2017 Retrofit Magazine Conference

Presentation on:

Energy Retrofit Case Studies

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ASTM E06 – Voting Member Building Performance

2017 Retrofit Magazine Conference

Presentation on:

Energy Retrofit Case Studies

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Energy Retrofit Case Studies

Learning Objectives

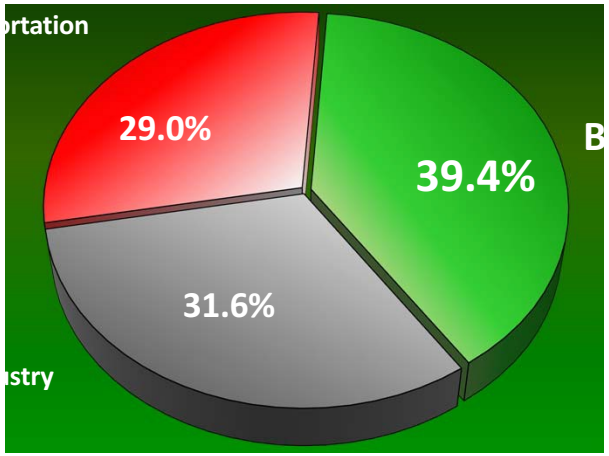
- Importance of Retrofitting today's current Commercial Building Stock (Energy Efficiency)
- Review Potential Insulating Strategies for Energy Upgrades of Masonry Structures (Types of Walls)
- Review Current Research and Discuss Cautions on Insulating Existing Masonry Structures
- Review Case Studies Demonstrating Successful Energy Upgrade / Retrofits of Masonry Structures

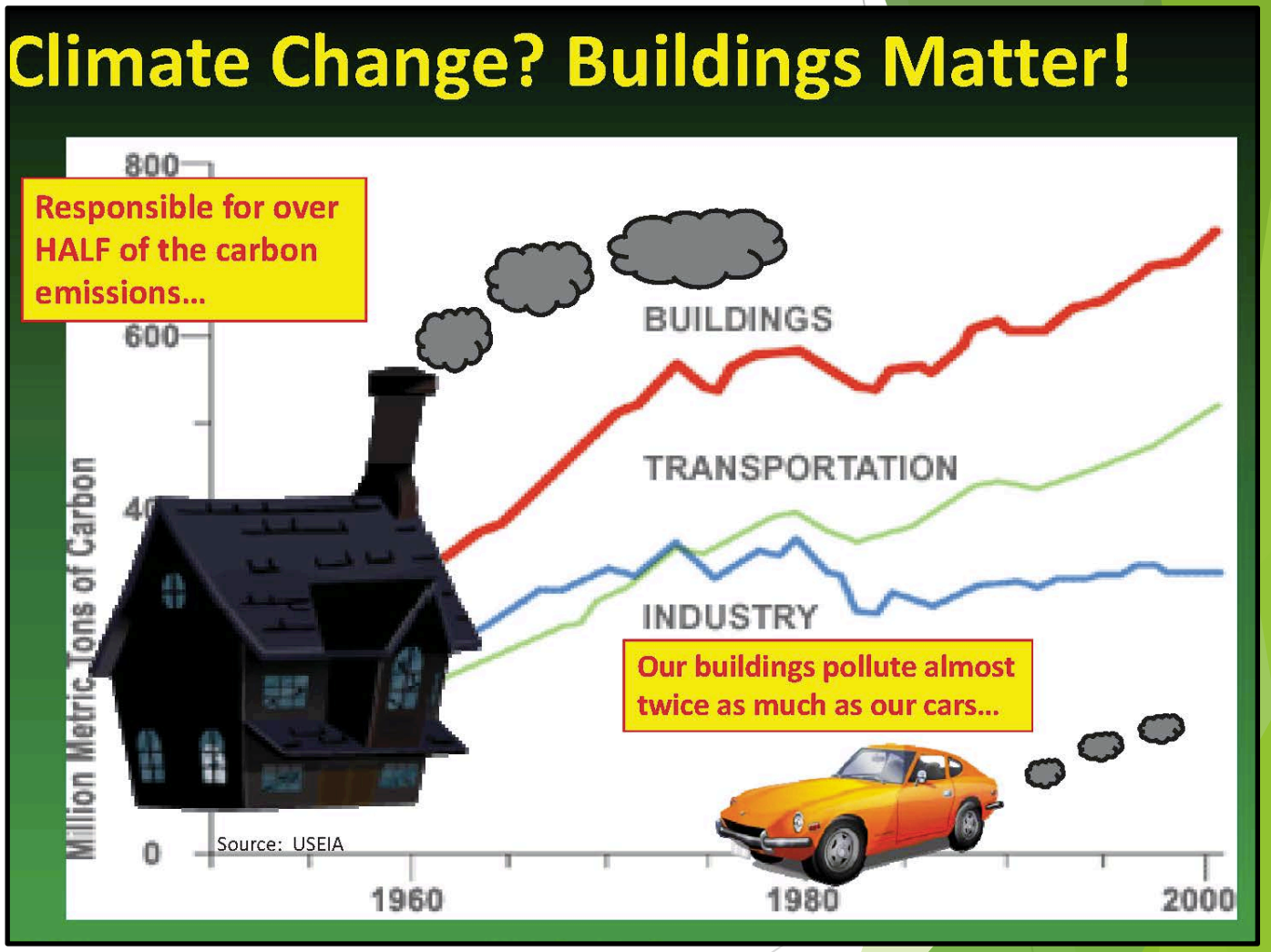
Energy Retrofit Case Studies

Photo courtesy of ABAA

Energy Retrofit Case Studies

- Existing Buildings in the United States are responsible for over half of the carbon emissions (source USEIA) today.





Slide Courtesy of:
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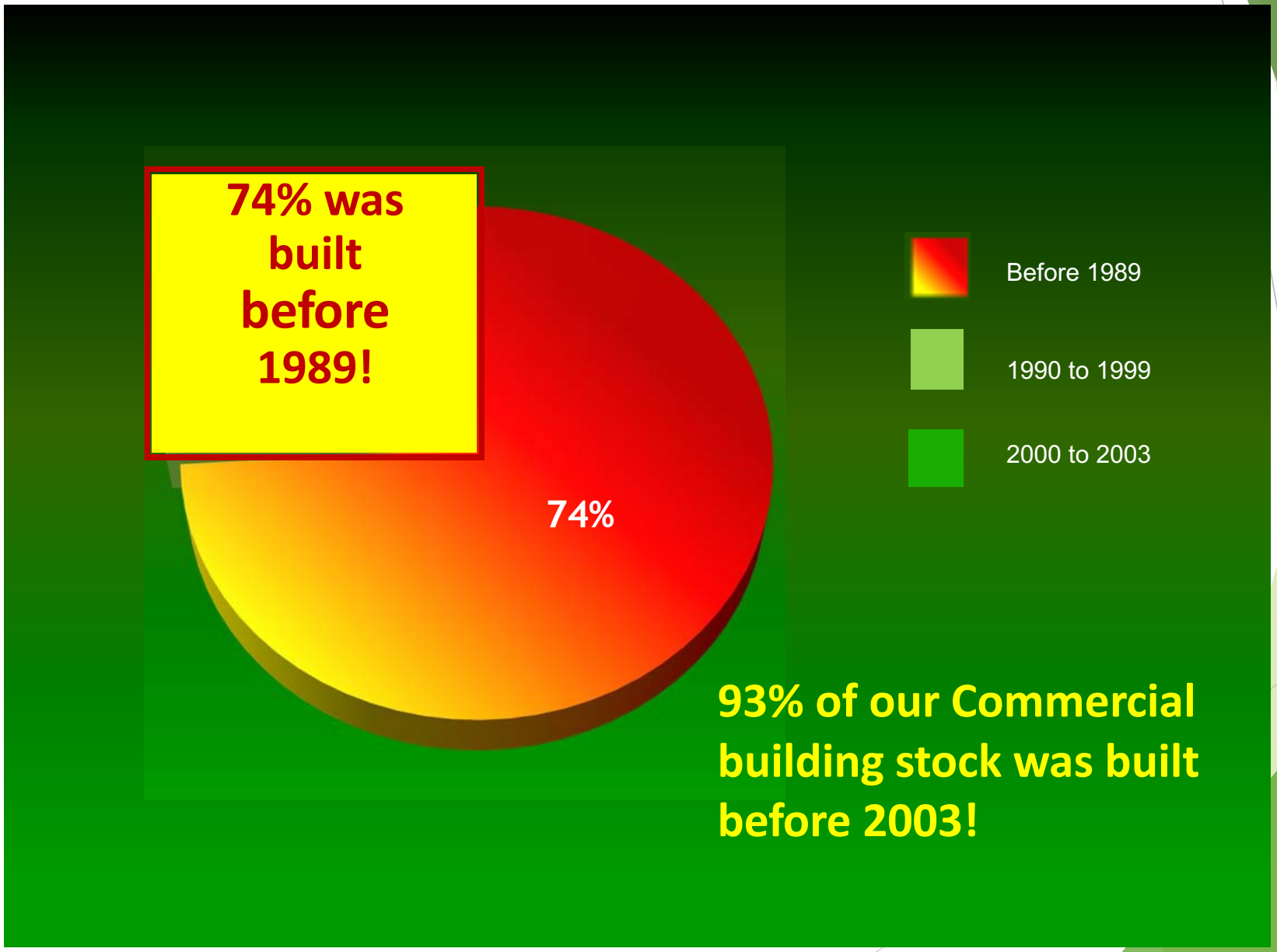
US Commercial Buildings



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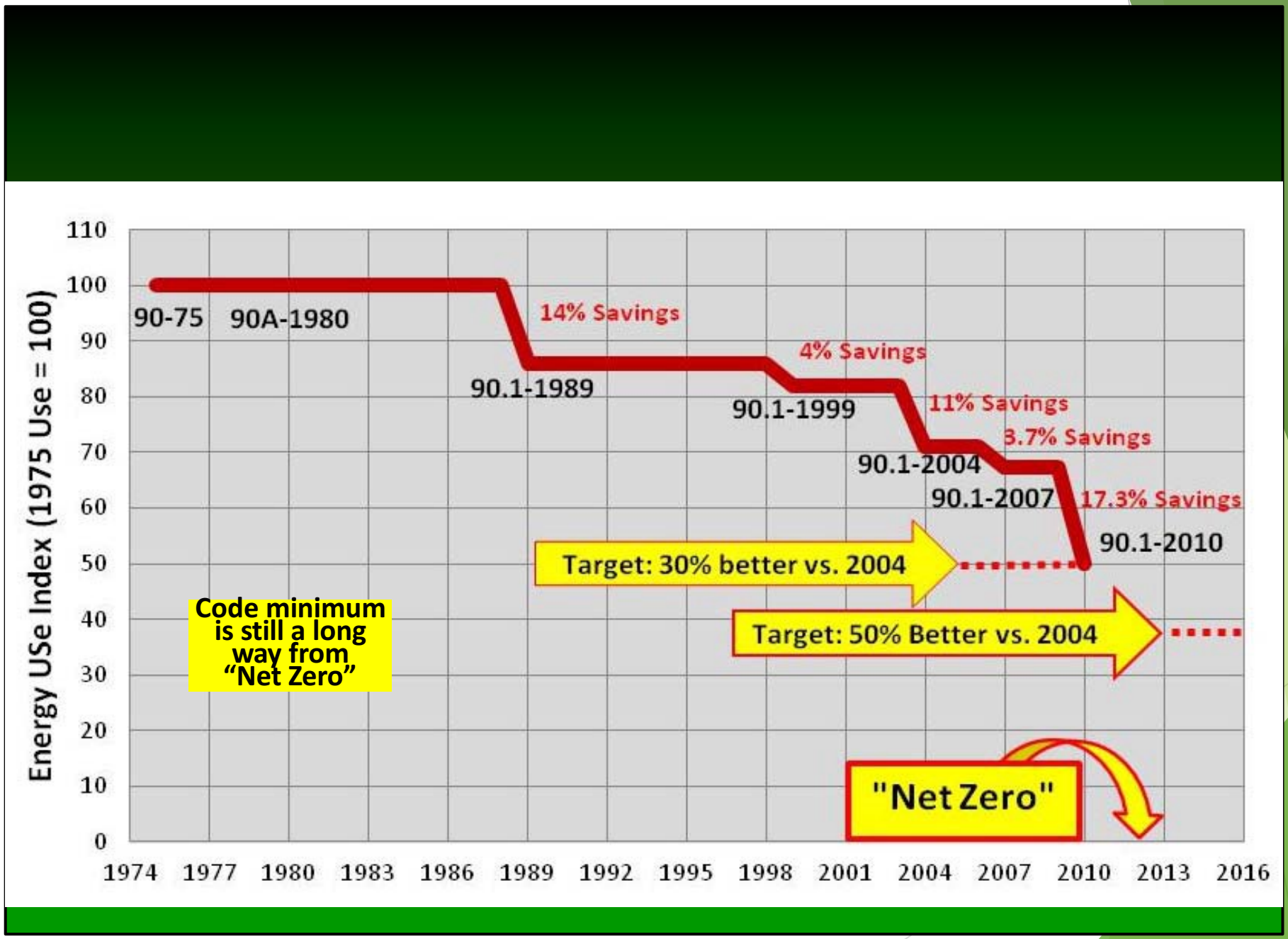

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Energy Retrofit Case Studies

