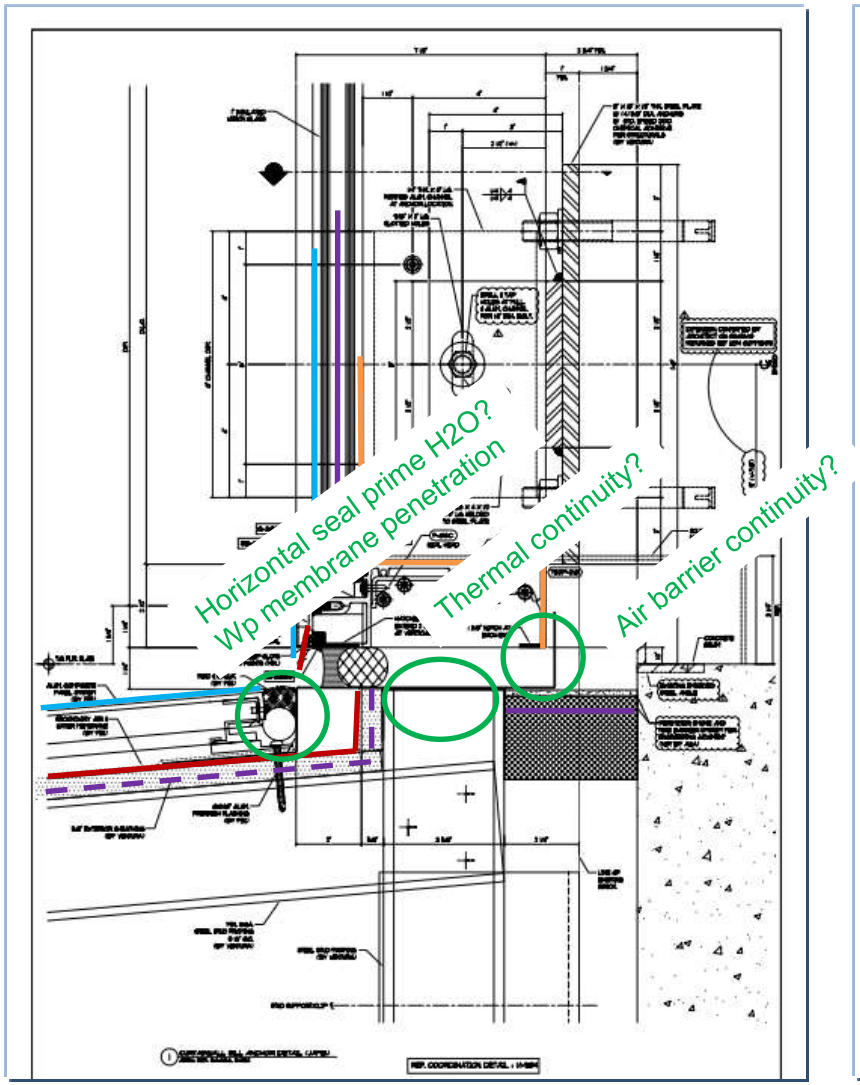
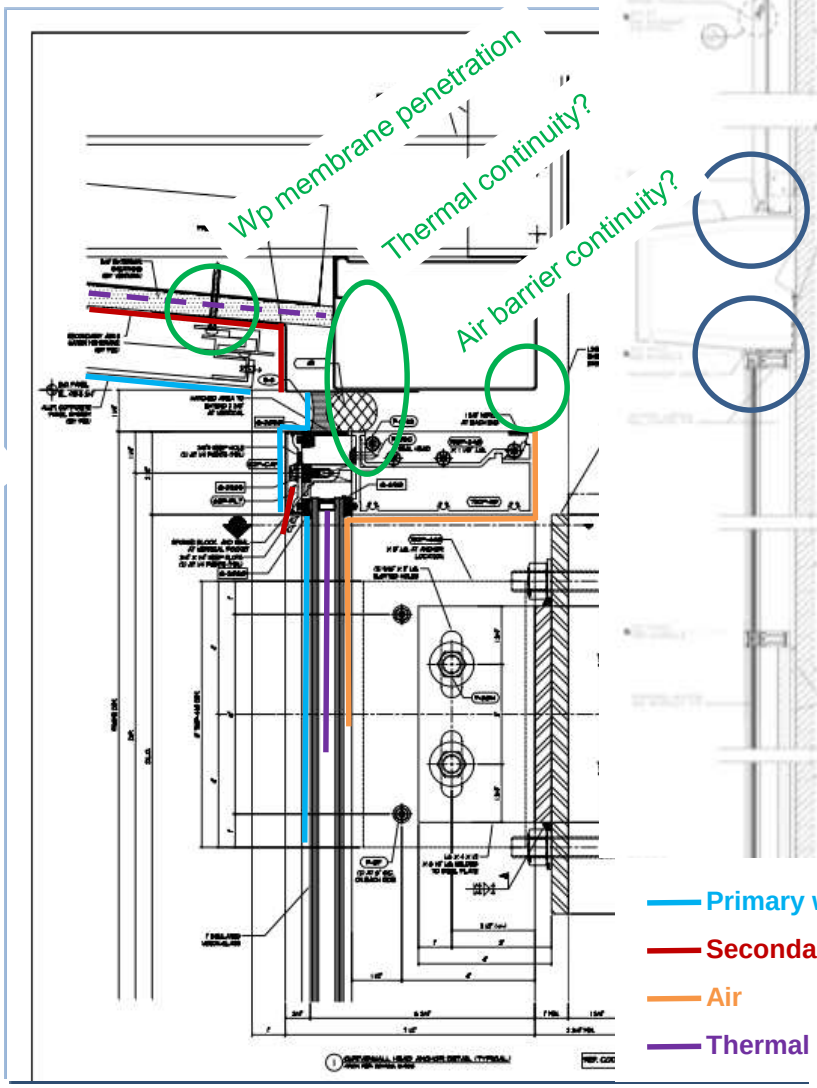
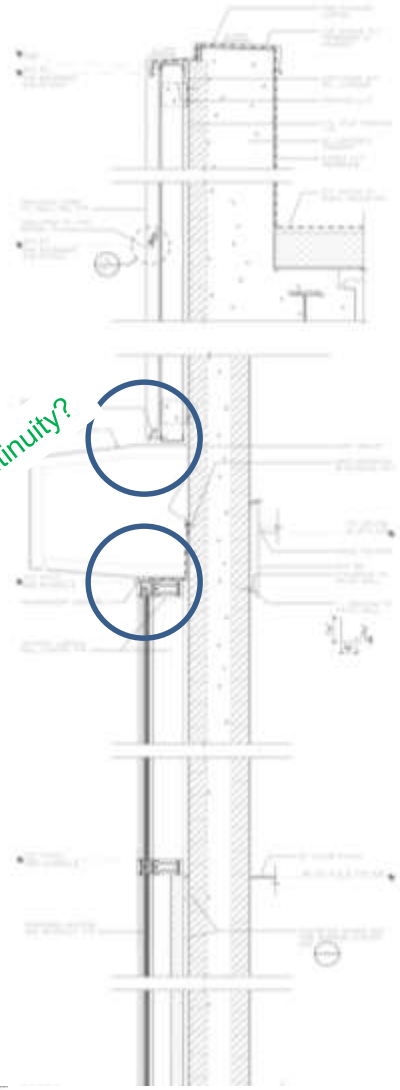
Thermal

