Selection of Air Barriers What to Consider

Andrew Wagner, P.E.

WDP & Associates Consulting E

abaa EDUCATION

Air Barrier Association of America (ABAA) is a Registered Provider with The American Institute of Architects Continuing Education Systems. Credit earned on completion of this program will be reported to CES Records for AIA members. Certificates of Completion for non-AIA members are available on request.

This program is registered with the AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

air barrier
abaa
association of
america

CONTINUING EDUCATION
AIA

Andrew Wagner, P.E.
Senior Engineer

awagner@wdpa.com

434-284-032

www.wdpa.com

abaa
EDUCATION

Overview

- Intro - What is the best air barrier?
- What considerations should drive the selection of air barriers?
- Discussion of Code requirements
- Discussion and evaluation of material properties
- Common misconceptions

air barrier
abaa
association of
america

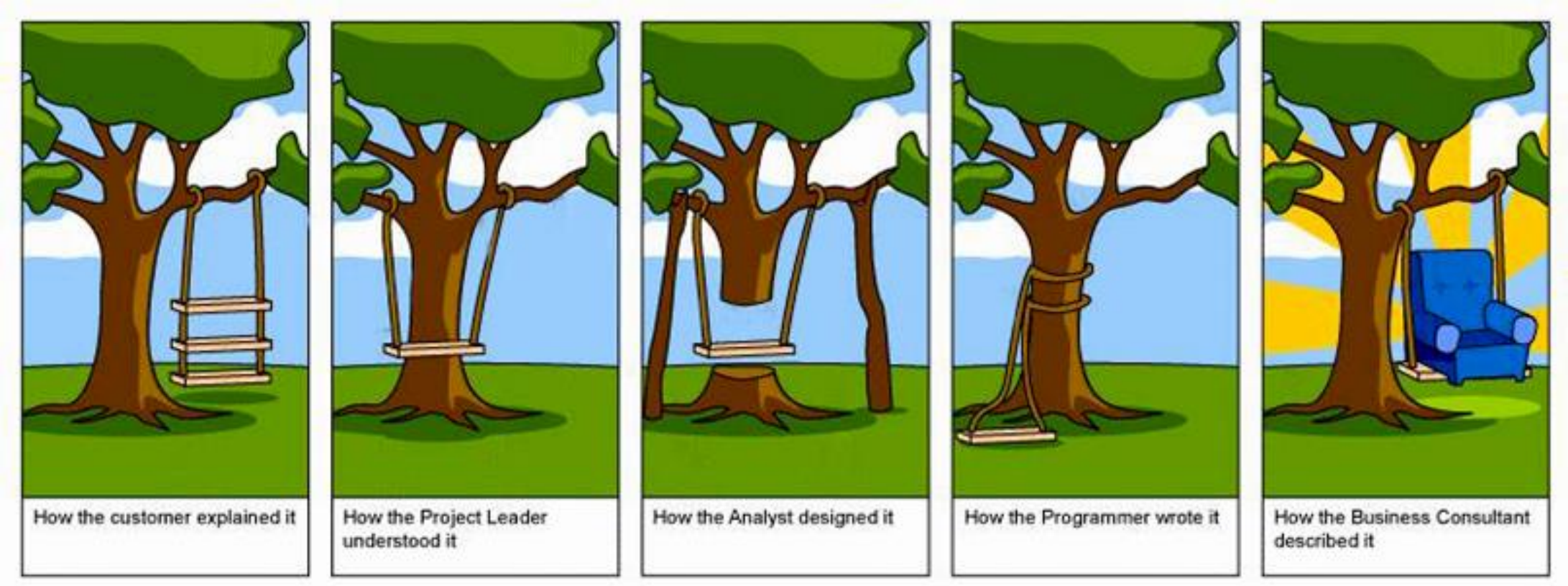
What is the Best Air Barrier???

