New Building Envelope Requirements

Peter Golter - 3M
J. Lee Durston - Morrison Hershfield

Agenda

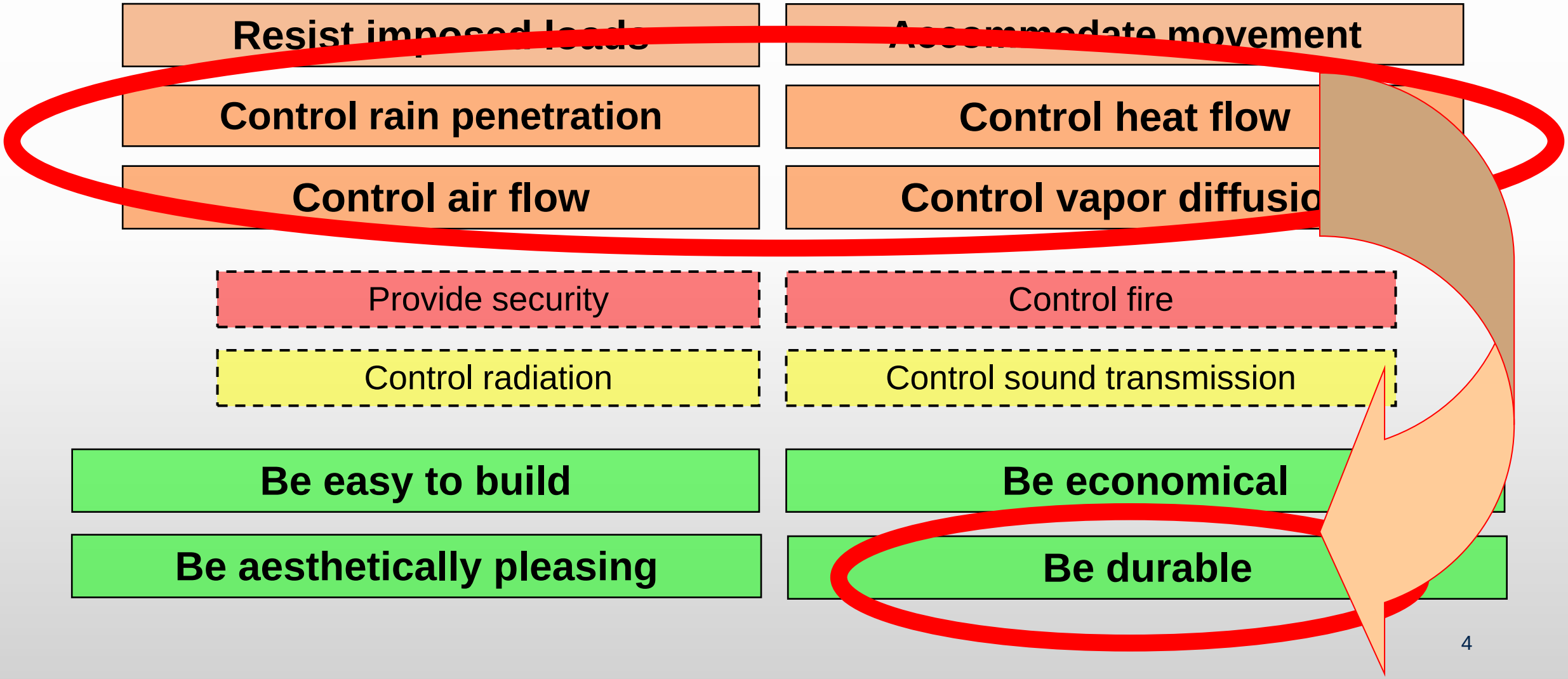
1. Types of Construction
2. Code Requirements: New vs. Rehabilitation
3. Design Considerations
4. Surface Preparation Requirements
5. Types of Materials
6. Testing/Validation
7. Overview of the Different Wall Assemblies

Two Major Types of Construction

New Construction

Renovation Construction – 2014 ICRI Project of the Year

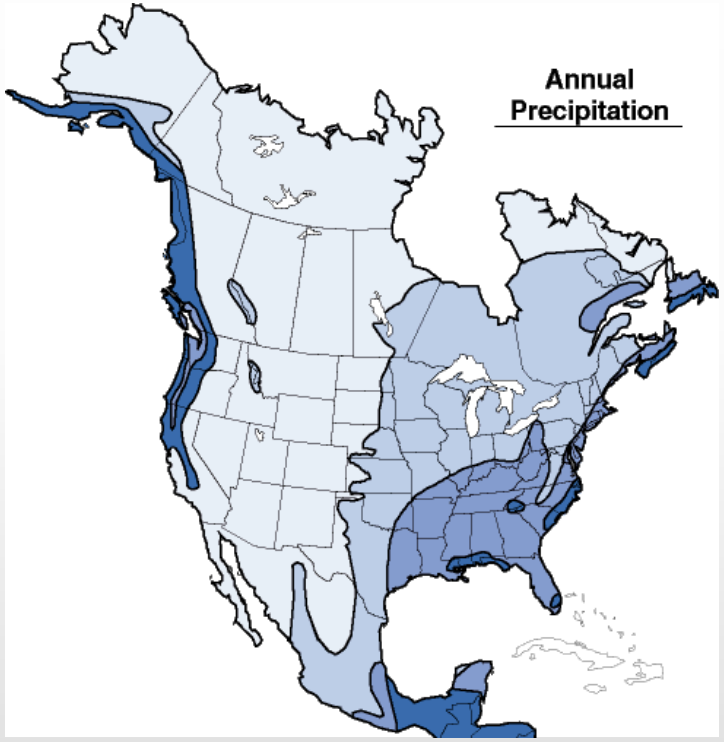
5 Key Elements of Any Building Envelope



Climate Zones

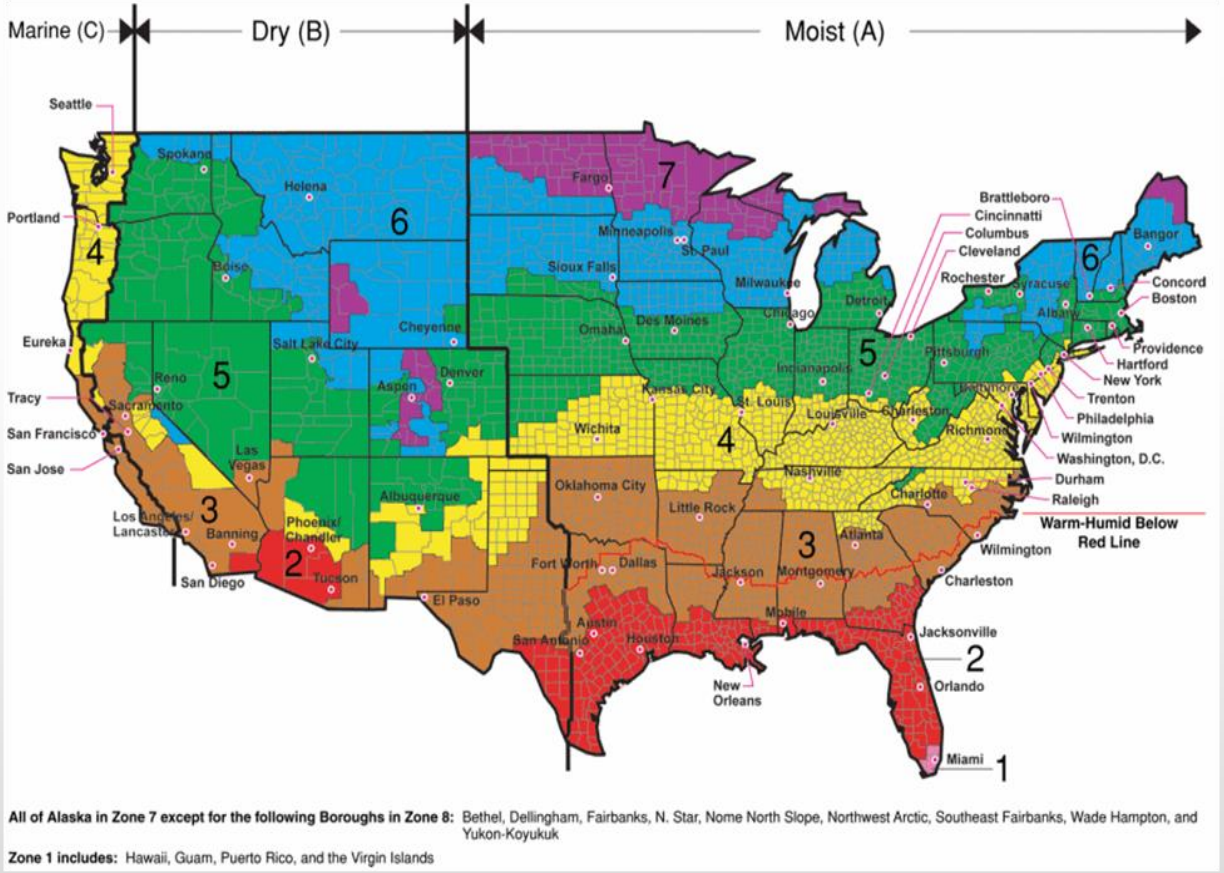
- .