Shop Drawings







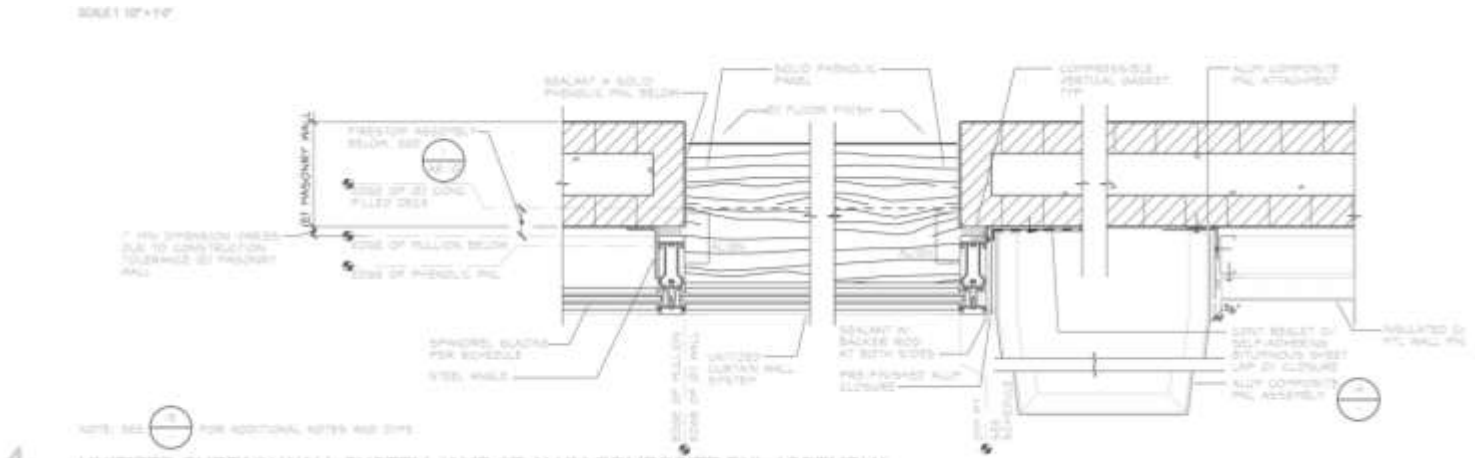
Primary water

Secondary water

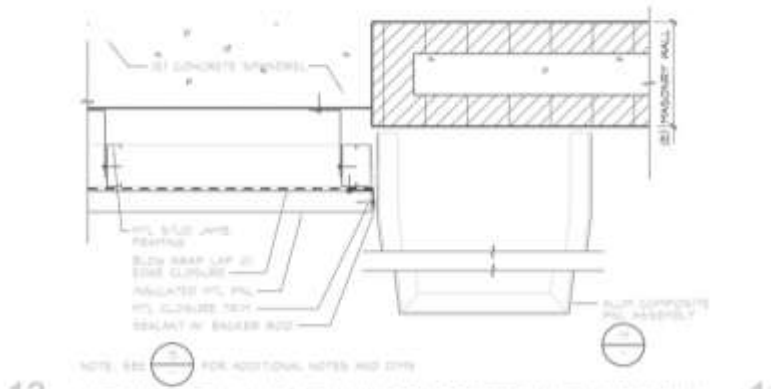
Air

Thermal

Barrier Continuity **(plan)**

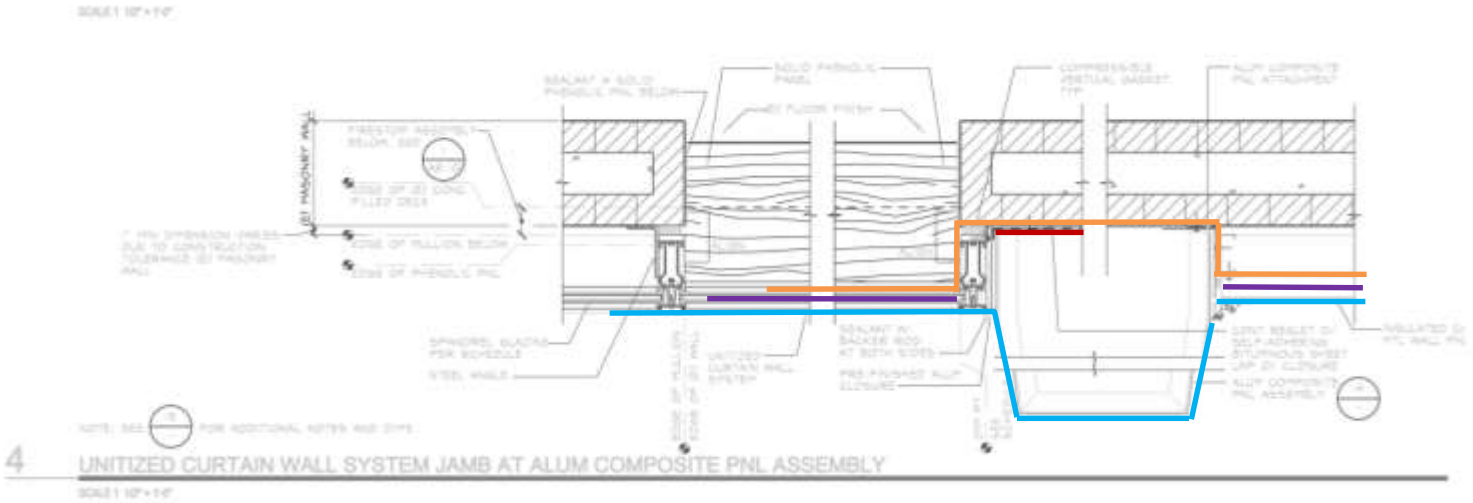


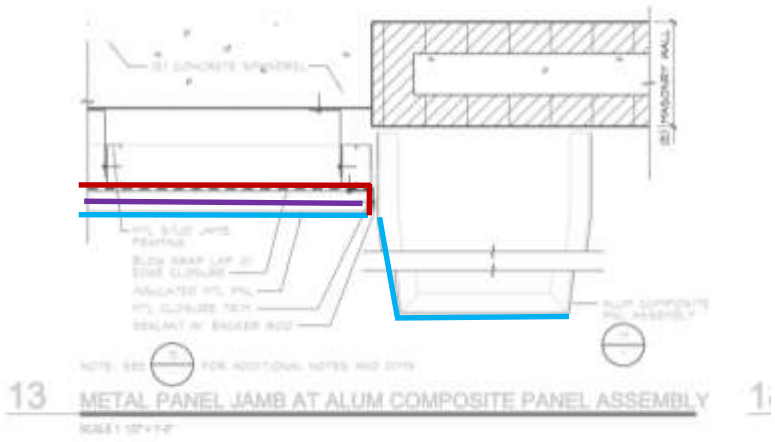
4 UNITIZED CURTAIN WALL SYSTEM JAMB AT ALUM COMPOSITE PNL ASSEMBLY



