Durability and Moisture Control – Building Enclosure Design for the South WoodWorks

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Course Description

Building enclosures are responsible for controlling heat flow, air flow, vapor flow and a number of other elements. In the southern US, they are also essential for termite prevention. This presentation will explore design considerations associated with wood-frame building enclosures and the role of control layers in addressing items such as durability, termite prevention and control, and thermal continuity. Beginning with a review of building enclosure design fundamentals and considerations, it will then cover best practices for a variety of wood-frame building enclosure assemblies and details. Next, a brief overview of termites encountered in the South will be presented, with a focus on prevention and control strategies for multi-family and commercial wood buildings. A combination of initial design strategies to prevent termites from entering structures and proper maintenance programs for surveillance will be reviewed. Finally, critical details of building enclosure assemblies (walls, ground plane intersection, windows, roofs) will be reviewed with an emphasis on continuity of critical barriers against moisture and termites. The program will conclude with an interactive discussion and opportunity for attendees to engage.

Learning Objectives

- Review building science fundamentals and building enclosure design considerations for wood-frame buildings in hot and humid regions (with focus on Texas and Louisiana).
- Explore the role of control layers in building enclosures for elements such as heat flow, bulk water intrusion and air flow.
- Identify the types of termites found in the South and understand their paths of entry into building structures and the damage they may cause.
- Understand and apply the termite protection requirements of the International Building Code and local codes for multi-family and commercial projects.

Outline

- Mid-Rise Wood Framed Buildings in the South
- Building Science/Control Layers
- Material Types by Control Layers
- Building Code Requirements
- Design Development
- Challenging Details
- Construction Administration

Mid-Rise/Wood Framed Buildings in the South

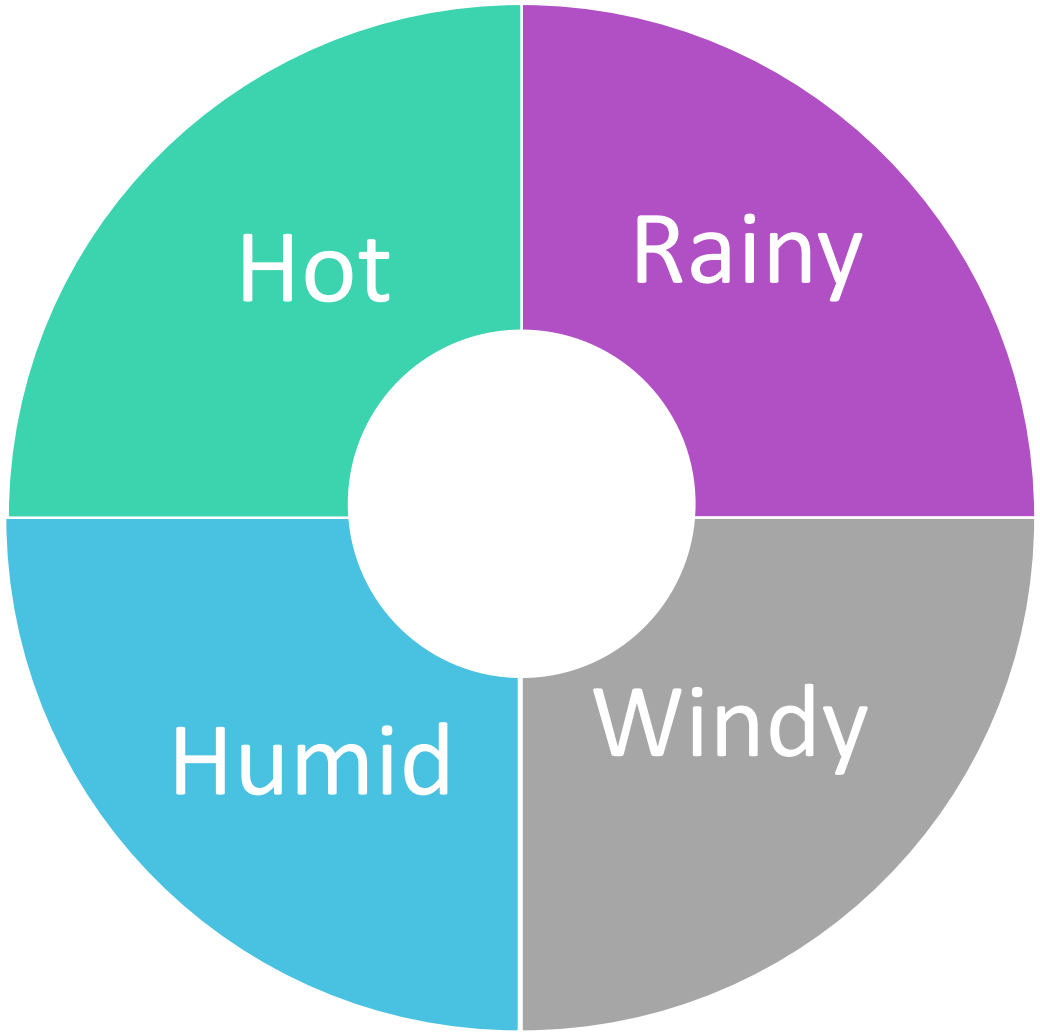
Introduction

- Building Enclosures for Wood-Frames Buildings

  – Building durability
  – User comfort
  – Energy efficiency
  – Architectural finish
  – Resist and transfer loads

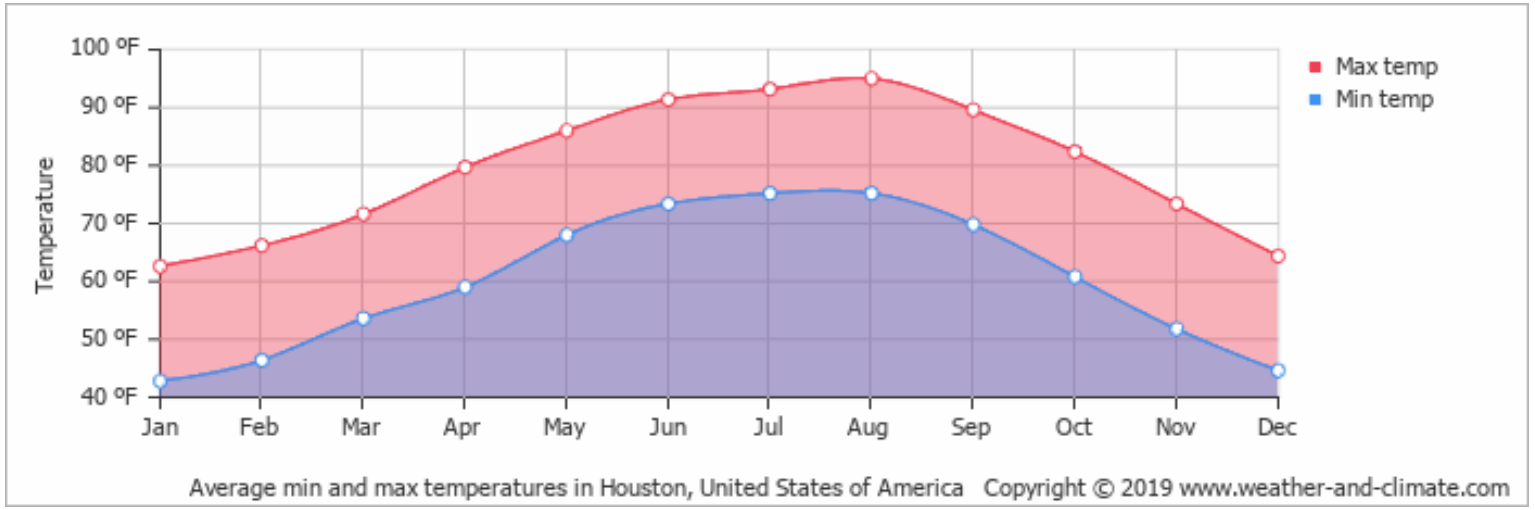
Introduction

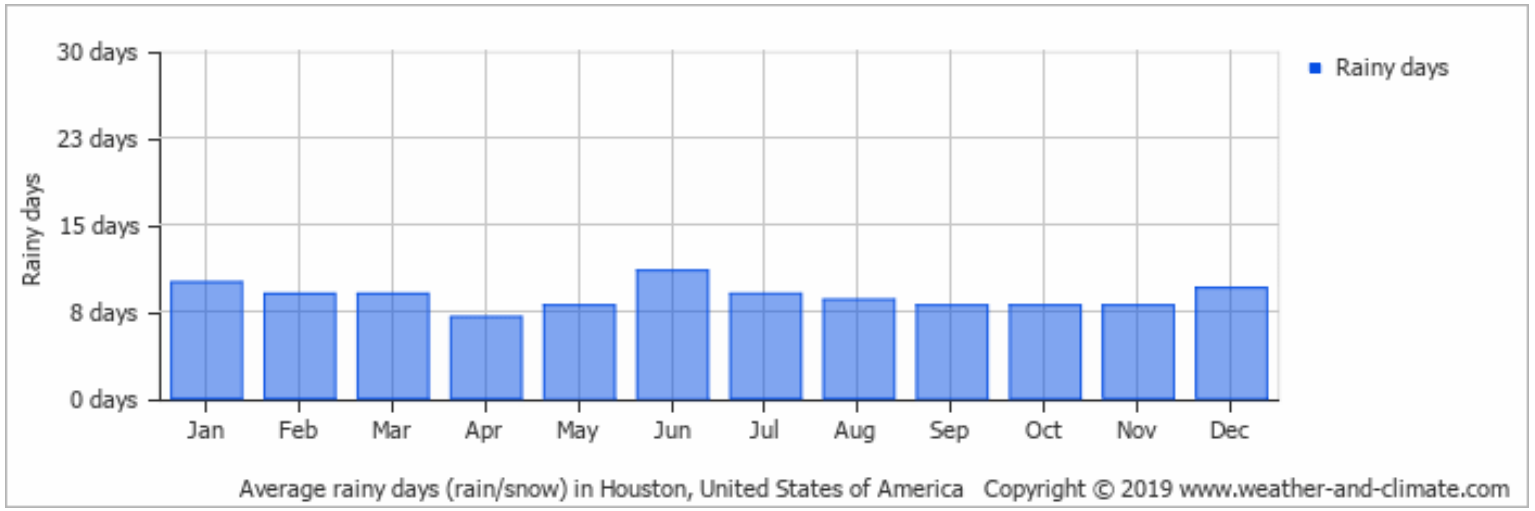
Southern Climate



Introduction

- Coastal and Hot-Humid – Houston as an Example





Introduction

- Extreme Weather

Picture Credit: PBS, "*Katrina, 10 Years Later*." https://www.pbs.org/wgbh/frontline/article/katrina-10-years-later-three-documentaries-to-watch/
Weather Underground, "Hurricane Harvey Strengthens to 110 mph Winds; Catastrophic Flooding Likely in Texas."

