SoCal Chapter

Air Barrier & Continuous Insulation

Presented by:

Karim P. Allana, PE, RRC, RWC

Allana Buick & Bers, Inc. CEO & President, Sr. Principal

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Building Enclosure QA/QC
Hilton Hawaiian Village, Honolulu, HI

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Karim P. Allana, PE, RRC, RWC

Education: B.S., Civil Engineering, Santa Clara University

Registration: P.E., Civil Engineering, California, Washington, Nevada, and Hawaii

Certification: Registered Roof Consultant (RRC), Roof Consultants Institute, and Registered Waterproofing Consultant (RWC)

Overview:

- CEO and Senior Principal at Allana Buick & Bers.
- Former Turner Construction Employee (Project Engineering and Superintendent)
- Over 37 years experience providing superior technical standards in all aspects of building technology and energy efficiency.
- Principal consultant in forensic investigations of building assemblies, failure analysis, evaluation and design of building infrastructure and building envelope evaluation and design.
- Expert in all aspects of building envelope technology.
- Completed numerous new construction, addition, rehabilitation, remodel and modernization projects for public and private sector clients.
- Specialization in siding, roofing, cement plaster, wood, water intrusion damage, window assemblies, storefronts, below grade waterproofing, energy efficiency, solar engineering and complex building envelope and mechanical assemblies.

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Presentation Overview

- Air Barrier and Continuous Insulation
- Air Barrier Testing for Enclosure Performance

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Air Barriers and Continuous Insulation Requirements

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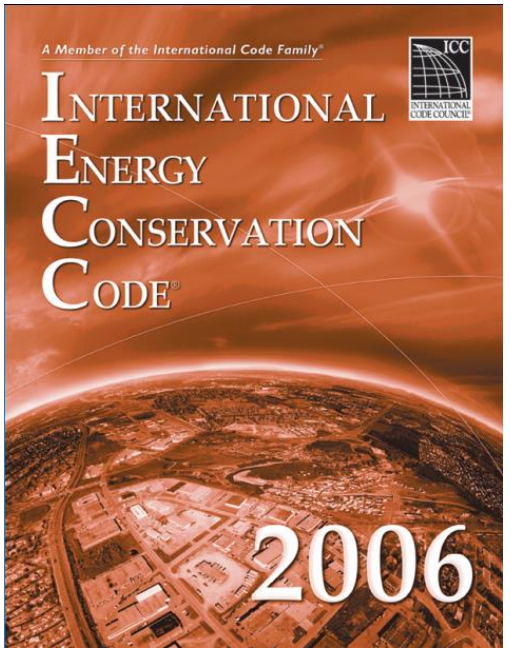
2006 IECC

- STATE ADOPTIONS
- Alaska, Tennessee
- Maui County*
- Honolulu County*
- Hawaii County*
- *Have independent and
- separate amendments
- Air Barrier Overall Requirements
- Residential vs. Commercial requirements
- General, non-quantative building envelope requirements
- Testing of the building envelope air barrier not required
- Quantified air leakage limitations for fenestration and doors with testing requirements.
- Not climate zone dependent



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2012 IECC
Air Barrier/Leakage Rates

- Assemblies of materials and components that have an average air leakage not exceeding 0.04 cfm/sf, under a pressure differential of 1.57 psf, when tested in accordance with ASTM E2357,E1677, E1680, or E283; or
- Exception to Section CEC Section 14.3(a)9B if all joints are sealed and all of the materials are installed as air barriers in accordance with the manufacturer's instructions.
- Consistent with air leakage req in IECC (140.3(a)9B)

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2015 IECC Code Adoption

- In March 2017 State of Hawaii Adopted the 2015 International Energy Conservation Code (IECC)
- Counties were provided a two year period to adopt
- Full adoption will occur in 2019
- Currently, most federal government projects require air barriers
- Air Barriers are required in both Residential and Commercial Construction

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Continuous Insulation Defined

- *Insulation that is continuous across assemblies that separate conditioned from unconditioned space. It is installed on the exterior or interior or is integral to any opaque surface of the building envelope and has no thermal bridges other than fasteners and necessary service openings.*

  -2013 Title 24, Part 6

- *Insulation that is installed in such a that is continuous and is uninterrupted by framing members or other construction elements that would reduce the thermal resistance of the insulation.*

  -2004 ASHRAE 90.1 User's Manual

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R Value Reductions; Why Code is Requiring It!

TABLE A9.2-2 Effective Insulation/Framing Layer R-Values for Wall Insulation Installed Between Steel Framing

Nominal Depth of Cavity, in.	Actual Depth of Cavity, in.	Rated R-Value of Airspace or Insulation	Effective Framing/Cavity R-Value at 16 in. on Center	Effective Framing/Cavity R-Value at 24 in. on Center
Empty Cavity, No Insulation				
4	3.5	R-0.91	0.79	0.91
Insulated Cavity				
4	3.5	R-11	5.5	6.6
4	3.5	R-13	6.0	7.2
4	3.5	R-15	6.4	7.8
6	6.0	R-19	7.1	8.6
6	6.0	R-21	7.4	9.0
8	8.0	R-25	7.8	9.6

Metal framed wall assemblies require a reduction factor.

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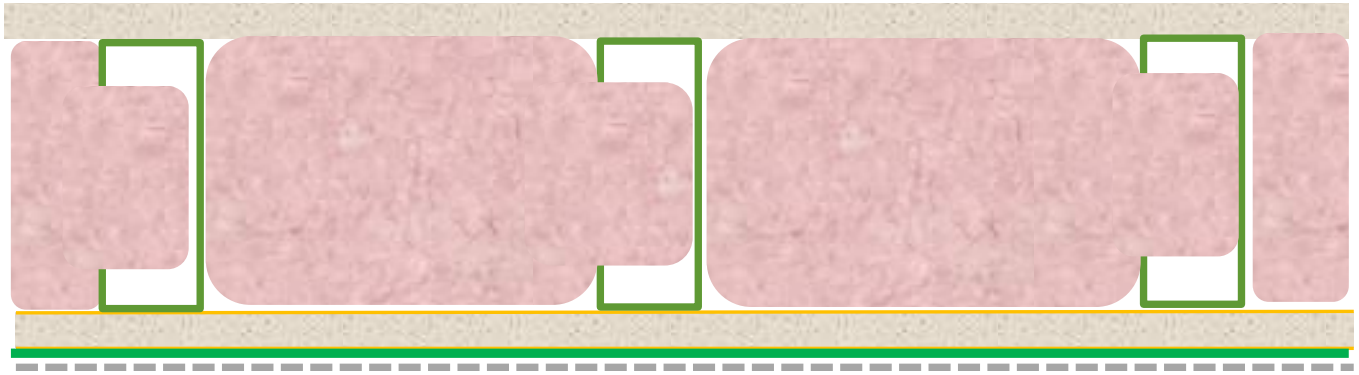
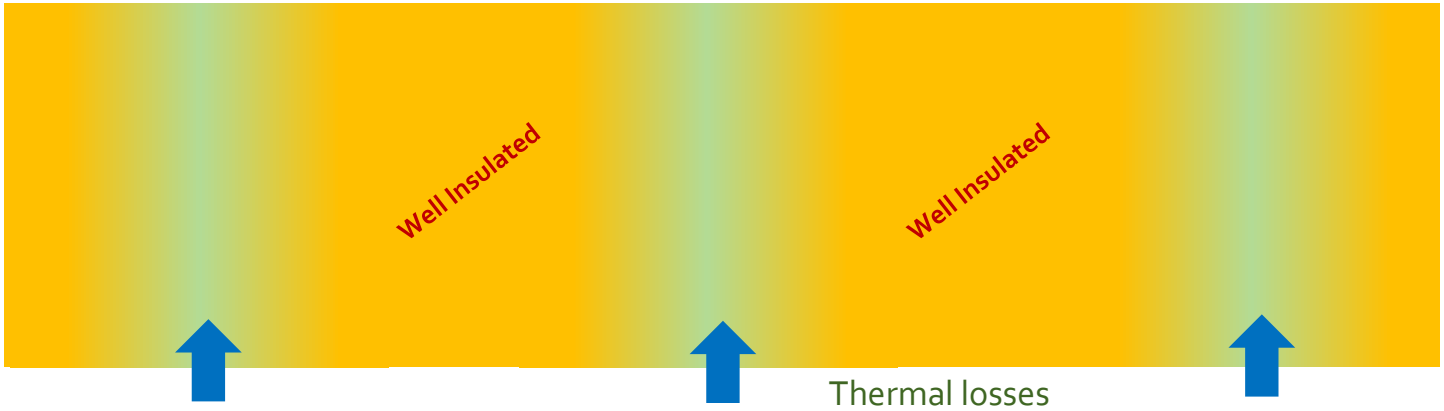
Typical Exterior Insulation



Traditional Insulated Wall Section



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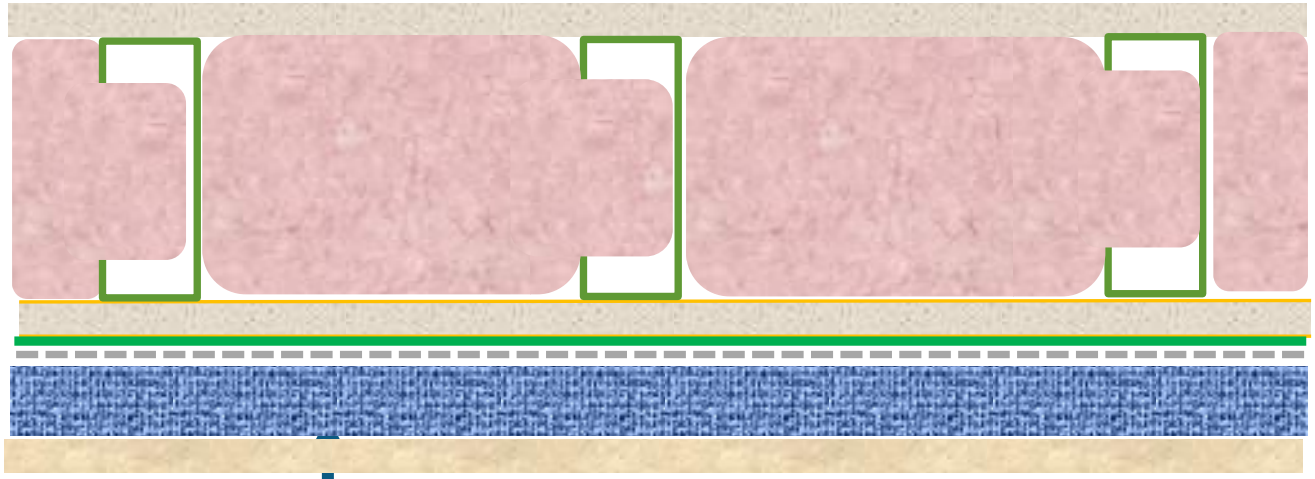
Typical Continuous Exterior Insulation



Continuous Insulated Wall Section

Smaller Thermal Anomalies

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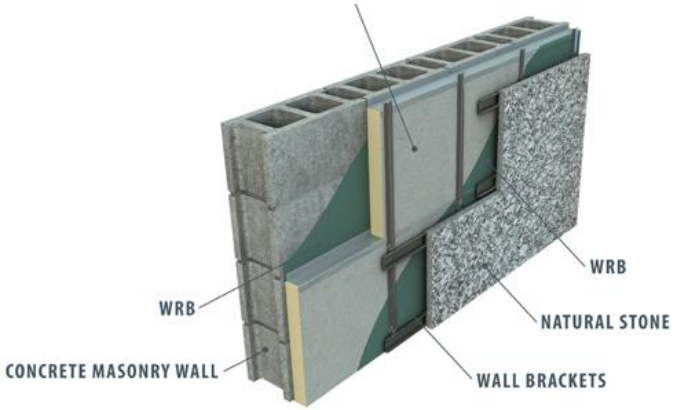
How do we Solve the CI challenge?