13 METAL PANEL JAMB AT ALUM COMPOSITE PANEL ASSEMBLY

Barrier Continuity **(plan)**





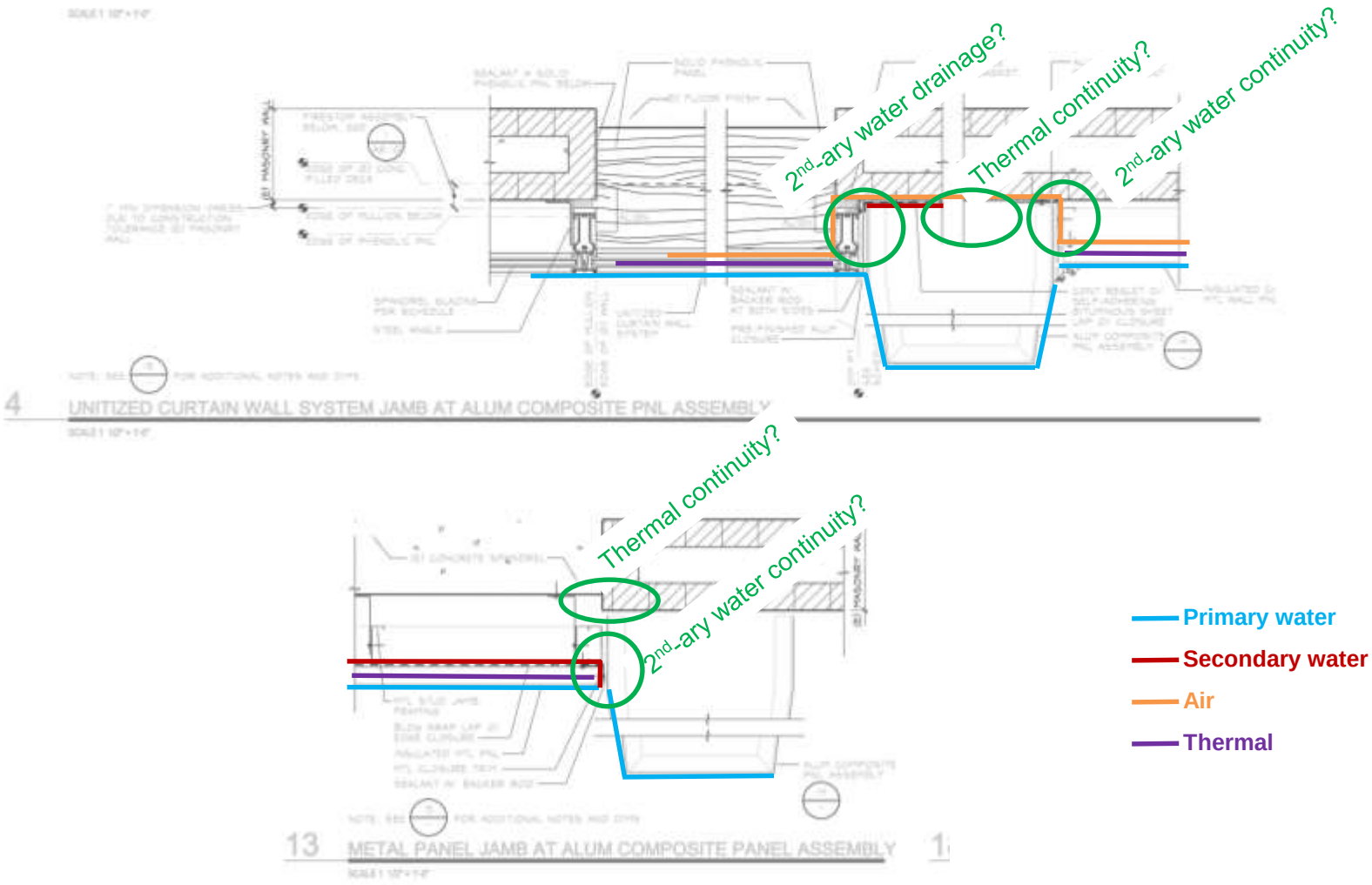
Primary water

Secondary water

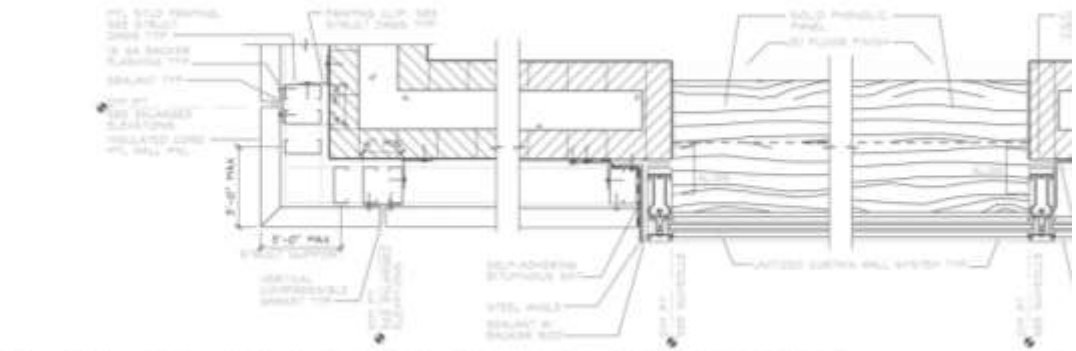
Air

Thermal

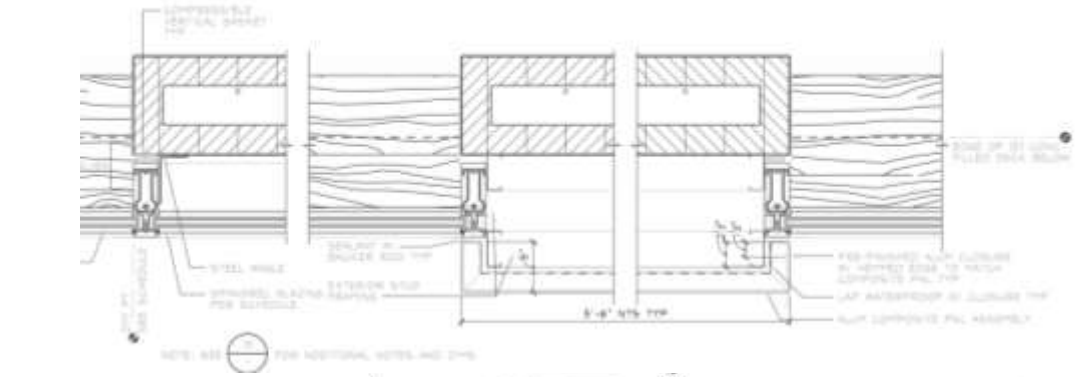
Barrier Continuity **(plan)**