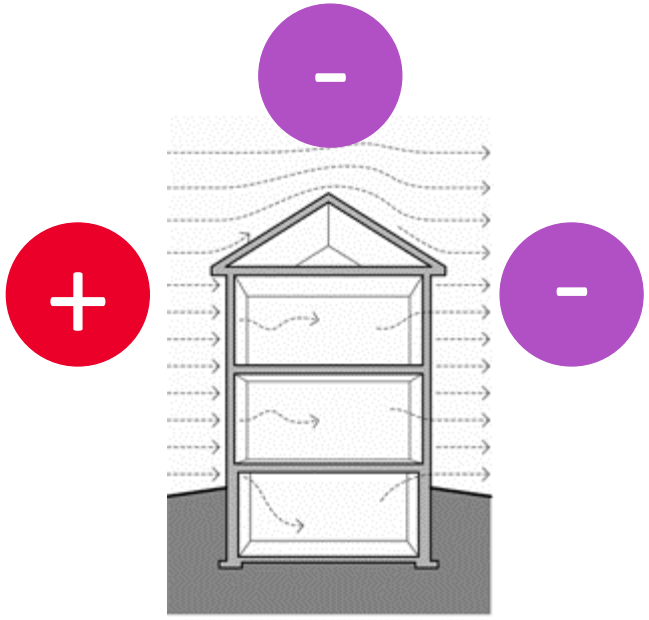
Introduction

- Water Infiltration

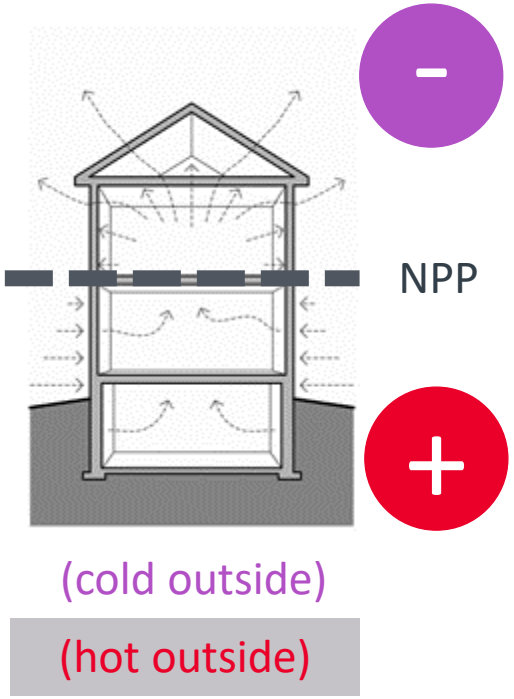
Introduction

- Air Leakage

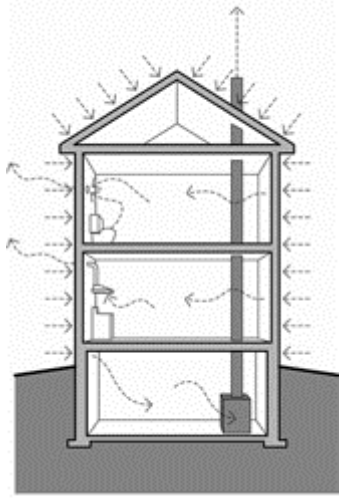
Wind



Stack Effect

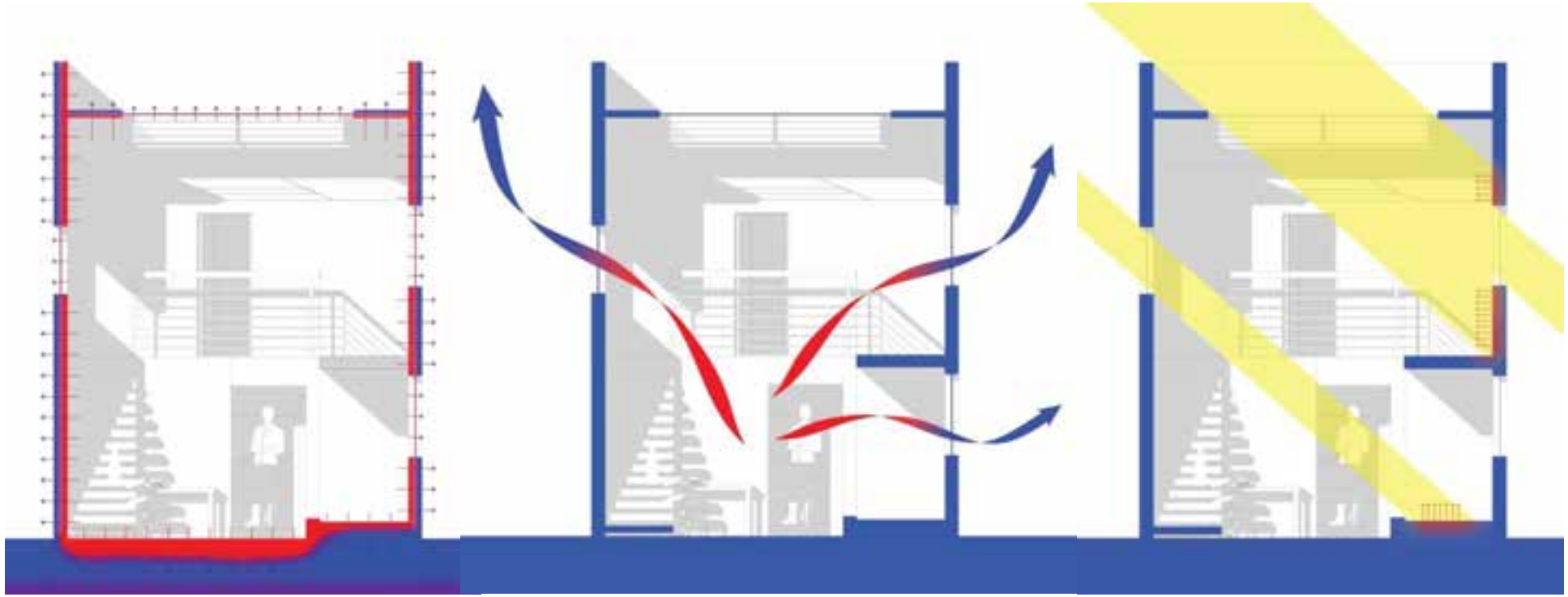


Mechanical Pressurization



Introduction

- Thermal and Heat Transfer



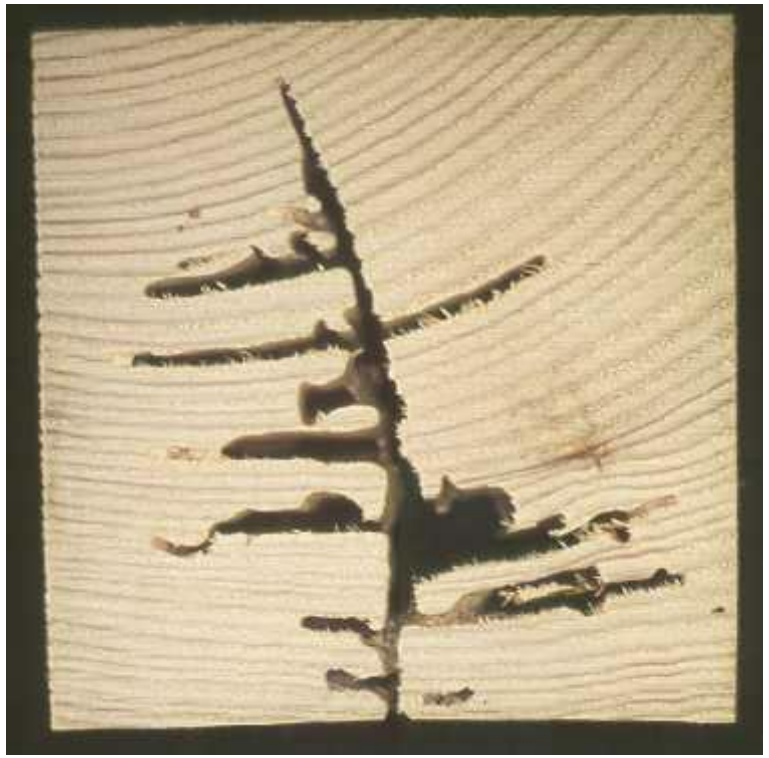
Conduction Convection Radiation

Introduction

Humidity Control

Introduction

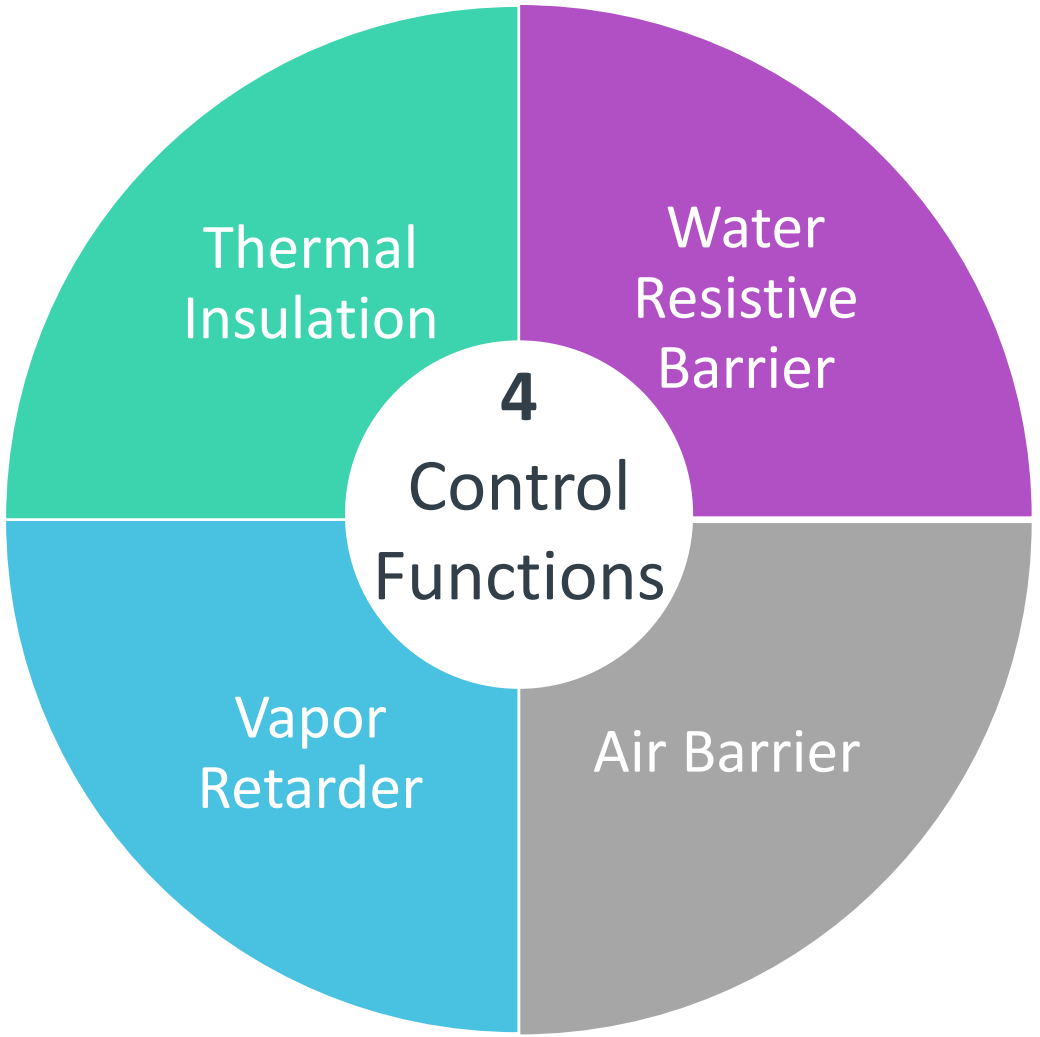
- Pest/Termite Control



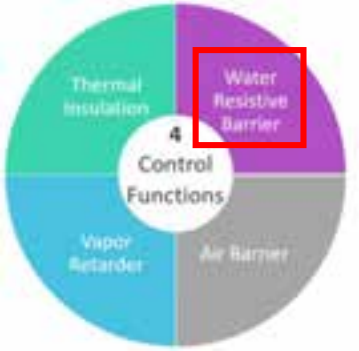
Picture Credit: Canadian Wood Council, "*Termites*." https://cwc.ca/why-build-with-wood/durability/durability-hazards/termites/

Building Science/Control Layers

Building Science/Control Layers



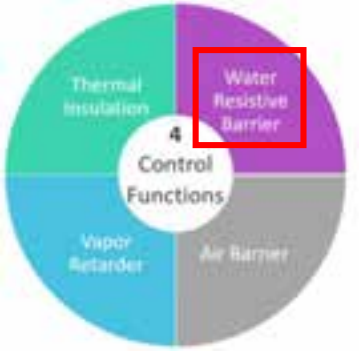
Building Science/Control Layers



- Water

1. Deflection
2. Drainage
3. Drying
4. Durability

Building Science/Control Layers



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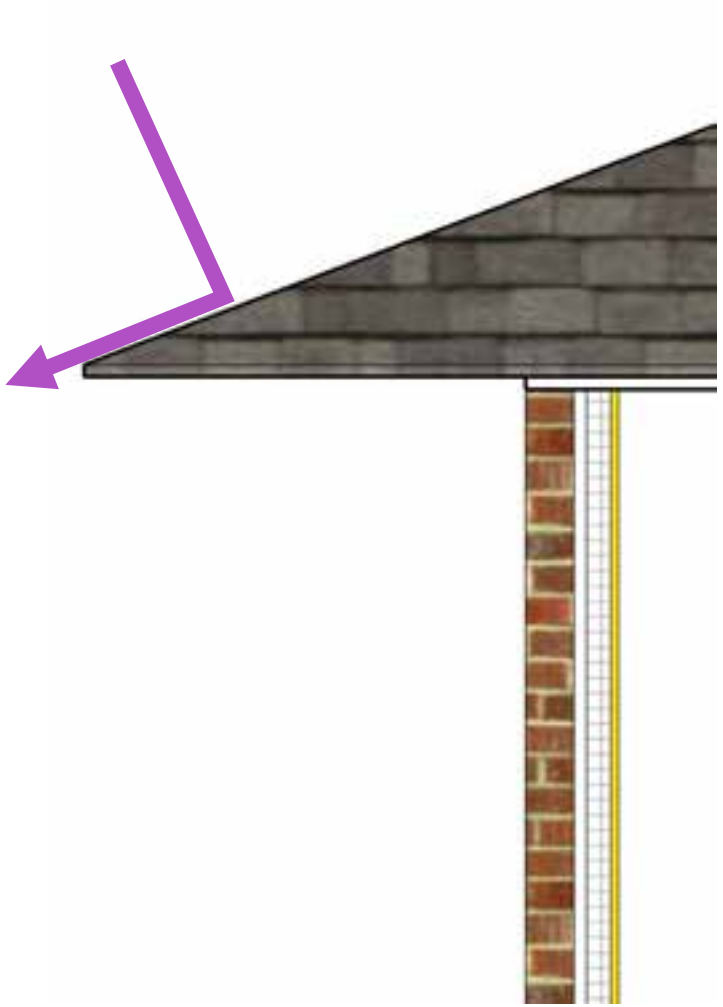

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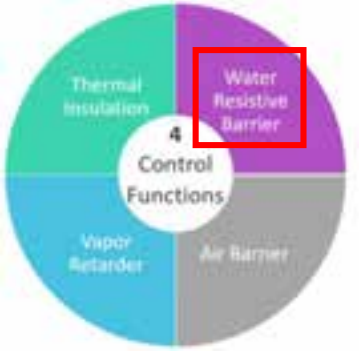

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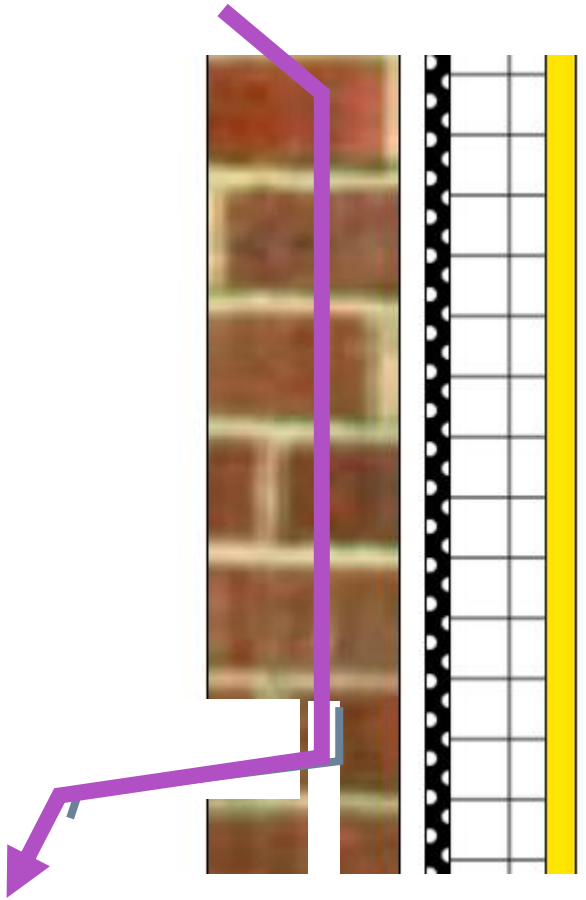

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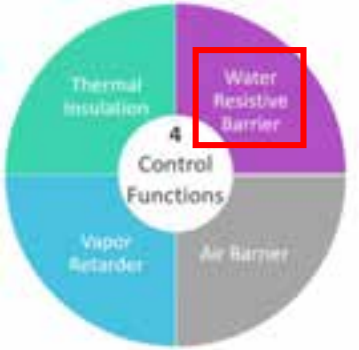

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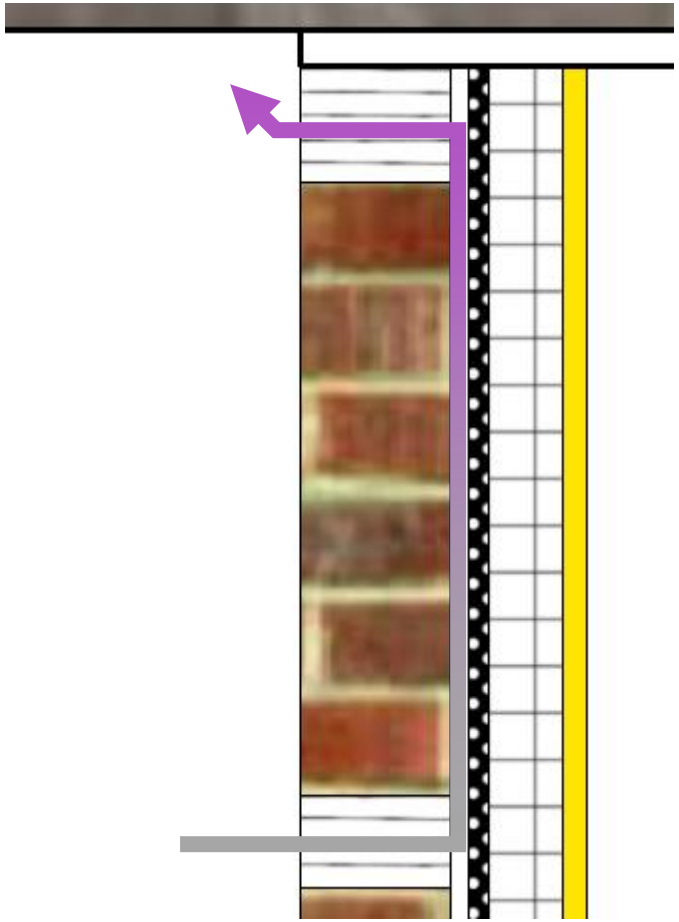
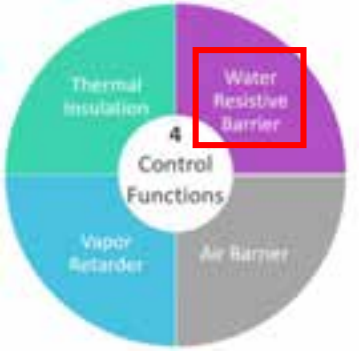


Building Science/Control Layers



- Water

1. Deflection
2. Drainage
3. Drying
4. Durability

"No wrong materials…
Just materials used for the wrong applications"

Building Science/Control Layers

- Air

Air leakage typically take place through:

- joints, gaps and cracks in the construction
- gaps created where the structure penetrates the outer skin of the building
- cracks around door and window openings
- gaps where services enter the building

