2025 SPRAYFOAM Convention & Expo
Daytona Beach, FL February 9-12

Air Barriers are Really Simple, Right?

THEN WHY ALL THE CONFUSION?

LAVERNE DALGLEISH

Laverne Dalgleish
Executive Director, Air Barrier Association of America

Laverne has promoted high performance durable building both in North America and Internationally, He started the Air Barrier Association of America in 2001 which has grown into a whole industry and air barriers have become a Building Code requirement.
He continues to work on developing standards and in implementing site quality assurance programs.

ldalgleish@buildingprofessionals.com
Cell: 204 771 7351

SPFA SPRAY POLYURETHANE FOAM ALLIANCE

SPFA Antitrust Policy

"Our policy is to comply with all federal, state and local laws, including the antitrust laws. It is expected that all company member representatives involved in SPFA activities and SPFA staff will be sensitive to the unique legal issues involving trade associations and, accordingly, will take all measures necessary to comply with U.S. antitrust laws and similar foreign competition laws."

It is a per se violation of the federal antitrust laws for competitors to agree on prices, limitation of supplies, allocation of customers or territory, or boycotts. "Per se" means that no legal defense can be used to mitigate this automatic violation.

Even an agreement by competitors that is for the good of society and our industry may be a violation of the antitrust laws if it could affect competition.

If a topic of antitrust concern is raised at any time during a meeting, note your objection for the record. If the topic continues to be discussed, you should leave the room immediately and contact SPFA's general counsel and your company's attorney for further guidance.

Ensure that every SPFA meeting, where members are present, has an agenda, the agenda is followed, and minutes are kept by SPFA staff of the proceedings.

Understanding and acting on the requirements of U.S. and foreign antitrust and competition laws sometimes can be difficult. If you have a question about the propriety of activities or discussions in SPFA, you are encouraged immediately to contact your company's legal counsel and SPFA management.

Spanish Translation Disclaimer

This presentation will include subtitles generated automatically based on the speaker's voice using automated translation software.

SPFA has undertaken reasonable efforts to provide an accurate translation, however, no automated translation is perfect nor is it intended to replace human translators. The translated subtitles are provided as a service and "as is." SPFA makes no warranty or representation of any kind as to the accuracy, reliability, or correctness of any of the translated subtitles. Any discrepancies or differences created in the translation from English to Spanish are not binding and have no legal effect for compliance, enforcement or other purposes.

Air Barriers are Really Simple, Right?

Air barriers start out really simple, it is simply a material that stops or reduces the flow of air through a material. The first thing people think of is why is this different than a vapor barrier? The next question is where do I put an air barrier? On the inside? On the outside? Does it Matter? Now this is where it starts to get complicated. There is a saying that all questions should be answered with "It Depends" which in this case is very true. This presentation will walk you through the decisions you need to make when designing and installing air barriers and point out some pitfalls you want to avoid.

Air Barriers are Really Simple, Right?

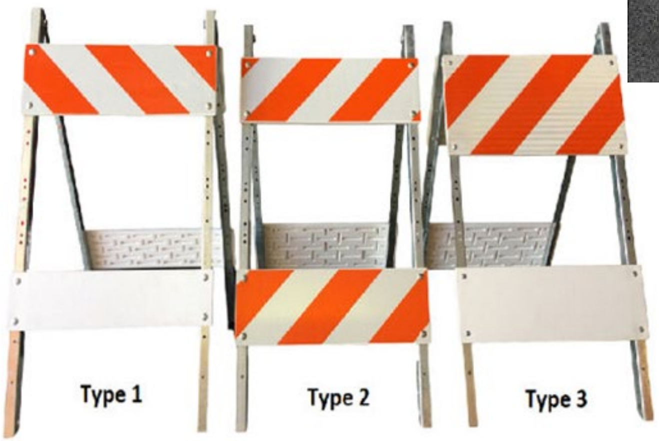
Learning Objectives

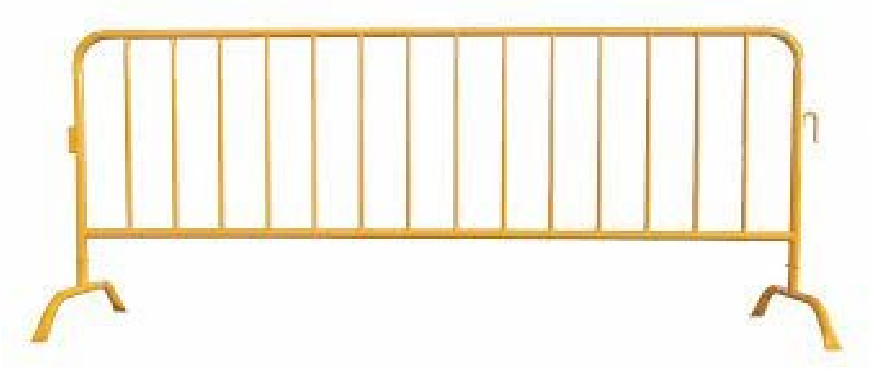
1. Identify the main reason why you would install an air barrier in a building
2. Explain the difference between an air barrier and a vapor barrier
3. Characterize the key requirements for an air barrier
4. Compare the amount of water transfer of a vapor barrier and an air leak
5. List the benefits resulting from an airtight building

Air Barriers are Really Simple, Right?

