



Commercial Air Barriers—The Details

Massachusetts Energy Code Technical Support Program



We Speak  Building



Who Is Mass Save®?



- Mass Save® is an initiative sponsored by Massachusetts' gas and electric utilities and energy efficiency service providers, including
 - The Berkshire Gas Company
 - Blackstone Gas Company
 - Cape Light Compact
 - Columbia Gas of Massachusetts
 - Eversource Energy
 - Liberty Utilities
 - National Grid
 - Unitil
- The Sponsors of Mass Save work closely with the Massachusetts Department of Energy Resources to provide a wide range of services, incentives, trainings, and information promoting energy efficiency that help residents and businesses manage energy use and related costs.



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Agenda




- Air Barrier Basics & Refresher
- Air Barriers and Building Science
- Key Requirements
- Design Considerations
- Installation Details

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About Your Instructor...



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mass save Energy Code Technical Support Program
Savings through energy efficiency

ALLIANCE TO SAVE ENERGY
Using less. Doing more.

NYS Energy Office

NEW ENERGY STORE

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Why Air Barriers?



- Shown to significantly reduce air leakage in a building for energy savings

<https://www.airbarrier.org/technical-information/energy-savings-calculator/>

- Part of a successful moisture management plan
- Code requirement in some states - and in MA 9th Edition
- Need to control water, air, vapor and thermal performance of the wall assembly

Air Leakage in Existing Buildings

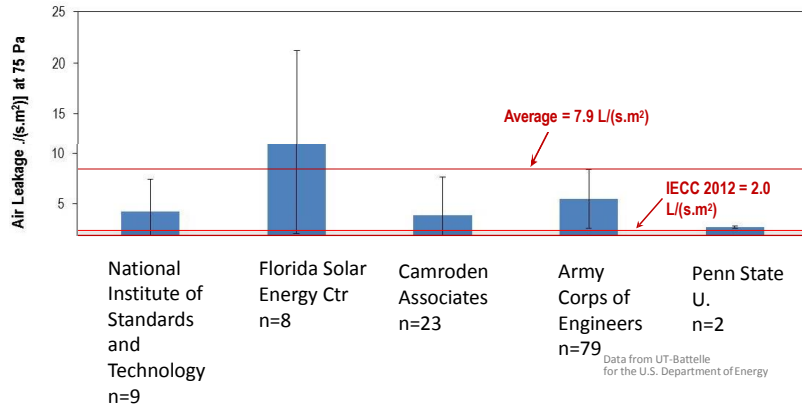


Photo credit: Michael C. DeWein and Camproden Assoc.

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Building Science

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Building Science Behind the Need



- What are we actually trying to do with Air Barriers?
 - Reduce air flow
 - Reduce moisture flow
 - Improve the performance of the insulation

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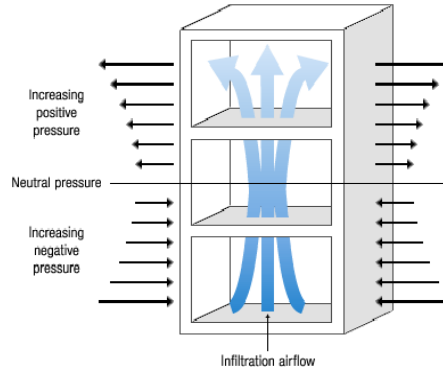
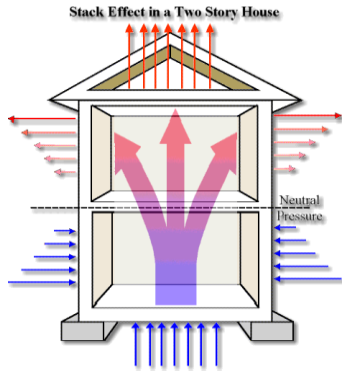
Building Science Behind the Need



