BUILDINGENERGY NYC

Inside and Out: Insulating Our Existing Masonry Buildings

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Curated by Jodi Smits Anderson

Northeast Sustainable Energy Association (NESEA)
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Description

In the Northeast, we have the benefit and burden of a large stock of uninsulated masonry buildings of various typologies and conditions. Leaving these buildings as they are is untenable with the global effort to reduce carbon emissions, and will not address climate shifts, the fabric of community, or the health of occupants. We will explore insulating from the interior, exterior, or both. In all cases the approach and design must be informed by retrofit feasibility, durability and toxicity of materials, installation cost, embodied carbon, emissions, labor capabilities, and overall envelope performance including freeze/thaw damage.

Learning Objectives

1. Employ design concepts that promote reliable and durable solutions for upgrading thermal performance existing masonry walls

2. Explain how air sealing and vapor control affect the performance of historic masonry enclosures when insulting from inside

3. Identify and address constraints that inform the decisions in the design process for insulating existing masonry walls

4. Summarize current code considerations informing different solid masonry retrofit options

Introduction

What is “High Performance”?

User Priorities / Concerns:

1. Comfortable
2. Healthy
3. Energy Efficient
4. Resilient
5. Affordable
6. Aesthetically pleasing

Masonry Priorities / Concerns:

1. It wants to be dry
2. It wants to be seen

Issues

Building type:

- Tower in the park
- Within a street

2022 Building Code:

- Requires firestopping of combustable material in facades.

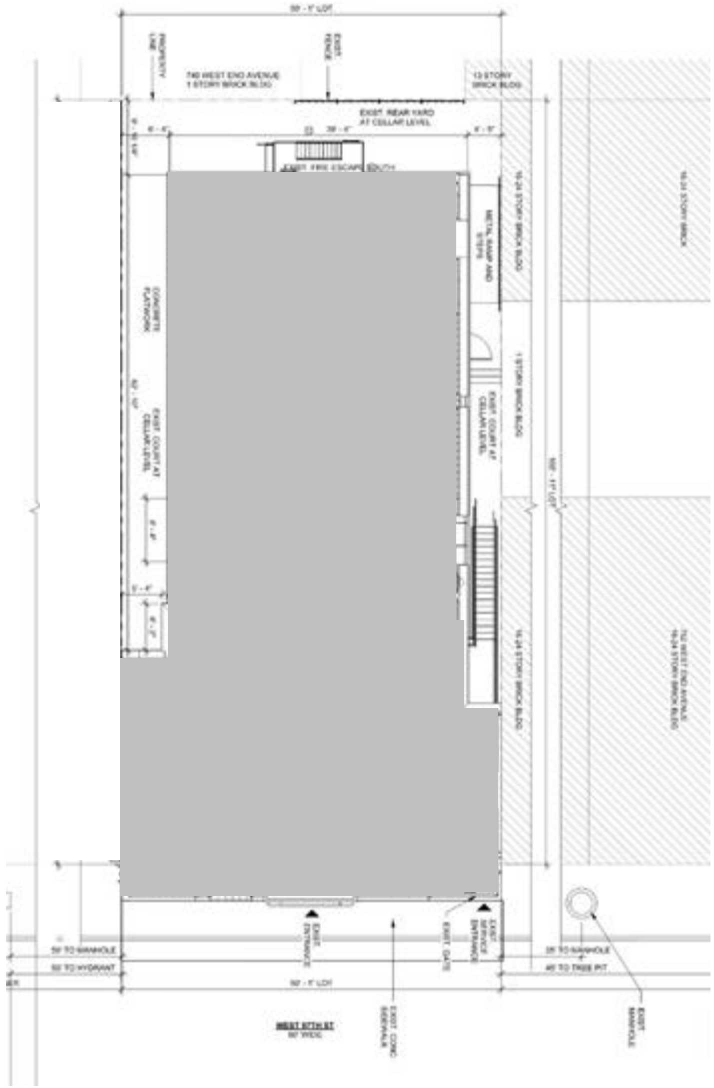
Exterior

- Long term maintenance / FISP
- Structure issues
- Code requirements
- Zoning
- Change image

Interior

- Loss interior space
- Code requirements
- Thermal breaks
- SHPO standards (3 ½”)
- Covers lead paint

Building Type

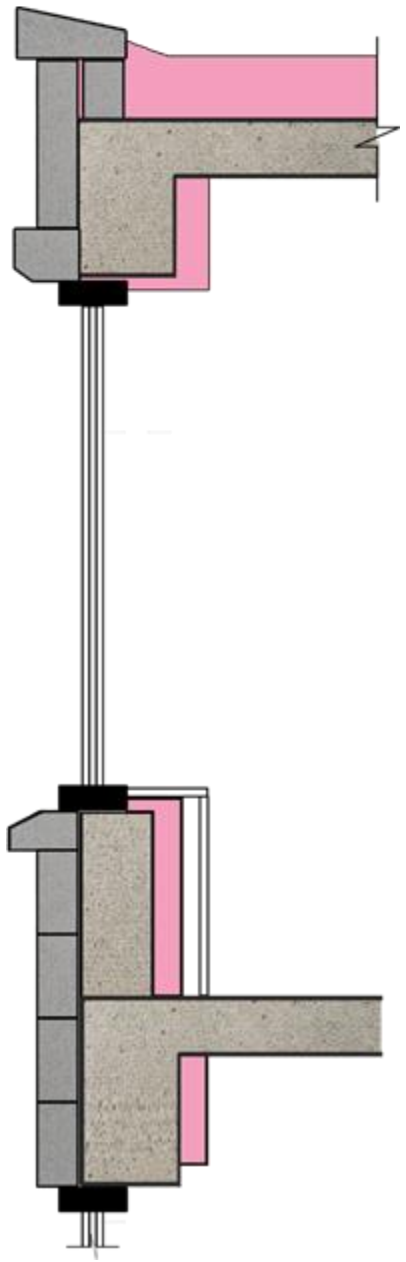


Tower in the Park

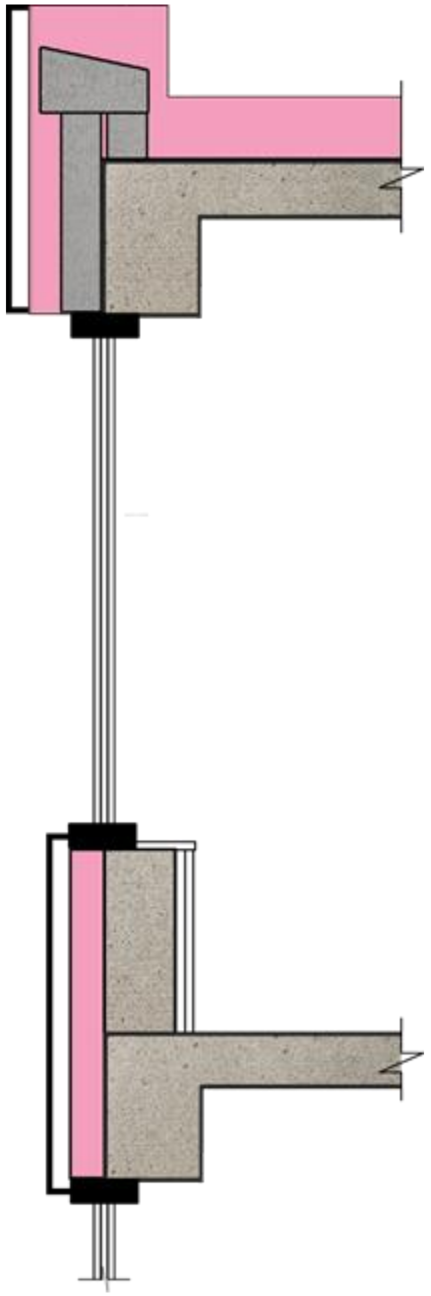
Within Street

Insulation Options

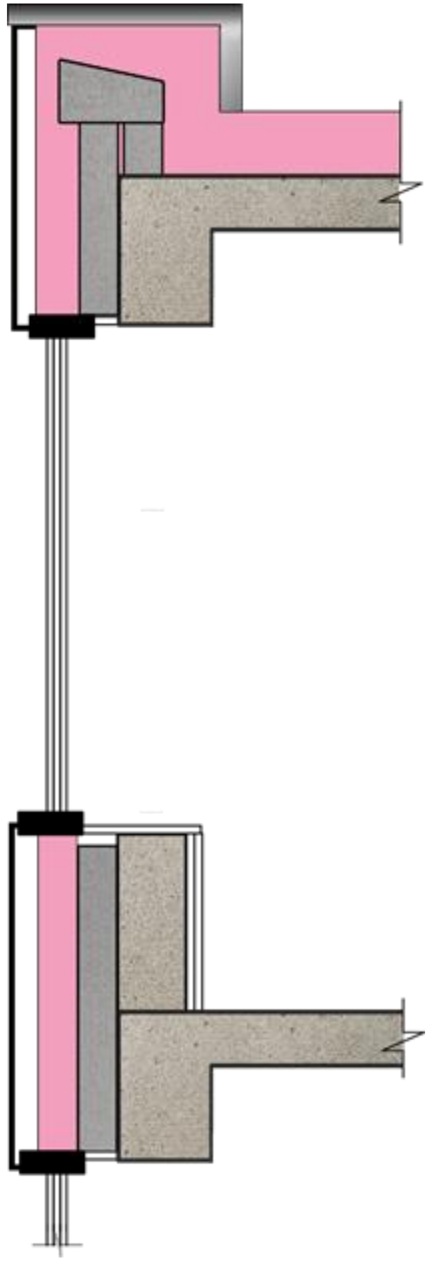
Interior Insulation



Exterior Insulation



Recladding

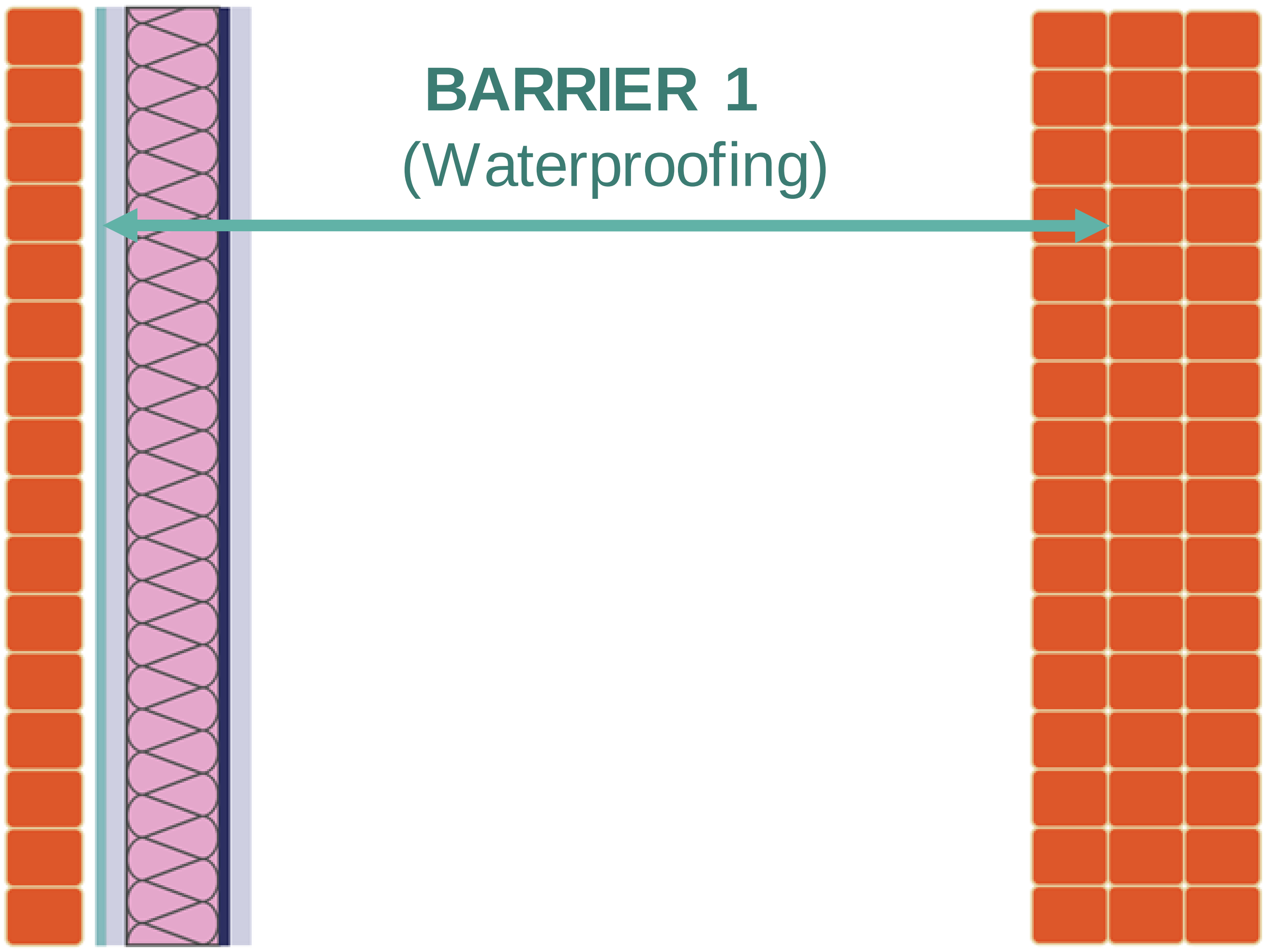


Overcladding

Masonry Walls – Four Barriers

Contemporary vs. Masonry Walls

Very good -
Waterproofing



Decent to very poor –
absorptive brick
(No waterproofing)

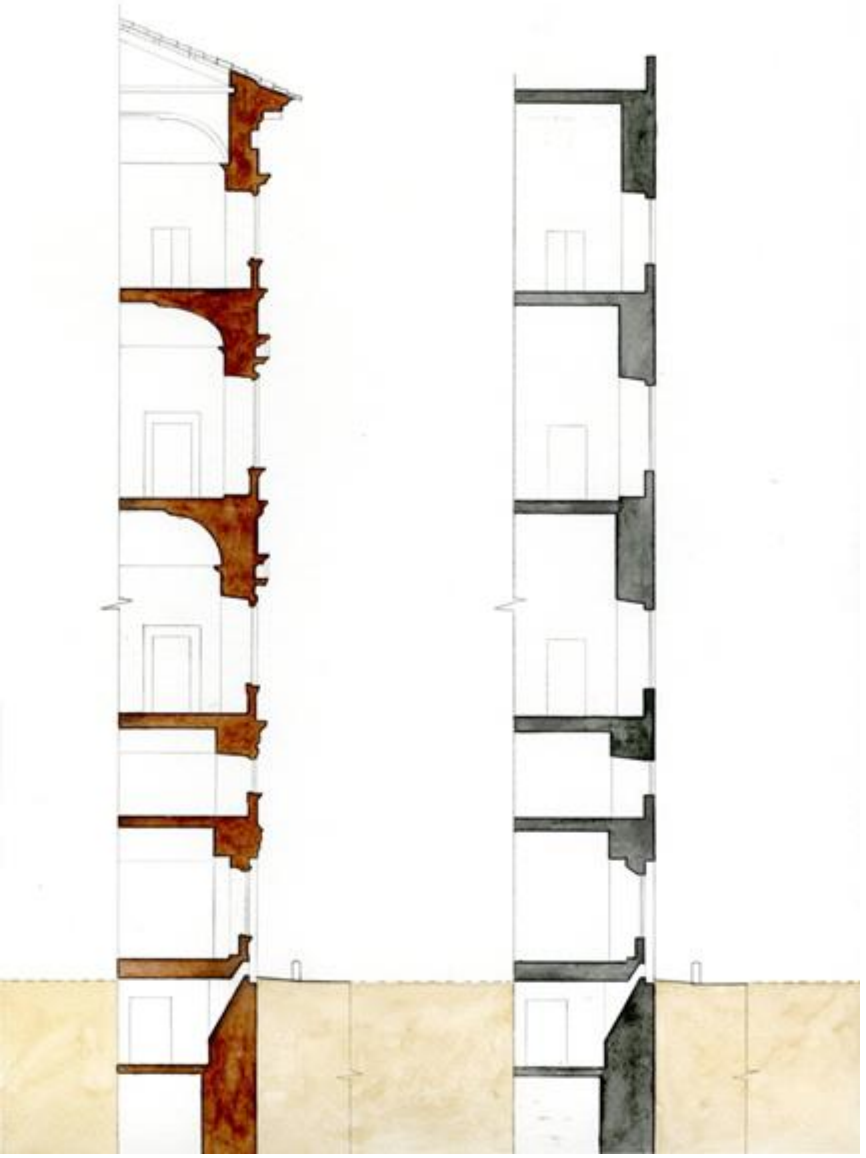
Lightweight + Multilayered

Mass + Monolithic

Facade Forms / Functions – Managing Water!

- Projecting bandcourses, ledges, window hoods and sills; gutters = Functional – not just decorative


Typical facades in Rome

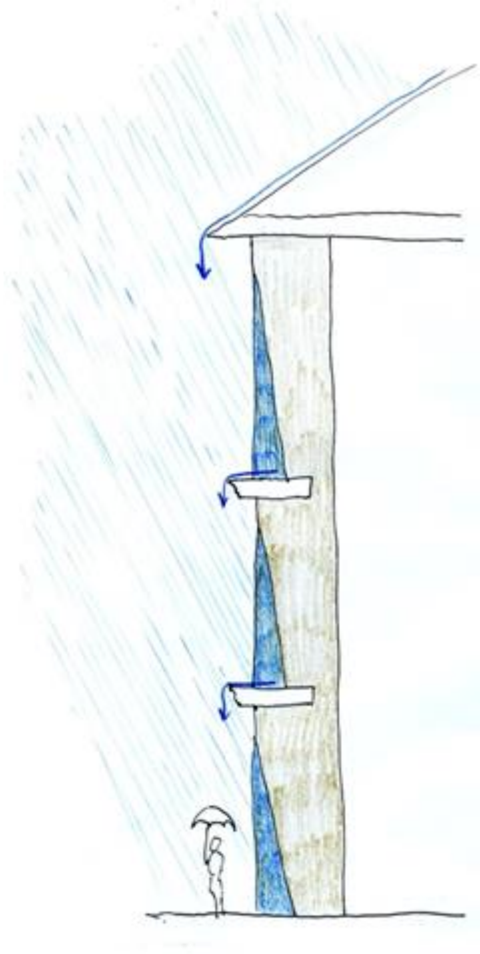


Detailed facade   Planar facade

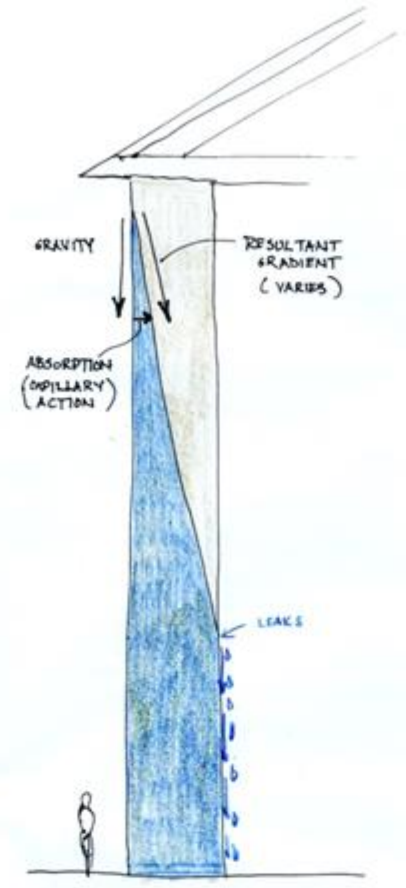
Facade Forms / Functions – Managing Water!

- Projecting bandcourses, ledges, window hoods and sills; gutters = Functional – not just decorative
- Material choices = compatible masonry and mortar (good maintenance – regular repointing)

Typical facades in Rome



Detailed facade



Planar facade

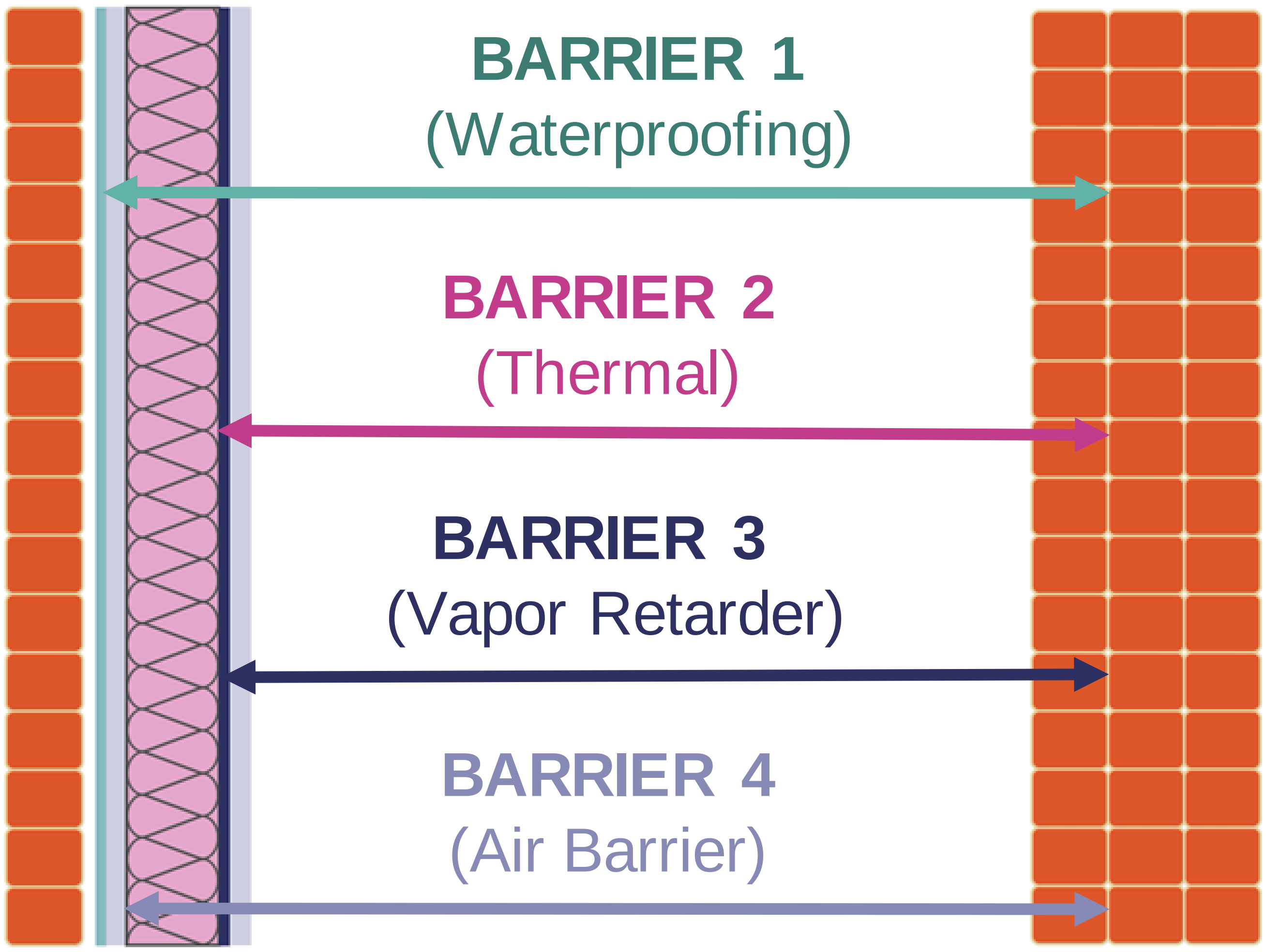
Contemporary vs. Masonry Walls

Very good - Waterproofing

Insulation (R12+)

Vapor Retarder (0.06 perms)

Airtight (0.004 cfm/sf)



Decent to very poor – absorptive brick (No waterproofing)

Poor – conductive R2

Flow through - permeable (0.7 perms)

Very poor - leaky (0.25 cfm/sf)

Lightweight + Multilayered

Mass + Monolithic

Code Issues

New Building Code (In effect 11/7/2022)

Buildings bulletin 2022-013

BC 718.2.6.1.1 requires noncombustible fireblocking at the following locations:

1. Around wall openings;
2. At the floor level for a height of not less than 8 inches;
3. Between different occupancy groups, vertically or horizontally as applicable. BC 1406.2.3 for combustible exterior wall coverings

Covered in the following sections

- BC 1407.16 for MCM
- BC 1408.7 for EIFS
- BC 1409.16 for HPL
- BC 2603.5.5.1 for foam plastic insulation
- BC 2613.5 for FR

Zoning Resolution

12-10 – DEFINITIONS

Not Floor Area

(12) exterior wall thickness, up to eight inches:

i. where such wall thickness is added to the exterior face of a building wall existing on April 30, 2012, provided the added wall thickness has a thermal resistance (R-value) of at least 1.5 per inch

However:

- If residential still have to comply with the Multiple Dwelling Law.
- You are not permitted to go over a property line at a party wall
- Landmarks may limit what you can do
- The thinnest panels we have found are 8.5” (typically 8 to 12")