- Material Selection

- Design Consideration



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Material Selection Considerations

- R-value
- Air and vapor permeability
- Moisture resistance
- Composite qualities (i.e. – integral cladding, weather resistant barrier, air barrier, interior vapor barrier)
- Fire Resistance
- UV Resistance (for open joint assemblies)
- Furring and Effective R Reductions

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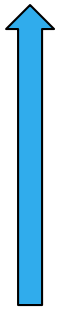
Continuous Insulation Options



R
Value

- <u>Insulation Panels and Materials</u>
- ccSPF – Closed Cell Spray Polyurethane
- PolyIso – Polyisocysanurate
- XPS – Extruded Polystyrene
- Mineral Wool Insulation
- EPS – Expanded Polystyrene

- <u>Insulation Panel Enhancements</u>
- Foil Facing
- Plywood Facing
- Reinforced Cementitious Coating Faced

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Insulation Panel Manufacturers

Manufacturer	Product Name	R / inch	Perms
A	A	6	< 0.3
B	B	5.0 6.5	1.5 < 0.3
C	C	3.85	> 2.0
D	D	5.2 *	1.5
E	E	5.0 *	0.2
F	F	4.3	27.2
G	G	4.2	50
H	H	6.62 **	1.39
I	I	6.0 *	< 1.0
J	J	6.0 *	< 1.0

* Based on LTTR
** 6.62 – 6.9 Based of Formulation

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Insulation Assembly Manufacturers

Manufacturer	Product Name	R / inch	Perms
EIFS – Exterior Insulating Foam System			
A	A	3.6	Varies
B	B	3.8	Varies
C	C	N P	N P
D	D	N P	N P
SIPS – Structural Insulated Panel			
E	E	3.6	0.5
F	F	3.5	< 1.0
G	G	4.2	< 1.0
ICF – Insulated Concrete Forms			
H	H	5 - system	N P
I	I	1.8 / 4 *	0.624
J	J	N P	0.63
K	K	2.4 / 3.8 *	2.3

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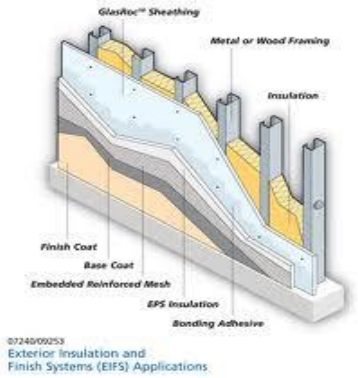
Continuous Insulation Composites

- Insulated Concrete Forms

- Structural Insulated Panel System



- Exterior Insulated Foam System

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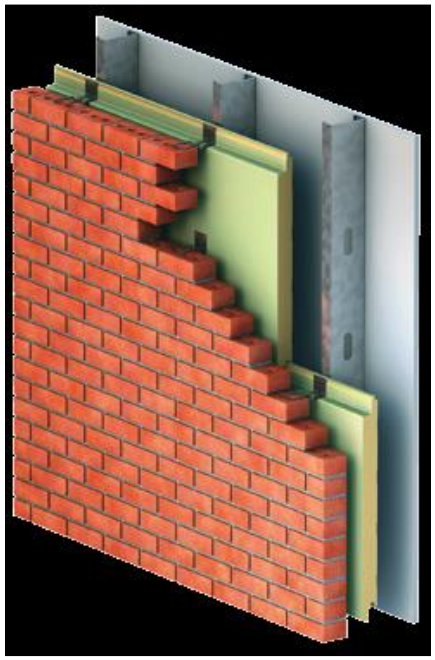
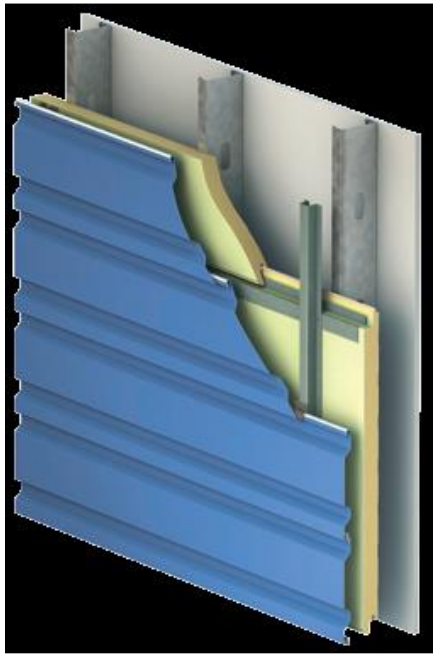
Metal Panels With Insulation





- These types of system requires clips and mechanical fasteners that bridges heat.
- Adhered Insulation like EIFS does not require fasteners.

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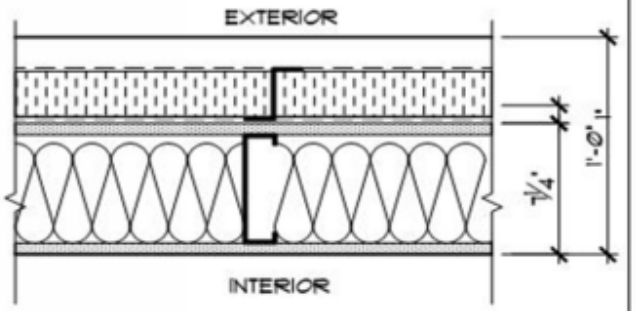
Wall Section Real R Value

E4

EXTERIOR WALL
METAL SIDING
(TYPE IA)



HORIZONTAL METAL SIDING
(A) AEP PRESTIGE METAL PANEL SYSTEM OR
(B) STANDING SEAM METAL SIDING,
¾" VERTICAL FURRING CHANNELS @ 24" O.C. GALV. STEEL
2 1/2" (R-15) POLYISO RIGID INSUL
WEATHER BARRIER (PER SPEC)
5/8" TYPE 'X' GWB SHEATHING
6" STEEL STUD @16" O.C. WALL (PER STRUCTURAL)
R-21 BATT INSULATION
5/8" TYPE 'X' GWB
PVA PRIMER

E-4					
Material	Thickness	Perms	Pub. R-Value	Reduction	Eff. R-Value
Metal Cladding	1.5	0.01	0	0	0
Air Space	0.75	100	0.25	0	0.25
Foil Faced PolyIso with Z girts 16 inches on center *1	2.5	0.01	15	0.74	3.9
WRB/AB	0	23	0	0	0
Sheathing (Gyp)	0.625	50	0.5	0	0.5
Unfaced Batt with metal studs 16 inches on center *2	6	70	21	0.65	7.4
Sheathing (Gyp)	0.625	50	0.5	0	0.5
PVA Primer and Paint	0	0.5	0	0	0
Inside Air	0	0	0.68	0	0.68
	12		37.93		13.23
			Base Line		Base Line

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San Diego International Airport Continuous Insulation Mock-Up

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Continuous Insulation System for SD Airport

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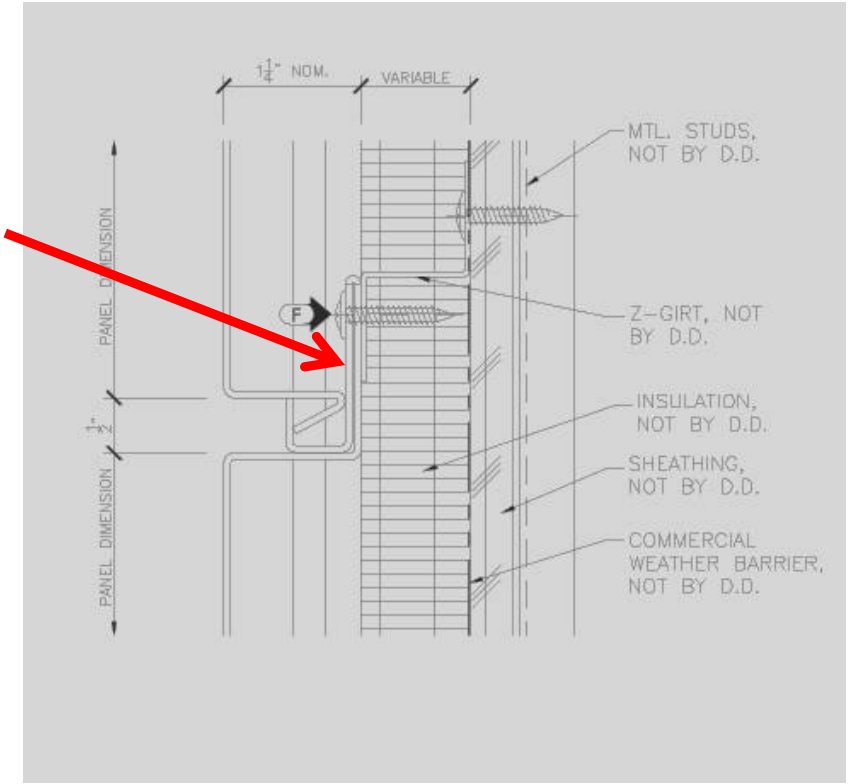
Thermal Bridges

- Because metal is a terrific conductor of heat, thermal bridges increase the U-value of an assembly
- In a side by side comparison, metal stud framing is 15 - 50% less efficient than wood framing
- Z-girts through continuous insulation assemblies increase the U-values of the assembly by 20-40%
- R-21 with Z-girts = R-15eff



