HARNESSING Industry Change
2017 ICAA Convention & Trade Show
Hyatt Regency • Dallas • October 5–7

INSULATION CONTRACTORS ICAA ASSOCIATION OF AMERICA

How to Meet Code and Manage Moisture in an Environment of Increasing Air Tightness Requirements

Ted Winslow
10.04.17

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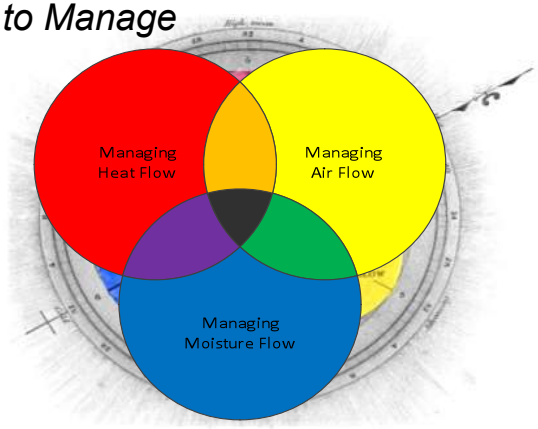
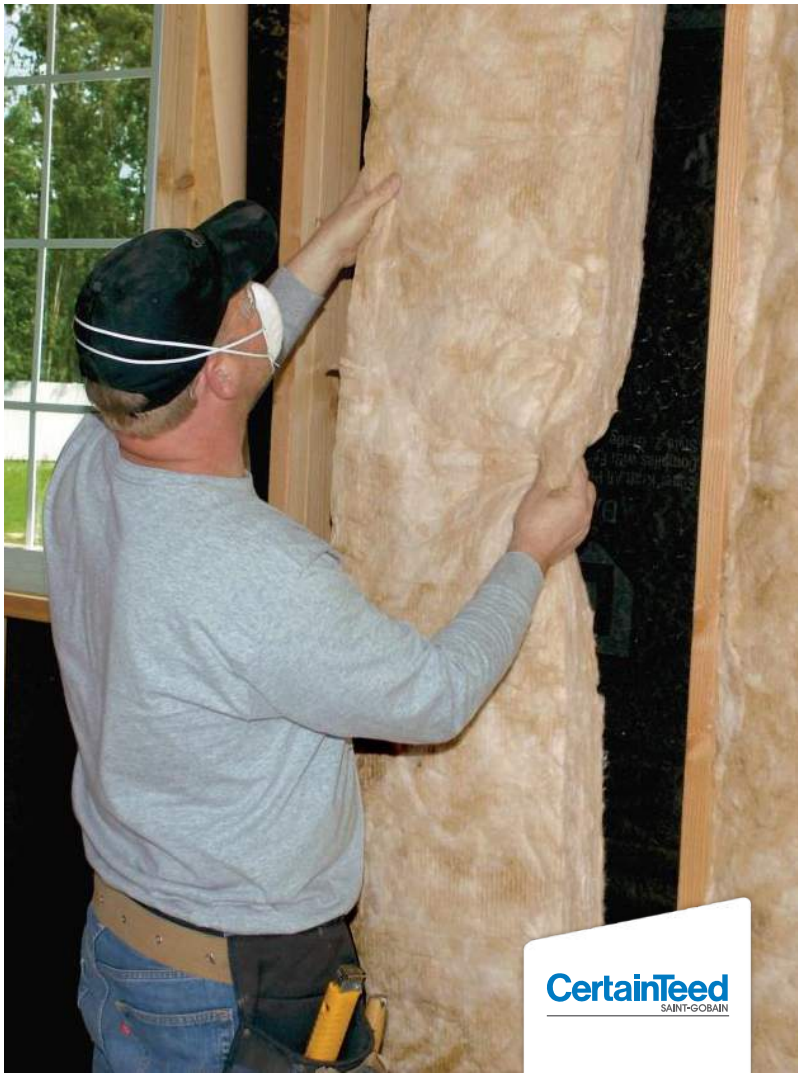
Builders are taking a Strategic Approach to…

Meet evolving building code requirements

Balancing approaches to Manage

- *Heat Flow*
- *Air Flow*
- *Moisture Flow*

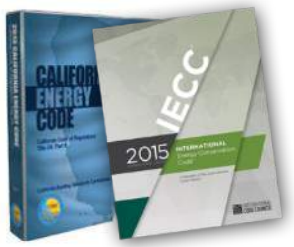




Heat Flow

Air Flow

Moisture Flow



Building Codes Are Driving Towards

Heat Flow

Air Flow

Increased Focus

Increased Risk

Moisture Flow

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ROBUST

BUT WHAT IS ROBUSTNESS?

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HOW CAN WE DETERMINE ROBUSTNESS?

ITS ALL ABOUT THE POTENTIAL…

> "Although biological contaminants have been given little attention until relatively recently, substantial proportion of building-related illness (BRI) and sick building syndrome (SBS) … is the result of exposure to such contaminants. … There is abundant evidence from investigations in several countries that symptoms of eye, nose, and throat irritation as well as cough and tiredness and fatigue are present in excess among persons or populations in certain buildings. Although several agents have been suggested as causative, the most extensive evidence is found for dampness and mold."
>
> — American Industrial Hygiene Association[2]

> "Since an interior polyethylene vapor barrier prevents wall assemblies from drying inward during the summer, a layer of poly can actually make the wall wetter than it would be without the poly."
>
> — Green Building Advisor[3]

IN MANAGING *HEAT FLOW*,
WE TRY TO KEEP IT *IN* OR *OUT*…

BUILDING METHODS TO CONTROL HEAT FLOW

CAVITY INSULATION

Fiberglass

Mineral Wool

Cellulose

Spray Foam

Reflective Insulation

Radiant Barriers

Hybrid Systems

INSULATING SHEATHINGS

Expanded Polystyrene (EPS)

Extruded Polystyrene (XPS)

Polyisocyanurate (PIR/PUR)

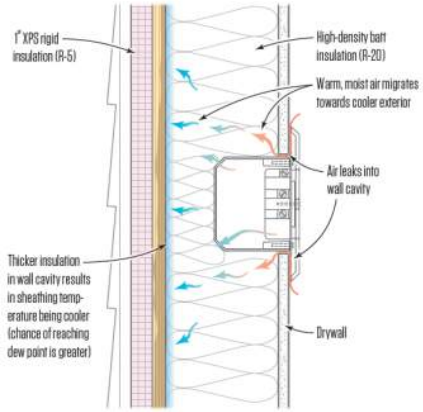
Fiberglass

Stone Wool

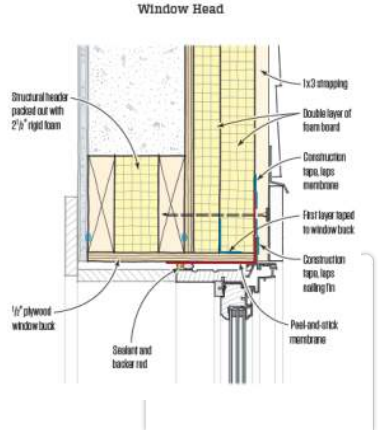
BUILDING METHODS TO CONTROL HEAT FLOW

EXTERNAL RIGID FOAM BOARD < 2”

- Advantage: shifts the wooden frame to the inner side of the house
- But requires a high R-value to be efficient
  - Ex. R5 XPS + R15 Fiberglass, 70F inside, 20F outside → 32F on external sheathing (cold!)
- Requires a drainage plane between the sheathing and the insulation
- Complex details at windows/doors and sidewall penetrations
- Cold climates:
  - XPS or Polyiso: block moisture diffusion towards outside in winter → can trap moisture
  - Concerns with interior Vapor retarder combined with vapor-barrier exterior insulation
  - If external insulation has to be used, dense Mineral Wool is preferred (safer)
- Hot and humid climates:
  - Dense foams preferred (EPS, XPS, Polyiso… block moisture from outside)



Source: JLC, 2017

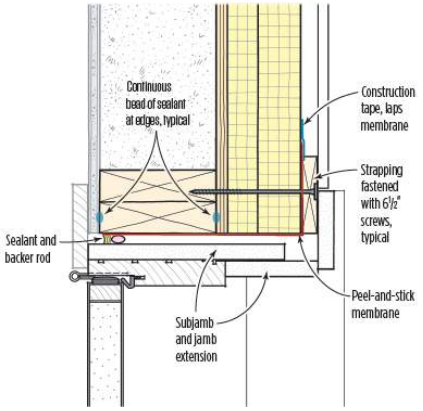


BUILDING METHODS TO CONTROL HEAT FLOW

EXTERNAL RIGID FOAM BOARD >2”