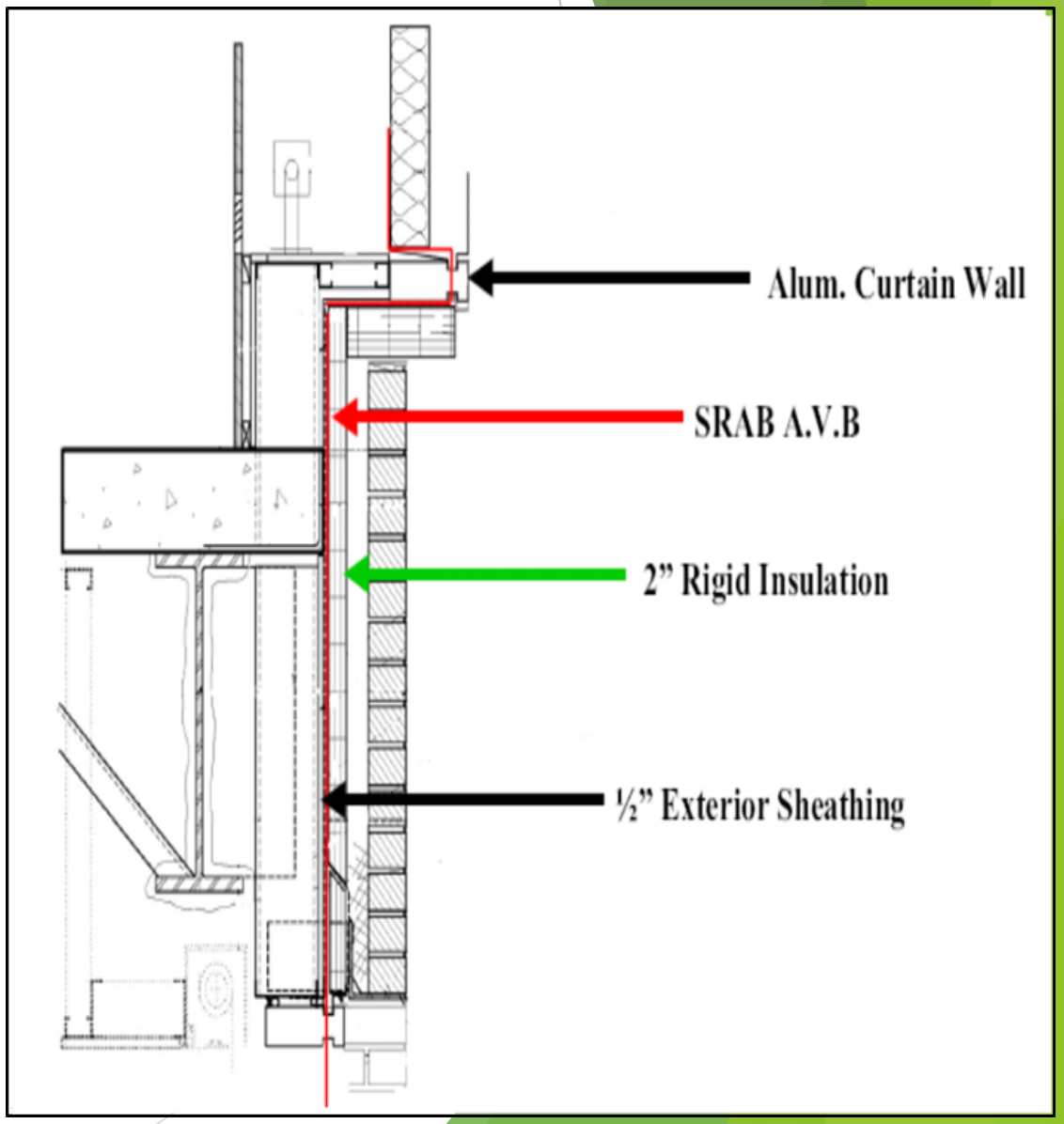
- What are the Two Key Components to Energy Upgrade of Existing Buildings?

Energy Retrofit Case Studies

What do we need in our Walls to save Energy?

Continuous Insulation & An Air Barrier!!!!

- Building with A Continuous Air Barriers can save a building up to 35% of their energy costs - NISTIR 7238
- USACE Report Dr. Alexander Zhivov
  - Air Tightness is a Must to reduce Energy Usage / Validates NISTIR
  - Built or renovated and Tested over 400 Buildings
- An Air Barrier can be installed any where in the enclosure
- Air Barriers Must be structurally supported to with stand internal and external pressures



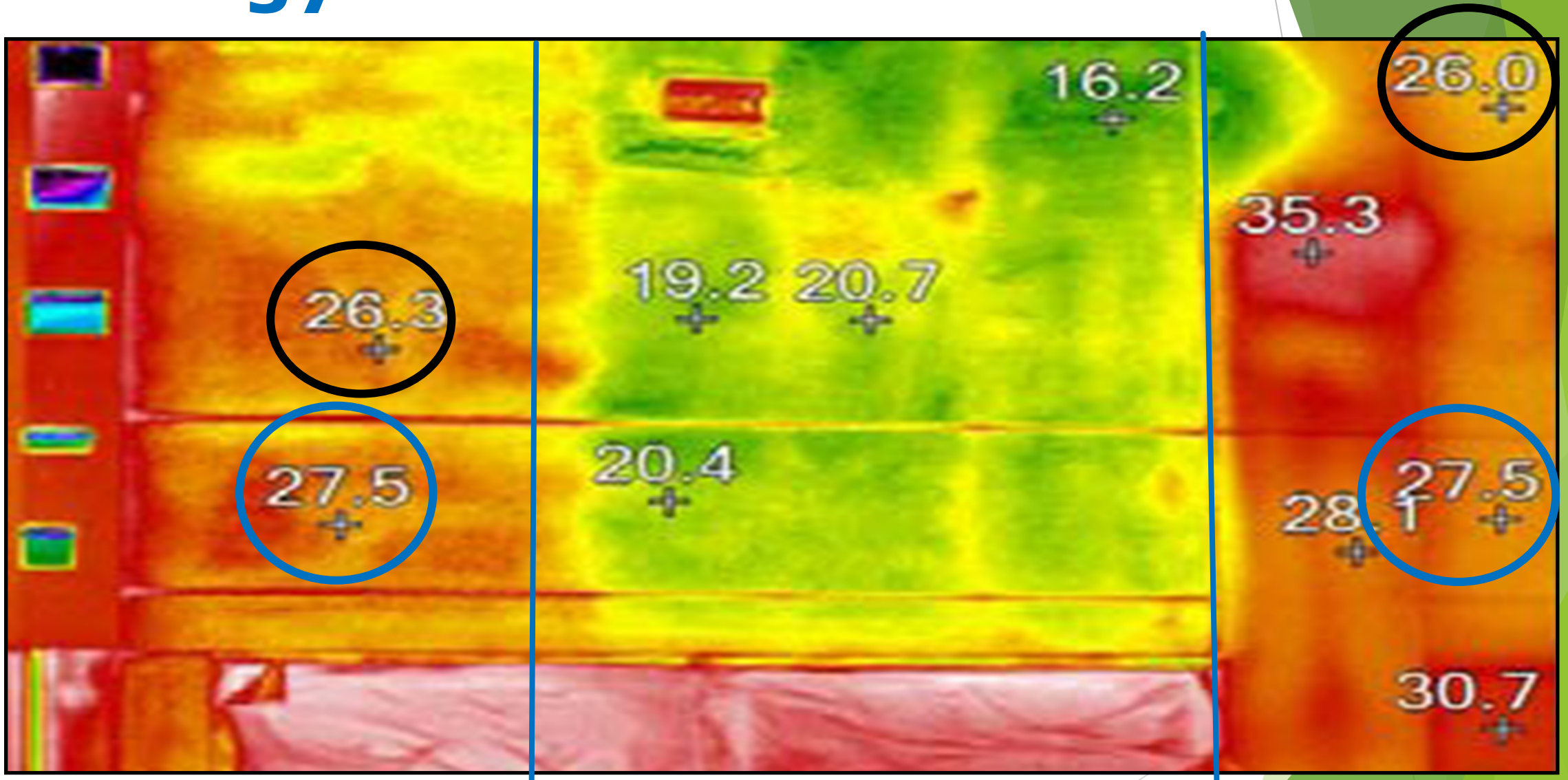
Energy Retrofit Case Studies

Air Barrier – No Insulation

Air Barrier w Insulation

NO Air Barrier & Insulation

Energy Retrofit Case Studies



Air Barrier – No Insulation

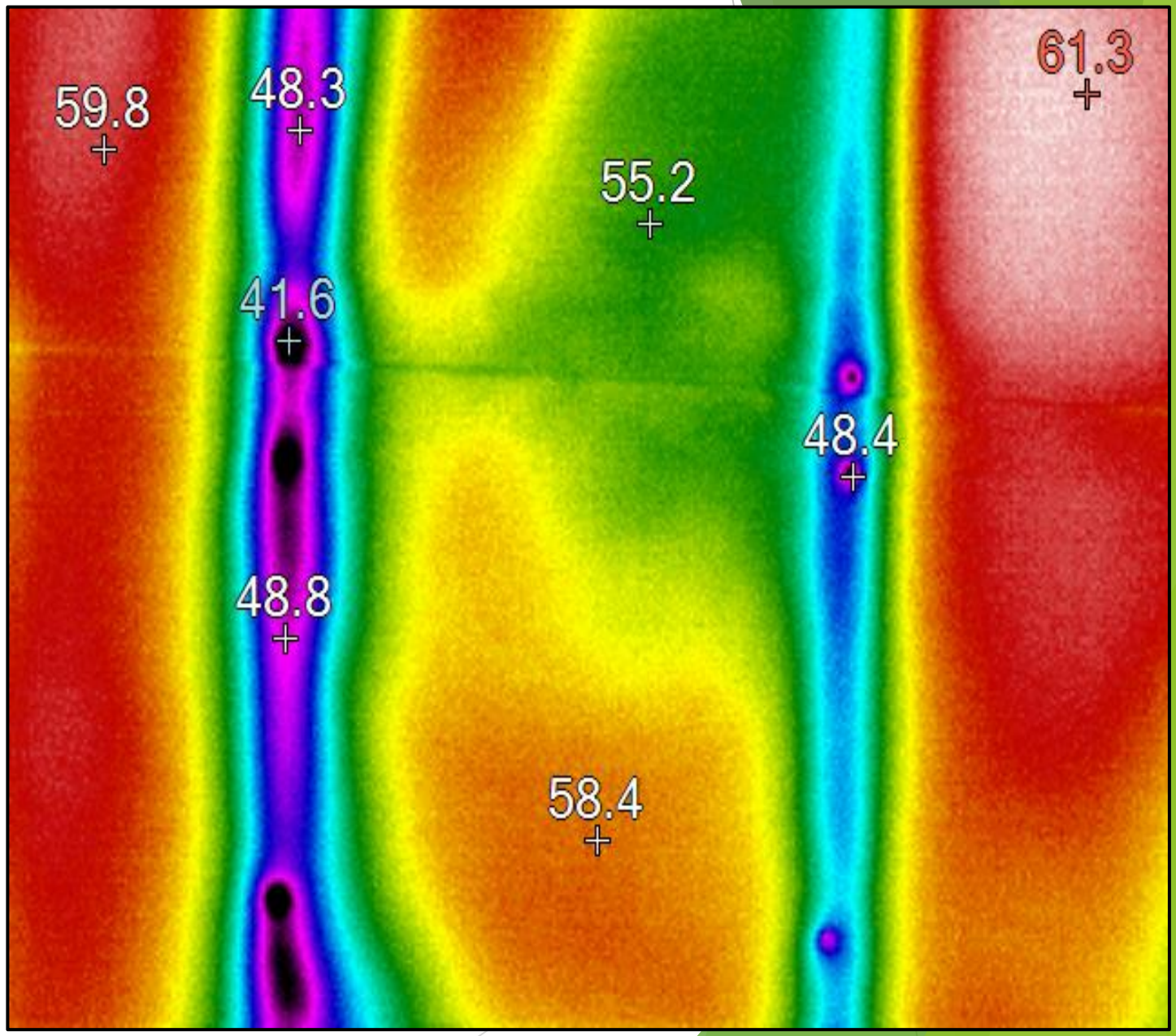
Air Barrier w Insulation

NO Air Barrier & Insulation

Why Continuous Insulation???

What is the R Value of a 2”x 6” with R 19 Batt Insulation

R 7.1



ASHRAE Handbook of Fundamentals

Effective Insulation/Framing Layer R-Values

Steel-framed wall information adapted from ANSI/ASHRAE/IESNA Standard 90.1-2007 Table A9.2B.

Stud Wall Framing Type	Nominal Cavity Depth (inches)	Actual Cavity Depth (inches)	Rated R-Value	Effective R-Value at 16 in. on Center[1]	% Change (Rated vs Effective)	Effective R-Value at 24 in. on Center[2]	% Change (Rated vs Effective)
Batt Insulated Cavity							
Steel	4	3.50	R-11	R-5.5	-50%	R-6.6	-40%
Steel	4	3.50	R-13	R-6.0	-54%	R-7.2	-45%
Steel	4	3.50	R-15	R-6.4	-57%	R-7.8	-48%
Steel	6	6.00	R-19	R-7.1	-63%	R-8.6	-55%
Steel	6	6.00	R-21	R-7.4	-65%	R-9.0	-57%
Steel	8	8.00	R-25	R-7.8	-69%	R-9.6	-62%
Wood	4	3.50	R-11	R-9.3	-15%	R-9.5	-14%
Wood	4	3.50	R-13	R-10.8	-17%	R-11.1	-15%
Wood	4	3.50	R-15	R-12.3	-18%	R-12.7	-15%
Wood	6	5.50	R-19	R-16.0	-16%	R-16.3	-14%
Wood	6	5.50	R-21	R-17.5	-17%	R-17.9	-15%
Wood	8	7.50	R-25	R-21.1	-16%	R-21.5	-14%

** Rating for airspace per ANSI/ASHRAE/IESNA Standard 90.1-2007.*

[1] Per the ASHRAE Handbook of Fundamentals, a residential wall framing factor of 25 percent is assumed for conventional framing at 16 in. on center.