air barrier
abaa
association of
america

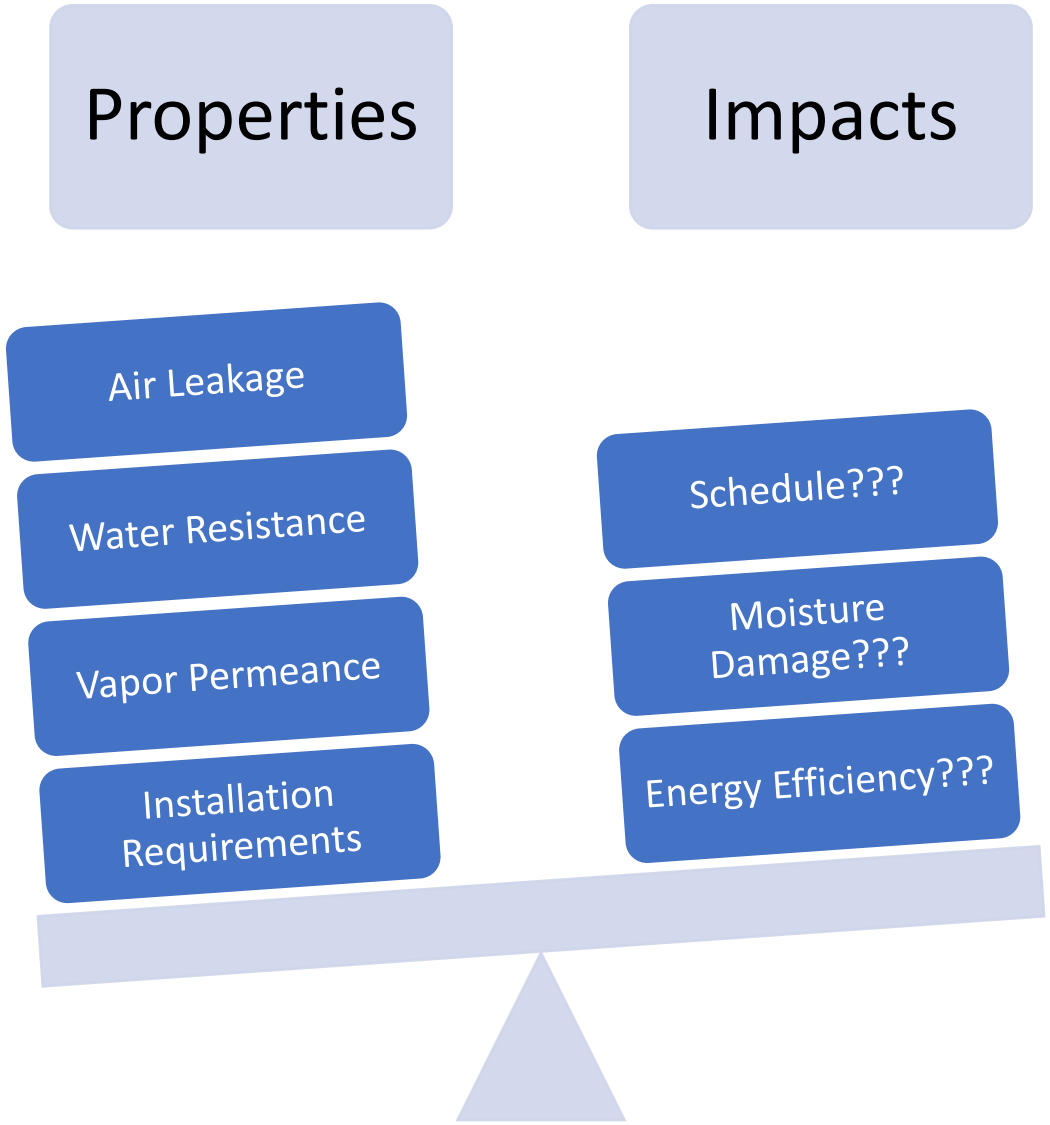
What is the Best Air Barrier???

air barrier
abaa
association of
america

Depends on the Project



Assess Performance and Physical Properties



Performance Properties

Critical Traits Related to Air, Moisture, and Heat Transfer Across the Exterior Envelope

- Air Leakage
- Water Resistance
- Thermal Resistance
- Vapor Permeance

<u>Governed by:</u>

- Code Requirements
- Industry Standards
- Building Purpose and Anticipated Use
- Owner Expectations
- Physics

