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Achieving a High Performance Air Barrier System

Materials, Codes, Installation and Site Quality Control

Presented by Mr. Peter Spafford
Air Barrier Association of America

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LEARNING OBJECTIVES

- Define key air barrier material characteristics using building code requirements to evaluate if the test methods and performance requirements for a particular air barrier meets code

- Describe compliance options to meet code reference documents such as ASHRAE 90.1-2010 or IECC 2012 to determine if design intent will meet code requirement

LEARNING OBJECTIVES

- Through use of illustration and actual project site photo's, identify acceptable and unacceptable installation of a variety of air barrier materials to determine if the assembly would meet manufacturers installation instructions

- Determine knowledge, skills and ability requirements of air barrier installers against other related trades, such as roofers and waterproofers and identify criteria to assess qualifications of trades to perform the air barrier installation.

- Assess various quantitative and qualitative test processes and procedures using sample tests to verify the quality of an air barrier installation

AIR BARRIERS

KEY REQUIREMENTS

AIR BARRIERS

KEY REQUIREMENTS

- Impermeable material
- Continuous
- Strong: resist positive and negative loads
- Durable

AIR BARRIERS

IMPERMEABLE MATERIAL

- 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 and has a air permeance of less than:

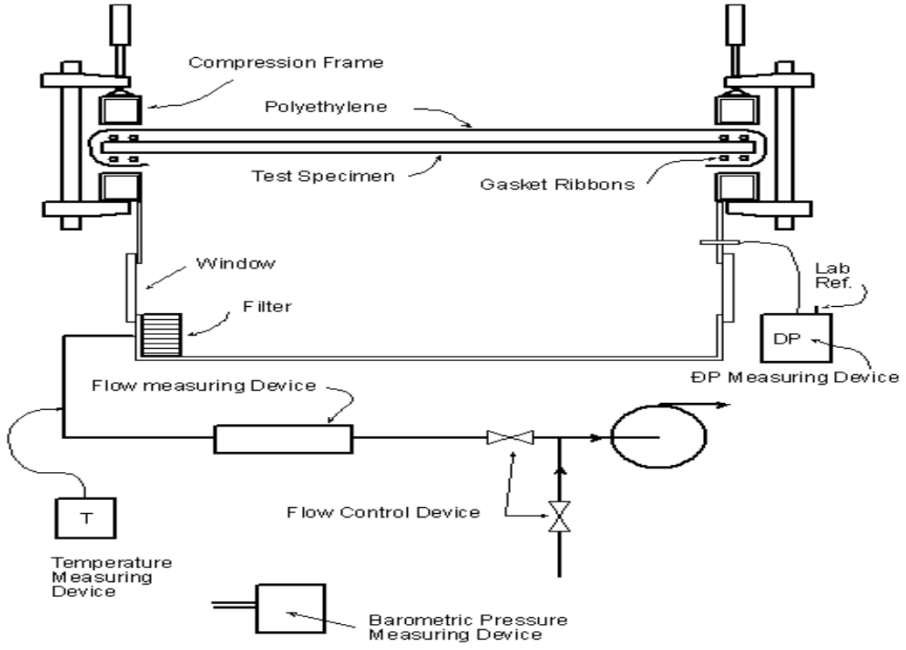
  0.02 L/s/m^2 @ 75 Pa

  0.004 CFM/ft^2 @ 1.56 lb/ft^2

AIR BARRIERS

IMPERMEABLE MATERIAL

ASTM 2178 TEST METHOD



AIR BARRIERS

CONTINUOUS

- 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

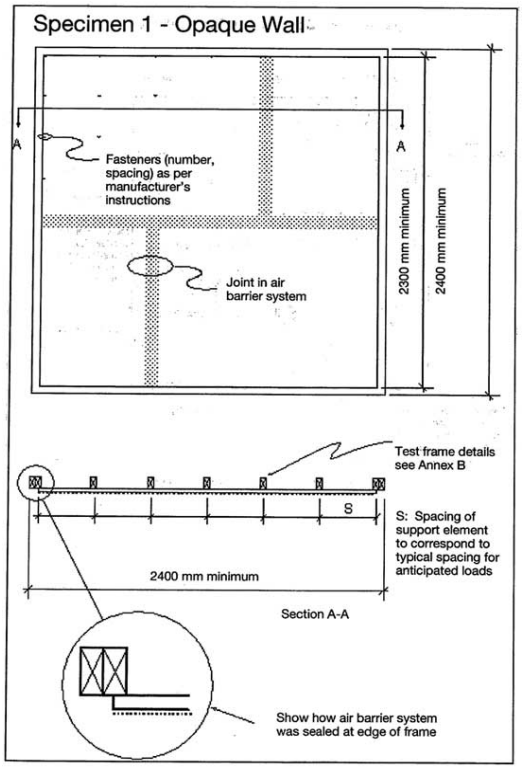
AIR BARRIERS

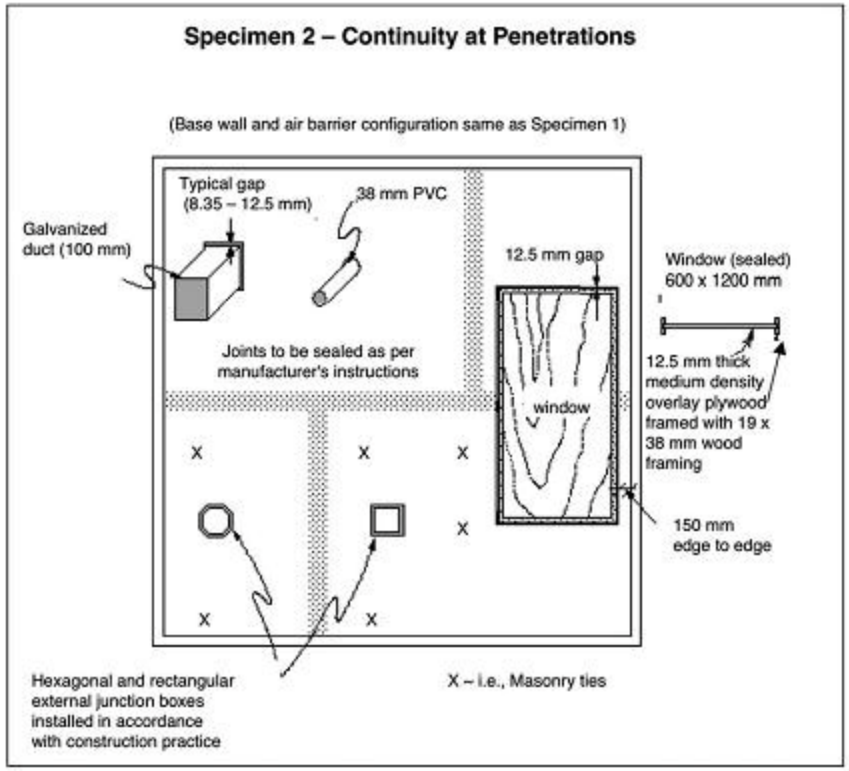
CONTINUOUS

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

AIR BARRIERS
CONTINUOUS

- ASTM E 2357





AIR BARRIERS

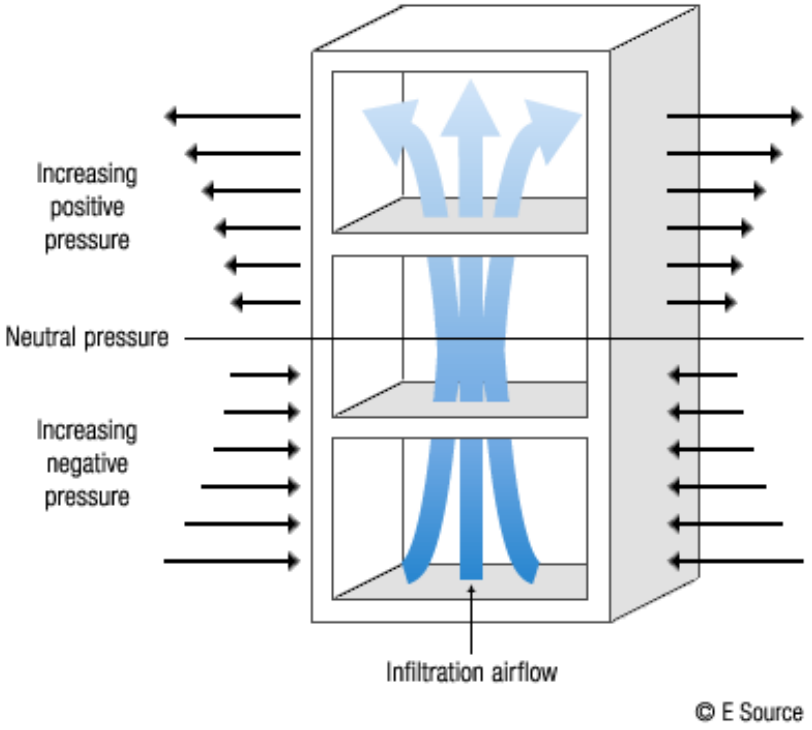
CONTINUOUS

- ASTM E 2357

AIR BARRIERS

STRONG

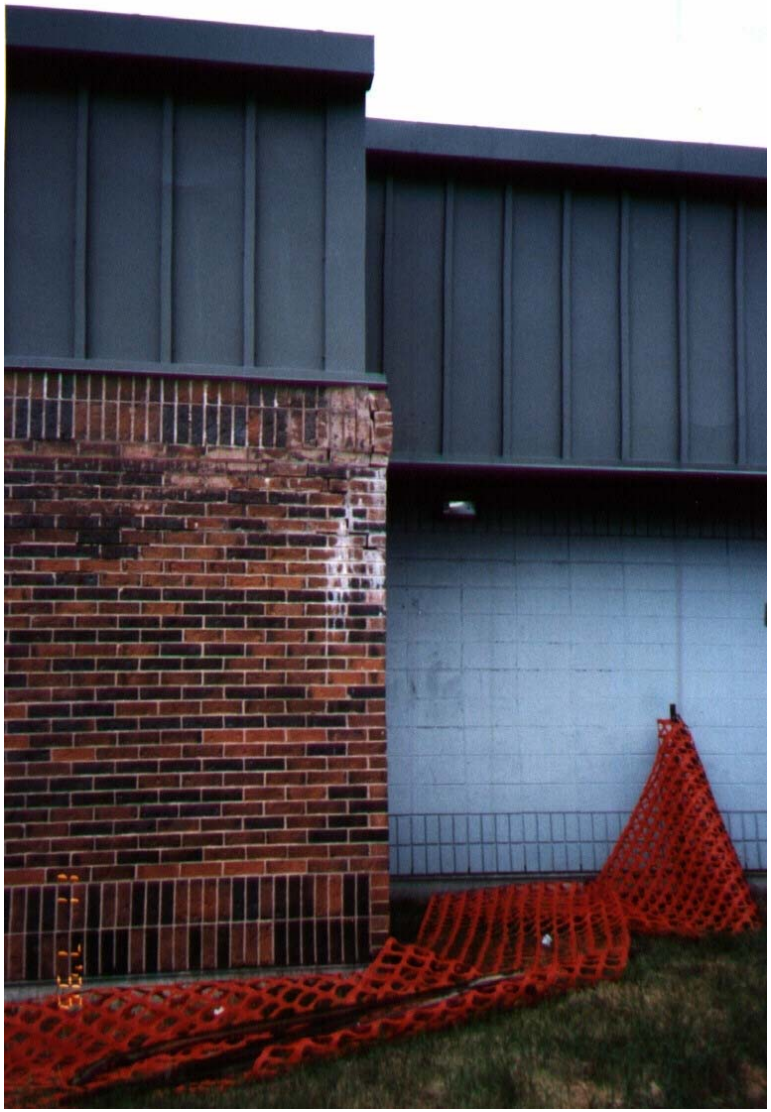