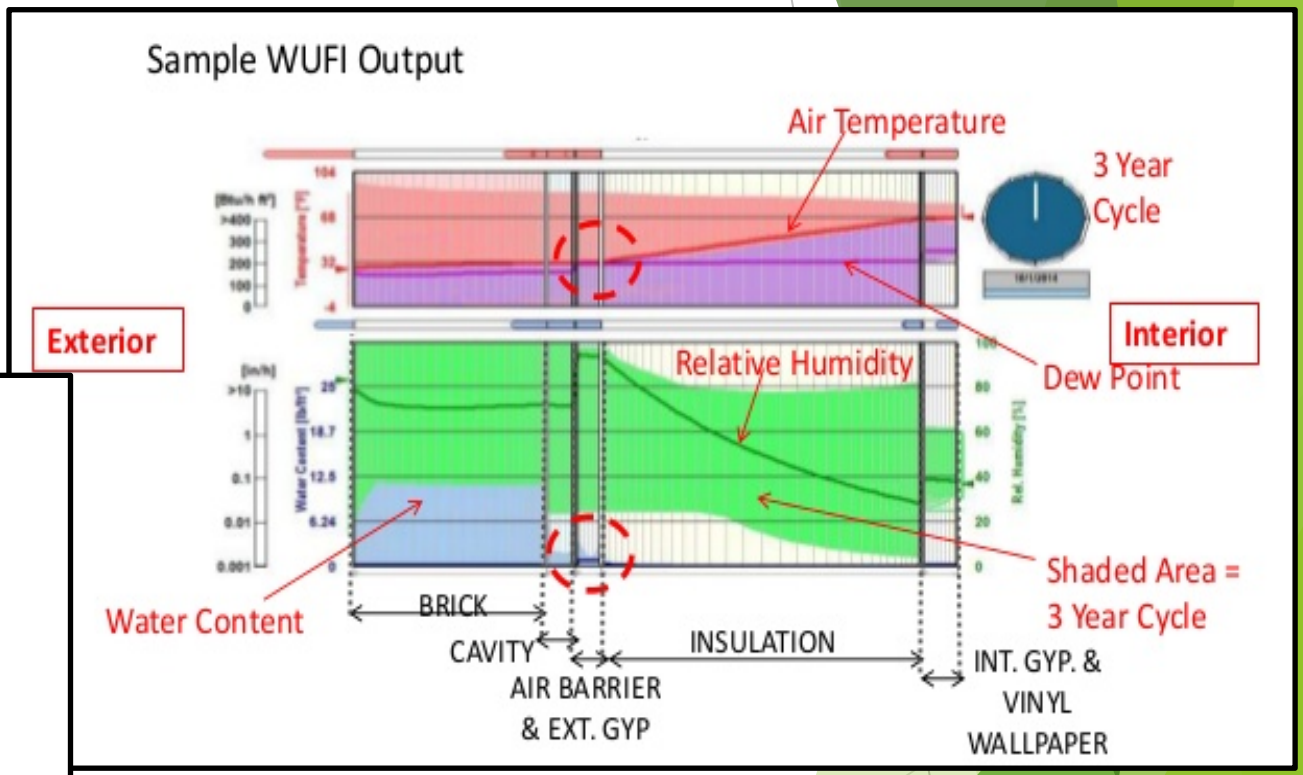
2 Per the ASHRAE Handbook of Fundamentals, a residential wall framing factor of 22 percent is assumed for conventional framing at 24 in. on center.

Energy Retrofit Case Studies

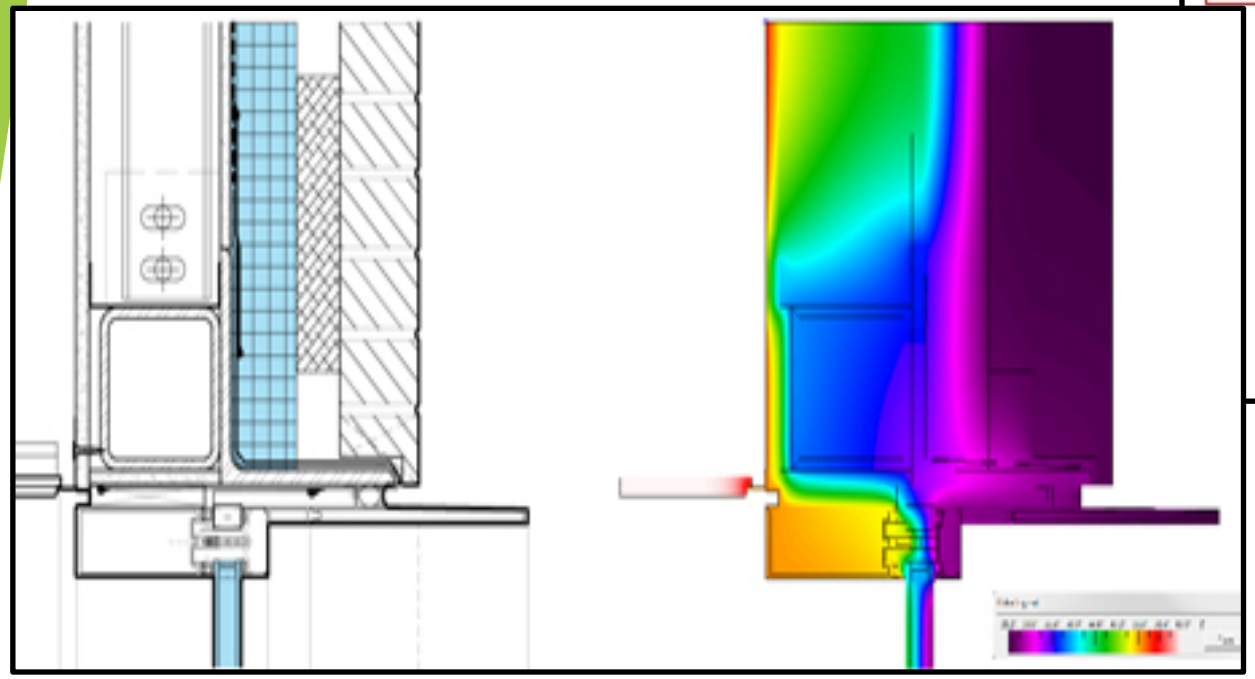
What Else Should We Do to Ensure We Retrofit It Right???

Computer Modeling Programs:

- Therm
- WUFI
- eQuest



WUFI

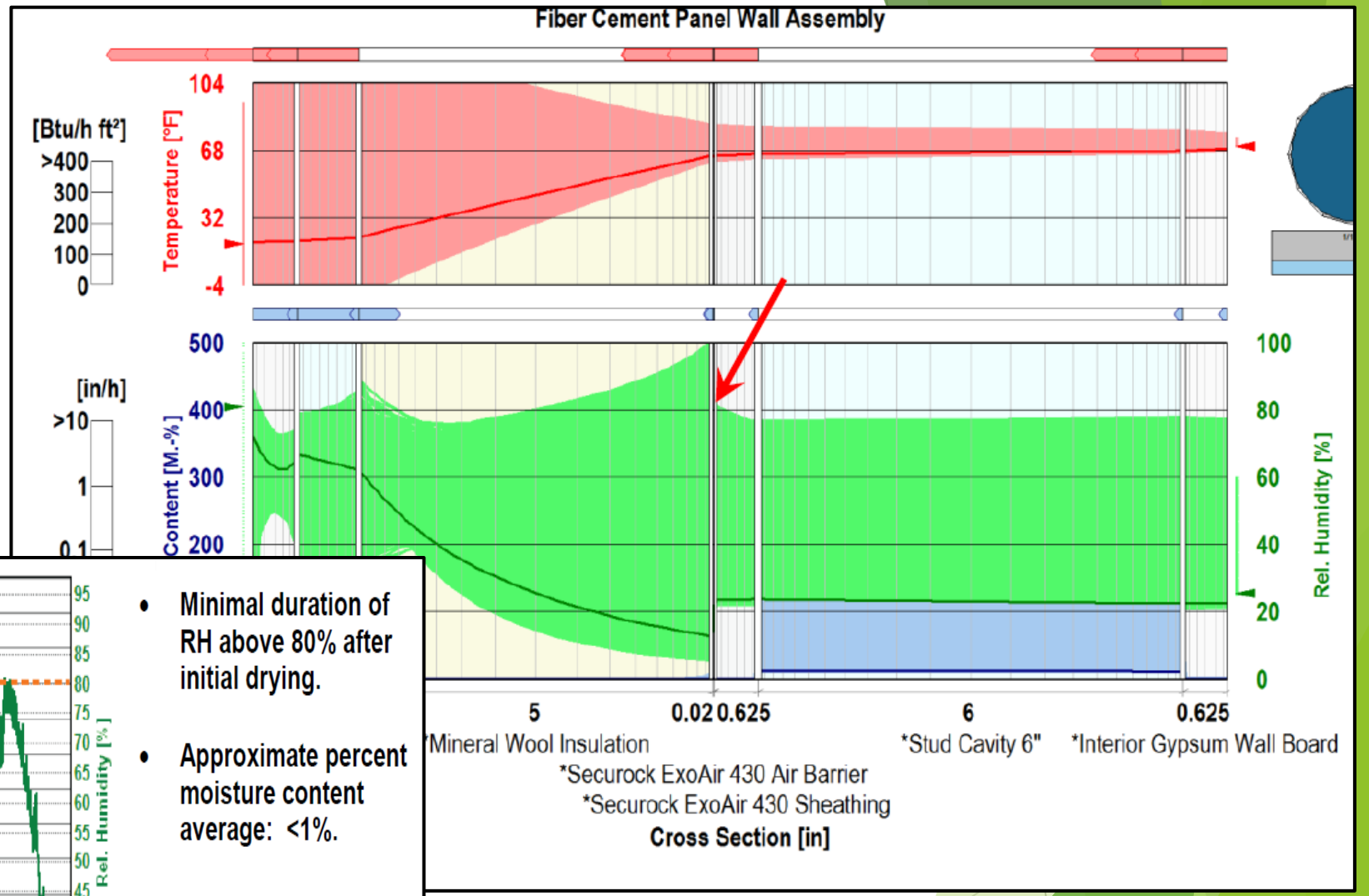


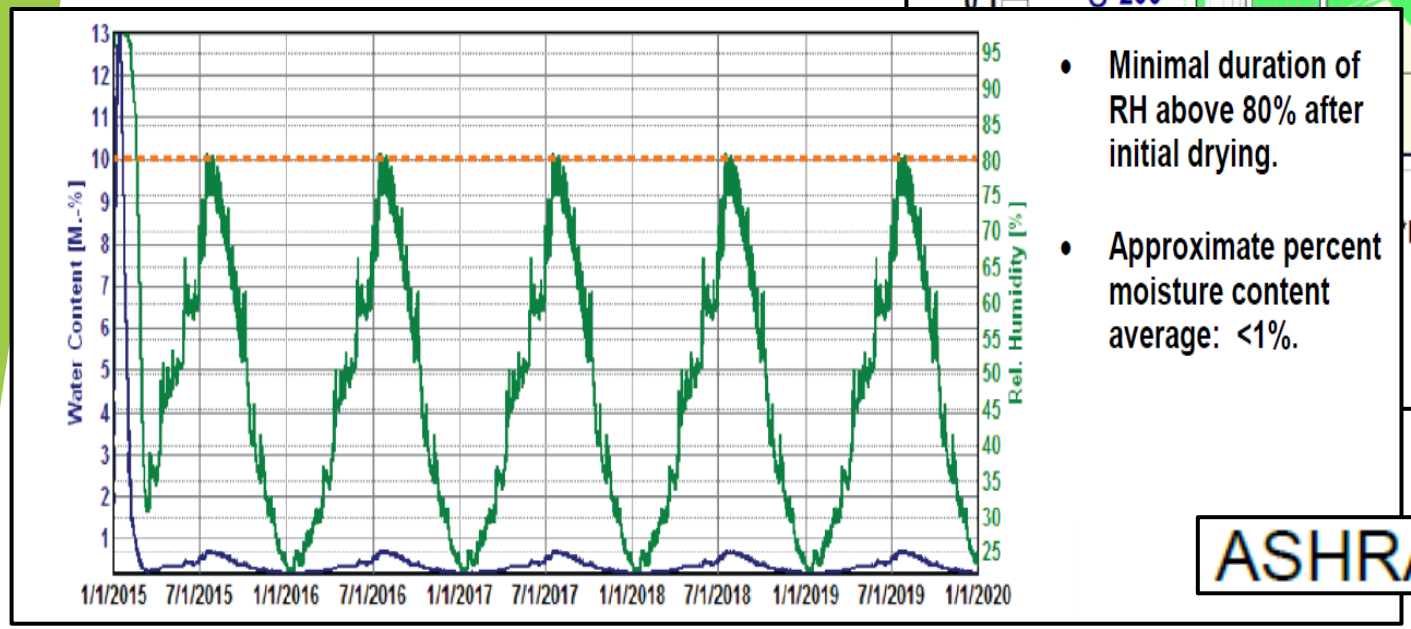
Therm

Caution – Output is only as good as the Input!!!!!

IBC 2015

- **Section 1405.3**
  - Vapor Retarders as described in Section 1405.3.3 shall be provided in accordance with Section 1405.1 and 1405.3.2 **or an approved design using accepted engineering practice for hydrothermal analysis**





- Minimal duration of RH above 80% after initial drying.
- Approximate percent moisture content average: <1%.

ASHRAE 160

Caution – Output is only as good as the Input!!!!!

Energy Retrofit Case Studies

What Else Should We Do to Ensure We Re-Build It Right???