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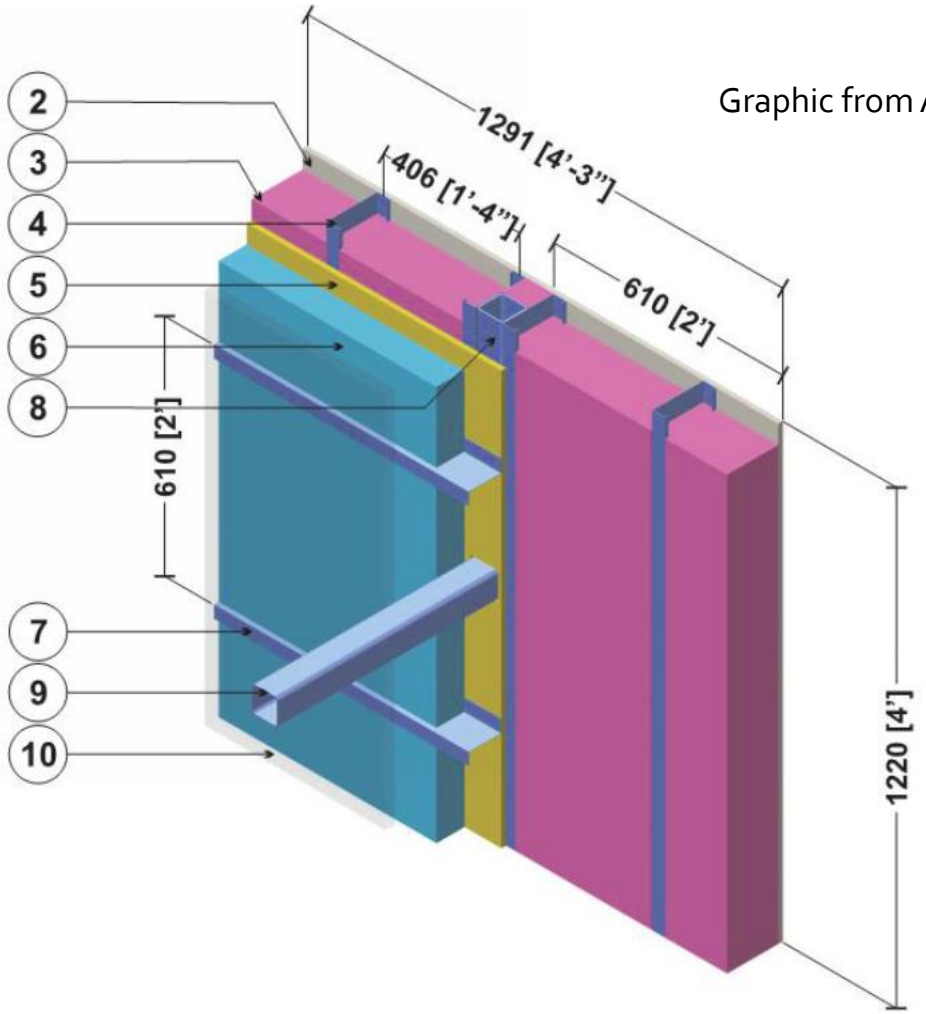
Z-Girt and Canopy Support



Graphic from ASHRAE-D-RP-1365

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Air Barrier Basics

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Air Barrier Defined

- "Materials assembled and joined together to provide a barrier to air leakage through the building envelope. An air barrier may be a single material or a combination of materials."

  -2015 International Energy Conservation Code (IECC)

- A system of materials combined to form continuous control of the air leakage of a building.

  -Air Barrier Association

- Air barriers define the location of the pressure boundary of the building enclosure.

  -Joseph Lstiburek of the Building Science Corporation

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How Does Air Leakage Occur

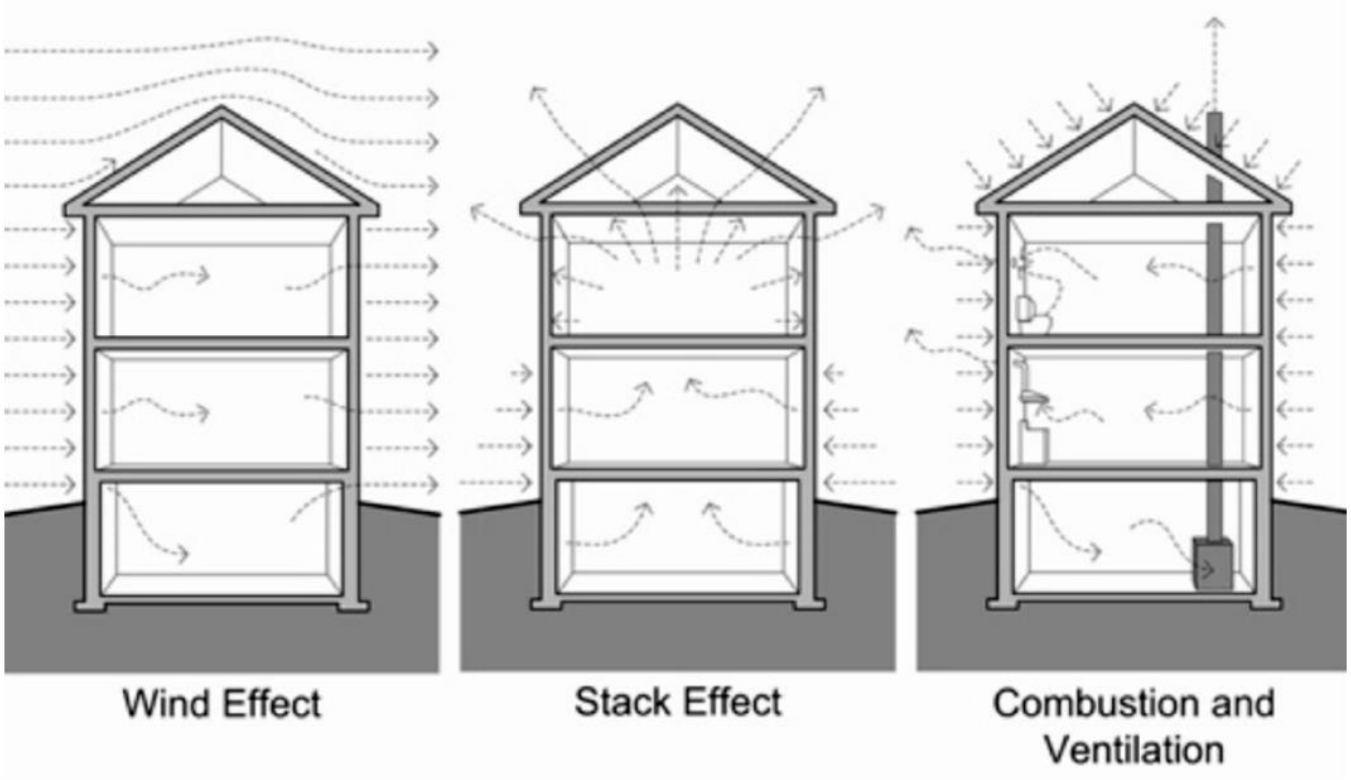

Figure 1: Examples of infiltration. Image courtesy: Building Science Corporation, www.buildingscience.com

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Material vs. Assembly vs. System

- Air Barriers are commonly defined and tested in three categories:
- As a Material
- As an Assembly (network of materials)
- As a System (network of assemblies)

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Material vs. Assembly vs. System

- Air Barrier Material Testing Requirements

ASTM E2178-11 Standard Test Method for *Air Permeance* of Building Materials.

< 0.02 L/(s•m²) @ 75 Pa (0.004 cfm/ft² @ 1.57 lb/ft²)

- Air Barrier Assembly Testing Requirements

ASTM E2357-11 Standard Test Method for Determining *Air Leakage* of Air Barrier Assemblies

<0.2 L/(s•m2) @ 75 Pa (0.04 cfm/ft2 @ 1.57 lb/ft2)

- *Air permeance is the amount of air that migrates through a material, whereas…*
- *Air leakage is the air that passes through holes or gaps*

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Material vs. Assembly vs. System

Air Barrier System (Building) Testing Requirements

- ASTM E779-10: Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

  2015 IECC - Energy Code Requires:

  < 0.40 cfm/ft² @ 1.57 lb/ft²

  US Army Corps of Engineers Requires:

  < 0.25 cfm/ft² @ 1.57 lb/ft²

- ASTM E1827-11: Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
- ASTM E283-04: Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
- ****Testing can be done by Unit(s), Floor(s) or Building. If air barrier testing is planned by unit, detailing and continuity needs to be by unit.*

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Air Barrier Techniques and Materials

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3 Typical Air Barrier Approaches

- Air Tight Drywall and Framing
- Exterior Sheathing
- Exterior Weather Resistive Barrier
- *Most successful approach is a combination of approaches*

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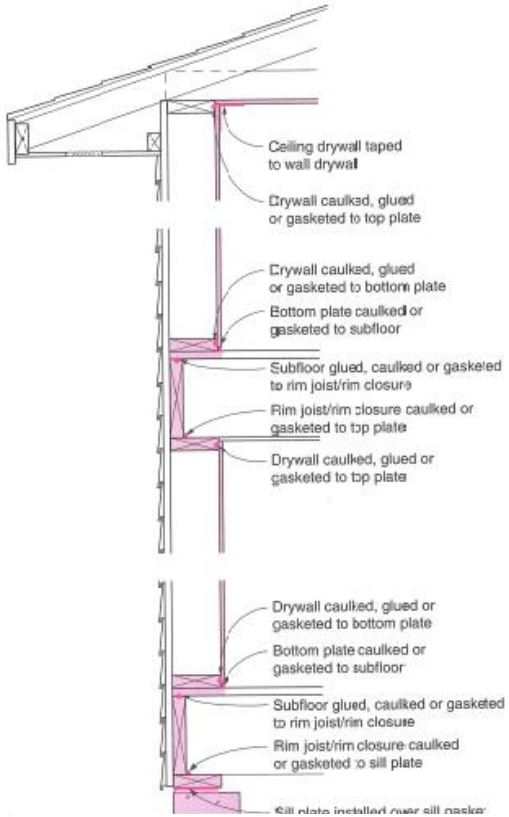
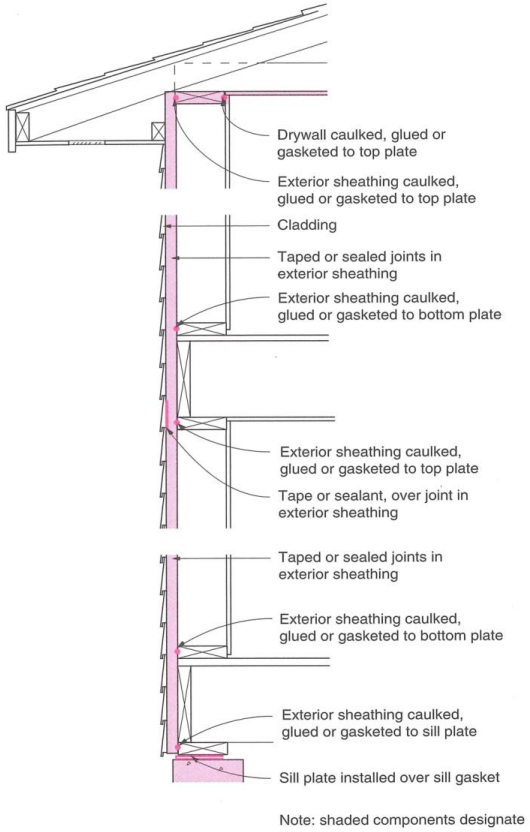
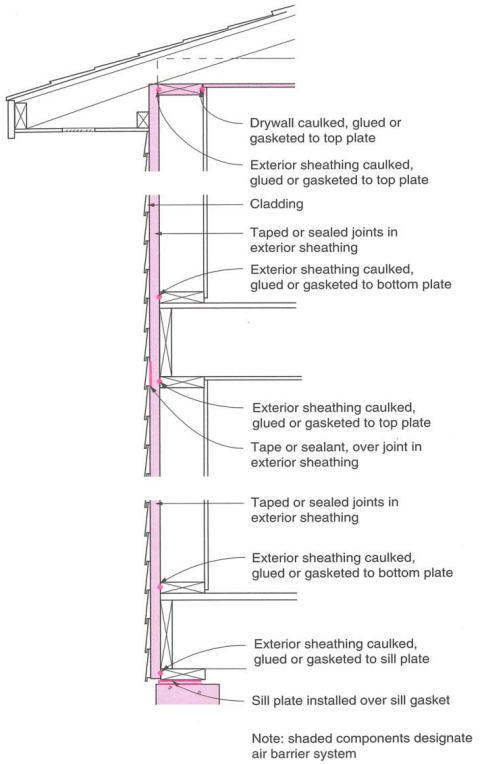
Air Barrier Approaches