- Withstand positive and negative loac due to wind, stack and mechanical pressures
- Not to displace other building enclosure components
- ASTM 2357 test method applies botl positive and negative pressures to specimen to simulate wind gusts anc pressures from stack and mechanica



AIR BARRIERS

DURABLE

- Materials are typically installed as a non-maintainable components within the wall assembly
- Need to last the life of the enclosure and be resilient
- Durable to deal with moisture, temperature, building movement over the intended life span



AIR BARRIERS

AIR LEAKAGE PERFORMANCE REQUIREMENTS

- **Material** - 0.004 CFM/ft²@ 1.56 lbs/ft² pressure difference (ASTM E 2178)
- **Accessory** – tapes, strips, caulking, etc - 0.004 CFM/ft²@ 1.56 lbs/ft² pressure difference (ASTM E 283)
- **Component** – windows, doors, skylights, etc. - 0.04 CFM/ft²@ 1.56 lbs/ft² pressure difference (ASTM E 283)
- **Assembly** (Wall assembly, roof assembly, foundation assembly)- 0.04 CFM/ft²@ 1.56 lbs/ft² pressure difference (ASTM E 2357)
- **System** (Whole Building) - 0.40 CFM/ft²@ 1.56 lbs/ft² pressure difference (ISO 9972, ASTM E 779, CGSB 149.10)

AIR BARRIERS

OTHER TEST CRITERIA ESTABLISHED BY ABAA

- Other test methods developed for each material type as part of ABAA evaluation process

- Currently developed for:

  - Self Adhered Membranes
  - Liquid Applied Membranes
  - Medium Density Sprayed Polyurethane Foam
  - Board Stock – Rigid Cellular Thermal Insulation Board
  - Factory Bonded Membranes to Sheathing
  - Mechanically Fastened Commercial Building Wraps
  - Adhesive backed commercial building wraps

AIR BARRIERS

OTHER TEST CRITERIA ESTABLISHED BY ABAA

- In process evaluation criteria:
  - Open Cell Sprayed Polyurethane Foam
  - Engineer Polymer Films for Interior Application
  - The specific evaluation criteria for each material can be found on the ABAA website.

AIR BARRIERS

OTHER TEST CRITERIA ESTABLISHED BY ABAA

5.3 Fluid Applied Membranes

All testing shall be conducted with the applied liquid material within the minimum / maximum range. The specific thickness of the material which was used when conducting the following tests shall be recorded on the test report and shall be the site installed thickness.