Photo credit: Michael C.DeWein

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Air Flow Stack Effect

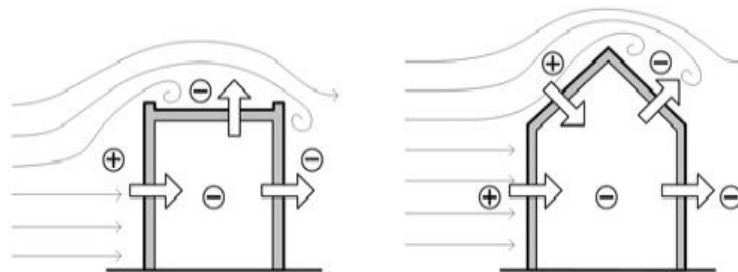


© E Source

Graphic from E Source

Photo credit: Air Barrier Association of America

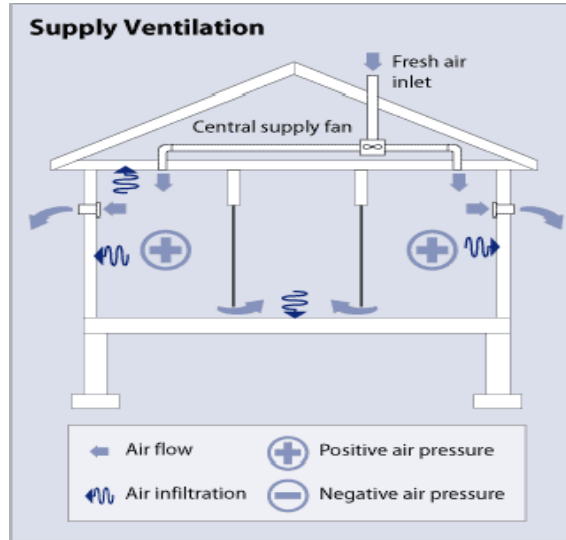
Air Flow Wind Effect



Graphic from E Source

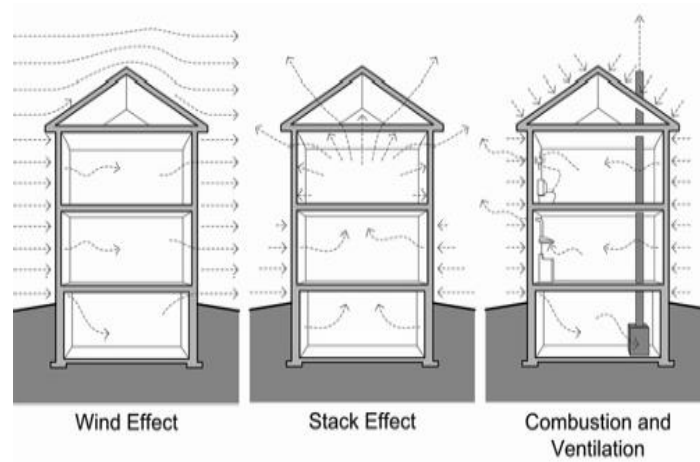
Photo credit: Air Barrier Association of America

Air Flow Mechanical Equipment Effect




Graphic from E Source

Air Flow Combined



Graphic from E Source

Building Science Moisture Flow

 Energy Code
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Graphic from E Source & Building Science Corporation

Building Science Leakage Impacts on Moisture

Moisture transfer into space due to air leakage

City	Base (lb./ft²·year)	0.25 L/s.m² (lb./ft²·year)
Miami	~18	~1.5
Chicago	~13	~1.0
Winnipeg	~10	~0.8