Temperature & Humidity



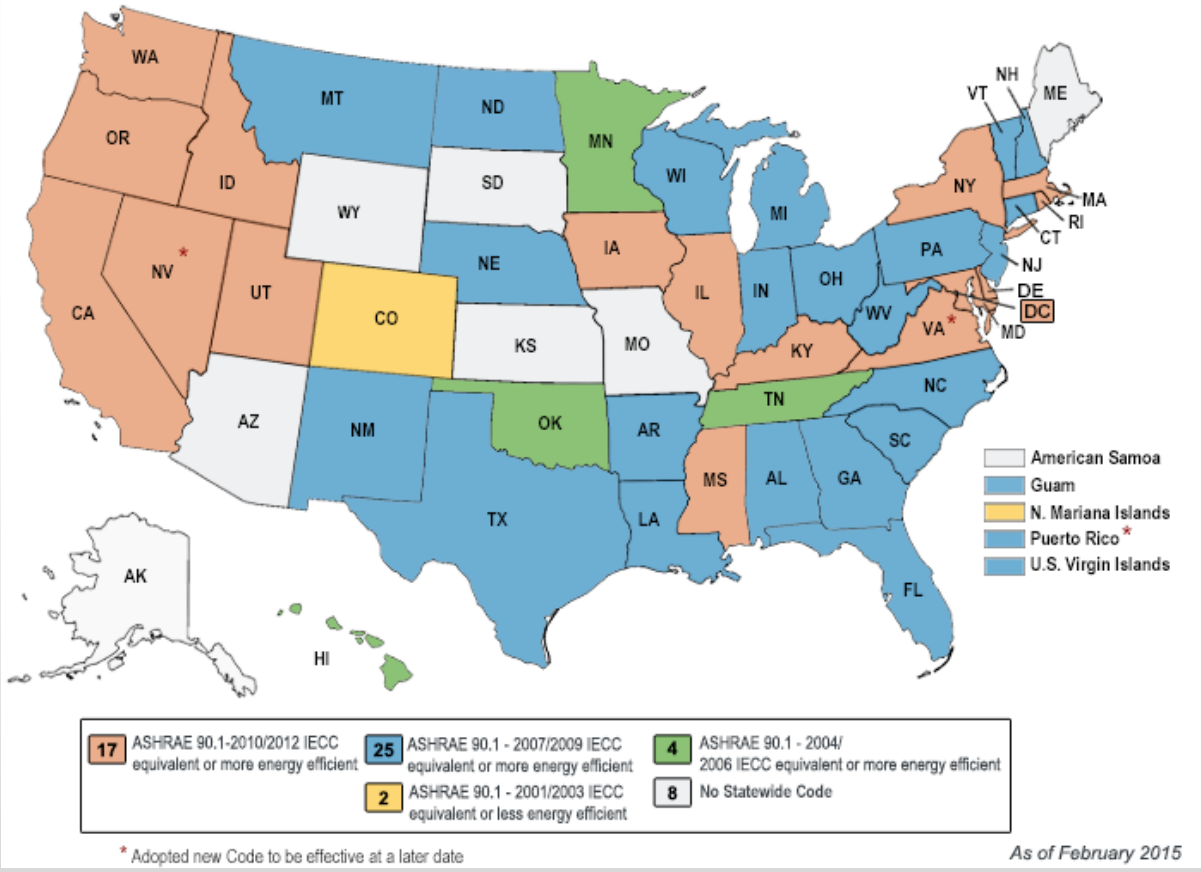
Precipitation

Mapping it Out



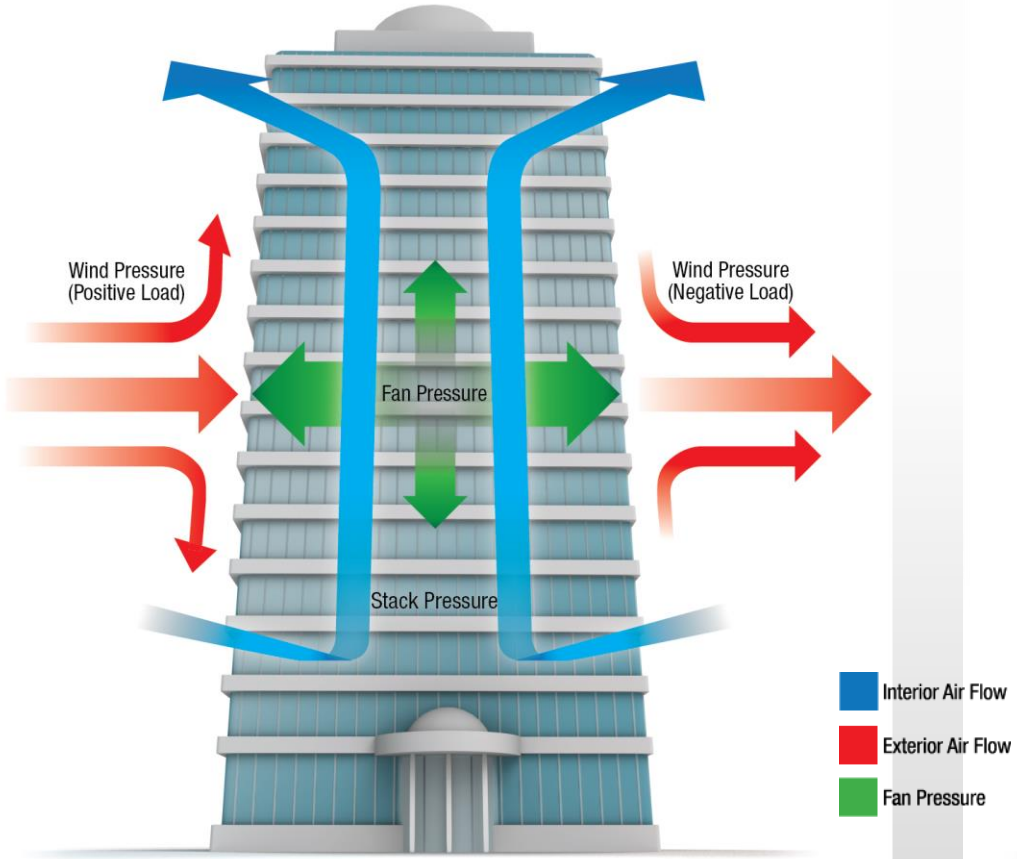
All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dellingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

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



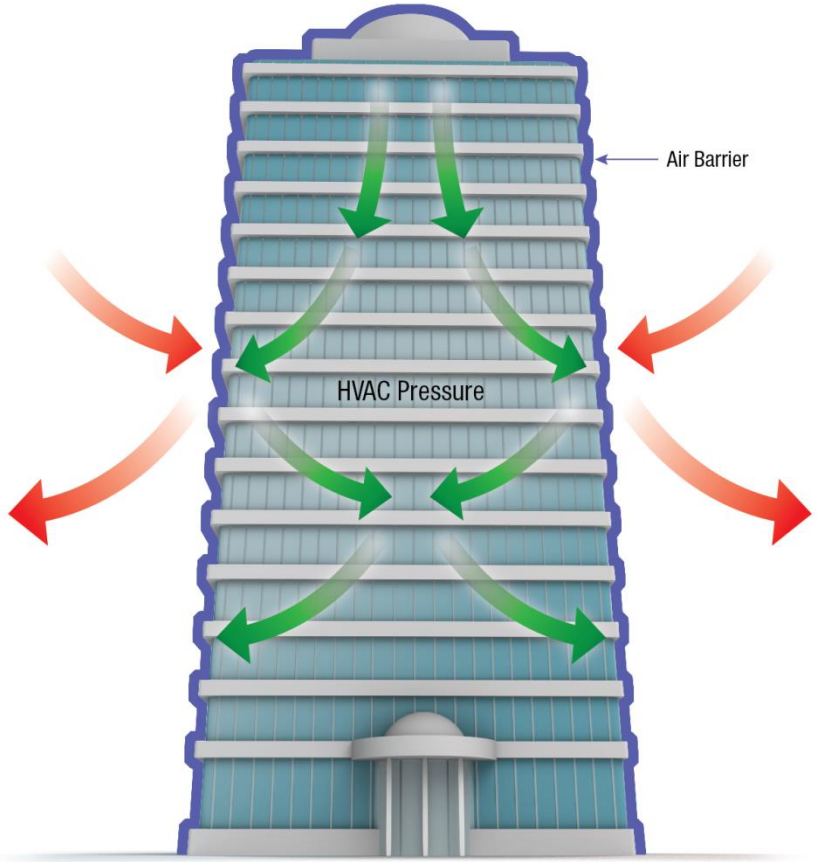
Why Use Air Barrier Systems?

Common Environmental Challenges of Buildings



Typical building without an air barrier system.

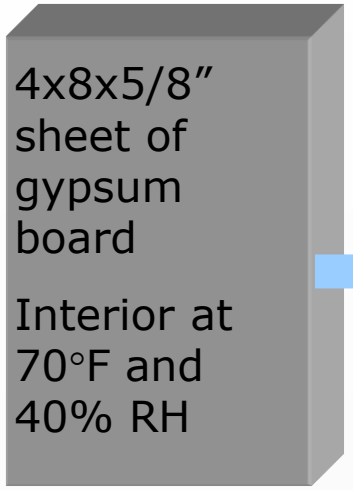
A Continuous Air Barrier Helps Maximize Building Efficiency



Building with a continuous air barrier system.

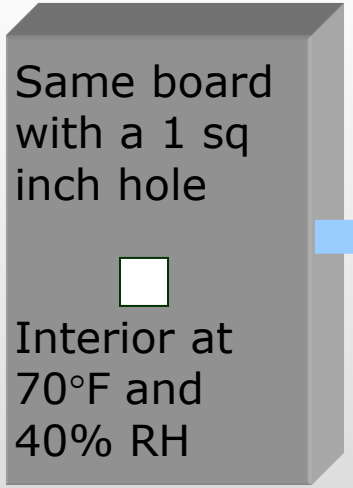
Why? Airtightness.

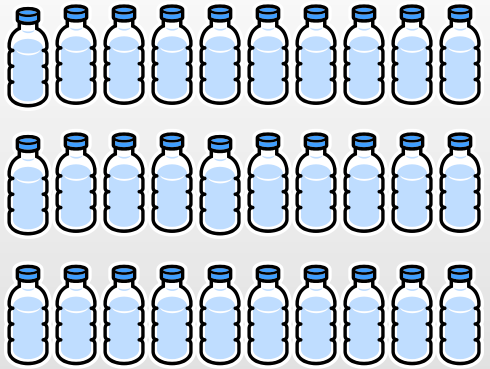
Diffusion



1/3 quart of water

Air Leakage





30 quarts of water

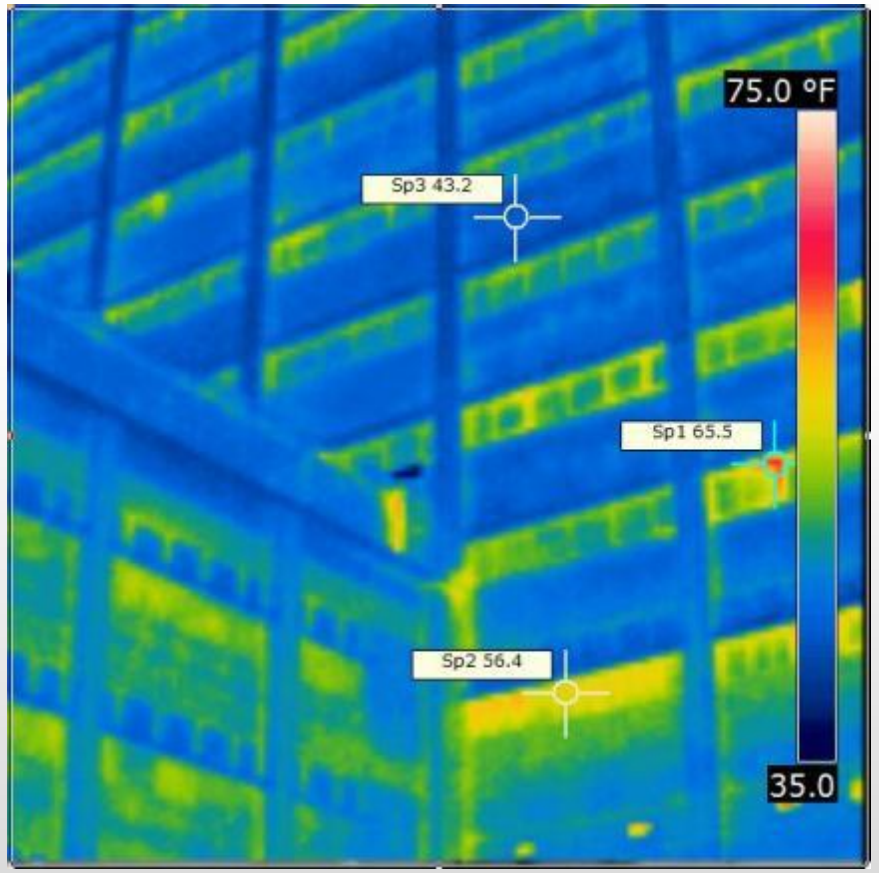
*In a cold weather climate over one heating season.
Builder's Guide to Cold Climates, Lstiburek, Joseph. 2004.