Product Property	Test Standard	Test Standard Title	Unit	Requirement	
				Min	Max
Air Permeance	ASTM E2178-11	Standard Test Method for Air Permeance of Building Materials	cfm /ft^2 at a pressure differential of 1.57 psf (L/(s·m^2) at a pressure differential of 75 Pa)	- -	0.004 (0.02)
Water Resistance	AATCC 127 - 2008	Water Resistance: Hydrostatic Pressure Test for 5 h	inches (cm)	22 (55)	-
Self Sealability	ASTM D1970 / D1970M - 11	Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection - Section 8.9 Nail Sealability	-	Pass or specify sealing detail around fasteners	-
Pull Adhesion	ASTM D4541-09e1	Modified Version of Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete using Portable Pull-Off Adhesion Testers– Specify substrates and surface preparation for glass fiber faced gypsum sheathing and concrete block. Declare failure mode.	psi (kPa)	16 (110) or report value at substrate failure	-
Crack Bridging	ES-AC 212	Acceptance Criteria for Water-Resistive Coatings used as Water-Restive Barriers over Exterior Sheeting	-	Pass	-
	OR				
	ASTM C1305-08	Standard Test Method for Crack Bridging Ability of Liquid Applied Waterproofing Membrane– Report thickness and joint treatment (158° for 2 weeks)	-	Pass	-
Water Vapor Permeance (at applied thickness)	ASTM E96/E96M-10 (Desiccant and Water Methods)	Standard Test Methods for Water Vapor Transmission of Materials	US Perms (ng/(Pa·s·m^2))	Declare	

AIR BARRIERS

CODE REQUIREMENTS

BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

5.4.3 Air Leakage

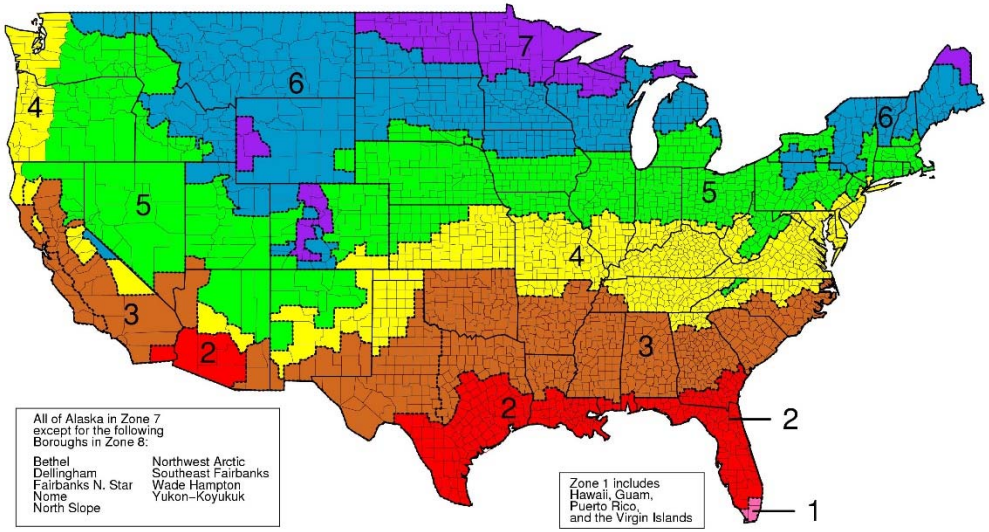
5.4.3.1 Continuous Air Barrier

The entire building envelope shall be designed and constructed with a continuous air barrier.

Exceptions to 5.4.3.1:

a) Semi-heated spaces in climat zones 1 thru 6.

b) Single wythe concrete mason buildings in climate zone 2B.



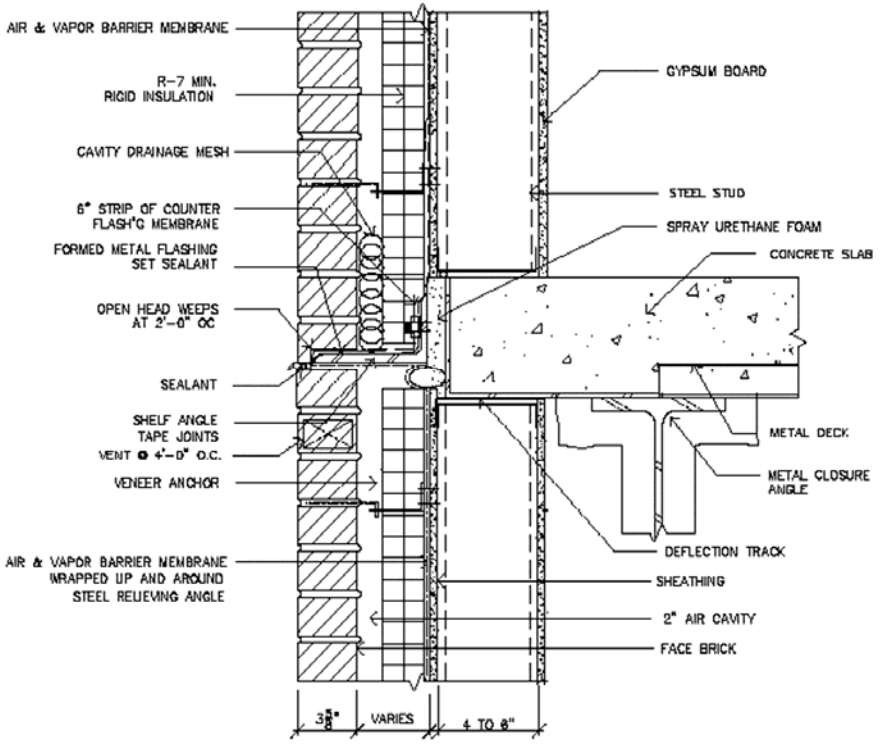
BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

5.4.3.1.1 Air Barrier Design

The air barrier shall be designed and noted in the following manner:

a. All air barrier components of each building envelope assembly shall be clearly identified or otherwise noted on the construction documents.