Barrier Continuity **(plan)**

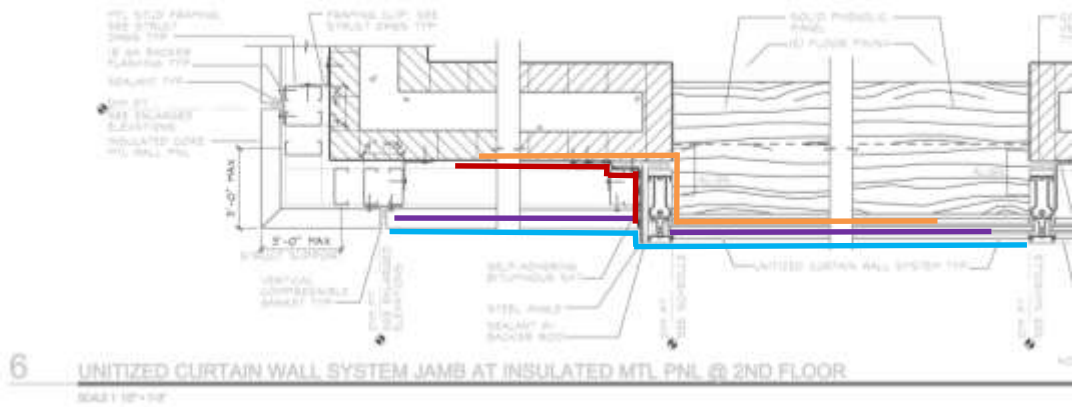


6 UNITIZED CURTAIN WALL SYSTEM JAMB AT INSULATED MTL PNL @ 2ND FLOOR

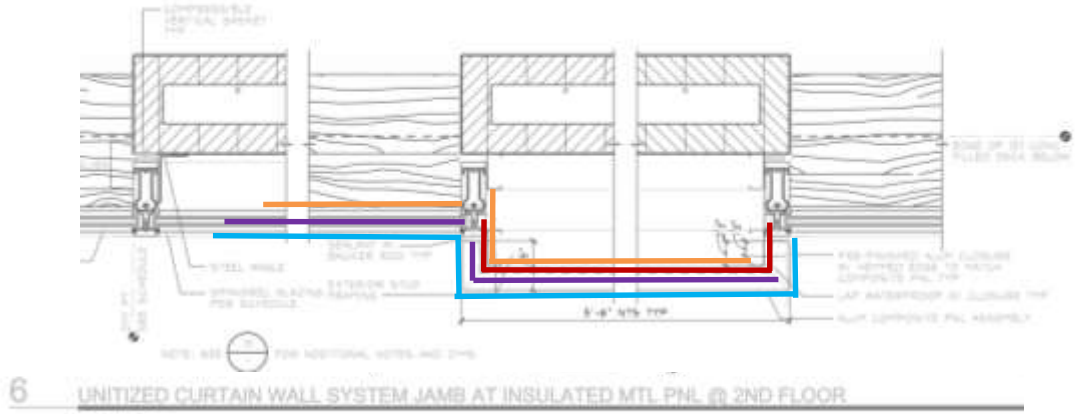


6 UNITIZED CURTAIN WALL SYSTEM JAMB AT INSULATED MTL PNL @ 2ND FLOOR

Barrier Continuity **(plan)**

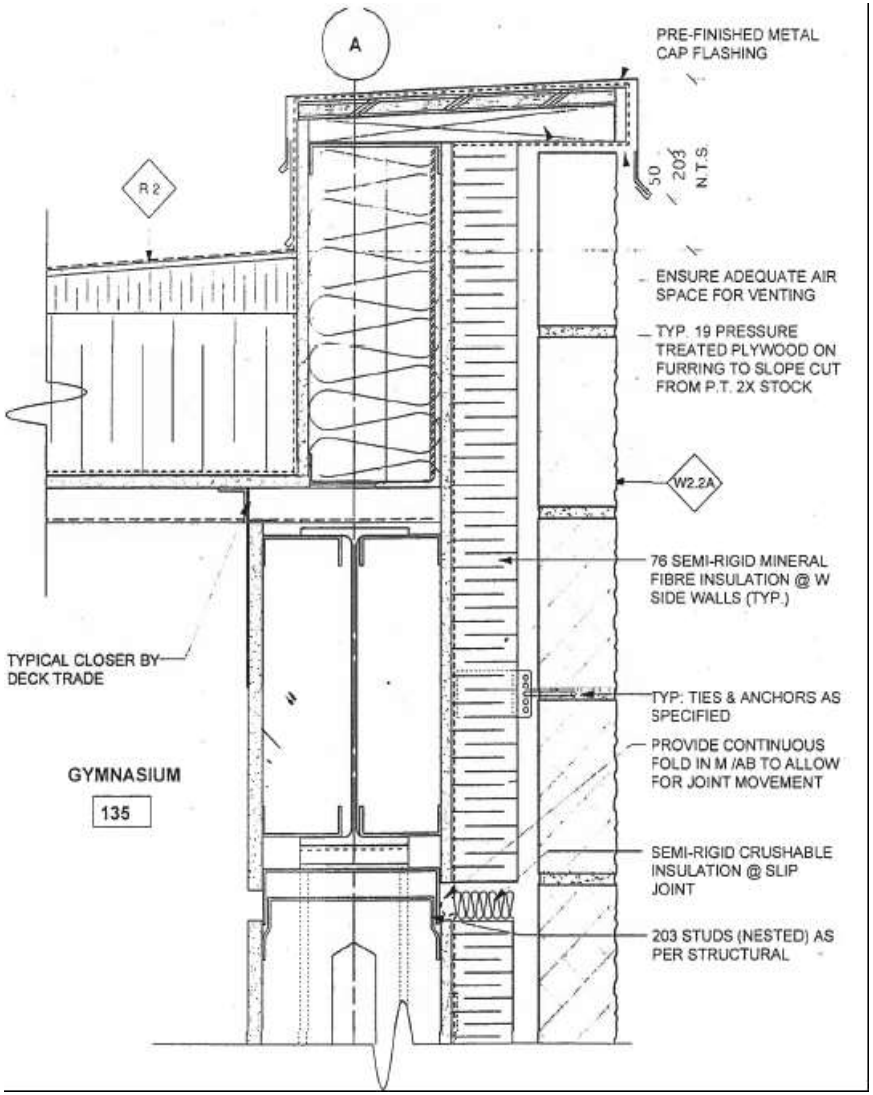