- Air barriers. Vapor barriers. Water-resistive barriers are all the same right?
- No – So why is there some much confusion?
- The answer is also confusing

Some people take the position that nothing is absolute, so there cannot be any “barriers”.





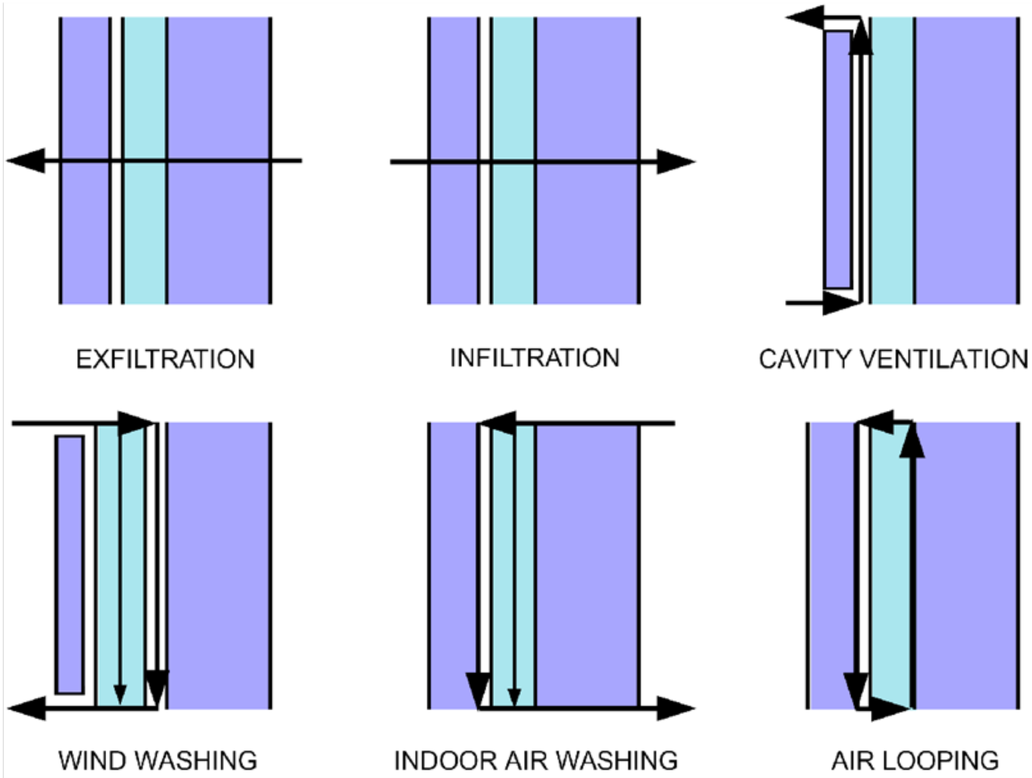
SPFA
SPRAY POLYURETHANE FOAM ALLIANCE

What is an Air Barrier?

Control layer or plane of air tightness which stops (significantly reduces) air from passing through a material

People automatically jump to an air barrier material but does a material provide the control layer or plane of airtightness?

What is an Air Barrier?

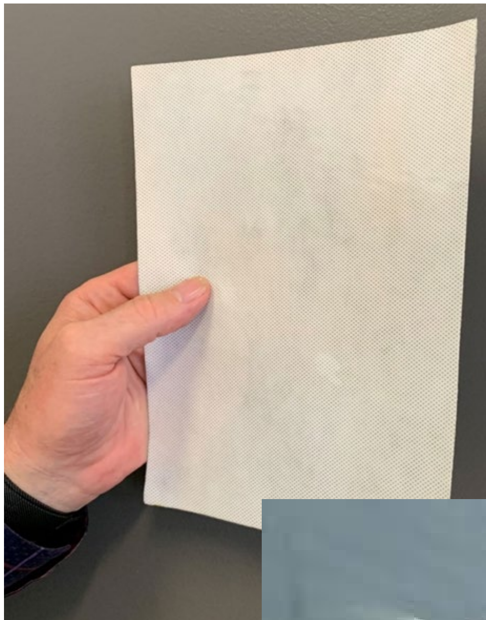


What is an Air Barrier?

What is the performance requirement for an air barrier?