- Challenges attaching cladding and windows
- Additional anchoring points for cladding required (larger bending momentum)
- Limited choice of siding (stucco, fiber cement)
- Can be cost prohibitive in single family applications

Door Jamb (Plan View)



Source: JLC, 2017

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BUILDING METHODS TO CONTROL HEAT FLOW

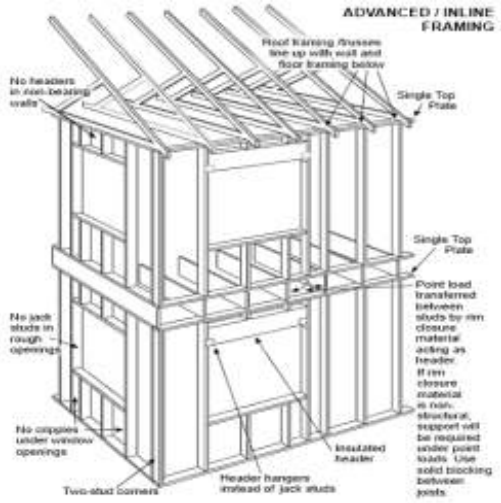
EXTERNAL CCSPF

- Can be used both in residential and commercial applications (more common)
- More common in applications incorporating cladding that wouldn't be impacted by foam surface inconsistency (e.g. bricks, stucco…)

BUILDING METHODS TO CONTROL HEAT FLOW

EVOLVING TECHNIQUES AND PRACTICES

- Advanced Framing Techniques
- Double-Stud Walls
- Continuous Insulation
- Structural Insulated Panels (SIPs)
- Insulated Concrete Forms (ICFs)



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IN MANAGING HEAT FLOW,
IT IS ABOUT USING ROBUST SOLUTIONS…

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BUT HOW CAN WE CONTROL HEAT FLOW…

EFFECTIVE INSULATION

This means properly installed and high-quality insulation that:

- Reduces heat transfer to improve comfort
- Protects homes from moisture damage which improves durability

INEFFECTIVE INSULATION

Thermal Performance

- Misaligned insulation causing gaps and voids. This can cause comfort problems in the home by allowing unwanted air flow.
- Pipes compressing insulation reduce the thermal value and effectiveness.

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CONTROLLING THERMAL FLOW

INEFFECTIVE INSULATION

CONTROLLING THERMAL FLOW

INEFFECTIVE INSULATION

Thermal Performance

Controlling Thermal Flow

Bonus Room over Garage

Improperly installed insulation can drop due to gravity.

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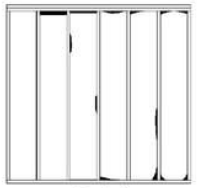
CONTROLLING THERMAL FLOW

IECC AND ENERGY STAR REQUIREMENTS


Grade I


Grade II


Grade III

GRADE I

- < 2% compression, no more than 30% of insulation depth

GRADE II

- < 2% missing, <10% compression

GRADE III

- > 2% < 5% missing, open on one side.

MORE THAN 5% - UN-INSULATED

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CONTROLLING HEAT FLOW

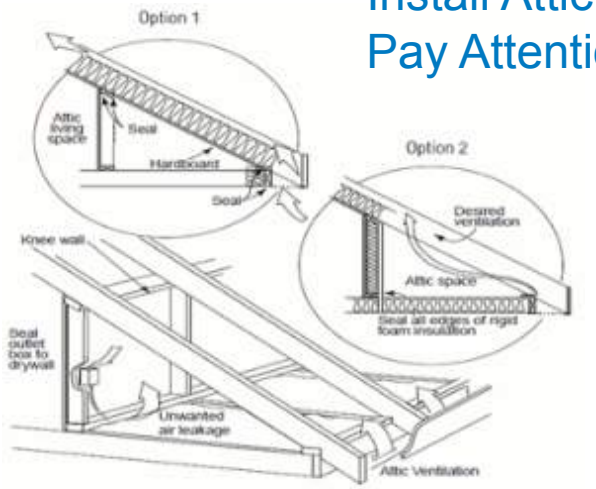
Thermal Performance

COMMON CHALLENGES

Roof/Ceiling System
Walls
Windows
Basements
Crawlspaces
Slabs
Cathedral Ceilings
Knee Walls

PRACTICAL SOLUTIONS

Insulate & Seal
Avoid Compression
Install Attic Baffles
Pay Attention to Details



Seal kneewall to create a continuous air barrier.

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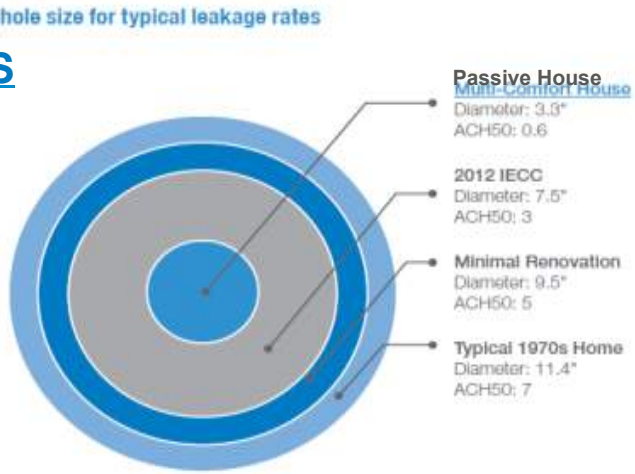
IN MANAGING *AIR FLOW*,
WE TRY TO KEEP IT *IN* OR *OUT*…

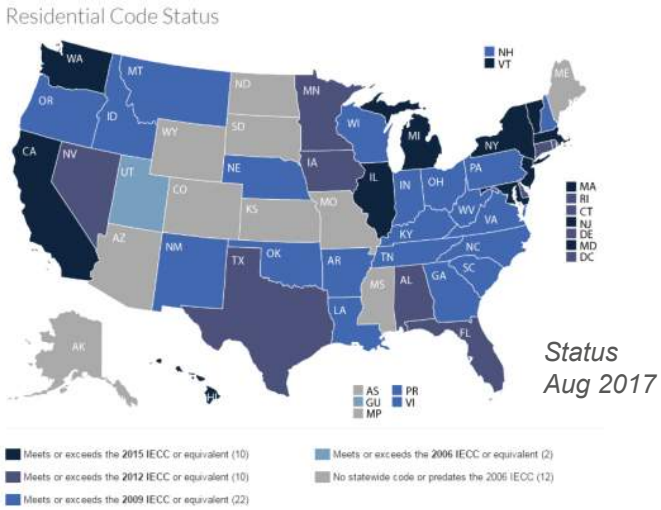
Air Tightness

AIR LEAKAGE/AIR TIGHTNESS

2012-15 IECC INCLUDES <u>MANDATORY REQUIREMENTS</u>

- **AIR LEAKAGE RATE (ACH – AIR CHANGES/HOUR)**
- **SECTION R402**
  - Climate Zones 1 & 2: 5 ACH
  - Climate Zones 3, 4, 5, 6, 7, 8: 3 ACH
  - Reported at 50 Pascals





Status Aug 2017

Code Officials can require this testing be conducted by 3rd Party

Test anytime after creation of all penetrations of the building thermal envelope – ASTM test <u>mandatory</u>

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BUILDING METHODS TO CONTROL AIR FLOW

INTERIOR AIR BARRIERS

Polyamide Film

Polyethylene Film

Spray Foam

Caulking/Sealing

Drywall

EXTERIOR AIR BARRIERS

Roofing Membrane

Peel & Stick Asphalt Membrane

Built-up Modified Asphalt

Plywood

Polystyrene Board (XPS or EPS)

Polyurethane Board

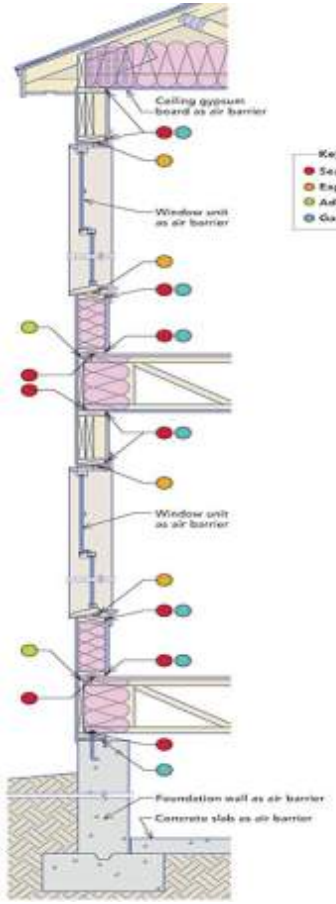
WRB – Weather Resistive Barrier

AIR-FLOW CONTROL ON THE INSIDE…

Air Tightness

INTERIOR AIR-SEALING STRATEGIES

Std. Caulk & Seal Packages
Spray-Applied Sealant Systems
Airtight Drywall Approach
Spray-Foam
Poly/SVR Sheetings + tape