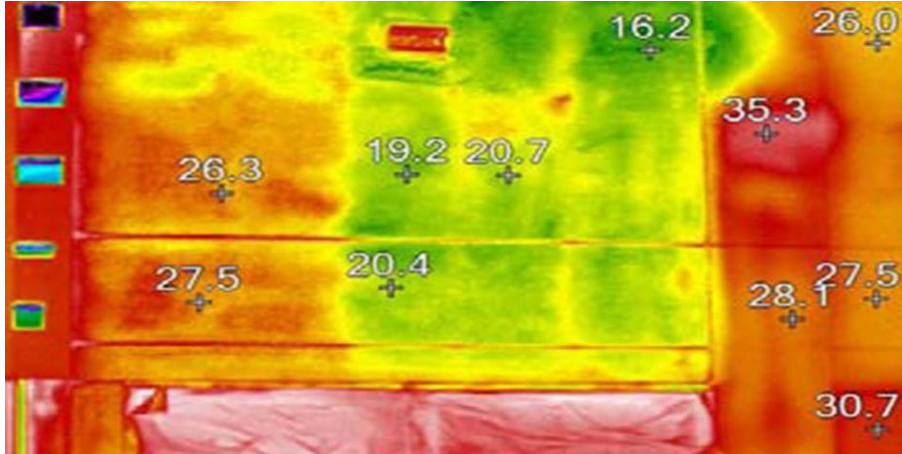
 Energy Code
Technical Support
Program

Photo credit: Air Barrier Association of America

Air Leakage Impacts

Insulation Efficacy



Air Barrier – No Insulation

Air Barrier with Insulation

NO Air Barrier & With Insulation

Photo credit: Air Barrier Association of America

Building Science

Insulation Efficacy

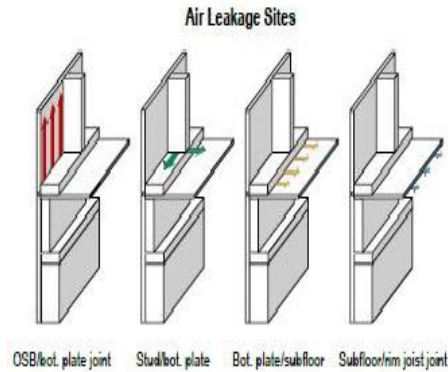
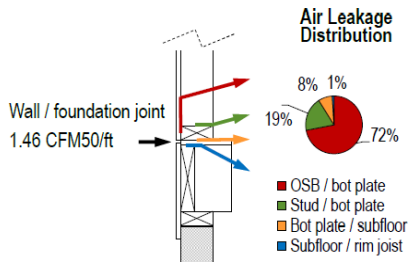
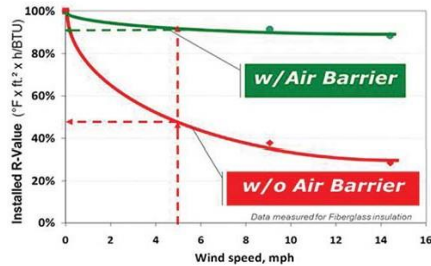


Photo credit: Michael C. DeWein Air Barrier Association of America

Building Science Insulation Efficacy



Graph 1: Wind Washing Effect on Thermal Insulation Performance

Source: Impact of Airflow on the Thermal Performance of Various Residential Wall Systems utilizing a calibrated hot box; Thermal Envelopes VI: Heat Transfer in Walls - Principles

Photo credit: Air Barrier Association of America

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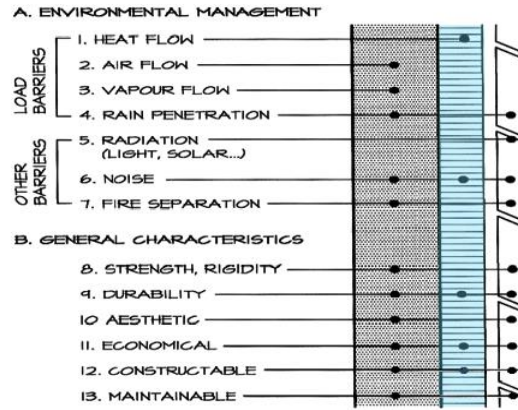
Building Science Insulation Efficacy

*“Air Barriers cannot be dealt with
without understanding that they
are part of a wall assembly”*

N.B. Hutcheon's CBD-48 - Requirements for Exterior Walls

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Building Science Systems Approach



ENVELOPE REQUIREMENTS (PRIMARY FUNCTIONS)

Photo credit: Air Barrier Association of America

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Characteristics of an Effective Air Barrier

- Air impermeable material
- Continuous
- Strong: resist positive and negative loads
- Durable

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Key Requirements

C402.5.1.2.1

- A **material** that has been designated to provide the primary function of controlling the movement of air through a building assembly and when tested in accordance with ASTM E2178-01 and has a air permeance of less than:

0.02 L/s/m² @ 75 Pa

0.004 CFM/ft² @ 1.56 lb/ft²

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Key Requirements

C402.5.1.1

- The air barrier shall be joined in an air-tight and **flexible manner** to the air barrier material of adjacent systems, allowing for the relative **movement** of systems due to **thermal and moisture variations** and creep. Connections shall be made between:
 - foundation and walls
 - walls and windows or doors
 - different wall systems
 - walls and roof
 - wall and roof over unconditioned spaces
 - walls, floors, and roofs across construction, control and expansion joints

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Key Requirements

- All penetrations of the air barrier and paths of air infiltration/exfiltration shall be made air-tight



Photo credit: Air Barrier Association of America

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Key Requirements Air Impermeable

ASTM 2357 - Standard Test Method for Determining Leakage of Air Barrier Assemblies

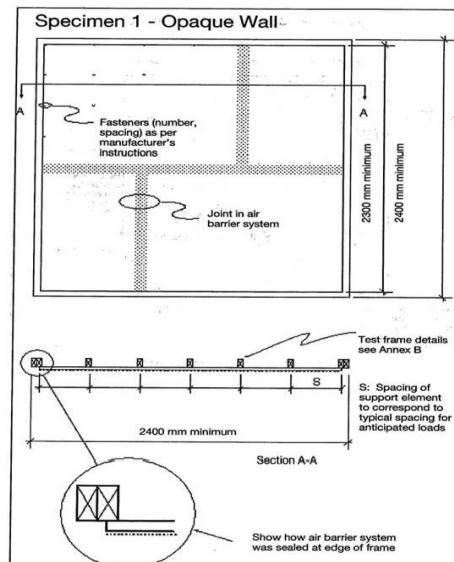


Photo credit: Air Barrier Association of America

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Key Requirements

Air Impermeable

ASTM 2357 - Standard Test Method for Determining Leakage of Air Barrier Assemblies

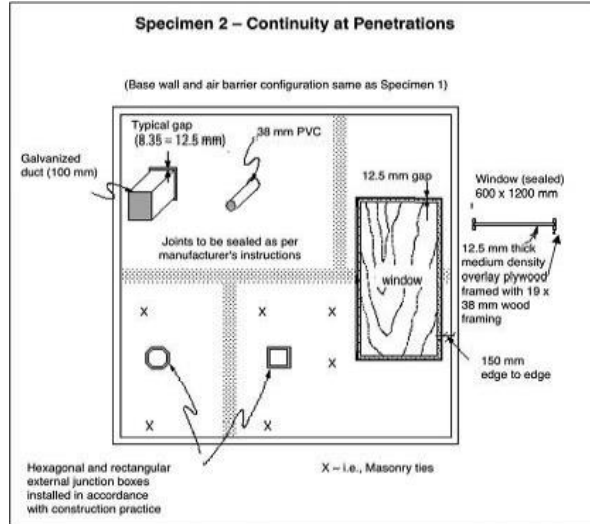


Photo credit: Air Barrier Association of America

Key Requirements

Air Impermeable

ASTM 2357 - Standard Test Method for Determining Leakage of Air Barrier Assemblies



Photo credit: Air Barrier Association of America

Key Requirements

Air Impermeable



- Withstand positive and negative loads due to wind, stack and mechanical pressures
- Not to displace other building enclosure components
- ASTM 2357 test method applies both positive and negative pressures to specimen to simulate wind gusts and pressures from stack and mechanical

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KEY Performance Requirements

ALL Components!



Building Component	Maximum Leakage Performance Level	Standard Source
Material	0.004 CFM/ft ² @ 1.56 lbs/ft ² pressure difference	ASTM E 2178
Accessory (tapes, strips, caulking)	0.004 CFM/ft ² @1.56 lbs/ft ² pressure difference	ASTM E 283
Component (windows, doors, skylights)	0.04 CFM/ft ² @1.56 lbs/ft ² pressure difference	ASTM E 283
Assembly (wall, roof, foundation)	0.04 CFM/ft ² @1.56 lbs/ft ² pressure difference	ASTM E 2357
System (whole building)	0.40 CFM/ft ² @1.56 lbs/ft ² pressure difference	ISO 9972, ASTM E 779, CGSB 149.10

Photo credit: Air Barrier Association of America

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Air Barriers and Construction



IECC 2015C 402.5.1 and C402.5.1.1

- Continuous air barrier for all assemblies
- Across joints
- Joints & seams to be sealed
- Penetrations & joints sealed and compatible with material and location
- Recessed-lighting: compliant fixtures
- Placement: inside, outside, or within assemblies composing envelope

ABAA Program or Auditor – Third Party?