Make Sure Brick Can Handle Different Moisture / Freeze Thaw Cycles

Photo by: Construction Specifier Institute

- ASTM C67 – 14 Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile

Energy Retrofit Case Studies

Insulation and Air Barrier Strategies

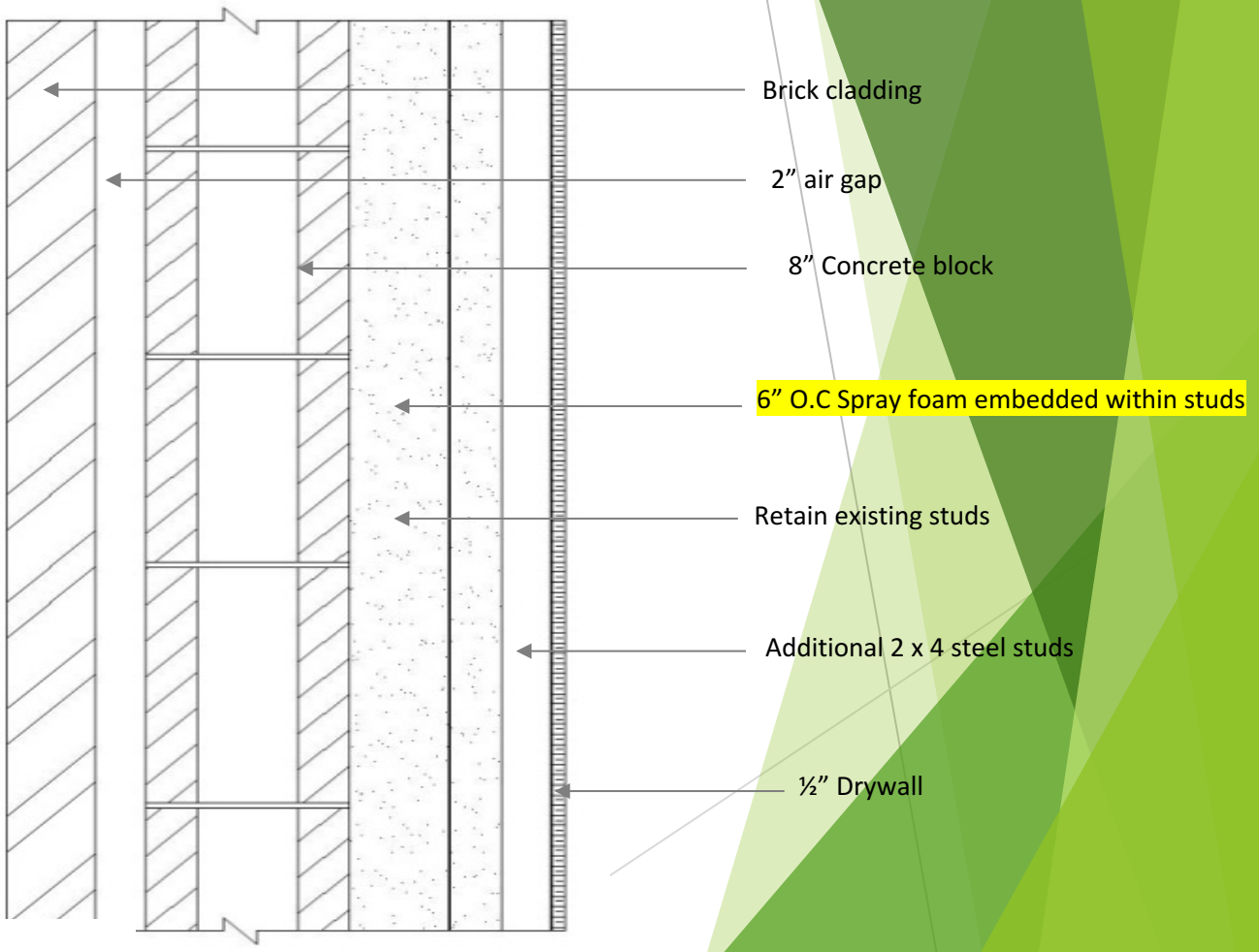
Study - CBEI / ORNL / ABAA

Open-cell Spray foam insulation:

- 6” Spray foam applied onto the existing wall
- Additional 2 x 4” hollow steel stud framing at 16” o.c.

** Tear off the fiberglass batts but keep the existing steel studs. Erect additional 2x4 steel stud framing in front of existing studs.*

- ½” Drywall with latex paint (to serve as vapor semi-permeable air barrier)



Wall Designs Courtesy of:

CBEI CONSORTIUM for BUILDING ENERGY INNOVATION

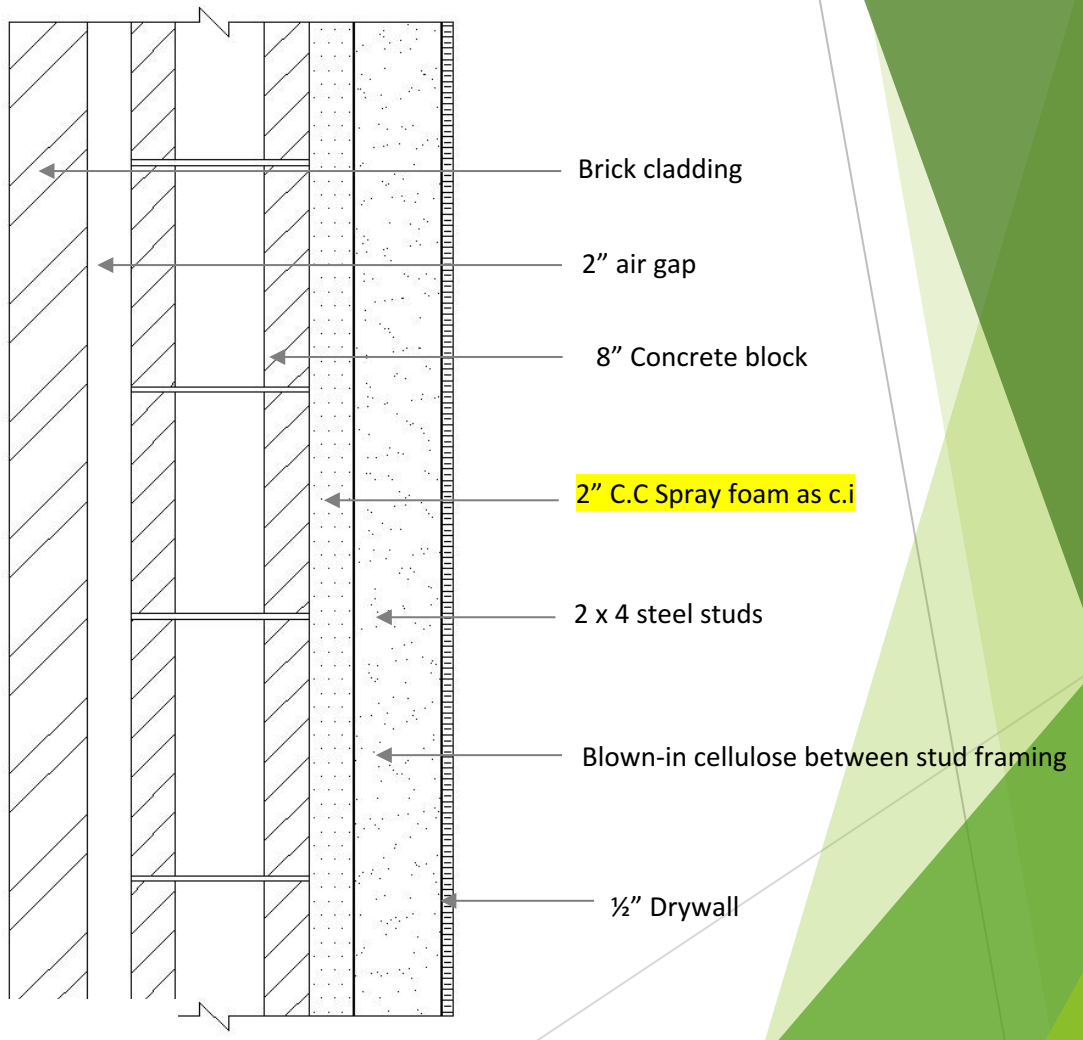
Energy Retrofit Case Studies

Insulation and Air Barrier Strategies

Hybrid Spray foam insulation:

- 2” Spray foam application
- 2 x 4” steel stud framing at 16” o.c
- 4” Blown-in cellulose between the stud framing
- ½” Drywall

The existing fiberglass batts and steel studs will have to taken down to spray continuous layer of foam on the inside of the CMU.



Wall Designs Courtesy of:

CBEI CONSORTIUM for BUILDING ENERGY INNOVATION

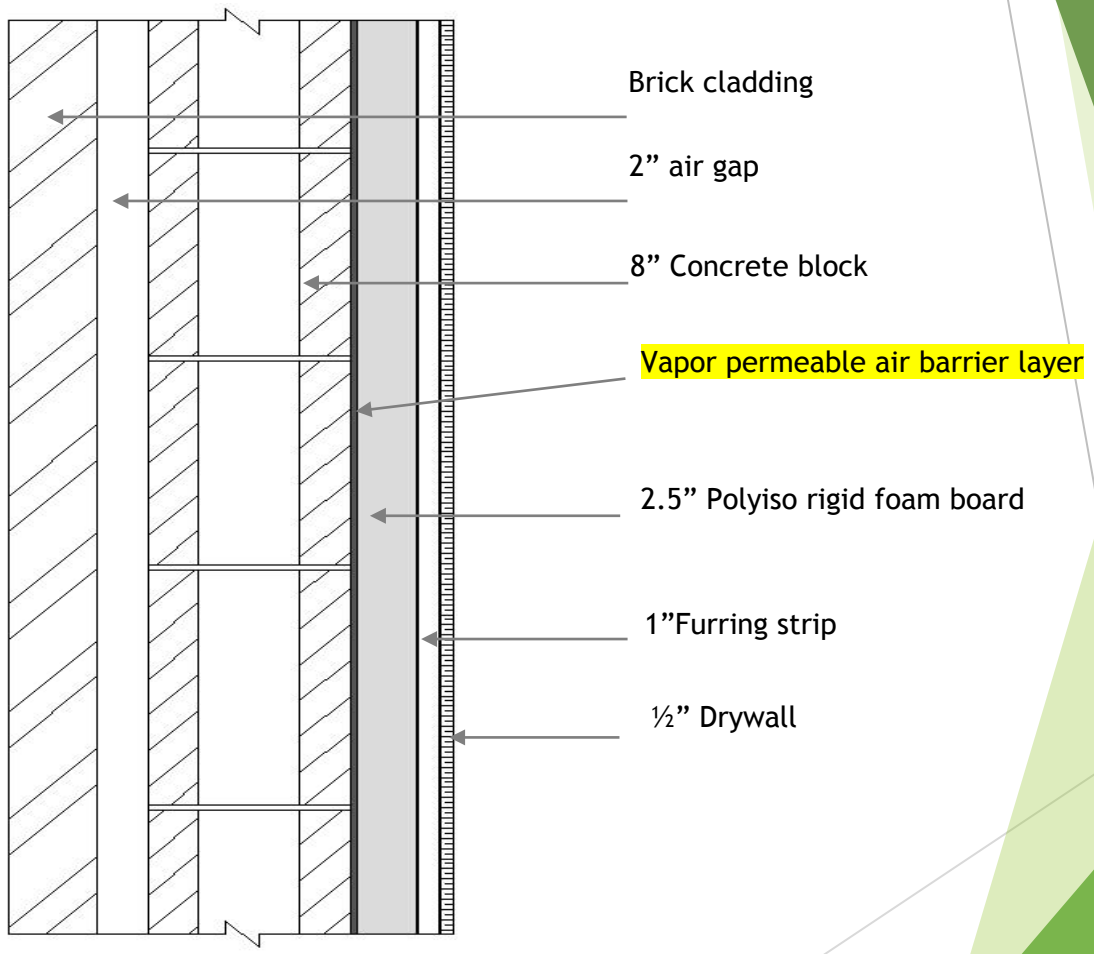
Energy Retrofit Case Studies

Insulation and Air Barrier Strategies

Rigid foam board application:

- Air barrier layer
- 2.5” Rigid foam board continuous insulation
- 1” furring strip
- ½” Drywall

The existing fiberglass batts and steel studs will have to taken down and rigid foam board applied as a continuous insulation layer.



Wall Designs Courtesy of:

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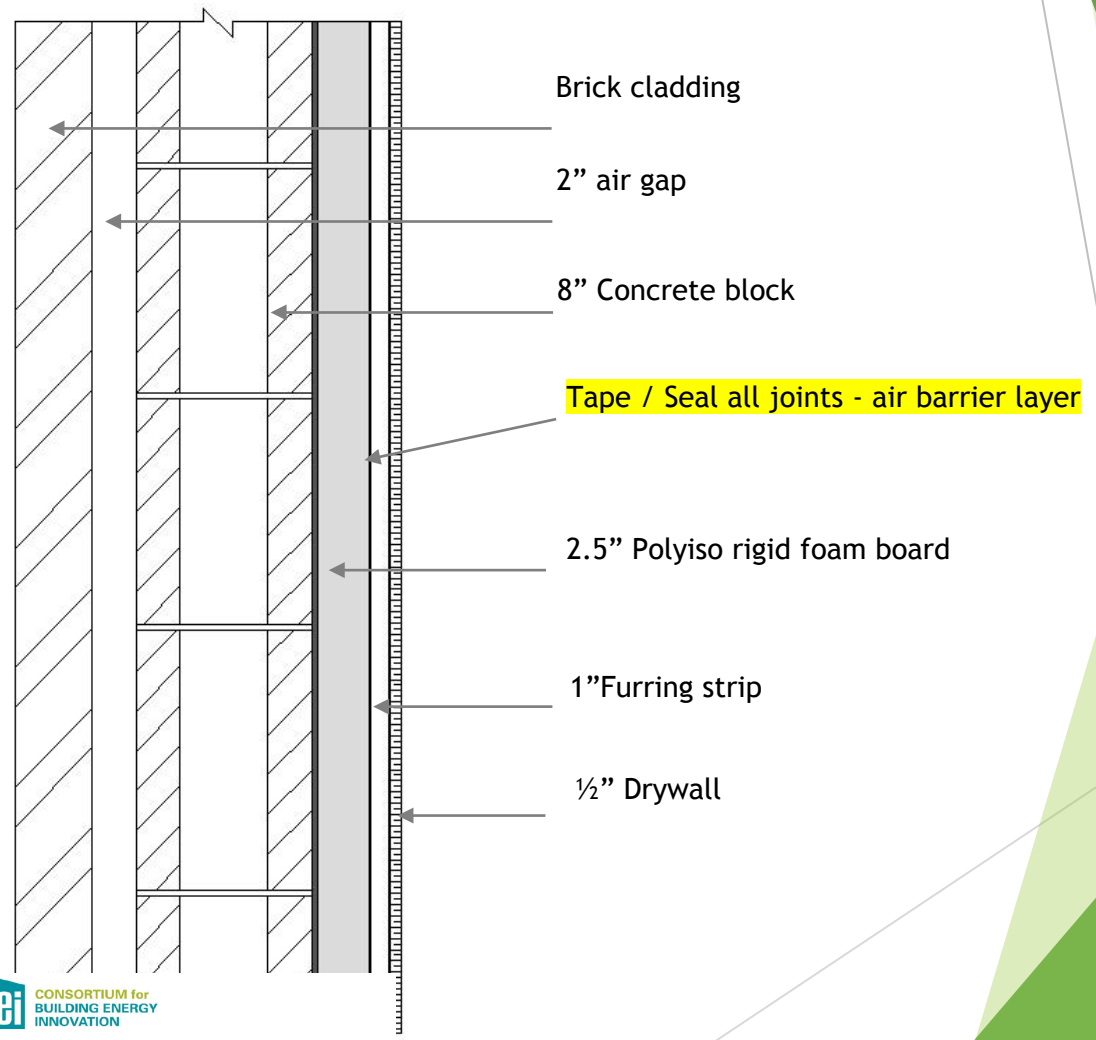
Energy Retrofit Case Studies

Insulation and Air Barrier Strategies

Rigid foam board application:

- 2.5” Rigid foam board continuous insulation with taped seams/board joints *(To serve as an effective air barrier layer)*.
- 1” furring strips
- ½” Drywall

The existing fiberglass batts and steel studs will have to taken down and rigid foam board applied as a continuous insulation layer.