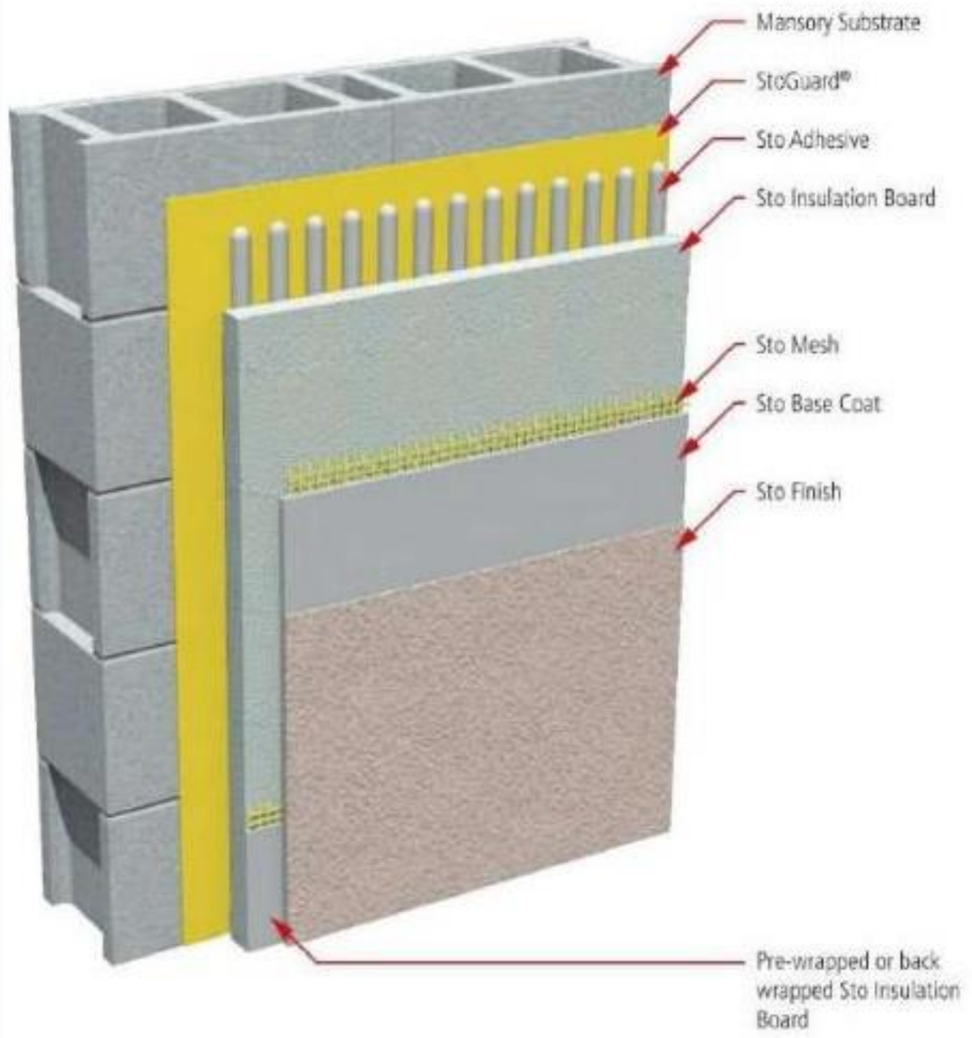
This may change with the City of Yes Zoning changes. Sustainable changes are expected to be certified on Earth Day

Exterior Insulation

Harlem River II overcladding

Before

After

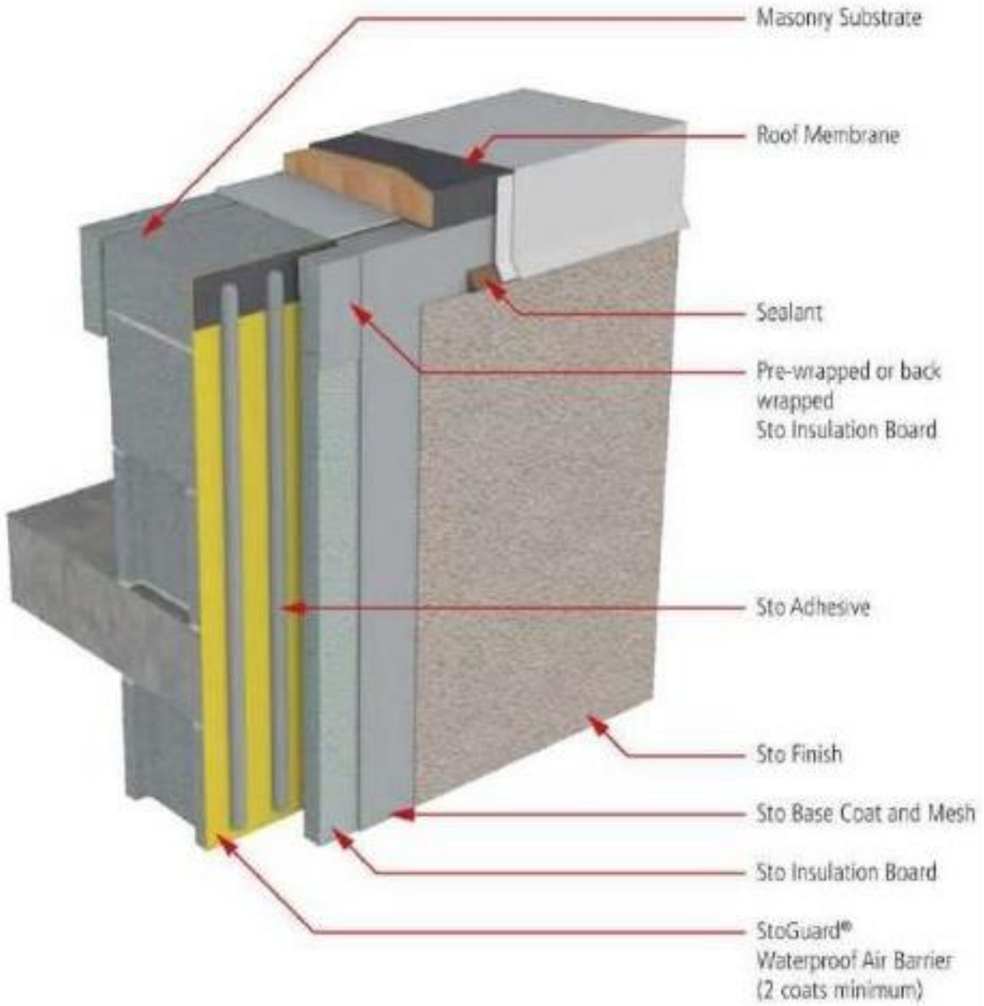


Notes:

Detail shows the components of StoTherm® ci Continuous Insulation System:

1) StoGuard® Waterproof Air Barrier (2 coats minimum)
2) Sto Adhesive
3) Sto Insulation Board
4) Sto Base Coat
5) Sto Mesh
6) Sto Finish

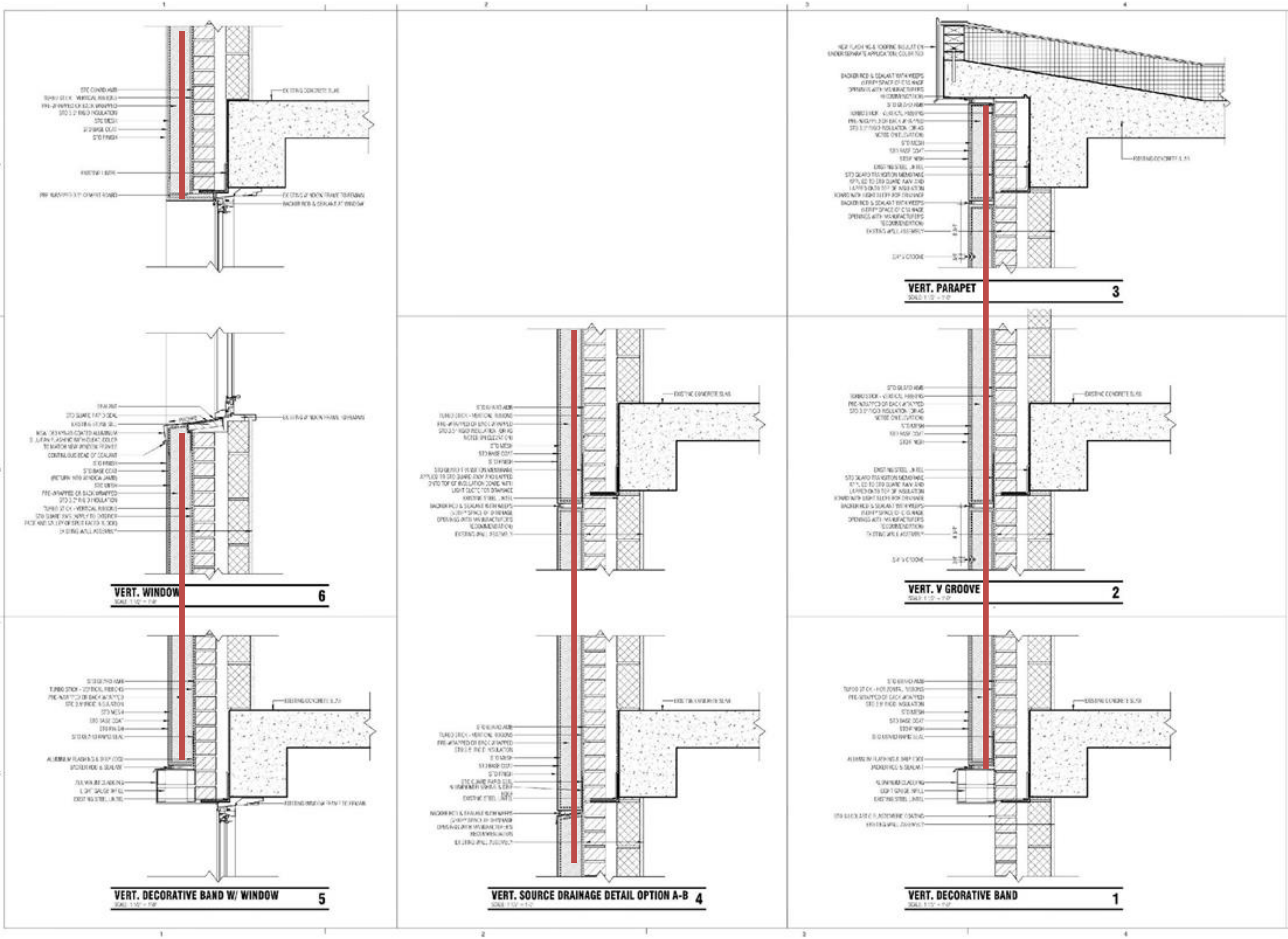
IMPORTANT: Components not identified as Sto are furnished by other manufacturers and are not necessarily installed by trades who install the Sto products. Refer to project specific contract documents.



Notes:

1) Provide continuity of roof membrane along back of parapet with base coat for air barrier continuity and verify compatibility of roof membrane if in contact with base coat.
2) Completely insulate back side of parapet if necessary to prevent condensation within parapet based on climate conditions.
3) Provide minimum 2.5 inch (65mm) overlap of parapet coping over face of StoTherm® ci. Increase overlap with building height.

IMPORTANT: Components not identified as Sto are furnished by other manufacturers and are not necessarily installed by trades who install the Sto products. Refer to project specific contract documents.



Harlem River II

2850 Frederick Douglass Blvd, New York, NY 10039

Owner
Harlem River Preservation LLC
247 W 37th Street, 4th Floor
New York, New York 10018

Architect
Curtis + Ginsberg Architects
55 Broad Street, Floor 9
New York, New York 10004

Energy + Sustainability
Bright Power
11 Hanover Square, 21st Floor
New York, New York 10005

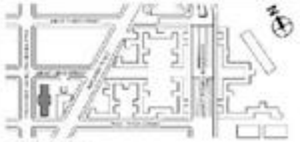
MEP
Ingloso AE
632 Pompton Ave,
Cedar Grove, NJ 07009

Historic Preservation
Higgins Quasebarth & Partners LLC
11 Hanover Square, 16th Floor
New York, New York 10005

Expediter
JM Zoning LLC
225 Broadway, Suite 1300
New York, New York 10007

Environmental - Lead + Asbestos
Airtek
39-37 29th Street
Long Island City, NY 11101

Exterior and Waterproofing Consultant
RAND Engineering & Architecture, DPC
159 West 25th Street
New York, NY 10001



SITE KEY PLAN

No.	Date	Revision

No.	Date	Submission
6	04/07/2022	100% CD SET - EXTERIOR
5	10/15/2021	PLAN REVIEW REV01
4	08/16/2020	FINAL FILING SET - EXTERIOR
3	05/20/2021	UPDATED FILING SET - EXTERIOR
2	12/15/2020	50% CD SET
1	06/29/2020	PLAN AND COST REVIEW

Title:

BUILDING SPECIFIC EIFS DETAILS II

Job No.: 20005
Scale: 1 1/2" = 1'-0"
Drawn By: EI
Checked By: CC/AM

HR-2

Sheet No.:

A-311.00

DOB#: M0447333-S1

Exterior Insulation

Exterior Panels

Panel make up

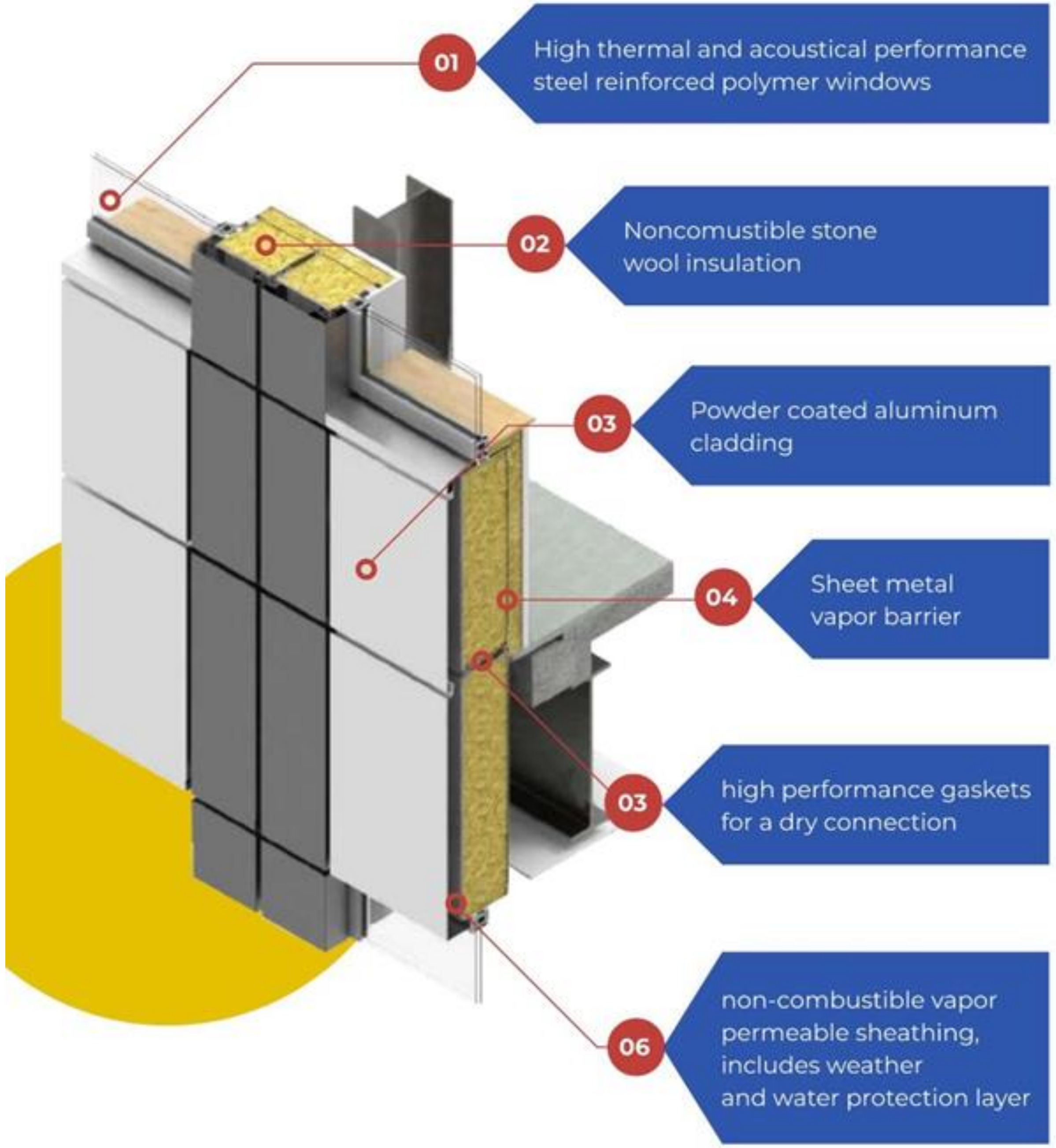


Image 3 is a 3-D image of the typical panel that was modeled in Heat3. The typical panel size was modeled as 7'6" wide (or 90") and 10' high (or 120"). These dimensions were provided based on the expected horizontal and vertical spacing of the joints. The horizontal spacing of the vertical purlins are 24", for a total of three in the main cavity in addition to the two at the joint.

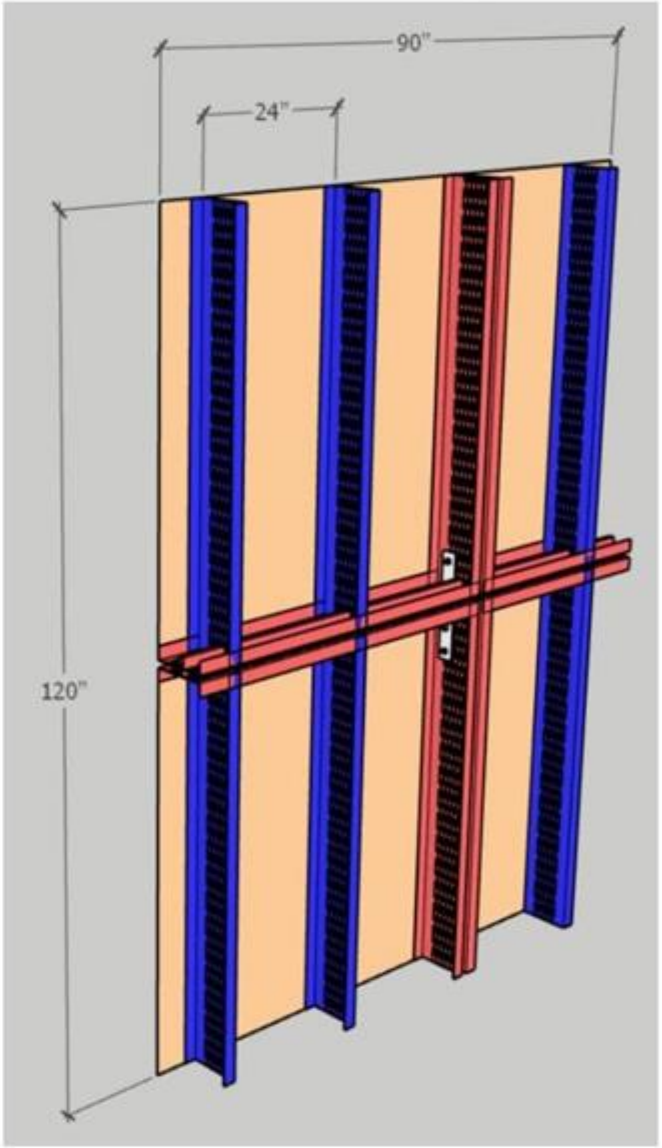


Image 3: 3-D model of typical section with dimensions.

HEAT3 MODELING RESULTS

The results of the Heat3 modeling are summarized in table 2 and figure 1. Cases 1.0 through 4.0 represent each of the four thicknesses of exterior insulation modeled with interior insulation. Cases 1.1 through 4.1 are the same but without interior insulation. The final two cases (Code 1 and 2) were modeled to compare the R-Value requirement to the corresponding U-Value requirement for DC and Philadelphia (Code 1) and New York City (Code 2).

The red text in figure 1 indicates that the U-Value does not meet energy code in any of the three cities evaluated. Blue text indicates that DC and Philadelphia are met, and green text indicates all three cities are met.

Table 2: Heat3 modeling results for all cases.

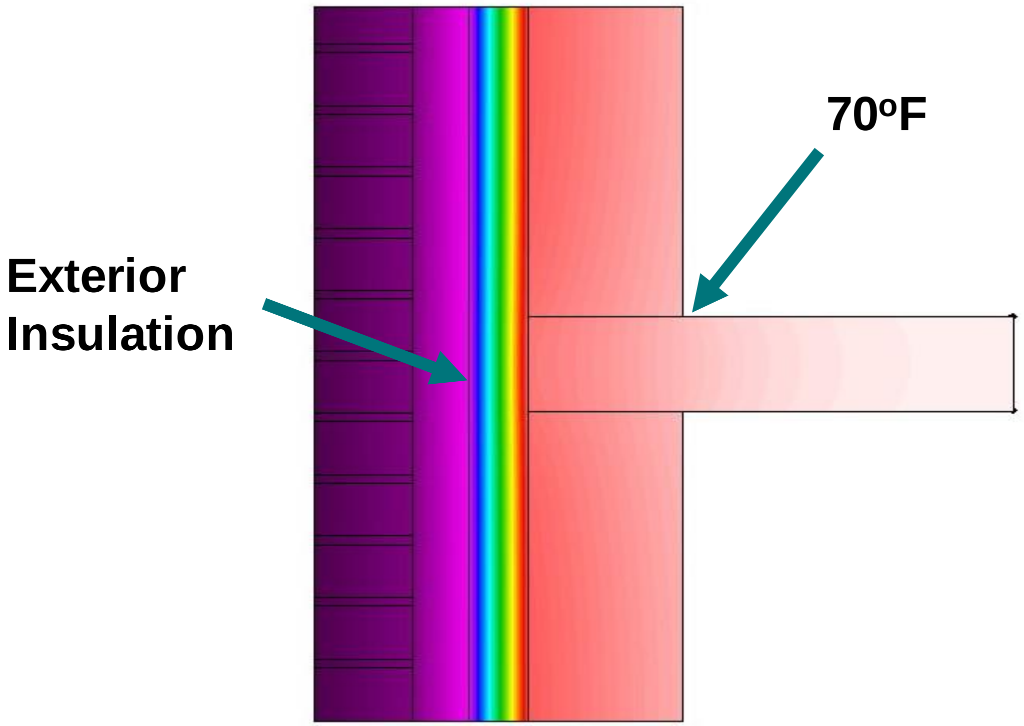
			Model Results		NYC Code		DC and Philadelphia Code	
Case Name	Ext. Insulation Thickness (in)	Cavity Insulation Thickness (in)	U Value (Btu/hr-ft2-F)	R Value (hr-ft2-F/Btu)	U Value (Btu/hr-ft 2-F)	R Value (hr-ft2-F/Btu)	U Value (Btu/hr-ft2-F)	R Value (hr-ft2-F/Btu)
Case 1.0	6	2	0.0431	23.2	0.0610	16.4	0.0640	15.6
Case 2.0	8	2	0.0373	26.8	0.0610	16.4	0.0640	15.6
Case 3.0	10	2	0.0304	32.8	0.0610	16.4	0.0640	15.6
Case 1.1	6	0	0.0552	18.1	0.0610	16.4	0.0640	15.6
Case 2.1	8	0	0.0452	22.1	0.0610	16.4	0.0640	15.6
Case 3.1	10	0	0.0348	28.7	0.0610	16.4	0.0640	15.6
Case 1.0*	6	2	0.0567	17.6	0.0610	16.4	0.0640	15.6
Case 2.0*	8	2	0.0547	18.3	0.0610	16.4	0.0640	15.6
Case 3.0*	10	2	0.0503	19.9	0.0610	16.4	0.0640	15.6
Case 1.1*	6	0	0.1112	9.0	0.0610	16.4	0.0640	15.6
Case 2.1*	8	0	0.0989	10.1	0.0610	16.4	0.0640	15.6
Case 3.1*	10	0	0.0892	11.2	0.0610	16.4	0.0640	15.6

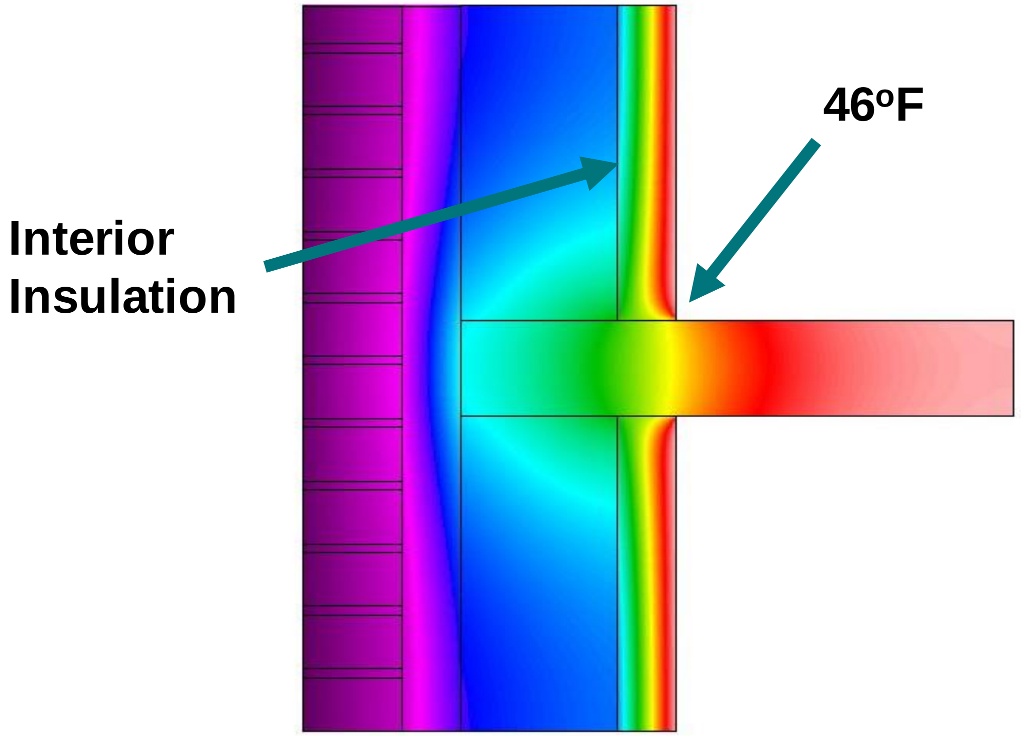
*These cases were modeled with no perforations in the studs.