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AIR-FLOW CONTROL ON THE OUTSIDE…

EXTERIOR AIR-SEALING SOLUTIONS

WEATHER-RESISTIVE BARRIERS (WRB)

- Mechanically-Attached
- Self-Adhered
- Liquid-Applied
- Spray-Applied
- Trowel-Applied

INTEGRATED SHEATHINGS & TAPES

- e.g. Zip System (Huber)

SPRAY-FOAM

CONTROLLING THERMAL FLOW

THROUGH CONTROLLING AIR FLOW

Many leakage pathways at windows & junctions between walls and bottom/top plates

Source: Building America report 1506, March 2015, K. Ueno and J. Lstiburek

AIR-FLOW CONTROL ON THE FRAME…

Air Tightness

FRAME AIR-SEALING SOLUTIONS

Ex. NORTON ACCUFRAME PLUS ENERGY SEAL

High performance durable flexible foam, installed by framers or insulation contractors

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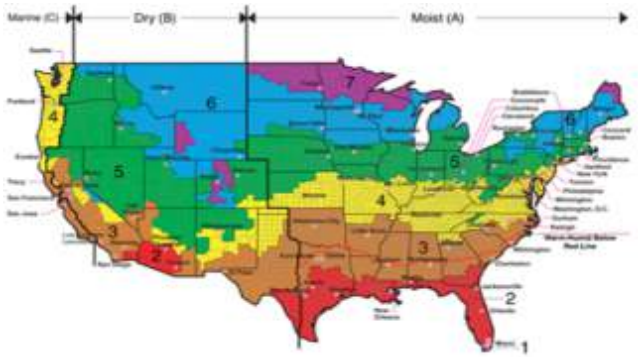
IN MANAGING *MOISTURE FLOW*,
WE TRY TO KEEP IT *IN** OR *OUT*…

KEEPING MOISTURE (VAPOR) IN*…



VAPOR RETARDERS (2012 IRC)

R702.7 Vapor retarders.
Class I or II vapor retarders are required on the interior side of frame walls in Climate Zones 5, 6, 7, 8 and Marine 4.

Exceptions:

1. Basement walls.
2. Below grade portion of any wall.
3. Construction where moisture or its freezing will not damage the materials.

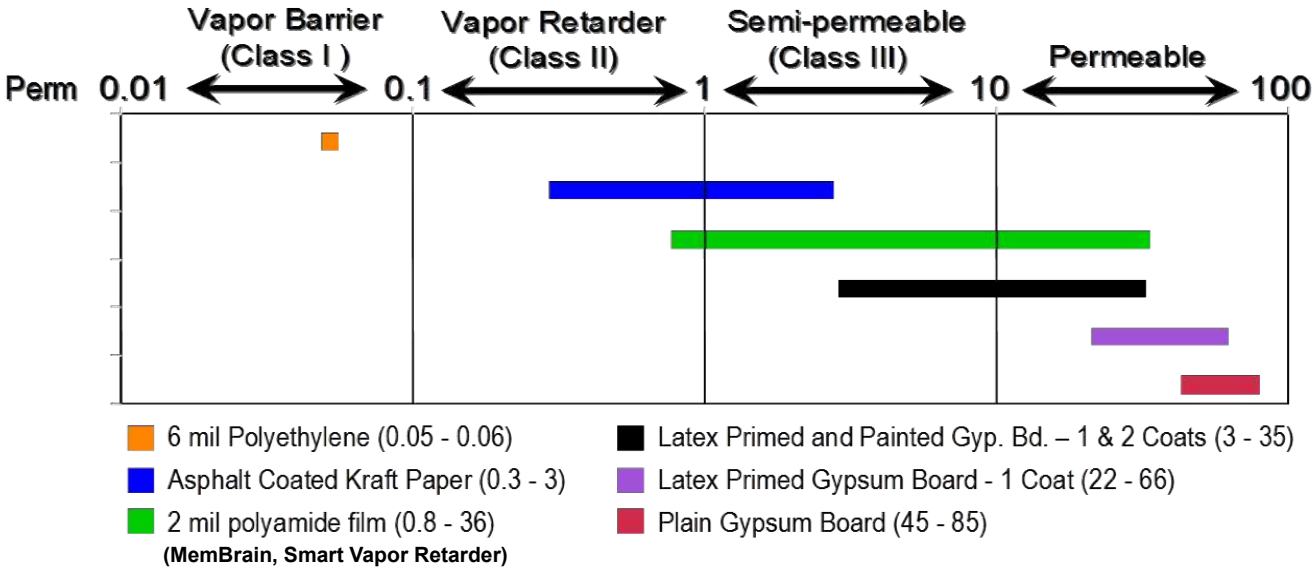
MOISTURE MANAGEMENT – VAPOR RETARDER

VAPOR RETARDER (R702.7.2)

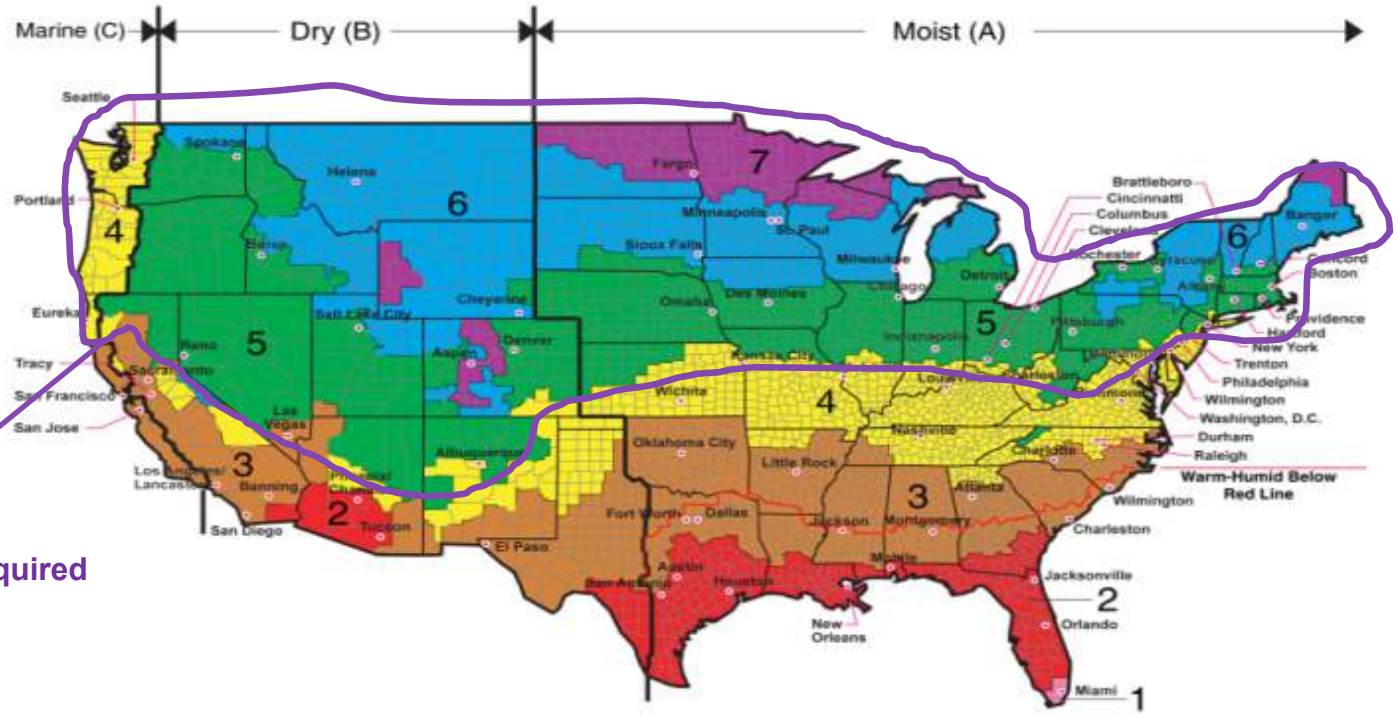
Class I: Polyethylene sheet, unperforated aluminum foil