6 UNITIZED CURTAIN WALL SYSTEM JAMB AT INSULATED MTL PNL @ 2ND FLOOR

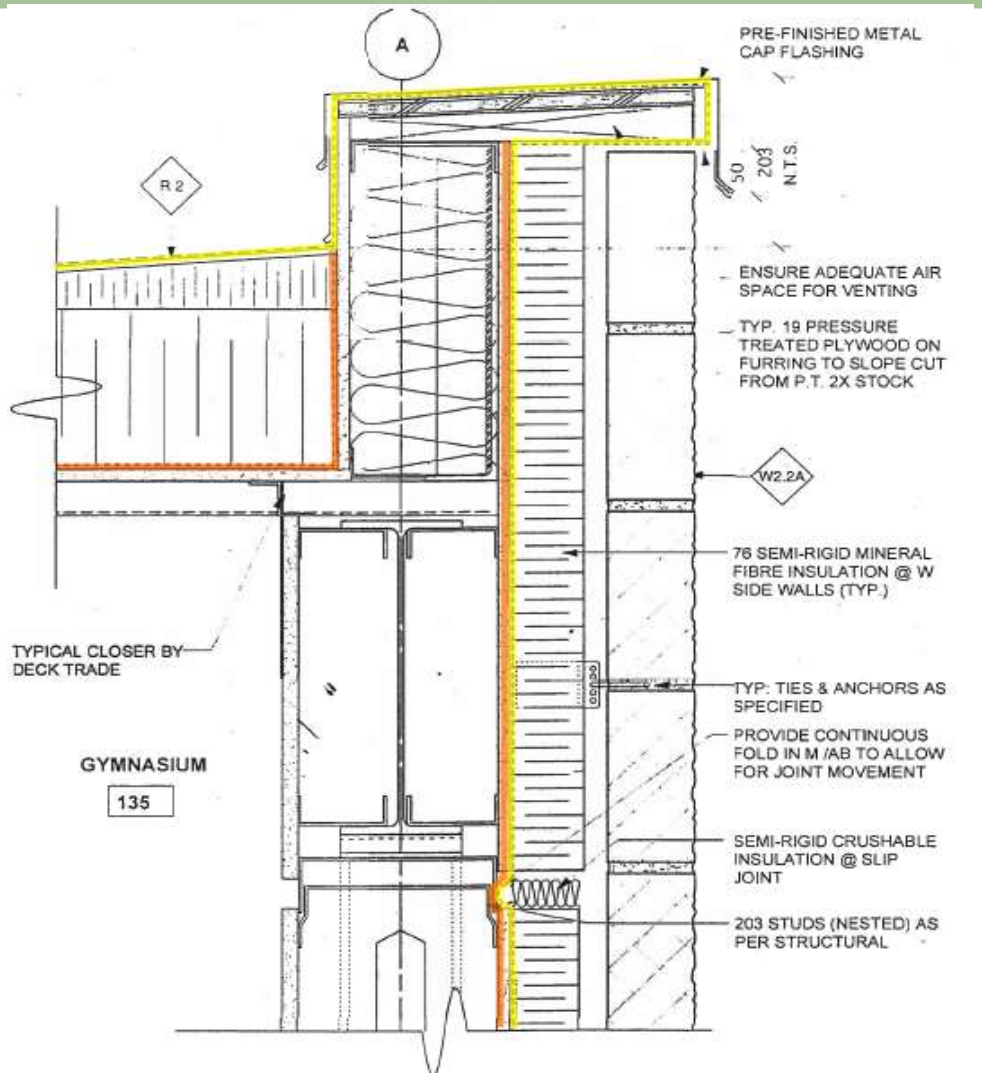


6 UNITIZED CURTAIN WALL SYSTEM JAMB AT INSULATED MTL PNL @ 2ND FLOOR

Parapet


A
R 2
PRE-FINISHED METAL CAP FLASHING
50
203
N.T.S
ENSURE ADEQUATE AIR SPACE FOR VENTING
TYP. 19 PRESSURE TREATED PLYWOOD ON FURRING TO SLOPE CUT FROM P.T. 2X STOCK
W2.2A
76 SEMI-RIGID MINERAL FIBRE INSULATION @ W SIDE WALLS (TYP.)
TYPICAL CLOSER BY DECK TRADE
TYP: TIES & ANCHORS AS SPECIFIED
PROVIDE CONTINUOUS FOLD IN M /AB TO ALLOW FOR JOINT MOVEMENT
GYMNASIUM
135
SEMI-RIGID CRUSHABLE INSULATION @ SLIP JOINT
203 STUDS (NESTED) AS PER STRUCTURAL