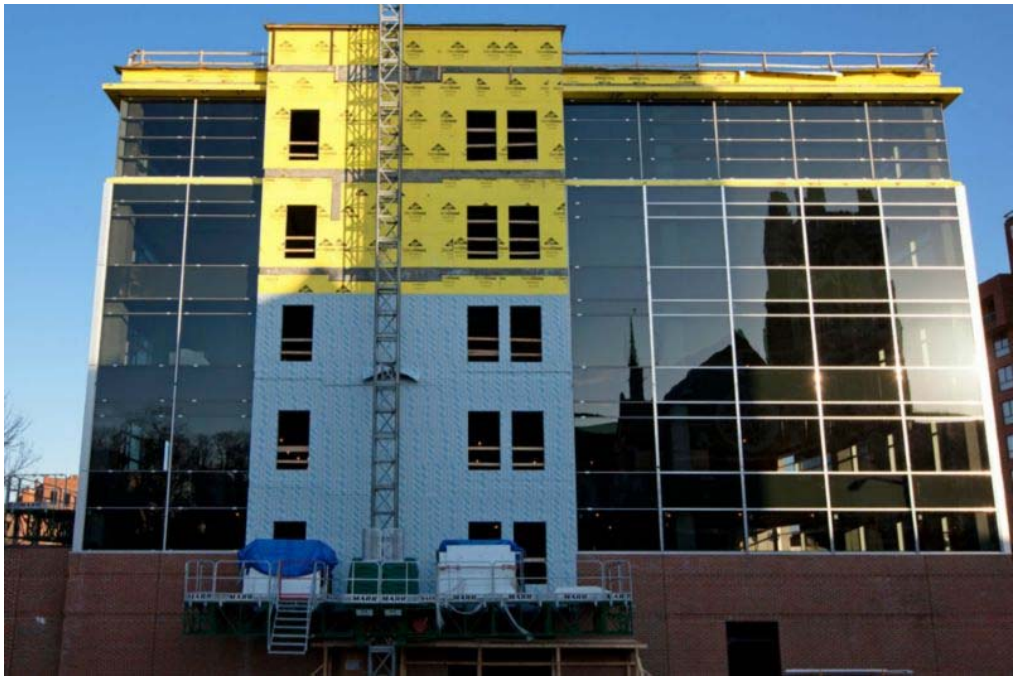
BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

5.4.3.1.1 Air Barrier Design

The air barrier shall be designed and noted in the following manner:

b. The joints, interconnections, and penetrations of the air barrier components including lighting fixtures shall be detailed or otherwise noted



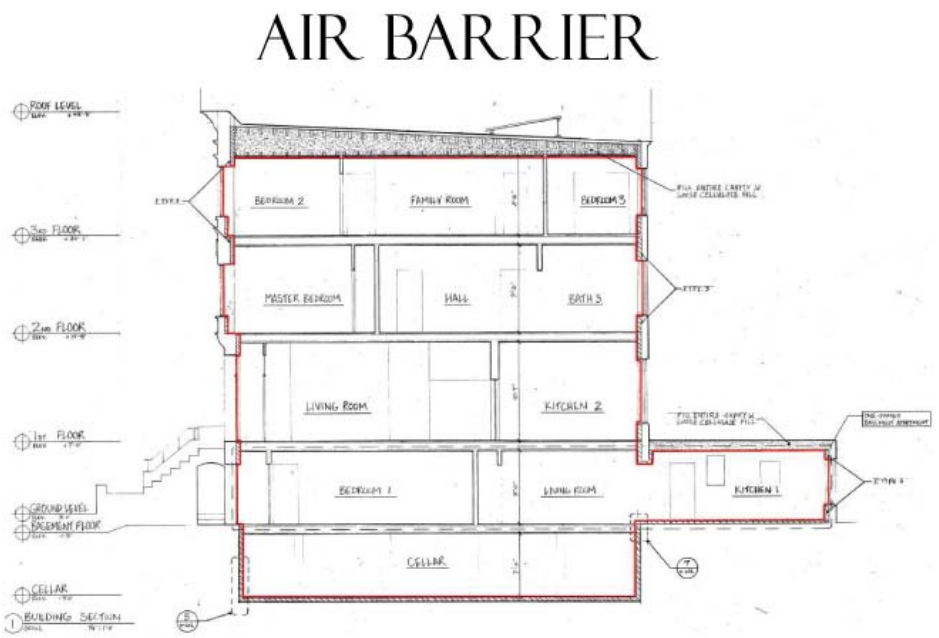
BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

5.4.3.1.1 Air Barrier Design

The air barrier shall be designed and noted in the following manner:

c. The continuous air barrier shall extend over all surfaces of the building envelope (at the lowest floor, exterior walls, and ceiling or roof).



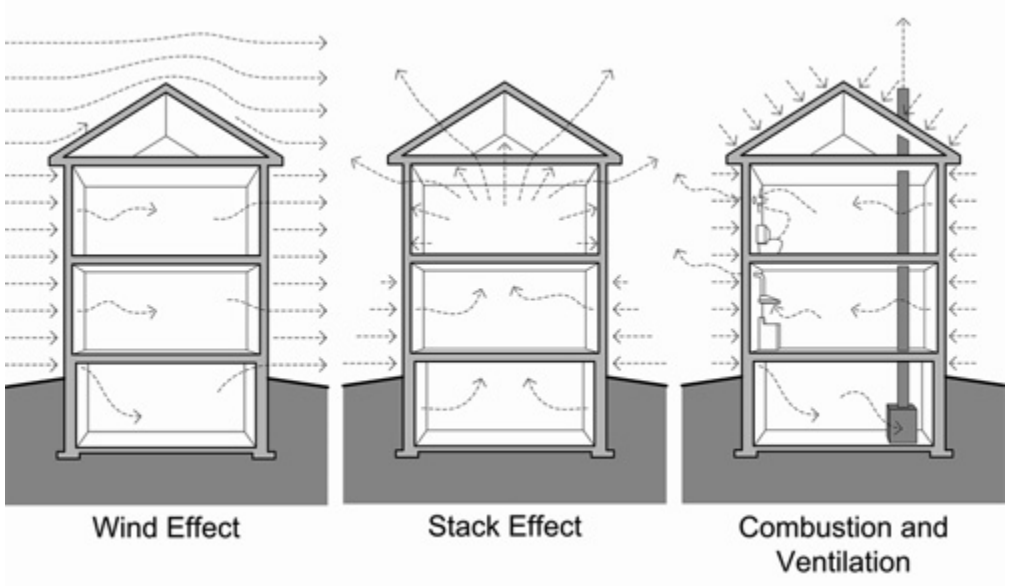
BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

5.4.3.1.1 Air Barrier Design

The air barrier shall be designed and noted in the following manner:

d. The continuous air barrier shall be designed to resist positive and negative pressures from wind, stack effect, and mechanical ventilation.



BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

5.4.3.1.2 Air Barrier Installation

The following areas of the continuous air barrier in the building envelope shall be wrapped, sealed, caulked, gasketed, or taped in an approved manner to minimize air leakage:

a. Joints around fenestration and door frames (both manufactured and site-built)