Design Considerations when Selecting an Air Barrier

- Geographic Location/Climate
- Wall Types
  - Masonry (CMU)
  - Ext. Gypsum Sheathing
  - OSB or Plywood
  - Curtain-wall
- Type of Insulation
  - Extruded Polystyrene
  - Expanded Polystyrene
  - Batt Insulation
- Type of Air Barrier
  - Non-permeable
  - Permeable

Changing Focus on Envelope

- Last Decade's Focus: Durability
  - WRB & Rainscreen
  - Design Reviews
  - Field Review & Testing
- Next Decade's Focus: Energy
  - Air & Thermal Barriers
  - Whole Building Energy Modeling
  - Whole Building Commissioning

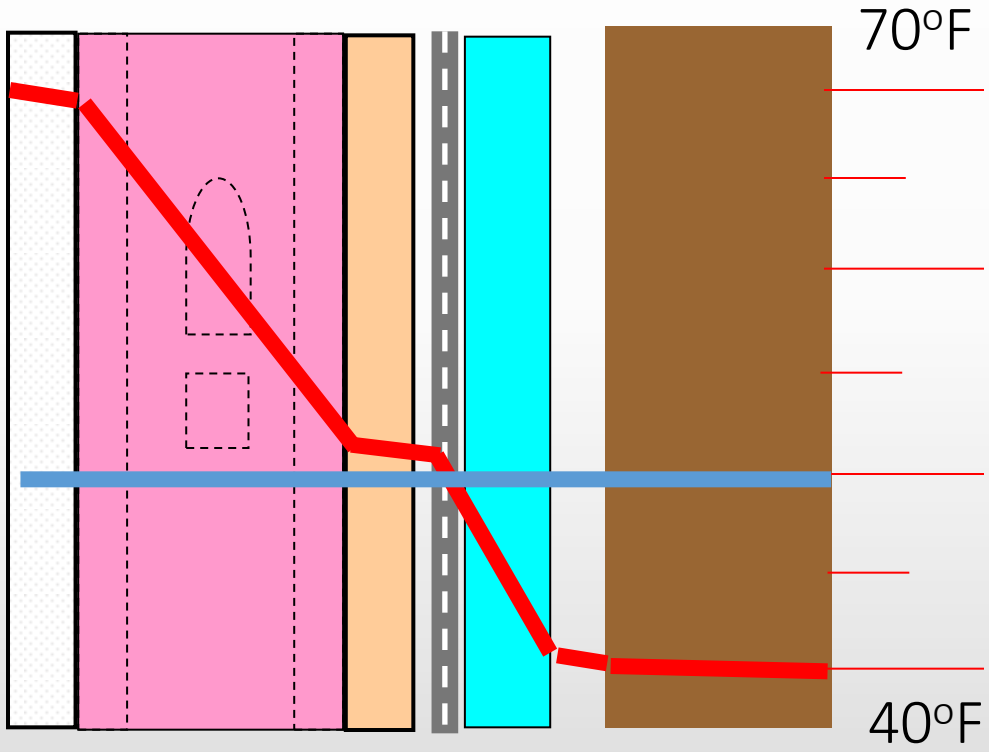


What has changed under IECC 2012

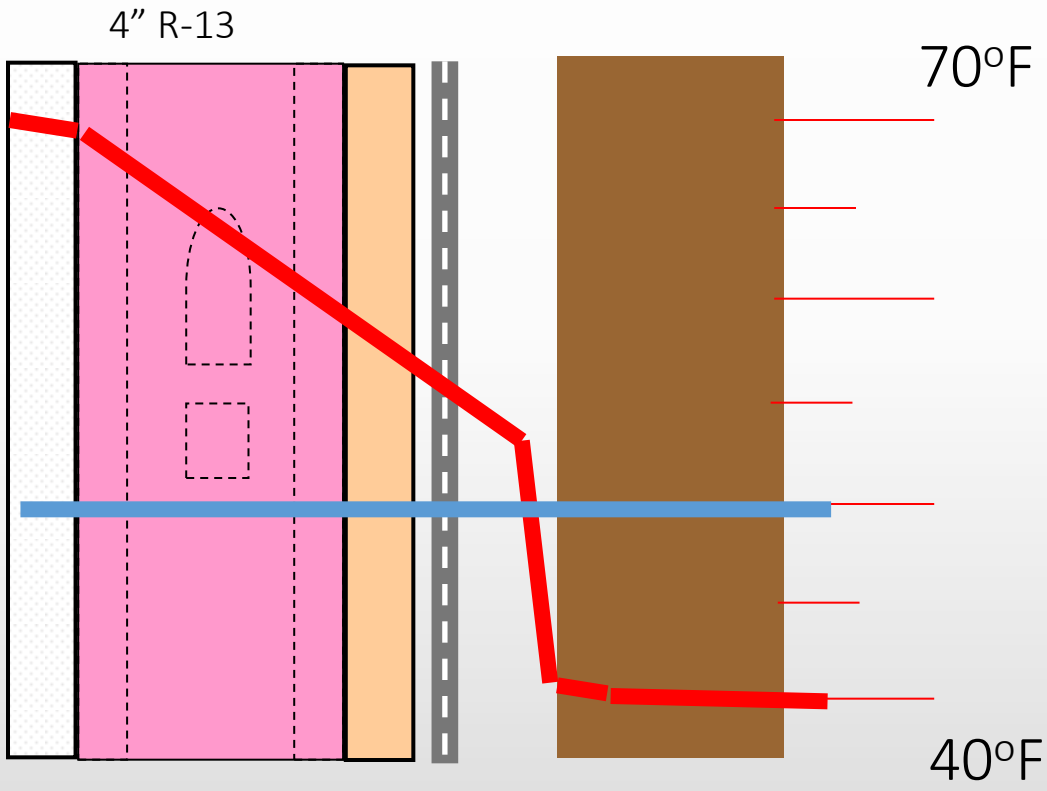
- Notable to the Envelope:
- Continuous air barrier requirements apply to all buildings (not just those over 5 stories)
  - Some states/jurisdictions now require whole building air leakage testing
- Upgraded Continuous Insulation requirement for opaque assemblies
  - Depends on climate zone R-19 + R-8.5 c.i. for steel studs
- Maximum fenestration area reduced to 30% of gross above-grade wall area
  - Unless 50% of floor area is within daylight zone, then allowed up to 40%

Sample Calculations

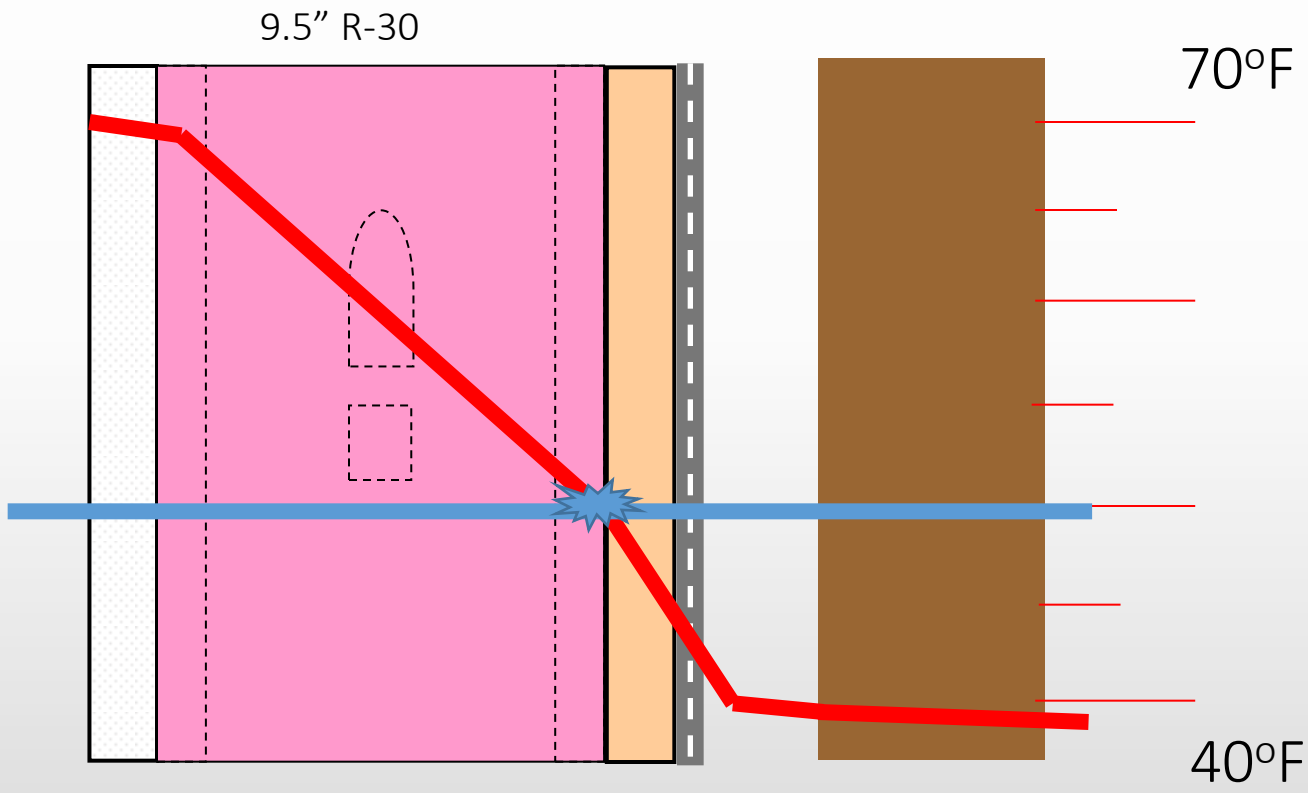
Material	R-Value	delta T	Temp
			40.0
brick	0.5	0.5	
			40.5
air space	1.2	1.1	
			41.6
rigid insulation	10	9.4	
			51.0
plywood sheathing	0.6	0.6	
			51.6
batt insulation	19.0	17.9	
			69.5
gypsum wallboard	0.5	0.5	
			70.0