Class II: Kraft-faced fiberglass batts

Class III: Latex or enamel paint



IECC 2015 REQUIREMENTS – VAPOR RETARDERS



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Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands

MOISTURE MANAGEMENT – VAPOR RETARDER

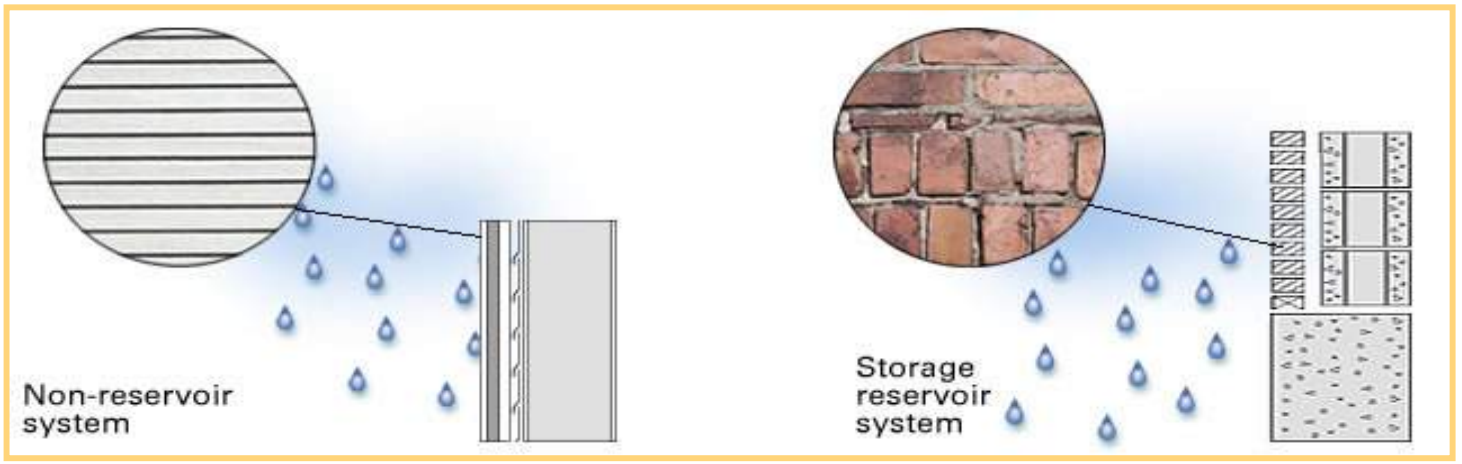
R702.7.1 CLASS III VAPOR RETARDERS

- Class III vapor retarders shall be permitted where any one of the conditions in Table R702.7.1 is met
- Reminder: the moisture performance of the assembly strongly depends on the R-value **on both sides of the sheathing**
  - Ex. 70F inside and 20F outside (winter)
  - R13 inside + R5 outside → 34F on sheathing
  - R24 inside + R5 outside → 29F on sheathing
  - R13 inside + R10 outside → 42F on sheathing

CLIMATE ZONE	CLASS III VAPOR RETARDERS PERMITTED FOR:[a]
Marine 4	Vented cladding over wood structural panels.
	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Insulated sheathing with *R*-value ≥ 2.5 over 2 × 4 wall.
	Insulated sheathing with *R*-value ≥ 3.75 over 2 × 6 wall.
5	Vented cladding over wood structural panels.
	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Insulated sheathing with *R*-value ≥ 5 over 2 × 4 wall.
	Insulated sheathing with *R*-value ≥ 7.5 over 2 × 6 wall.
6	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Insulated sheathing with *R*-value ≥ 7.5 over 2 × 4 wall.
	Insulated sheathing with *R*-value ≥ 11.25 over 2 × 6 wall.
7 and 8	Insulated sheathing with *R*-value ≥ 10 over 2 × 4 wall.
	Insulated sheathing with *R*-value ≥ 15 over 2 × 6 wall.