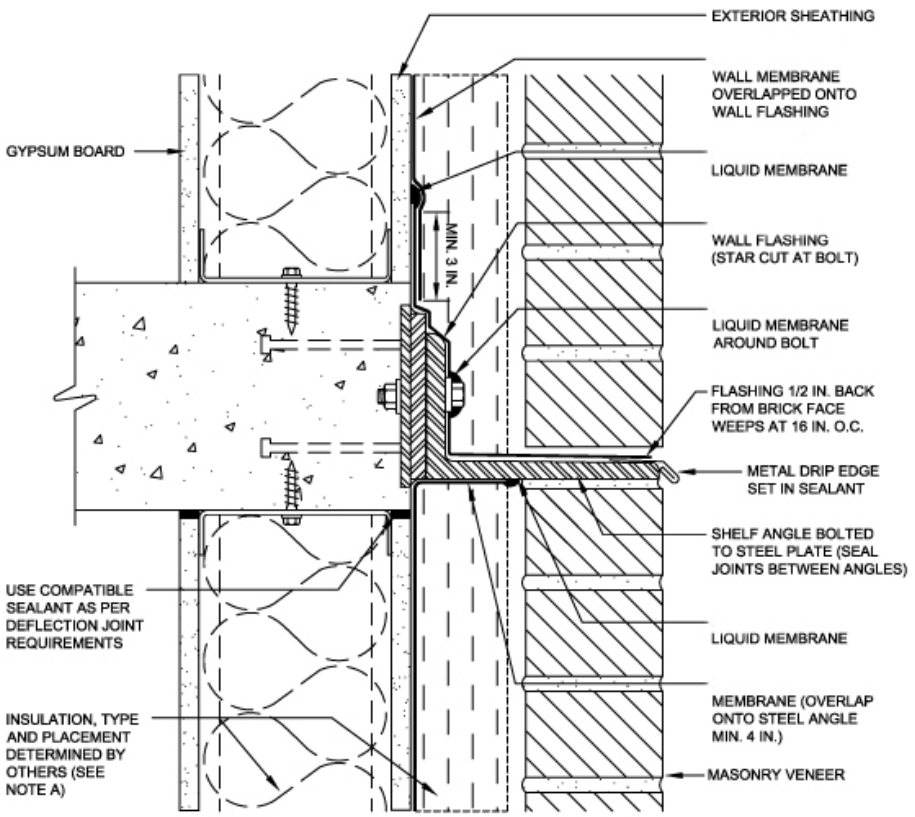
BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

5.4.3.1.2 Air Barrier Installation

The following areas of the continuous air barrier in the building envelope shall be wrapped, sealed, caulked, gasketed, or taped in an approved manner to minimize air leakage:

b. Junctions between walls and floors, between walls at building corners, between walls and roofs or ceilings.



BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

5.4.3.1.2 Air Barrier Installation

The following areas of the continuous air barrier in the building envelope shall be wrapped, sealed, caulked, gasketed, or taped in an approved manner to minimize air leakage:

c. Penetrations through the air barrier in building envelope roofs, walls, and floors

d. Building assemblies used as ducts or plenums.

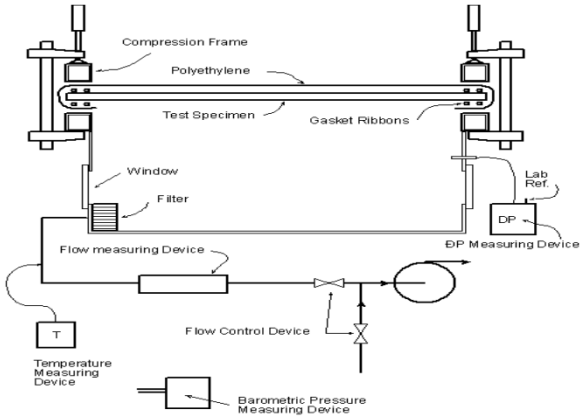
e. Joints, seams, connections between planes, and other changes in air barrier materials.

BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

5.4.3.1.3 Acceptable Materials and Assemblies.

Continuous air barrier materials and assemblies for the opaque *building envelope* shall comply with one of the following requirements:



a. Materials that have an air permeance not exceeding 0.004 cfm/ft2 under a pressure differential of 0.3 in. w.g. (1.57psf) when tested in accordance with ASTM E 2178.

BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

The following materials meet the requirements of 5.4.3.1.3 a:

1. Plywood (minimum 3/8 in)
2. Oriented strand board (minimum 3/8 in)
3. Extruded polystyrene insulation board (minimum ½ in)
4. Foil-faced urethane insulation board (minimum ½ in)
5. Exterior gypsum sheathing or interior gypsum board (minimum 1/2 in)
6. Cement board (minimum 1/2 in)
7. Built up roofing membrane
8. Modified bituminous roof membrane
9. Fully adhered single-ply roof membrane
10. A Portland cement/sand parge, stucco, or gypsum plaster (minimum 1/2 in. thick)
11. Cast-in-place and precast concrete.
12. Sheet metal.
13. Closed cell 2 lb/ft^3 nominal density spray polyurethane foam (minimum 1 in)

BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

b. Assemblies of materials and components (sealants, tapes, etc.) that have an average air leakage not to exceed 0.04 cfm/ft² under a pressure differential of 0.3 in. w.g.(1.57psf) when tested in accordance with ASTM E 2357 ASTM E 1677, ASTM E 1680 or ASTM E283;

The following assemblies meet the requirements of 5.4.3.1.3 b.

1. Concrete masonry walls that are:
    i. Fully grouted, or
    ii. Painted to fill the pores.

Figure 3 – Specimen Installed in Chamber (Outside View) Wall Specimen 2+3

BUILDING CODES ASHRAE 90.1

ASHRAE 90.1 - 2010

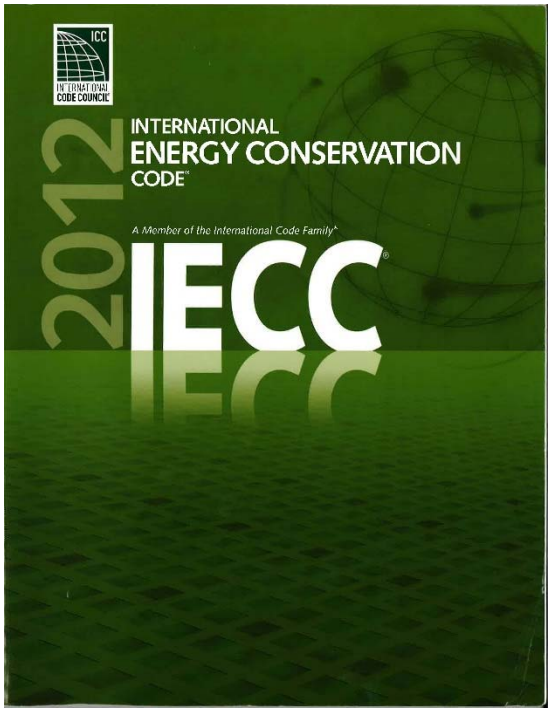
Other items included in 5.4.3 (Air Leakage)

- 5.4.4.2 Fenestration
- 5.34.3.3 Loading Dock Weatherseals
- 5.4.3.4 Vestibules

BUILDING CODES ASHRAE 90.1

INTERNATIONAL ENERGY CONSERVATION CODE - 2012

- Similar language and requirements to ASHRAE 90.1-2010
- C402.4 Air Leakage outlines
  - Zones excluded (Climate zone 1, 2 and 3)
  - Air barrier construction compliance
  - 3 compliance options



BUILDING CODES ASHRAE 90.1

INTERNATIONAL ENERGY CONSERVATION CODE - 2012

Material C402.4.1.2.1	Assembly C402.4.1.2.2	Building Test C402.4.1.2.3

• ASTM 2178
• 0.004 cfm / ft^2
• List of 15 materials that are acceptable – *provided joints are sealed and installed as an air barrier*
	• ASTM 2357, 1677 or 283
	• 0.04 cfm / ft^2
	• List of 2 assemblies deemed to comply, if joints are sealed
	  • Concrete Masonry Walls (coated with block filler or two coats of a paint or sealant)
	  • Portland Cement / sand parge, stucco or plaster (min ½ inch)
		• ASTM 779
		• 0.40 cfm/ft^2
		• Or equivalent method approved by code official

AIR BARRIERS

INSTALLATION

INSTALLATION

VARIOUS AIR BARRIER MATERIALS

INSTALLATION

TYPICAL AIR BARRIER MATERIALS

- Self Adhered Membranes
- Liquid Applied Membranes
- Medium Density Sprayed Polyurethane Foam
- Board Stock – Rigid Cellular Thermal Insulation Board
- Factory Bonded Membranes to Sheathing
- Mechanically Fastened Commercial Building Wraps

INSTALLATION

TYPICAL AIR BARRIER MATERIALS

- Substrate Prep is key to all materials !