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Design Considerations

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Design Considerations General



- Type of building
- Expected service life of building
- Climate region
- Intended or resultant interior conditions
- Type of construction
- Type of building enclosure system

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Design Considerations Building Type



- Different interior environments within the building
- High rise or low rise
- High end or low end



Photo credit: Air Barrier Association of America

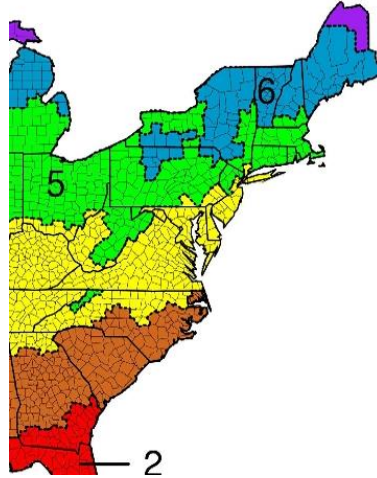
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Design Considerations

Climate Region



- Heating and cooling needs
- Moisture loads of climate region
- Wind loads
- Solar heat loads
- Local building code requirements



ASHRAE Climate Zone Map at www.buildingadvisor.com

Photo credit: uS-DOE/PNNL BECP

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Design Considerations

INTERIOR Moisture Conditions



- Moisture loads due to occupancy
- HVAC System
- Humidified or not
- Ventilation Systems



Photo credit: Michael C. DeWein Air Barrier Association of America

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Design Considerations

Wall Type



- Wood framed
- Concrete Masonry Units
- Light Gauge Metal Framing
- Concrete framed



Photo credit: Air Barrier Association of America

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Design Considerations

Cladding Attachment



Photo credit: Michael C. DeWein

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Design Considerations

Moisture Loads



BUILDING ENCLOSURE SYSTEM – MOISTURE LOADS

- Hygrothermal performance of components
- Hygrothermal performance of assembly
- Durability of components
- Solar heat gain / reflectivity of veneer layer

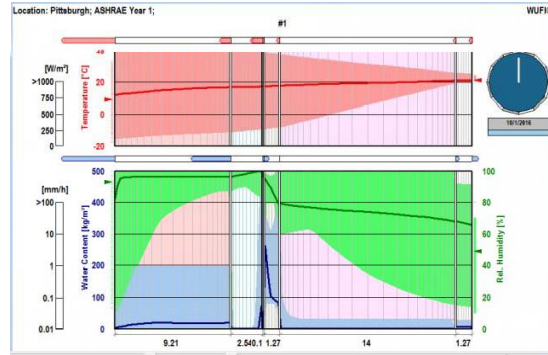


Photo credit: Air Barrier Association of America

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Design Considerations

Detailing!



- The concept is to select and target a component of the wall that is **air impermeable** and to deliberately make it an airtight "assembly" by sealing the **joints and penetrations**.
- Pen test: can you follow the identified air barrier layer through out the building enclosure without lifting your pen ?

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Design Considerations

Pen Test...!