IECC Compliance

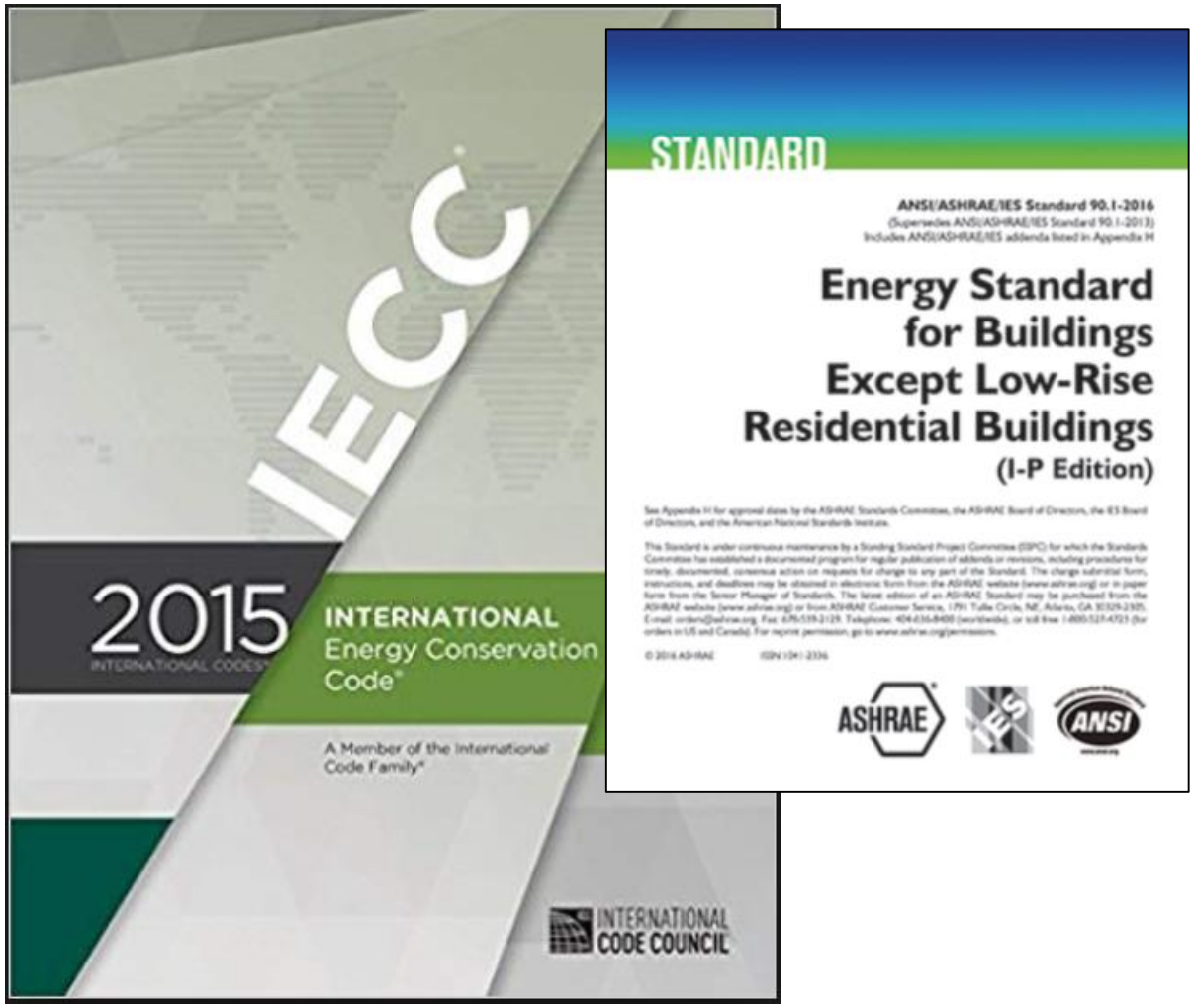
IECC Compliance Paths

- ASHRAE 90.1 Compliance
- Prescriptive Compliance
  - U-Factor Alternate
- Total Building Performance
  - Requires Models

Air Leakage – Commercial Construction

2015 IECC Commercial Requirements

- Required at Thermal Envelope
- Materials
  - 0.004 cfm/ft² @ 0.3 in W.G.
- Assemblies
  - 0.04 cfm/ft² @ 0.3 in W.G.
- Specific Requirements for Fenestrations
- Installation Requirements



Air Leakage – Residential Construction

TABLE R402.4.1.1
AIR BARRIER AND INSULATION INSTALLATION

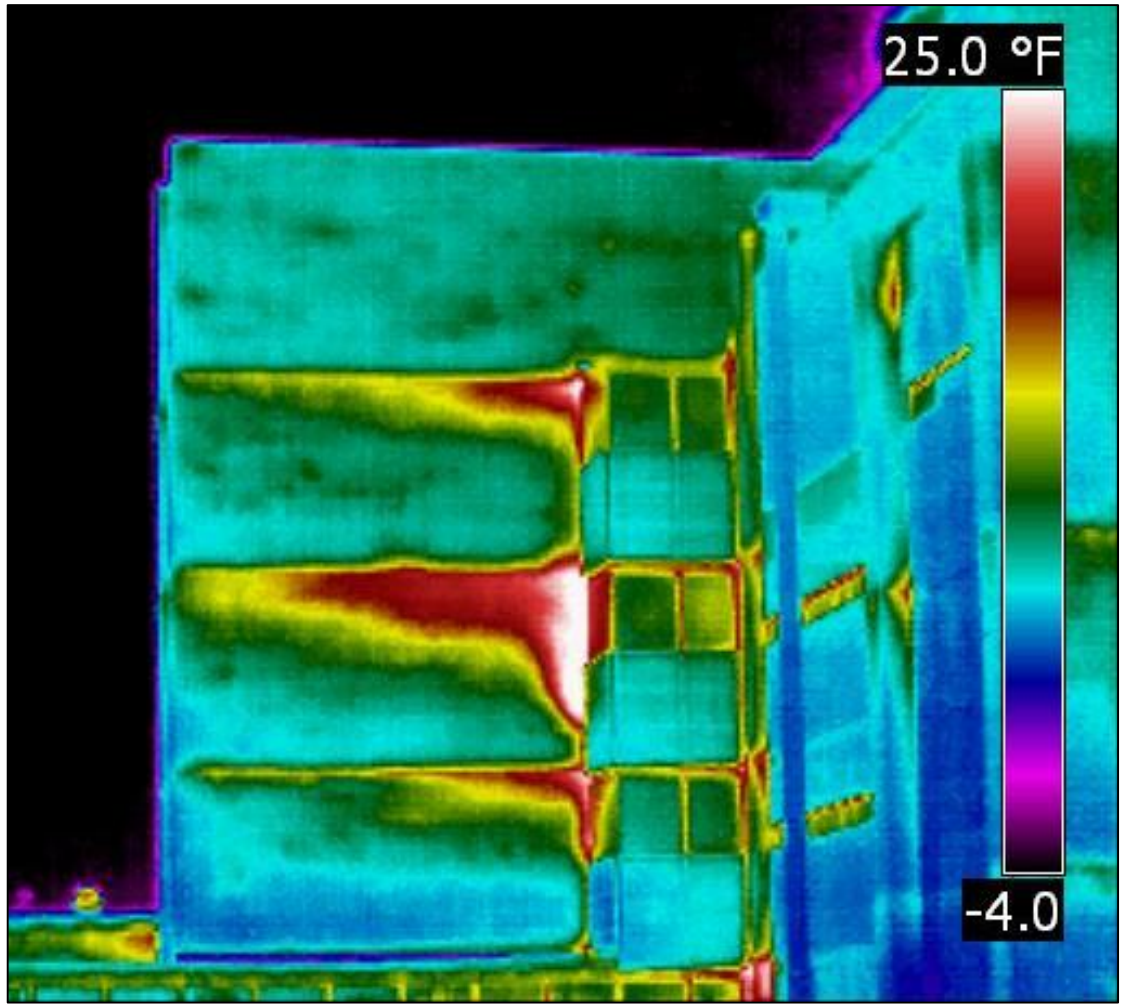
COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. The exterior thermal envelope contains a continuous air barrier. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling/soffit 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.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
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.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between window/door jambs and framing, and skylights and framing shall be sealed.	
Rim joists	Rim joists shall include the air barrier.	Rim joists shall be insulated.
Floors (including above garage and cantilevered floors)	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extends from the bottom to the top of all perimeter floor framing members.
Crawl space walls	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.	Where provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls.
Shafts, penetrations	Duct shafts, utility penetrations, and flue shafts opening to exterior or unconditioned space shall be sealed.	
Narrow cavities		Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be sealed to the drywall.	Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.
Plumbing and wiring		Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate them from the showers and tubs.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.	
HVAC register boots	HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall.	
Concealed sprinklers	When required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	