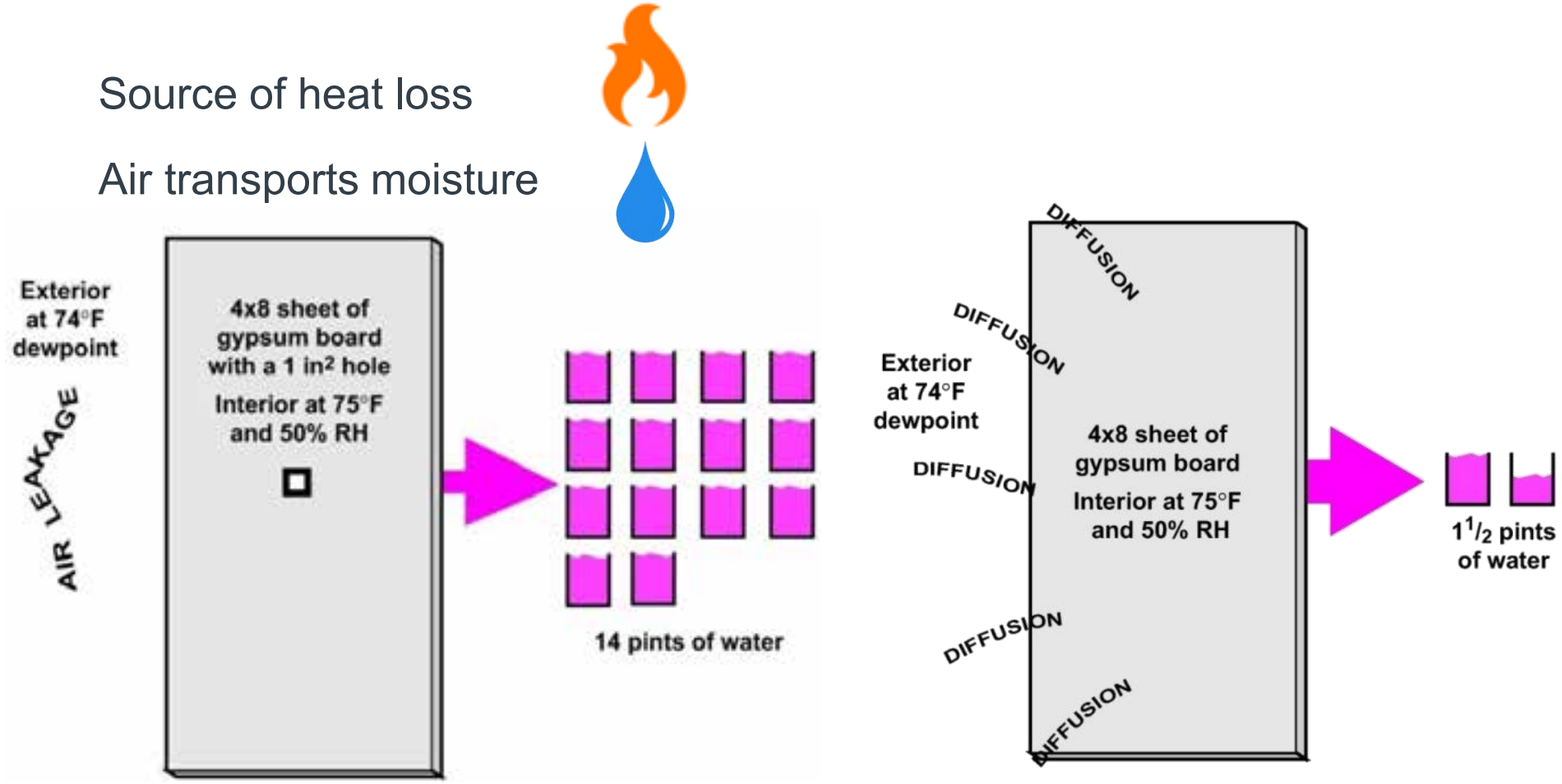
Devil is in the details

Building Science/Control Layers

- Air

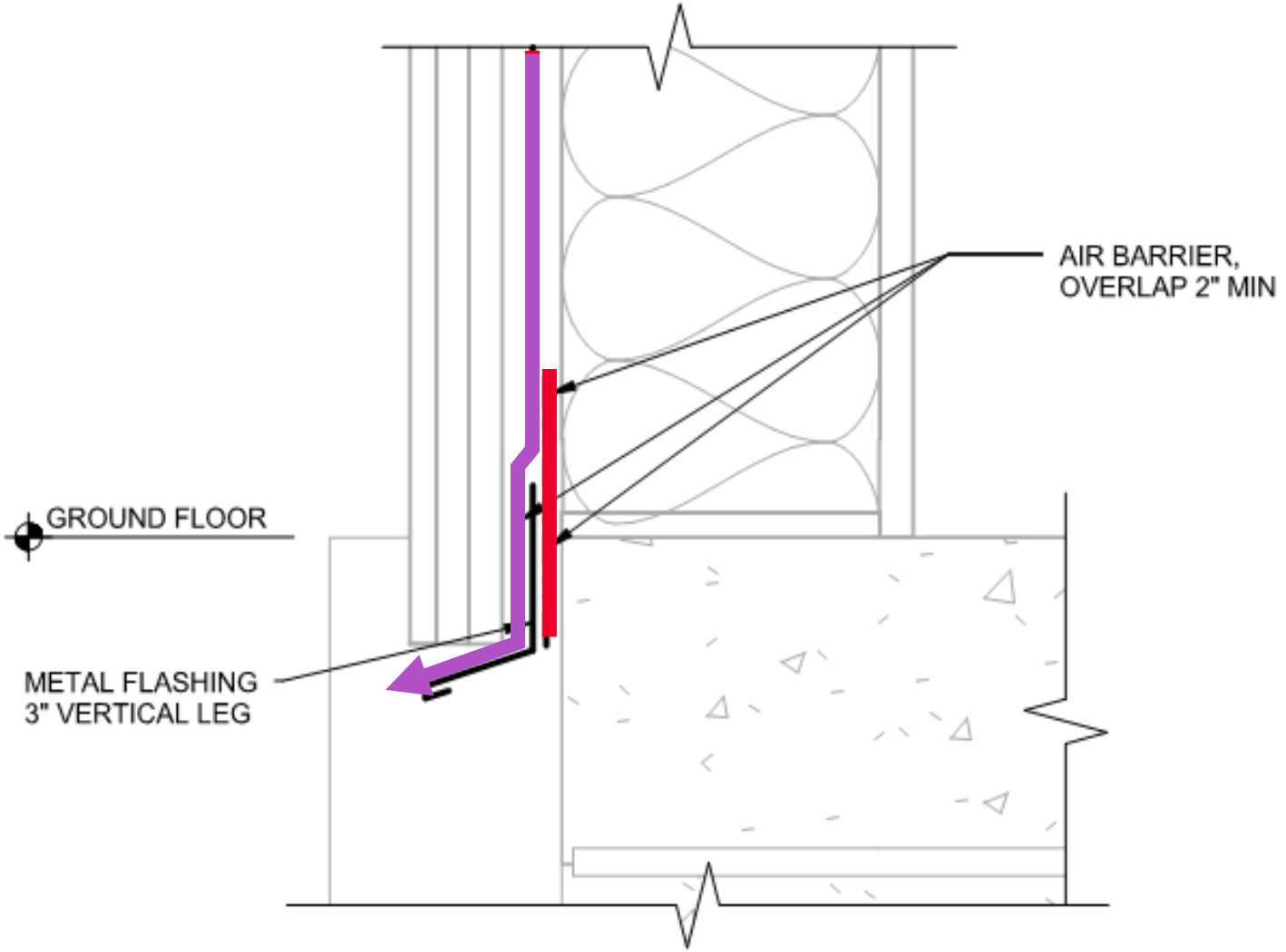
Source of heat loss

Air transports moisture



Building Science/Control Layers

- Air

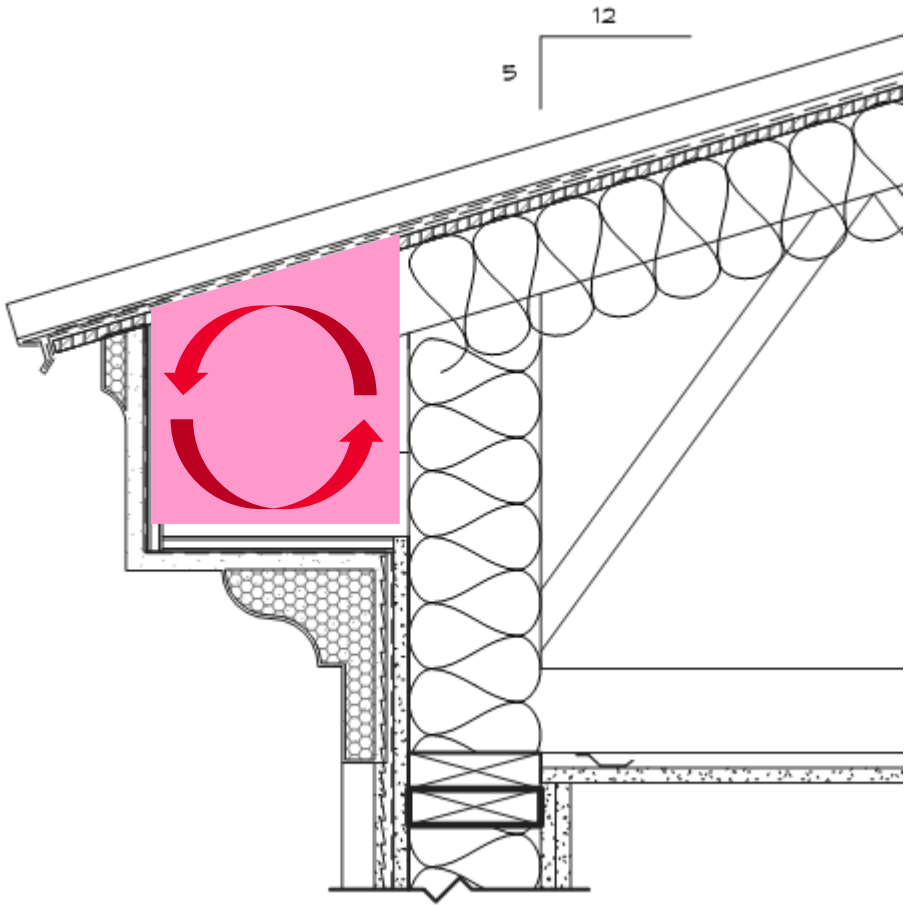


Building Science/Control Layers

- Thermal

- **BTU**: Unit for energy. The amount of heat required to raise the temperature of 1 lb. of water by 1 °F
- **U-Factor**: How fast heat passes through a material. BTUs that passes through 1 ft^2 in 1 hour for 1 °F temperature difference.
- **R-Value**: How well materials resist heat flow. R=1/U

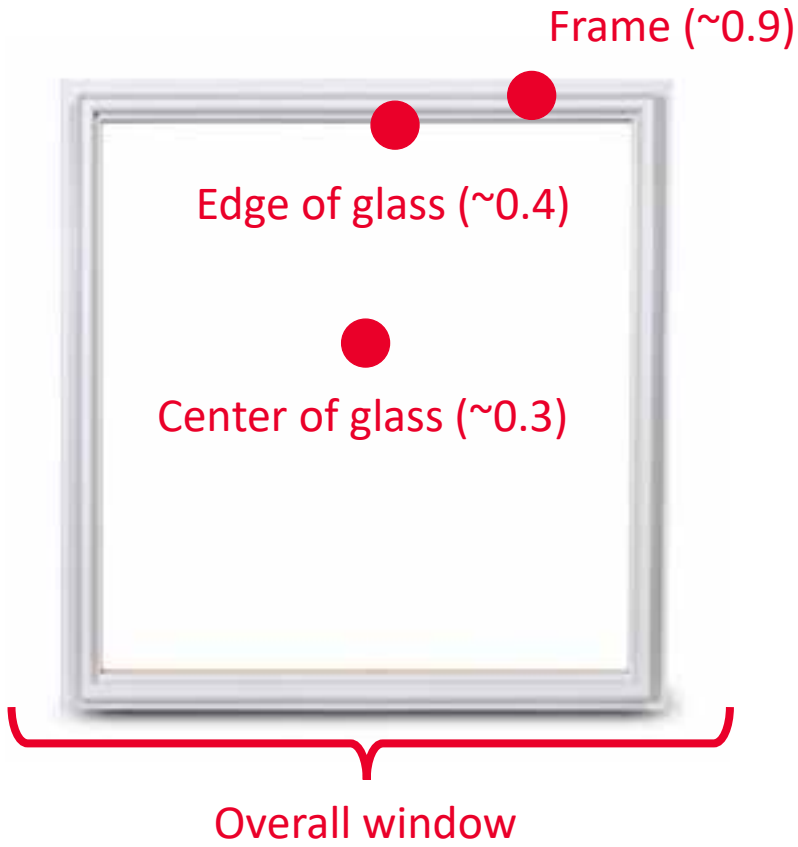
Heat loss/gain $= \frac{Area \times \Delta T}{R-Value}$, in BTUs per hour



Building Science/Control Layers

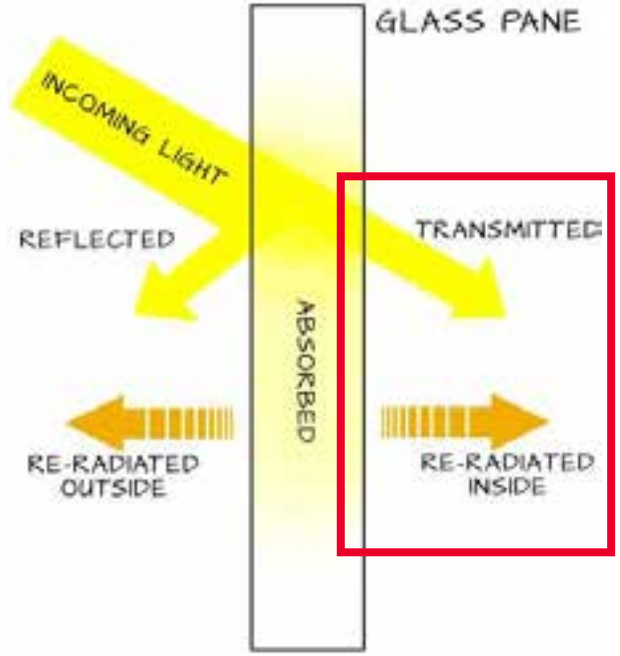
- Thermal

  - U-factor for windows



  - SHGC

    Fraction of incident radiation that is admitted (~0.2 to 0.9)



Building Science/Control Layers

- Thermal

Thermal bridging: an area of the building fabric which has a higher thermal transmission than the surrounding parts of the fabric

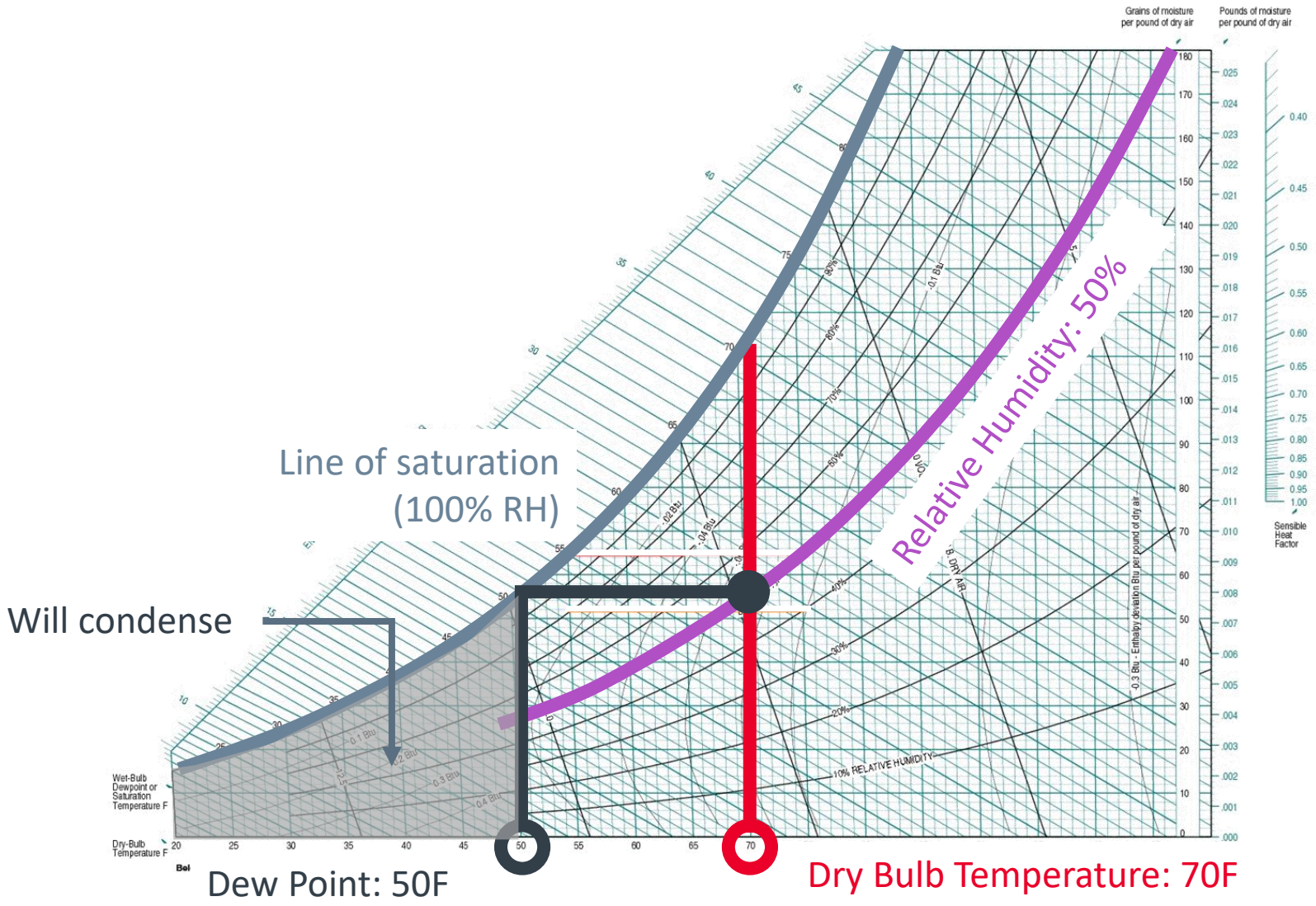
Results in a reduction in the overall thermal insulation of the structure.

Building Science/Control Layers

- Vapor

Condensation

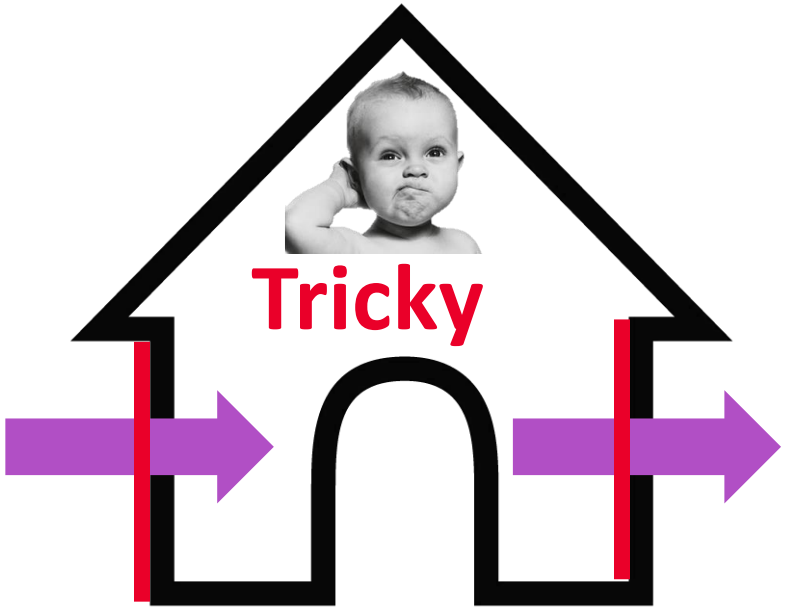
– **Psychrometric Chart**



Building Science/Control Layers

- Vapor

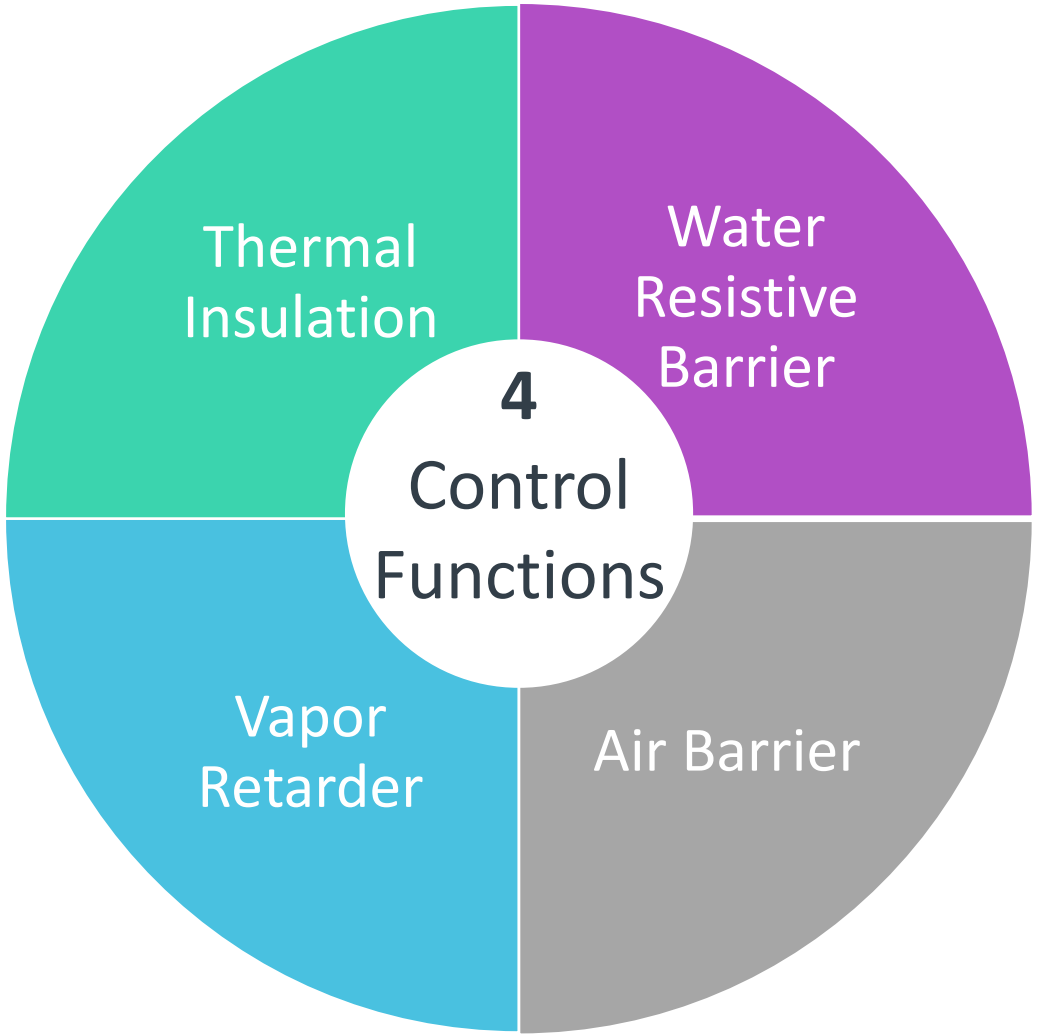
But where do you install it?