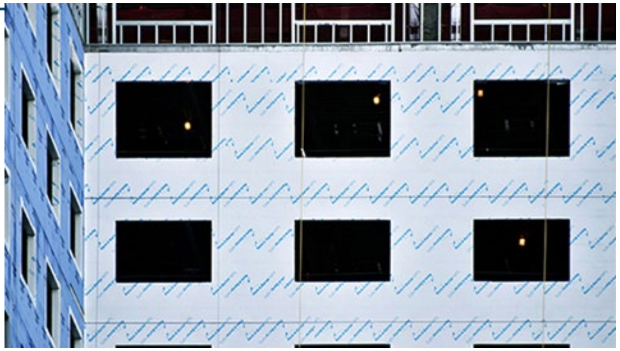
- Depends on
- Material
- Accessory
- Sub-Assembly
- Assembly
- Component
- System

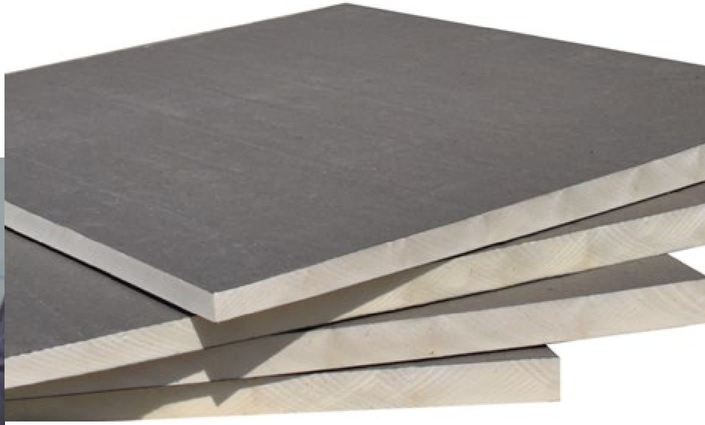
What is an Air Barrier?



SPFA
SPRAY POLYURETHANE FOAM ALLIANCE

What is an Air Barrier?





What is an Air Barrier?

Air barrier requirements	
Air Barrier Material - the big pieces	**0.004** CFM/ft²@ 1.56 lbs/ft² pressure difference (ISO 14857 ASTM E2178)
Air Barrier Accessory – tapes, strips, caulking, etc.	**0.004** CFM/ft²@ 1.56 lbs/ft² pressure difference (ASTM E283)
Air Barrier Component – windows, doors, skylights, etc.	**0.04** CFM/ft²@ 1.56 lbs/ft² pressure difference (ASTM E283)
Air Barrier Assembly - wall assembly, roof assembly, foundation assembly	**0.04** CFM/ft²@ 1.56 lbs/ft² pressure difference (ASTM E2357)
Air Barrier System - Whole Building	**0.10*** CFM/ft²@ 1.56 lbs./ft² pressure difference (ISO 9972, ASTM E 779 ABAA AB-001)
*proposed maximum air leakage rate	

SPRAY POLYURETHANE FOAM ALLIANCE

What is a Vapor Retarder (Barrier)?

- Material designated to reduce the water vapor transmission rate through the material

What is a Vapor Retarder (Barrier)?

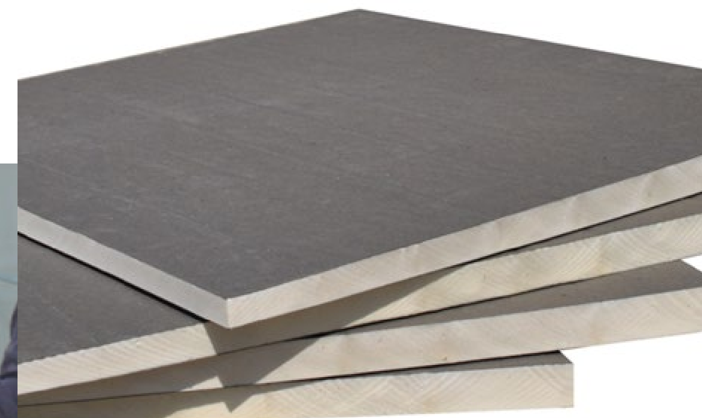
- **Material** designated to reduce the water vapor transmission rate through the material
- Notice we have specifically identified a material – no accessories, sub-assemblies, assemblies or systems
- Every construction material has a water vapor transmission rate

What is a Vapor Retarder (Barrier)?

Vapor Retarder (Barrier) Performance Requirements		
Vapor Retarder (Barrier) Material - the big pieces, there are only pieces – big or small		
International Building Code Table 1404.3(2)	Climate Zone 1,2 3,4 (except Marine 4) Marine 4, 5,6,7,8	Vapor Retarder Class III II,III I, II, III (Table 1404.3(3)
A vapor retarder should be the simplest control layer in a building assembly, but it is the most complex		

Class I	less than or equal to 0.1 Perm
Class II	greater than 0.1 Perm and less than or equal to 1.0 Perm
Class III	greater than 1.0 perm and less than or equal to 10.0 Perms

What is an Vapor Retarder (Barrier)?