Interior Drywall Approach



Exterior Sheathing



Exterior Barrier

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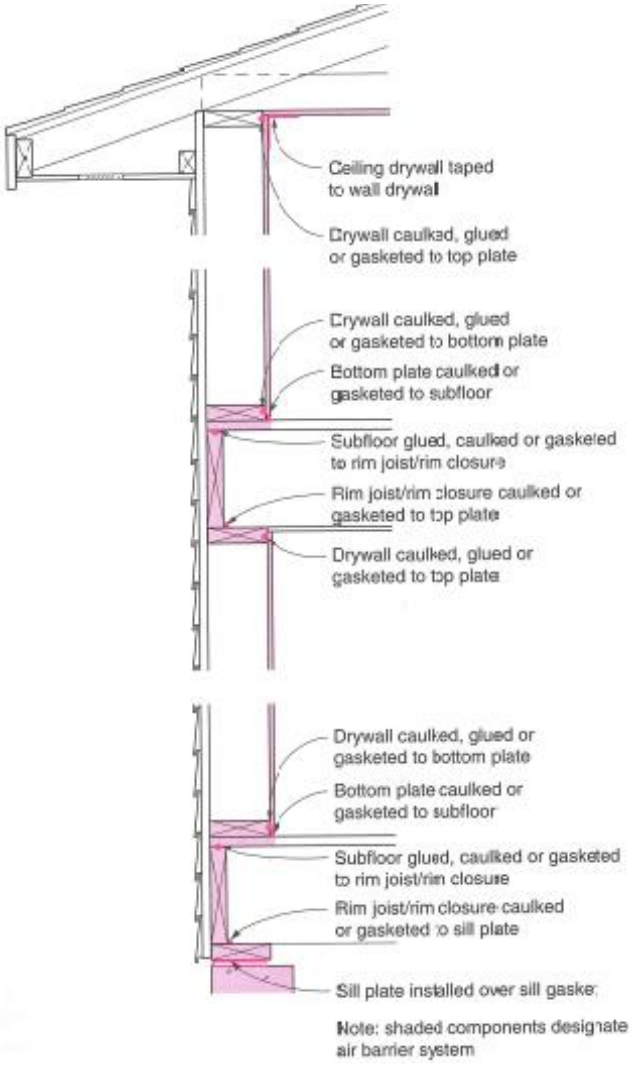
Air Tight Drywall and Framing Approach



Taken from Moisture Control Handbook

- Requires taped seams, spray foam, sealants and other air barrier transition components

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Air Tight Drywall and Framing Approach

Pros

- Controls the entry of interior, moisture laden air from entering into wall cavity
- Can be enhanced with ccSPF
- Repaired easily
- Inspected visually and tested easily
- Lower cost

Cons

- Does not control exterior humidity from reaching interior cool surfaces
- Humid air from outside can condense on interior surfaces (Not recommended for Hawaii)
- Easily damaged by occupant usage
- Demising walls require detailing
- Several trades involved in the proper installation of the entire system

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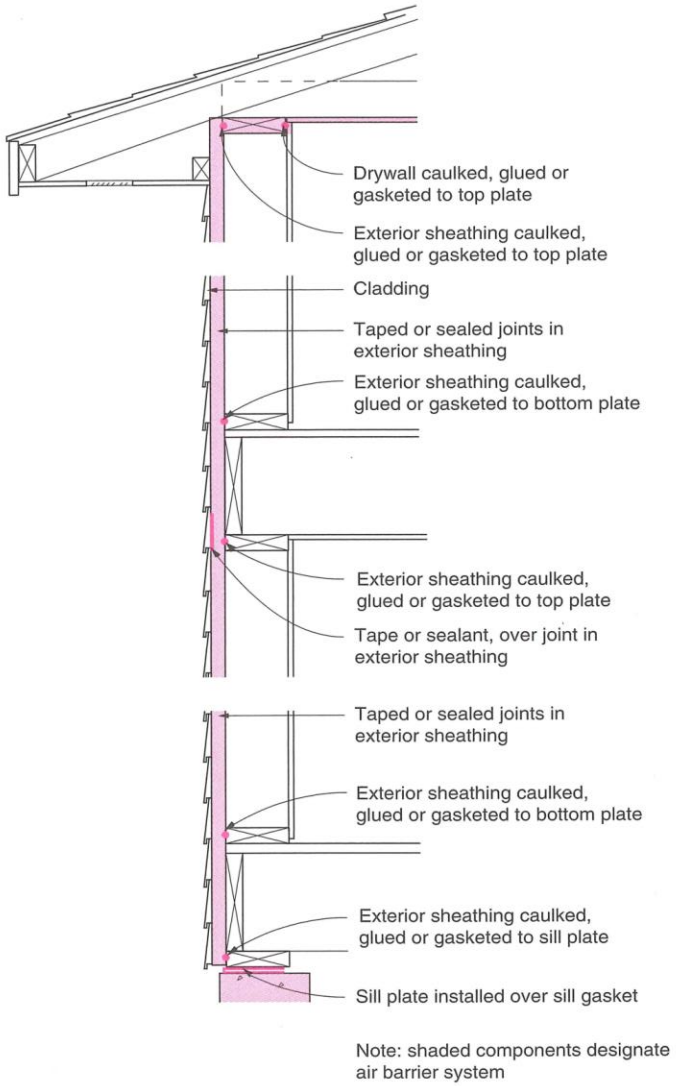
Exterior Sheathing Approach



Taken from Moisture Control Handbook

- Plywood
- OSB
- Gypsum Board
- Requires tapped seams, spray foam, sealants and other air barrier transition components

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Seal Joints and Gaps

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Seal Joints and Gaps in Sheathing

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Thoroughly Seal Gaps in Sheathing

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Sealing Sheathing Joints

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Tape, Mud or Seal Joints and Gaps

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Seal Joints and Gaps

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Exterior Sheathing Approach Pros and Cons

Pros

- Cost Effective
- Can be enhanced with ccSPF
- Controls both air and vapor
- One – two trade installation
- Inspected visually and tested / repaired easily
- Controls wind-washing of insulation

Cons

- Building Movement Could Create Discontinuity
- Joint Treatment may be Weather Sensitive
- Subject to construction damage / penetrations after installation
- Requires weather resistant barrier to control moisture

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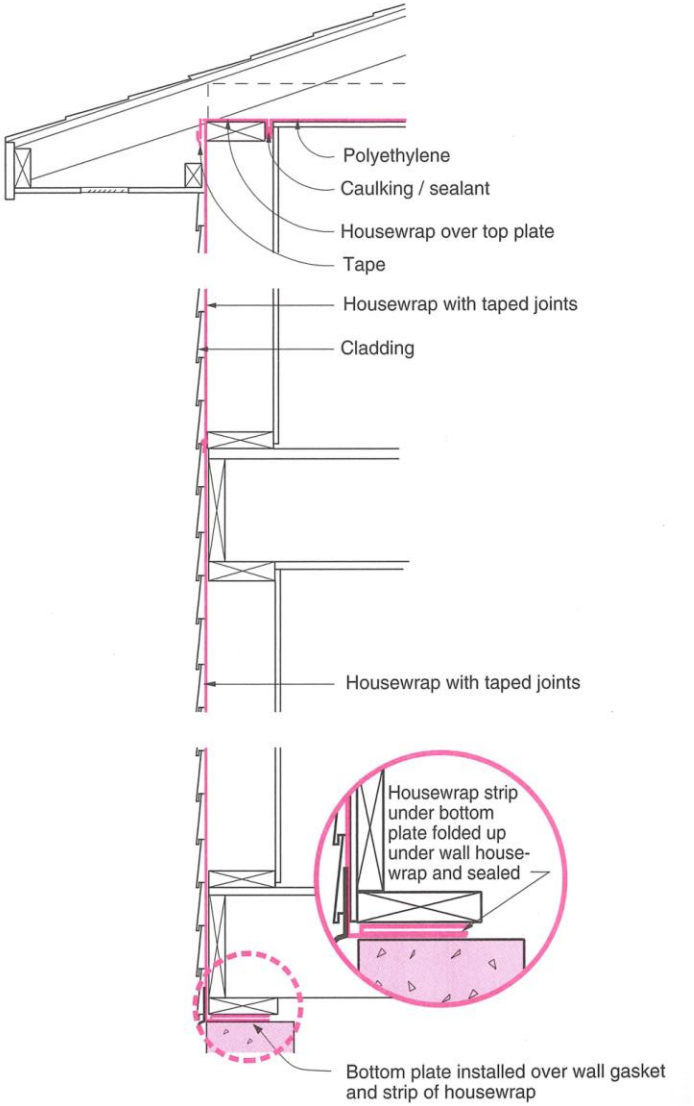
Exterior Weather Resistant Barrier Approach



Taken from Moisture Control Handbook

- Liquid Applied Coatings
- Non-Adhered Membranes
- Adhered Membranes
  - Requires tapped seams, spray foam, sealants and other air barrier transition components

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Liquid Applied WRB and Air Barrier Mock-Up

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Liquid Applied w/Self Adhered Flashings

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Liquid Applied Approach Pros and Cons

Pros

- Controls air, vapor and moisture
- One trade installation
- Inspected visually and tested / repaired easily
- Controls wind-washing of insulation
- Controls exterior humidity (Hawaii)
- Nail Seal-ability
- Seamless