Table R702.7.1

TYPES OF CLADDING SYSTEMS

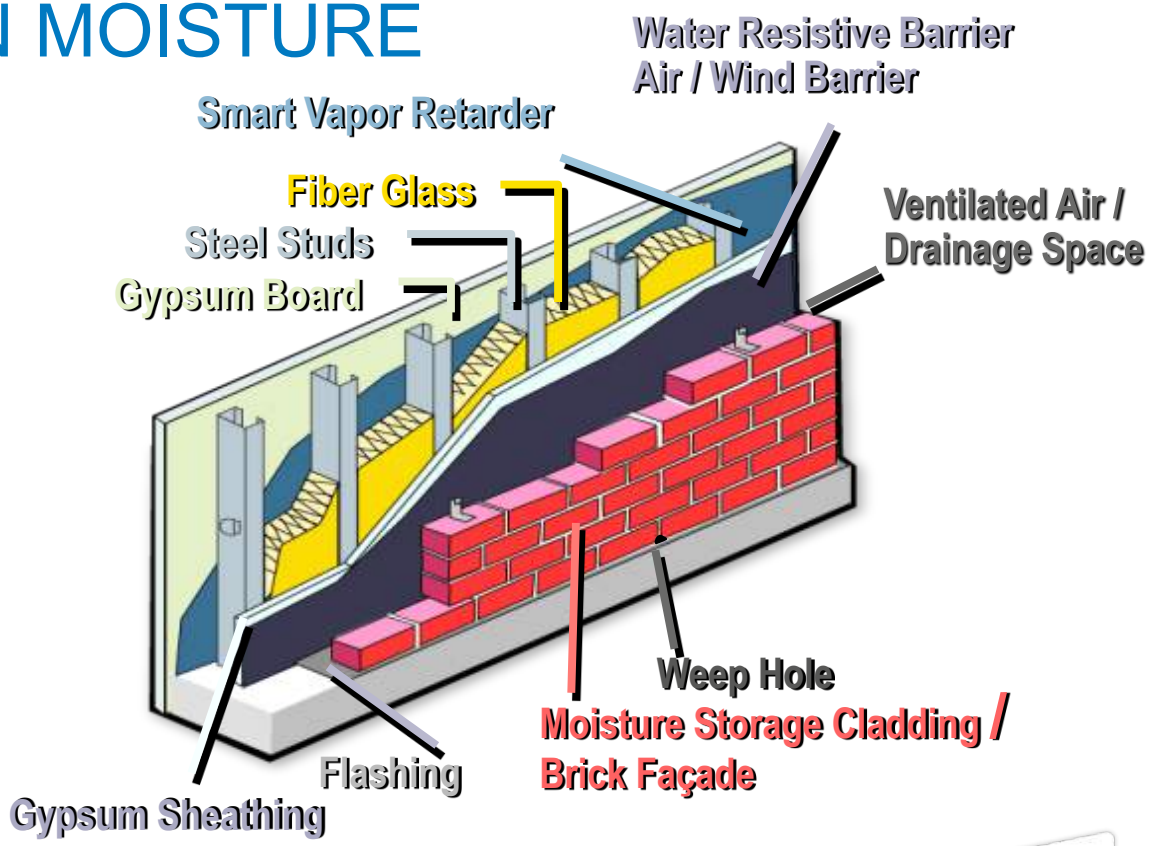


SOLAR DRIVEN MOISTURE

MOISTURE STORAGE CLADDINGS CAN ABSORB LARGE AMOUNTS OF WATER

SOLAR ENERGY CAN CAUSE HIGH VAPOR PRESSURES

SMART VAPOR RETARDERS ALLOW WATER VAPOR TO ESCAPE



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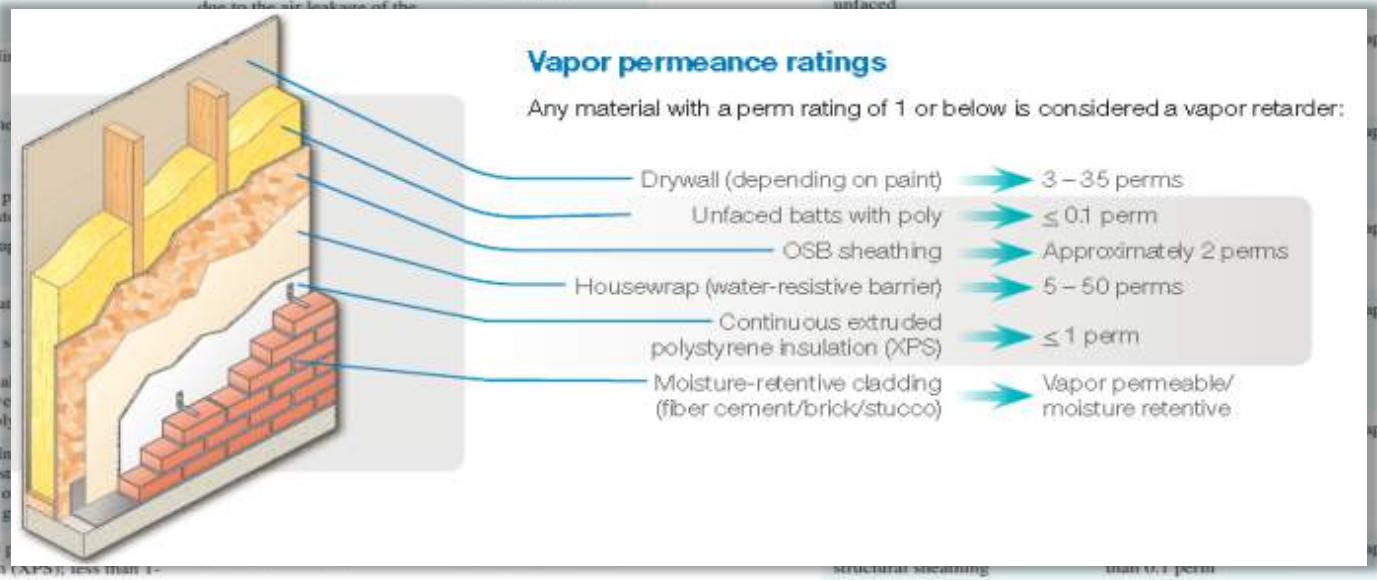
BUILDING MATERIALS – VAPOR PERMEANCE



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BUT WHAT IS ROBUSTNESS?
HOW CAN WE DETERMINE ROBUSTNESS?

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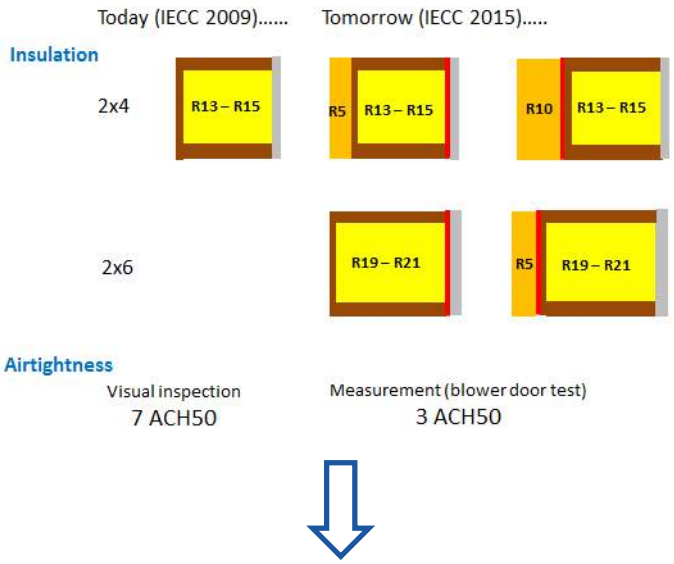
Our Solutions Need to Evolve with our Building Codes…

CONTEXT

Evolving Building Codes require increased levels of Insulation and Airtightness



Higher risk of moisture condensation & Less drying potential
But no change in the building code for moisture management!

ROBUST SOLUTIONS
In various Climate Zones

- **Is your wall system robust in terms of moisture management for your market?**
- **Can we think in terms of "systems solutions" and not only "products"?**

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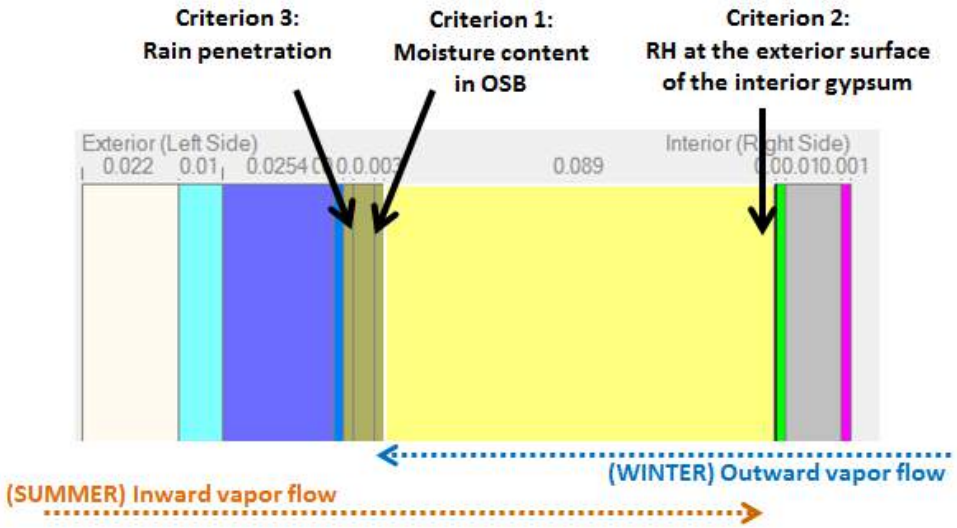
How do we assess the robustness of a wall assembly?

"ROBUST" to MOISTURE = The wall assembly will perform without moisture issues all year long



WUFI®

Airtightness defects (5 ACH50 or 3 ACH50 following code)
Rain infiltration 1%

Criterion 1

Avoid moisture condensation risk in winter

Moisture content in OSB < 20% when T > 40F (30-day running average)

Criterion 2

Avoid summer moisture condensation risk

Relative Humidity behind the interior gypsum board < 90%

Criterion 3

Avoid water accumulation in case of rain penetration

Assess maximum amount of water the assembly before failure of criterion 1 or 2

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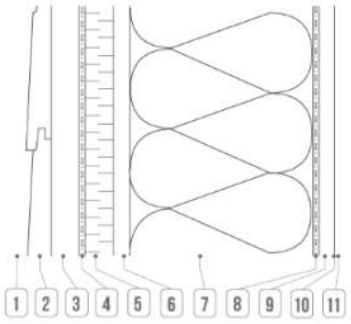
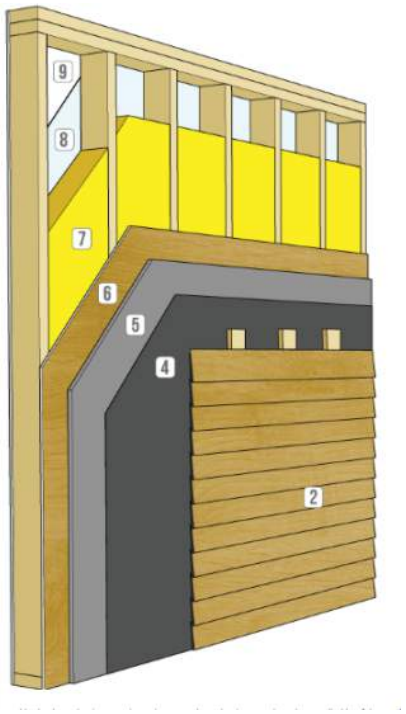
The Universal Wall doesn't exist…
Ex. Canadian Wood Council simulator

- Ex.: 2x6 R24 inside: should you use 1" Polyiso or 2" MW outside? PE foil or SVR inside?