Wall Designs Courtesy of:

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Energy Retrofit Case Studies

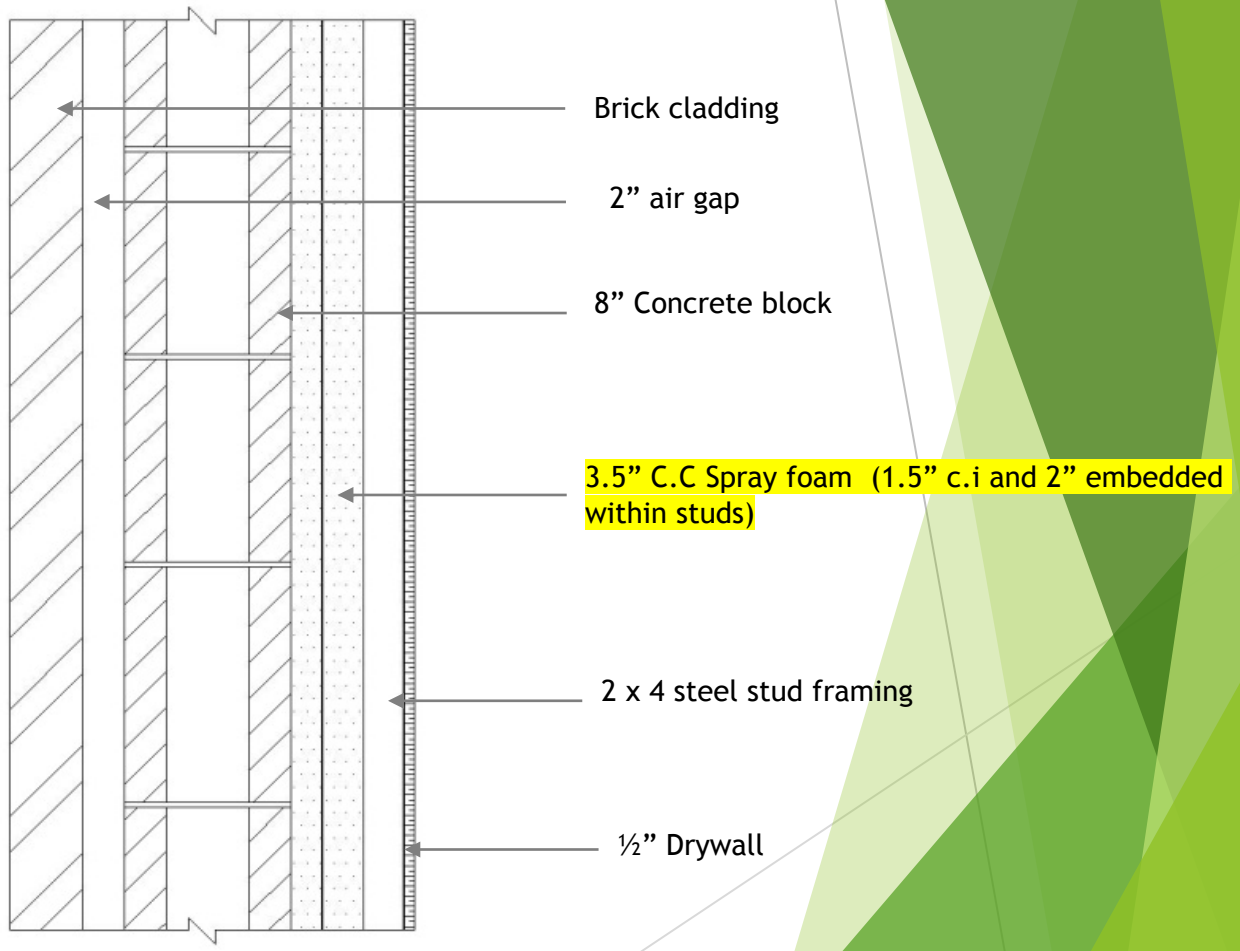
Insulation and Air Barrier Strategies

Closed-cell Spray foam insulation:

- 3.5” Spray foam applied onto the existing wall
- 2 x 4” steel stud framing at 16” o.c
- ½” Drywall

**** 1.5” Spray foam as continuous insulation while the remaining 2” embedded within the steel stud framing***

The existing fiberglass batts and steel studs will have to taken down to spray continuous layer of foam on the inside of the CMU.



Wall Designs Courtesy of:

CBEI CONSORTIUM for BUILDING ENERGY INNOVATION

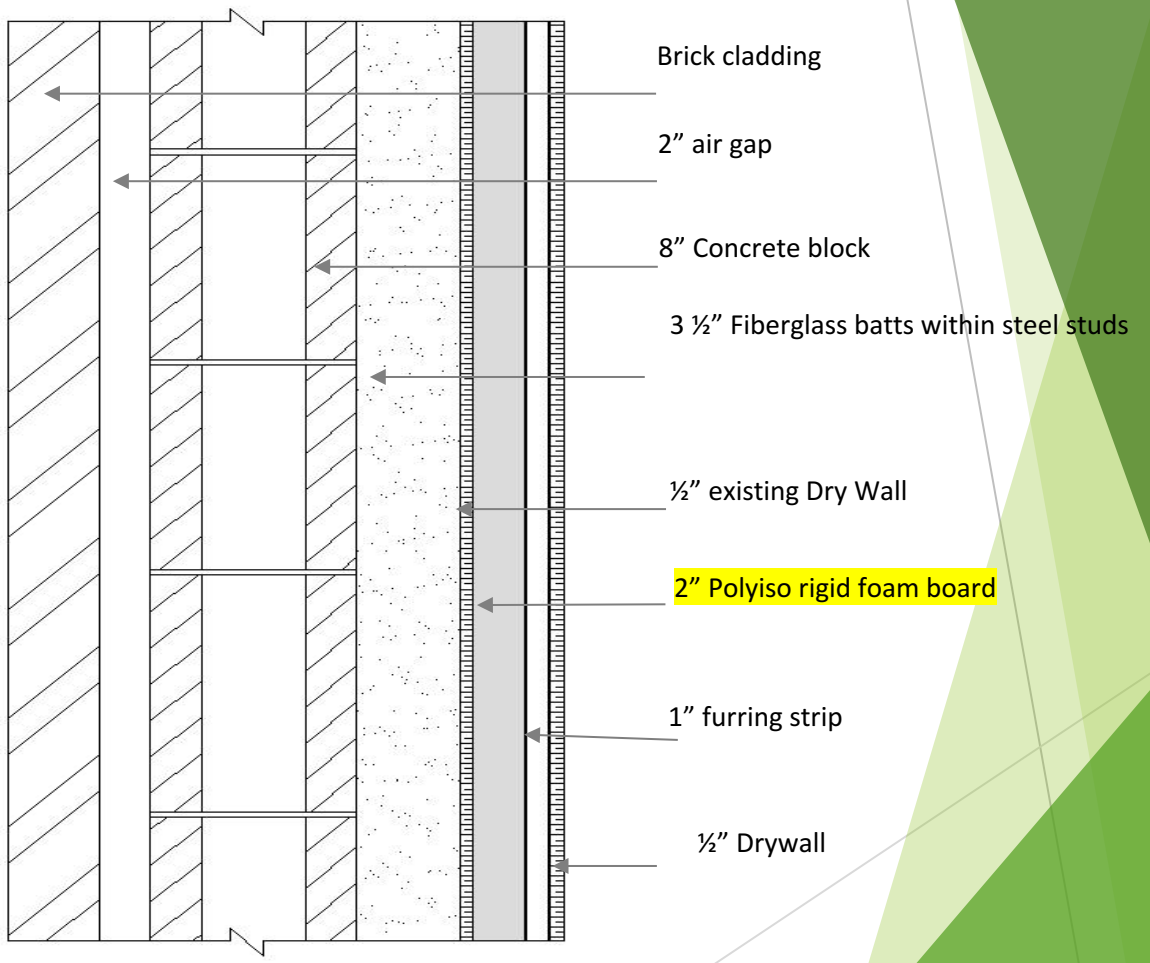
*Tested At Oak Ridge National Labs Test Platform

Energy Retrofit Case Studies

Insulation and Air Barrier Strategies

Rigid foam board application for retrofit over existing insulation:

- **EXISTING** - 3 ½" light gauge studs with R-11 fiberglass batts
- **EXISTING** - Gypsum Board
- 2" Rigid foam board continuous insulation with taped seams/ board joints
- 1" furring strip
- ½" Drywall



Wall Designs Courtesy of:

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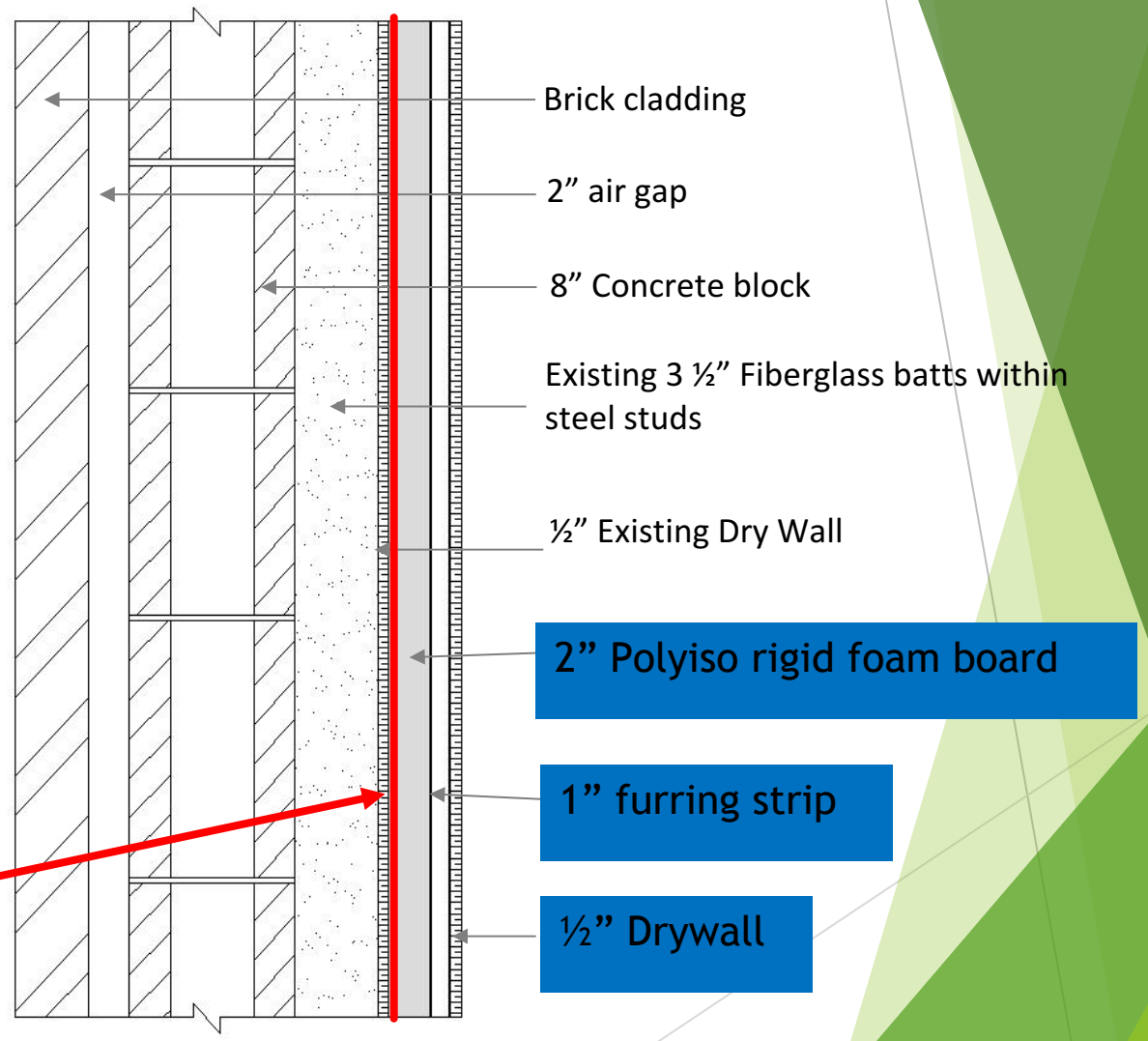
*Tested At Oak Ridge National Labs Test Platform

Energy Retrofit Case Studies

Advantages:

- Most Cost Effective
- Does Not Require Tear Down of the Existing Assembly
- High R-value / Inch vs Conventional Materials
- Moisture Resistant Foam Core