a. In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.

2015 IECC Residential Requirements

- Required at Thermal Envelope
- Required Testing @ 0.2 in W.G.
  - Zones 1&2: Not more than 5 ACH
  - Zones 3-8: Not more than 3 ACH
- Specific Requirements for Fenestrations
- Installation Requirements

Air Leakage – Things that Matter



- Have you met Code?
  - Project Costs associated with Code Compliance – Whole Building Testing, Modeling, etc.
  - Consider transitions
  - Consider clarity of air barrier limits in Design Documents
- What are the Project Goals?
  - LEED,
  - Sustainability goals
  - Operational needs – Museum vs. Office Building

Water Resistance

- Defined by IBC Section
  - Minimum 1 Layer of No. 15 Felt or approved equivalent
- Supplemental Considerations
  - Fastener Seal-ability
  - Membrane Orientation

Thermal Resistance

- Prescriptive Requirements outlined in IECC
  - R-Value of insulation materials, or
  - U-Factor for overall assembly
  - Requirements based on Climate Zone

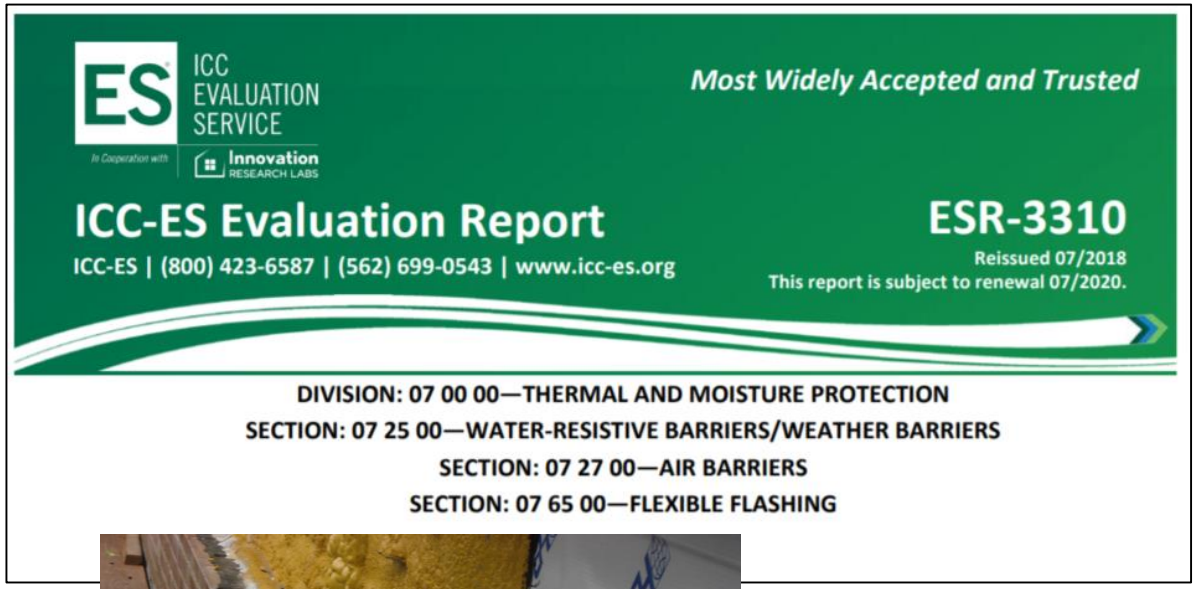
TABLE C402.1.3
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, *R*-VALUE METHOD[a]