SPRAY POLYURETHANE FOAM ALLIANCE

What is a Vapor Retarder (Barrier)?

- **Material** designated to reduce the water vapor transmission rate through the material
- Notice we have specifically identified a material – no accessories, sub-assemblies, assemblies or systems
- Every construction material has a water vapor transmission rate

What is a Water-Resistive Barrier?

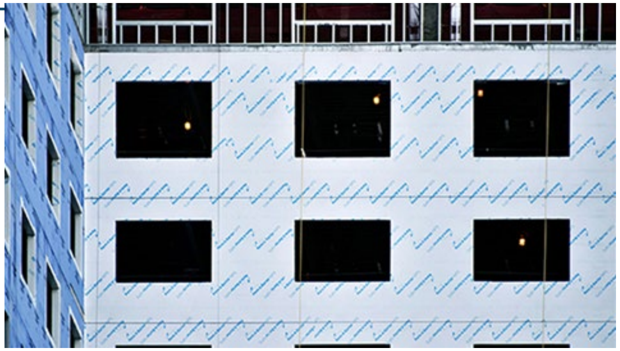
- Assembly of materials and accessories behind an exterior wall covering that is intended to resist the further intrusion of liquid water that has penetrated the exterior covering into the exterior wall assembly
- Code has got this right – it's an assembly which also can be called a control layer

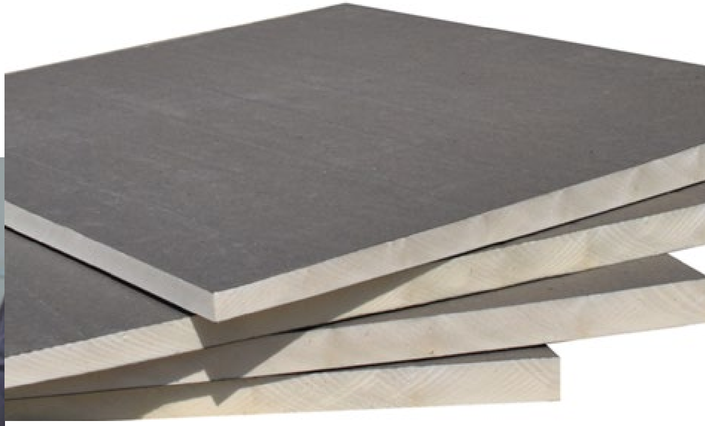
What is a Water-Resistive Barrier?

Water-Resistive Barrier Performance Requirements	
Water-Resistive Barrier Material - the big pieces	No liquid water through the material
Water-Resistive Barrier Accessories - Flashings, etc.	No liquid water through the material
Water-resistive barriers seems to be straight forward – keep water out	

SPRAY POLYURETHANE FOAM ALLIANCE

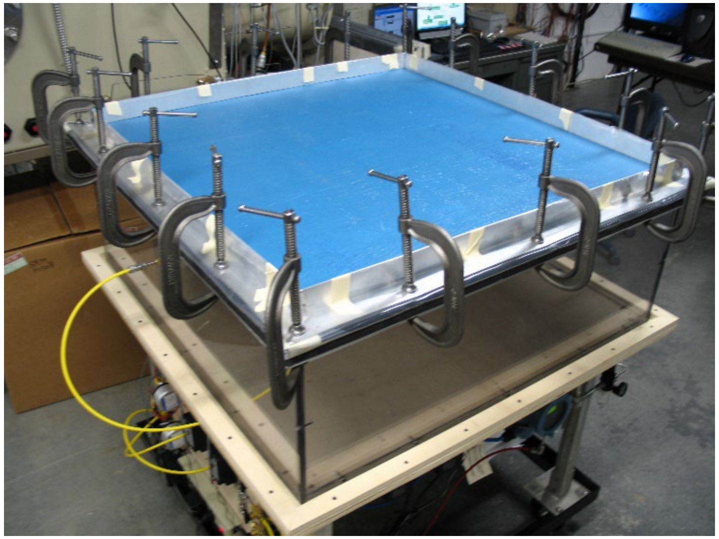
What is a Water-Resistive Barrier?

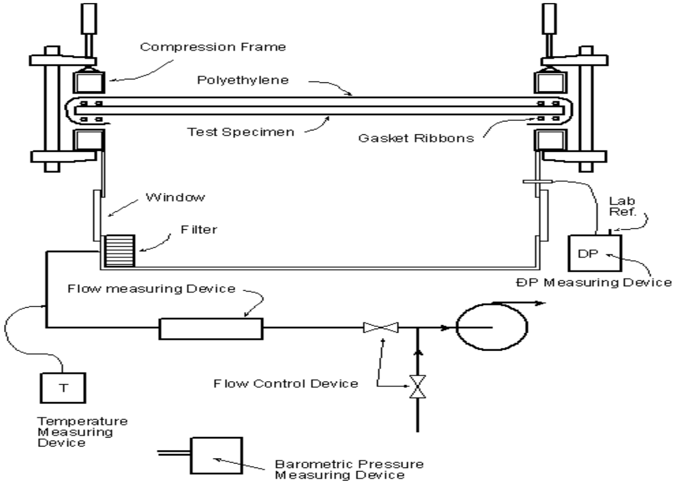




How do we test a air barrier Material?