WALL ASSEMBLY COMPONENTS		RSI	R
1	exterior air film	0.03	0.17
2	wood siding (bevelled)[2]	0.00	0.00
3	more than 3/4" (20mm +) air space[3]	0.00	0.00
4	asphalt impregnated paper[4]	0.00	0.00
5	1" (25.4mm) foil faced polyisocyanurate	0.97	5.51
6	7/16" (11.1mm) OSB sheathing	0.11	0.62
7	2x6 framing filled with R24 batt @ 16" o.c.	2.66	15.10
8	polyethylene	0.00	0.00
9	1/2" (12.7mm) gypsum board	0.08	0.45
10	finish: 1 coat latex primer and latex paint	0.00	0.00
11	interior air film	0.12	0.68
Effective RSI / R Value of Entire Assembly		3.97	22.53
Centre of Cavity RSI / R Value		5.54	31.43
Installed Insulation RSI / R Value(nominal)		5.20	29.51
Effective RSI / R Value of Assembly with Advanced Framing (advanced framing as defined by NBC9.36.2.4.(1))		4.16	23.61



Polyiso + PE foil

LOCATION:	Vancouver	Edmonton	Toronto	Montreal	St. John's
DURABILITY RATING BASED ON SIMULATIONS AND FIELD EXPERIENCE					
OUTBOARD TO INBOARD RATIO COMPLIANCE for listed locations only HDD< 6000	0.2	0.3	0.2	0.2	0.2

Polyiso + SVR

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MW + SVR

LOCATION:	Vancouver	Edmonton	Toronto	Montreal	St. John's
DURABILITY RATING BASED ON SIMULATIONS AND FIELD EXPERIENCE					

Under development: US DoE “Building Science Advisor”

Database of hundreds of configurations

- Decision support tool for builders and designers
- Provides expert advice on building envelope system performance from industry’s best researchers and building scientists
- Evaluates and compares moisture durability for a wide range of walls
- Presents guidance on proper methods to mitigate risk
- Promotes better-informed and decisions higher confidence regarding high performance wall assemblies

Building Science Advisor: Preliminary Output

Success Metrics: Moisture durability assessments that are used by the construction industry

Back/Decision | Air Gap | Water/Air Barrier | Sheathing | Vapor Retarder | Interior Finish | Air Tightness | Results

Summary of your wall

Map Location	Fort Worth, TX
Exterior Cladding	Vinyl Siding
Structure	2 x 4 16" o.c.
Cavity Insulation	Fiberglass Batt
Continuous Insulation	None
Air Space	Vented Air Space
Water/Air Barrier	Housewrap
Exterior Sheathing	Oriented Strand Board
Vapor Retarder	None
Interior Finish	Latex Paint
Air Tightness	5 ACH50

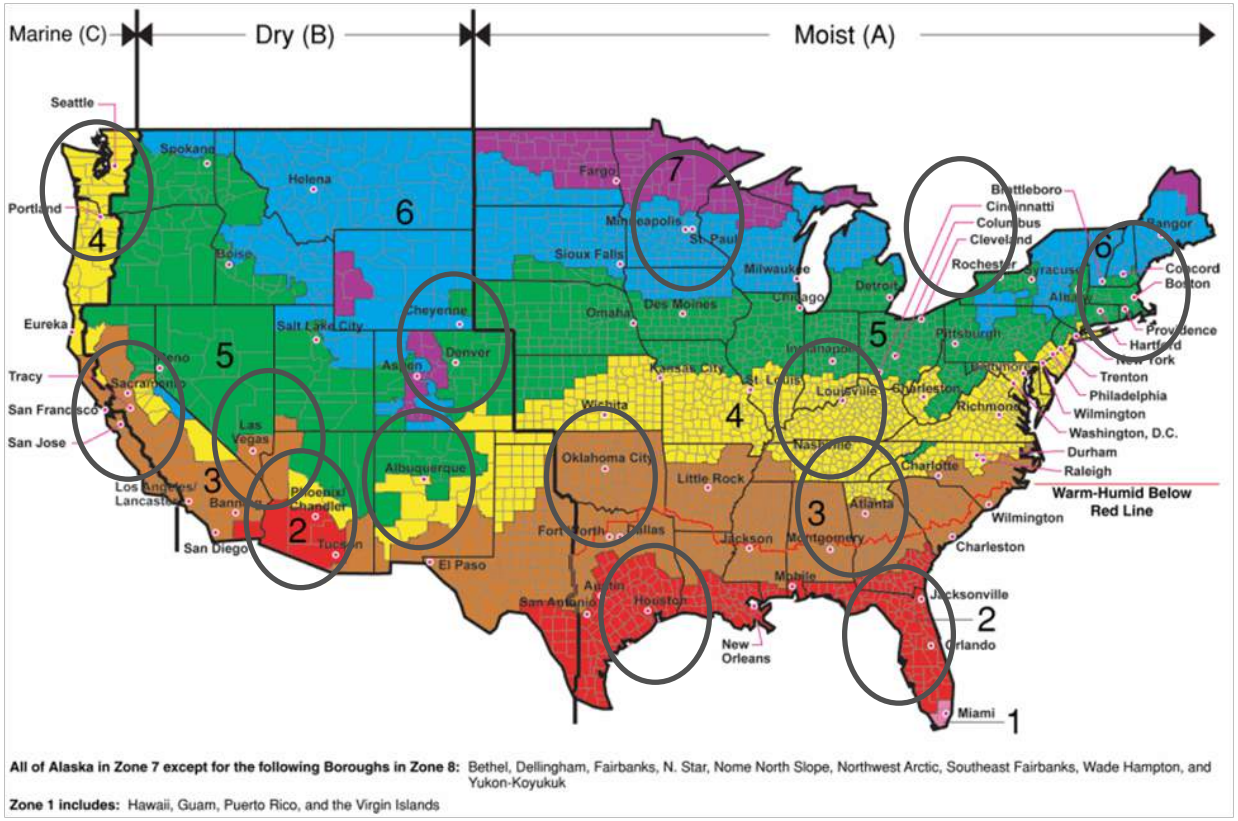
Predicted moisture durability performance

For "yellow" and "green" please use guidance table for optimized performance.

Guidance

- The wall design protects the inside from rain water, both directly and indirectly through cladding or wicking.
- The wall design is airtight, thus low air leakage is expected that could carry water vapor to the inside of the wall.
- The wall design avoids condensation and can dry to the inside, outside or both.

Need Market Specific Solutions and Systems…



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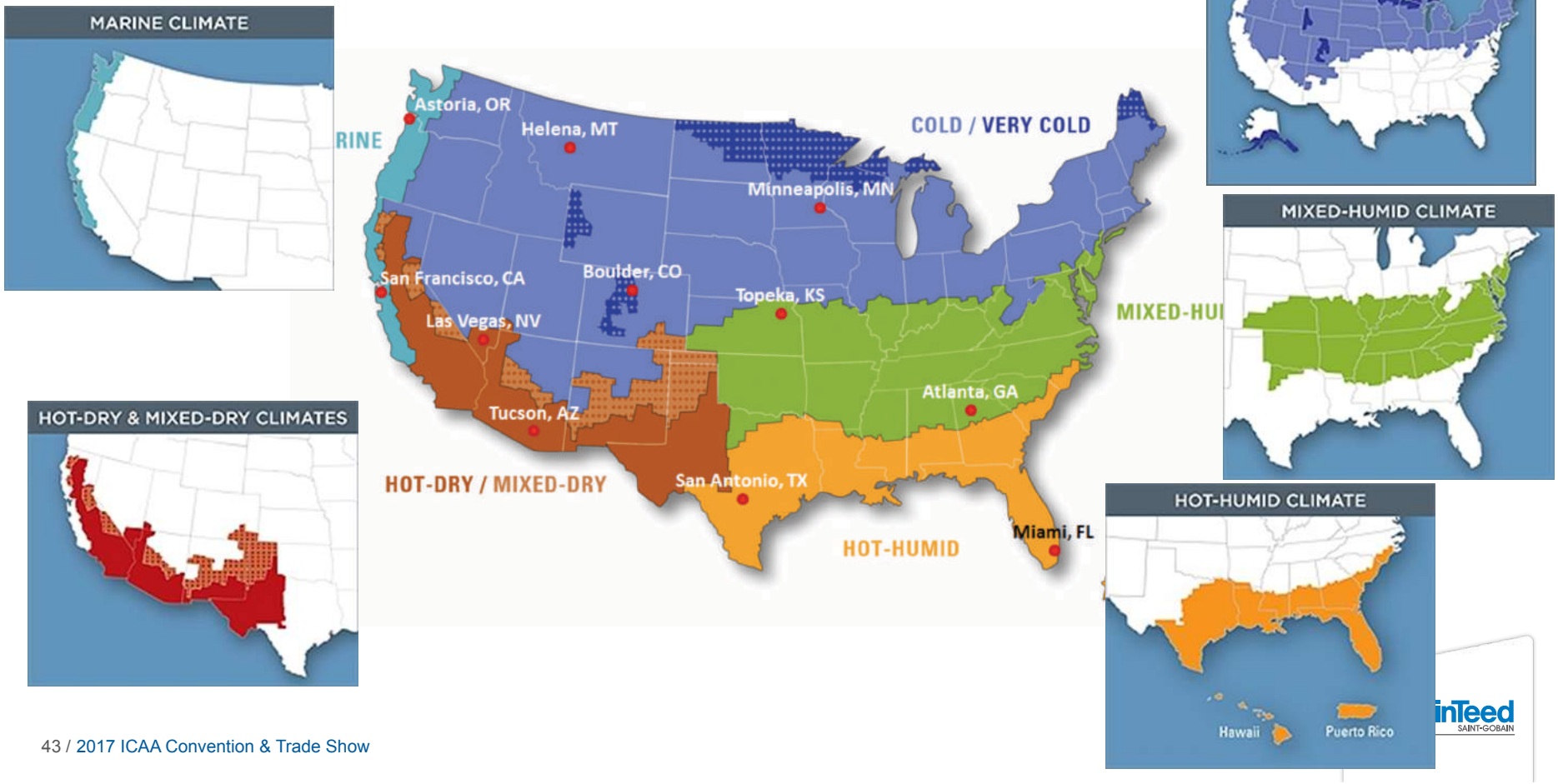
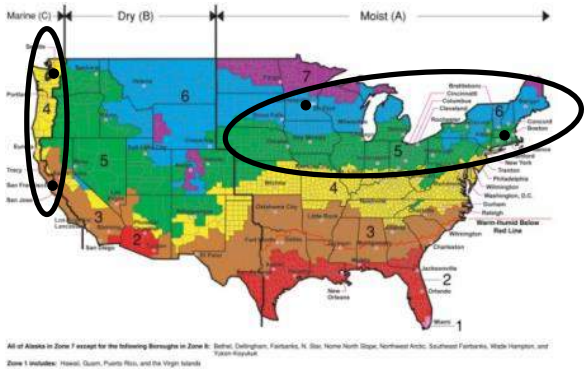