Cons

- Potential Adherence Issues with Multiple Substrates
- Blistering
- Requires substrate board
- May Require Crack Bridging Characteristics
- Current total system cost higher than other approaches

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Adhesion Issue

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Blistering

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Air and Water Barriers Manufacturers

- Permeable and Semi Permeable Fluid Applied:

Manufacturer	Product Name	Perms Dry / Wet	Air Leakage
A	A	0.08 / 5.85	0.0066
B	B	11.48/24.23	0.0036
C	C	0.09 / 0.03	<0.004 <0.004
D	D	0.57 / 36.12 0.23 / 1.02	0.004 0.0029
E	E	4.27 / 5.49	0.0064
F	F	0.828 / 9.2	0.0548
G	G	2.52 / 10.5	0.016
H	H	2.52 / 5.7	0.016
I	I	na / na na / na	0.0026 0.0035

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Non-Adhered Membrane, All Seams Taped

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Non-Adhered Membrane Approach

Pros

- Controls air, vapor and moisture
- One trade installation
- Inspected visually and tested / repaired easily
- Controls exterior humidity
- Potential for Nail Seal-ability
- Homogenous materials
- Not Weather or Temp dependent
- Large rolls = Fast installation

Cons

- Potential UV exposure issues if left un-cladded
- Potential blow off issues if left un-cladded
- Seams require taping
- May require substrate board to resistant inward and outward pressures
- Requires different fastenings than WRB installation
- Integration of flexible flashings

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Air and Water Barriers Manufacturers

- Non-Adhered Sheet Assemblies

Manufacturer	Product Name	Perms Dry / Wet	Air Leakage
A	A	25.31/32.68 42.65/42.48 56 / 54	0.0023 0.00225 Pass
B	B	12.33 / np 13.52 / np 45.45 / np	<0.001 <0.001 <0.0001
C	C	np / 212 np / 50	Not A.B. <0.0094
D	D	10 / np 12 / np	Not Test'd Not Test'd

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Adhered Membrane WRB and Air Barrier

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WRB/AB –Self Adhered Sheet

Pros

- Controls air, vapor and moisture
- One trade installation
- Inspected visually and tested / repaired easily
- Controls wind-washing of insulation
- Potential for Nail Seal-ability
- Homogenous materials
- No blow off issues

Cons

- Potential UV exposure issues if left un-cladded
- Requires substrate board
- May require primer
- Higher cost
- Heavier rolls
- Compatibility issues with other air barrier components

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Air and Water Barriers Manufacturers

- Self Adhered Sheet Assemblies –
- Vapor Permeable
- Vapor Barrier are acceptable in Hawaii

Manufacturer	Product Name	Perms Dry / Wet	Air Leakage
A	A	np / 0.05	0.0002
B	B	0.03 / 0.86	0.006
C	C	np / .047	0.0013
D	D	0.05 / np	<0.0009
E	E	np / 50	<0.0001
F	F	np / 50	<0.0001
G	G	np/ >15	<0.004

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SAM, Who is This guy on My details?

- Self adhered membrane is meant to supplement the WRB by:
  - Acting as a transition between details
    - Through wall flashings at grade
    - Head flashings
    - Window sill and jambs
    - Penetrations
  - Providing "self sealing" at highly nailed regions of the WRB for air and water
    - Brick ties
    - Trim
    - "z" girts
  - Providing a higher level of water resistance at horizontal projections

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Air Barrier & CI Design Considerations

- Location of the Air Barrier / WRB
- Thermal Bridging
- Edge treatments and terminations
- Sequencing and Testing – Review of WRB

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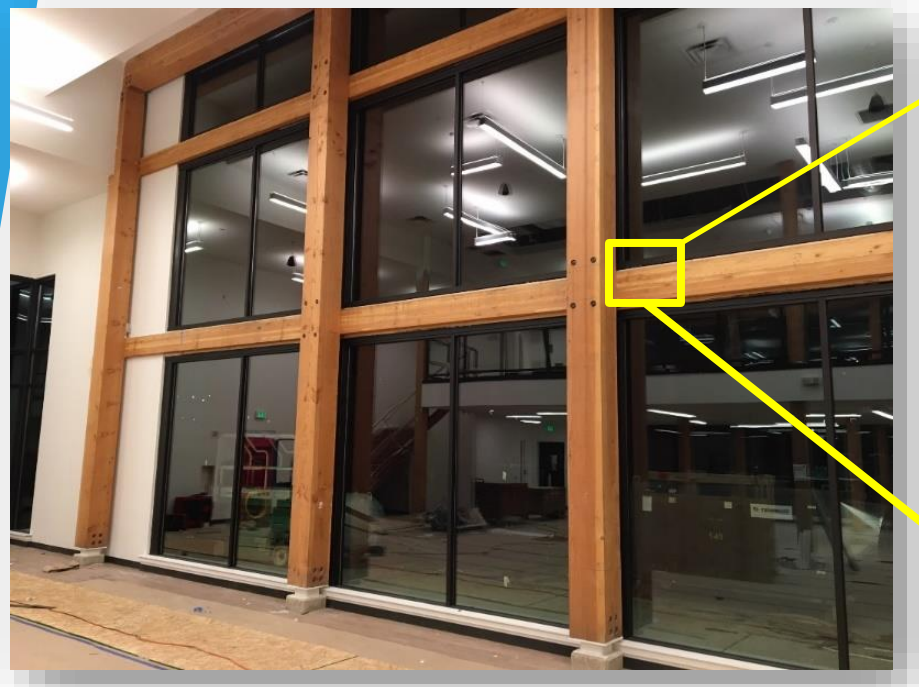
Interior Air Seal is Often Required in Fenestration



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Interior Air Seal Missing

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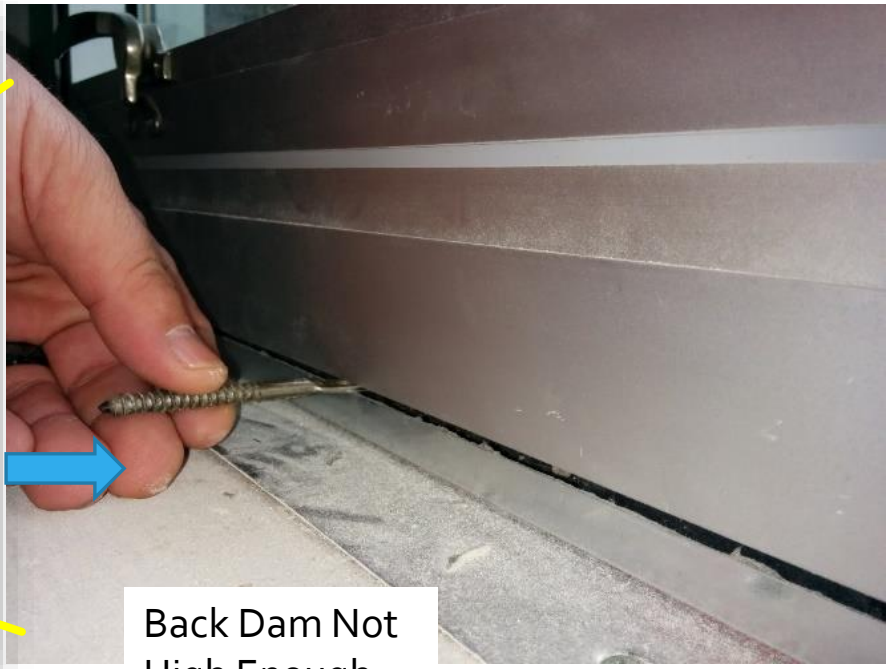
Interior Air Seal Missing



Back Dam Not High Enough

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Expansion Joints: Difficult to Get Air & Water Tight

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Mineral Wool And Self Adhered WRB

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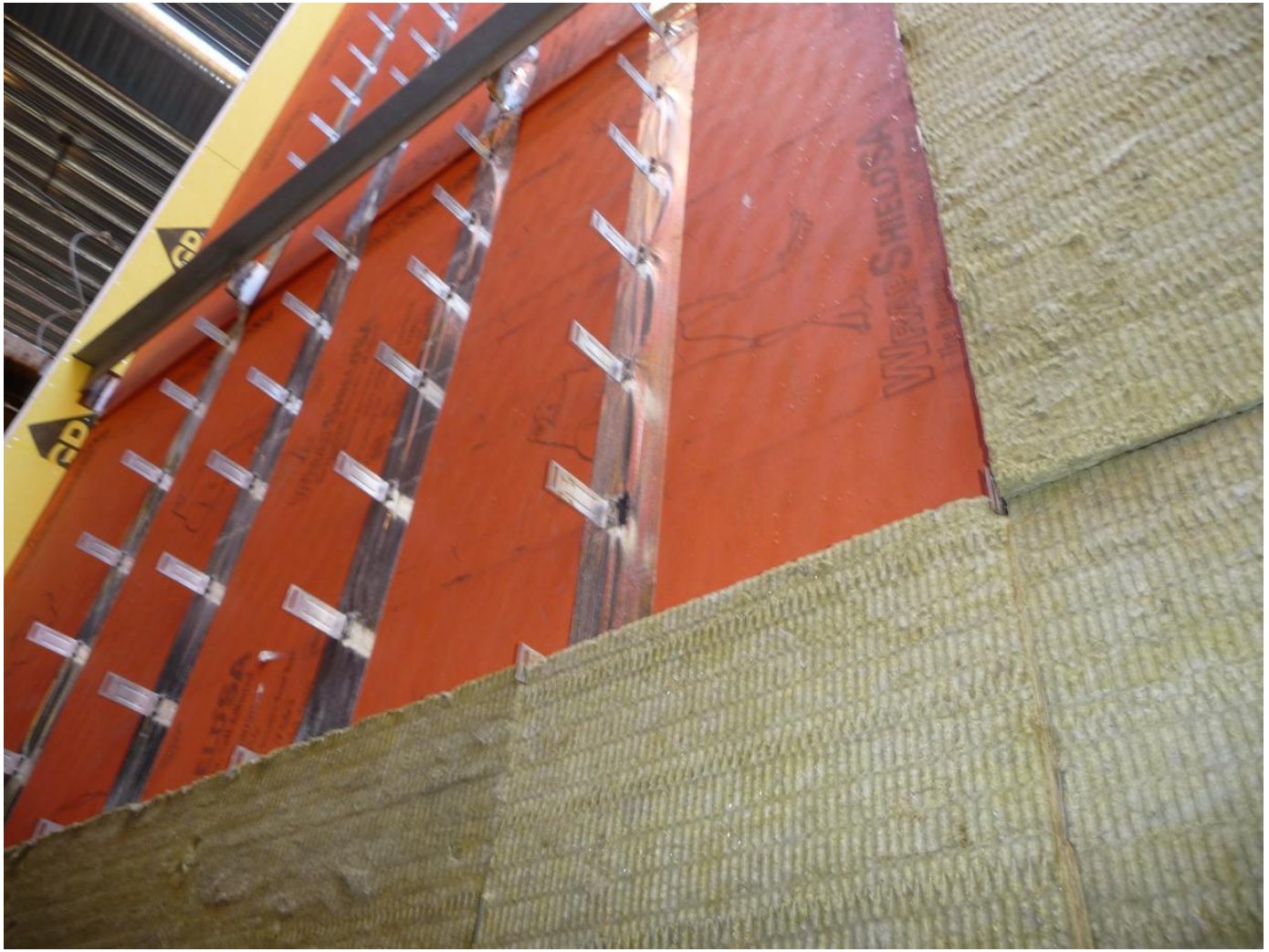
Brick Tie Back Attachment Knife Plate