ASTM E2178 Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials





How do we test a air barrier Material?

ASTM E2178 Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials

Kraft smooth peanut butter
Applied at 20 mils wet
Air leakage result -
0.0021 L/s·m^2 – it meets the requirement
However, would you use this material in your project?

Figure 5 –Full Application of Peanut Butter

ABAA Material Specifications

ABAA S0001, *Standard for Air and Water-Resistive Barriers – Medium Density Closed Cell Rigid Spray Polyurethane Foam – Material Specification*

ABAA S0003, *Standard for Air Barrier Material - Light Density Open Cell Semi-Rigid Spray Polyurethane Foam - Material Specification*

ABAA S0005, Standard for Air Barrier Material– Non-Insulating Sheathing - Gypsum Based - Material Specification

ABAA S0006, *Standard for Air Barrier Material - Mechanically Fastened Engineered Polymer Film - Material Specification*

ABAA S0007, *Standard for Air and Water-Resistive Barriers – Self-Adhered Sheet Membrane, Bitumen Based – Material Specification*

ABAA S0008, *Standard for Air and Water-Resistive Barriers – Fluid Applied Membrane – Material Specification*

ABAA T00010*, Standard Method for Building Enclosure Airtightness Compliance Testing*

ABAA S0011, *Standard for Air Barrier Material - Low Density Open Cell Rigid Spray Polyurethane Foam - Material Specification*

ABAA S0012, *Standard for Air and Water-Resistive Barriers – Factory-Bonded Membranes to Sheathing – Material Specification*

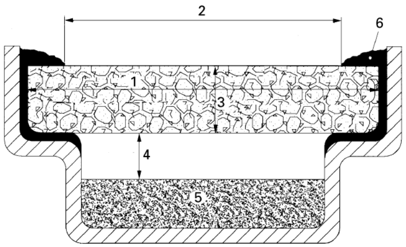
ABAA S00013, *Standard for Air and Water-Resistive Barriers – Mechanically Fastened Commercial Building Wraps – Material Specification*

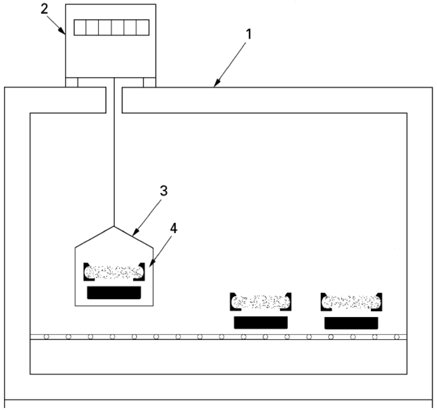
ABAA S0014, *Standard for Air and Water-Resistive Barriers – Rigid Cellular Thermal Insulation Board – Material Specification*

How do we test a vapor retarder (barrier)?

ASTM E96 Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

Procedure A Desiccants Method 0/50% R.H. and 73.4 °F
Procedure B Water Method 100/50% R.H. and 73.4 °F





SPFA SPRAY POLYURETHANE FOAM ALLIANCE

How do we test a vapor retarder (barrier)?

Change the temperature for E96 or change the atmospheres – you change the results

How often will a building assembly be at 73.4 °F or the material be in an atmosphere of either 25% or 75% R.H.?

How do we test a vapor retarder (barrier)?

What's the big deal? How bad can that be?

Sampling of water vapor transmission rates (ABAA website for fluid-applied evaluated material) n = 11			
Fluid-Applied	Desiccant method ng	Water method ng	Difference
Min WVT Rate	0.572	0.572	0 percent
Max WVT Rate	1763	2830	61 percent
Mean WVT Rate	0.89	1.8	102 percent
Min Percent Difference **Same material**	4.96 0.086 Perms	5.15 0.090 Perms	4 percent
Max Percent Difference **Same material**	4.3 0.075 Perms	2034 35.436 Perms	47,202 percent
Mean Percent Difference **Same material**	418 7.282 Perms	870 15.156 Perms	108 percent

How do we test a vapor retarder (barrier)?

ASTM E96 Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

Wood is an vapor barrier????

#2 spruce 2 x 4's when tested to E96 will be a Class II vapor retarder but in high humidity the moisture content of the wood will increase until moisture equilibrium – high enough the wood rots

How do we test a vapor retarder (barrier)?