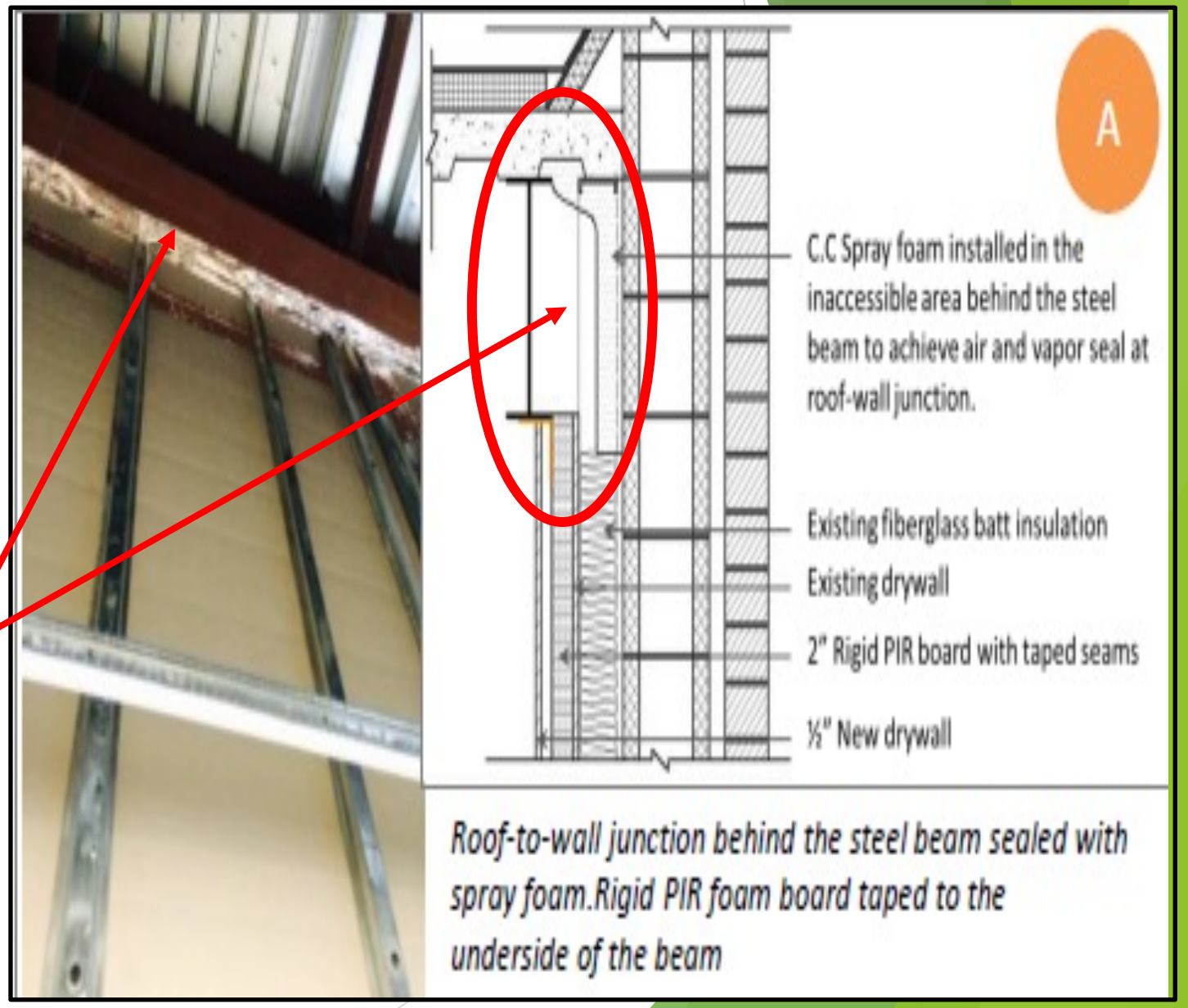
Everything to the Left of the **Red Line** is Existing

PIR Test Wall

Energy Retrofit Case Studies

Challenges / Issues:

- Rigid PIR foam board had to be firmly in contact w/ existing wall
- Assumes Existing Wall in good condition (No Mold or Structural Issue)
- Takes up Interior Square Footage
- Relying on Existing Insulation being in Excellent Condition (Assumption)
- Had to pull existing mechanicals further into room (electrical boxes, HVAC)
- Extended Window sill
- **Complexity and Issues with critical areas (Behind steel beams supporting roof)**
- **Complexity of Ensuring all Board Seams Were Taped and Tight**



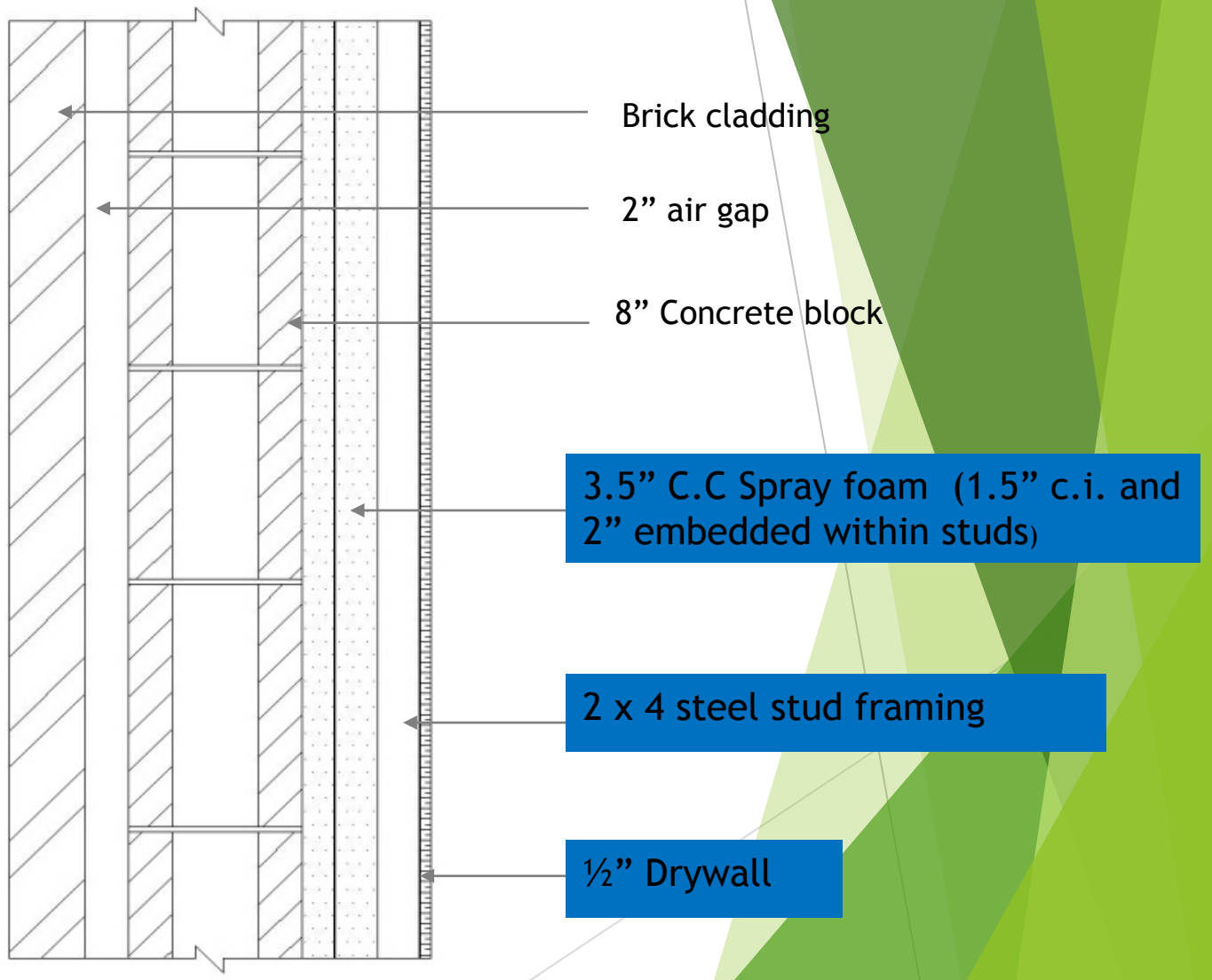
Energy Retrofit Case Studies

Advantages:

- Most Energy Efficient Solution
- Provides a seamless, continuous insulation
- Air, Vapor, and Thermal Layer all in one Product
- Ease of Installation helped reduce installation Cost
  - SPF made it possible to access and seal critical ad difficult areas

Challenges / Issues:

- Installation Requires a well-trained Certified Installer
- New studs required to be 1.5” off of wall
  - Extend window sill
- SPF – BEST Practice requires no one enter area after 24 hours of spraying



SPF Test Wall

Energy Retrofit Case Studies

Testing = 1 Year Of Monitoring

Data Collection from September 2015 and November 2015 Findings:

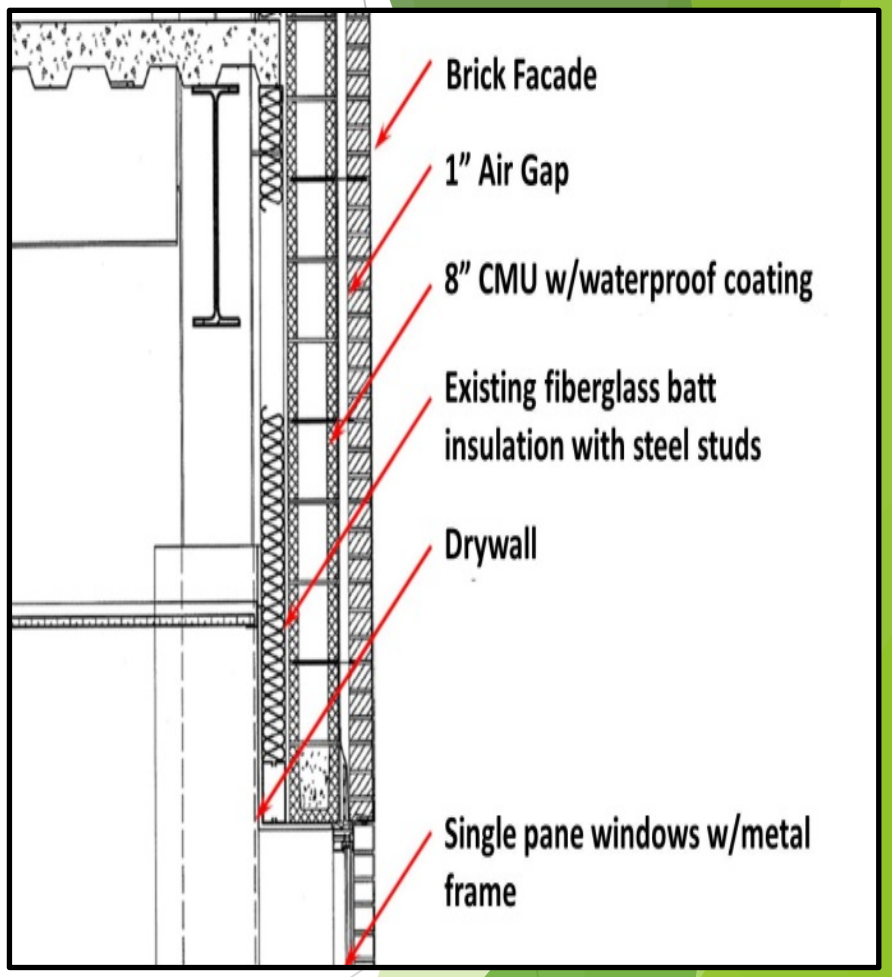
- Spray Foam Wall maintained more constant interior temperature as temperatures dropped into Winter Months
- Spray Foam Wall higher improvement in insulating properties in cold conditions
- Moisture Content for BOTH Walls were within the 40% - 70% range which was below the Critical Moisture Content Level (80%) - ASHRAE 160

ORNL – Test Hut

Energy Retrofit Case Studies

Closer to Home Projects

- Project A – Appleton WI
  - New Wall
    - Brick / Air Cavity / Block / PIR / New Studs / Drywall
- Project B – Milwaukee WI
  - New Wall
    - **Existing Brick & Precast** / New Windows / Rigid Foam & SPF / Existing Studs / New Drywall
- Project C – Hospital Climate Zone 5
  - New Exterior Wall
    - Existing GFRC Panel / Clip and Rail to Structure / Air Barrier / Windows / SPF / Exterior Sheathing / Metal Panels
- Project D – Chicago IL
  - New Wall
    - Brick Barrier Wall (Interlocking courses) / SPF / New Studs / Drywall



Common Existing Wall

Energy Retrofit Case Studies

Project A – Appleton WI

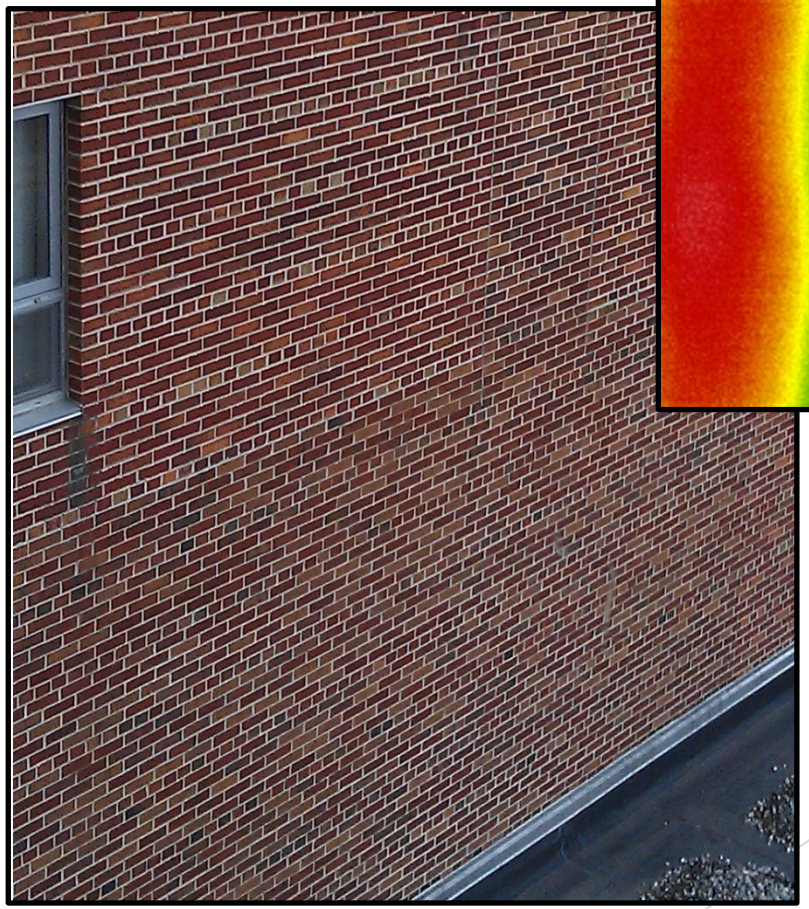
- New Wall
  - **Brick / Air Cavity / Block** / PIR / New Studs / Drywall