INSTALLATION

SELF ADHERED MEMBRANES

- Key Installation:
  - Proper overlap of joints and seams
  - Seal around all penetrations with mastic/sealant
  - Provide backing at deflection and control joints
  - Do not span gaps larger than recommended by manufacturer
  - Roll membrane to enhance adhesion

INSTALLATION

SELF ADHERED MEMBRANES

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

INSTALLATION

SELF ADHERED MEMBRANES – PROPER INSTALL

INSTALLATION

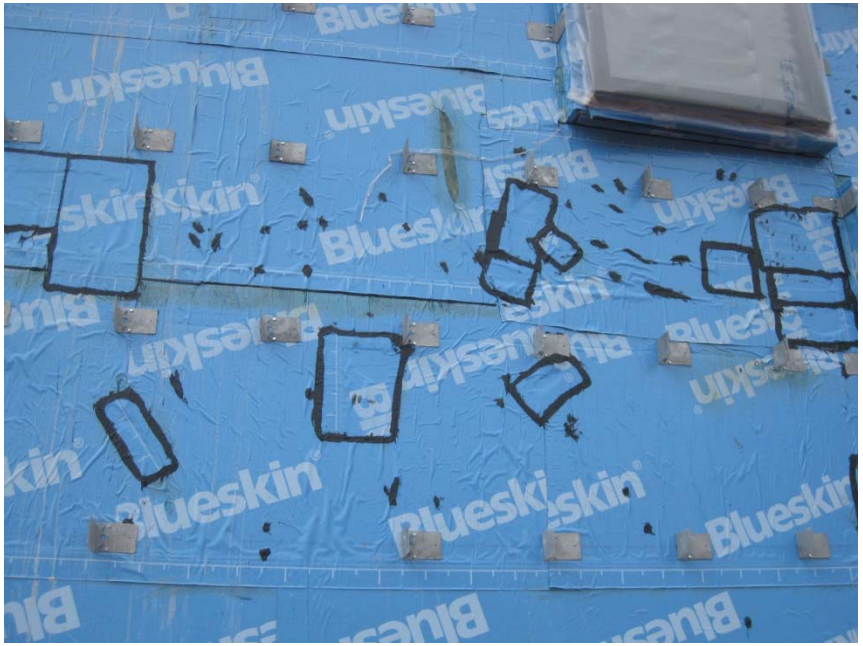
SELF ADHERED MEMBRANES – PROPER INSTALL

INSTALLATION

SELF ADHERED MEMBRANES – PROPER INSTALL

INSTALLATION

SELF ADHERED MEMBRANES – POOR INSTALL

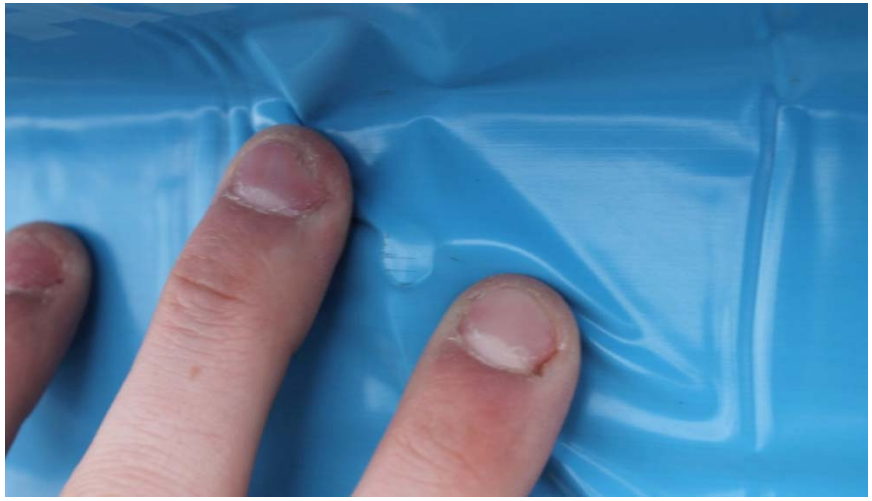


INSTALLATION

SELF ADHERED MEMBRANES – POOR INSTALL

INSTALLATION

SELF ADHERED MEMBRANES – POOR INSTALL



INSTALLATION

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

INSTALLATION

LIQUID APPLIED MEMBRANES

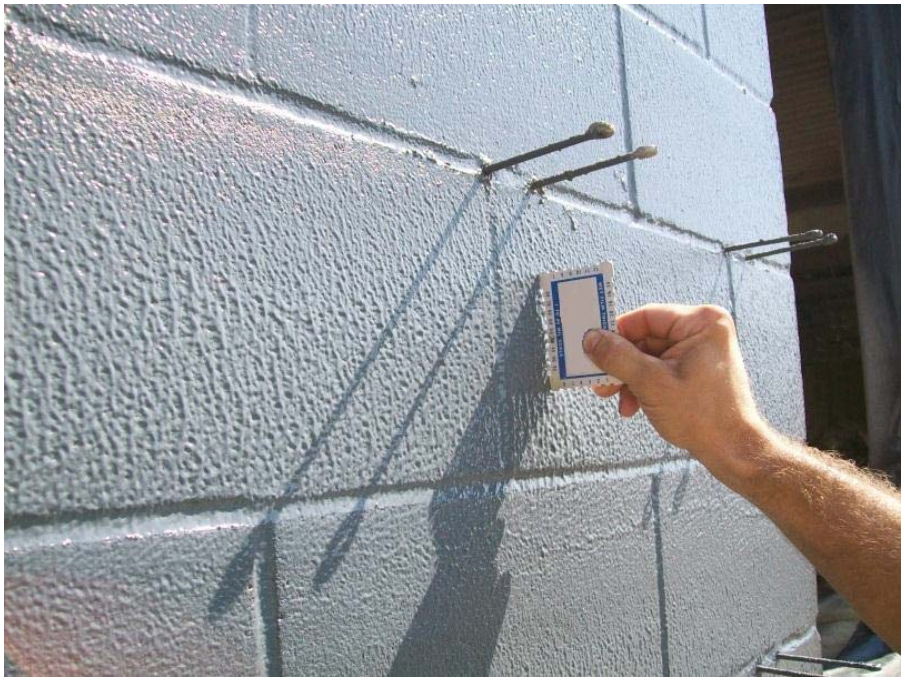
- Common Field Issues
  - Insufficient thickness
  - Slumping of material
  - Missed detailing
  - Poor substrate preparation
  - Blisters or pin holing
  - Application over gaps that have not been pre-treated