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings[b]	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-25 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-49
Walls, above grade																
Mass	R-5.7ci[c]	R-5.7ci[c]	R-5.7ci[c]	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building	R-13+ R-6.5ci	R-13 + R-6.5ci	R13 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13+ R-19.5ci	R-13 + R-13ci	R-13+ R-19.5ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13 + R-7.5ci	R-13+ R17.5ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R13 + R-15.6ci or R-20 + R-10ci	R13 + R-15.6ci or R-20 + R-10ci
Walls, below grade																
Below-grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-10ci	R-10ci	R-10ci	R-12.5ci
Floors																
Mass[e]	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-12.5ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci
Joist/framing	NR	NR	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30[f]	R-30[f]	R-30[f]	R-30[f]	R-30[f]
Slab-on-grade floors																
Unheated slabs	NR	NR	NR	NR	NR	NR	R-10 for 24″ below	R-10 for 24″ below	R-10 for 24″ below	R-10 for 24″ below	R-10 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-20 for 24″ below
Heated slabs	R-7.5 for 12″ below	R-7.5 for 12″ below	R-7.5 for 12″ below	R-7.5 for 12″ below	R-10 for 24″ below	R-10 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-15 for 36″ below	R-15 for 36″ below	R-15 for 36″ below	R-20 for 48″ below	R-20 for 24″ below	R-20 for 48″ below	R-20 for 48″ below	R-20 for 48″ below
Opaque doors																
Nonswinging	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

Water Resistance – Things that Matter

- Is water resistance necessary?
  - What is the intended building air barrier?
- Verify ICC-ES Reports
  - Substrate and installation requirements to ensure water resistance will be acceptable.
- What supplemental products may be necessary?
  - How do accessory materials interact with your air barrier?



Vapor Permeance

- Amount of water vapor that will transfer through a given section of membrane
- Determined through ASTM E96 Testing
  - Procedure A – Dessicant Method
  - Procedure B – Water Method
- Note: RESULTS VARY

PHYSICAL AND CHEMICAL PROPERTIES		
PROPERTY	TEST METHOD	RESULT
Water Vapor Permeance (57ng/Pa•s•m²)	ASTM E96 Desiccant Method	≤1.0 perm
Water Vapor Permeance (572ng/Pa•s•m²)	ASTM E96 Water Method	>10 perms
Corrosivity	ASTM C665	No unusual aspect of corrosion such as pitting, cracking and adhesive cure inhibition
Fungi Resistance	ASTM C1338	No growth