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Hat Channel Over Continuous Insulation

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Edge Treatments and Terminations

- Insulation requires a designed solution at it's terminations
- Windows and Doors
- Floor Line Flashings
- Z-girts
- Soffits and Parapets
- Let's review Windows and Z-Girts as they are most typical

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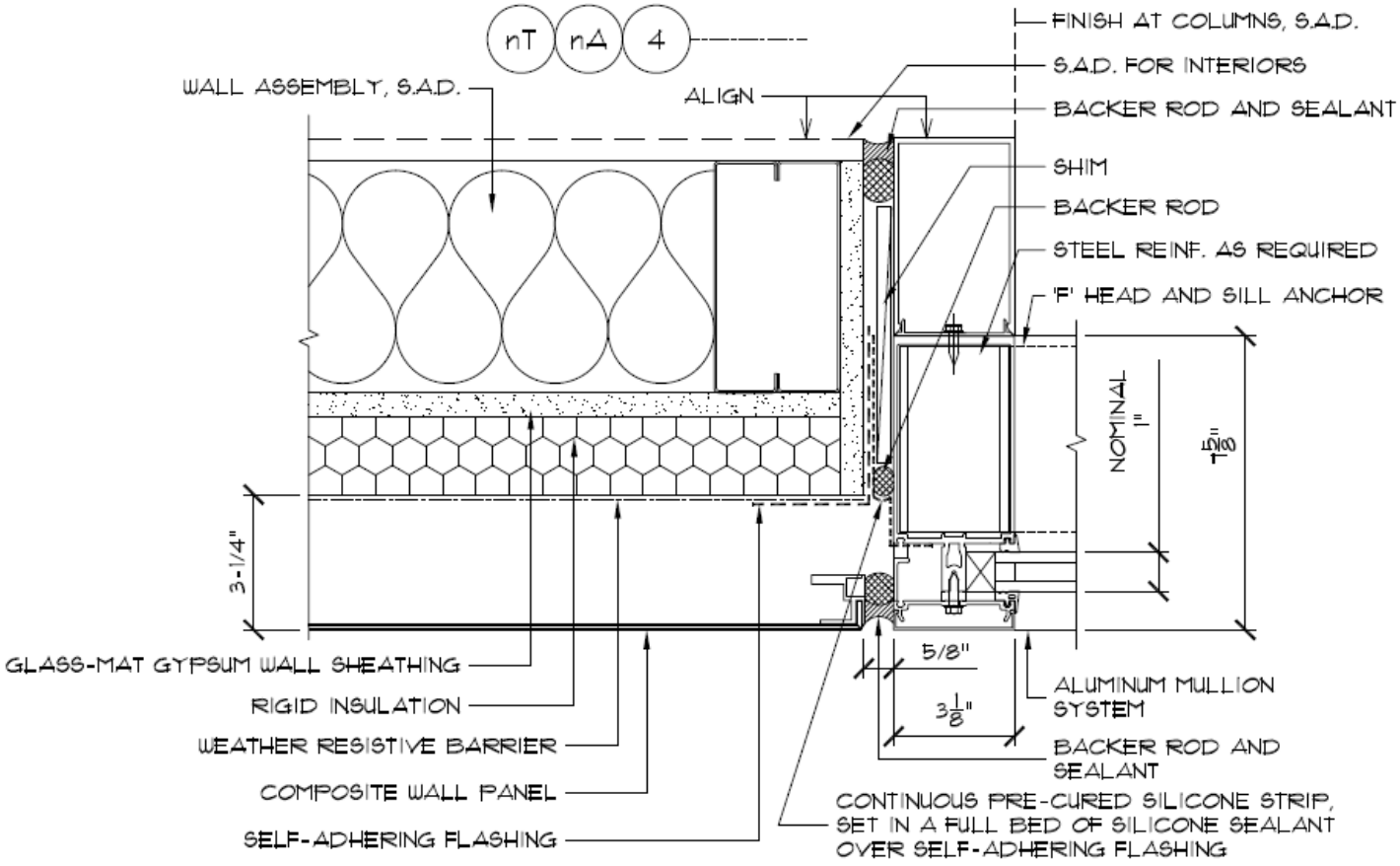
Window Jamb



COMPOSITE WALL PANEL TERMINATION AT TYPICAL VERTICAL STOREFRONT JAMB

SCALE: N.T.S.

FILE:

6
A651

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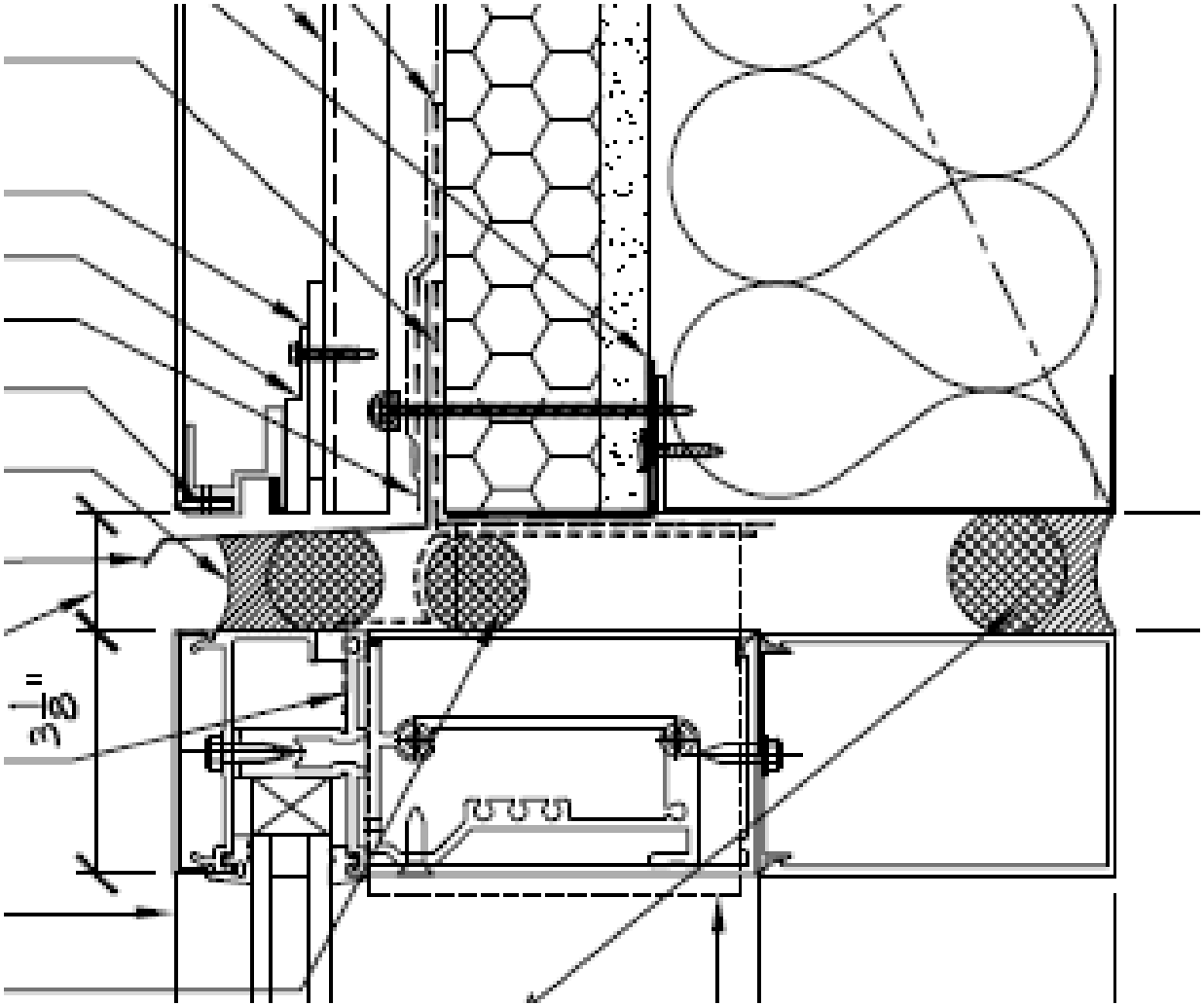
Window Head



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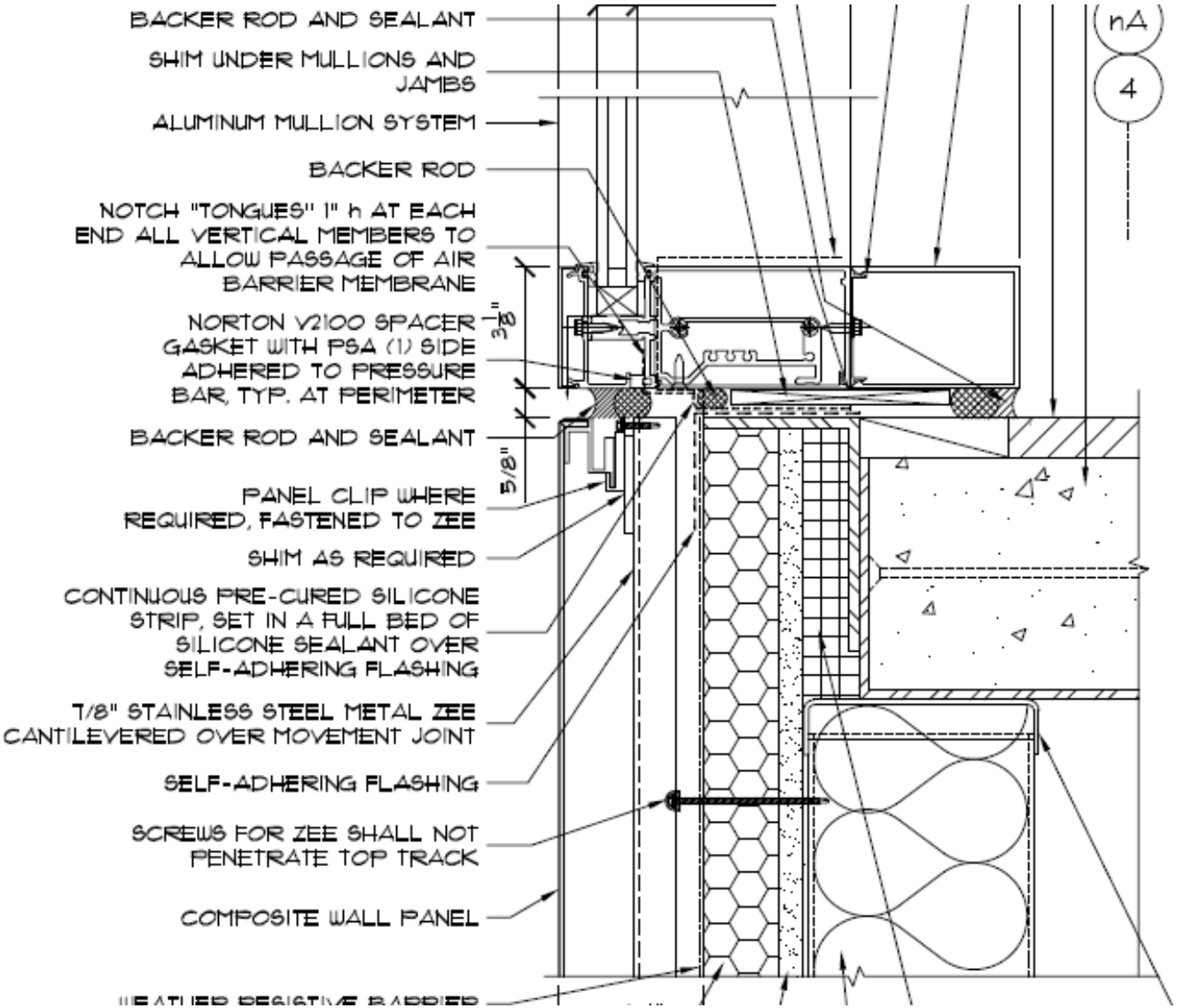
Window Sill