Material Types by Control Layers

Material Types by Control Layers

- A single product may perform one or many of these functions



Material Types by Control Layers

- Water

Sheet Water-Resistive Barrier

Liquid-Applied Membranes

Material Types by Control Layers

	Thermal	Water	Air	Vapor
Building paper 		●		
Spun bonded polyolefin mechanically fastened house wrap 		●		

Material Types by Control Layers

	Thermal	Water	Air	Vapor
Fluid applied membrane 		●		
Self-adhered membrane 		●		

Material Types by Control Layers

- Air

Sheet air / water resistive barrier

Fluid applied air / water resistive barrier

Material Types by Control Layers

	Thermal	Water	Air	Vapor
Fluid applied membrane 			●	
Self-adhered membrane 			●	

Material Types by Control Layers

	Thermal	Water	Air	Vapor
Spray foam 			●	
Spun bonded polyolefin mechanically fastened house wrap 			●	

Heat Transfer/Conduction

- Thermal

Fiberglass batt

Mineral wool

Spray foam

XPS
Extruded polystyrene

Polyiso
Polyisocyanurate

EPS
Expanded polystyrene

Material Types by Control Layers

- Vapor

Classification:

Class I: ≤ 0.1 perms

Colloquially: vapor barriers

Polyethylene

Class II: 0.1 to 1.0 perms

Kraft faced batt

Class III: > 1.0 perms

Gypsum

Material Types by Control Layers

	Thermal	Water	Air	Vapor
Fluid applied membrane 				Depends on formulation
Self-adhered membrane 				Depends on formulation

Material Types by Control Layers

	Thermal	Water	Air	Vapor
Batt 				Depends on formulation (faced)
Spray foam 				Depends on formulation

Building Code Requirements

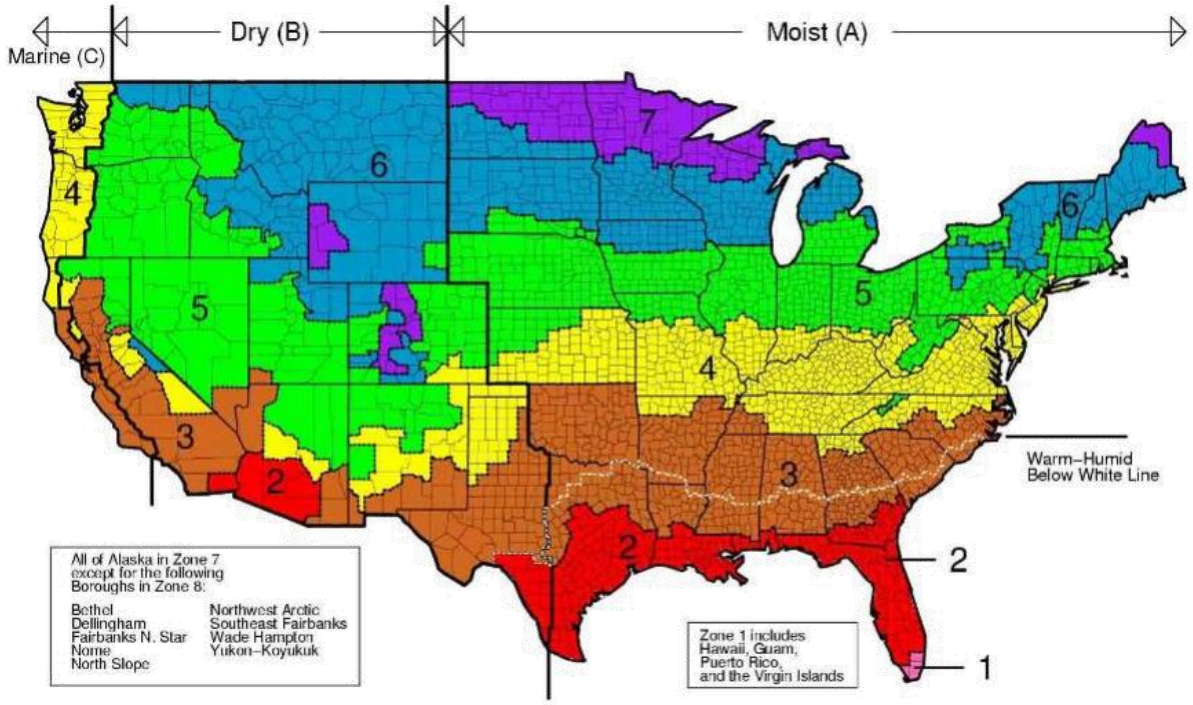
Building Code Requirements

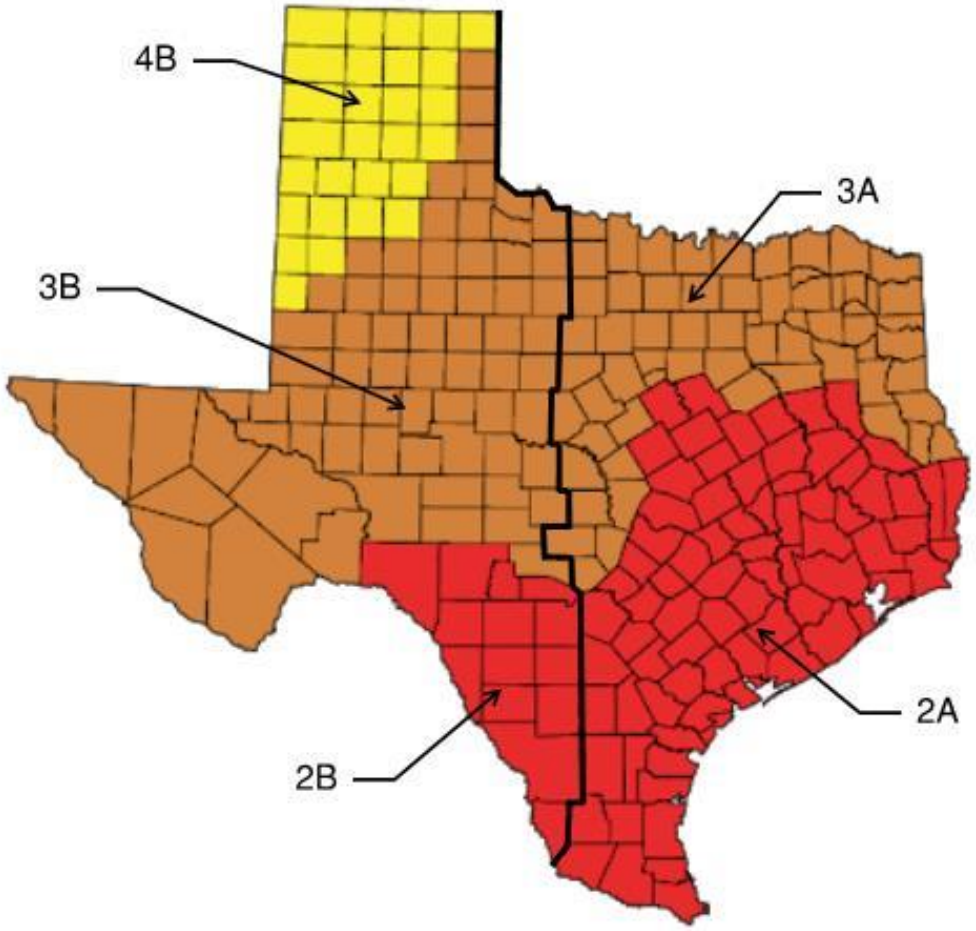
Texas

- Commercial: 2015 IECC – Commercial Provisions
- Residential: 2015 IECC – Residential Provisions
- Residential Single-Family: 2015 IRC

Building Code Requirements

- Texas – Thermal Zones





Building Code Requirements

- R-value Requirements for Exterior Wall – Texas

Building Use	Climate Zone	Assembly Maximum (U-Factor Method)	Insulation Min. R-Value
Commercial (2015 IECC section C402)	2 A and 2 B	U-0.064	R-13 + R-3.8ci or R-20
	3 A and 3 B	U-0.064	R-13 + R-3.8ci or R-20
	4 B	U-0.064	R-13 + R-3.8ci or R-20
Residential (2015 IECC section R402)	2 A	U-0.084	R-13
	3 A	U-0.060	R-20 or R-13 + R-5.0ci
	4 B	U-0.060	R-20 or R-13 + R-5.0ci

Building Code Requirements

- R-value Requirements for Roof – Texas

Building Use	Climate Zone	Assembly Maximum (U-Factor Method)	Insulation Min. R-Value
Commercial (2015 IECC section C402)	2 A and 2 B	U-0.064	R-38
	3 A and 3 B	U-0.064	R-38
	4 B	U-0.064	R-38
Residential (2015 IECC section R402)	2 A	U-0.030	R-38
	3 A	U-0.030	R-38
	4 B	U-0.026	R-49

Building Code Requirements

- Continuous Air Barrier Requirements – Texas (2015 IECC C402.5)

Building Use	Component	Criteria
Commercial	General Requirements	• A continuous air barrier shall be provided throughout the building thermal envelope • The air barriers shall be permitted to be located on the inside or outside of the building envelope, located within the assemblies composing the envelope, or any combination thereof
	Exception	• Air barriers are not required in buildings located in Climate Zone 2 B
	Air Barrier Construction	• The air barrier shall be continuous for all assembles that are thermal envelope of the building and across the joints and assemblies • Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials • Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in manner compatible with the materials and location

Building Code Requirements

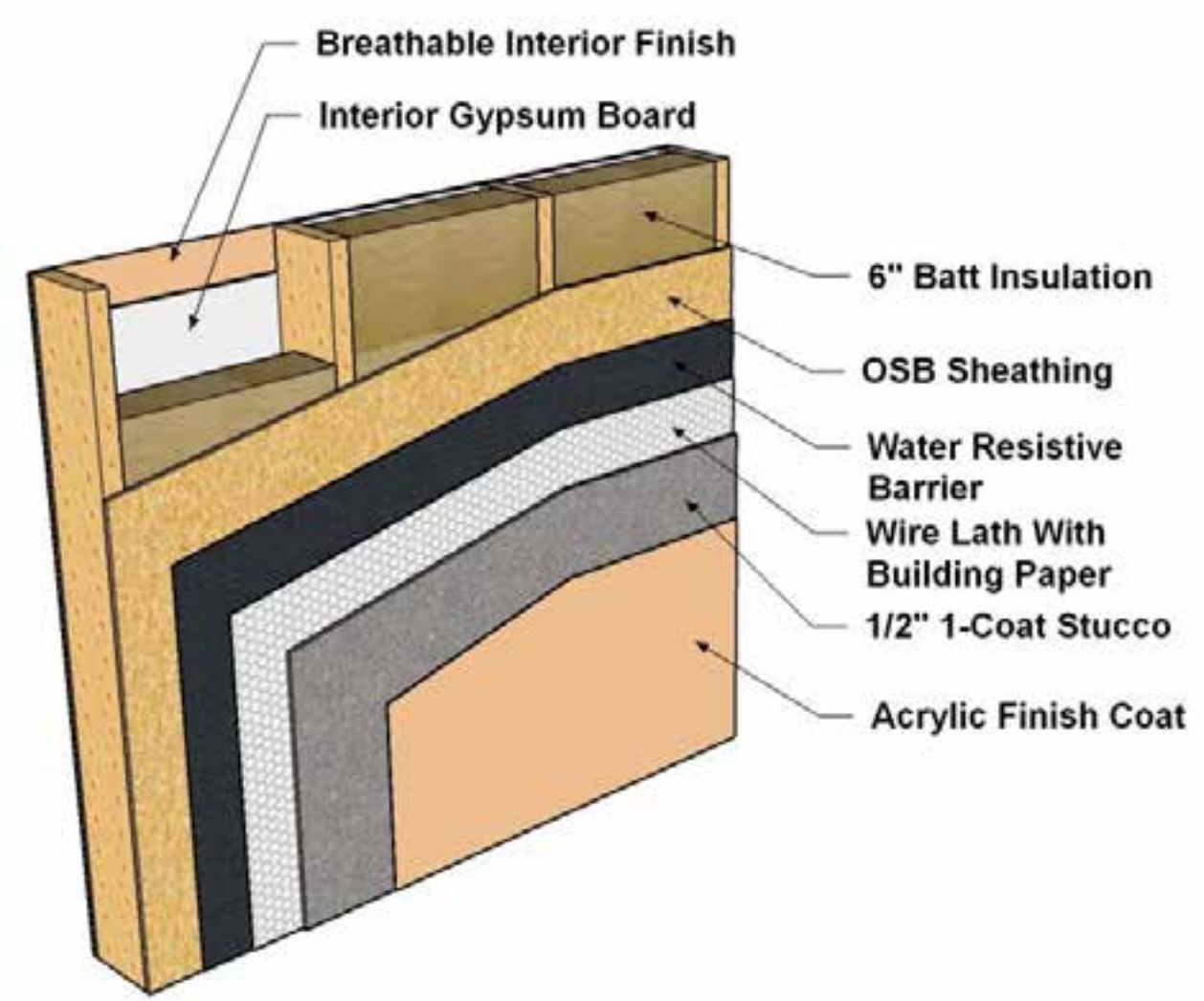
- Continuous Air Barrier Requirements – Texas (2015 IECC C402.4)

Building Use	Component	Criteria
Residential	General Requirements	• A continuous air barrier shall be installed in the building envelope • The exterior thermal envelope contains a continuous air barrier • Breaks or joints in the air barrier shall be sealed
	Ceiling/Attic	• The air barrier in any dropped ceiling shall be aligned with the insulation and any gaps in the air barrier shall be sealed • Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed
	Walls	• The junction of the foundation and sill plate shall be sealed • The junction of the top plate and the top of exterior walls shall be sealed • Knee walls shall be sealed