Vapor Permeance

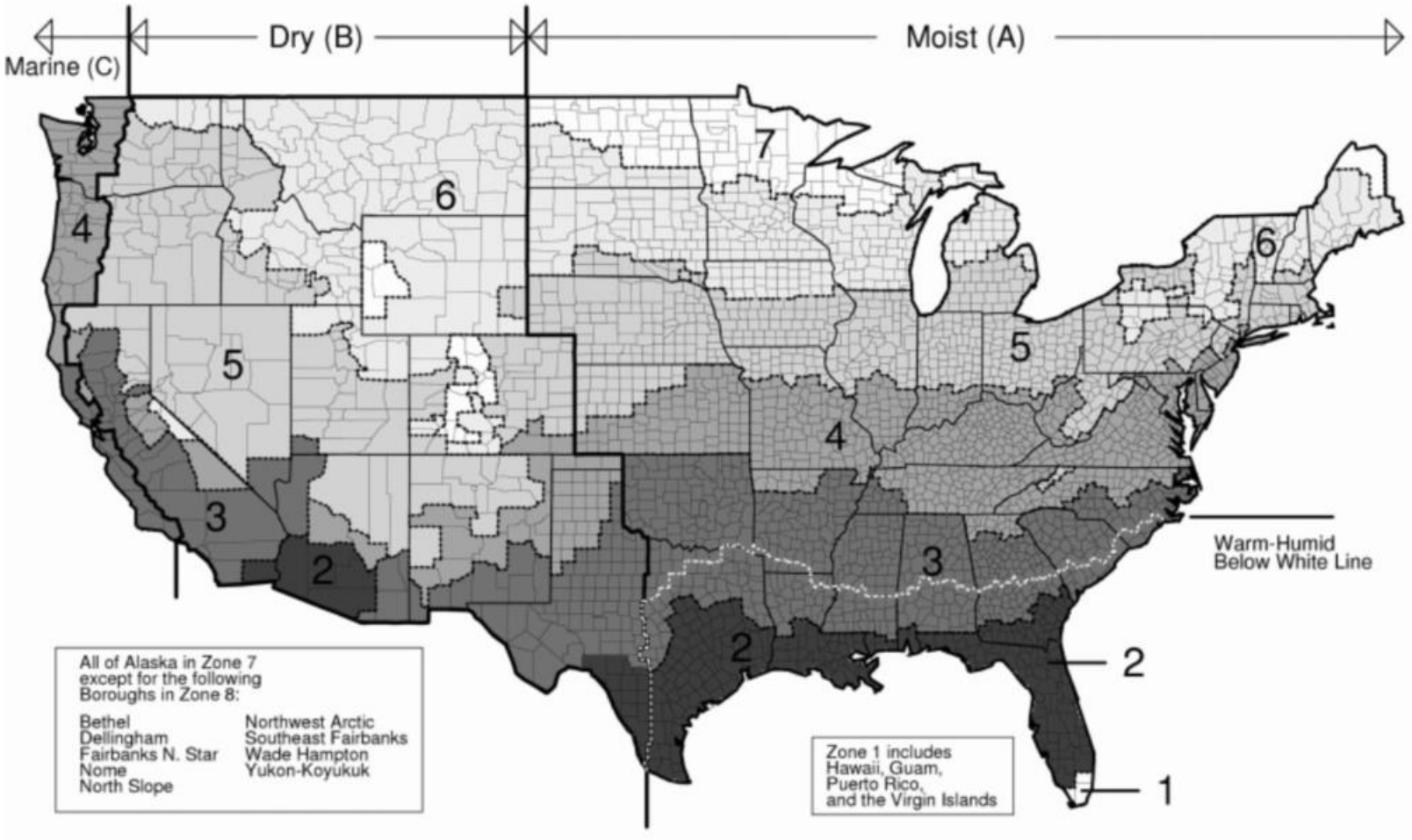
IBC Requirement Evolution

- 2009
  - Class I and II required on interior side of framed walls in Climate Zones 5, 6, 7, 8, and Marine 4
  - Class III is permitted where requirements in Table 1405.3.1 are met
- 2012
  - Little Change from 2009
  - Clarification of Climate Zones

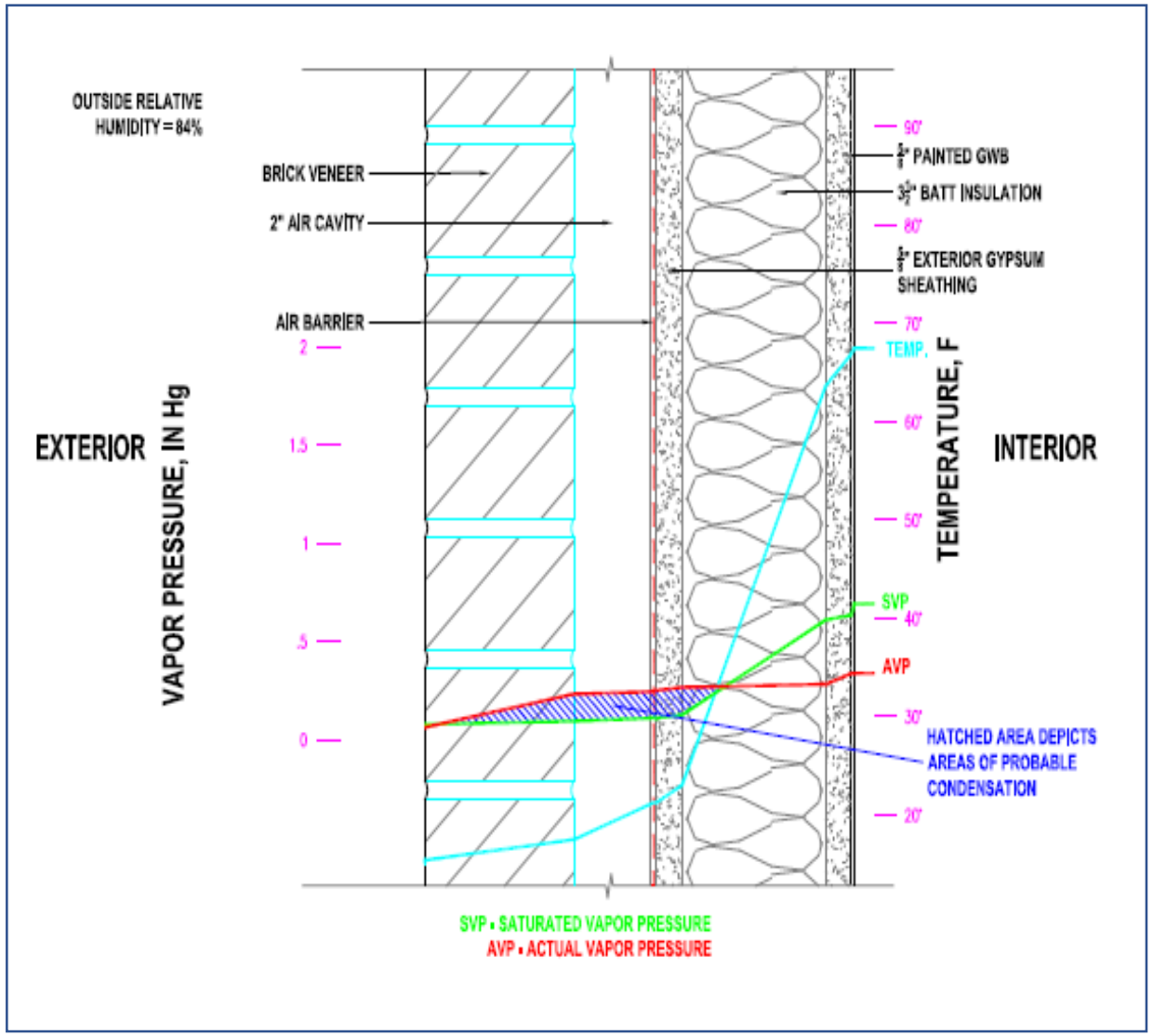
2015 IBC Requirements

- Must comply with prescriptive requirements or perform hygrothermal analysis
- Class I and II vapor retarders NOT permitted on interior side of framed walls in Climate Zones 1 and 2
- Class I vapor retarders NOT permitted on interior side of framed walls in Climate Zones 3 and 4