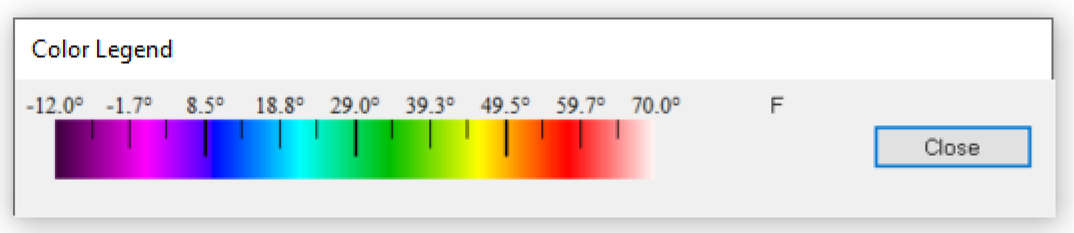
Interior Insulation

Thermal Bridging Issues

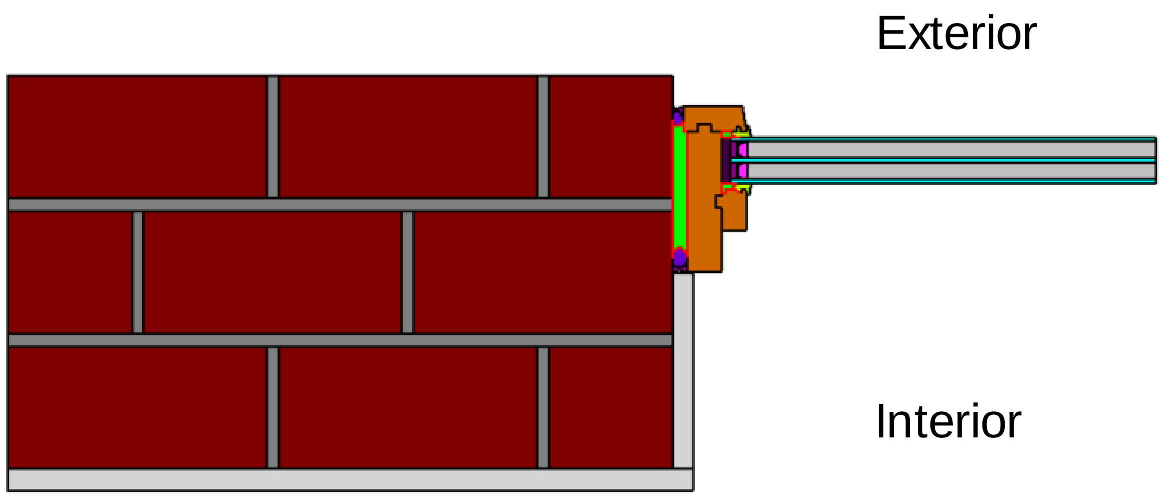
Interior Approach

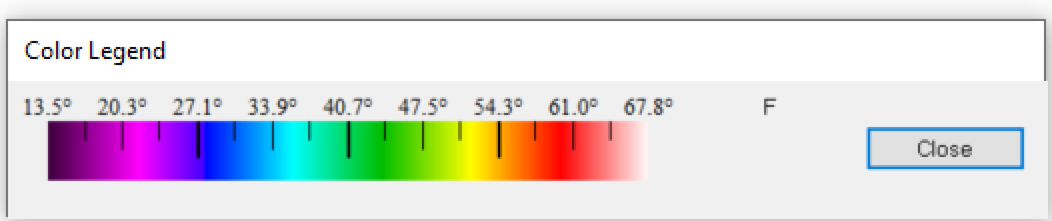


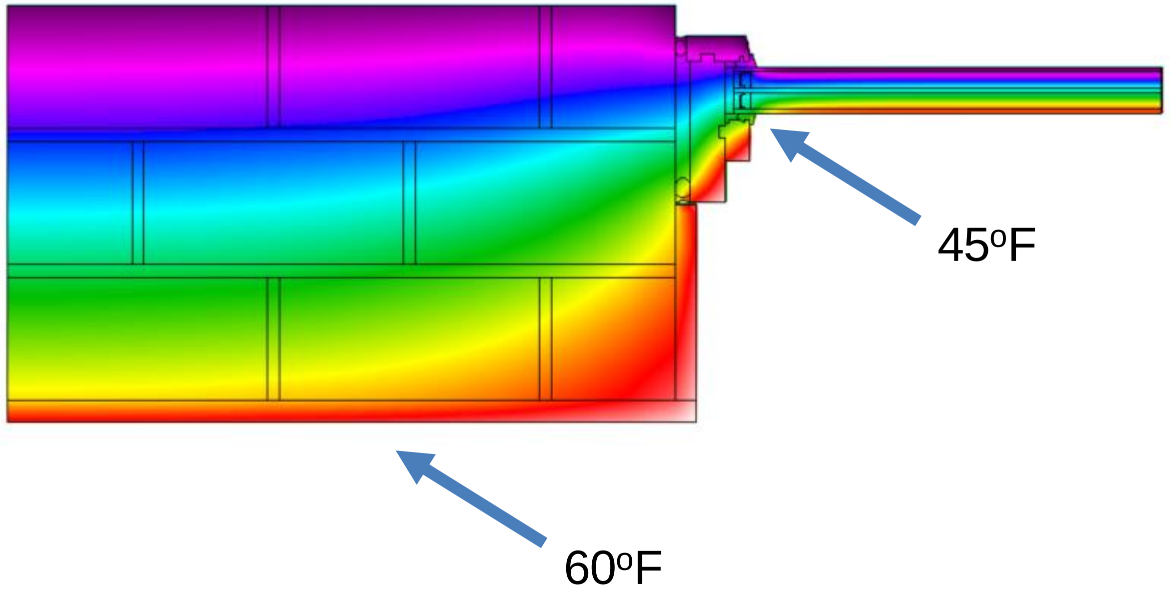


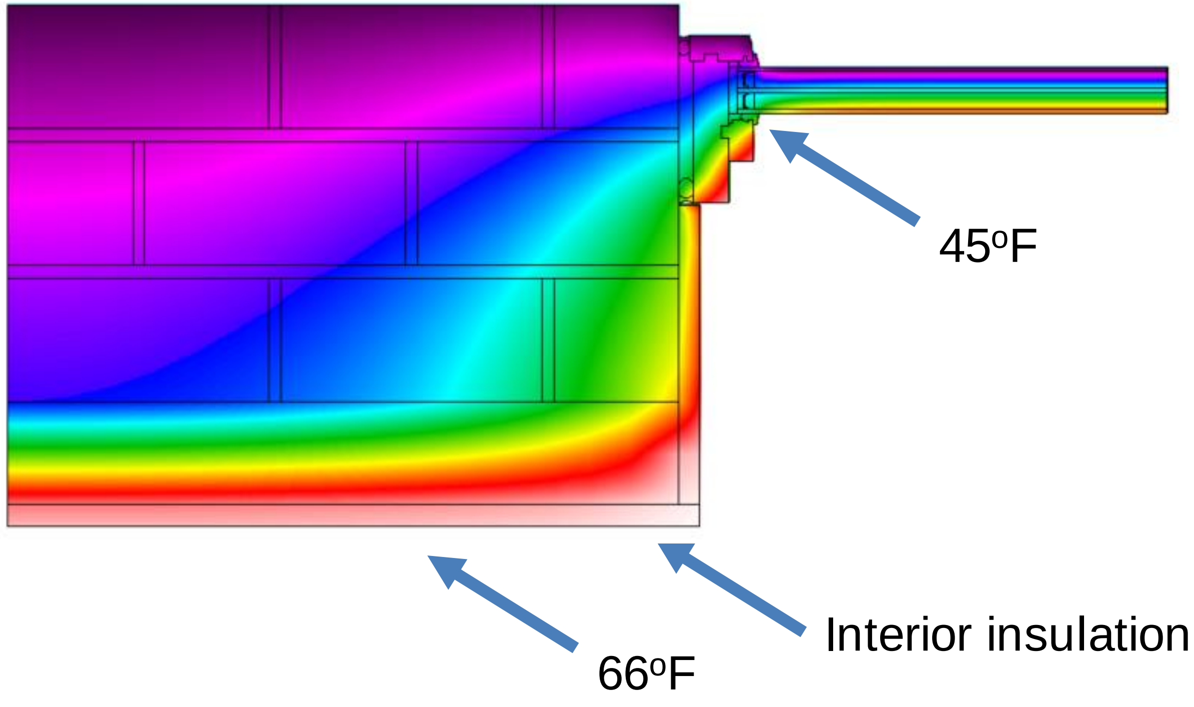


Interior Approach



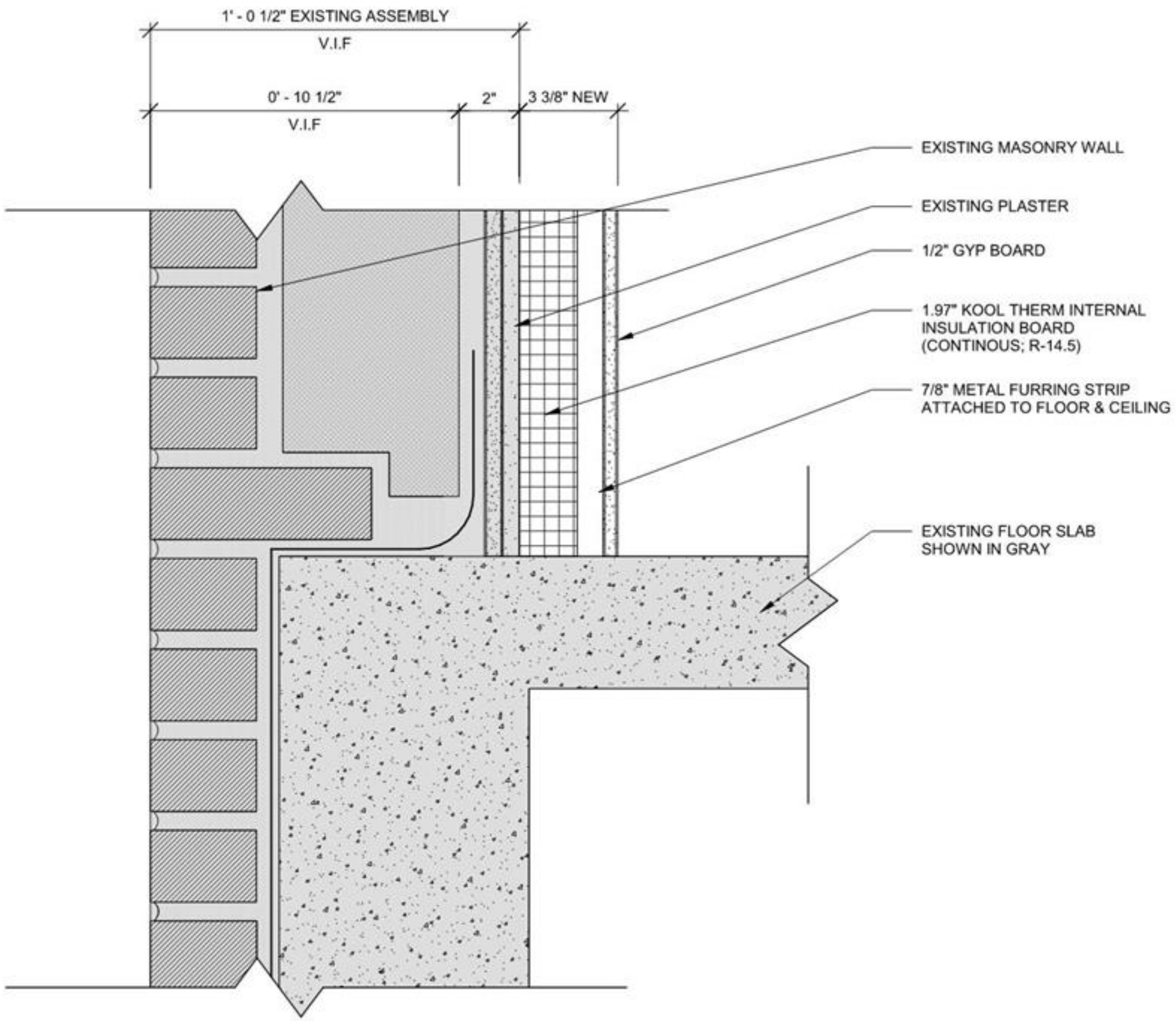






Interior Insulation

Architectural Issues



OPTION 2: R-20.18 (TOTAL: EXISTING+NEW)

TOTAL DEPTH OF NEW ASSEMBLE: 3.3"

Option 2 - Board Insulation with furring strip (Kingspan K-9)		R-value
	Outside air flim	0.17
Existing	4" Brick	0.4
	6" CMU	1.67
	1 3/8" airspace	1
	5/8" plaster	0.39
New	1.97" K9 Internal Insulation	14.5
	7/8" Furring Strip (AIR GAP)	0.92
	1/2" gypsum board	0.45
	inside air flim	0.68
	Total R-Value	20.18
	Total U-Value	0.049554

OUTLET BOXES TO BE SURFACE MOUNTED
*VAPOR/AIR BARRIER TBD BASED ON HYGROTHERMAL ANALYSIS

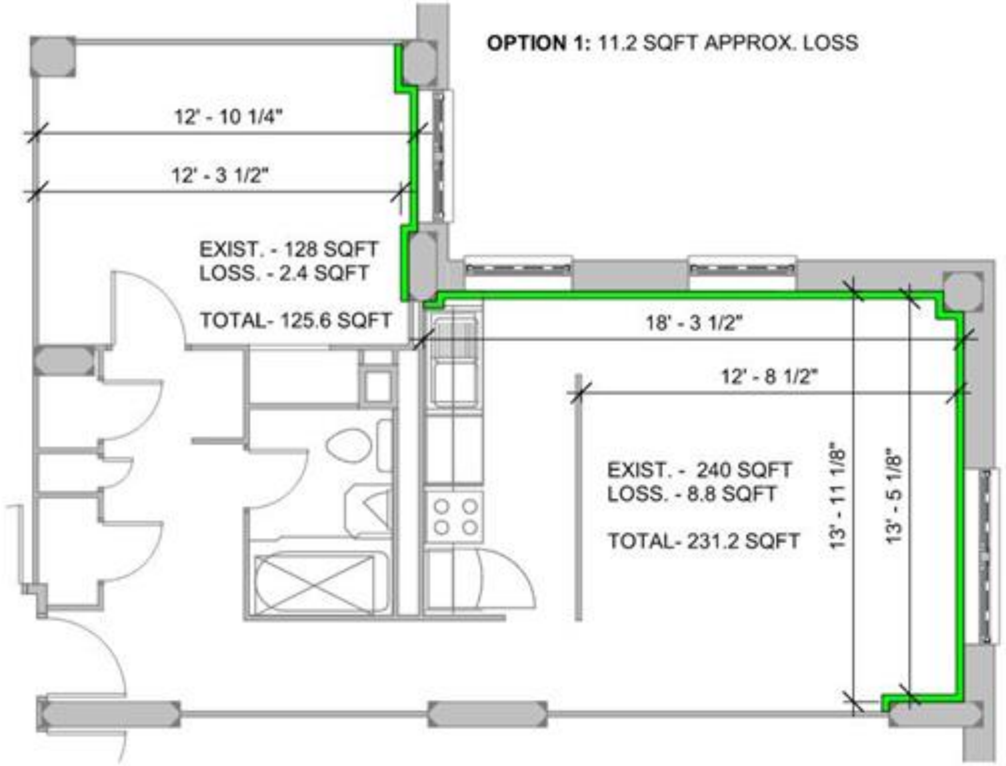
WOULD COMPLY WITH 2020NYCECC U-VALUE MAXIMUM