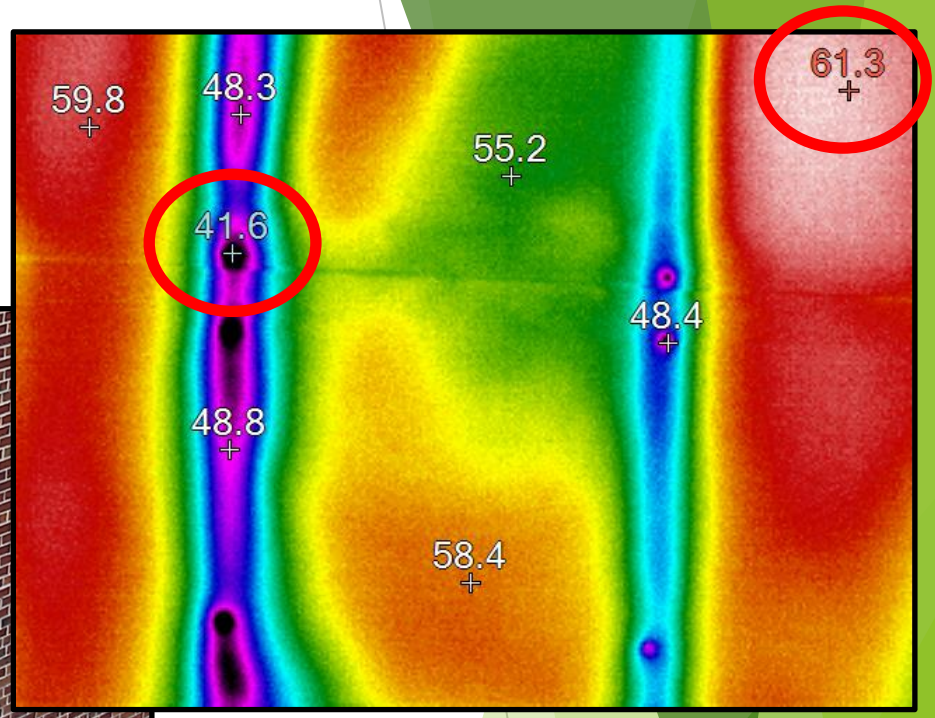
Steps Taken:

- Demo Entire Existing Interior Wall
- Tested Brick for Water Absorption
- WUFI Model Run for Climatic Conditions and Anticipation of Dew Point / Moisture in Wall of a Year
- Complete Gut and Remodel

Findings:

- Reduced the Thermal Bridging at Studs
- Consistent Thermal Performance of Wall





Existing Wall Prior Retro-Fit
Thermal Bridging at Studs and Fasteners

Energy Retrofit Case Studies

Project A – Appleton WI

- New Wall
  - **Brick / Air Cavity / Block** / PIR / New Studs / Drywall

Steps Taken:

- Demo Entire Existing Interior Wall
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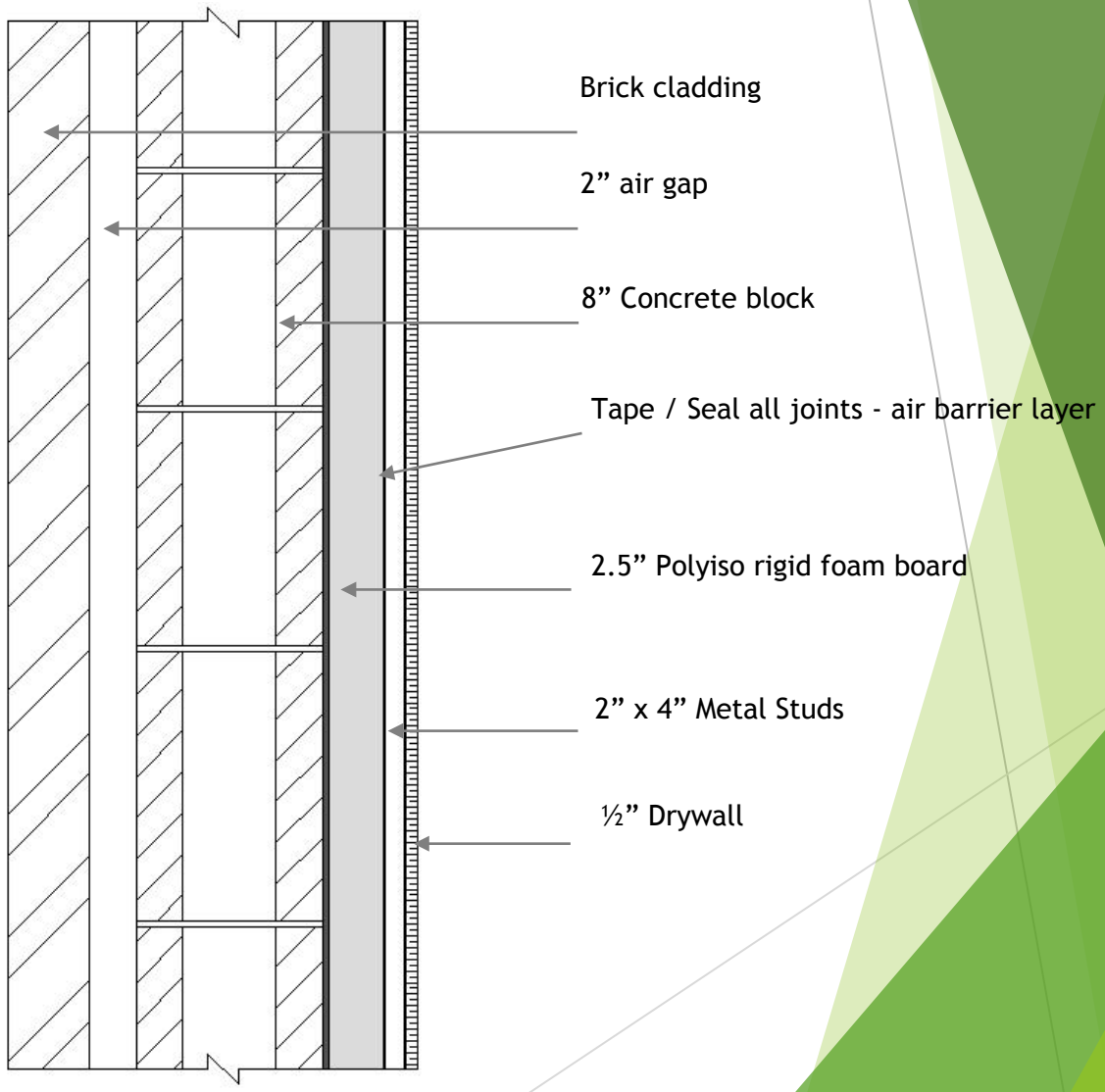
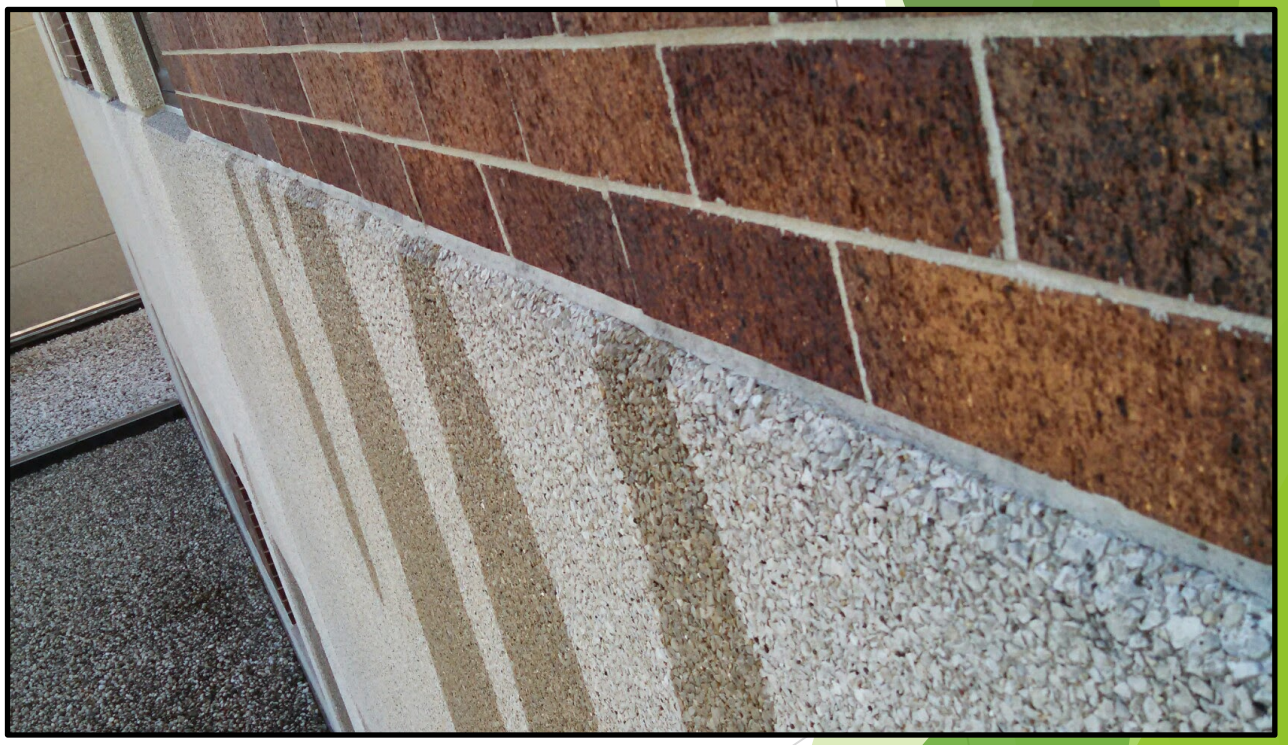


Energy Retrofit Case Studies

- Project B – Milwaukee WI
  - New Wall
    - **Existing Brick & Precast** / New Windows / Rigid Foam & SPF / Existing Studs / New Drywall

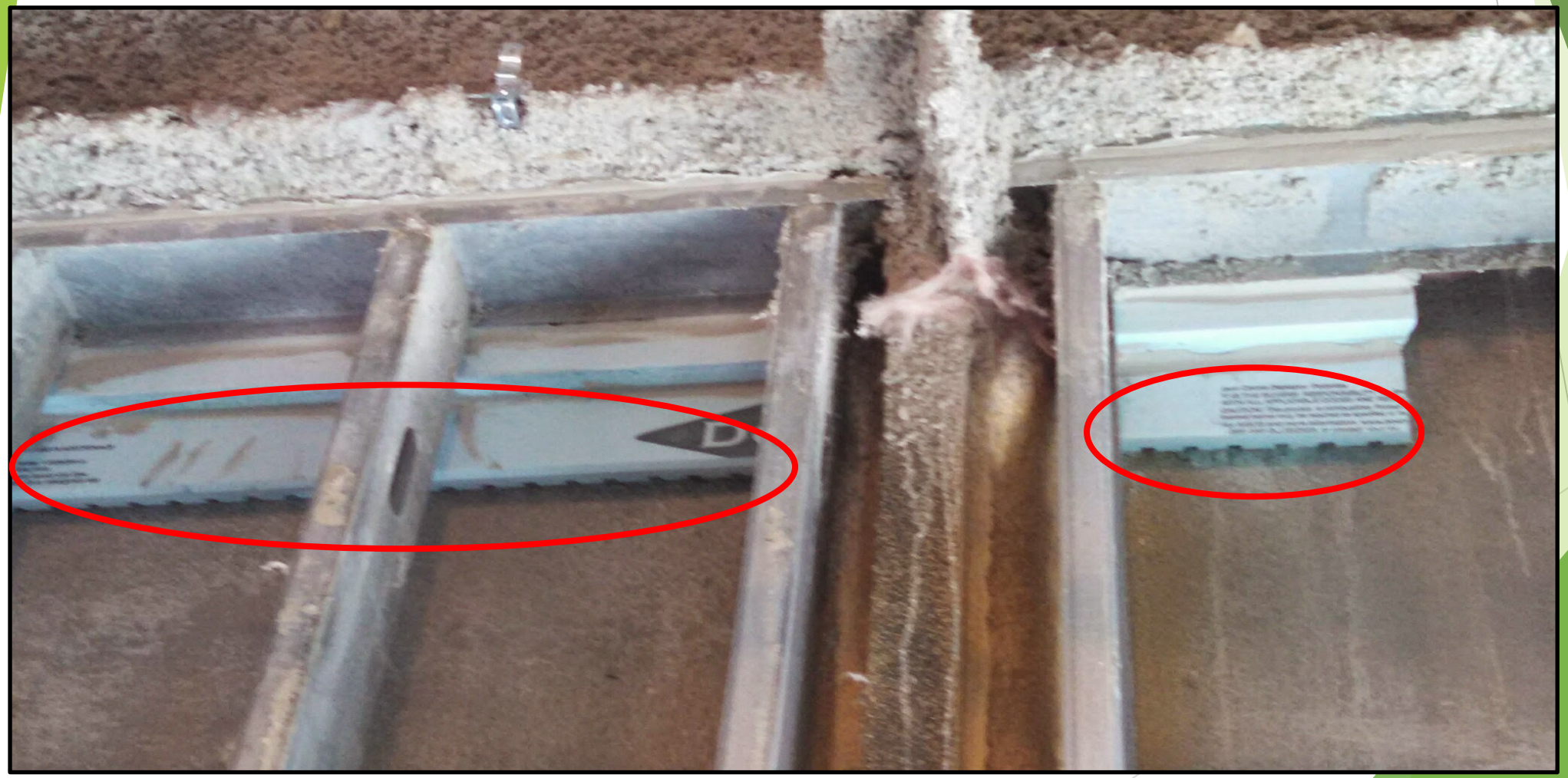
Energy Retrofit Case Studies

- Project B – Milwaukee WI
  - New Wall
    - **Existing Brick & Precast** / New Windows / Rigid Foam & SPF / Existing Studs / New Drywall