Parapet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PRE-FINISHED METAL CAP FLASHING
R 2
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203
N.T.S.
ENSURE ADEQUATE AIR SPACE FOR VENTING
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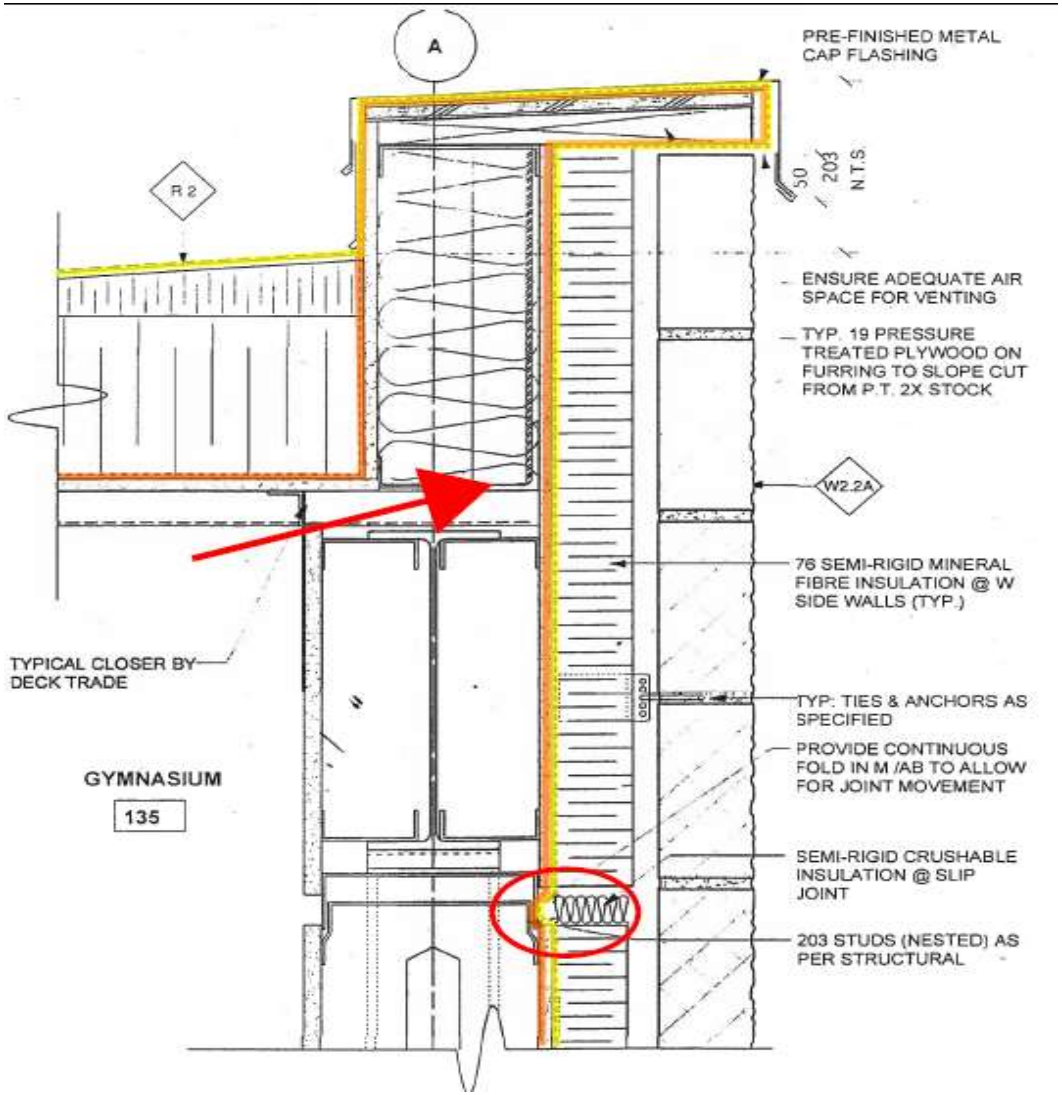