INSTALLATION

FLUID APPLIED MEMBRANES – PROPER INSTALL

INSTALLATION

FLUID APPLIED MEMBRANES – PROPER INSTALL



INSTALLATION

FLUID APPLIED MEMBRANES – POOR INSTALL

INSTALLATION

FLUID APPLIED MEMBRANES – POOR INSTALL

INSTALLATION

FLUID APPLIED MEMBRANES – POOR INSTALL

INSTALLATION

MEDIUM DENSITY SPF

- Key Installation
  - Environmental conditions (wind, temperature, humidity)
  - Health and Safety of applicator and work site
  - Thickness of passes
  - Equipment settings (pressure, temperature, 1:1 ratio)

INSTALLATION

MEDIUM DENSITY SPF

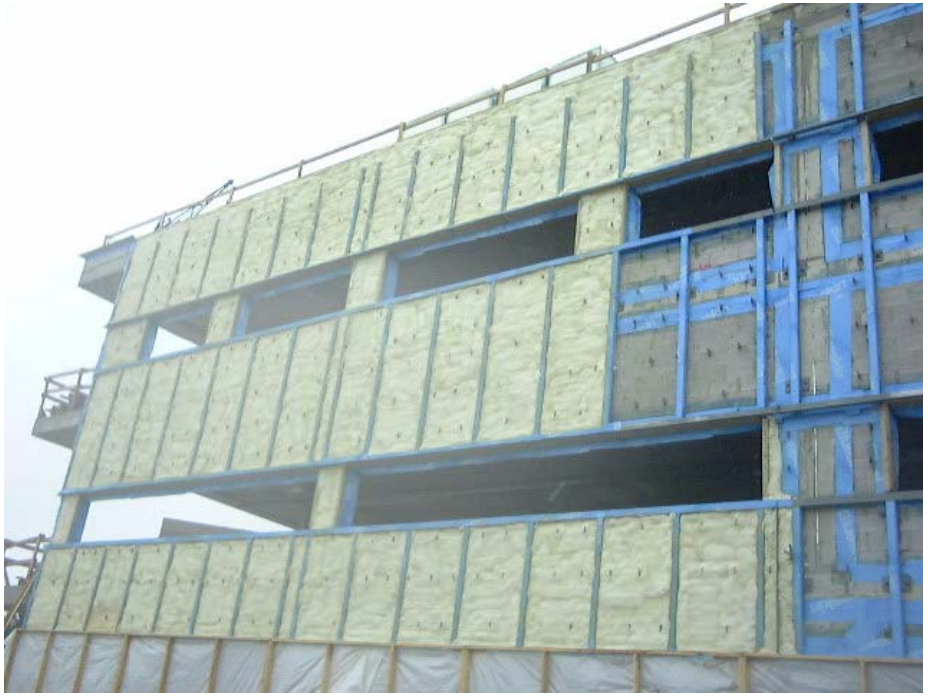
- Common Field Issues
  - Insufficient thickness
  - Off-ratio
  - Adhesion to transition membranes and substrate
  - Other trades entering spraying area
  - Missing transition membrane at window openings, roof/wall intersection

INSTALLATION

SPRAYED POLYURETHANE FOAM – PROPER INSTALL

INSTALLATION

SPRAYED POLYURETHANE FOAM – PROPER INSTALL



INSTALLATION

SPRAYED POLYURETHANE FOAM– POOR INSTALL

INSTALLATION

SPRAYED POLYURETHANE FOAM– POOR INSTALL

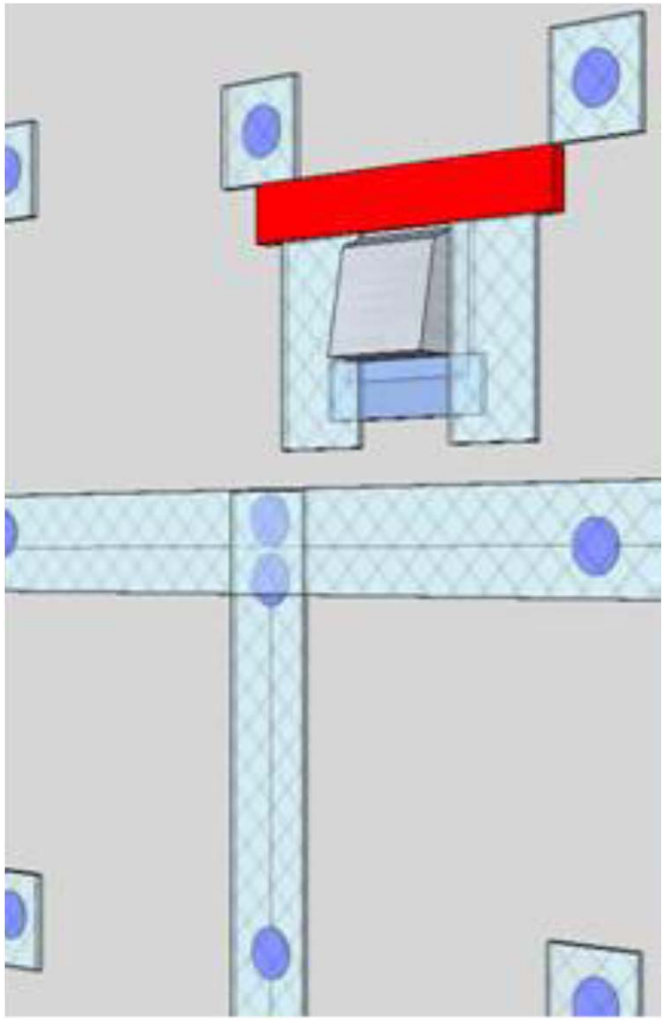
INSTALLATION

SPRAYED POLYURETHANE FOAM– POOR INSTALL

INSTALLATION

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



INSTALLATION

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

INSTALLATION

BOARD STOCK– PROPER INSTALL

INSTALLATION

BOARD STOCK – POOR INSTALL

INSTALLATION

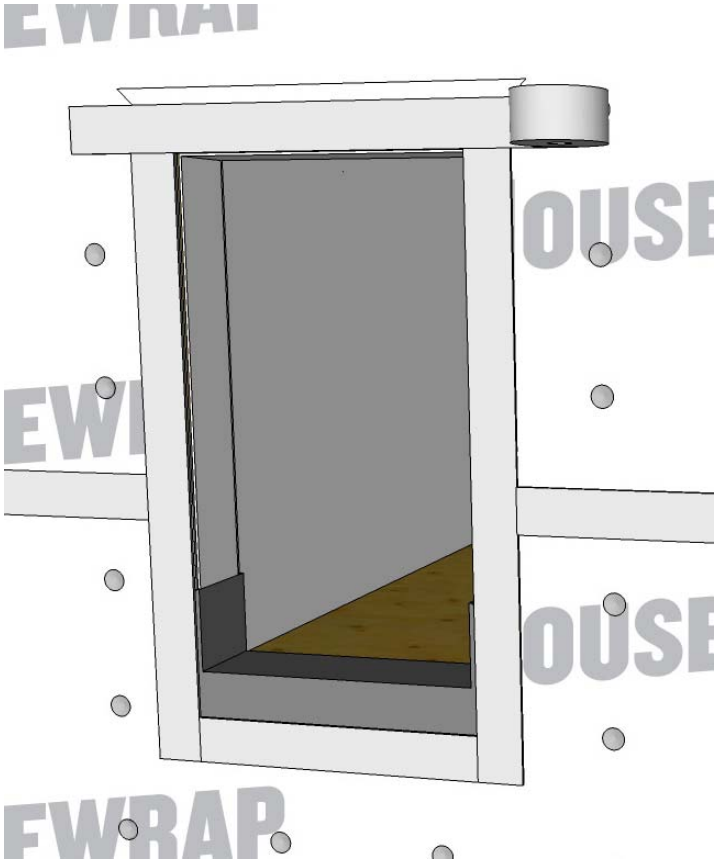
MECHANICALLY FASTENED COMMERCIAL BUILDING WRAP

- Proper Substrate Preparation
  - Address protrusions that might puncture material