Design Development

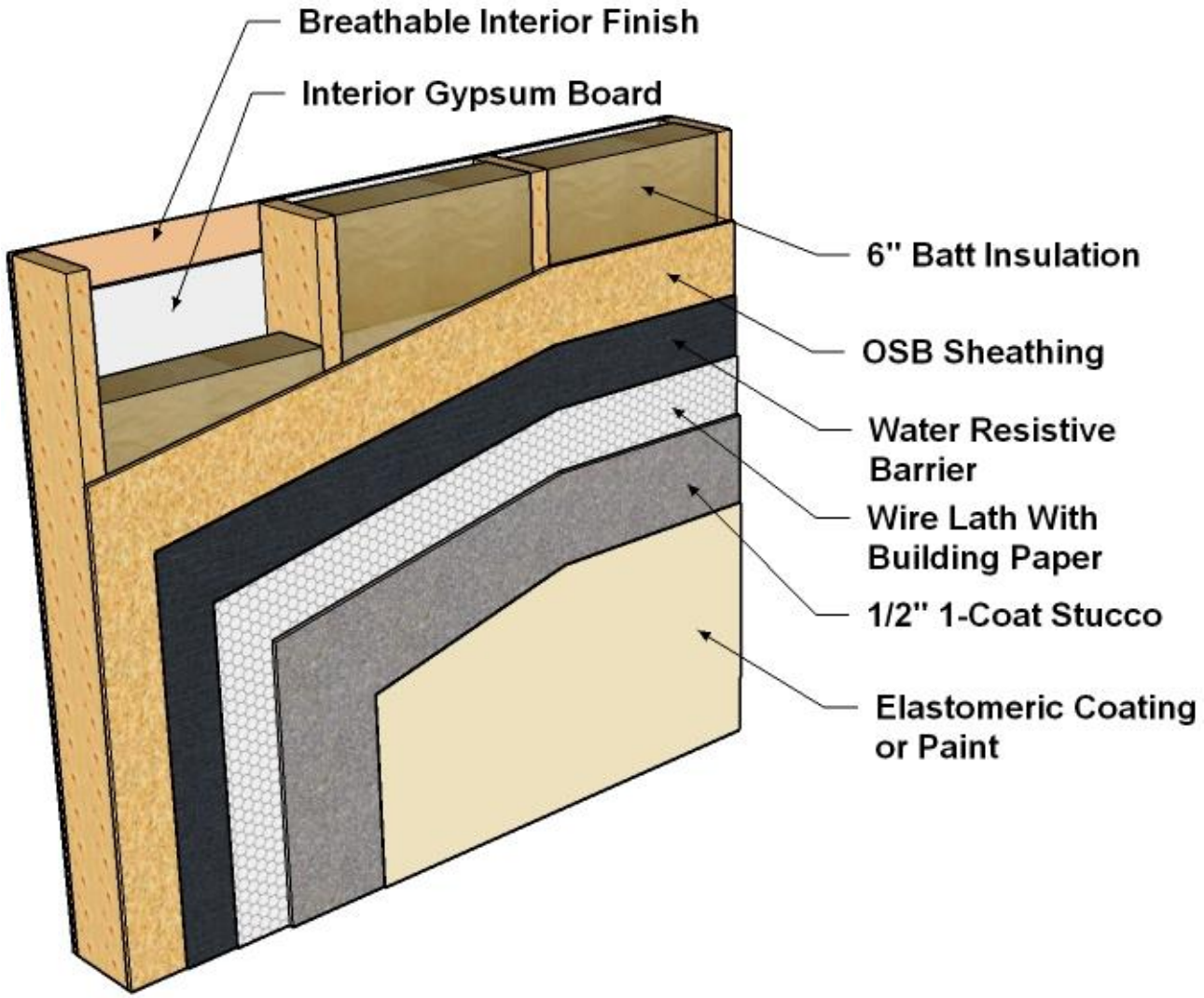
Typical Exterior Wall Systems

- Low Mass



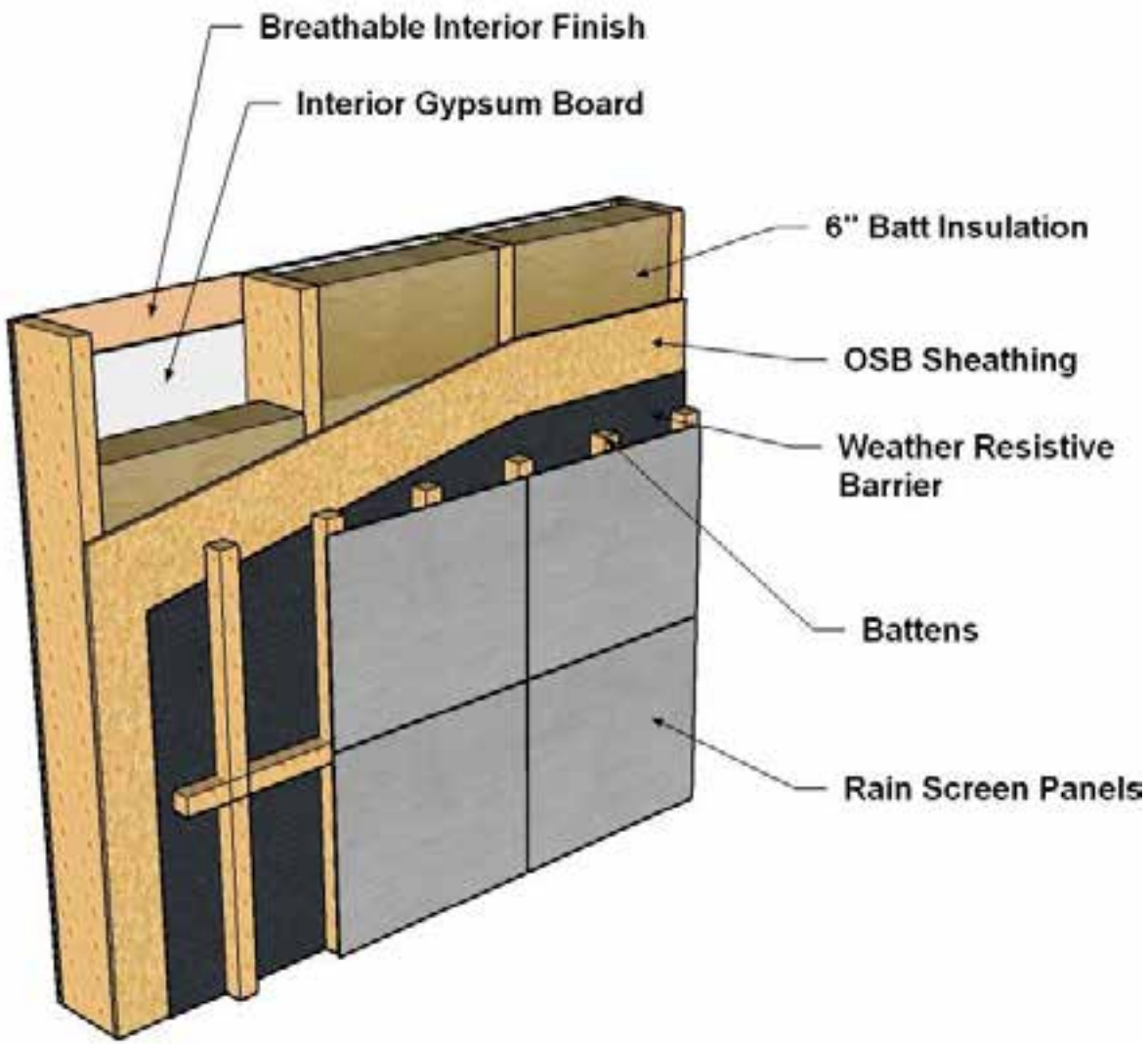
Typical Exterior Wall Systems

- Barrier



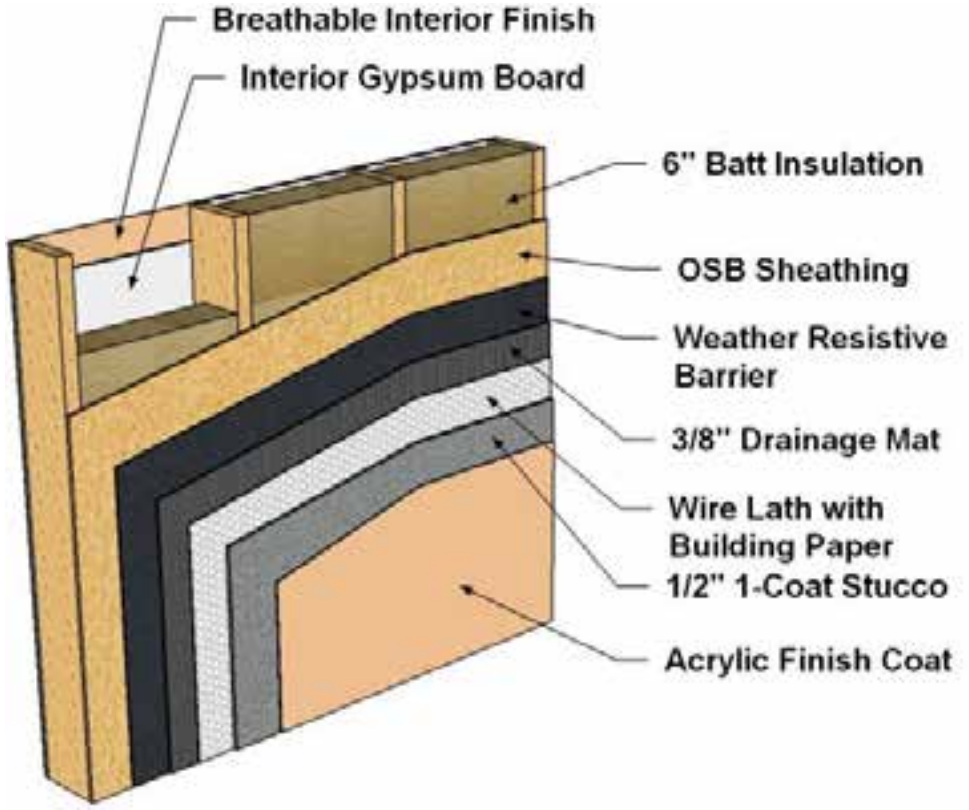
Typical Exterior Wall Systems

- Rainscreen

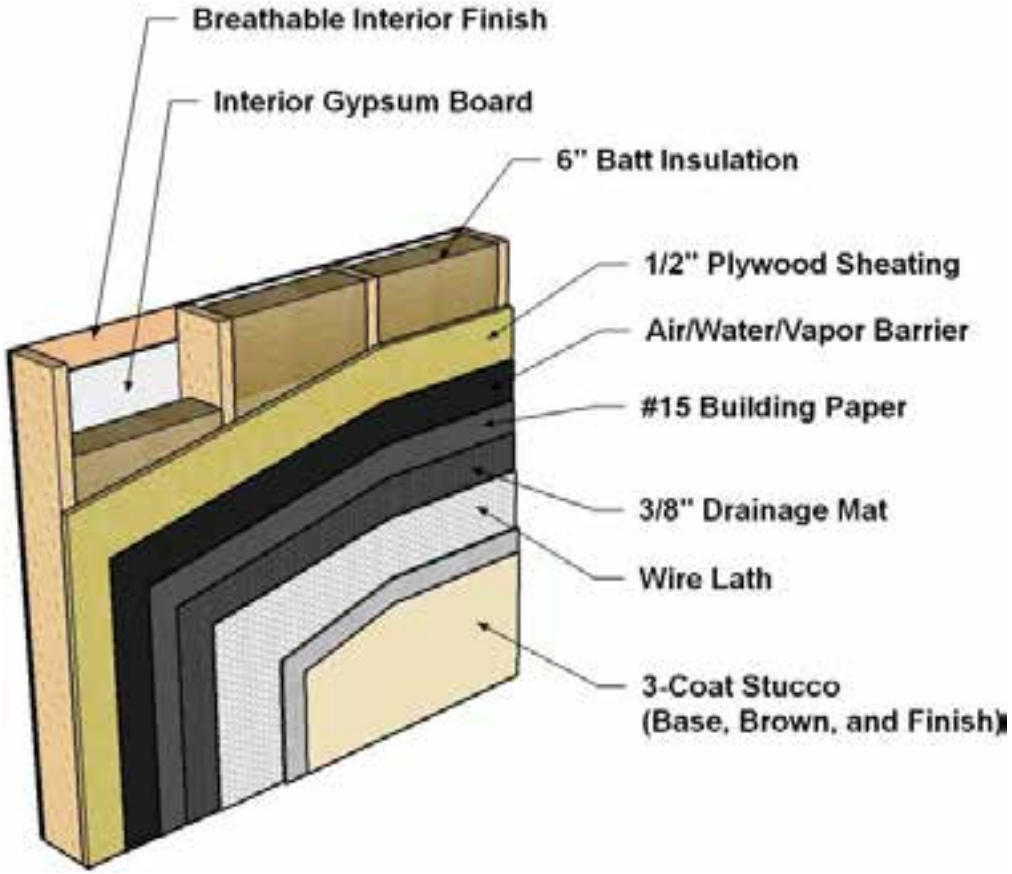


Typical Exterior Wall Systems

- Drainable



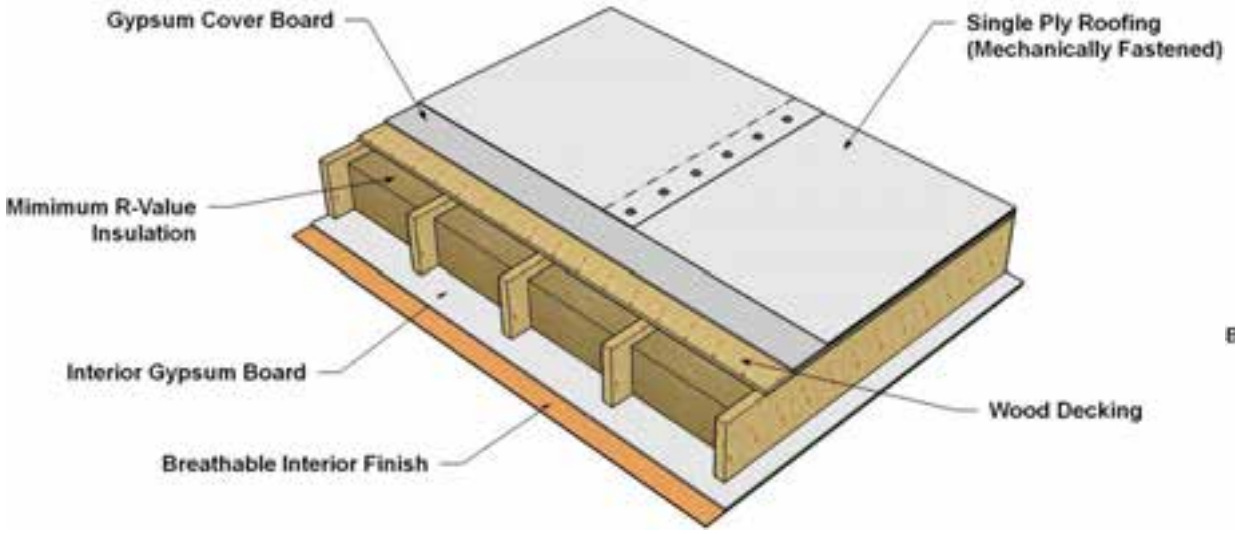
Typical



Recommended

Typical Roofing Systems

- Low Slope



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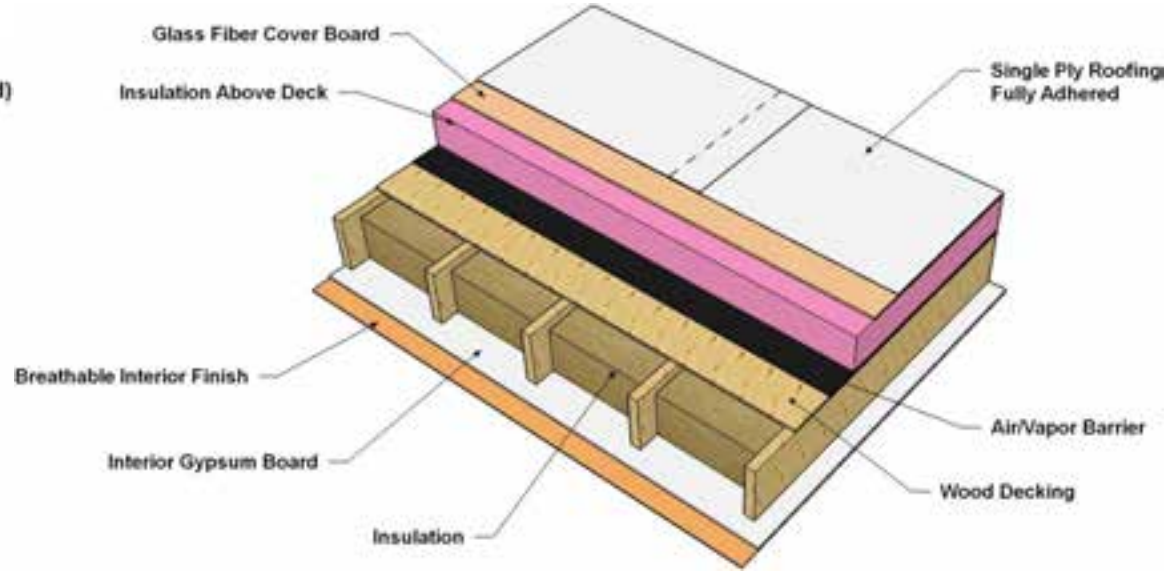
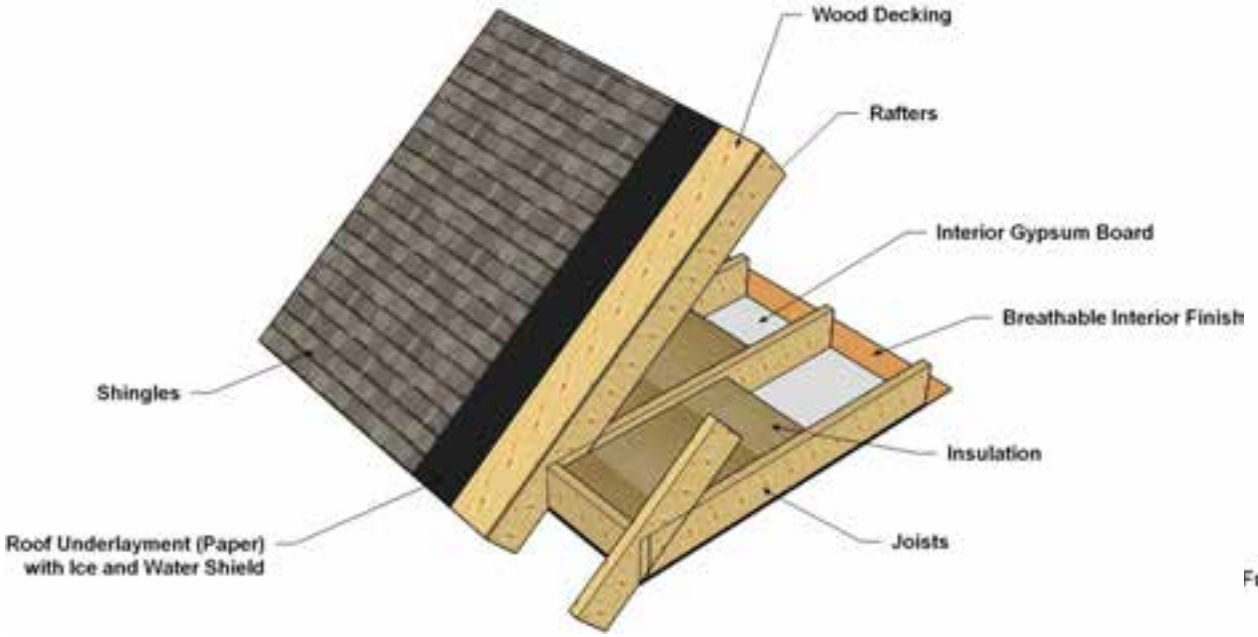