ASTM E96 Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials

Every construction material has a water vapor transmission rate but here is where start to get into the problems

An air barrier material can also be a class of vapor retarder

How do we test a water-resistive barrier)?

AATCC TM127 Test Method for Water Resistance: Hydrostatic Pressure

No drops on the other side of the specimen

after 5 hours with a 55 cm (22 inches) water column

How do we test a water-resistive barrier)?

What’s the big deal? How bad can that be?

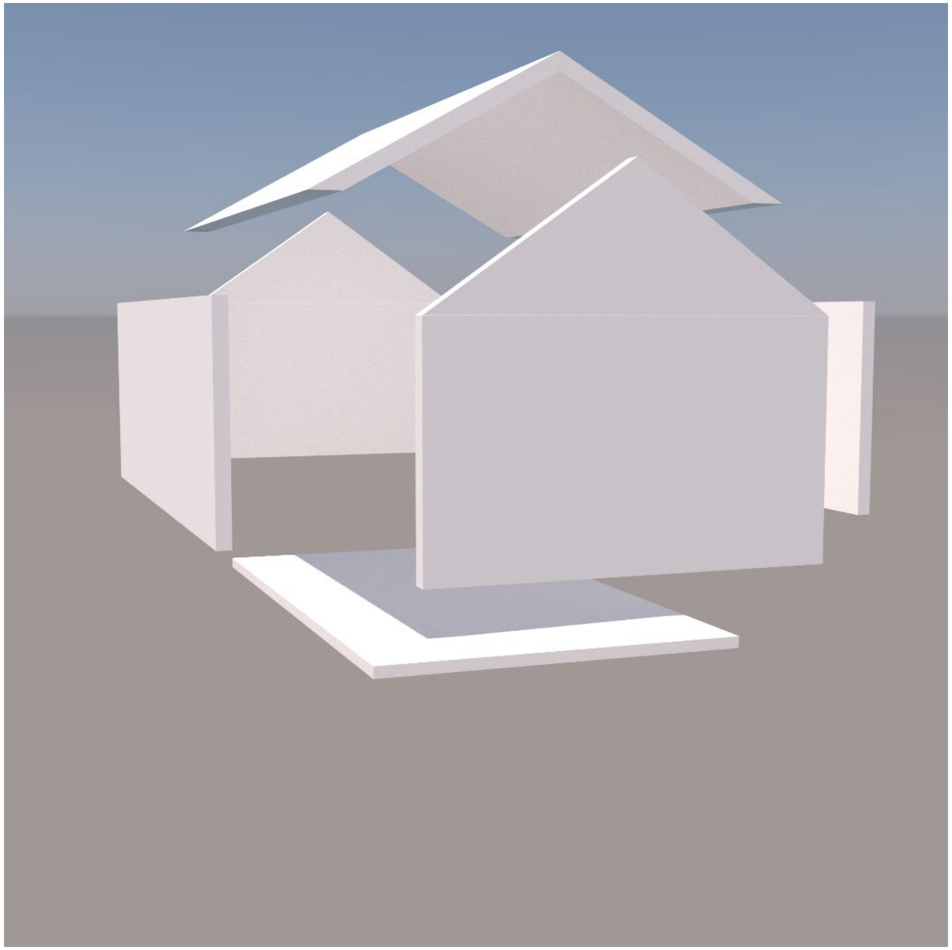
Good for thin materials – thick materials will become waterlogged but pass the test – 5/8-inch-thick gypsum boards

Building Assemblies (Walls, Roof, Foundation

Six sides to a building

Air leakage of air barrier assemblies critical for the airtightness of the whole building – all six sides

There are tests for walls and roofs



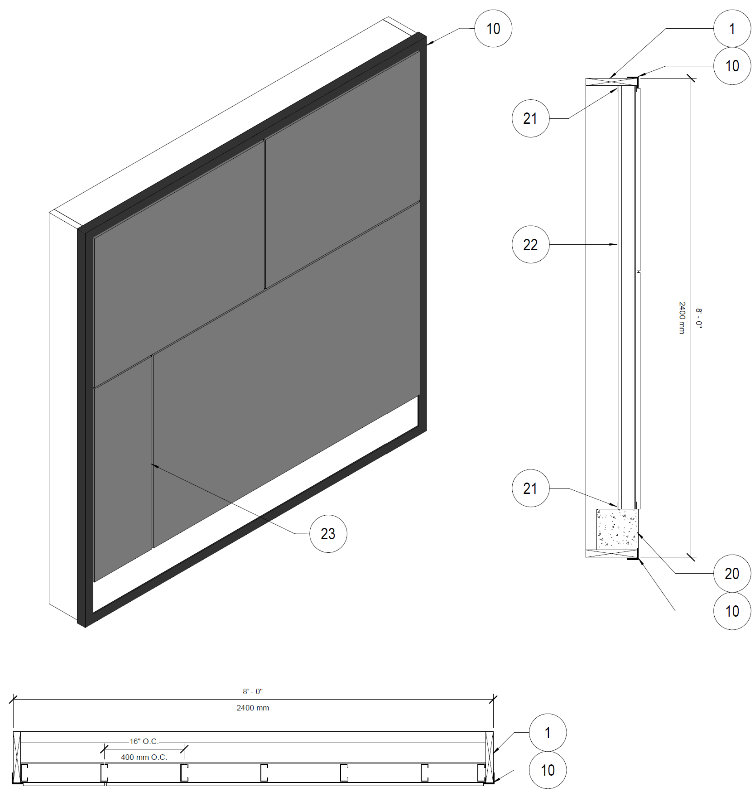
How do we test building assemblies for air leakage?