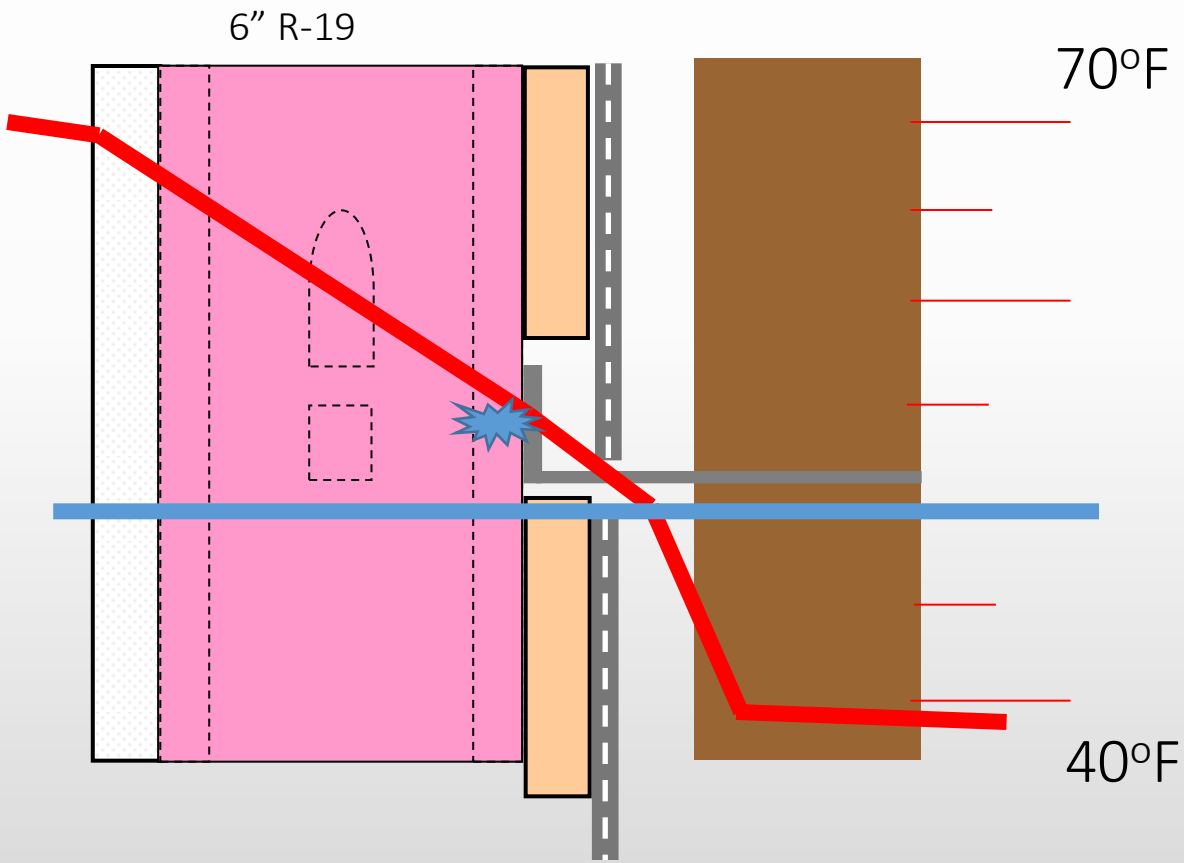
Typical Framing of The Past Ten Years



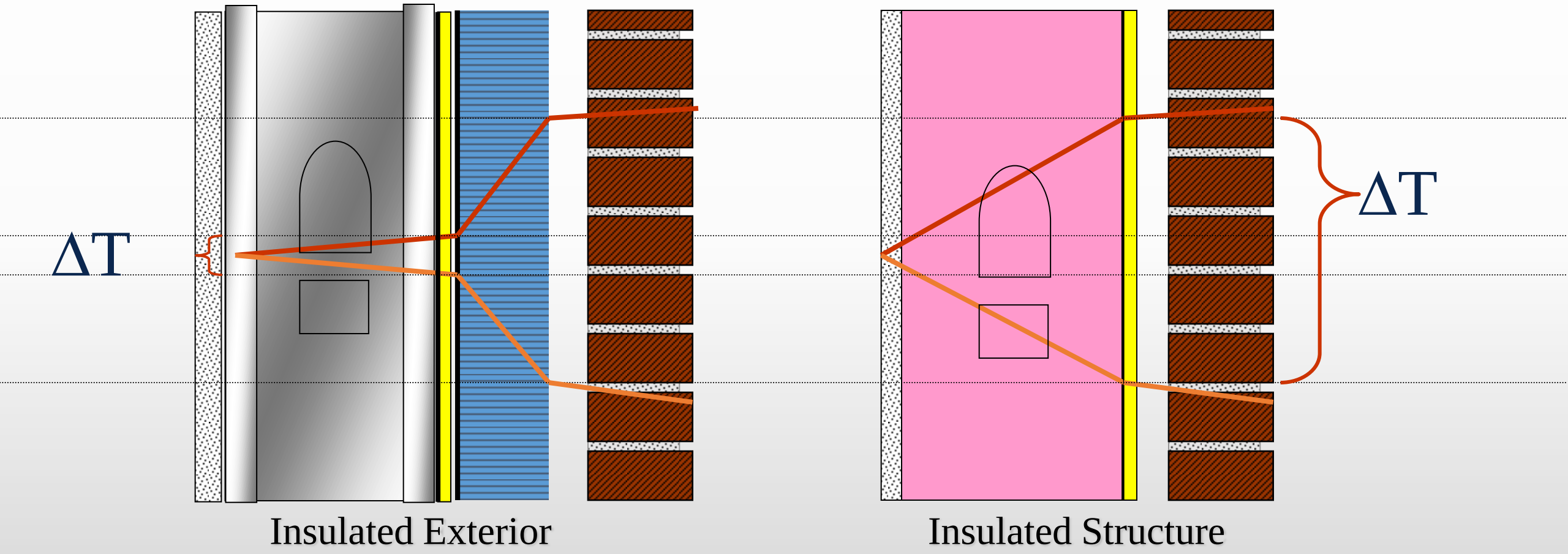
Larger Framing



Bad Idea



Thermal Gradient



Air Barriers – The Next Big Hurdle

Why Air Barriers and Why Now?

- Energy Conservation Measure
  - First Costs/Construction
  - Operational Costs

- Building Envelope Durability
  - H- Heat Barrier
  - A- Air Barrier
  - M_L- Moisture Liquid
  - M_V- Moisture Vapor

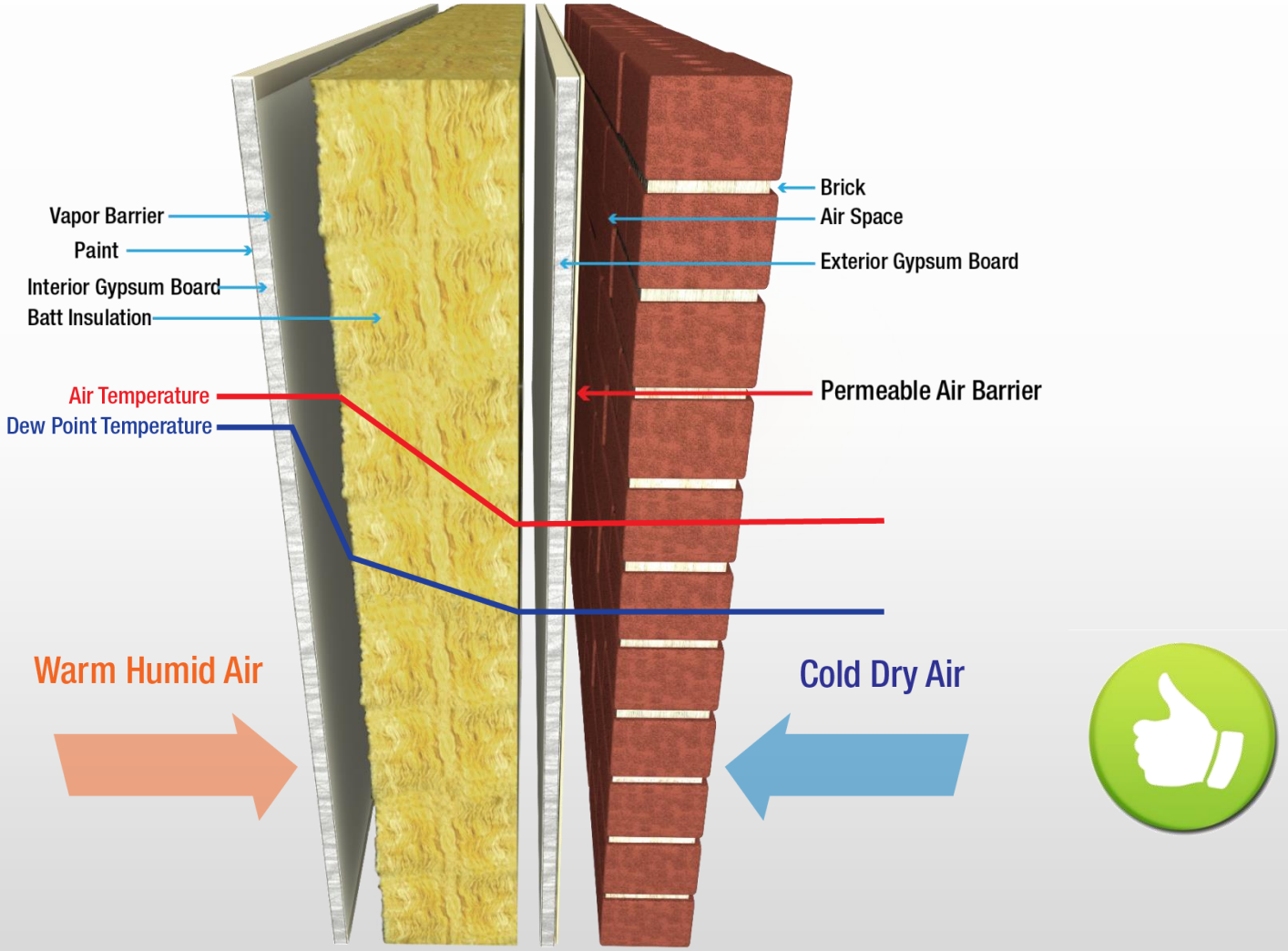
Energy

Durability

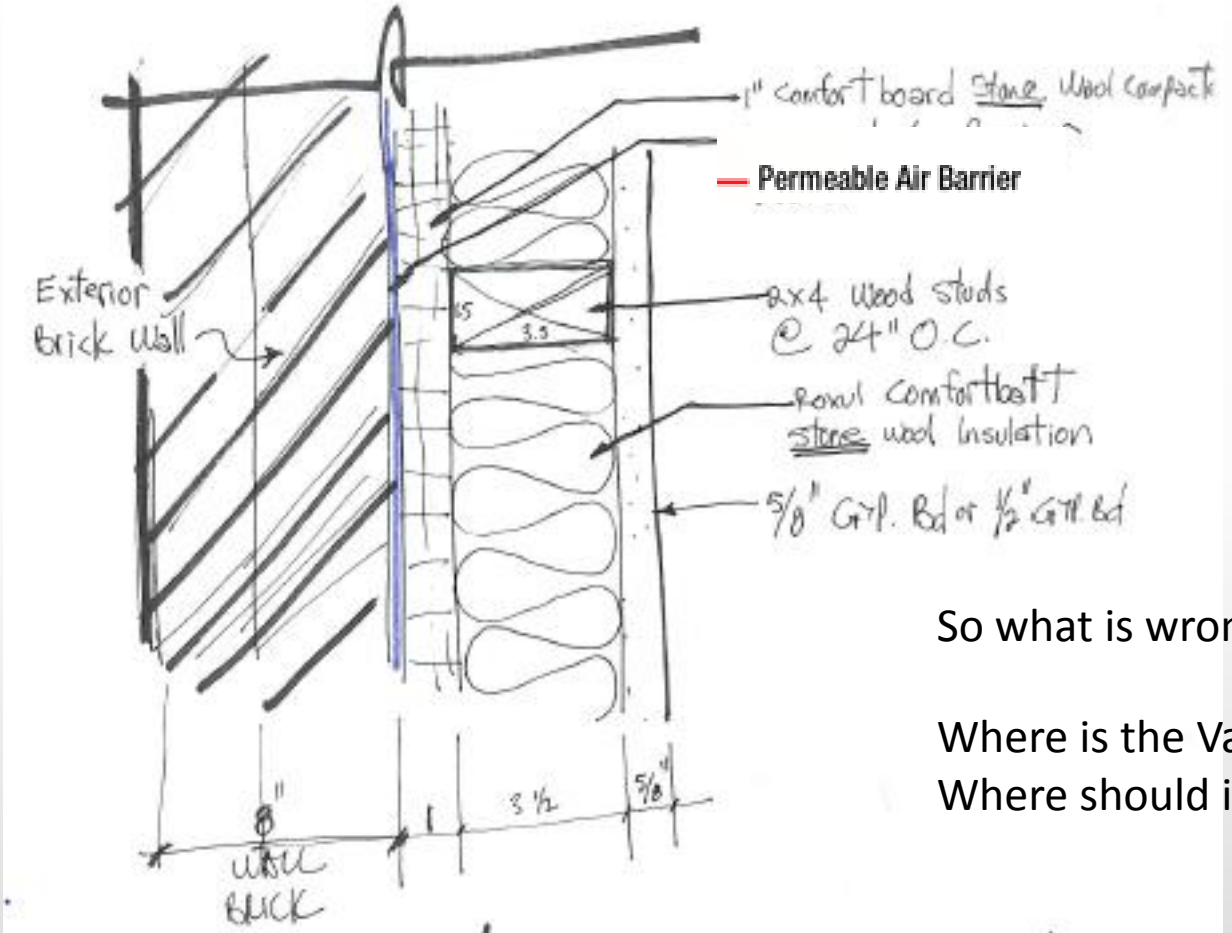
Retrofit for New Construction

Testing to determine compatibility with sealants

New Construction - Permeable Air Barrier Wall System
Northern Environments



Repurpose Construction - Permeable Air Barrier Wall System Northern Environments



So what is wrong with this detail?