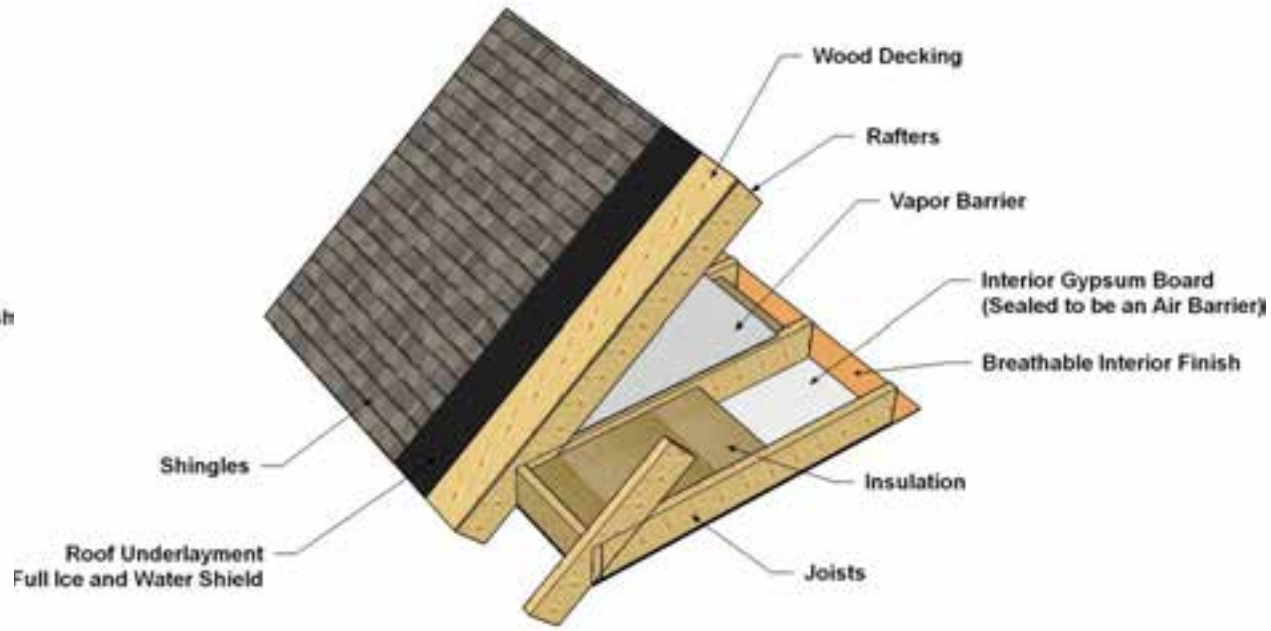
Recommended

Typical Roofing Systems

- Steep Slope



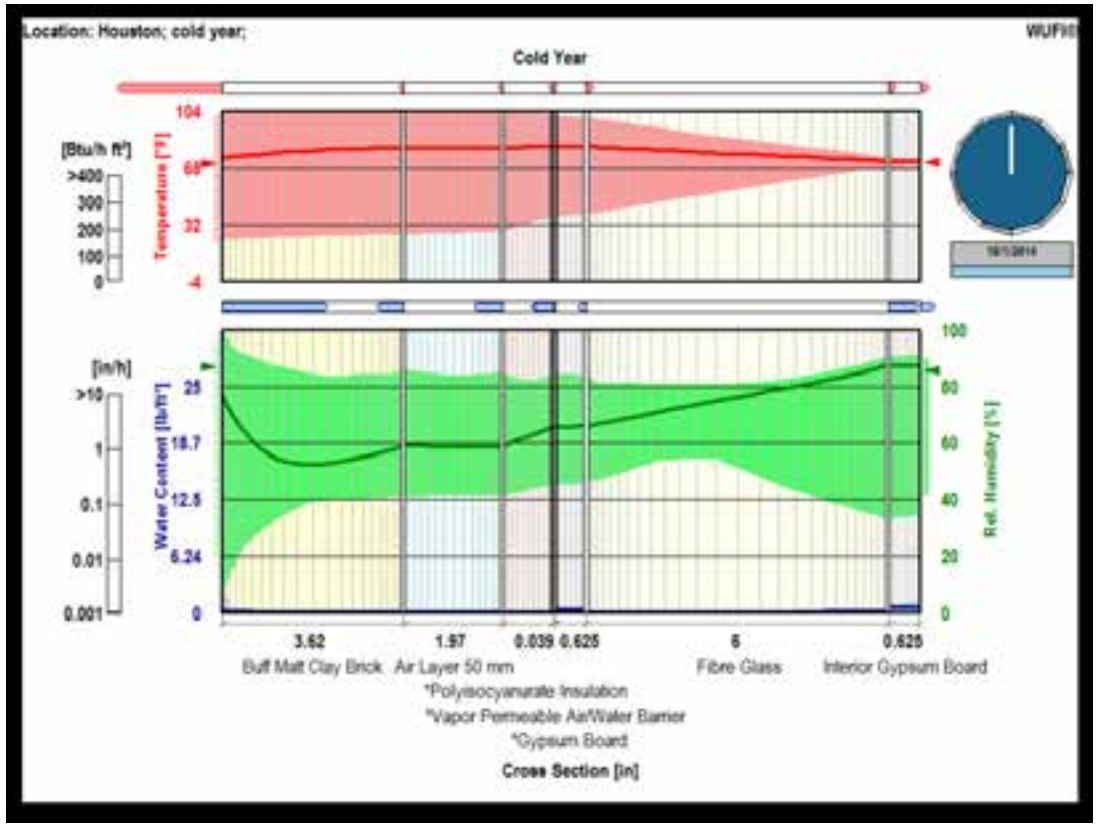
Typical



Recommended

Design Development

- Hygrothermal Modeling
  - A computer program that analyzes the movement of heat, air, and moisture based on
    - Constituent of wall assembly
    - Climate
    - Orientation
    - Initial conditions
  - After analysis, the program outputs
    - Water content in different layers of wall assembly over time
    - Whether mold is likely to grow in the assembly



Fenestration Systems

Radiation
UV through glass

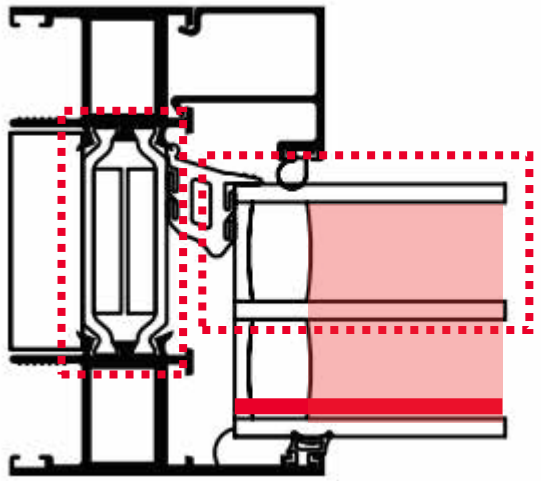
- Low-e coating
- Tinted glass

Convection
within air space

- Subdividing air spaces (more panes)
- Inert gases

Conduction
through frame

- Thermally broken frame



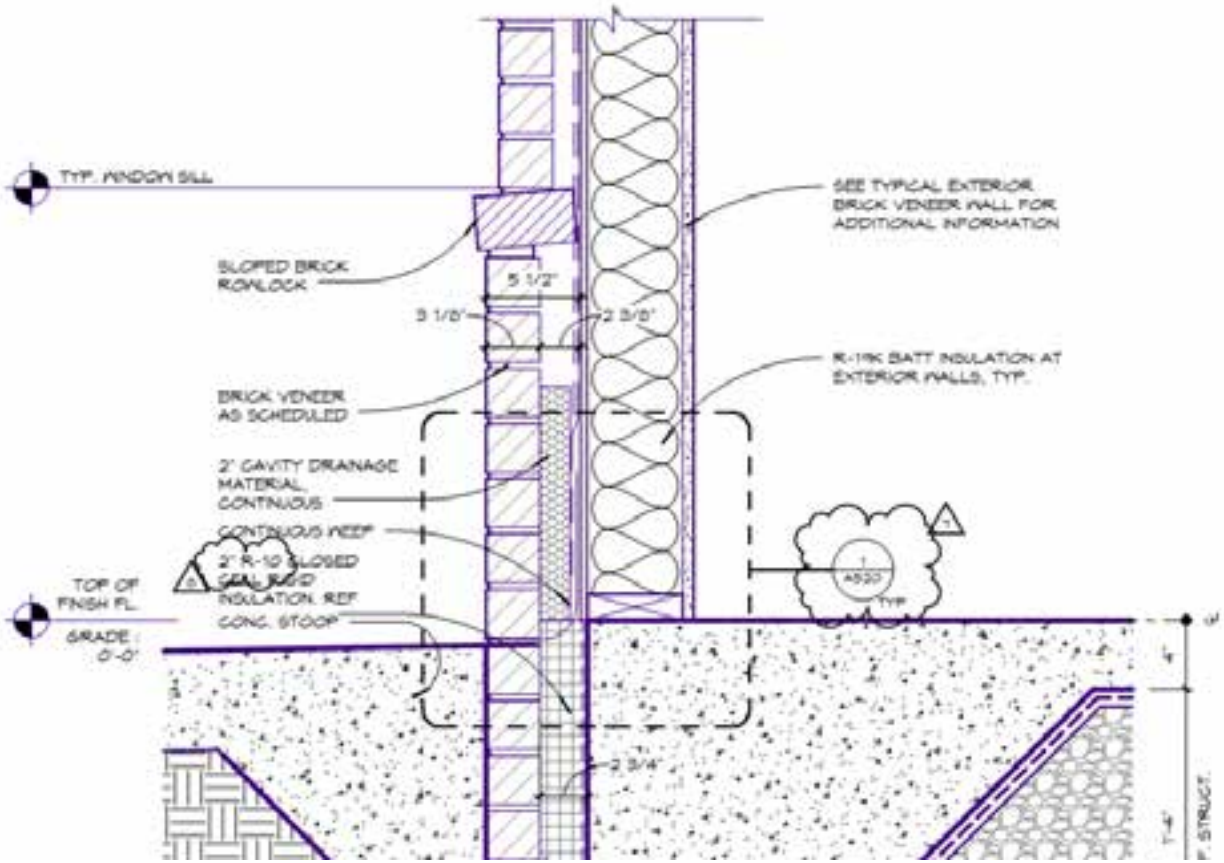
Design Development

- Discipline Coordination
  - Architect
  - Waterproofing Consultant
  - Structural Engineer
  - MEP/HVAC Engineer
  - Civil/Site Drainage Engineer
  - Fire Protection Engineer
  - BECx Consultant
  - Sustainability Consultant