Vapor Permeance – Climate Zones



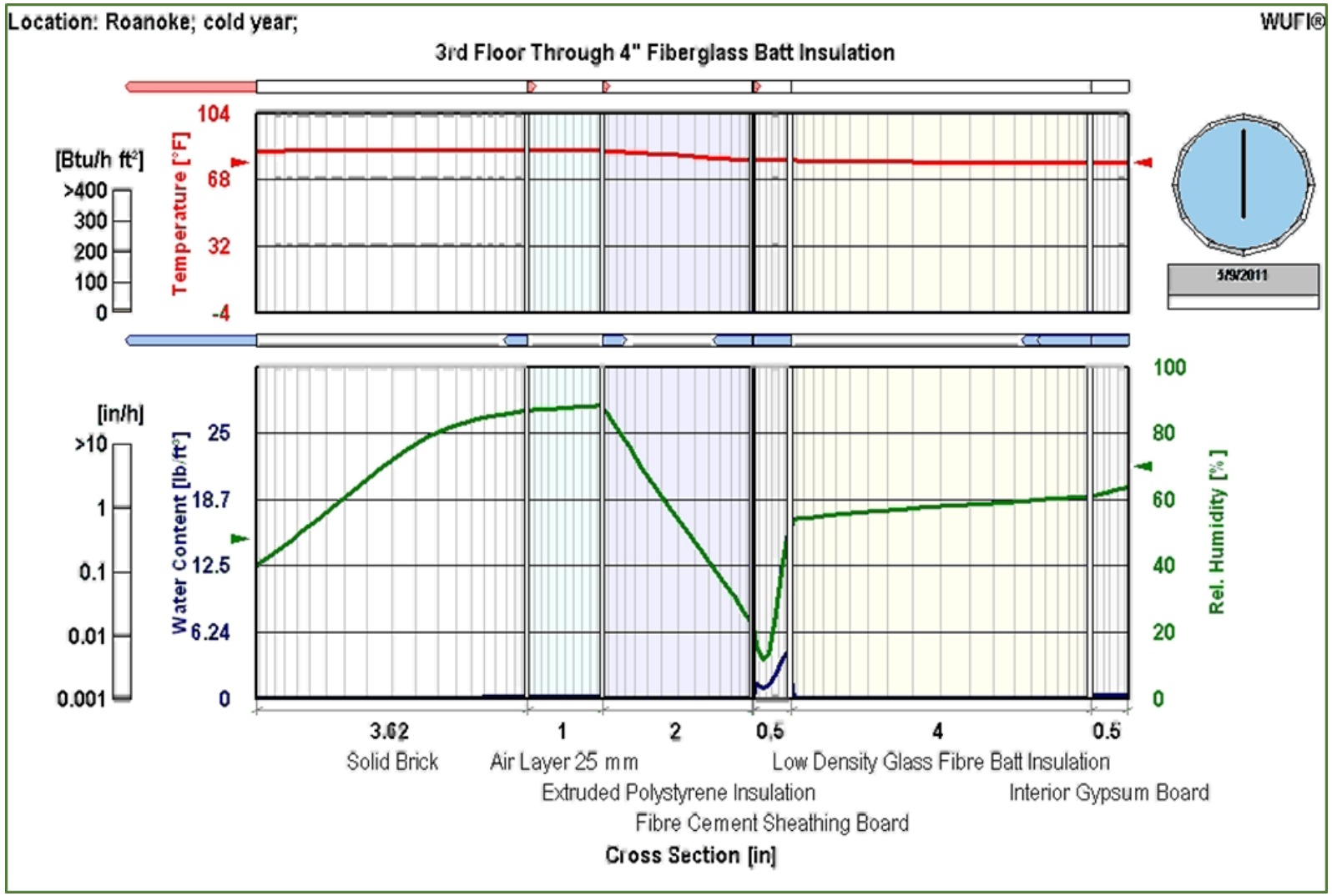
Vapor Permeance – Hygrothermal Analysis



Simultaneous Evaluation of Heat and Moisture Movement

- Assumes material properties
- Assumes interior and exterior conditions
- If interior and exterior temperature is set then temperature varies based on % of Thermal Resistance of each material
- If interior and exterior RH is set, then RH varies based on % Vapor Resistance of each material
- RH is Actual VP divided by Saturated VP

Vapor Permeance – Hygrothermal Analysis



Vapor Retarders

Not Always the Primary Barrier System

- Many products provide vapor resistance
  - Be especially vigilant when products are combined with thermal barriers
- Must consider the overall wall assembly – not just the air barrier membrane