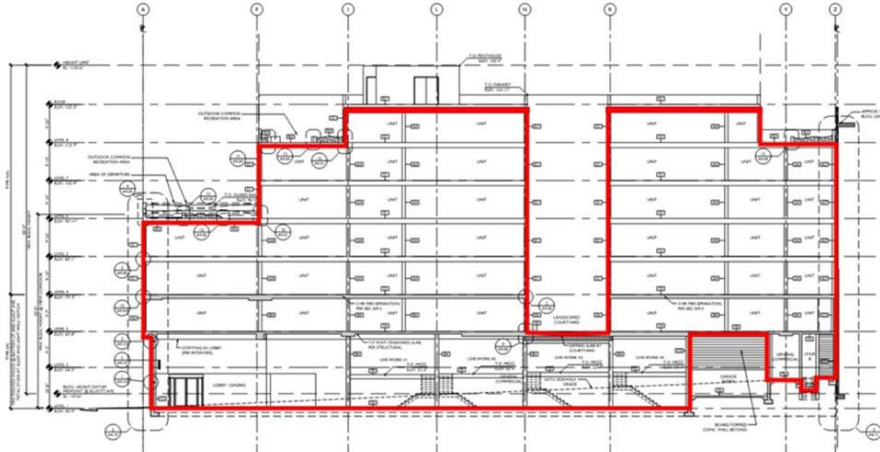


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Design Considerations

Detailing – MULTIPLE Transitions/Joints

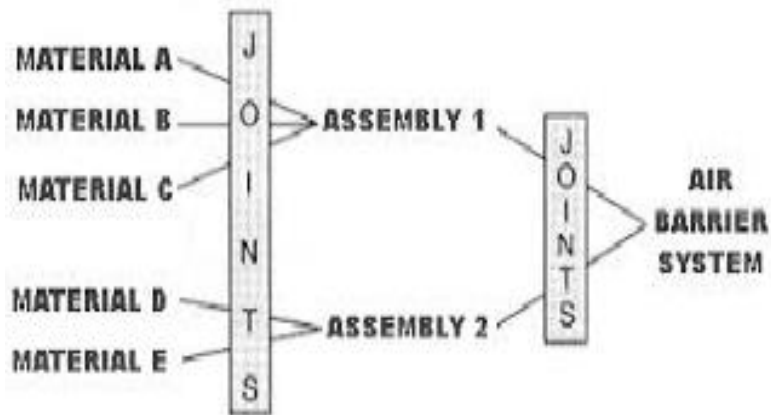


Photo credit: Air Barrier Association of America

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Design Considerations

Material Choices



Photo credit: Michael C. DeWein & Air Barrier Association of America

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Design Considerations

Material Choices



- Ensure compatibility and integration with other building enclosure materials

Flashing	Acrylic		Polyether LAB	Silicone LAB	Peel & Stick		Spray	Polystyrene board	Poliso Board	Building Wrap
	LAB	Asphalt LAB			Asphalt Membrane	Butyl Membrane	Polyurethane Foam			
Copper										
Stainless Steel										
Galv Steel (corrosive)										
Aluminum (corrosive)										
Copper fabric (asphalt)										
Copper fabric (non-asphaltic)										
Copper Asphalt										
Copper Paper										
Copper Drainage										
PVC										
PVC Kee										
PVC Kee SA (asphalt)										
EPDM										
EPDM SA (butyl)										
Peel & Stick (asphalt)										
Vinyl										
Not Compatible										
Caution										
Compatible										
need mor info										

Photo credit: Air Barrier Association of America

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Design Considerations

Material Choices



- Types of materials that are a part of air barrier assemblies:
 - Self-adhered membranes (permeable and non-permeable)
 - Liquid applied membranes (permeable and non-permeable)
 - Medium density closed cell sprayed polyurethane foam
 - Insulating board stock / Non-insulating board stock
 - Commercial building wraps
 - (New) factory-bonded membranes to sheathing

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Design Considerations

Material Choices



- You may have air barrier materials in your building that you did not even know:
 - Metal
 - Poured concrete
 - Steel
 - Wood
 - Some types of insulation
 - Water resistive barriers

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Design Considerations

Location



Exterior Application



Photo credit: Air Barrier Association of America

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Design Considerations

Critical Interfaces



- Roof / wall
- Foundation / wall
- Window, doors, curtain wall, storefronts
- Change in substrate
- Seismic and expansion joints
- Floor to floor
- Floor over unconditioned space
- Penetrations (utility, pipe, ducts)

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Design Considerations Roof/Wall Interface