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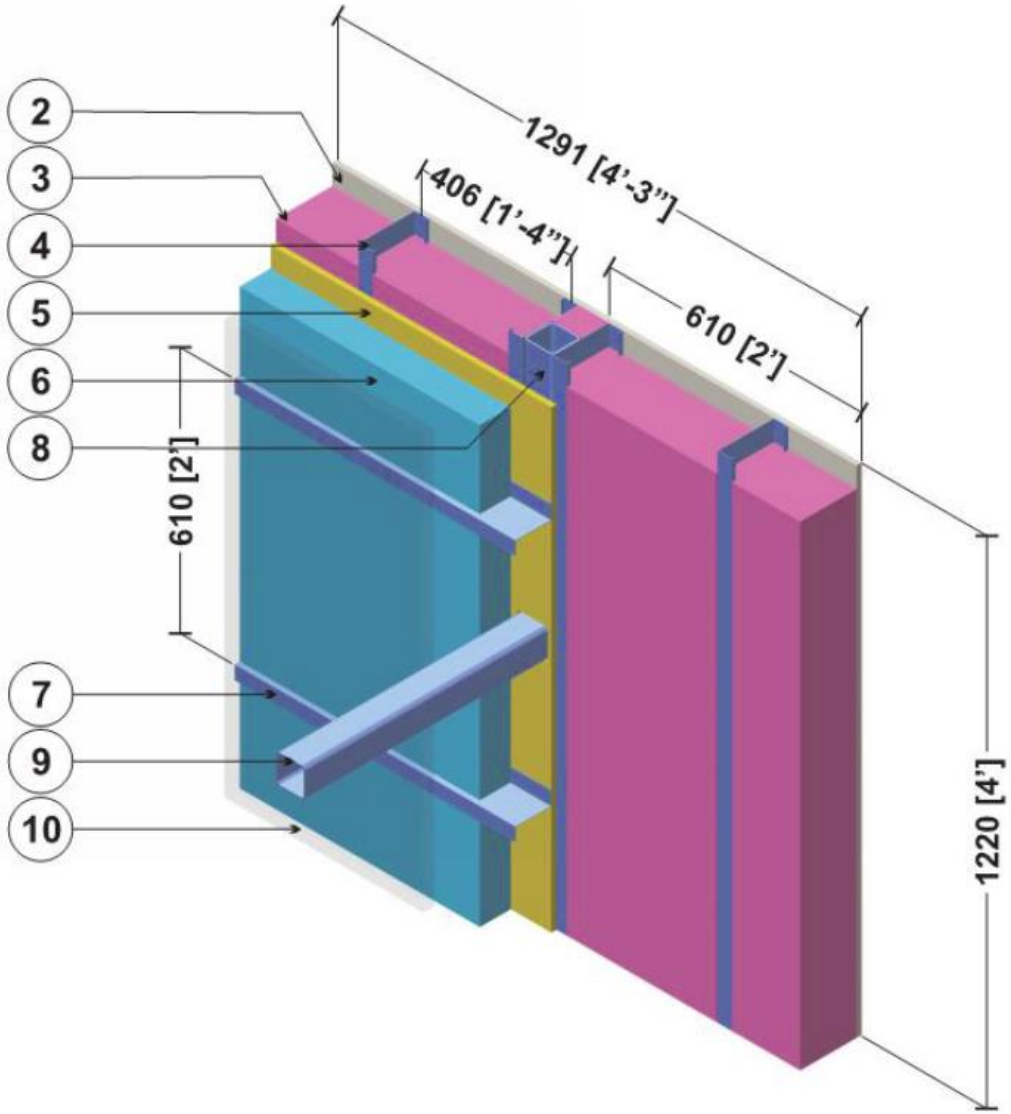
Z – Girt Detail



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WRB / Air Barrier over Insulation with Hat Channels

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WRB / Air Barrier Under the Insulation

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Air Barrier Testing

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Air Barrier System Test Standards

- **ASTM E779-10**: Standard test method for determining air leakage rate by fan pressurization
- **ASTM E1827-11**: Standard test methods for determining airtightness of buildings using an orifice blower door
- **ASTM E283-04**: Standard test method for determining rate of air leakage through exterior windows, curtain walls, and doors under specified pressure differences across the specimen
- **ASTM E1186**: Standard practices for air leakage site detection in building envelopes and air barrier systems

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ASTM E779
Whole Building Fan Pressurization

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ASTM E779
Whole Building Fan Pressurization

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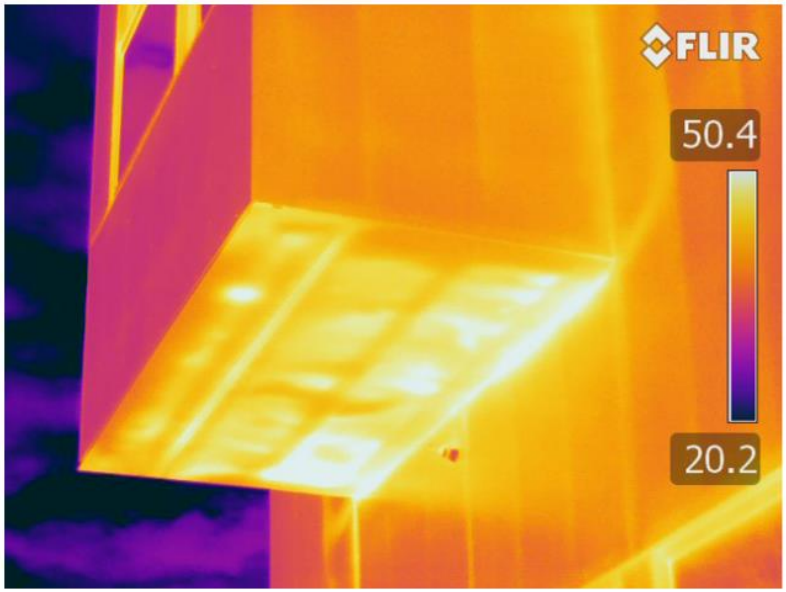
ASTM E1186 – 4.2.1
Positive Pressurization



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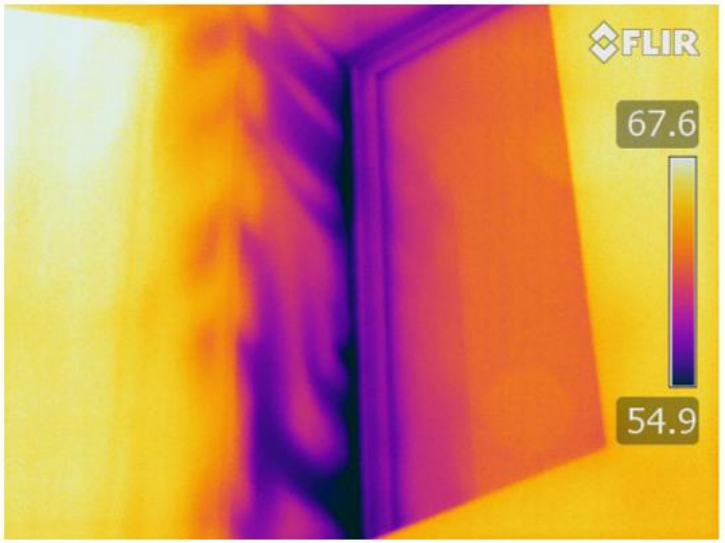
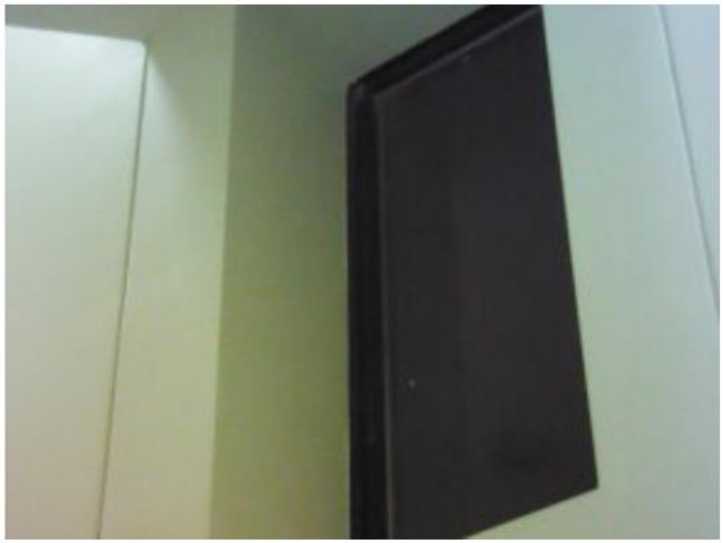
ASTM E1186 – 4.2.1 Depressurization