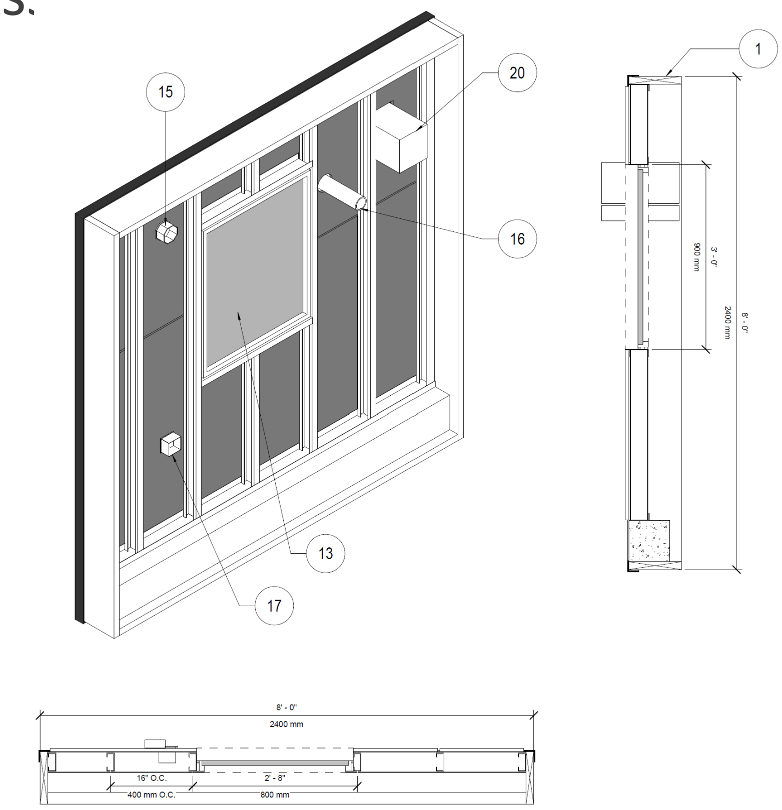
Have test methods for

- Walls – updating required
- Roofs – low slope and metal
- Foundations - TBD

How do we test building assemblies for air leakage– Walls?

ASTM E2357 Standard Test Method for Determining Air Leakage Rate of (Wall) Air Barrier Ass





How do we test building assemblies for air leakage – Walls?

ASTM E2357 Standard Test Method for Determining Air Leakage Rate of (Wall) Air Barrier Assemblies

SPFA
SPRAY POLYURETHANE FOAM ALLIANCE

How do we test building assemblies for air leakage– Walls?

ASTM E2357 Standard Test Method for Determining Air Leakage Rate of (Wall) Air Barrier Assemblies

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

How do we test building assemblies for air leakage – Roofs?