Where is the Vapor Barrier?
Where should it be?

Pre-Construction Considerations for Air Barriers

- Substrate Preparation
  - **Exterior Gypsum Sheathing**: fill gaps and wide joints
  - **Concrete Masonry Units with fins:** grind off or knock down fins
  - **Penetrations neither grouted nor filled**: detail appropriately

Image courtesy of Exterior Building Services

Substrate Preparation: CMUs

Acceptable Substrate

- Smooth surfaces
- No gaps
- No fins

Unacceptable Substrate

- Gaps in grout
- Rough grout with fins

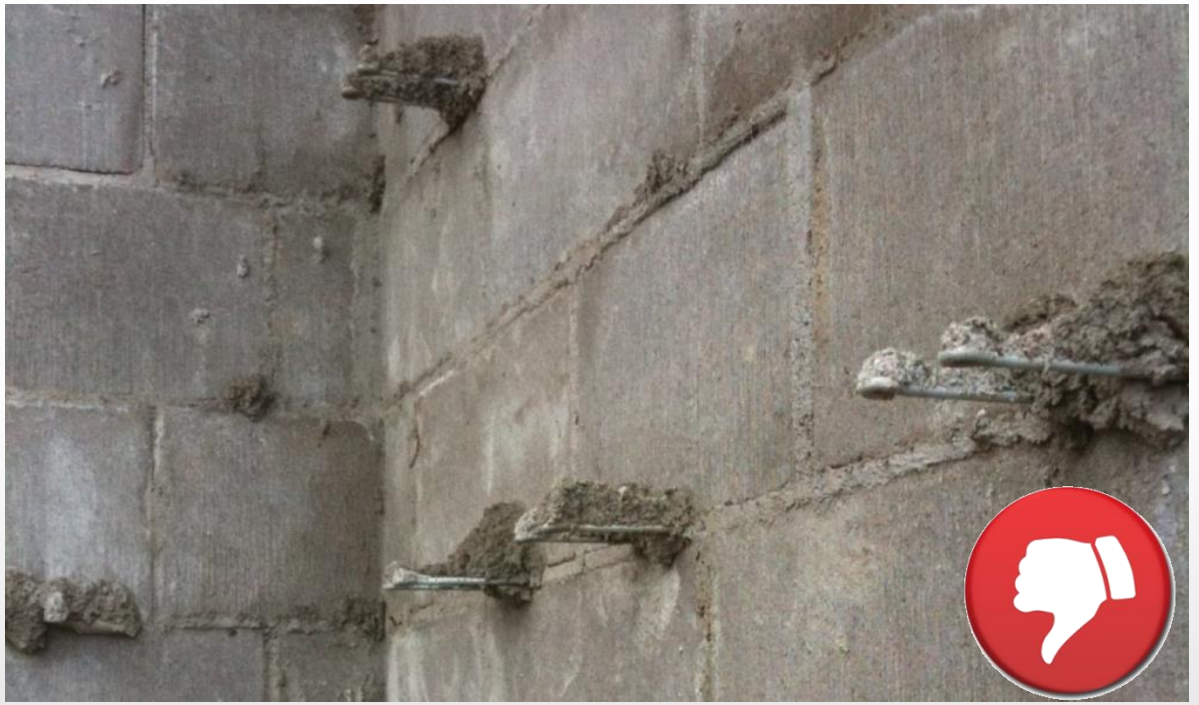
Image courtesy of Exterior Building Services

Substrate Preparation: Brick Ties

Acceptable Substrate

- No grout on ties
- No gaps around ties

Unacceptable Substrate



- Ties covered in grout

Image courtesy of Exterior Building Services

Substrate Preparation: Sheathing

Acceptable Substrate

- No gaps greater than ¼”
- Screws fully sunk
- No screw holes

Unacceptable Substrate

- Large gaps
- Screws protruding from the surface
- Holes from screws

Image courtesy of Exterior Building Services

Substrate Preparation: Roughness & Gaps

Unacceptable Substrates

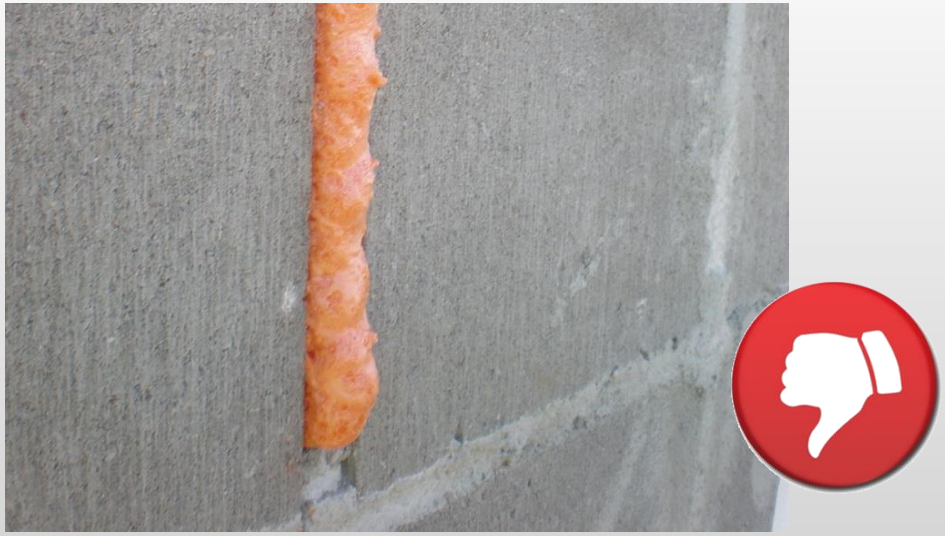


Image courtesy of Exterior Building Services

Required Fixes Before Installing an Air Barrier

Image courtesy of Exterior Building Services

Types of Air Barriers

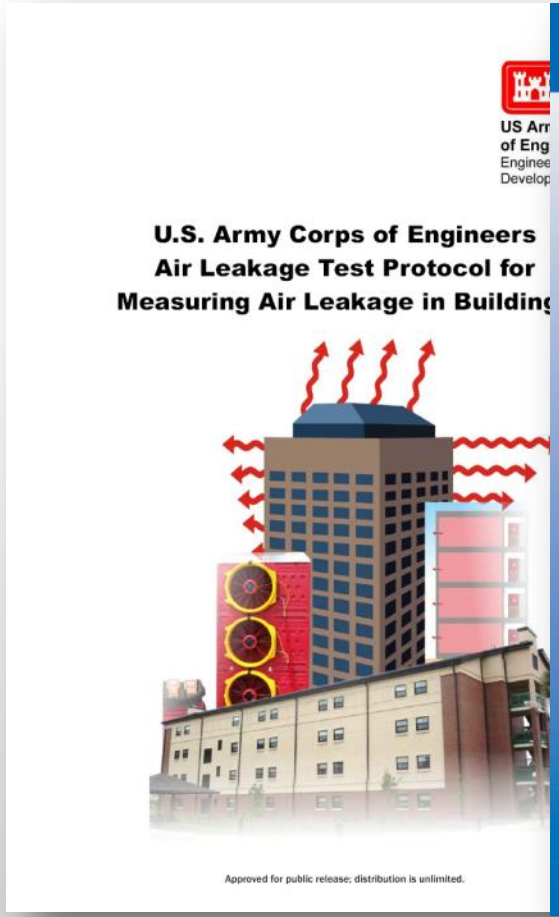
- Liquid-applied membrane systems
- Fully adhered membrane systems
- Tested fastening system for sheet systems
- Sandwich sheet materials between two structural panels
- Board stock systems

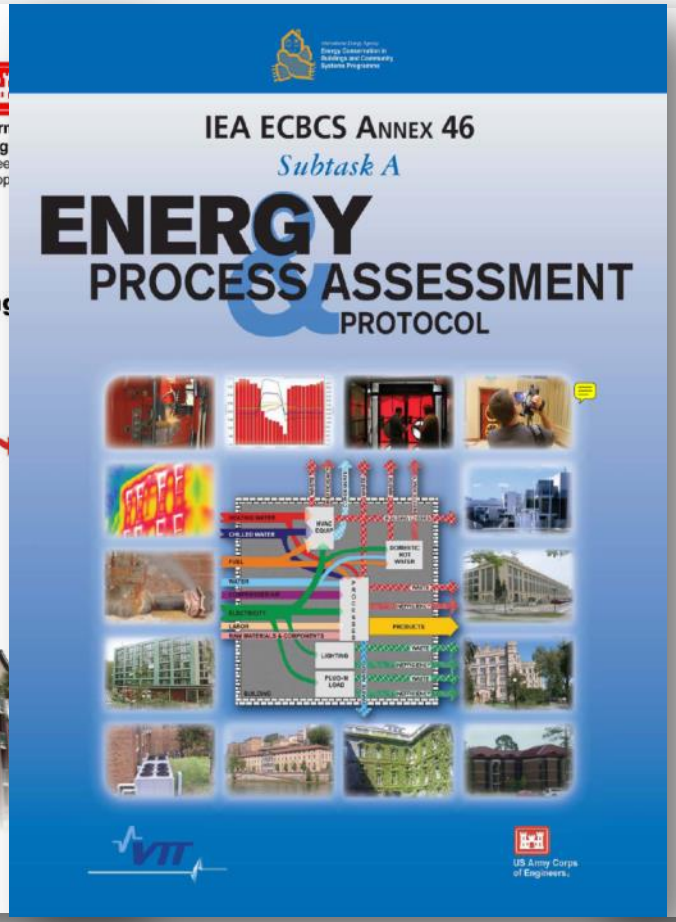
- Air barriers can be placed anywhere in the exterior envelope
- Less penetrations on exterior side
- Can share as an air/water barrier if installed on exterior side
- Must select proper air barrier for shared HAMM functions
- If it is located on the cold side, it should be vapor permeable