Challenging Details

Challenging Details

- Wall to Slab at Grade

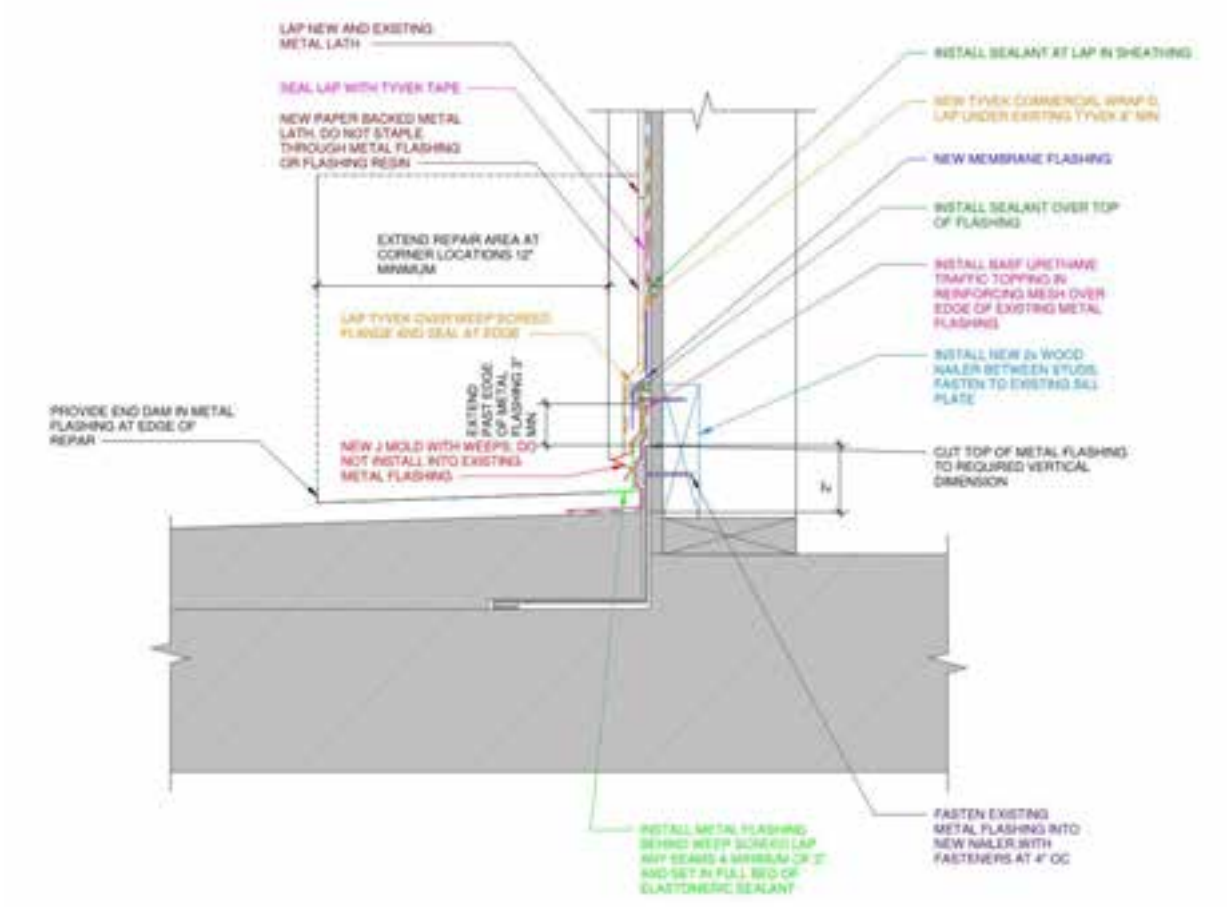


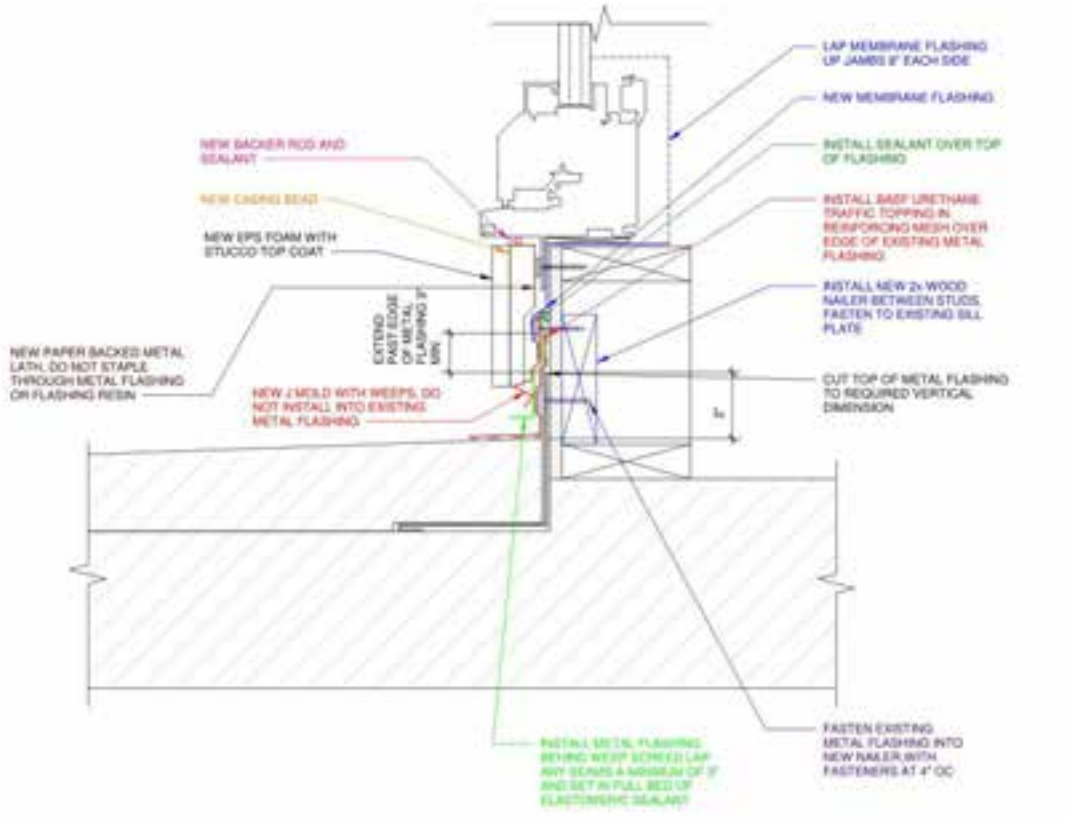
Challenging Details

- Podiums – Wall and Window Flashings

Challenging Details

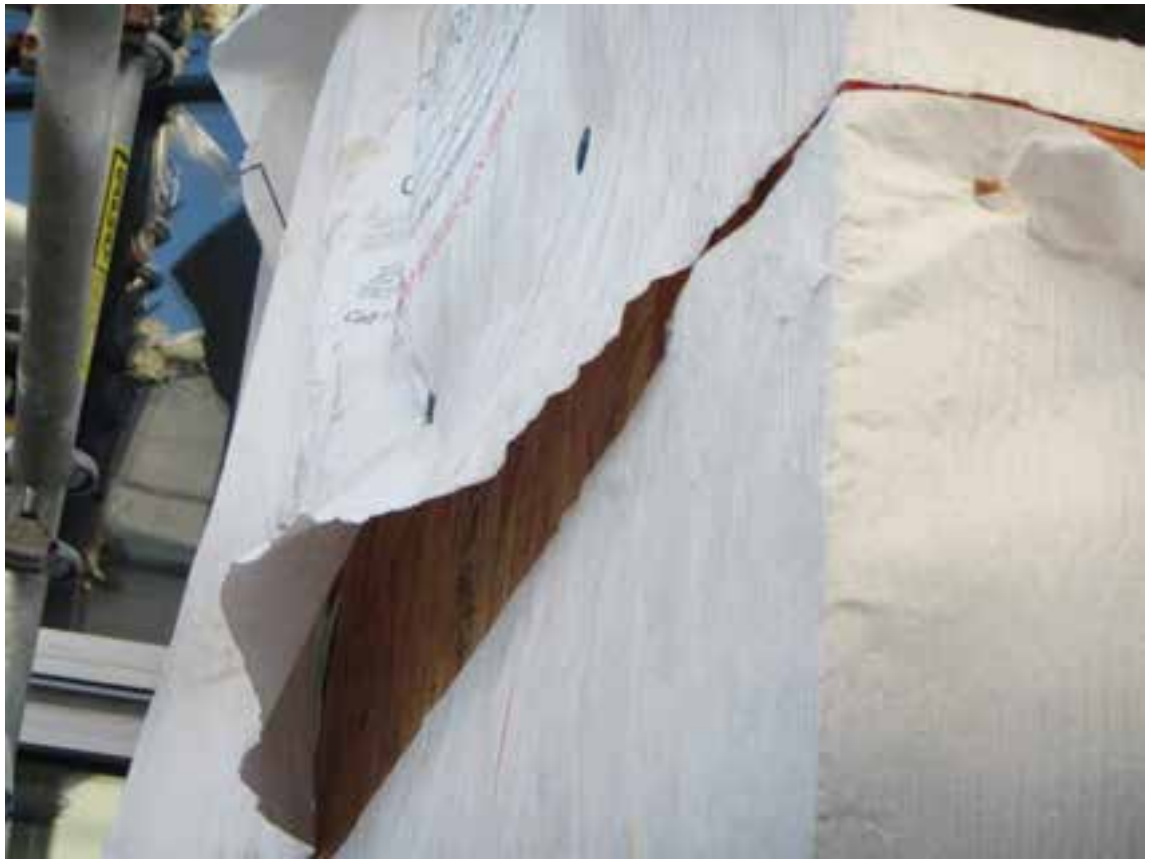
- Podiums – Detailing Recommendations





Challenging Details

- Field of Wall – Open Seams/Insufficient Overlap



Challenging Details

- Field of Wall – Open Seams/Insufficient Overlap

Challenging Details

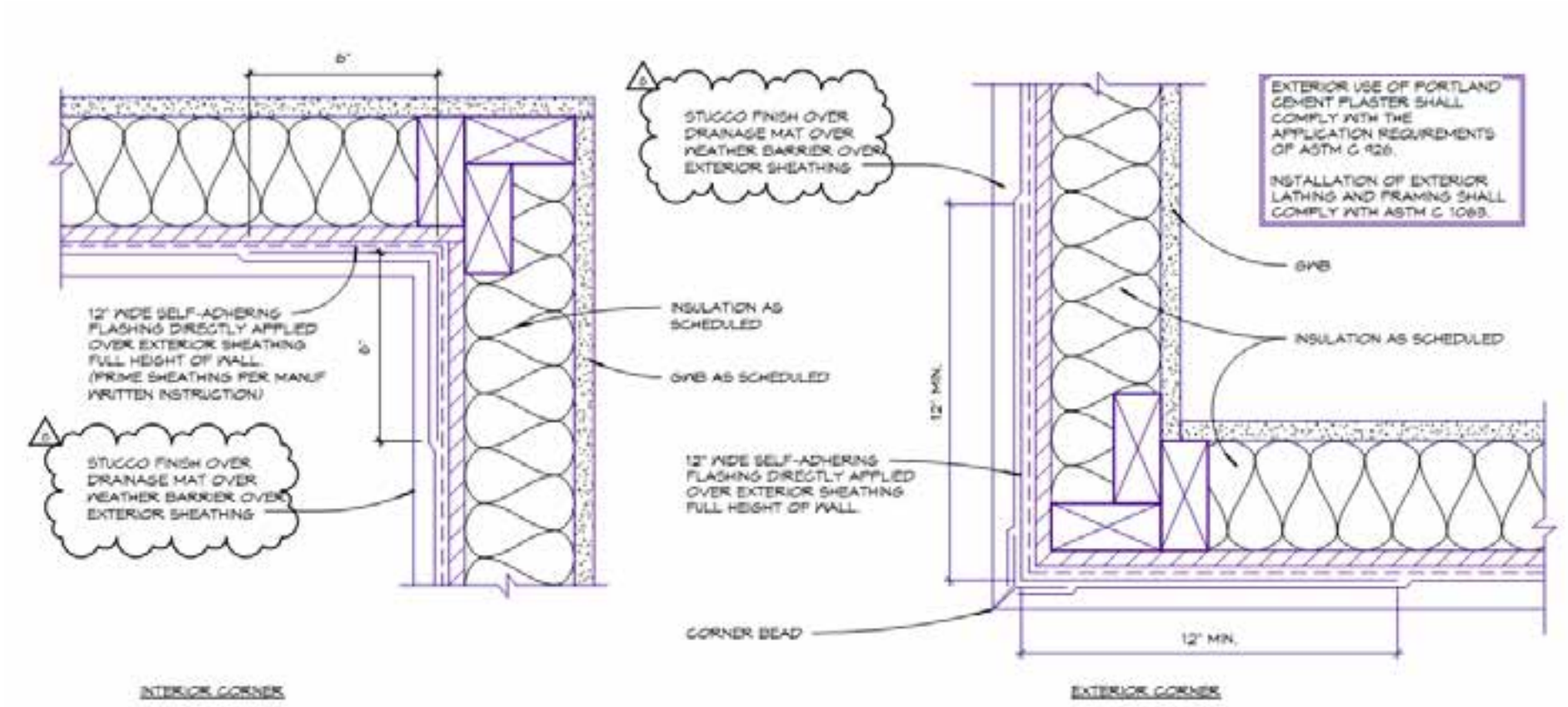
- Field of Wall – Damaged WRB

Challenging Details

- Building Corners

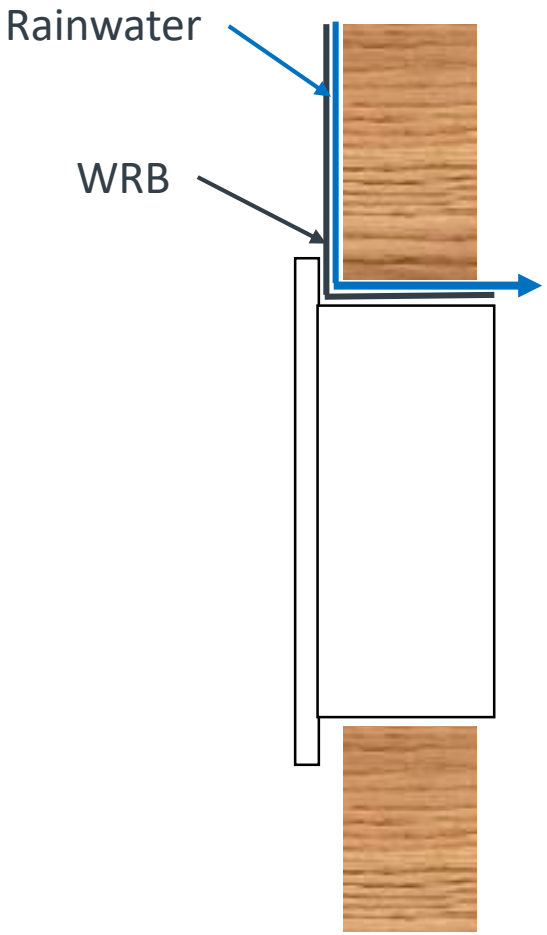
Challenging Details

- Building Corners - Detailing Recommendations



Challenging Details

- Punched Windows - Improper WRB Detailing at Head



Challenging Details

- Punched Windows – Poorly Adhered WRB at Corners

Challenging Details

- Punched Windows – Detailing Recommendations

Challenging Details

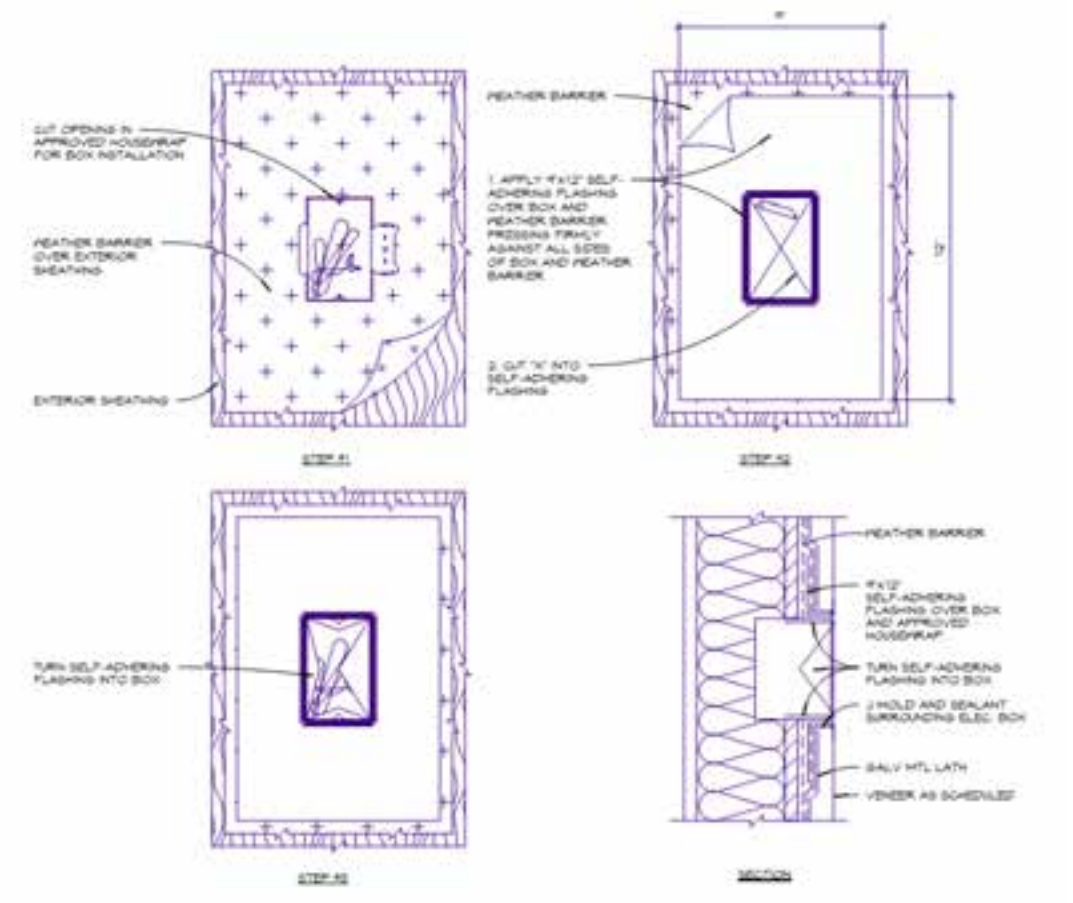
- Other Wall Penetrations – Lack of Flashing at Fire Sprinkler