MARINE CLIMATE
COLD & VERY COLD CLIMATES
MIXED-HUMID CLIMATE
HOT-DRY & MIXED-DRY CLIMATES
HOT-HUMID CLIMATE
RINE
Astoria, OR
Helena, MT
COLD / VERY COLD
Minneapolis, MN
San Francisco, CA
Boulder, CO
Topeka, KS
Las Vegas, NV
MIXED-HUI
Atlanta, GA
Tucson, AZ
HOT-DRY / MIXED-DRY
San Antonio, TX
Miami, FL
HOT-HUMID
Hawaii
Puerto Rico



MARINE (3C, 4C) - San Francisco, Seattle
& COLD & HUMID (5A, 6A) - Boston, Minneapolis

WUFI®

Wall cavity insulation only
(2x6 or 2x4 R-20)
Cedar shingles, fiber cement or vinyl siding

Kraft batts:
Pass criterion 1
Criterion 2 : moderate risk of summer condensation

Polyethylene (PE):
Pass criterion 1
Do not pass criterion 2 : high risk of summer condensation

Smart Vapor Retarders & ccSPF
Pass both criteria

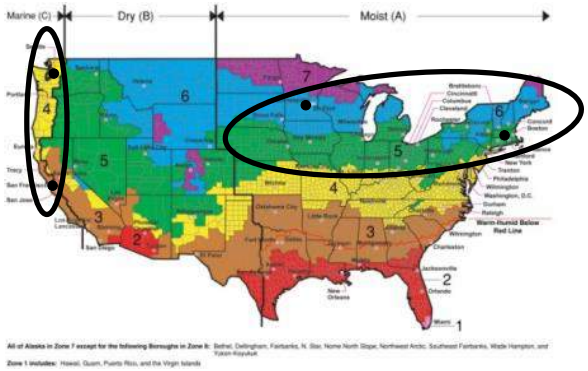
ccSPF

SVR
(SmartBatt or MemBrain)

Hybrid System
(1” ccSPF + 4.5” FG)

CertainTeed
SAINT-GOBAIN

NB: These results are based on WUFI Pro simulations only and sensitive to input parameters.

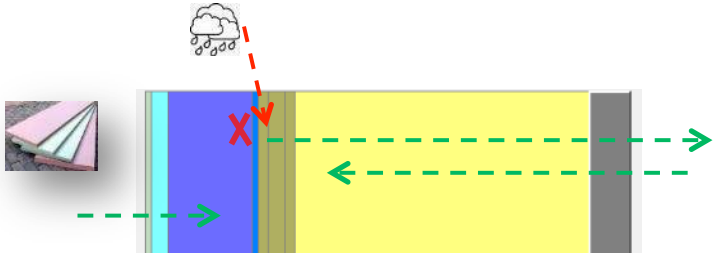


MARINE (3C, 4C) - San Francisco, Seattle
& COLD & HUMID (5A, 6A) - Boston, Minneapolis

WUFI®

Wall cavity insulation + exterior insulation
(2x4 R-13 + R-5)
Cedar shingles, fiber cement or vinyl siding

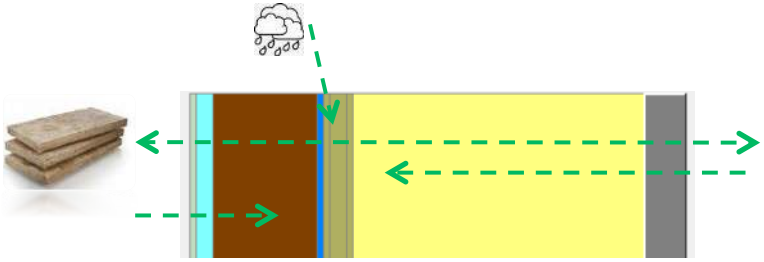
1" XPS (R-5) Exterior insulation + R-13 FG



With XPS: Pass both criteria 1 and 2

Criterion 3: if rain infiltrates the assembly it can dry only towards the interior
Risk increased in Seattle & Boston where it rains a lot

1.5" MW (R-5) Exterior insulation + R-13 FG

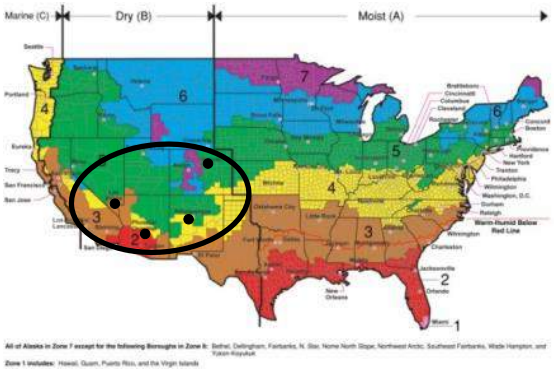


With Mineral Wool: Pass both criteria 1 and 2 and 3

Criterion 3: if rain infiltrates the assembly it can dry towards the interior & the exterior

NB: These results are based on WUFI Pro simulations only and sensitive to input parameters.

CertainTeed
SAINT-GOBAIN



DRY (2B, 3B, 4B, 5B)

Phoenix, Las Vegas, Albuquerque, Denver

WUFI®

Wall cavity insulation w. or w/o ext. insulation

Stucco or fiber cement

Unfaced, Kraft batts, PE, ocSPF, SVR

Pass criterion 1, 2 & 3

(reduced moisture entry in the wall assembly

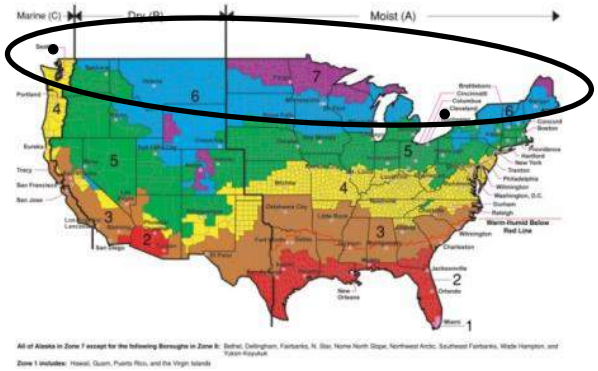
1” XPS (R-5) / 1.5” MW (R-5) Exterior insulation + R-13 FG / ocSPF

Pass criterion 1, 2 & 3

(reduced moisture entry in the wall assembly)

NB: These results are based on WUFI Pro simulations only and sensitive to input parameters.