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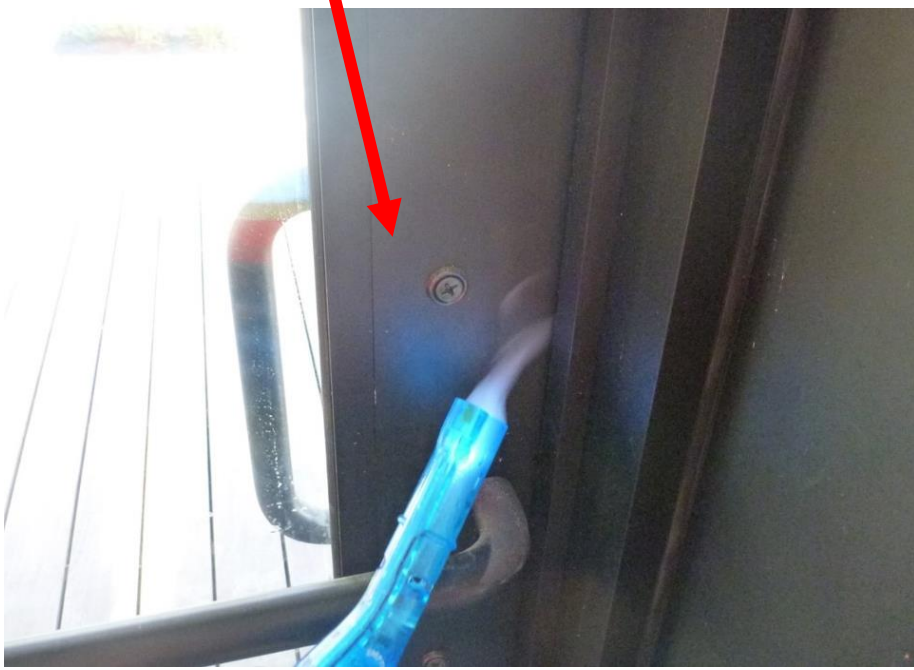
ASTM E1186 – 4.2.6 Smoke Tracers

No Air Leakage

Air Leakage



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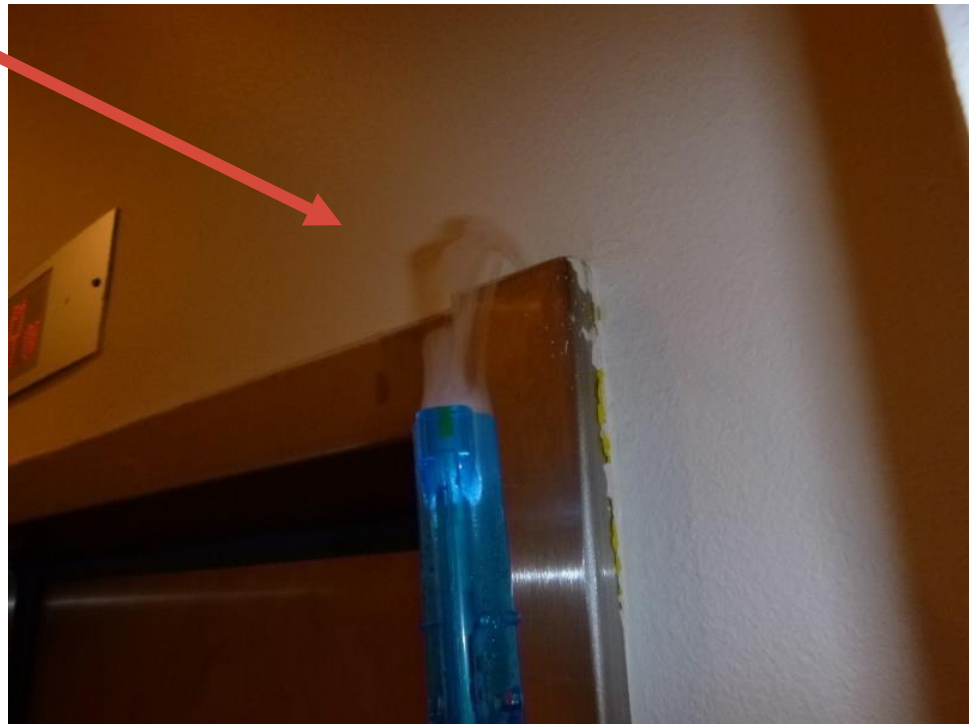
Elevator Core Diagnosing Air Leakage



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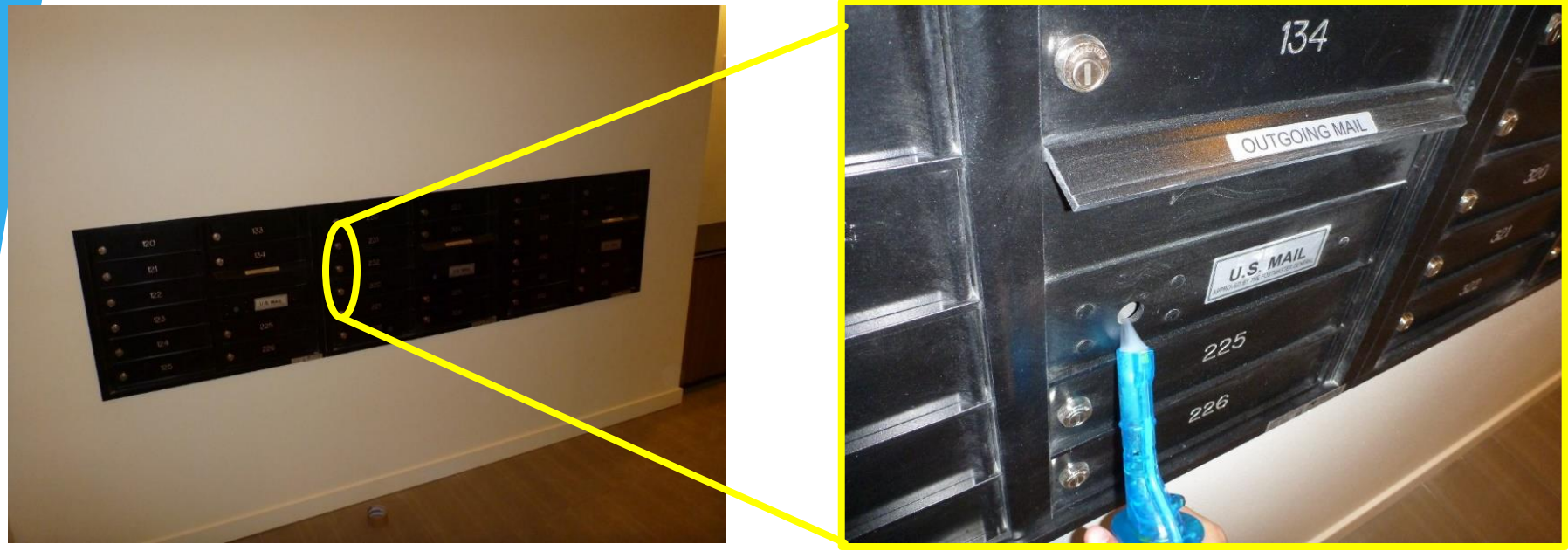
Mail Boxes, Diagnosing Air Leakage



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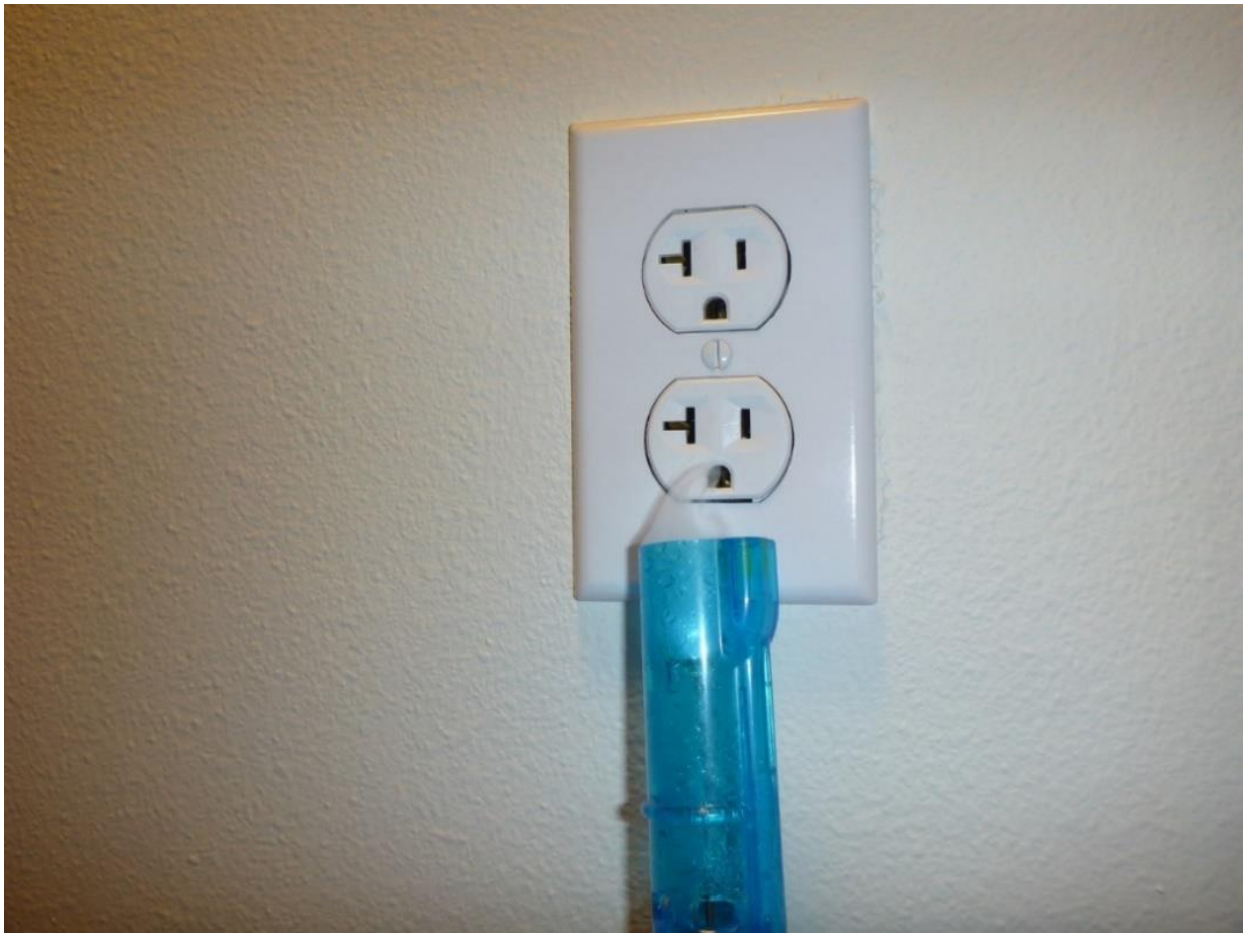
Diagnosing Air Leakage



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Conclusion and Take Aways

- Air barriers and continuous insulation are not required in every state
- More and more states are adopting it each year.
- Air barrier testing is not always required. State by State and city adoption
- As they become mandatory and more commoditized, it will help with costs
- Fluid applied air and WRB are becoming the standard of care for most commercial application

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Mahalo!

Karim Allana, PE, RRC, RWC
karim@abbae.com

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