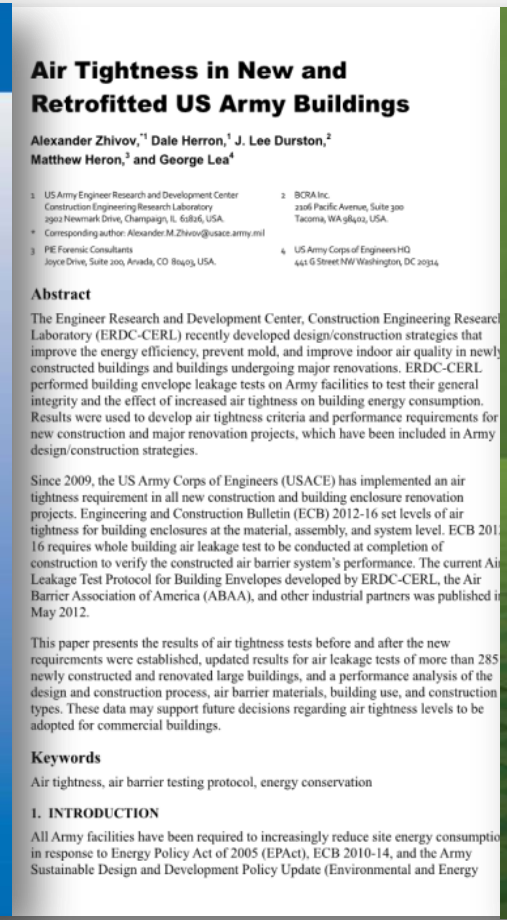
Benefits Of An Air Barrier System

- Reduced building enclosure moisture problems
- Improved indoor air quality
- Reduced building heating and cooling costs
- Improved acoustical isolation
- Isolates the indoor environment
- Sustainable, durable buildings

From Then to Now







Air Tightness in New and Retrofitted US Army Buildings

Alexander Zhivov,[*1] Dale Herron,[1] J. Lee Durston,[2] Matthew Heron,[3] and George Lea[4]

1 US Army Engineer Research and Development Center
Construction Engineering Research Laboratory
2902 Newmark Drive, Champaign, IL 61826, USA.

2 BCRA Inc.
2106 Pacific Avenue, Suite 300
Tacoma, WA 98402, USA.

* Corresponding author: Alexander.M.Zhivov@usace.army.mil

3 PIE Forensic Consultants
Joyce Drive, Suite 200, Arvada, CO 80403, USA.

4 US Army Corps of Engineers HQ
441 G Street NW Washington, DC 20314

Abstract

The Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) recently developed design/construction strategies that improve the energy efficiency, prevent mold, and improve indoor air quality in newly constructed buildings and buildings undergoing major renovations. ERDC-CERL performed building envelope leakage tests on Army facilities to test their general integrity and the effect of increased air tightness on building energy consumption. Results were used to develop air tightness criteria and performance requirements for new construction and major renovation projects, which have been included in Army design/construction strategies.

Since 2009, the US Army Corps of Engineers (USACE) has implemented an air tightness requirement in all new construction and building enclosure renovation projects. Engineering and Construction Bulletin (ECB) 2012-16 set levels of air tightness for building enclosures at the material, assembly, and system level. ECB 2012-16 requires whole building air leakage test to be conducted at completion of construction to verify the constructed air barrier system's performance. The current Air Leakage Test Protocol for Building Envelopes developed by ERDC-CERL, the Air Barrier Association of America (ABAA), and other industrial partners was published in May 2012.

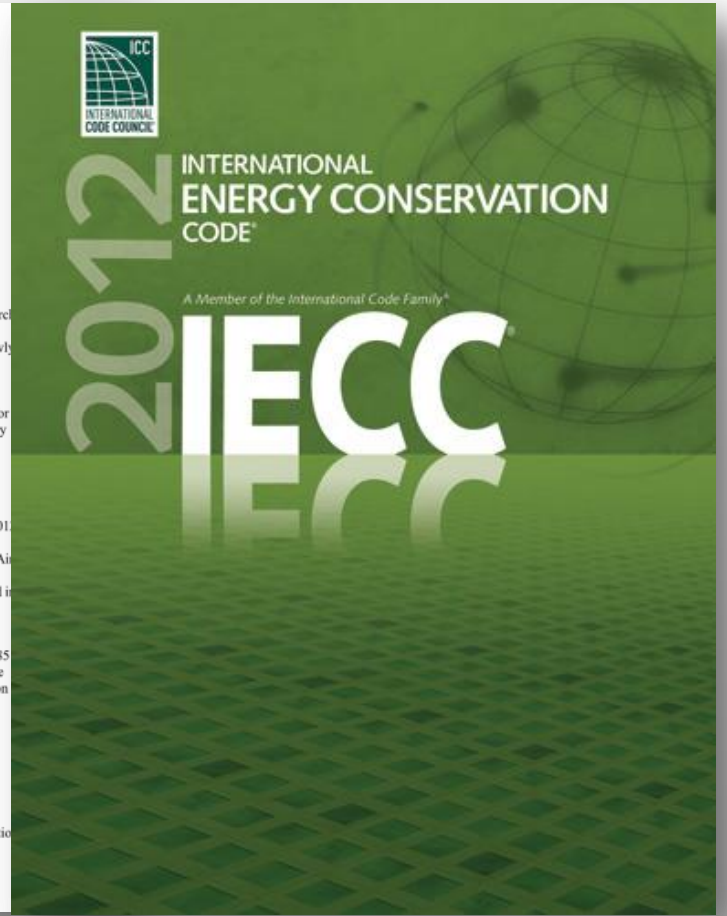
This paper presents the results of air tightness tests before and after the new requirements were established, updated results for air leakage tests of more than 285 newly constructed and renovated large buildings, and a performance analysis of the design and construction process, air barrier materials, building use, and construction types. These data may support future decisions regarding air tightness levels to be adopted for commercial buildings.

Keywords

Air tightness, air barrier testing protocol, energy conservation

1. INTRODUCTION

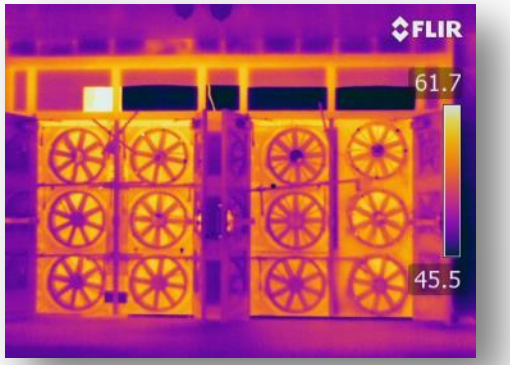
All Army facilities have been required to increasingly reduce site energy consumption in response to Energy Policy Act of 2005 (EPAct), ECB 2010-14, and the Army Sustainable Design and Development Policy Update (Environmental and Energy

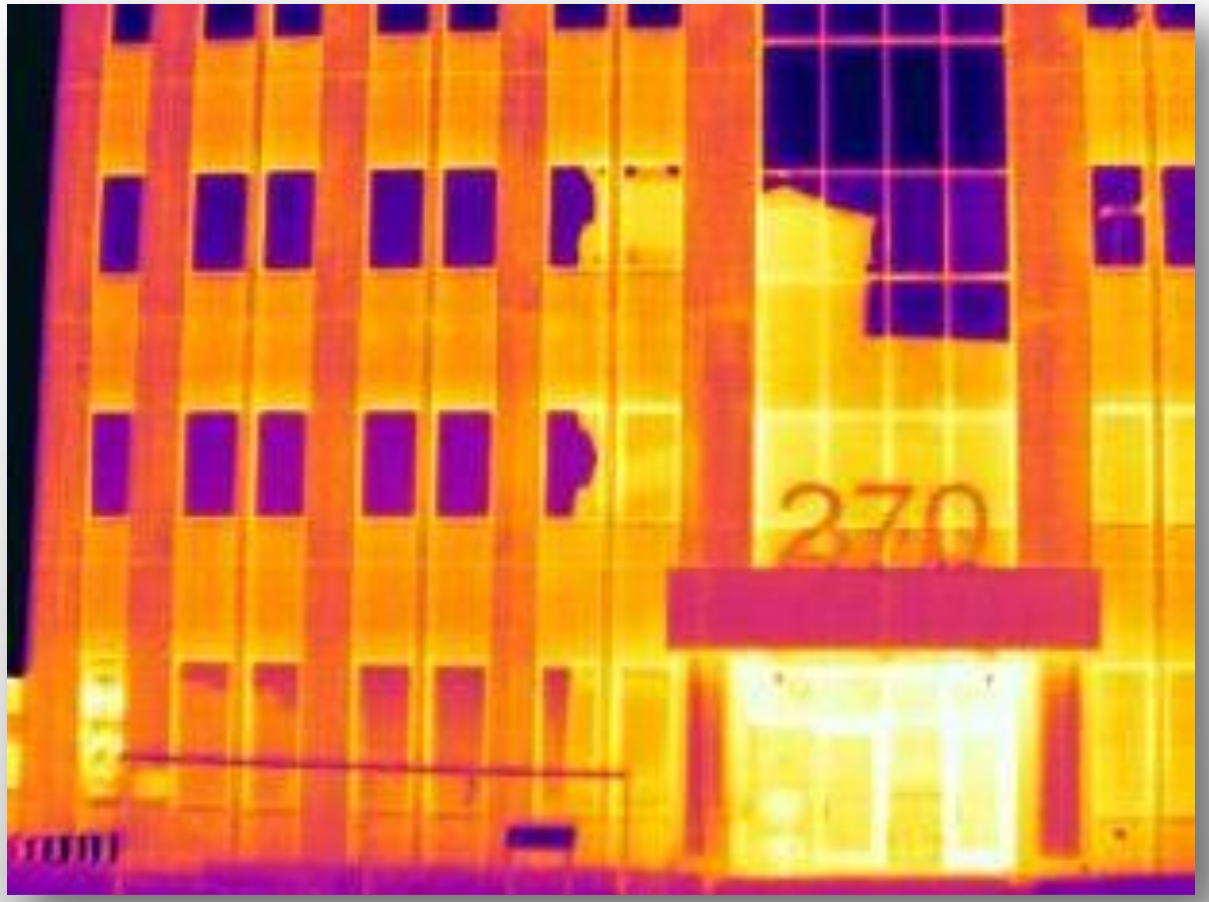


Commercial Air Barrier Testing

- In some states/cities - Now required of all buildings
- Know what is required on your project
- Know how to manage