SK-2 | INTERIOR INSULATION OPT 2

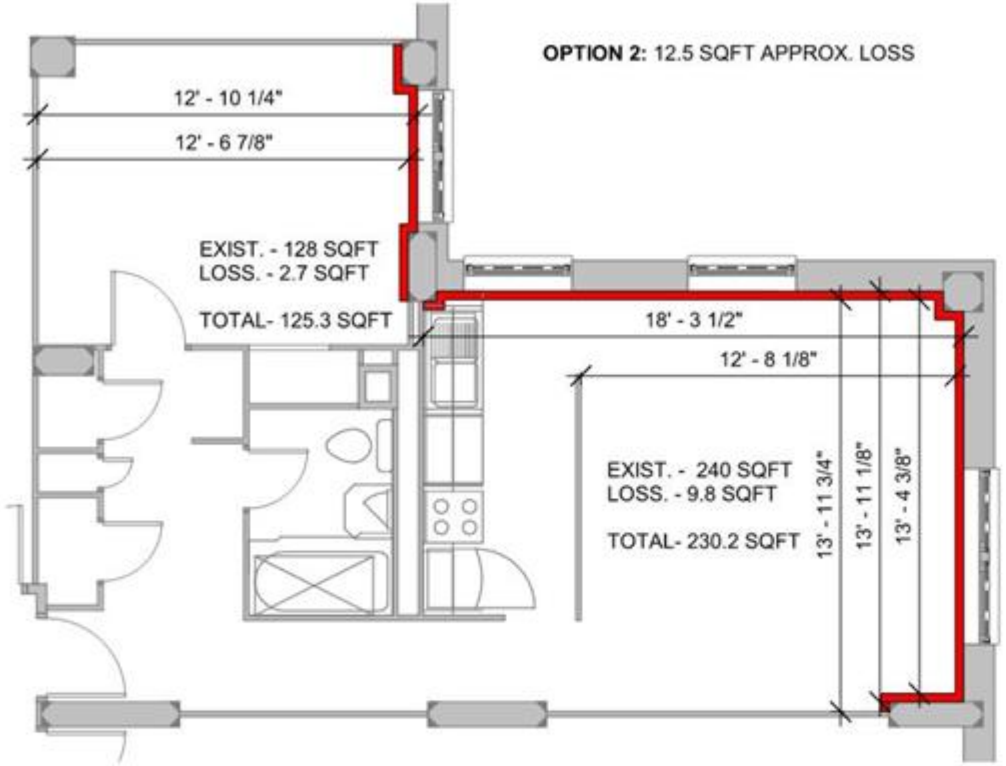
CLIENT 2020.47 EDENWALD HOUSES

 05/24/22

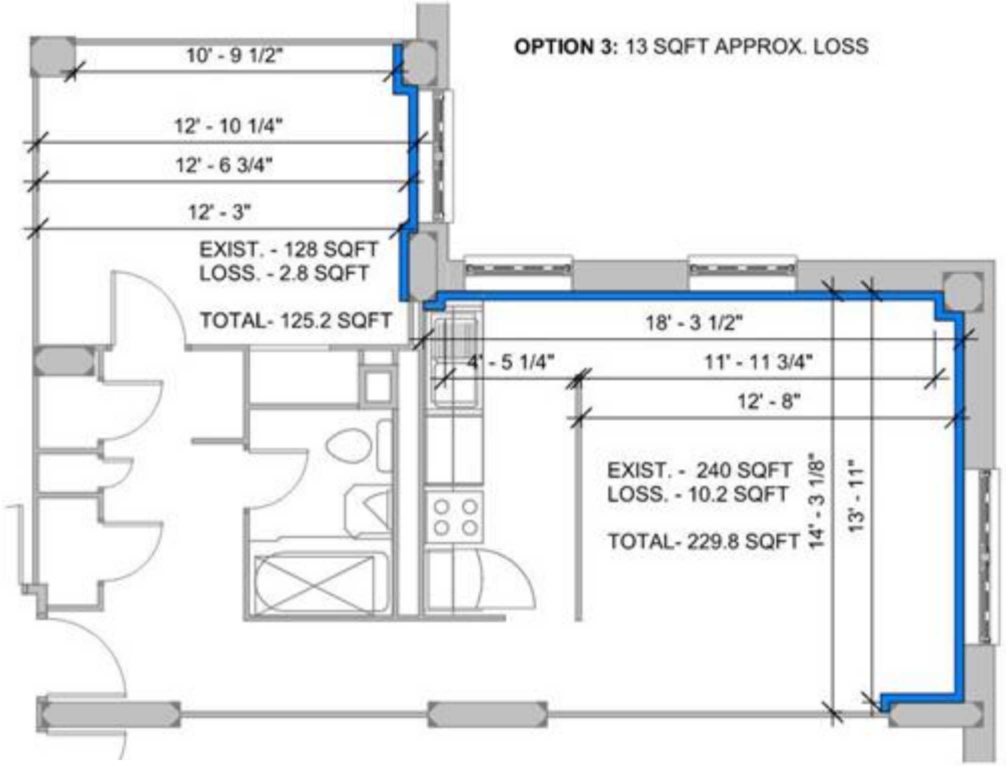
OPTION 1: 11.2 SQFT APPROX. LOSS



OPTION 2: 12.5 SQFT APPROX. LOSS



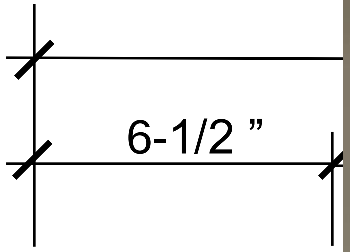
OPTION 3: 13 SQFT APPROX. LOSS



SK-4 | SPACE LOSS DIAGRAM PLANS

CLIENT 2020.47 EDENWALD HOUSES

 05/25/22



GWB
Finishes

Stud Framing

Insulation

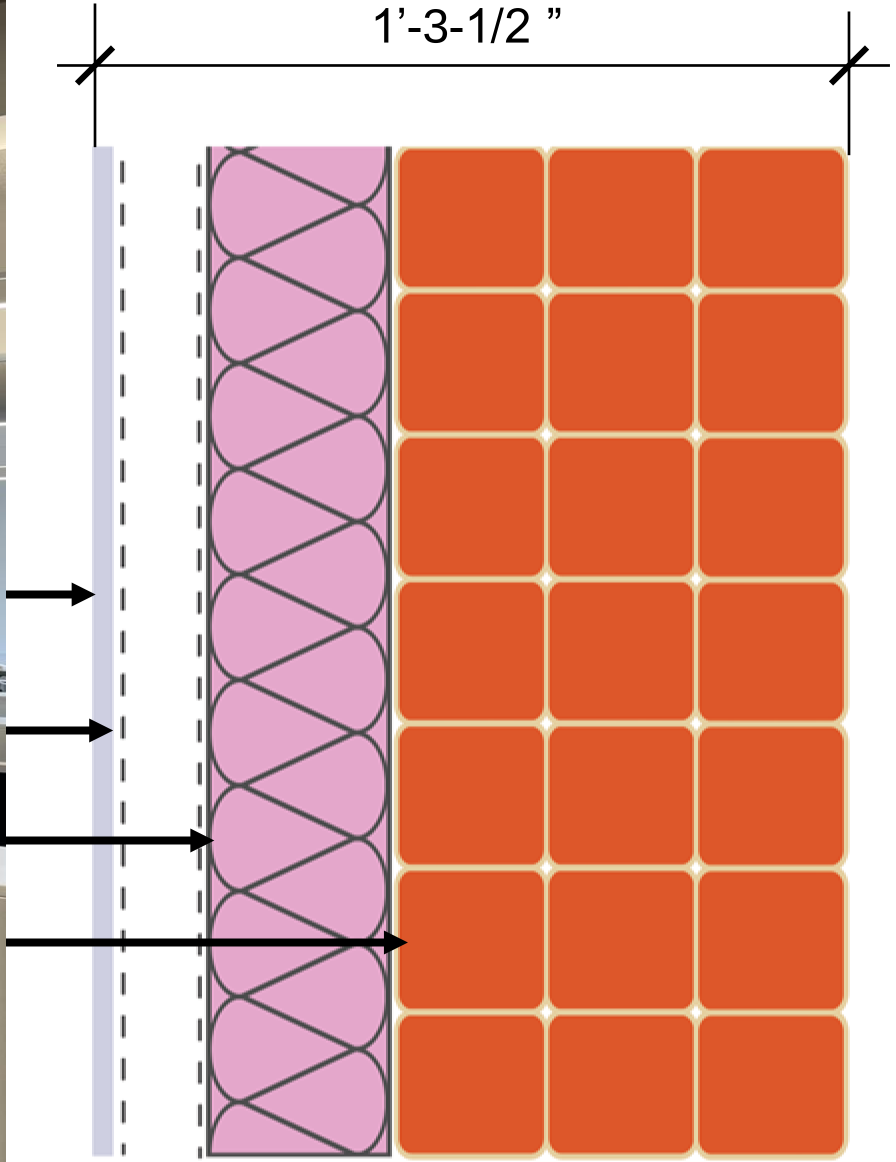
(E) Plaster Finishes

(E) Terracotta Block

(E) Air Space

(E) Brick Masonry

Ret



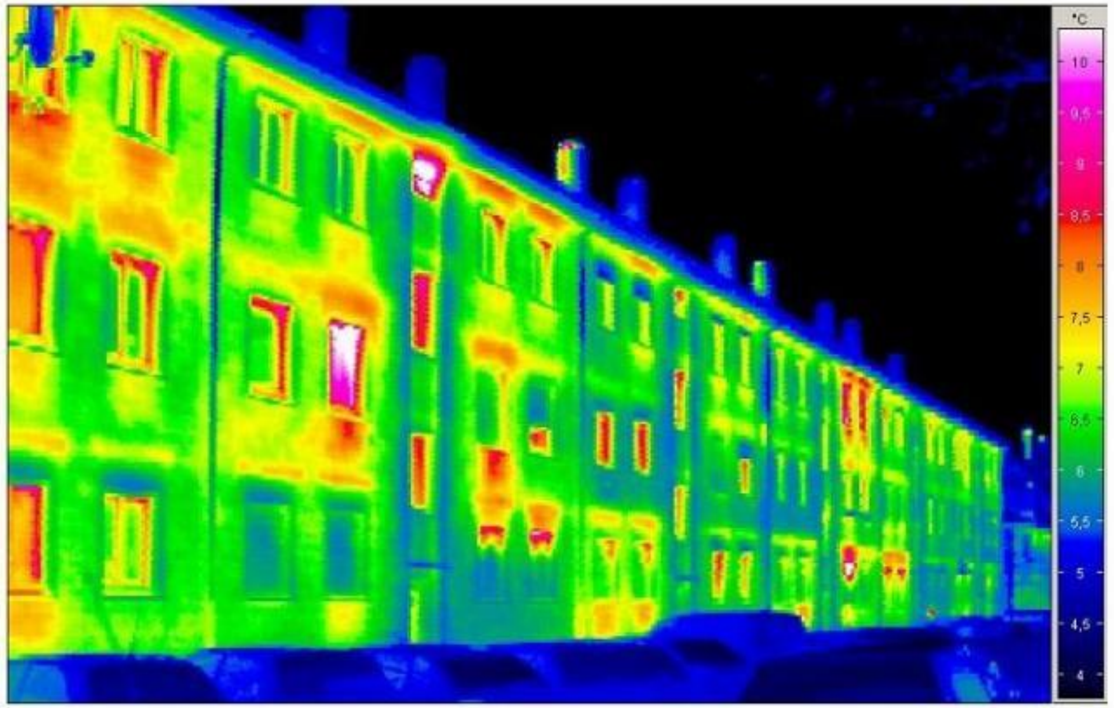
Remove existing interior finishes

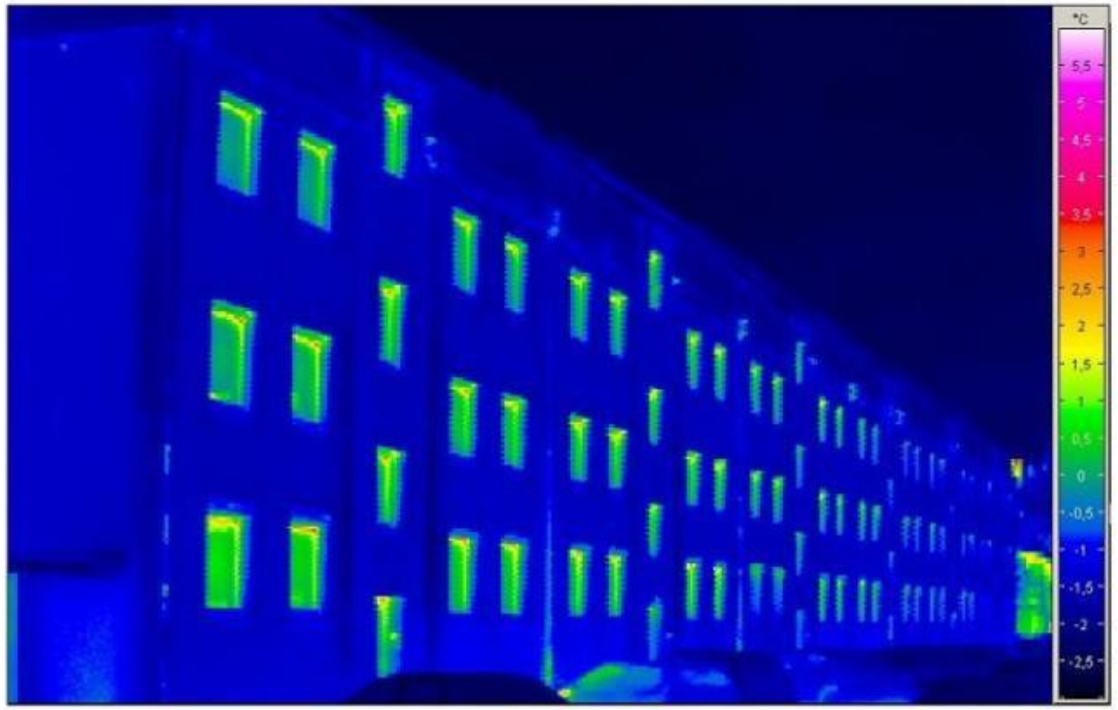
Interior Insulation

Freeze/Thaw and Moisture issues

“Wants” in Conflict

Dryer Brick vs. **Wetter** Brick





Passive House Institute

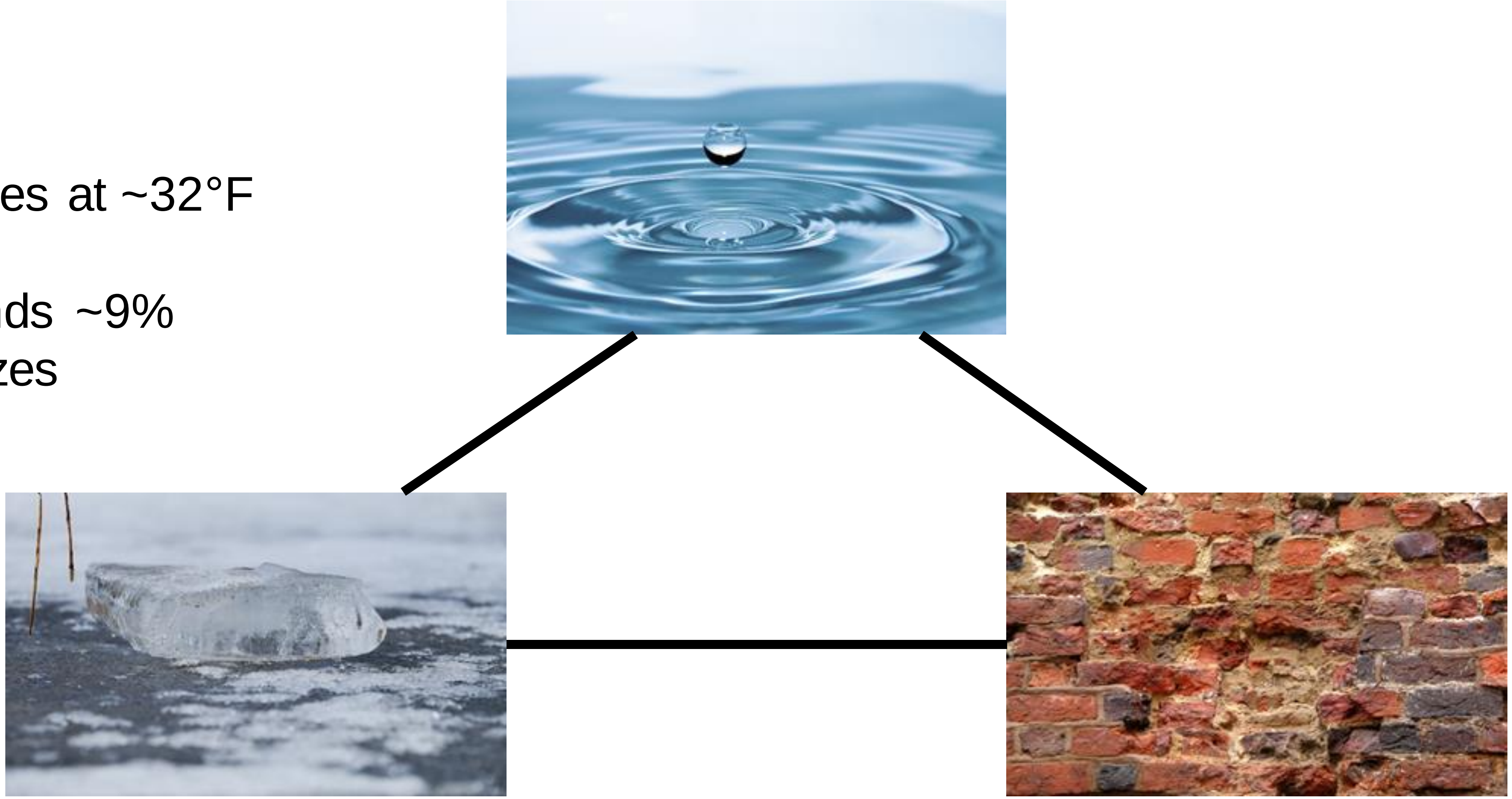
Inefficient/**Uncomfortable** vs. **Comfortable**/Efficient

Freeze-Thaw or Mold Damage?

Freeze/Thaw Damage Triangle

- Water Freezes at ~32°F
- Water expands ~9% when it freezes

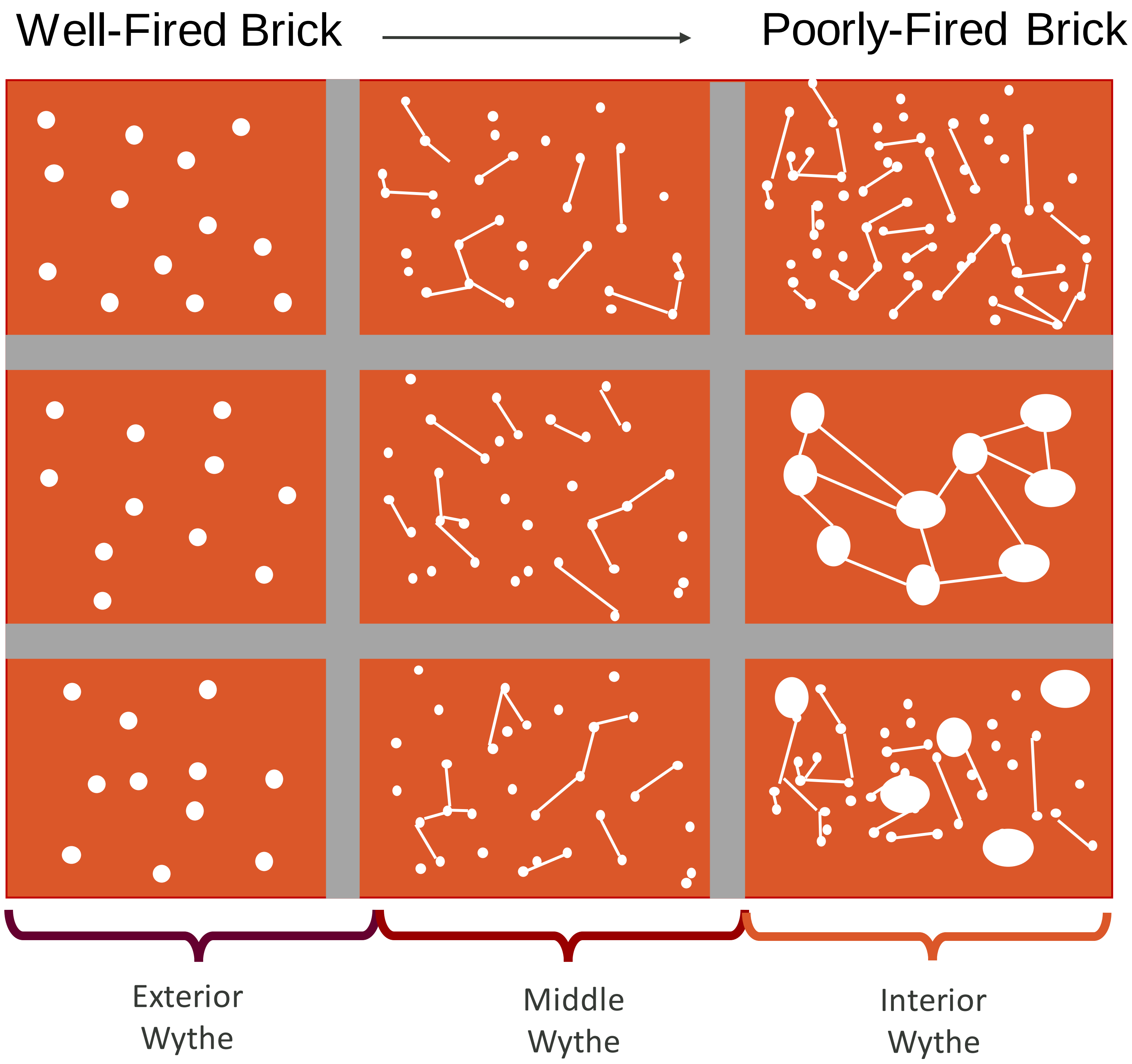
Water Absorption (Capillary Suction)



Freeze

Over-stressed Condition

“Bad Brick” and Capillary Suction



Freeze Thaw Destruction
Is A Whole Systems Failure

The masonry must be saturated (95% RH).
How did it get saturated?

And the weather must be well below freezing for an extended period.

The Questions Is:

How to avoid system failure, and achieve high performance?

Freeze Thaw?
Yes, but not an insulation problem

Freeze Thaw Damage – only at top of wall

Inspect and address the masonry

Pull everything away from the brick

(with possible exception of plaster at party walls)

Expose the Problems & Repair

Evaluating Brick Properties

In-Situ Performance

Observations

Brick Durability

ASTM C67 Testing

- Compressive Strength
- Absorption
- Saturation Coefficient
- Freezing and Thawing

Refiring Method

- Firing Temperature

Mercury Intrusion Porosimetry

- Maage Index

Hygric Properties

ASTM C20 Testing

- Density
- Porosity

ISO 15148 Testing

- Free Water Saturation
- Water Absorption Coefficient

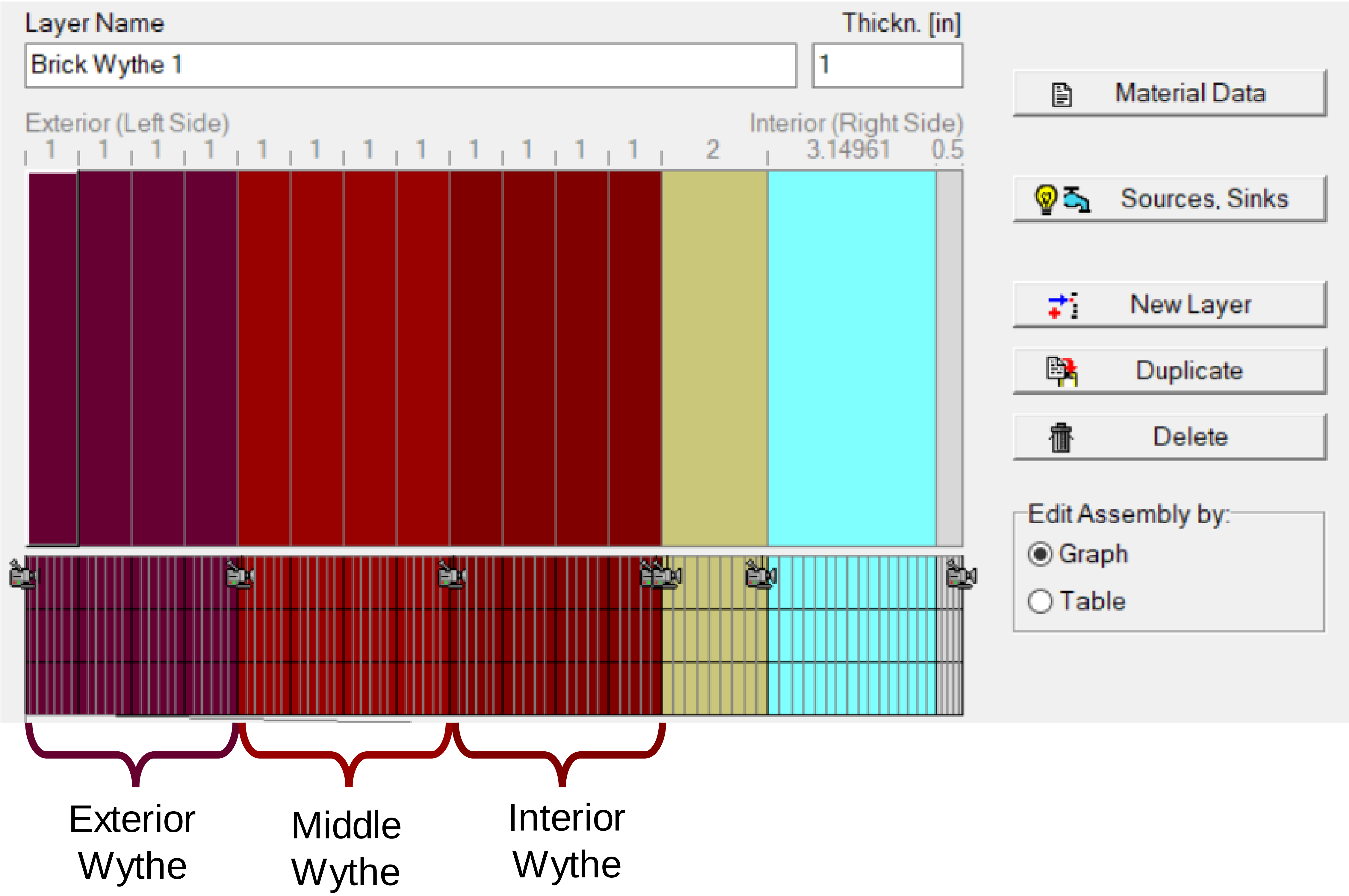
ASTM E96 Testing

- Water Vapor Diffusion Resistance

ASTM C1498 Testing

- Equilibrium Moisture Content

WUFI (Wärme und Feuchte Instationär)



Custom Brick Properties

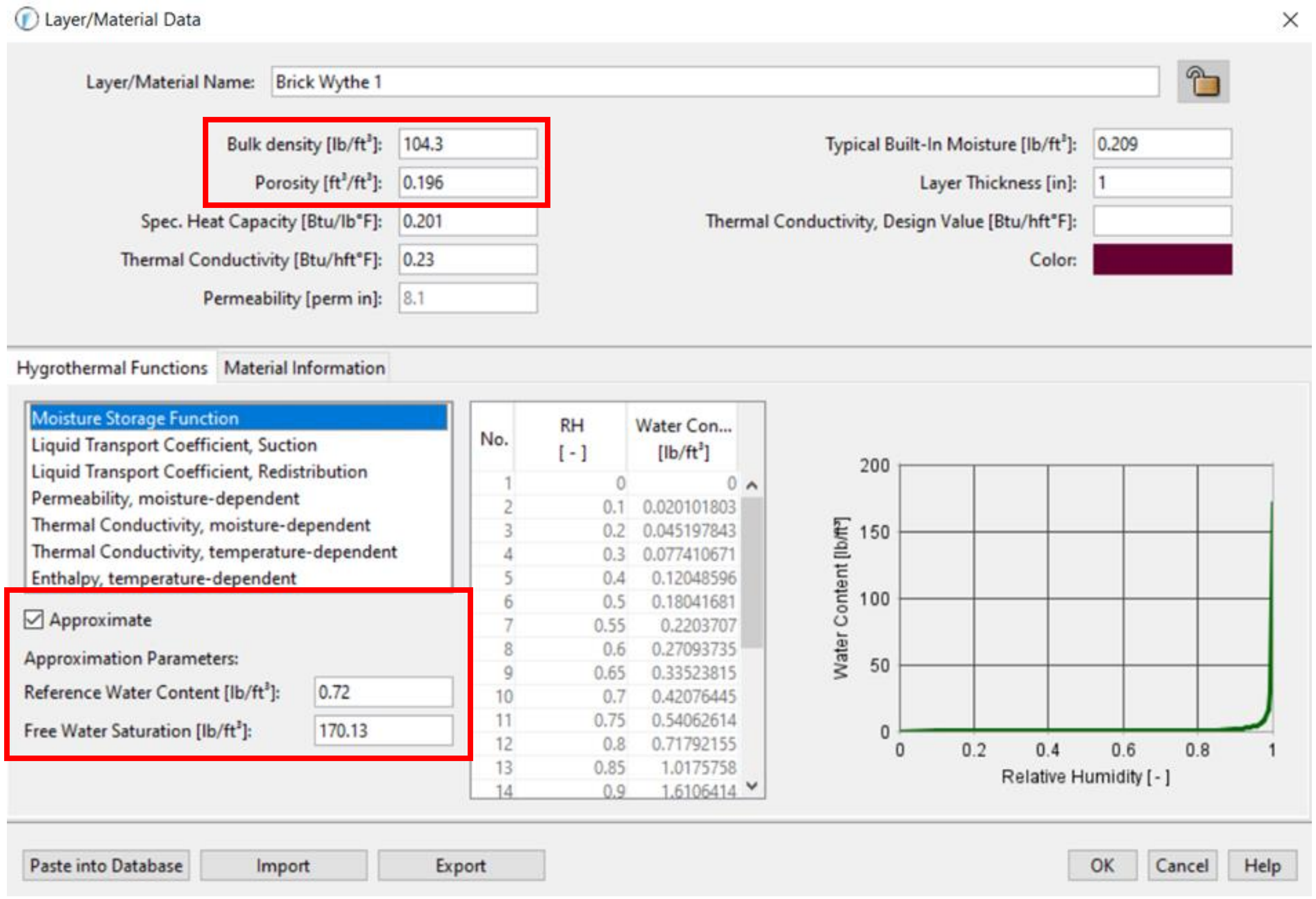
Bulk Density
(ASTM C20)

Porosity
(ASTM C20)

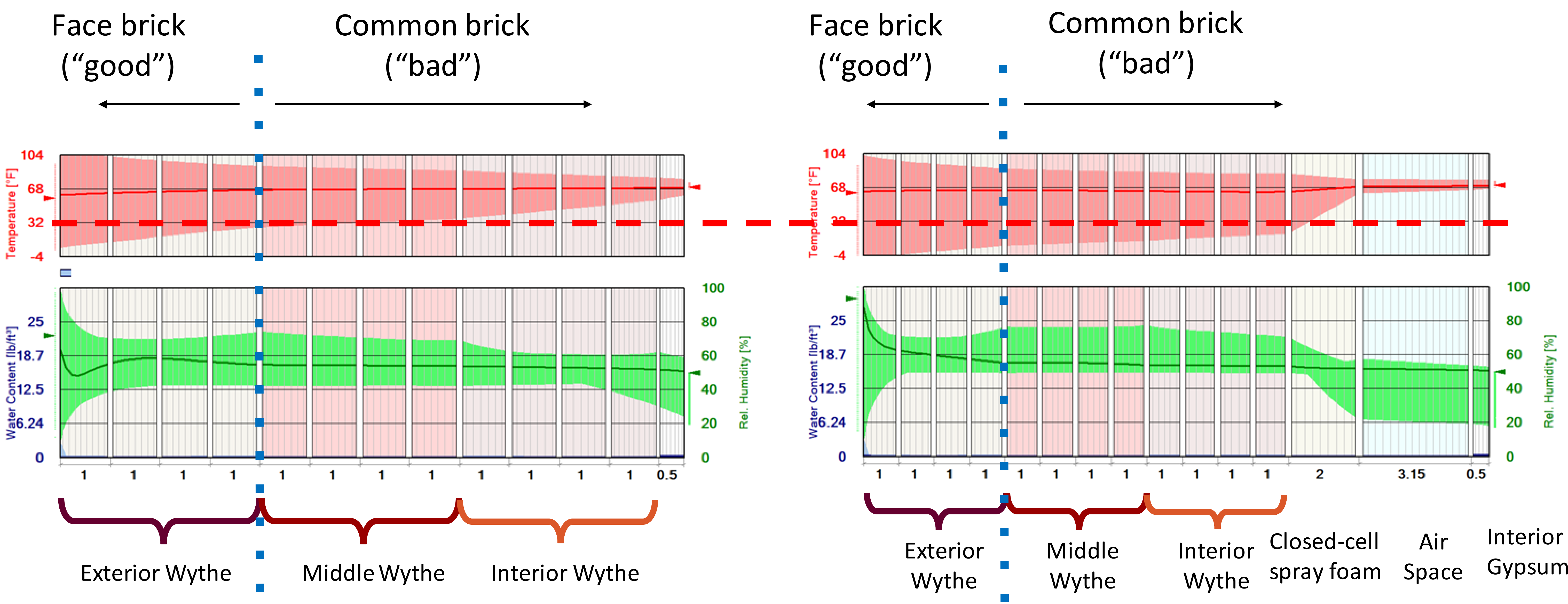
Free Water Saturation
(ISO 15148)

Reference Water Content
(ISO 15148)

Water Absorption Coefficient
(ISO 15148)



Uninsulated vs. Insulated Masonry

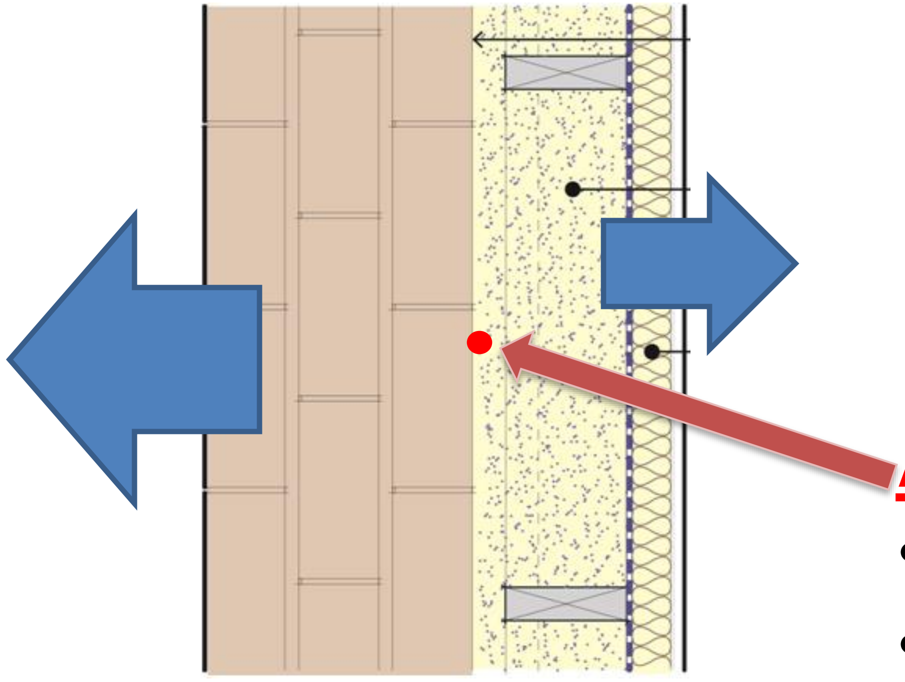


Let's Look At Some Assemblies

Albany, NY

Insulation:
Dense-Pack Cellulose
Mineral wool etc

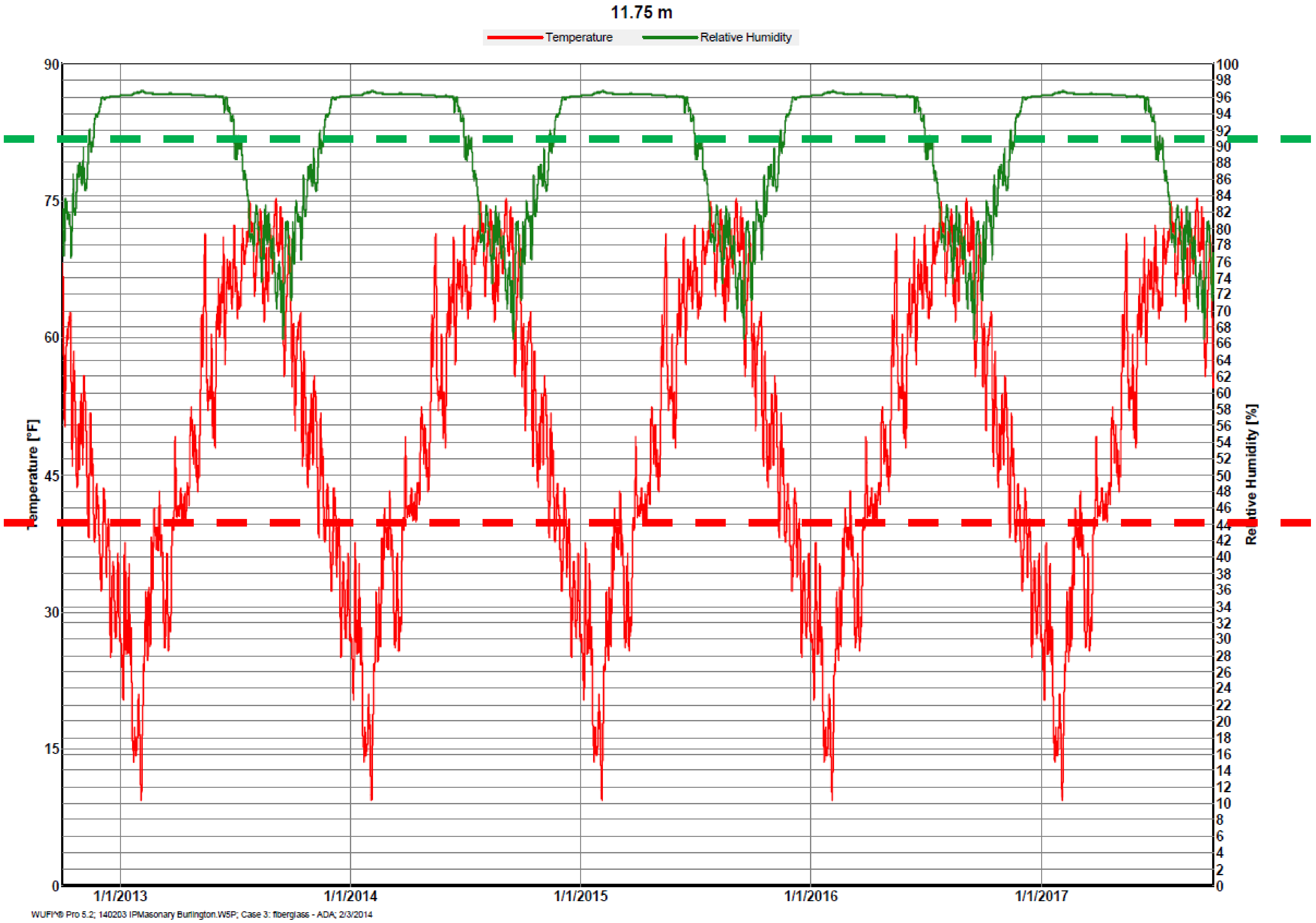
Outboard:
Shed water
Windtight
Vapor open