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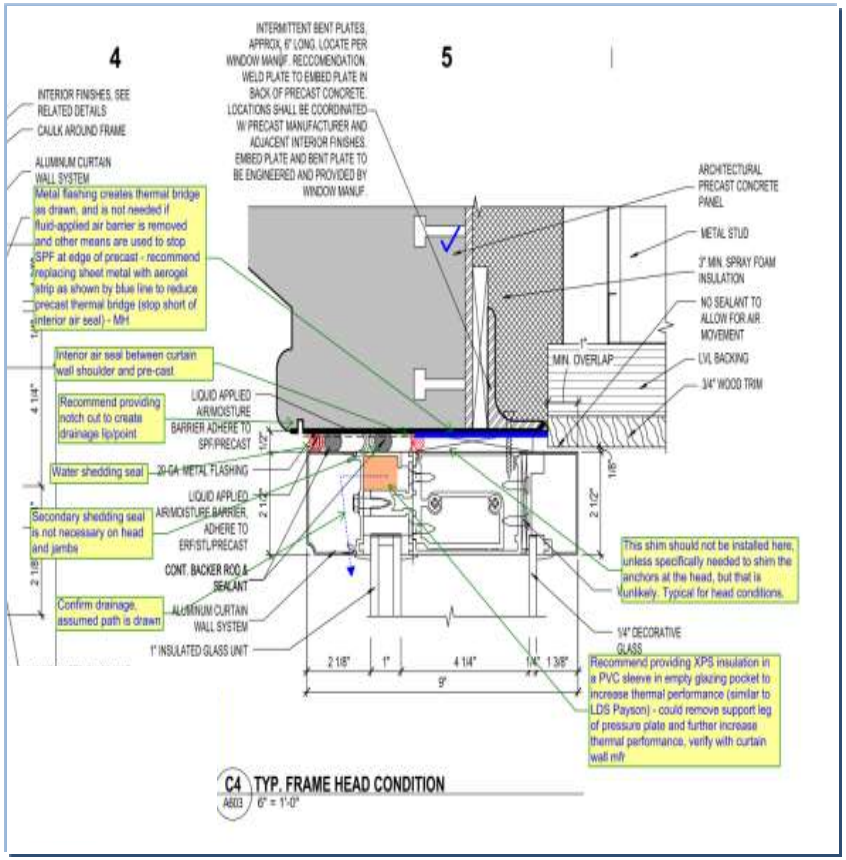
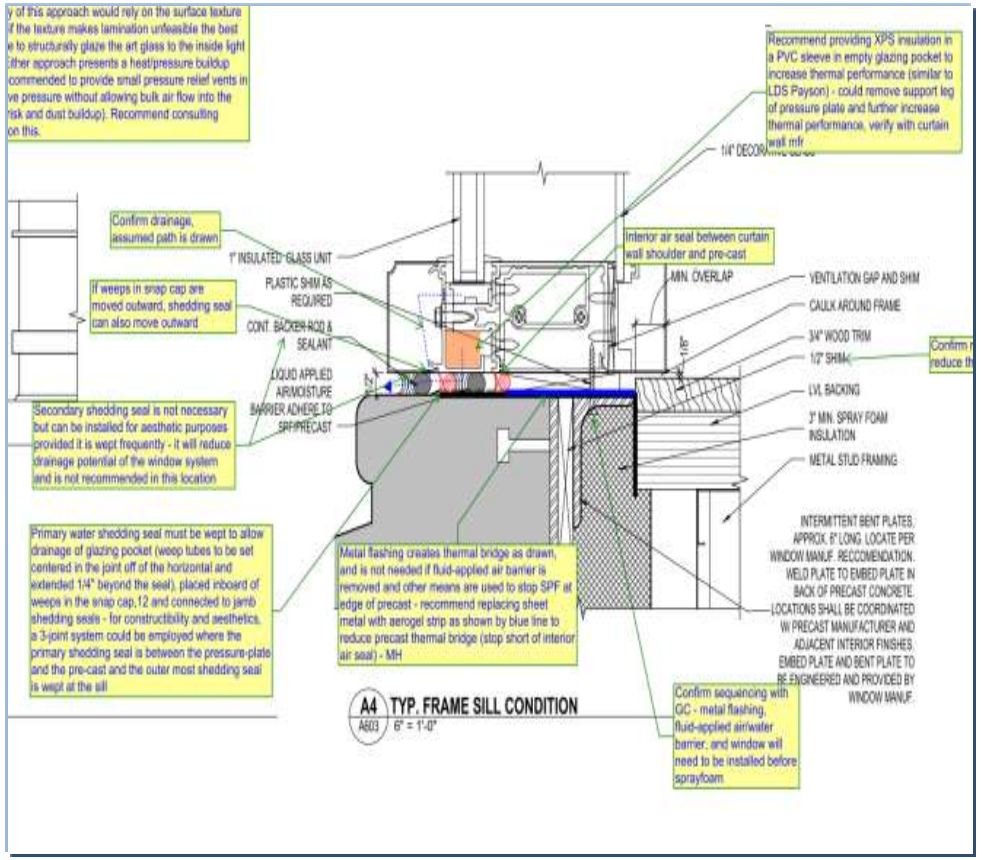
Barrier Continuity Example





This concludes The American Institute of Architects
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