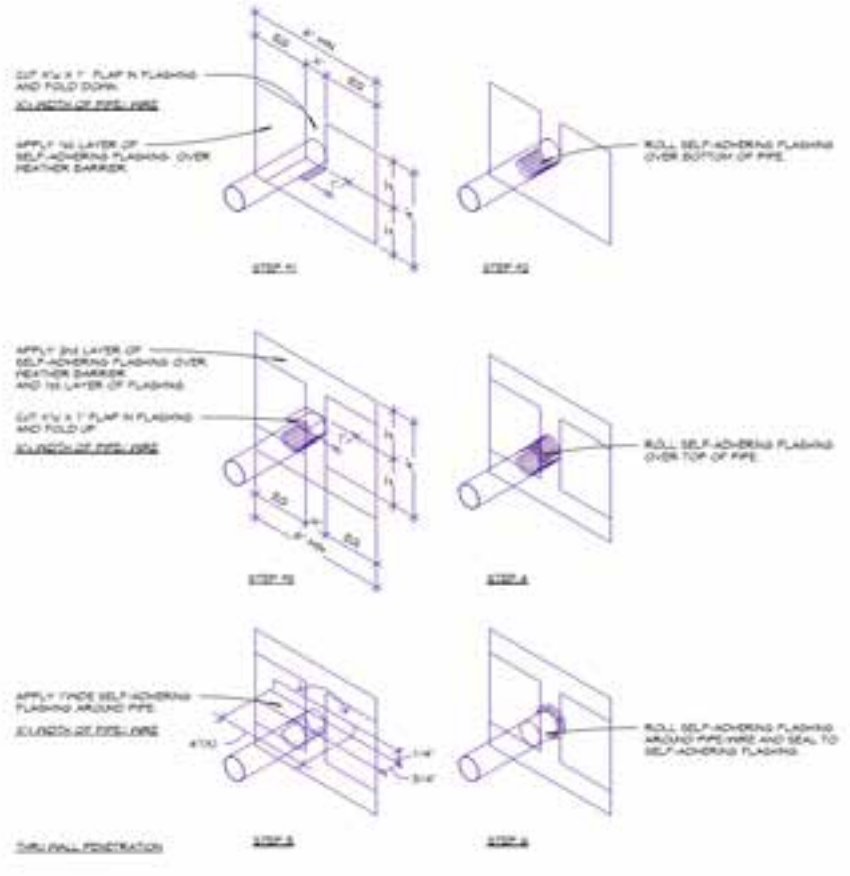
Challenging Details

- Other Wall Penetrations – Lack of Flashing at Pipe Penetrations

Challenging Details

- Other Penetrations – Detailing Recommendations



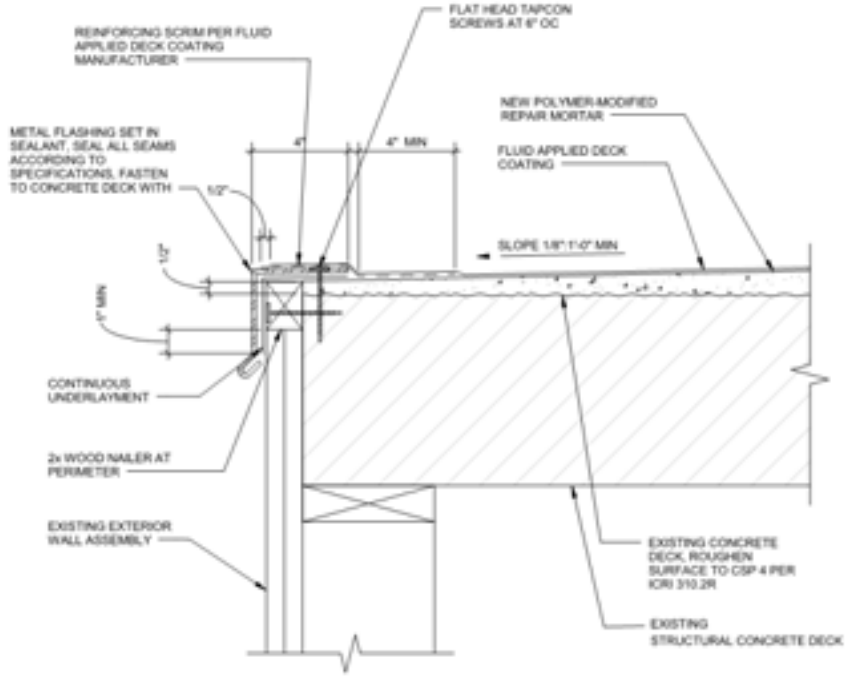


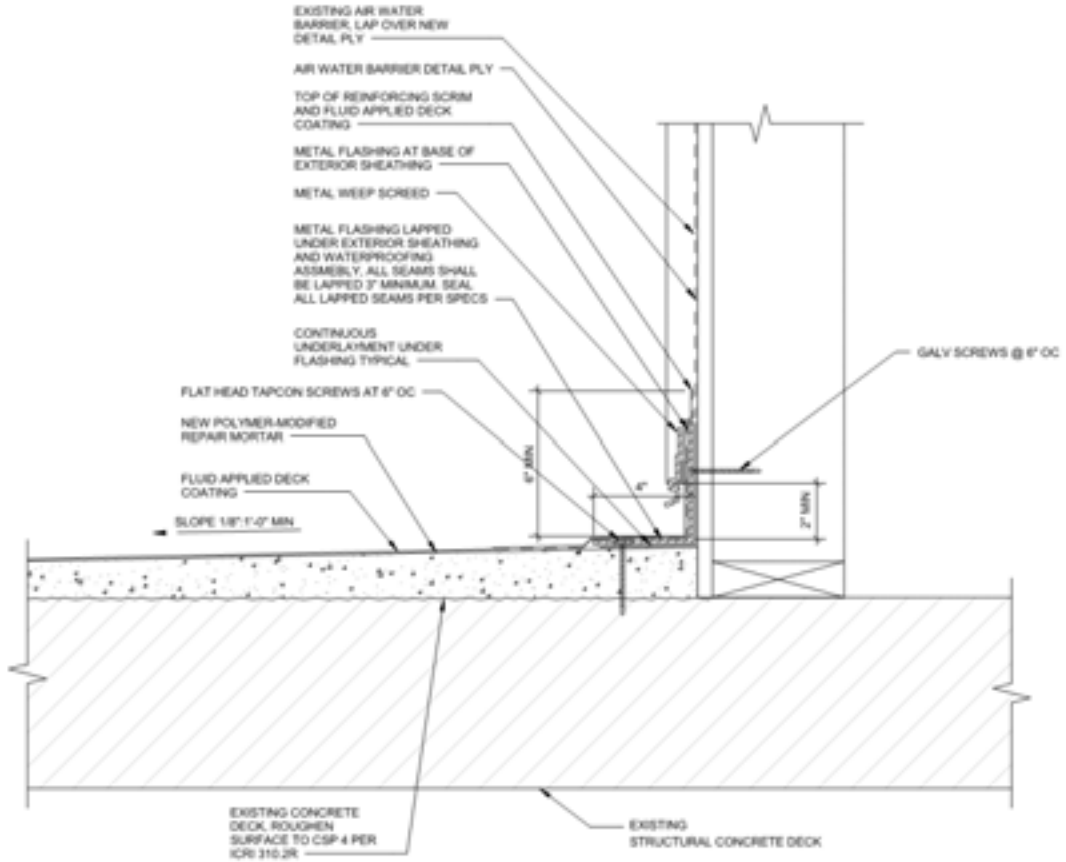
Challenging Details

- Balconies – Back Slope to Walls

Challenging Details

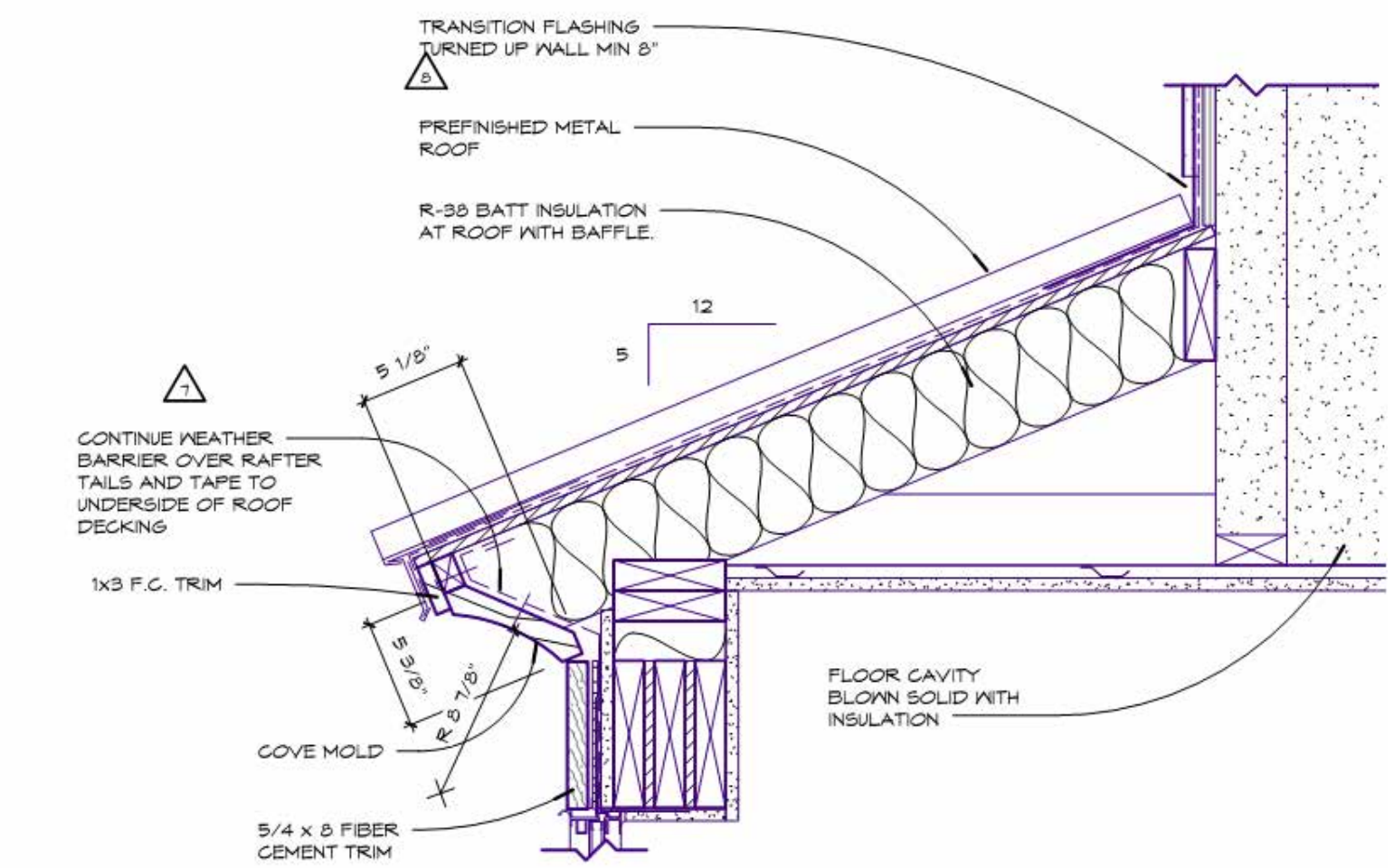
- Balconies – Detailing Recommendations





Challenging Details

- Roof-to-Wall Connections – Detailing Recommendations



Challenging Details

- Roof-to-Wall Connections – Sealant at Transitions

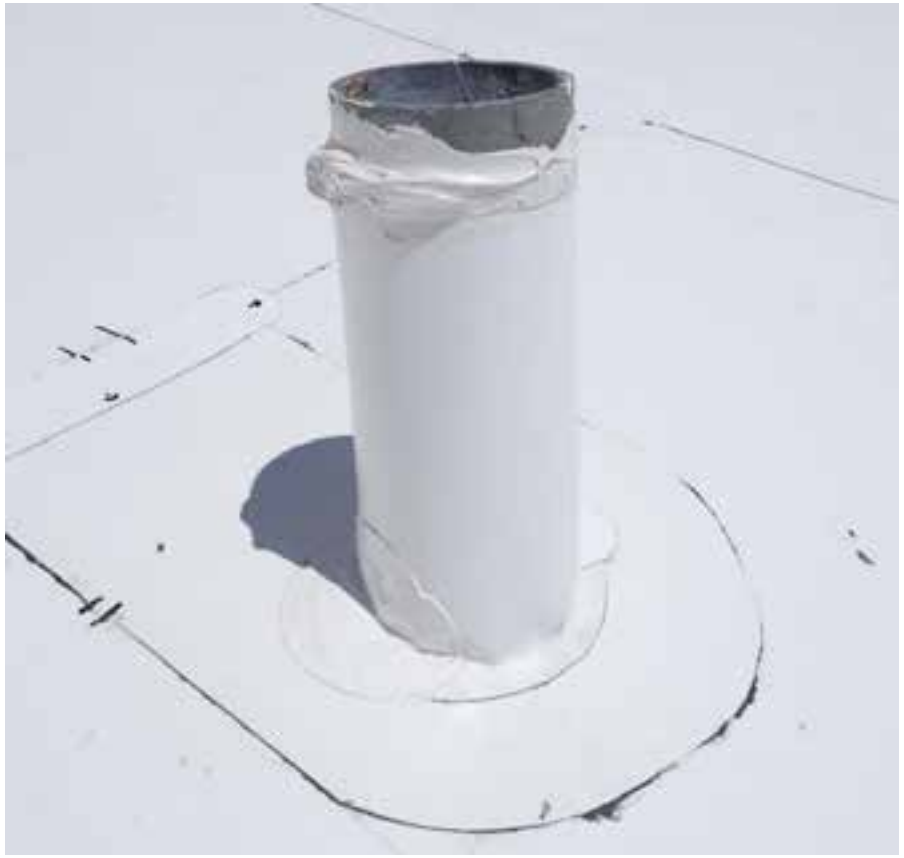
Challenging Details

- Field of Roofing – Slope and Drainage

Challenging Details

- Field of Roofing – Penetrations

No sealant

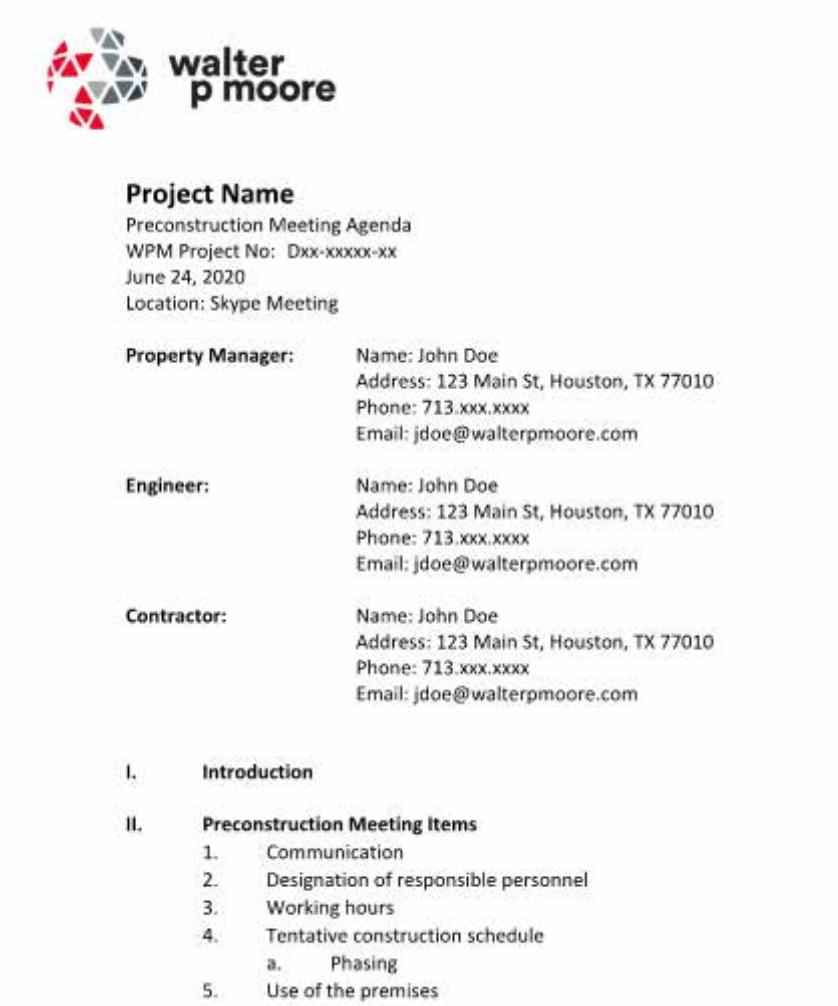


Properly clamped and sealed

Construction Administration

Construction Administration

- Critical Meetings
  - Pre-Construction Meetings
  - Pre-Installation Meetings
  - Mockup Reviews
  - Witness Testing Meetings
  - OAC Meetings



walter p moore

Project Name
Preconstruction Meeting Agenda
WPM Project No: Dxx-xxxxx-xx
June 24, 2020
Location: Skype Meeting

Property Manager: Name: John Doe
Address: 123 Main St, Houston, TX 77010
Phone: 713.xxx.xxxx
Email: jdoe@walterpmoore.com

Engineer: Name: John Doe
Address: 123 Main St, Houston, TX 77010
Phone: 713.xxx.xxxx
Email: jdoe@walterpmoore.com

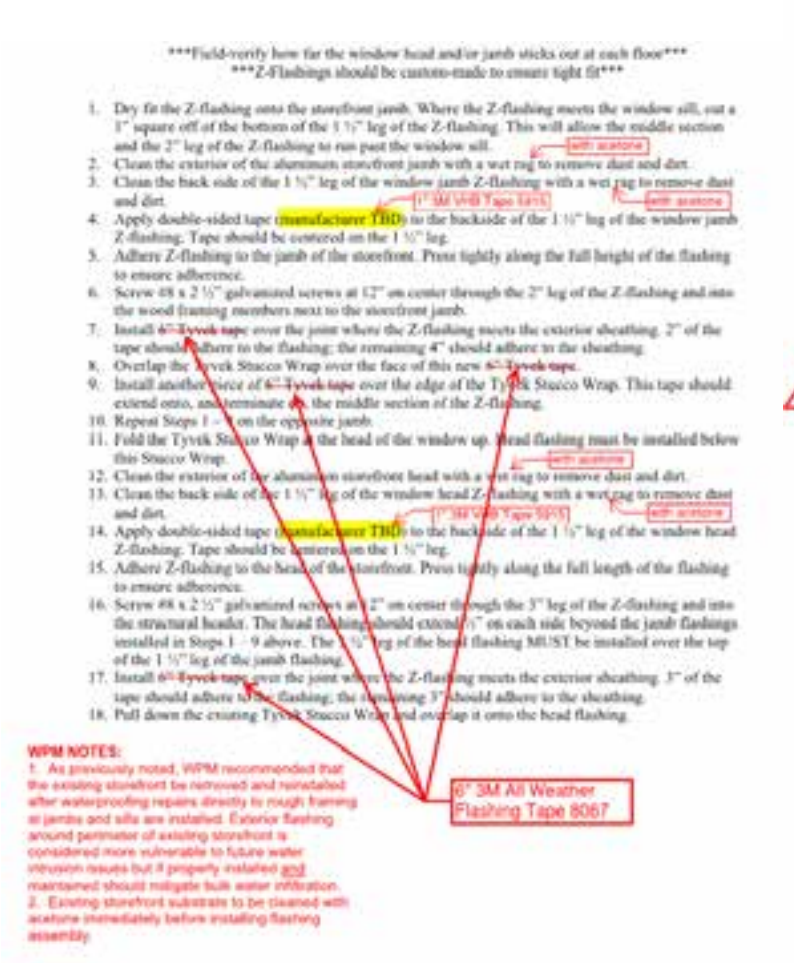
Contractor: Name: John Doe
Address: 123 Main St, Houston, TX 77010
Phone: 713.xxx.xxxx
Email: jdoe@walterpmoore.com

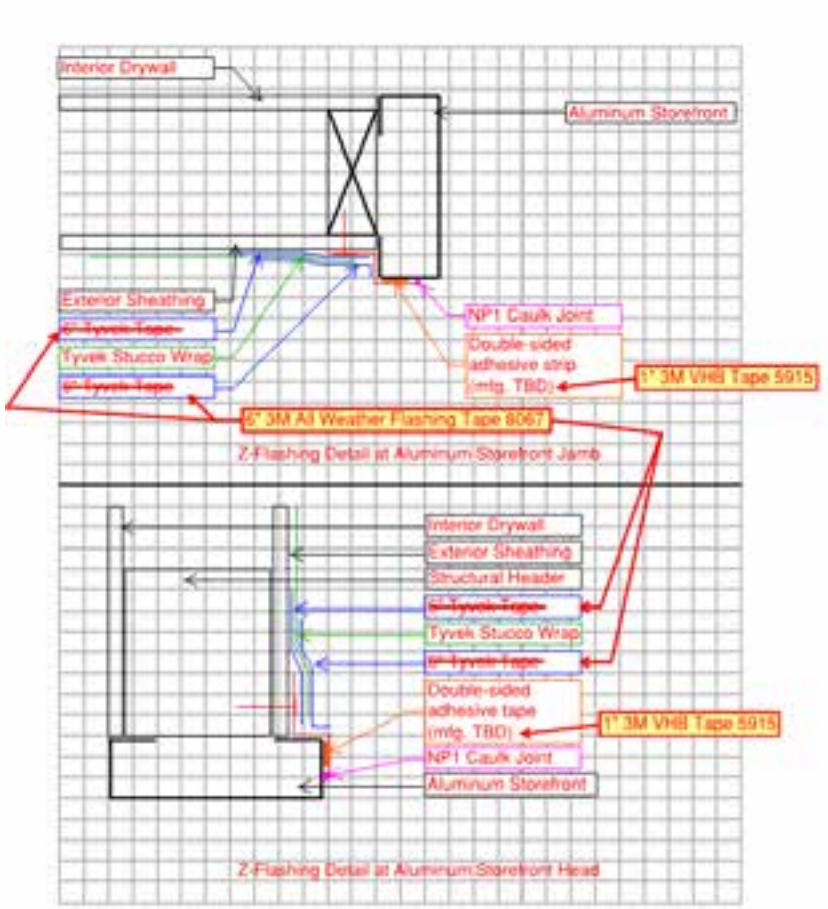
I. **Introduction**

II. **Preconstruction Meeting Items**
1. Communication
2. Designation of responsible personnel
3. Working hours
4. Tentative construction schedule
   a. Phasing
5. Use of the premises

Construction Administration

- Submittals and Shop Drawings





Construction Administration

- Field Mockups

Construction Administration

- Quality Assurance Testing

Summary

- Building enclosure is critical for the durability of buildings and well-being of residents
- Building enclosure must address all weather elements: water, air infiltration, thermal, and vapor
- There are a variety of control layers available, need to be selected based on the requirements and location of the building
- Detailing of control layers at transitions and discontinuities must be designed from below-grade foundation to the roof
- Construction administration is essential to ensure conformance of construction to design

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Practice Director – Enclosure Diagnostics
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