Air Barriers – Telling the truth

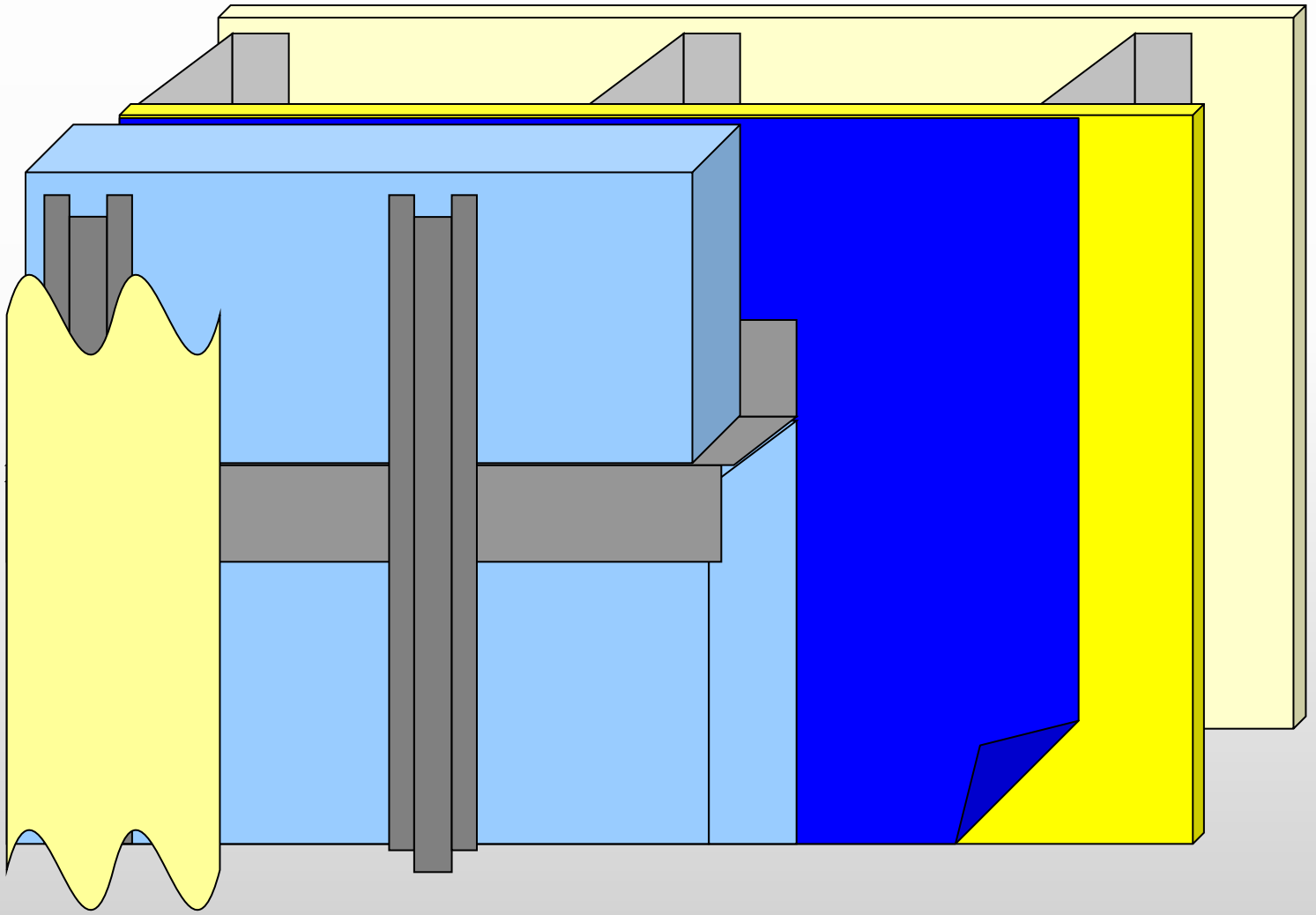




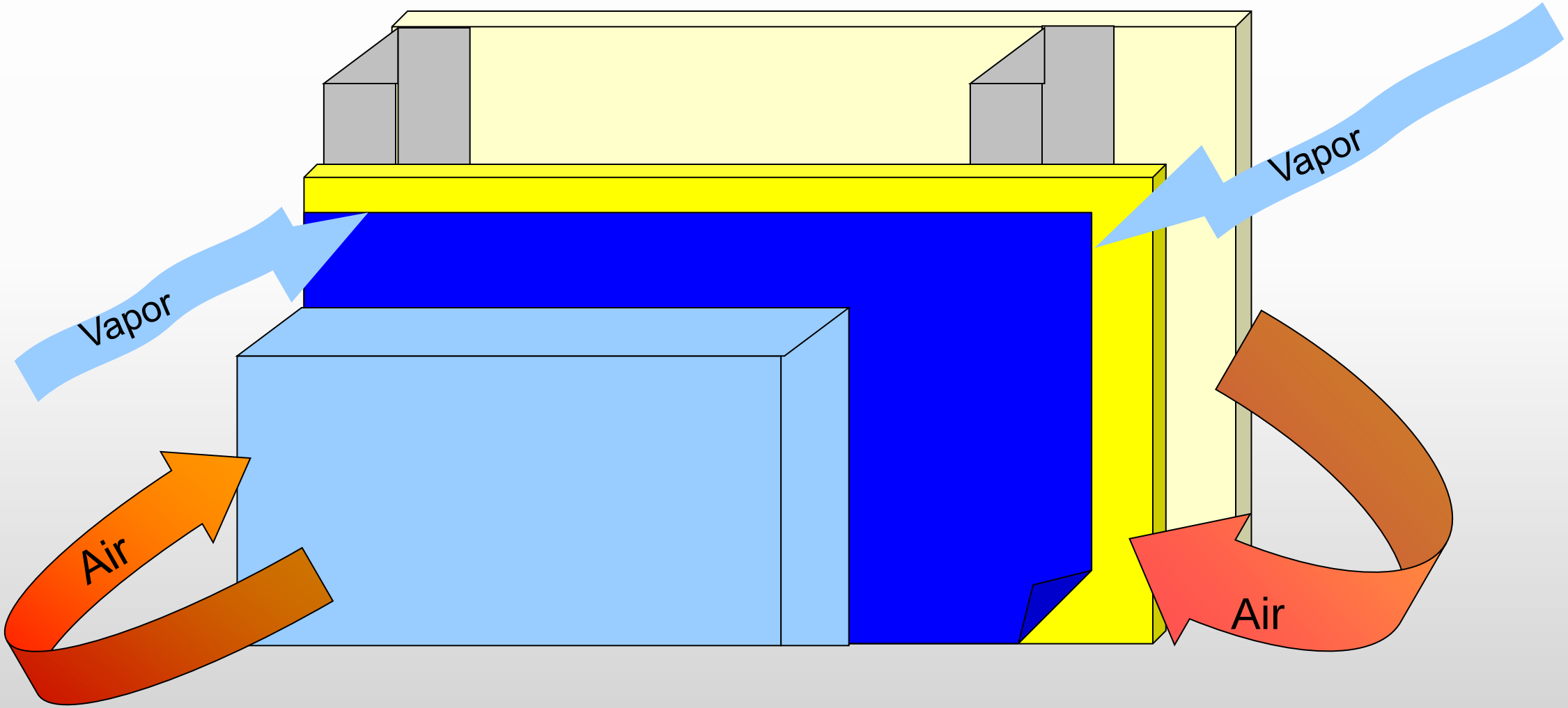
Air Barriers – Telling the truth

Universal Wall

Universal Wall

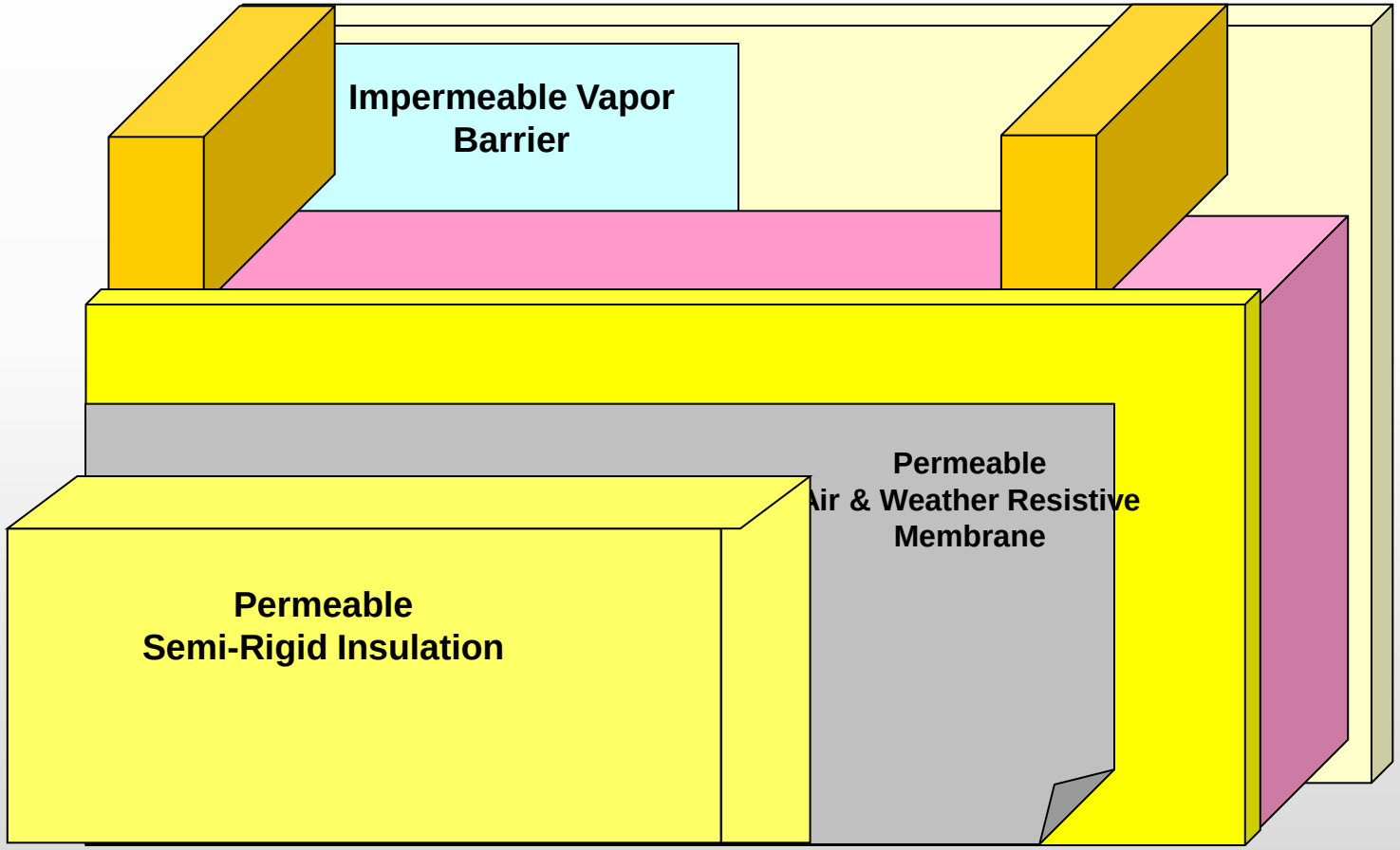


Universal Wall



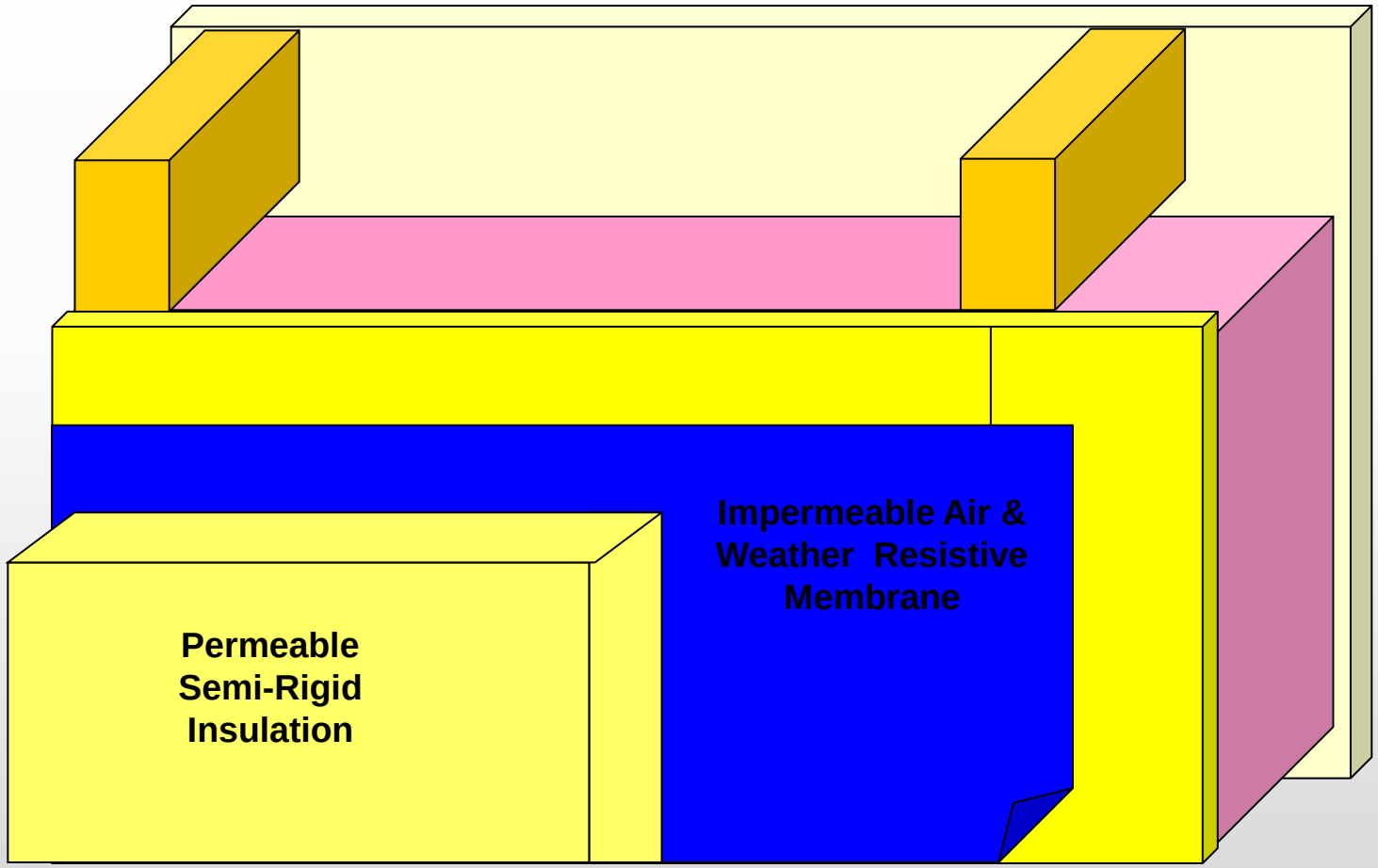
Marine Climate Assemblies

Preferred Wall Assembly
Marine Climate



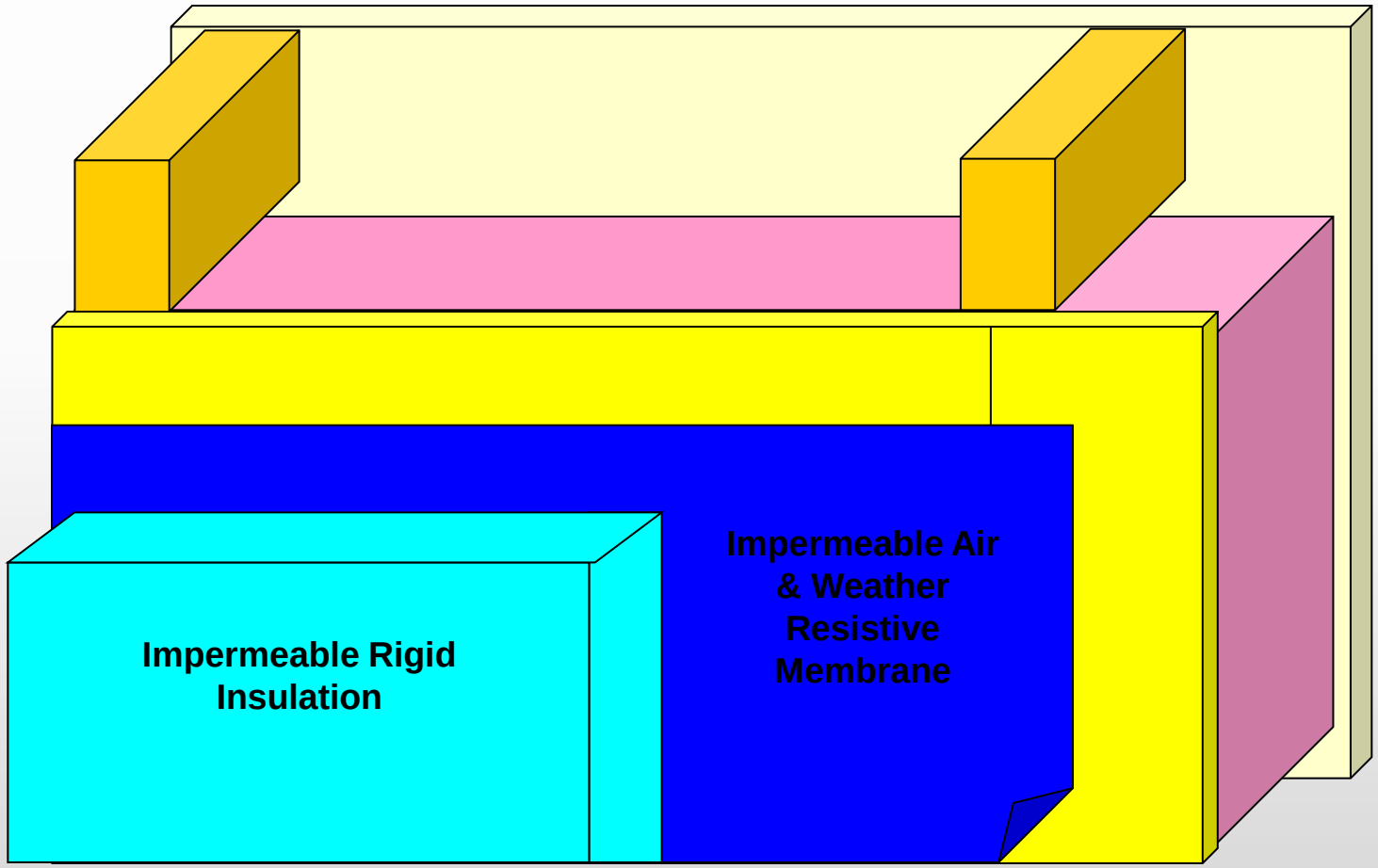
Mixed Humid Climate Assemblies