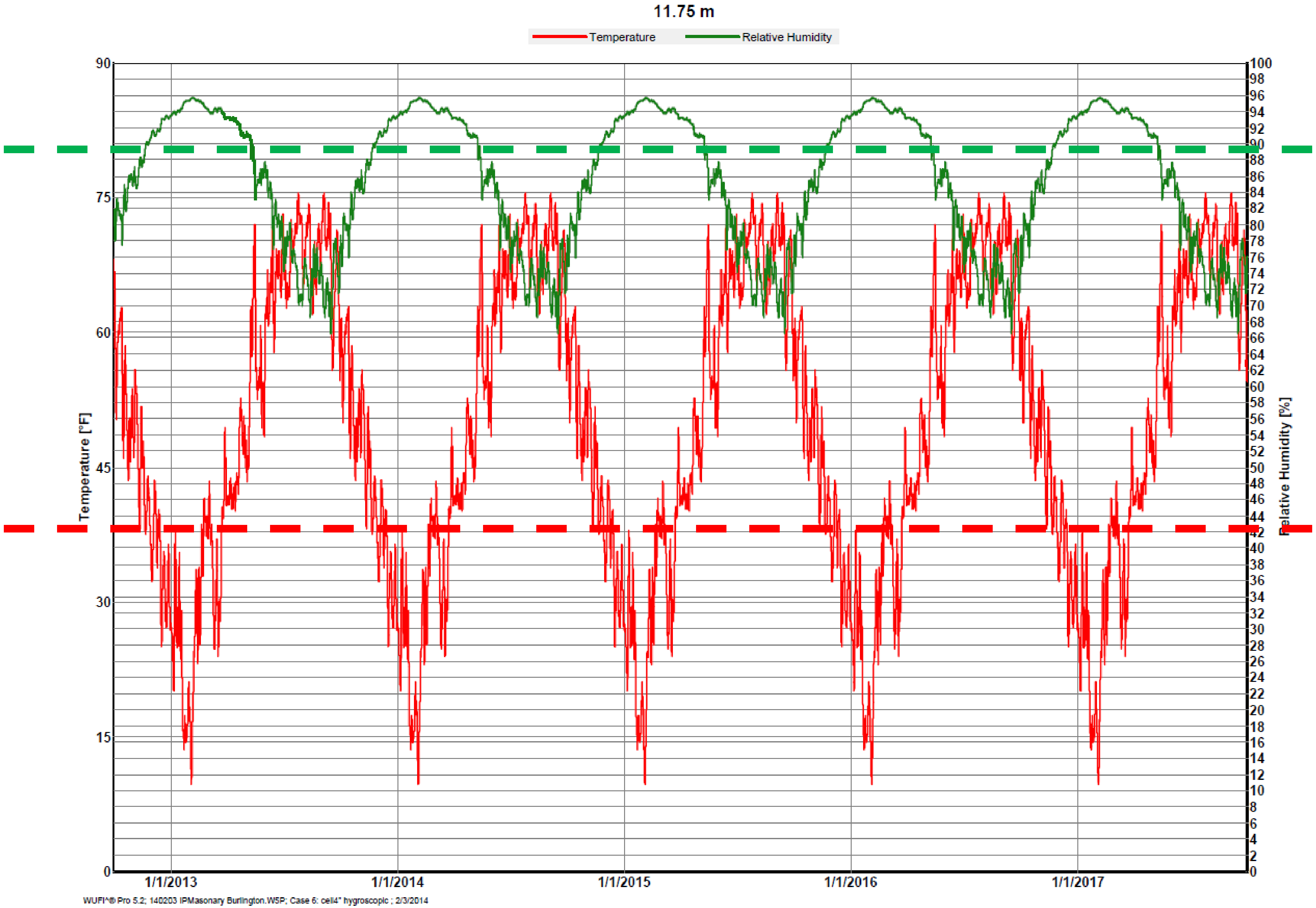
Inboard
Airtight
Vapor Retarding

At Red Dot
- Moisture load?
- Mold potential?
- Helping or hurting freeze-thaw potential?

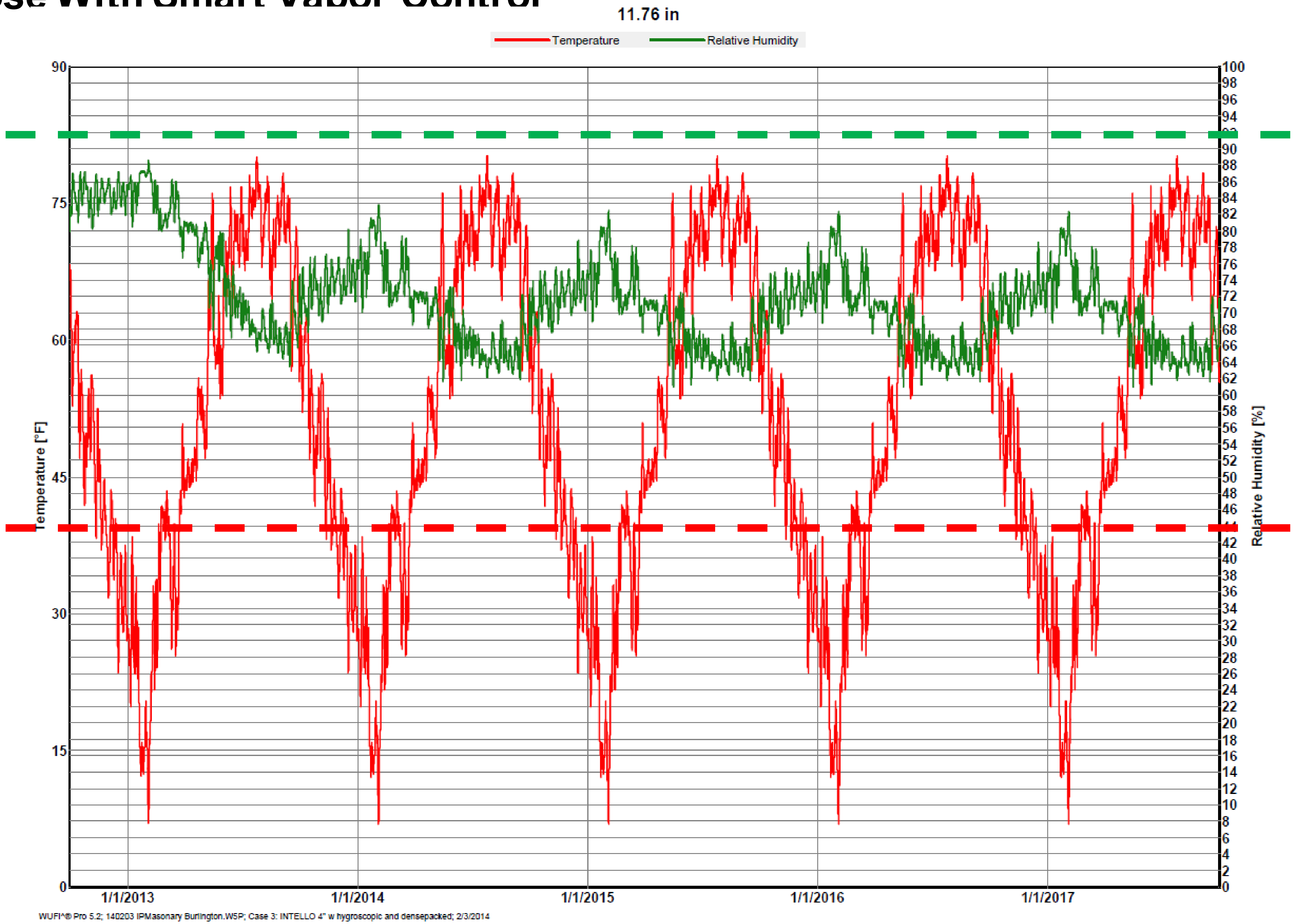
WUFI: 4” Fiberglass & Airtight Drywall



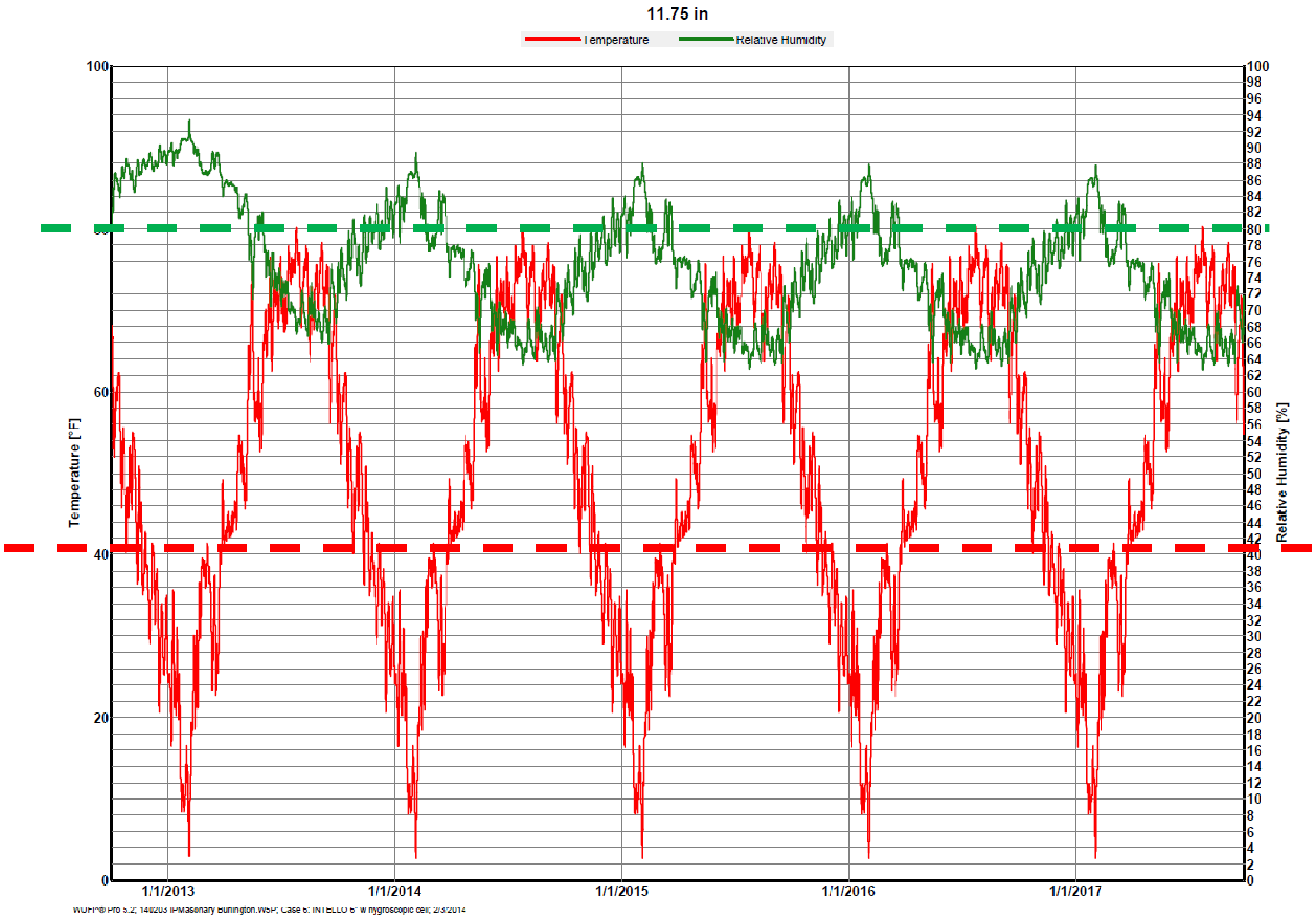
4” Cellulose Without Vapor Control



4" Cellulose With Smart Vapor Control



6” Cellulose With Smart Vapor Control

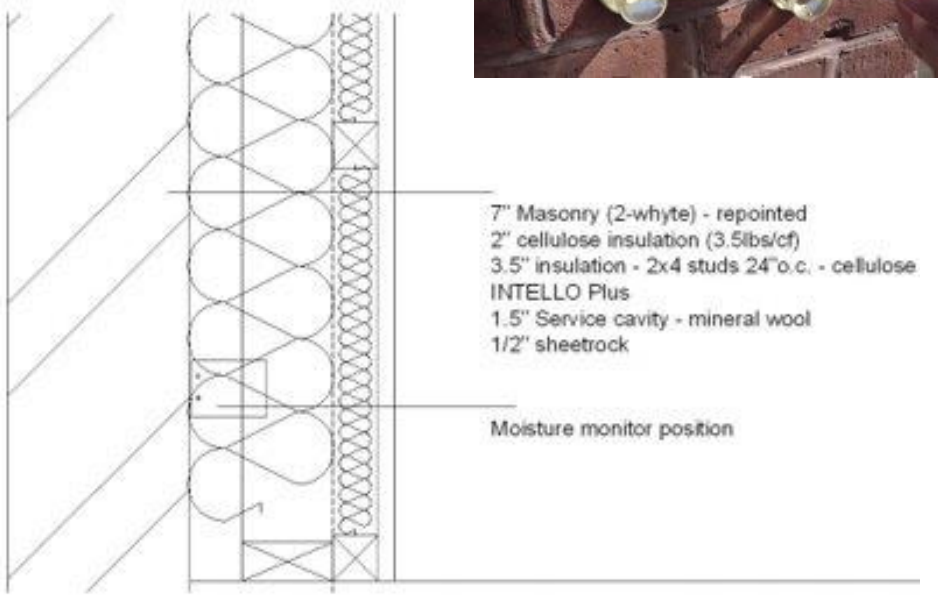


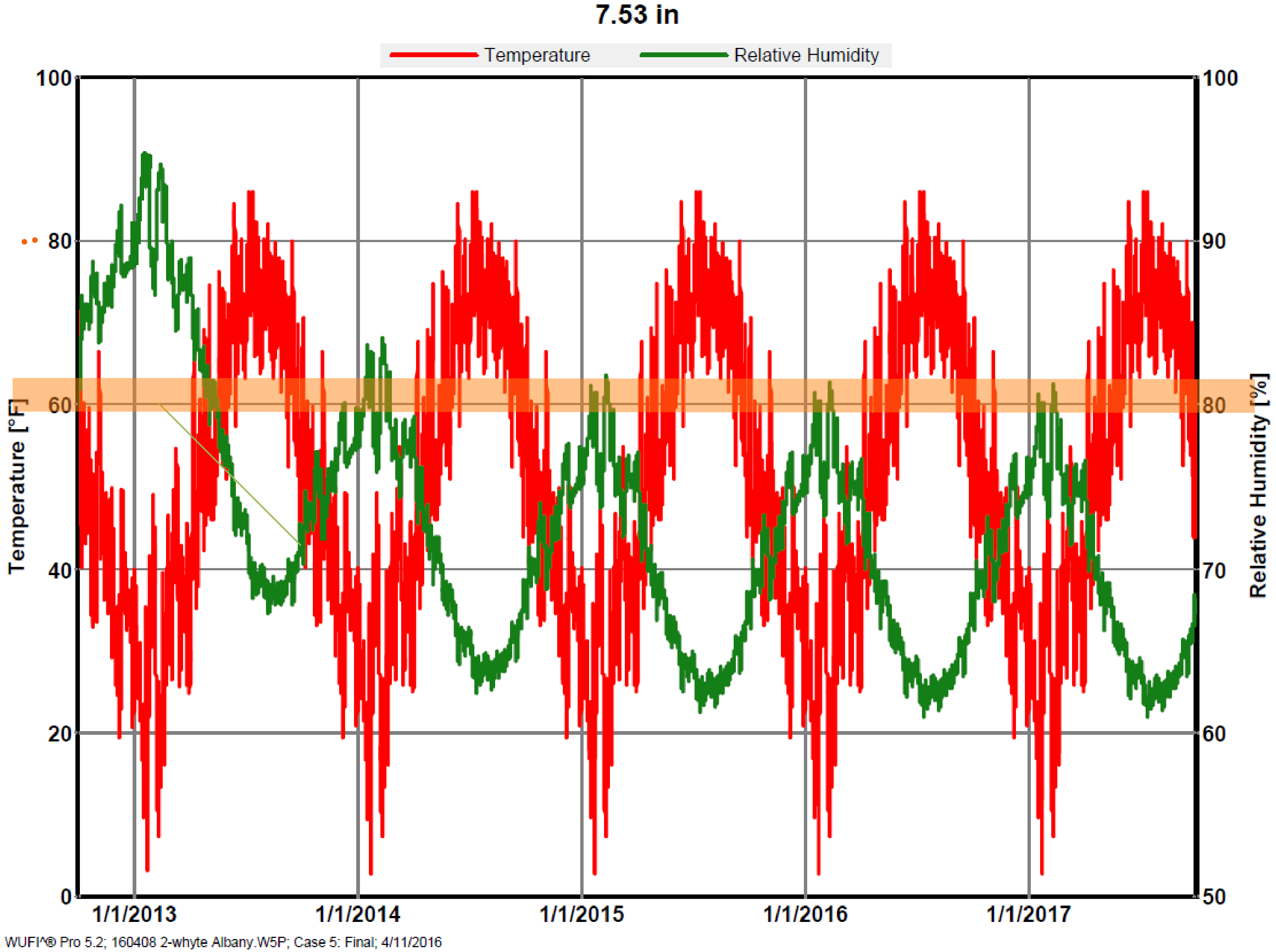
2 Whyte – Saugerties, NY – Climate zone 6 monitored masonry EnerPHit renovation

Assessment of RH % on brick/cellulose interface (condensing surface)

Overhangs - Keep it dry

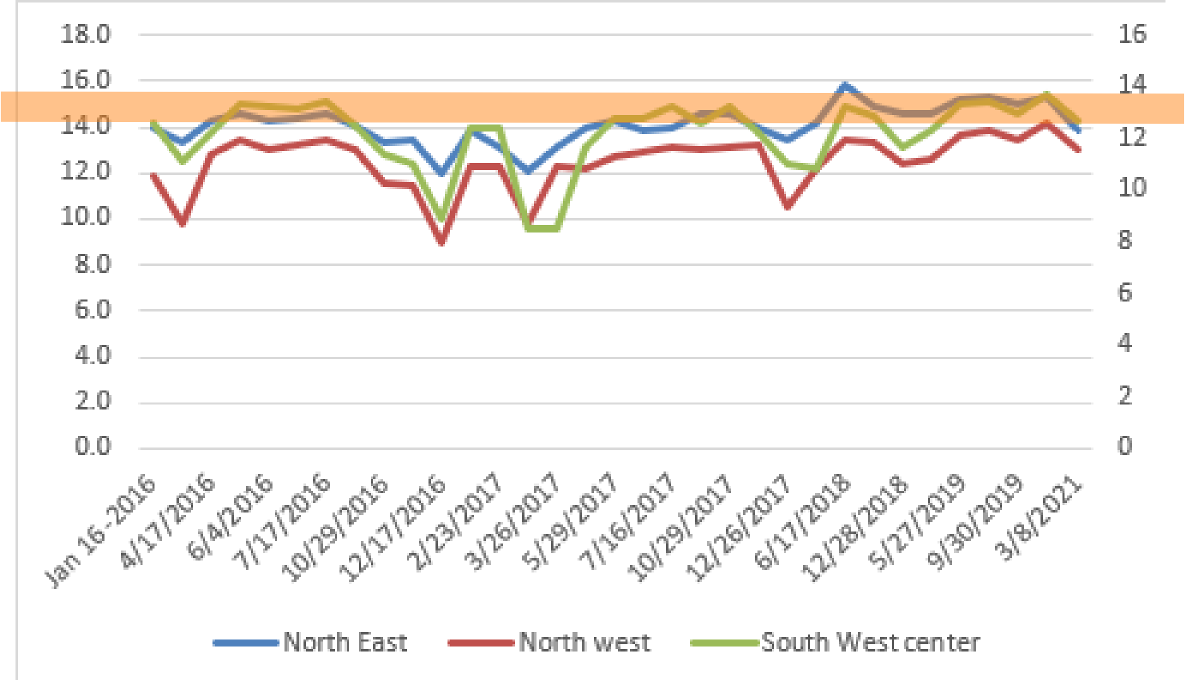
Assessment of masonry

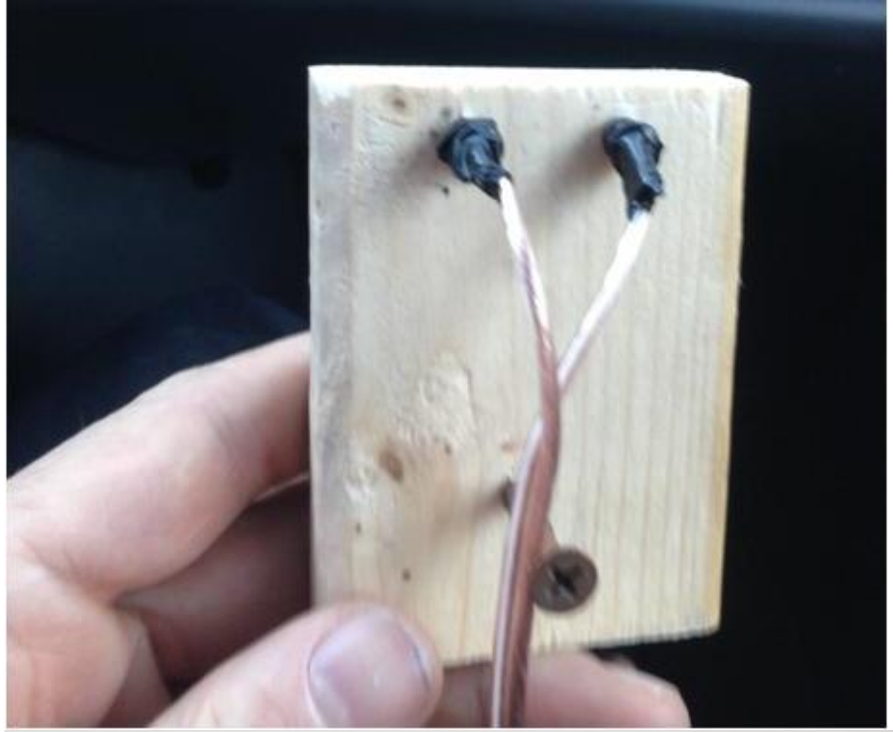




Stays below 80% RH

M% check (stay below 15M%)
In 3 exposed orientations (N,E,W)

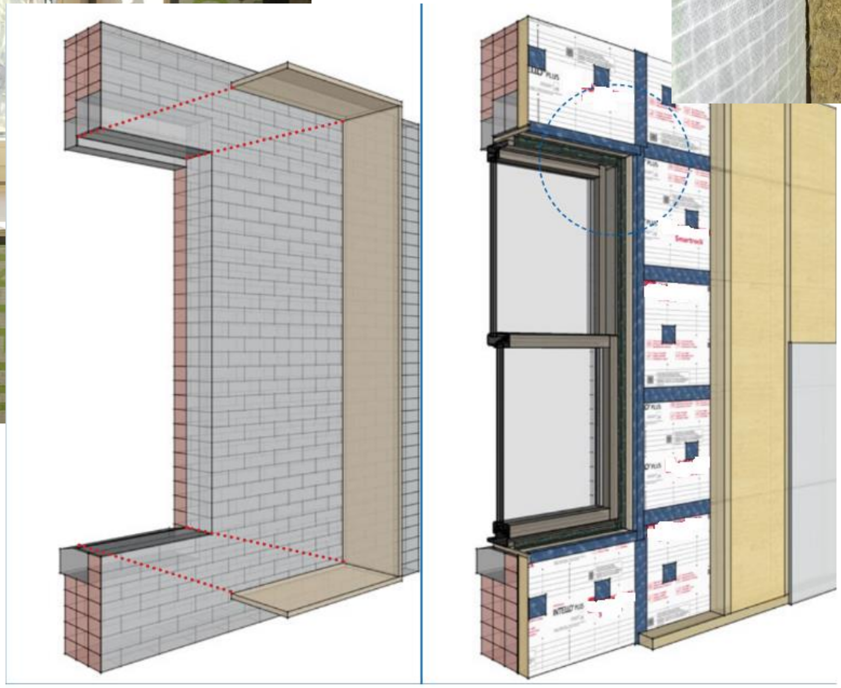




Balancing act – heat loss vs masonry health (and interior space)

	U-value (w/m2K)	Area	red factor	UA factor	Heat loss %	Areas %
Floor	0.19	142.6	75%	20.3	24%	25%
Brick wall	0.213	136.7	1	**29.1**	**34%**	**24%**
Larson wall	0.149	93.49	1	13.9	16%	16%
Flat roof	0.111	48.1	1	5.3	6%	8%
Gable walls	0.127	33.34	1	4.2	5%	6%
Pitched roof	0.114	114	1	13.0	15%	20%

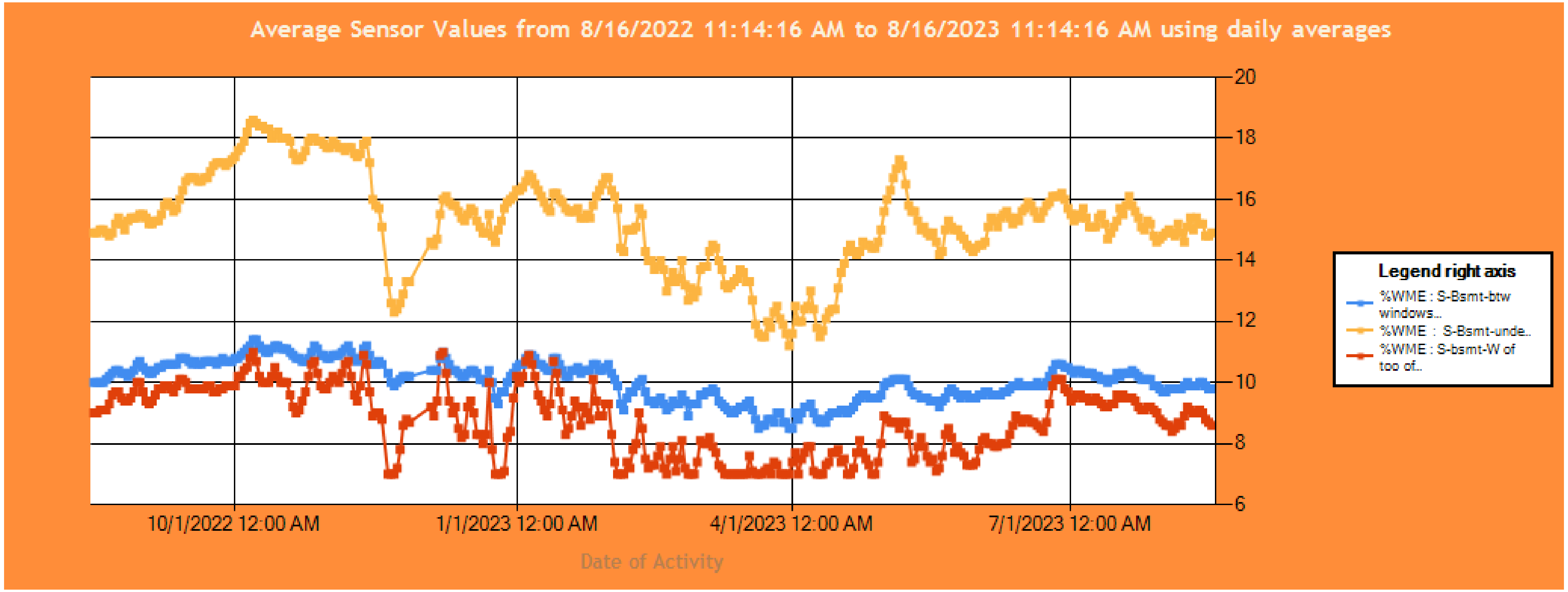
5” Mineral wool boards + INTELLO Plus (pinned) + service cavity