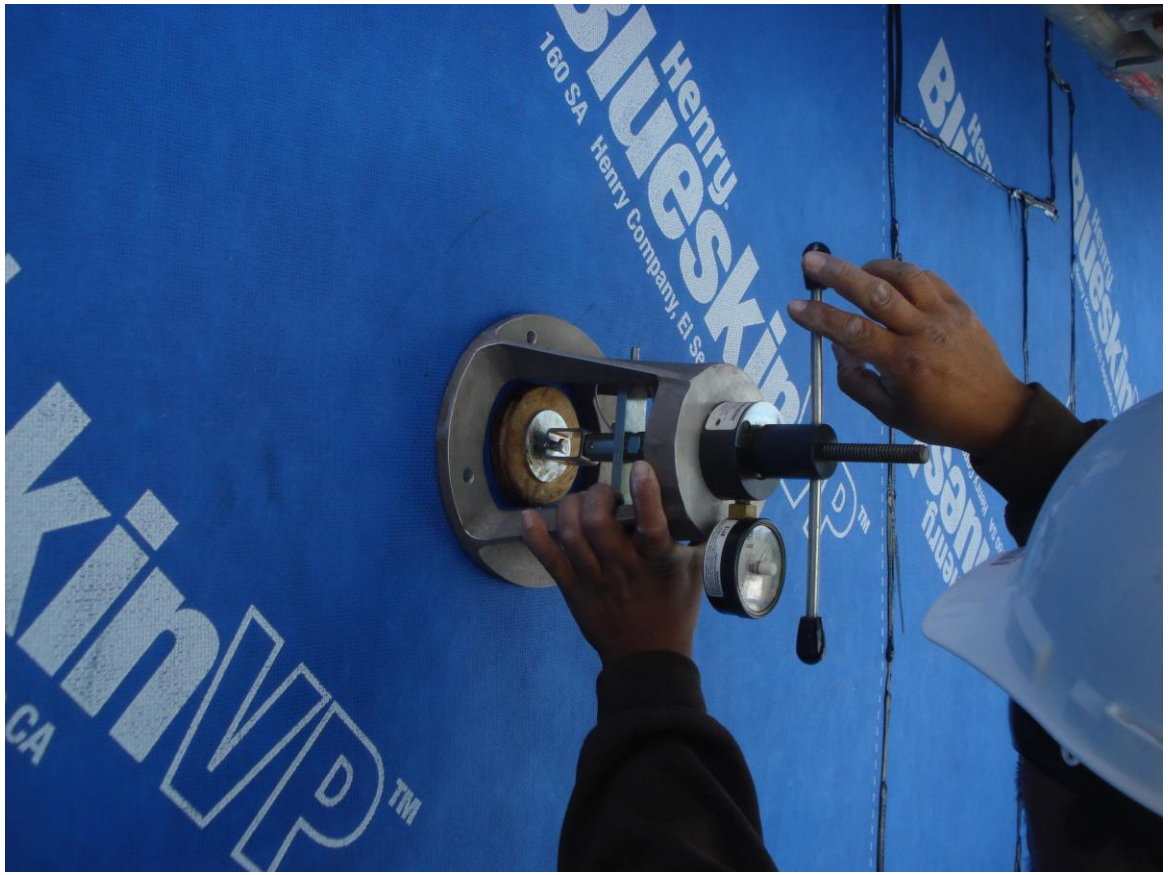
Common Vapor Retarders

- Foil Facers, Type I
- Extruded Polystyrene, Type I
- Interior Paint, Type II and III
- Brake Metal, Type I
- Sheet Polyethylene, Type I
- Kraft Facers, Type II

Vapor Permeance – Things that Matter

- The industry has evolved to understand that there are not hard fast rules for use of vapor retarders in all climate zones
- Typical wall and roof assemblies should be modeled
- Vapor Permeance and Thermal Resistance of all Materials in the assembly must be considered

Material Properties



<u>Include but not limited to:</u>

- Material Thickness
- Installation Requirements
- Adhesion
- Density

Material Properties – Material Thickness

Thickness Impacts Performance Properties

- Vapor permeance typically decreases as thickness increases
- For SPF, thermal resistance increases as material thickness increases
- Water and air infiltration resistance may be impacted if material is too thin

Material Properties – Material Thickness

Recommendations

- Thickness should comply with manufacturer's instructions
  - Do not specify material thickness
- Include QA requirements for verifying and documenting thickness
  - Consider ABAA QAP program

Material Properties - Installation

Recommendations

- Consider climate when selecting material
  - Fluid applied products must cure prior to exposure to rain
  - Self-adhered membranes typically have primers that must cure
  - Low temperature products are available for colder climates
- Establish requirements for addressing “wash out” or compromised membrane sections

Steps to Select an Air Barrier

Identify Project Characteristics

- Climate – Are there long periods of heavy rain?
  - If Yes, consider a self-adhered product
- Schedule – Will installation likely occur during cold months?
  - If Yes, consider a material that can be installed at low temperatures or that is not manufactured in the field

Determine Required Thermal Resistance

Evaluate the following:

- IECC Compliance Path
- Minimum U-factor based on MEP design
- Requirements based on NFPA 285 and other Codes

Evaluate Vapor Permeance

- Run hygrothermal models of typical wall and roof sections
- Use iterative analysis to evaluate the need for an vapor retarder and the location of the vapor retarder within the wall assembly

Thank You Sponsors!

TREMCO
Commercial Sealants & Waterproofing

GJC GENERAL
INSULATION COMPANY, INC.

TMI
Air Barrier Testing

Master Wall Inc.
30 YEARS STRONG

BE BUILDING ENCLOSURE

CoatingsPro MAGAZINE

PRISM

Architect's Newspaper