Preferred Wall Assembly
Mixed Humid Climate

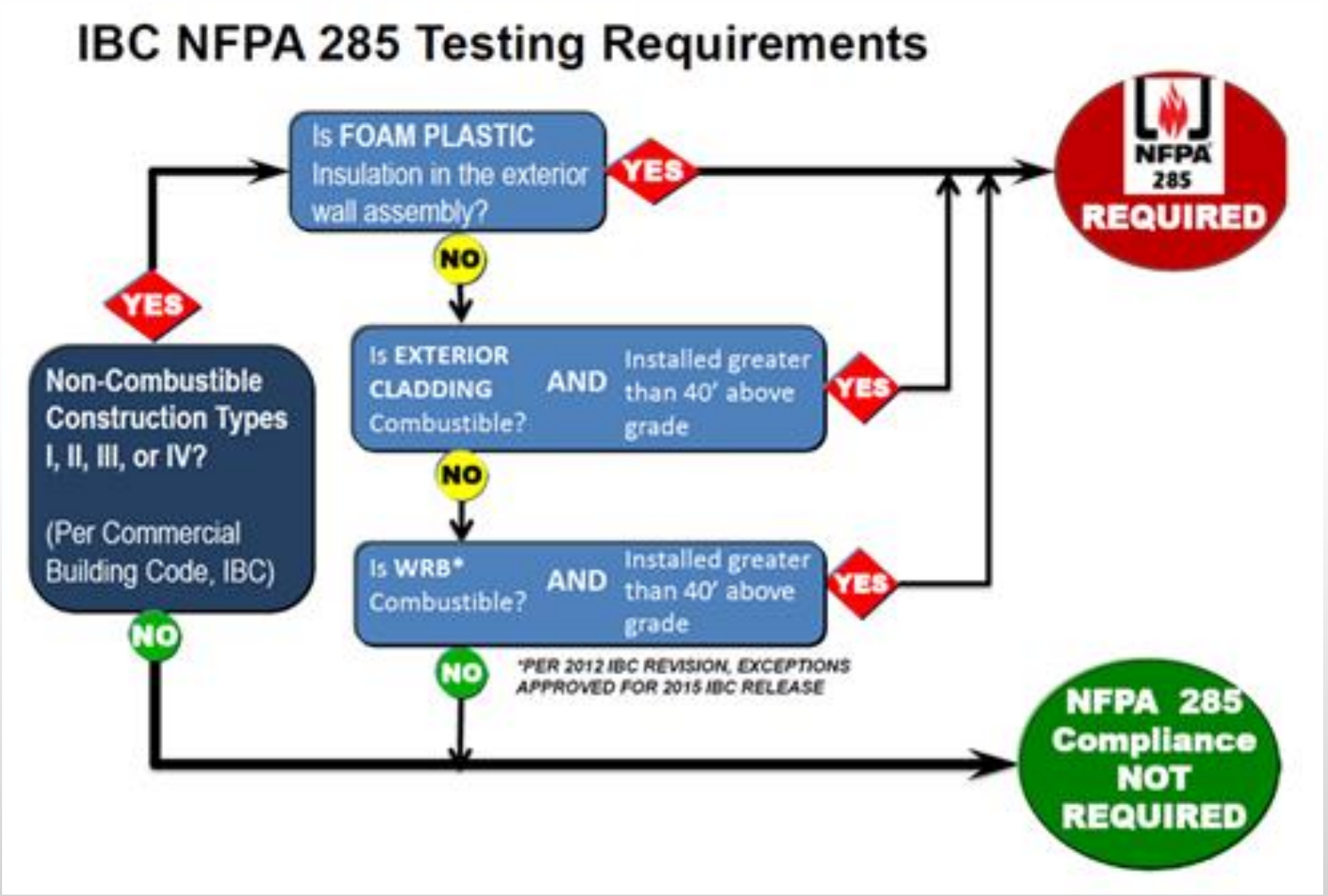


Hot Humid Climate Assemblies

Preferred Wall Assembly
Hot Humid Climate



IBC NFPA 285 Testing Requirements



Thank You - Discussion

- H. Peter Golter, P.E
  Business Development Manager
  3M Company
- hpgolter@mmm.com

- J. Lee Durston, Principal
  Building Science Consultant
  Morrison Hershfield
- ldurston@morrisonhershfield.com

MORRISON HERSHFIELD