Energy Retrofit Case Studies

- Project B – Milwaukee WI
  - New Wall
    - **Existing Brick & Precast** / New Windows / Rigid Foam & SPF / Existing Studs / New Drywall



Energy Retrofit Case Studies

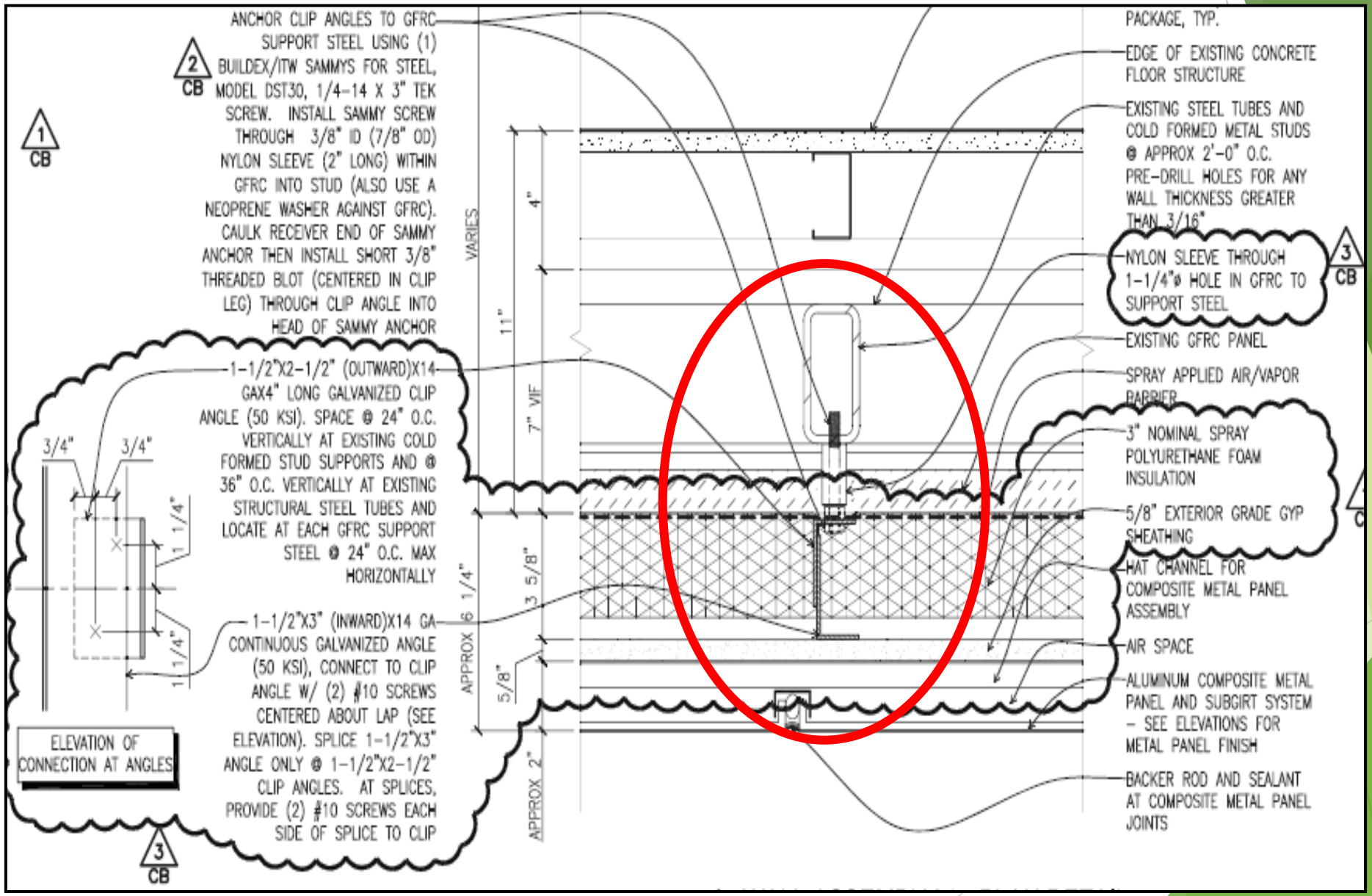
- Project B – Milwaukee WI
  - New Wall
    - **Existing Brick & Precast** / New Windows / Rigid Foam & SPF / Existing Studs / New Drywall

Energy Retrofit Case Studies

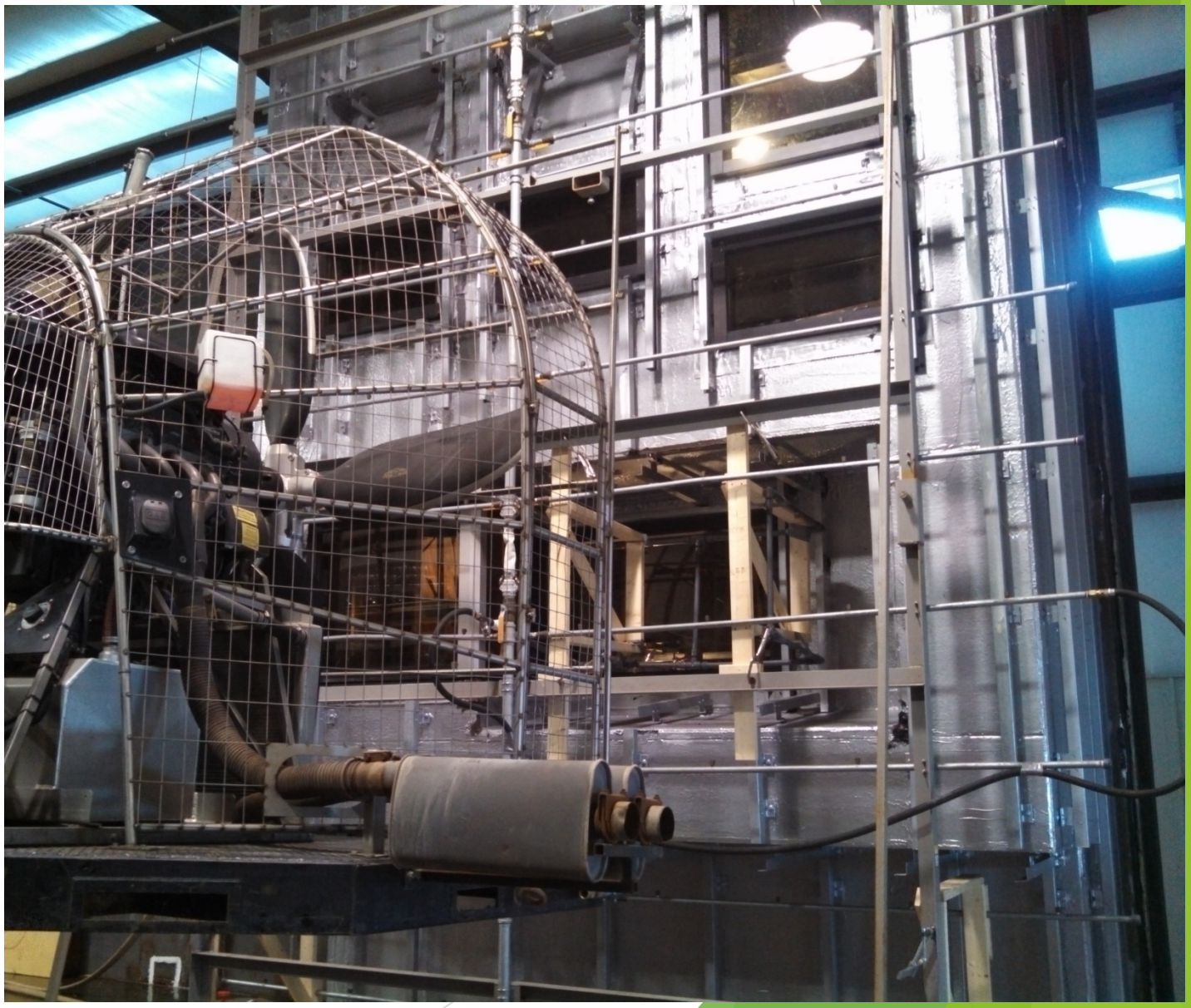
Energy Retrofit Case Studies

- Project C – Hospital Climate Zone 5
  - New Exterior Wall
    - Existing GFRC Panel / Clip and Rail to Structure / Air Barrier / Windows / SPF / Exterior Sheathing / Metal Panels

Energy Retrofit Case Studies



Energy Retrofit Case Studies



Energy Retrofit Case Studies

Energy Retrofit Case Studies

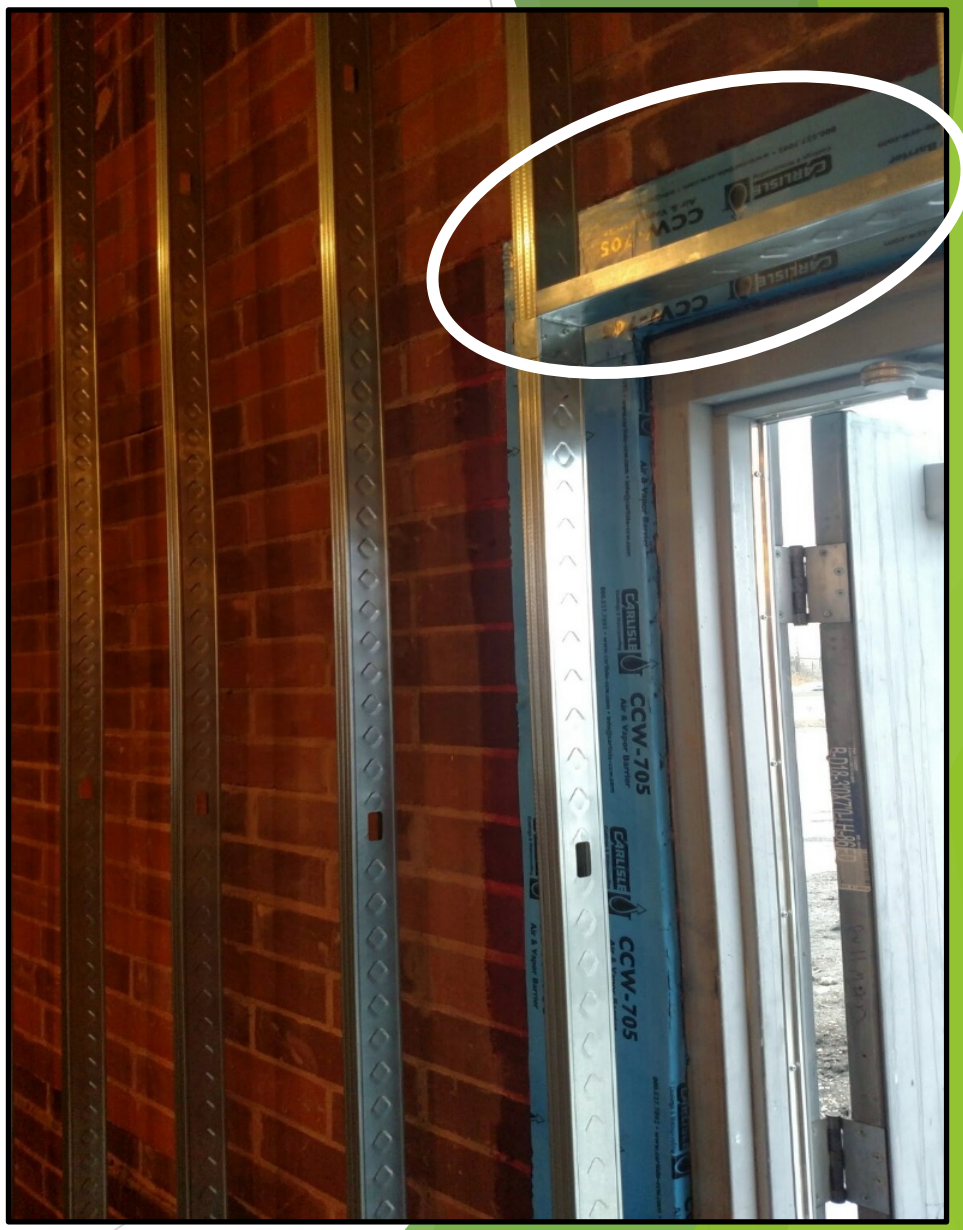
Energy Retrofit Case Studies

- Project C – Hospital Climate Zone 5
  - New Exterior Wall
    - Existing GFRC Panel / Clip and Rail to Structure / Air Barrier / Windows / SPF / Exterior Sheathing / Metal Panels

Energy Retrofit Case Studies

Project D – Chicago IL

- New Wall
  - **Brick Barrier Wall (Interlocking courses)** / SPF / New Studs / Drywall



Energy Retrofit Case Studies

Project D – Chicago IL

- New Wall
  - Brick Barrier Wall (Interlocking courses) / SPF / New Studs / Drywall

Energy Retrofit Case Studies

Project D – Chicago IL

- New Wall
  - Brick Barrier Wall (Interlocking courses) / SPF / New Studs / Drywall

Energy Retrofit Case Studies

Project D – Chicago IL

- New Wall
  - Brick Barrier Wall (Interlocking courses) / SPF / New Studs / Drywall

Whenever Using SPF – Only Specify an Absolute Minimum Thickness

Energy Retrofit Case Studies

Learning Objectives

- Importance of Retrofitting today's current Commercial Building Stock (Energy Efficiency)
- Review Potential Insulating Strategies for Energy Upgrades of Masonry Structures (Types of Walls)
- Review Current Research and Discuss Cautions on Insulating Existing Masonry Structures
- Review Case Studies Demonstrating Successful Energy Upgrade / Retrofits of Masonry Structures

Energy Retrofit Case Studies

Thank You For Your Time

Questions?????

- Presenter: Brian Stroik
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- Tremco Sealants & Waterproofing
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- Bstroik@tremcoinc.com
- Vice Chair – Air Barrier Association of America
- Past Chair National Building Enclosure Council
- Co-Chair BEC WI