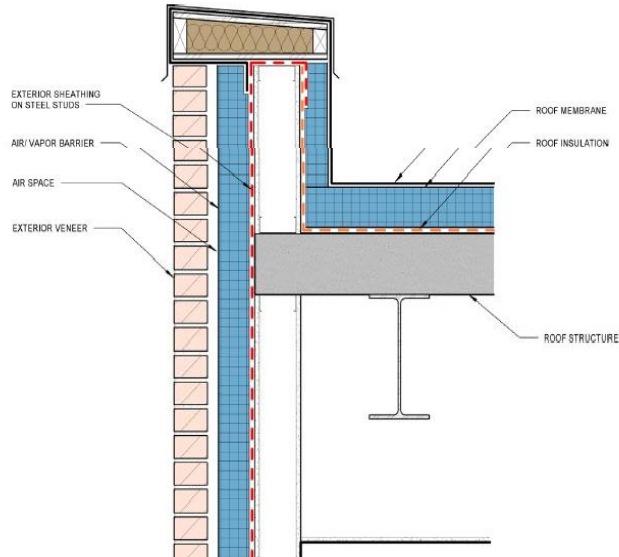


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Design Considerations Roof/Wall Interface



Low Roof / High Wall

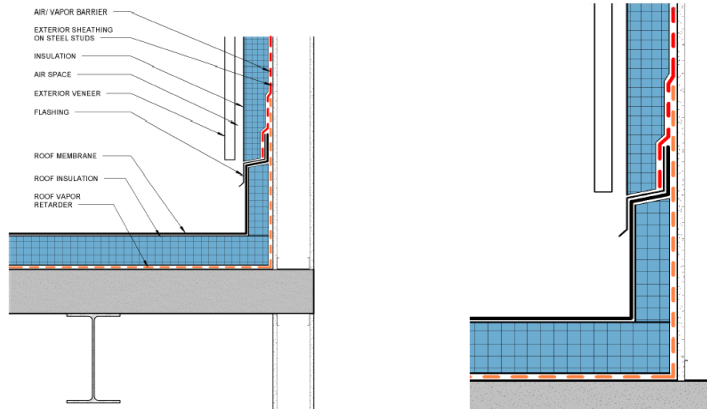


Photo credit: Air Barrier Association of America

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Installation Various Materials



Photo credit: Michael C. DeWein & Air Barrier Association of America

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Installation Various Materials



- Substrate prep is key to all materials !



Photo credit: Michael C. DeWein

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Installation

Various Materials



SELF ADHERED MEMBRANES

- Proper Substrate Preparation
 - Dry, free of moisture
 - Smooth, no large voids or protrusions
 - Priming of substrate (if required)



Photo credit: Michael C. DeWein

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Installation

Various Materials



SELF ADHERED MEMBRANES

- Common Field Issues
 - “Fish mouths”, wrinkles
 - Unadhered material
 - Inadequate substrate preparation
 - Exposed to UV past limits



Photo credit: Michael C. DeWein & Air Barrier Association of America

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Installation

Various Materials



LIQUID APPLIED MEMBRANES

- Proper Substrate Preparation
 - Dry, free of moisture
 - Treatment of joints and seams in exterior drywall
 - Masonry walls: struck flush, no protrusions
 - Detail openings, connections, penetrations



Photo credit: Air Barrier Association of America

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Installation

Various Materials



LIQUID APPLIED MEMBRANES

- Key Installation
 - Ensure all detailing is completed before or after liquid material
 - Watch temperature limitations for application
 - Spray evenly and consistent and avoid slumping of material
 - Ensure thickness meets specifications



Photo credit: Air Barrier Association of America

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Installation

Various Materials



LIQUID APPLIED MEMBRANES

- Common Field Issues
 - Insufficient thickness
 - Slumping of material
 - Missed detailing
 - Poor substrate preparation
 - Blisters or pin holing
 - Application over gaps that have not been pre-treated



Photo credit: Michael C. DeWein & Air Barrier Association of America

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Installation

Various Materials



MEDIUM DENSITY SPF

- Proper Substrate Preparation
 - Dry, free of moisture
 - Detailing of transitions, joints and intersections
 - Primers or adhesives may be required on galvanized steel and/or cleaning to remove oils
 - Ensure transition membranes are adhered well