No thermal bridges, material efficient

5” Mineral wool boards + INTELLO Plus – MONITORED

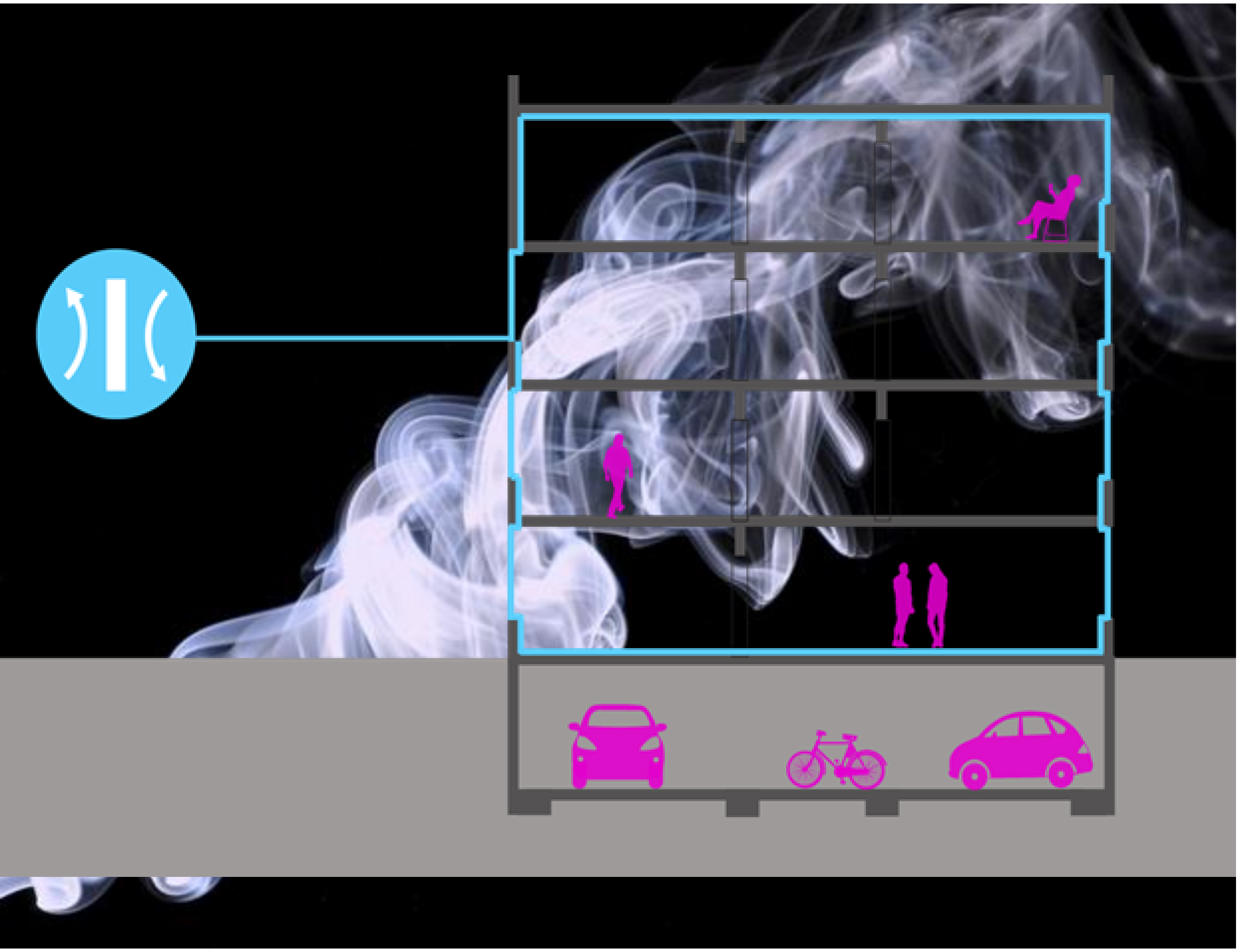
Omnisense monitoring of inner brick surface (M%) - 14 months – M% <18



Interior Insulation

Air Flow Issues

AIR CONTROL



Why is airtightness so important?

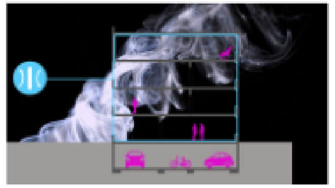
It disproportionately affects fundamental aspects of building performance

Joe Lstiburek:

"Air-sealing both sides of the wall is more important than the fluffing of the insulation in the cavity."

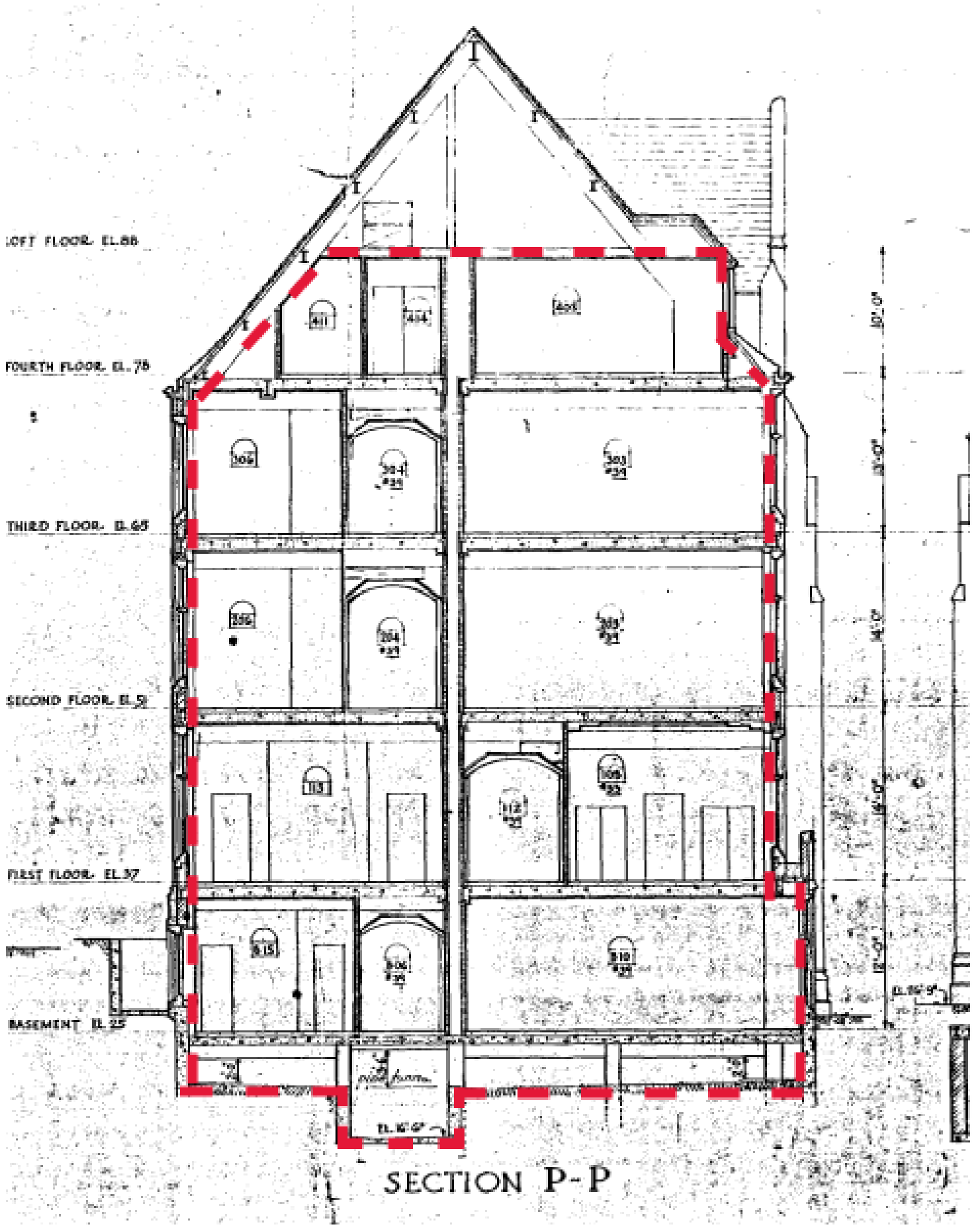
Order of importance

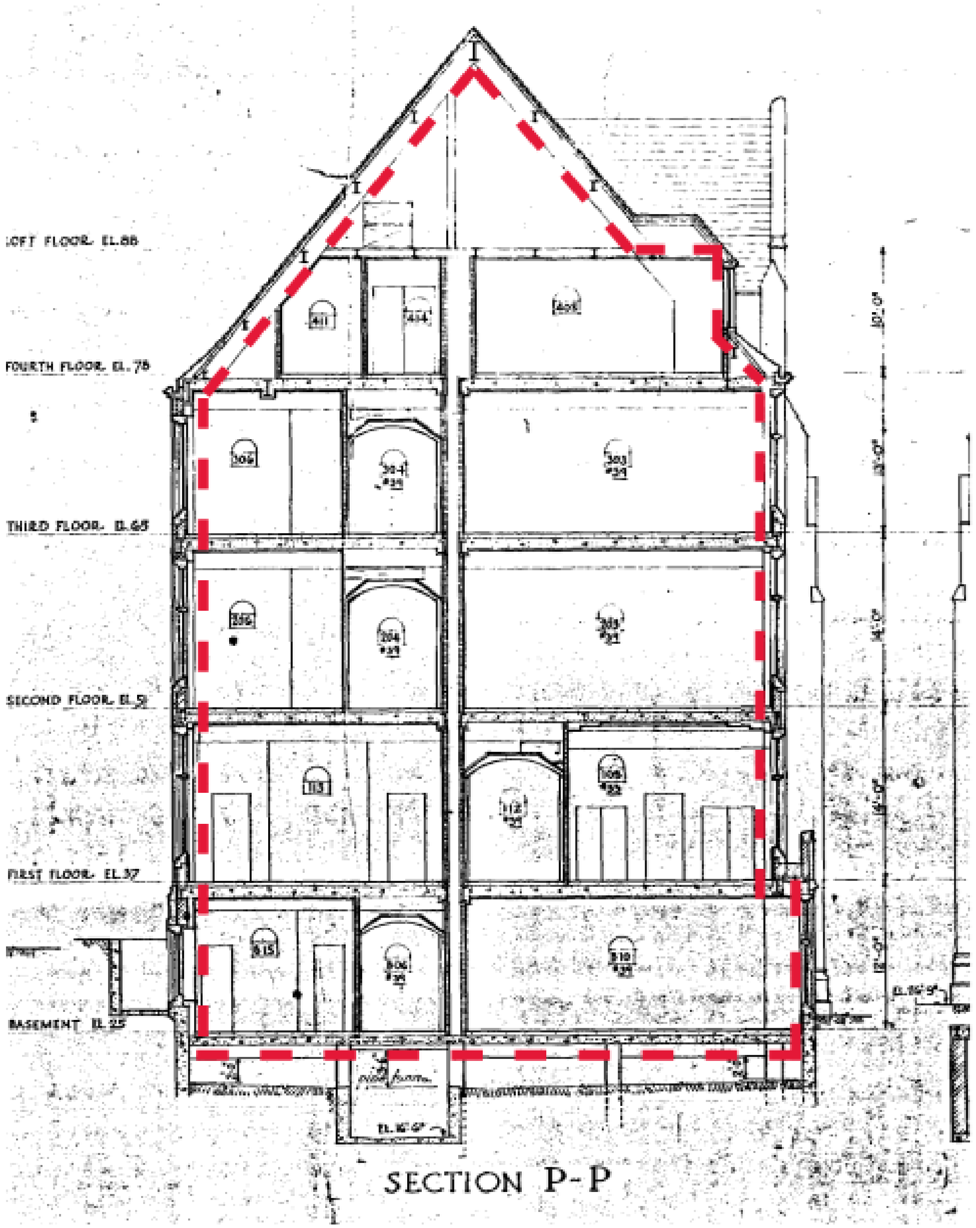
1. Water control
2. Air control
3. Vapor control
4. Thermal control



- Indoor Air Quality
- Comfort
- Durability
- Energy Consumption

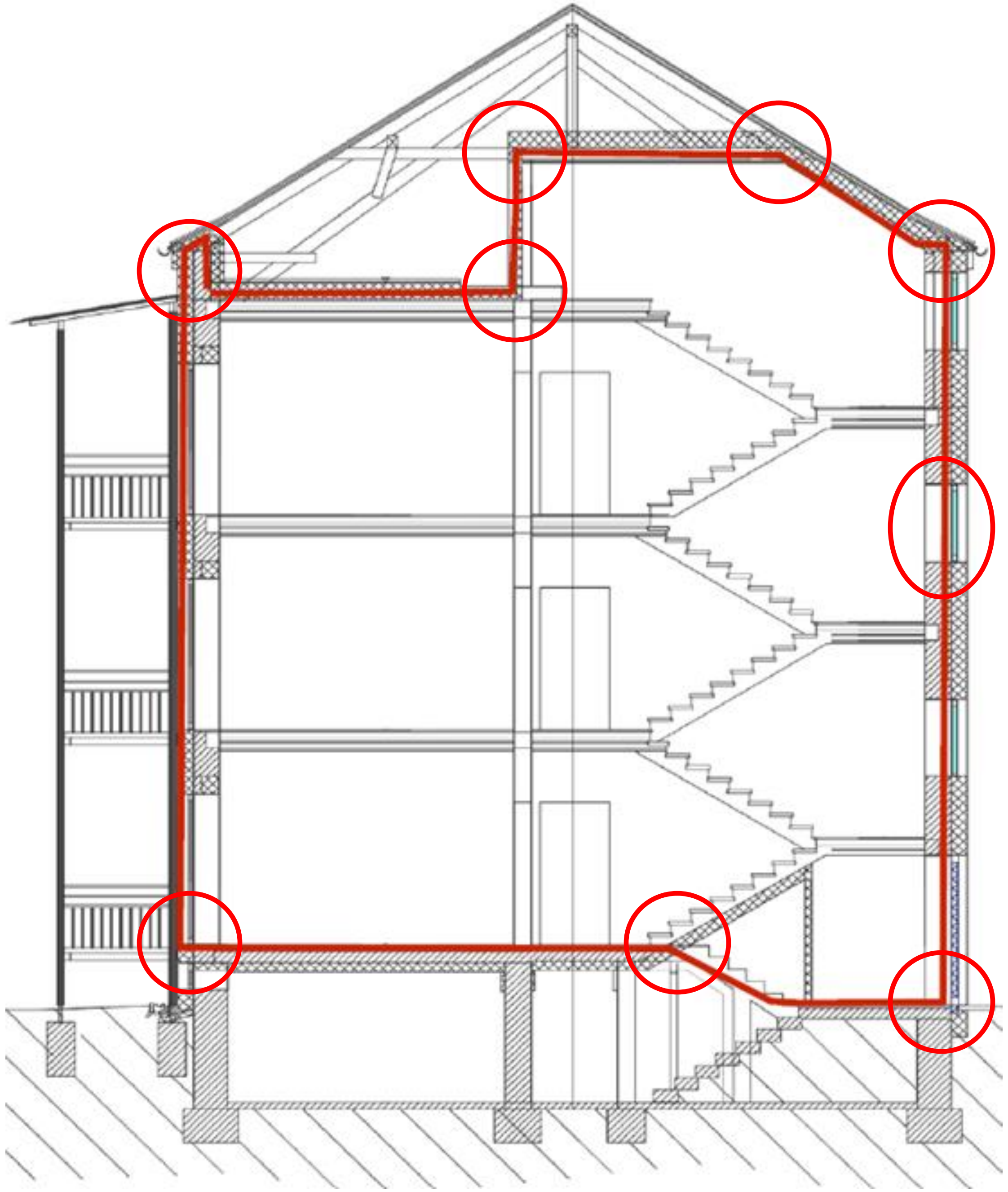
Defining the Thermal Envelope / Air Barrier



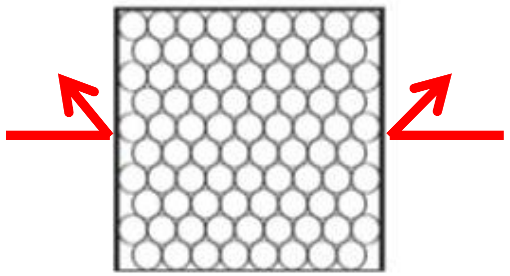


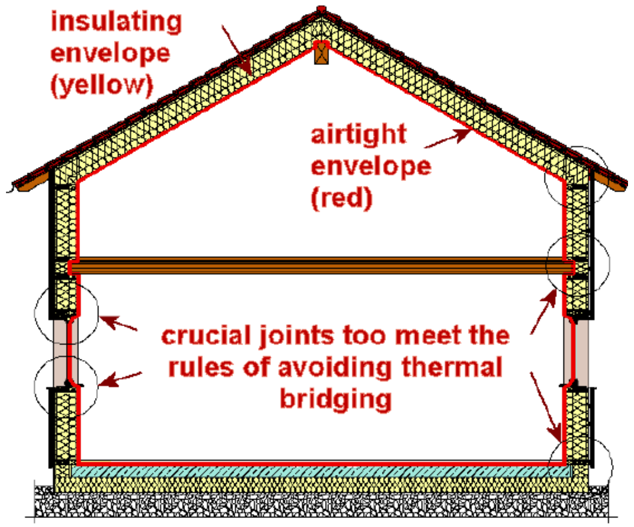
Continuity: In Design & Construction

1. Robust materials
2. Simplify the details
3. Consider the sequence
4. Seal penetrations
5. Repairable and verified
6. Protected



Air Control

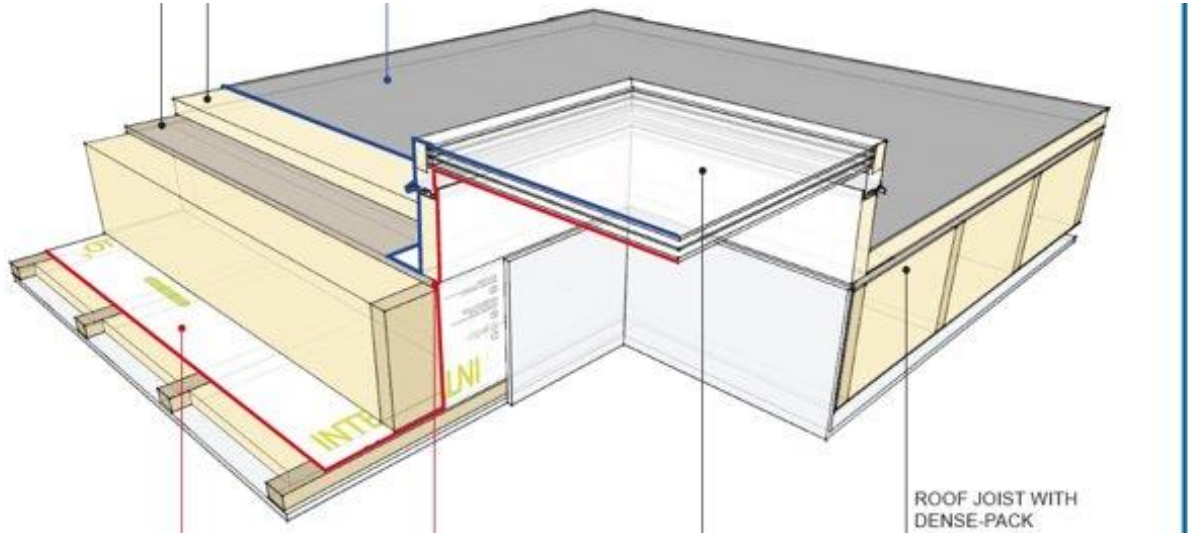


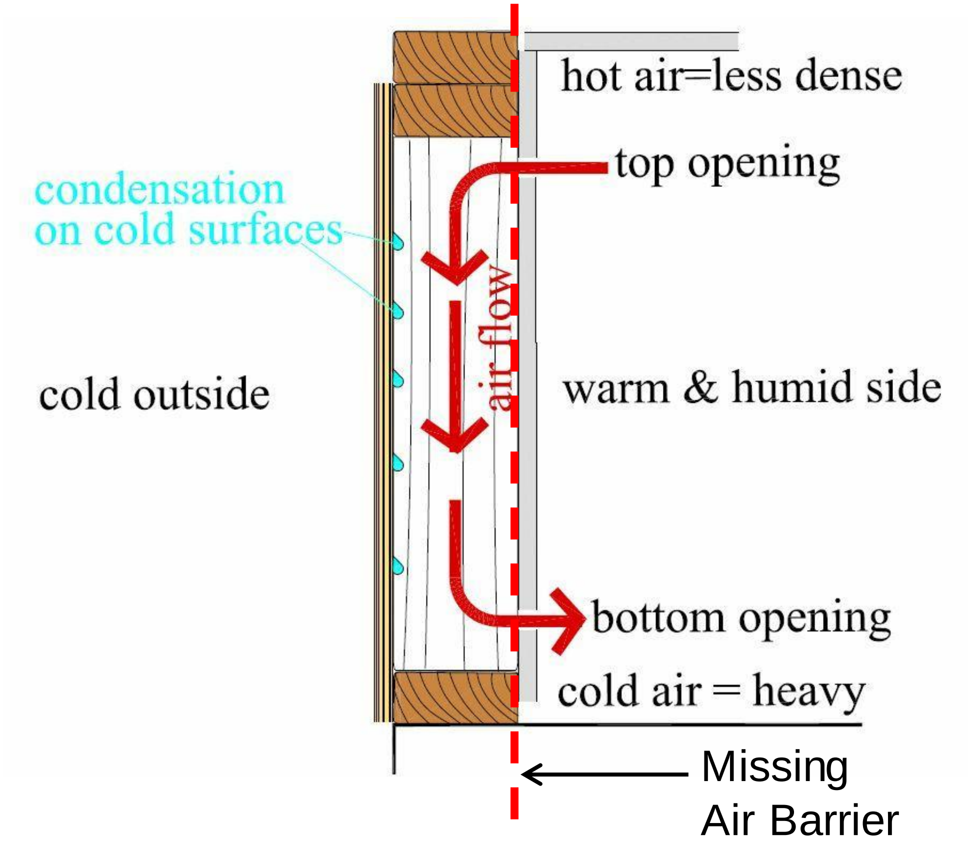


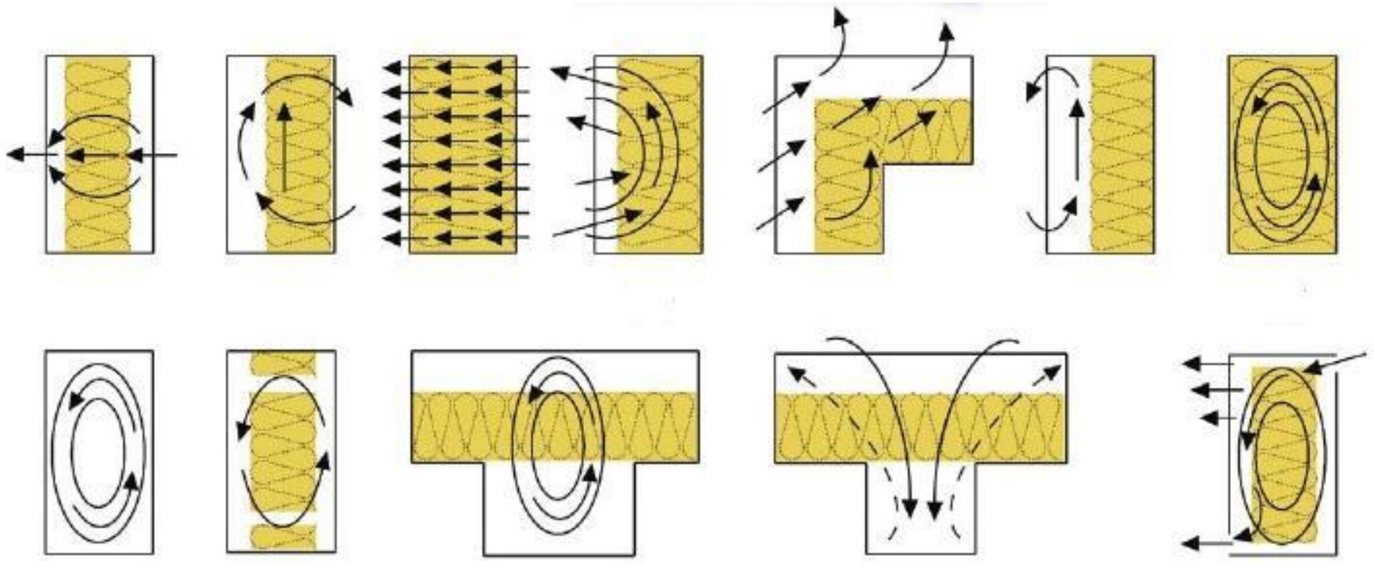
Ref http://passipedia.passiv.de/passipedia_en/

To optimize insulation **surround it** with airtightness on all 6 sides.