INSTALLATION

MECHANICALLY FASTENED COMMERCIAL BUILDING WRAP

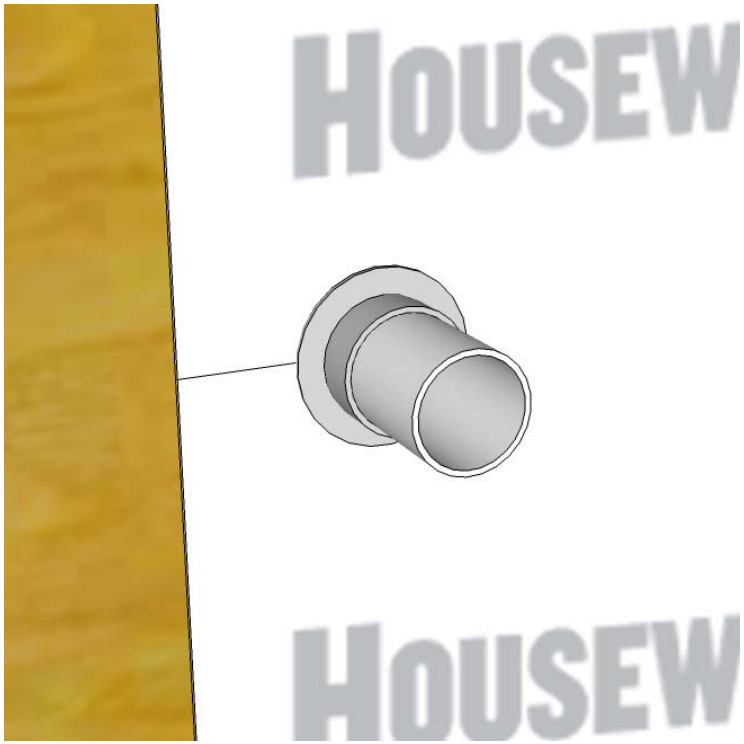
- Key Installation
  - Proper type of fasteners and fastening pattern
  - Proper overlap of seams and corners
  - Taping all seams
  - Detailing penetrations and details (windows, doors, etc)



INSTALLATION

MECHANICALLY FASTENED COMMERCIAL BUILDING WRAP

- Common Field Issues
  - Damage and tears during construction
  - Installation over sharp objects
  - Insufficient overlap of seams
  - Lack of integration into windows, doors and other openings



INSTALLATION

COMMERCIAL BUILDING WRAP – PROPER INSTALL

INSTALLATION

COMMERCIAL BUILDING WRAP – POOR INSTALL

INSTALLATION

COMMERCIAL BUILDING WRAP – POOR INSTALL

INSTALLATION

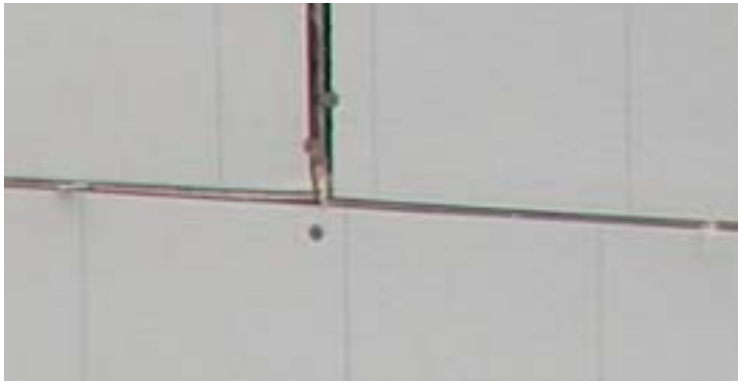
FACTORY BONDED MEMBRANES TO SHEATHING

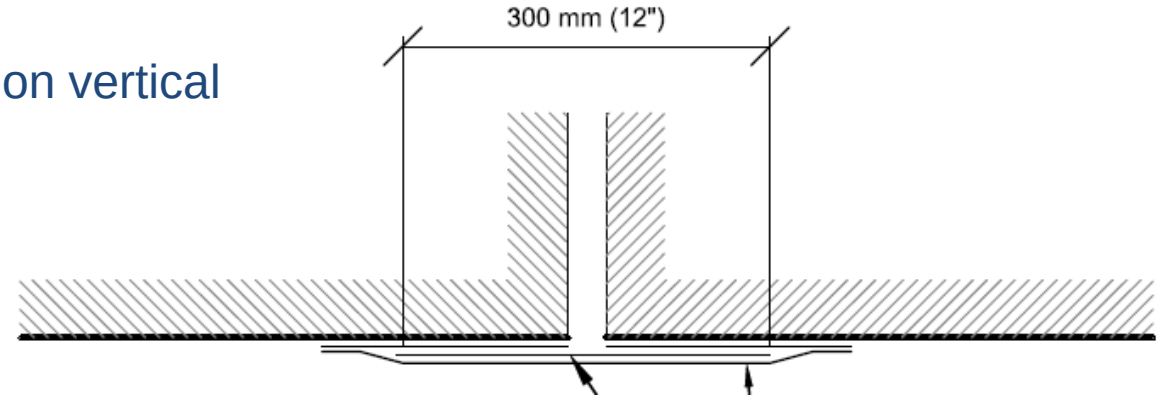
- Proper Substrate Preparation
  - Product is substrate
  - Proper fastening to substrate with recommended fasteners
  - Priming of membranes over sheathing

INSTALLATION

FACTORY BONDED MEMBRANES TO SHEATHING

- Key Installation
  - Treating of seams, edges, end joints and through wall penetrations with membranes
  - Off-set vertical joints
  - Membrane installation on vertical joints, then horizontal





INSTALLATION

FACTORY BONDED MEMBRANES TO SHEATHING

- Common Field Issues
  - Missed transition membranes or insufficient overlap
  - Over driven fasteners
  - Lack of primer for transition membranes

INSTALLATION

QUALITY ASSURANCE

Specification Language:

- Air Barrier Subcontractor Qualifications: Air barrier Subcontractor(s) shall be accredited at the time of bidding and during the complete installation period by the Air Barrier Association of America (ABAA) whose Installer(s) are certified in accordance with the site Quality Assurance Program used by ABAA.

- Implement the ABAA Quality Assurance Program

Thank you for your time!

Question and Answer Period

This concludes The American Institute of Architects
Continuing Education Systems Course

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