Photo credit: Michael C. DeWein & Air Barrier Association of America

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Installation

Various Materials



BOARD STOCK CELLULAR INSULATION

- Proper Substrate Preparation
 - May be substrate if fastened directly to framing members
 - For application over substrate, ensure smoothness and no sharp projections
 - Verify compatibility of sealants

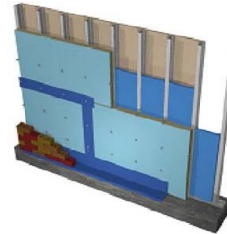


Photo credit: Air Barrier Association of America

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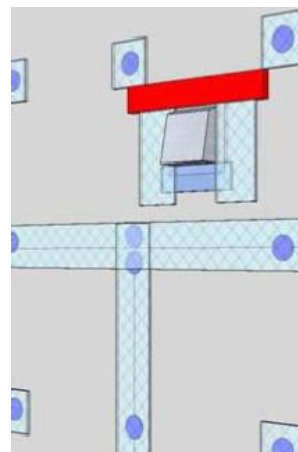
Installation

Various Materials



BOARD STOCK CELLULAR INSULATION

- Key Installation
 - Treating of seams, edges, end joints and through wall penetrations
 - Sealing penetrations and panel defects with sealant
 - Fastening of boards and types of fasteners
 - Integration with thru-wall flashing



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Installation Various Materials

BOARD STOCK CELLULAR INSULATION

- Common Field Issues
 - Lack of connection to windows, door and other details
 - Penetrations installed post-installation (electrical, mechanical)
 - Improper fasteners or sealants
 - Adhesion of tapes to board joints



Photo credit: Camroden & Air Barrier Association of America

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Installation Various Materials

- Mechanically Fastened Building Wrap
 - Substrate Preparation
 - Address Penetrations

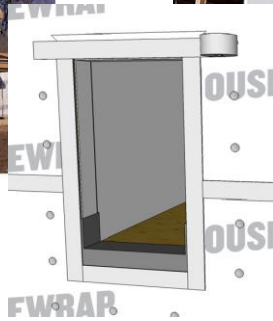


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Conclusion



- MANY details to review for code compliance – and inspect
- Air Barriers are and will continue to become code-mandated requirements across the U.S.
- One of the significant strategies to reduce energy consumption and contribute to moisture management
- Key performance of system is dependent on:
 - Proper design and detailing
 - Tested materials that are durable
 - Installation by certified applicators
 - Proper site inspections/audits and testing for commissioning of system

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QUESTIONS



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Upcoming Training Opportunities and... What Should We Cover?



- Documentation and Tools?
- Commissioning Commercial Buildings
- Commissioning Case Study?!
- Role of the Architect?
- How to Make Your Building Solar Ready!

Give Us Your Feedback - What Do YOU Need?

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Upcoming Trainings



May 30th, 1:00 to 3:05 PM (Webinar)

Applying the Energy Code to Existing Homes

COMcheck Case Study – Simple Commercial Building

June 20th, 8:30 to 10:00 AM (USGBC- Classroom)

Are You Ready for Solar Ready? And Other
Commercial Energy Code Updates.

June 27th, 1:00 to 3:05 PM (Webinar)

Residential Air Barriers

COMcheck for Existing Buildings

Give Us Your Feedback - What Do YOU Need?

Register at www.masssave.com/energycode

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Energy Code Support



Questions about the energy code?

Energy Code Support Hotline:

855-757-9717

Energy Code Support Email:

energycodesma@psdconsulting.com

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New Buildings and Major Renovations – Commercial



- **Incentives for efficiency levels beyond code and/or industry standard baselines:**
 - Whole building incentives
 - System incentives including
 - Air Compressors
 - Chillers
 - Lighting and Lighting Controls
 - Gas-Fired Heating Equipment
 - Variable Speed Drives
 - Custom Measures
 - And more

We also offer incentives and rebates for existing buildings.
Please visit www.MassSave.com for the details

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Thanks!

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76 years for life