- Primary Inboard
- Secondary Outboard (windtight)





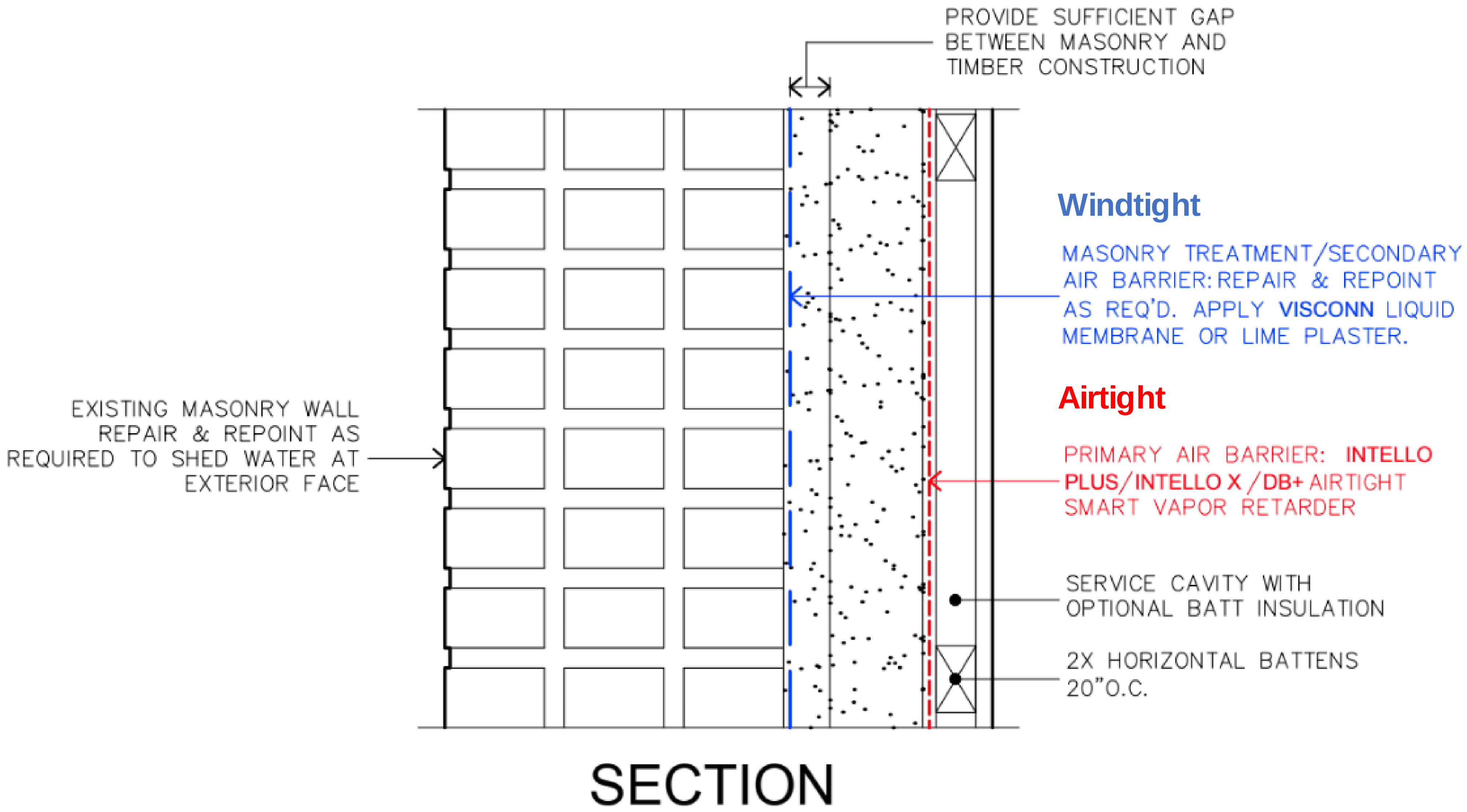


Mark Siddall

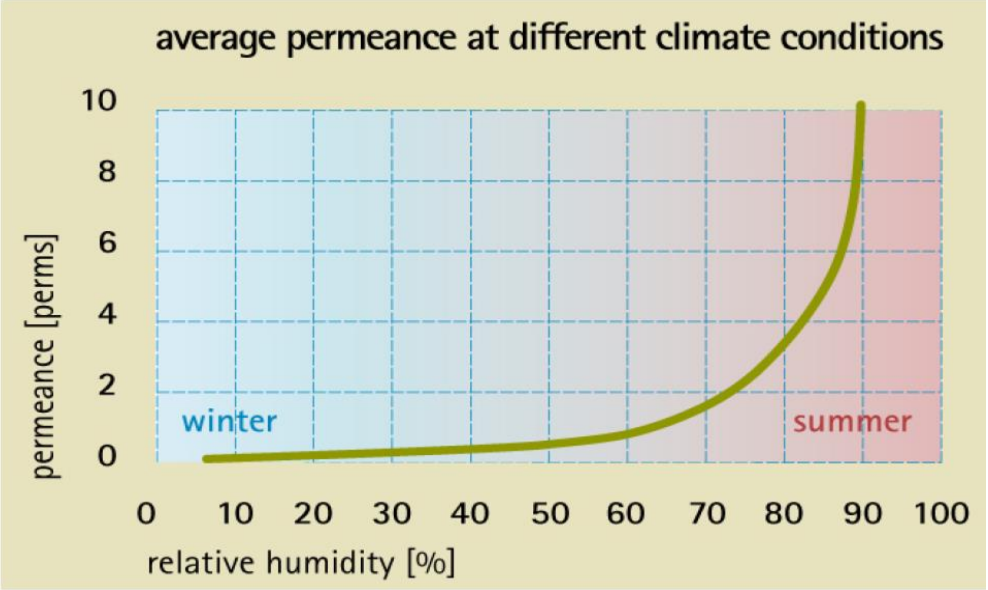
Make Airtight Inboard & Outboard

Optimal Airtightness Is Inboard Of Insulation

It keeps conditioned/humid air away from cold surfaces



Hydrosafe Smart Vapor Control



From vapor closed in winter (0.13 perms – low Class II)

To vapor permeable in summer (13 perms)

Minimizes wetting

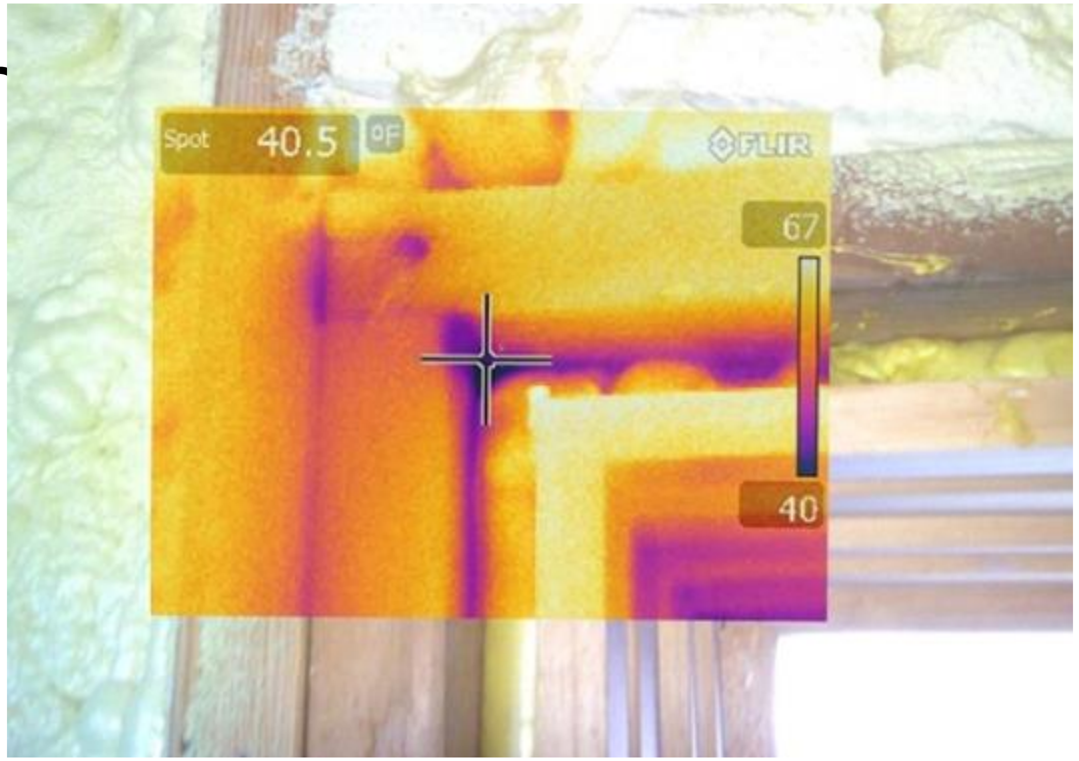
Maximizes drying potential

Make Brick Windtight/Airtight

Liquid-applied air barrier

Plaster

- Existing lime plaster that is in good condition or new lime plaster can be used as a vapor-open air barrier.
- Repointing/parching might be enough.
- liquid applied air barrier is a fast and effective airseal. (cost vs speed)

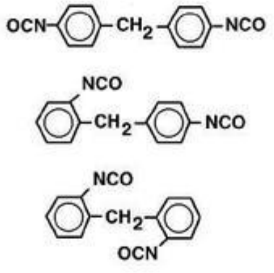


Dangerous **Toxic** ingredients
Unacceptable **fire accelerant**
Global warming potential Installation **problems**
Unreliable performance

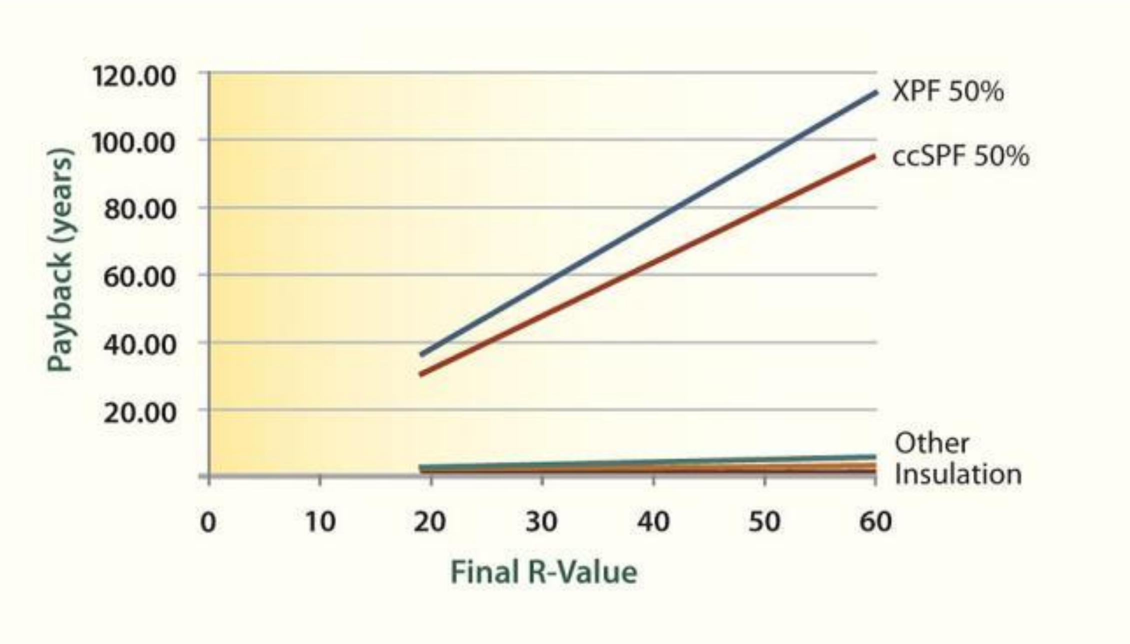
Reversible?

Not optimal.