CertainTeed
SAINT-GOBAIN



Canada: MARINE – Vancouver & COLD - Toronto

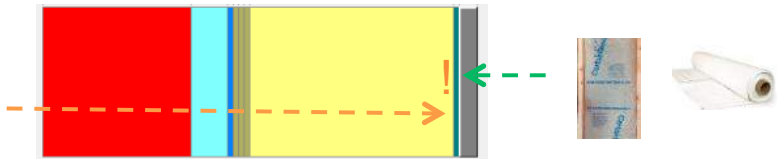
Wall cavity insulation only (2x6 R-23)

Brick cladding or vinyl siding

Kraft batts & Polyethylene

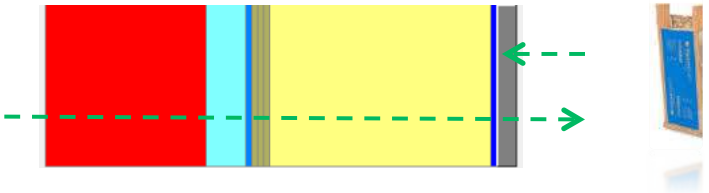
Pass criterion 1

Criterion 2 : moderate risk of summer condensation in Vancouver, low in Toronto

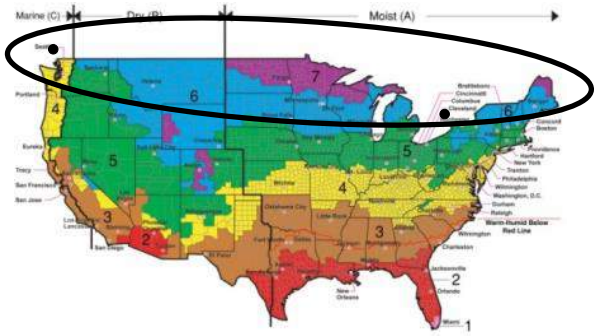


Smart Vapor Retarders (MemBrain)

Pass both criteria



NB: These results are based on WUFI Pro simulations only and sensitive to input parameters.



Canada: MARINE – Vancouver & COLD - Toronto

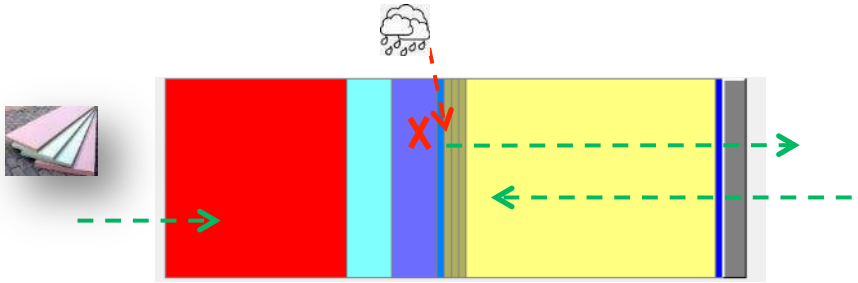
WUFI®

Wall cavity insulation + exterior insulation (2x6 R-20 + R-5)

Vapor retarder mandatory

Brick cladding or vinyl siding

1" XPS (R-5) Exterior insulation + R-13 FG

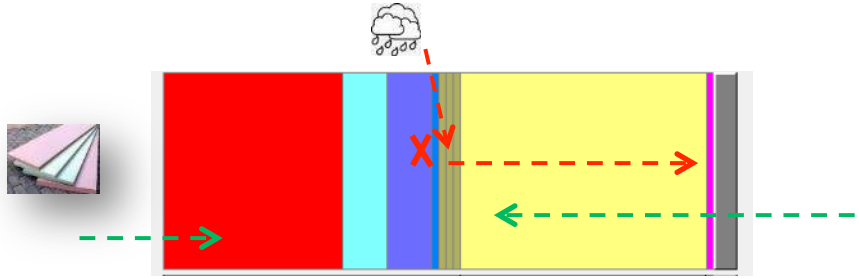


With MemBrain: Pass both criteria 1 and 2

Criterion 3: if rain infiltrates the assembly it can dry only towards the interior

Risk increased in Vancouver where it rains a lot

1.5" MW (R-5) Exterior insulation + R-13 FG + Poly



With PE: Pass both criteria 1 and 2

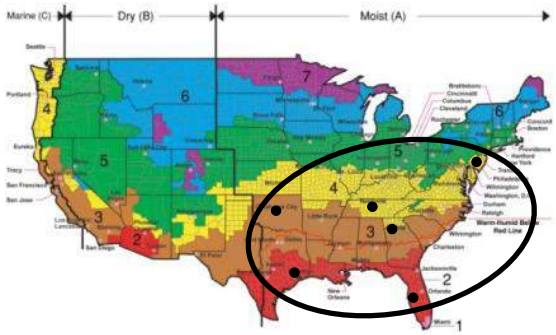
Criterion 3: if rain infiltrates the assembly it cannot dry at all, we create a "sandwich assembly"

Risk increased in Vancouver where it rains a lot

→ Need a Smart Vapor Retarder

CertainTeed SAINT-GOBAIN

NB: These results are based on WUFI Pro simulations only and sensitive to input parameters.



HOT HUMID (2A, 3A)

Houston, Tampa, Atlanta, Oklahoma city

& WARM HUMID (4A)

Nashville, Philadelphia

WUFI®

Wall cavity insulation only (2x4 R-13 or 2x6 R-20)

Brick, fiber cement, stucco or vinyl siding

Unfaced batts:

- Pass criterion 1 except in cities with cold winters (Houston & Philadelphia)
- Pass criterion 2

Kraft batts:

- Pass criterion 1
- Do not pass criterion 2 : high risk of summer condensation in fiberglass behind the kraft (vapor-closed), moderate in Philadelphia

Smart Vapor Retarders & Foams

Pass both criteria

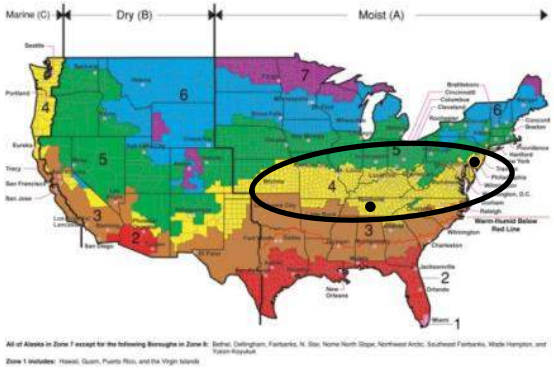
ocSPF ccSPF

Hybrid System (1” ccSPF + 4.5” FG)

SVR (SmartBatt or MemBrain)

CertainTeed SAINT-GOBAIN

NB: These results are based on WUFI Pro simulations only and sensitive to input parameters.



WARM HUMID (4A)

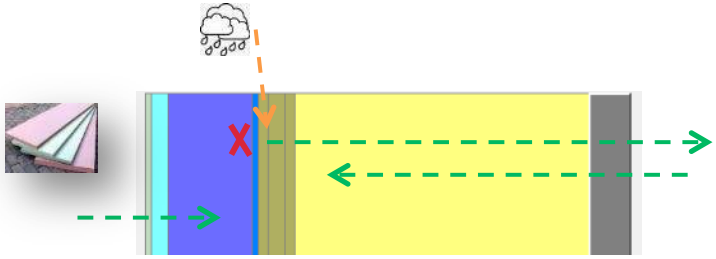
Nashville, Philadelphia

WUFI®

Wall cavity insulation + exterior insulation (2x4 R-13 + R-5)

Brick, fiber cement, stucco or vinyl siding

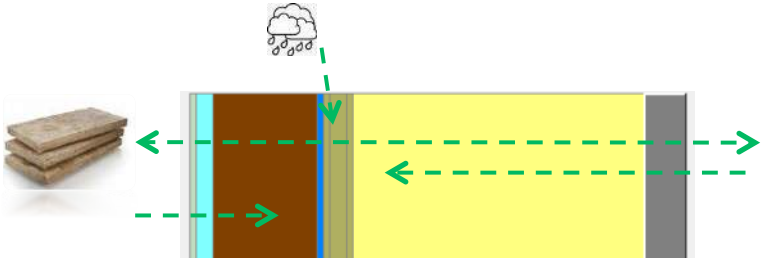
1" XPS (R-5) Exterior insulation + R-13 FG



With XPS: Pass both criteria 1 and 2

Criterion 3: if rain infiltrates the assembly it can dry only towards inside

1.5" MW (R-5) Exterior insulation + R-13 FG



With Mineral Wool: Pass all criteria 1 and 2 and 3

Criterion 3: if rain infiltrates the assembly it can dry towards inside and outside

CertainTeed SAINT-GOBAIN

NB: These results are based on WUFI Pro simulations only and sensitive to input parameters.

WE NEED TO KEEP MOVING FORWARD…

- **Our buildings must be robust; maintaining a greater potential to dry than wet.**
- **Smart vapor retarder systems and hybrid systems in 2x6 cavities**
    - **Very good systems in almost all climates, Real differential moisture management solution in both winter and summer**
        - **Advantage especially in warm and marine climate vs. unfaced and faced batts**
        - **Advantage in Canada where a vapor retarder is required even with exterior insulation**

- **Next step: focus on local code adaptation to better understand local construction practices**
- **Next step: understand local market needs as moisture management is not always the priority**

CertainTeed
SAINT-GOBAIN

THANK YOU