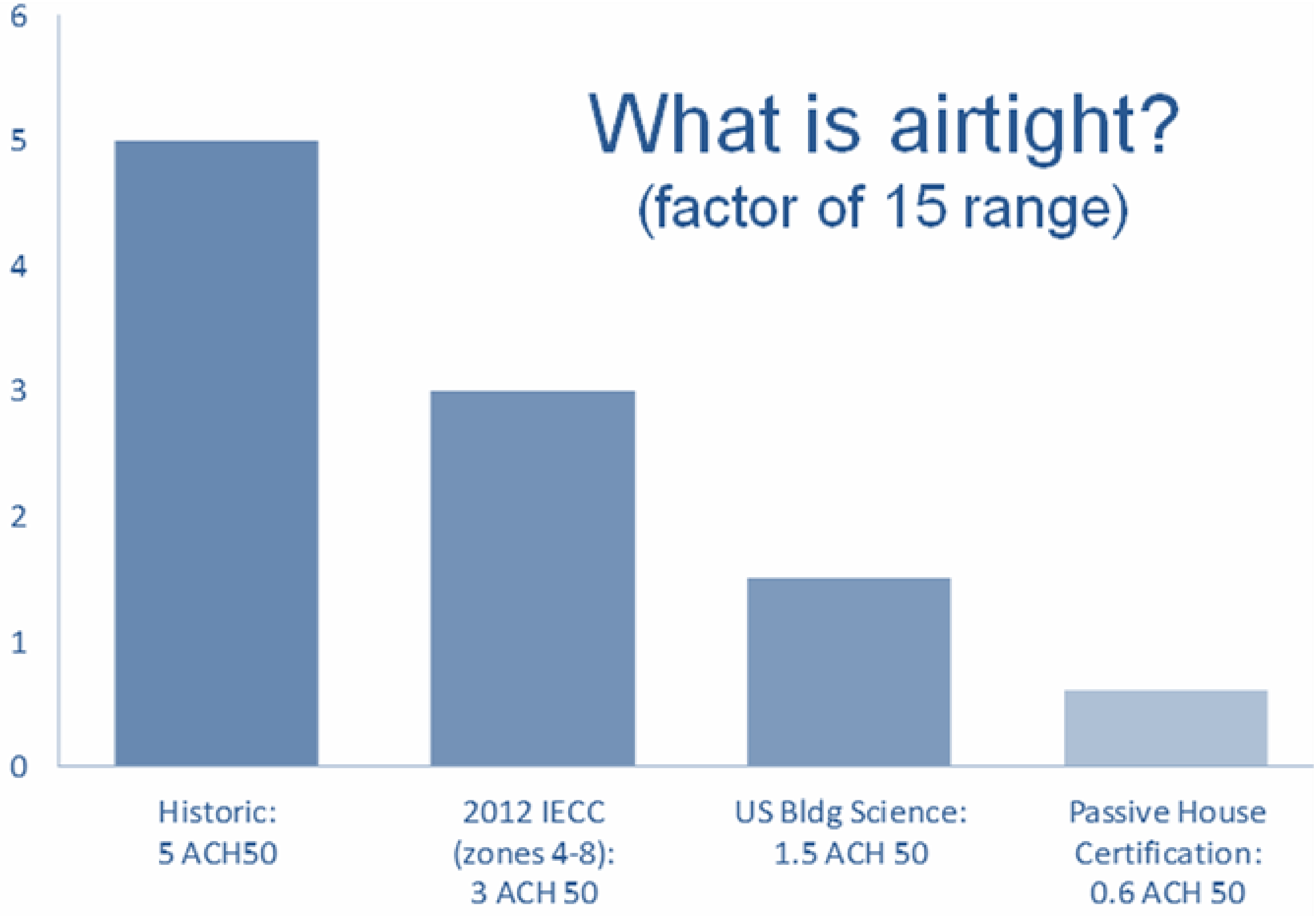
Woods Hole, MA 2011



Pure MDI's

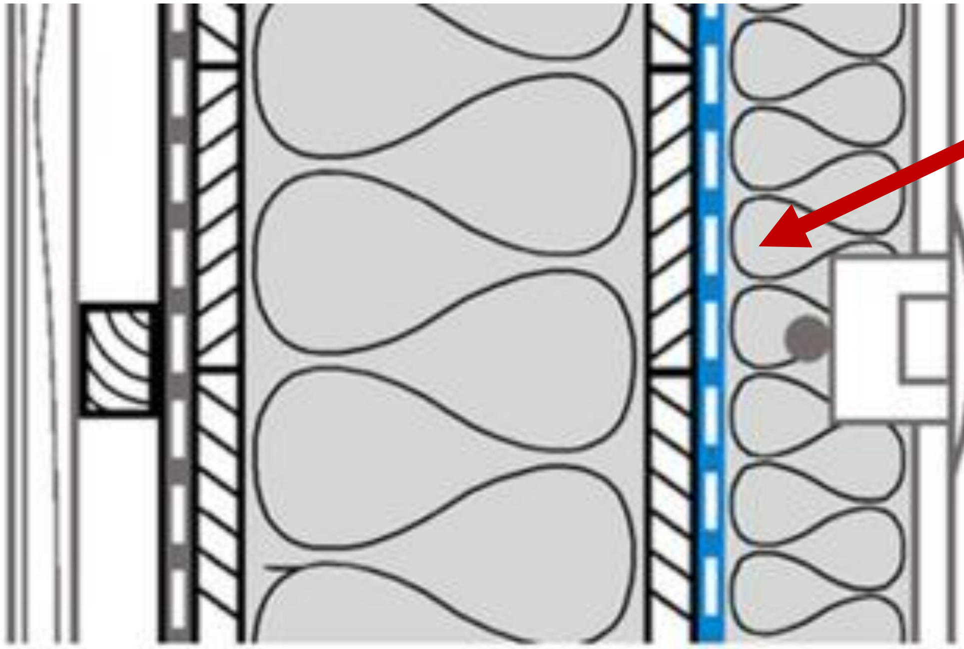


Air Control Progression

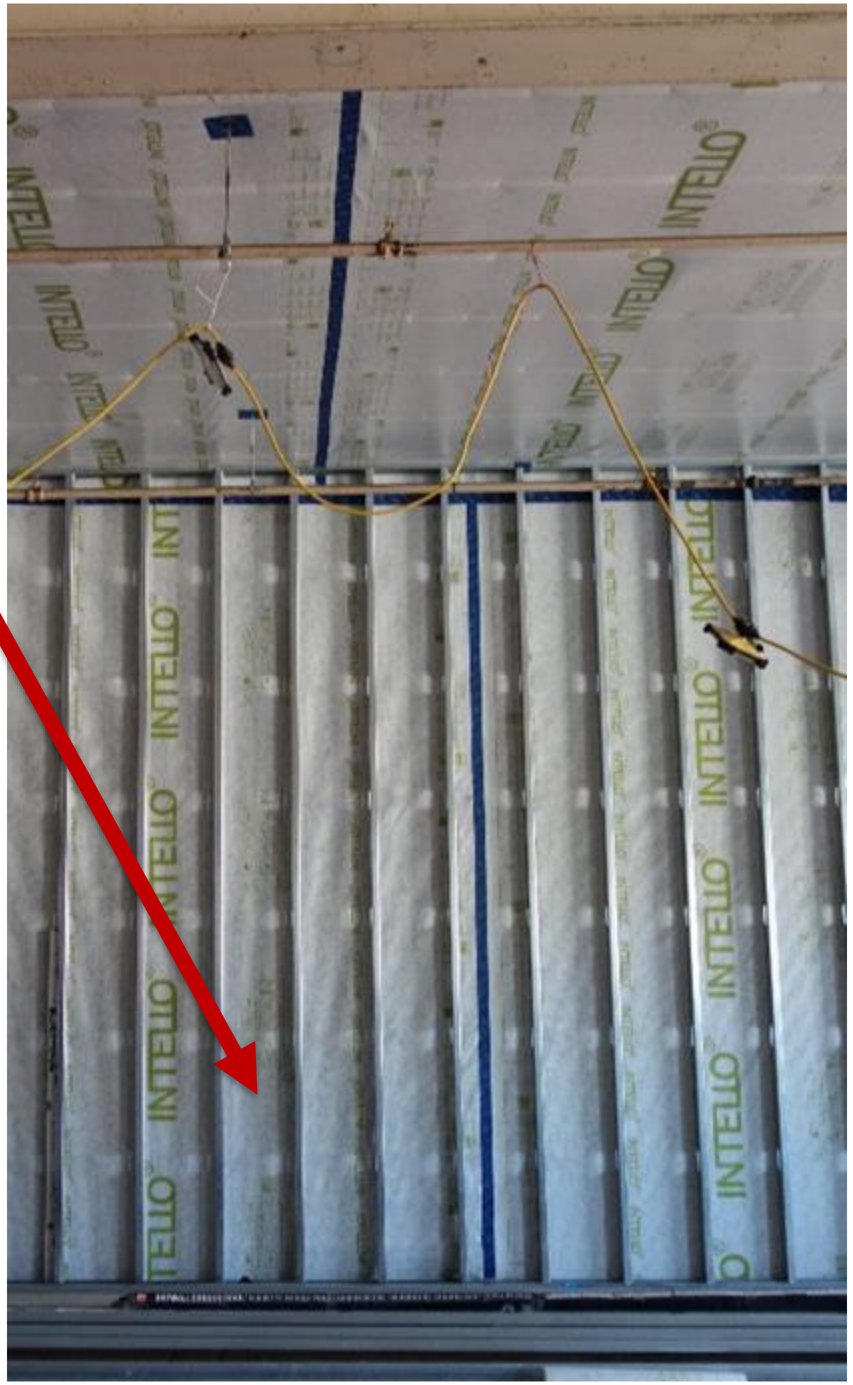


THE BLOWER DOOR DOESN'T LIE

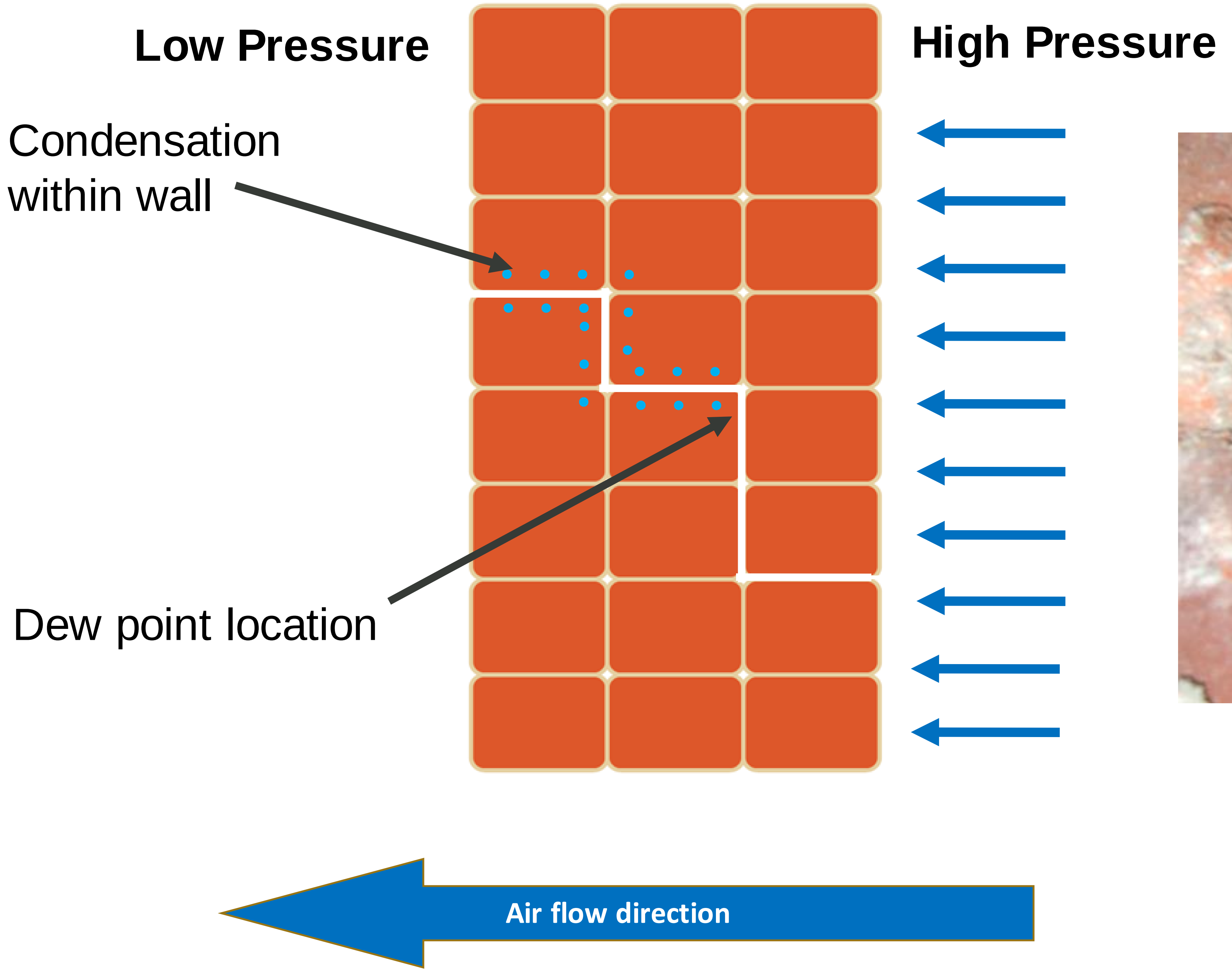
Serv



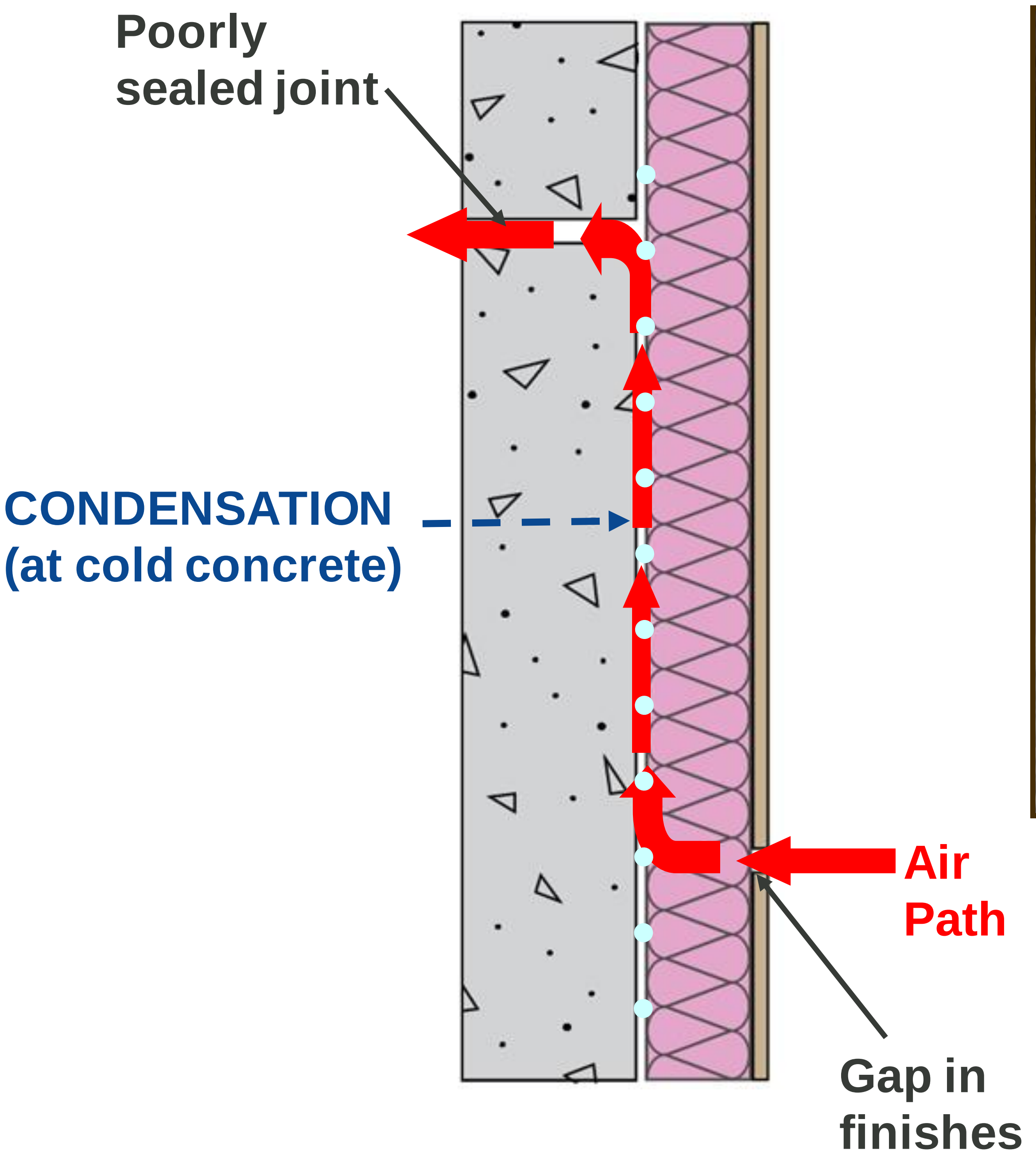
Service cavity protects airtight layer

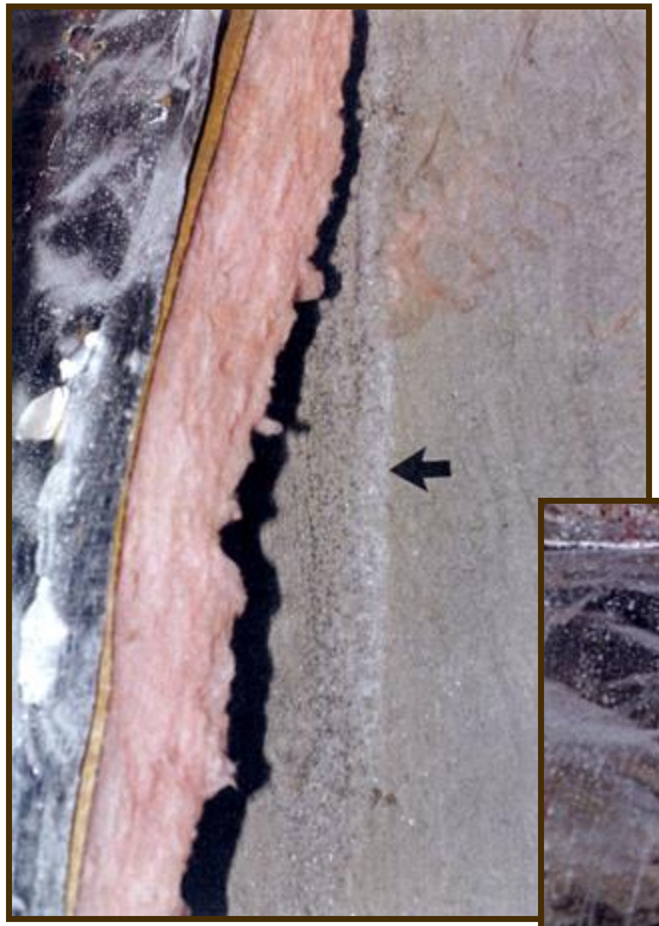


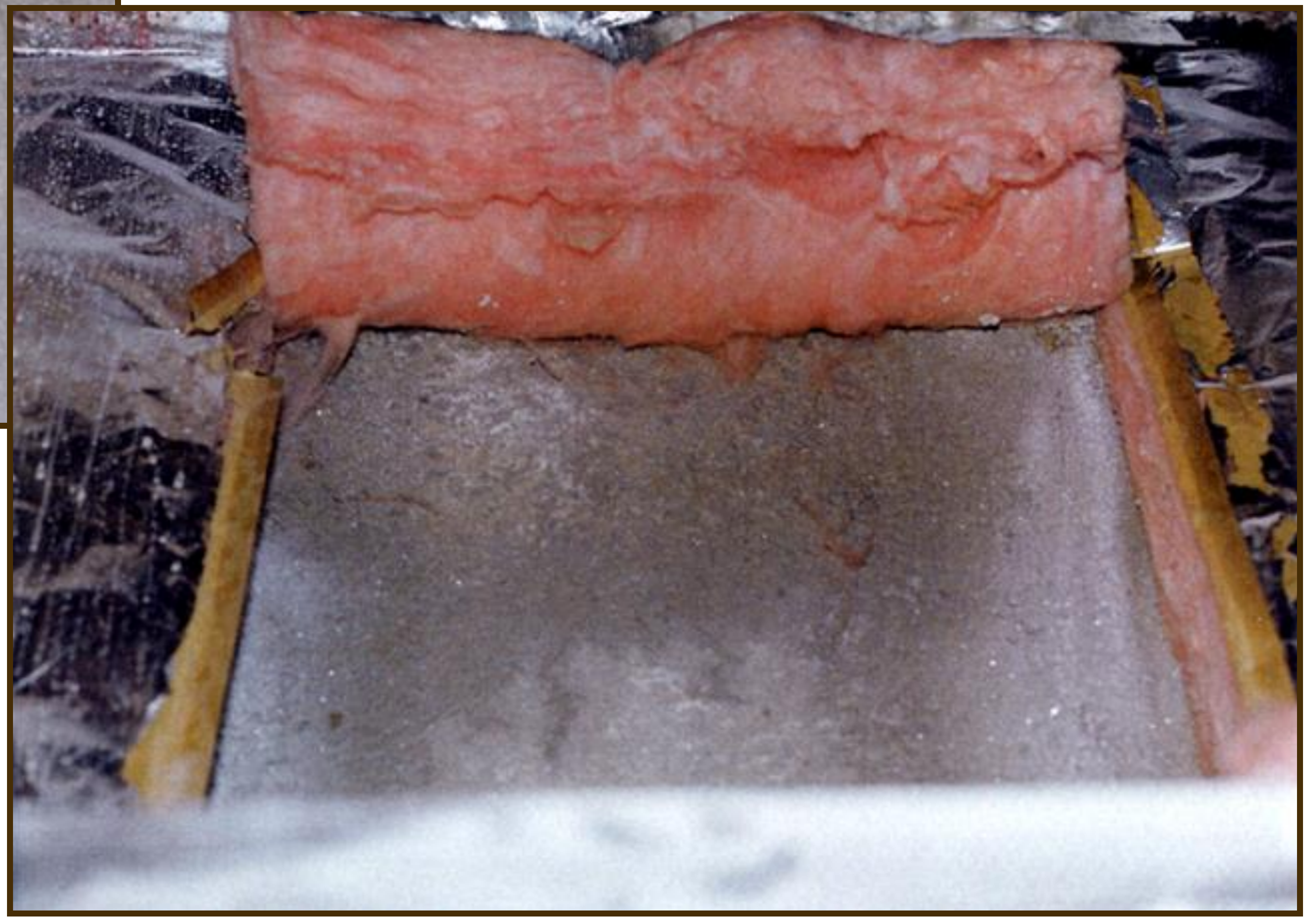
Hidden Condensation Due to Air Flow



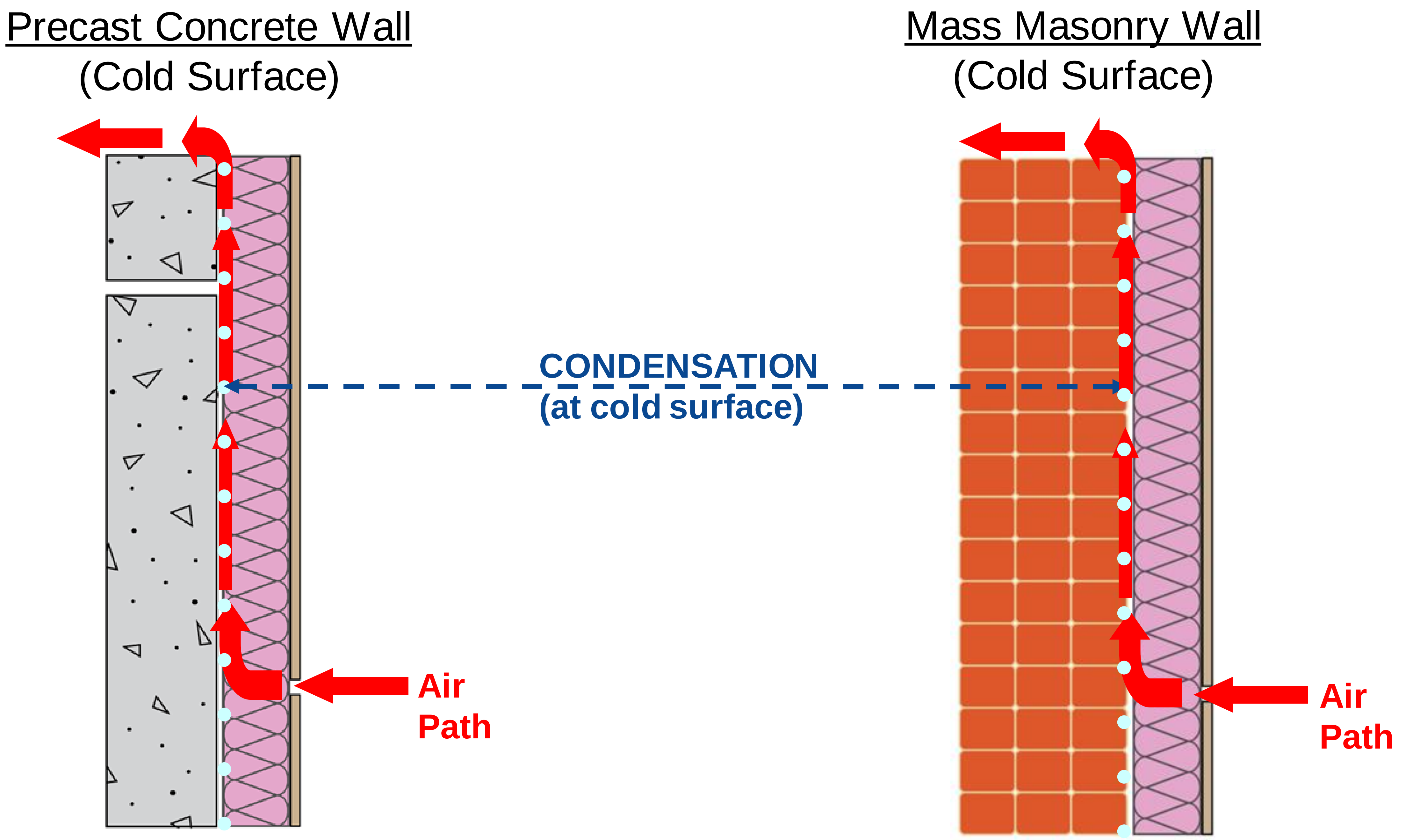
Surface Condensation Due to Air Flow





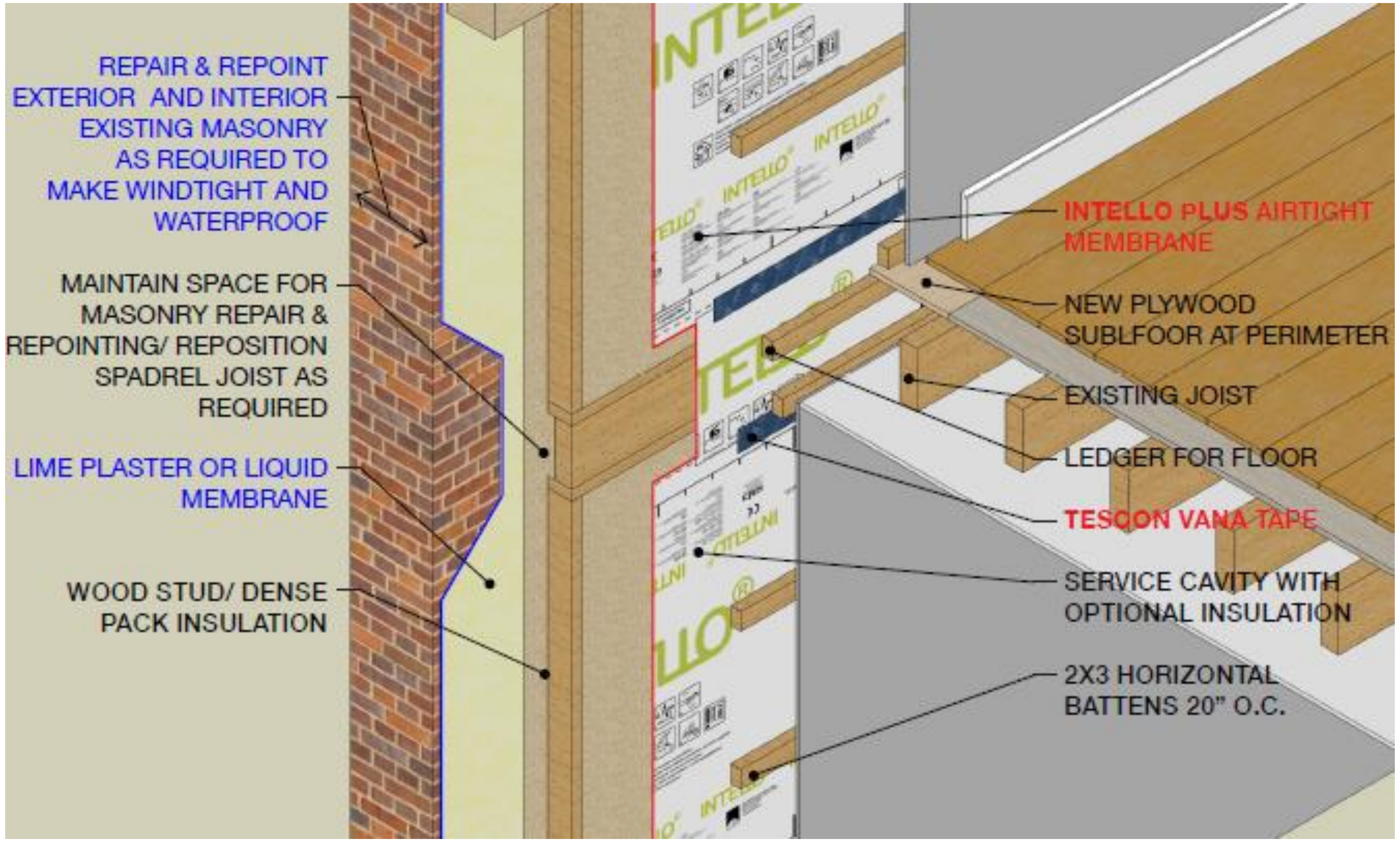


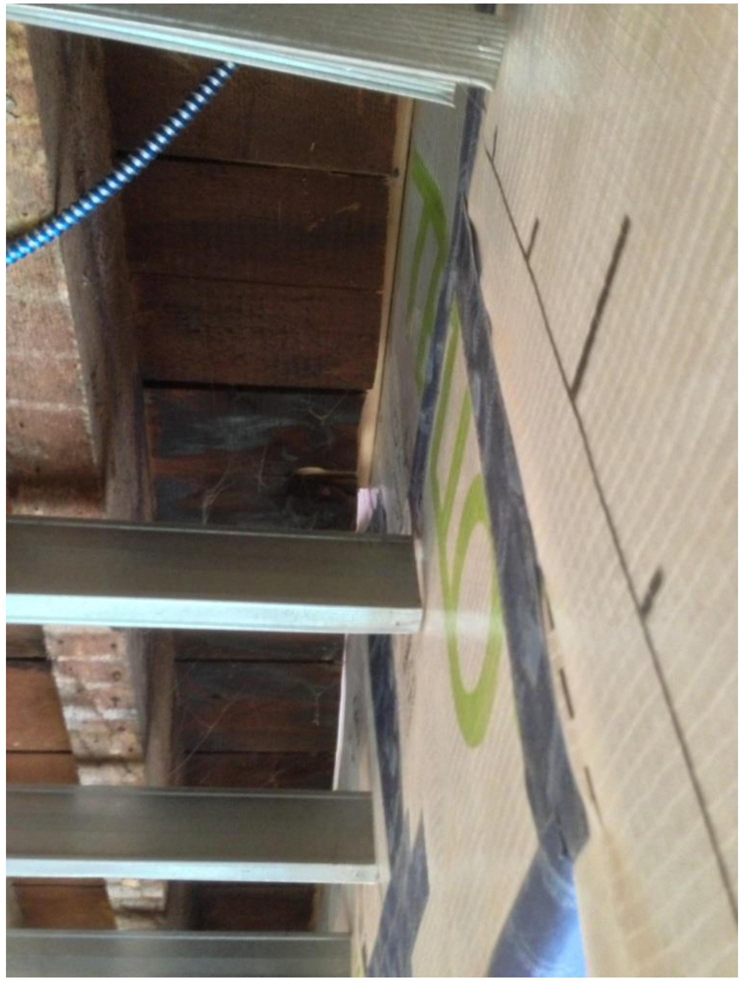
Air Flow – Masonry Walls



Air Leakage

Floor – Wall Connection

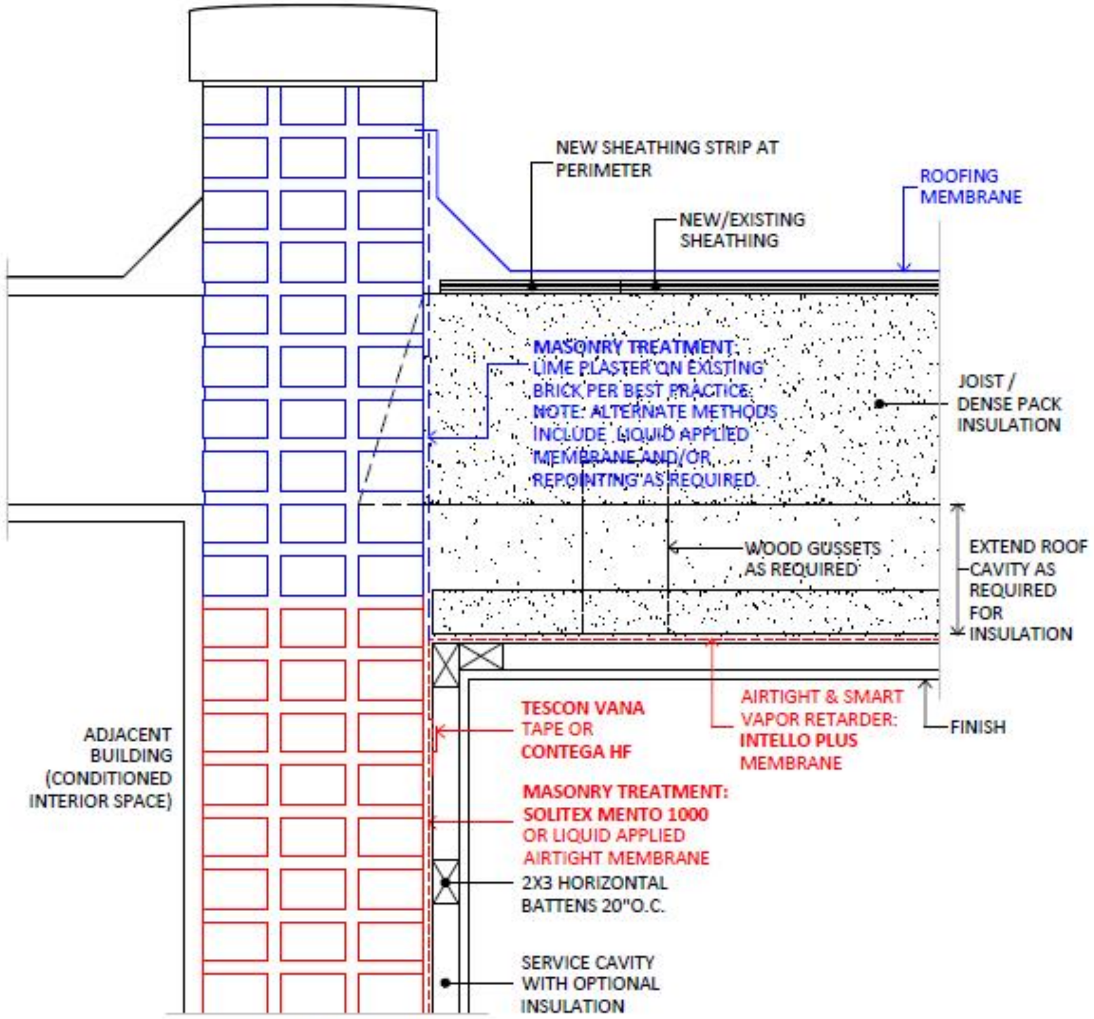




Roof – Wall Connection

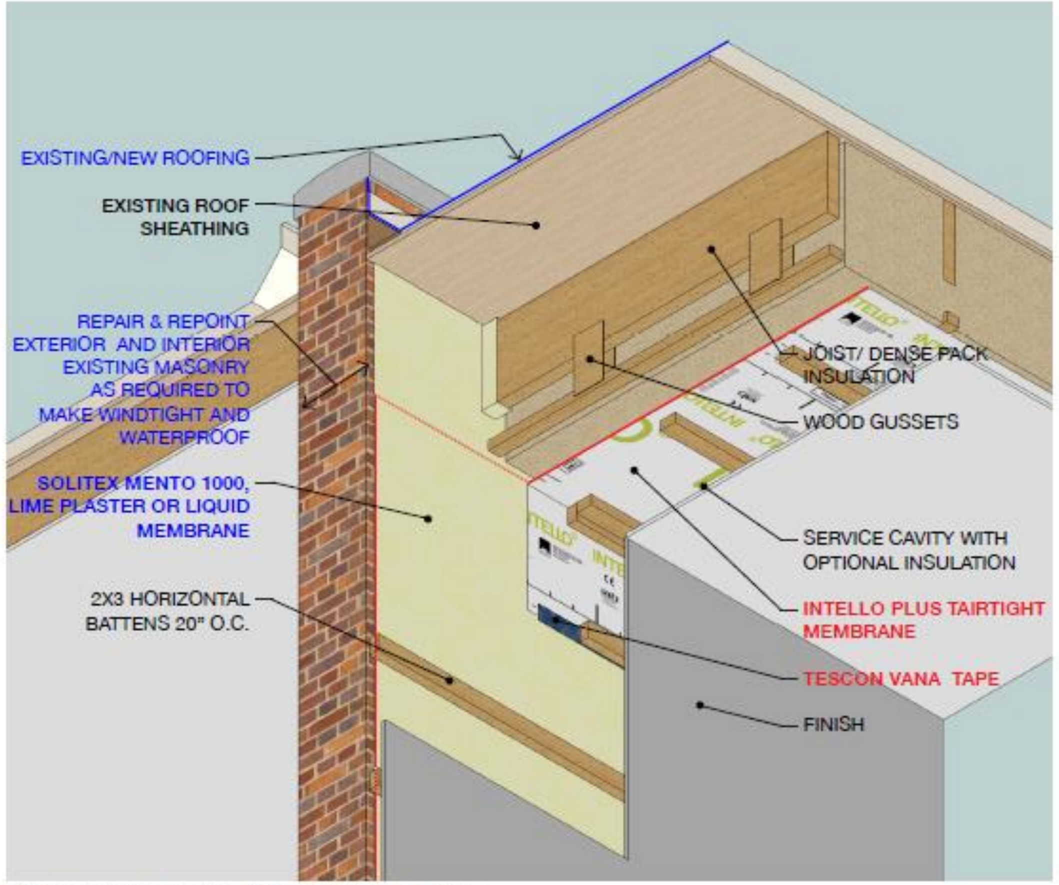
4b UNVENTED FLAT ROOF AT PARTY WALL

Disclaimer: Note that these drawings are diagrammatic and are not intended for direct use. A professional architect, engineer or builder must evaluate and customize per specific job requirements.



SECTION

SECTION DETAIL



View up at roof connection

Cost

EIFS Costs

EIFS SYSTEM COST ($/SQ.FT.)							
INSU-LATION TYPE	R-VALUE (per inch)	THICKNESS					
		2"		3"		4"	
		Dryvit	STO	Dryvit	STO	Dryvit	STO
EPS	3.85	$14-$18	$16-$18	$14-18	$16-$18	$14-$18	$18-$20
GPS	4.71	$20-$24	$17-$19	$21-$25	$17-$19	$20-$24	$19-$21
XPS	5.00	$22-$26	$20-$22	$22-26	$20-$22	$22-26	$22-$24
Mineral Wool	4.00	$36-$40	$26-$28	$36-$40	$26-$28	$36-$40	$28-$30

Note: Prices are estimates from manufacturers. An average between the two manufacturers was used for pricing.

Panel Costs

PANELIZED SYSTEM COST ($/SQ.FT.)		
INSU-LATION TYPE	R-VALUE	COST
Mineral Wool	22.1	$66.19

Interior Costs

Interior Insulation	$ / SQ. FT.
Option I	$28 to $32
Option II	$ 24 to $32

Conclusions

Determining Risk

- Condition of existing masonry
  - Reflective of quality and ability to withstand new exposure conditions

- Similarity between interior and exterior wythe / face stone
  - Estimate durability based on building history.
- Exposure
  - Review interior and exterior environmental conditions
- Reduce water penetration (mortar, repairs, flashing, etc.)

- Review material properties (mortar and brick)
  - Reliability of hygrothermal analysis results is questionable
  - Test brick masonry samples to determine properties

ASTM E3069 – Standard Guide for Evaluation and Rehabilitation of Mass Masonry Walls for Changes to Thermal and Moisture Properties of the Wall

Exterior

- Protects existing facade
- Reimages the project
- Less resident disruption

Interior

- Covers lead paint
- Requires resident relocation
- Issue of code clearances

EIFS

- No thermal breaks
- Variety of textures
- Lower cost
- More frequent maintenance

Panels

- Choice of material finishes.
- Structural Issues (how do you support)
- Thermal break issues
- Less frequent maintenance
- Higher Costs

Components of High Performance

1. Robust enclosure
2. Quality daylighting
3. Less toxic and more sustainable/low carbon
4. Healthy indoor air quality
5. More predictable and durable
6. Low Energy – “Zero Energy Ready”

Thank you!
Questions?

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