ASTM D8052 STANDARD TEST METHOD FOR QUANTIFICATION OF AIR LEAKAGE IN LOW-SLOPED MEMBRANE ROOF ASSEMBLIES

ASTM E1680 STANDARD TEST METHOD FOR RATE OF AIR LEAKAGE THROUGH EXTERIOR METAL ROOF PANEL SYSTEMS

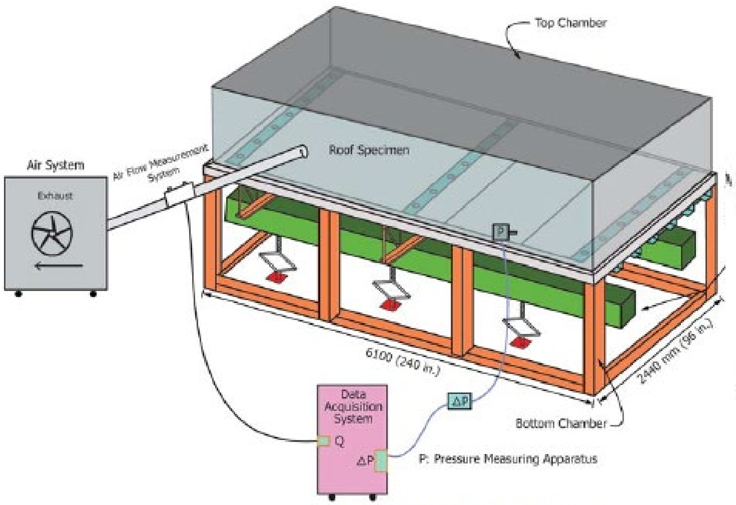
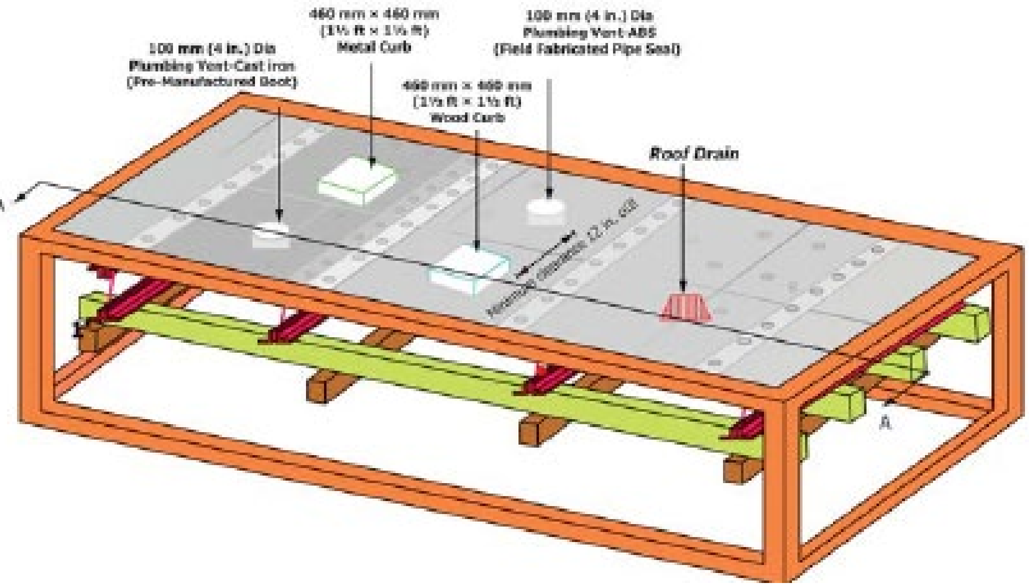
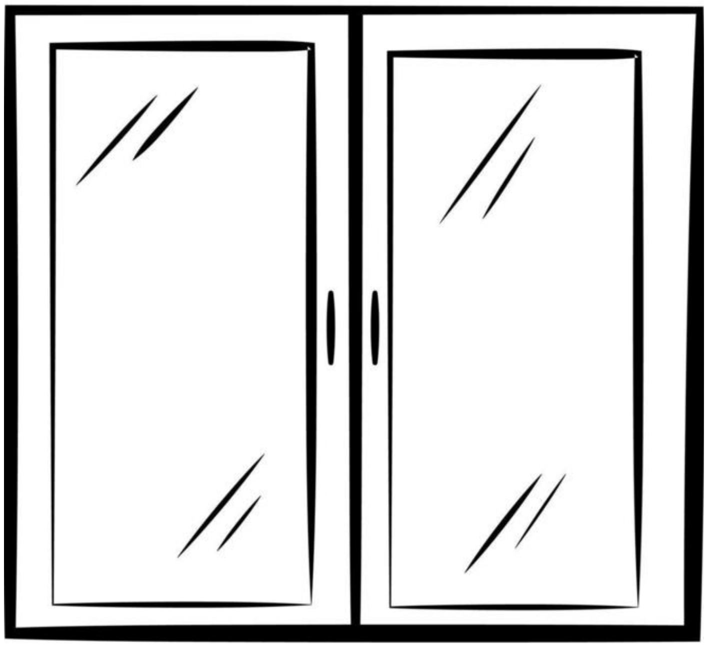


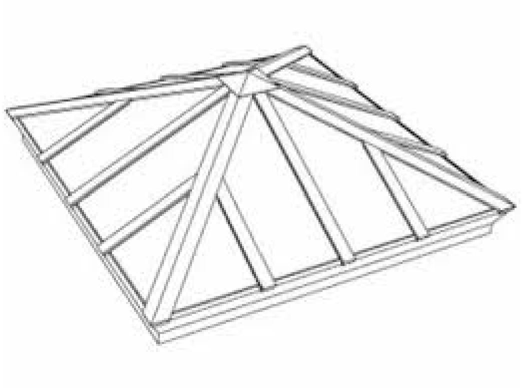
FIG. 1 Air Leakage Test Apparatus



How do we test air barrier components?

ASTM E283 Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen





SPFA SPRAY POLYURETHANE FOAM ALLIANCE

How do we test air barrier components?

ASTM E283 Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

Not only do they have to be airtight, but you need to connect the wall air barrier to them

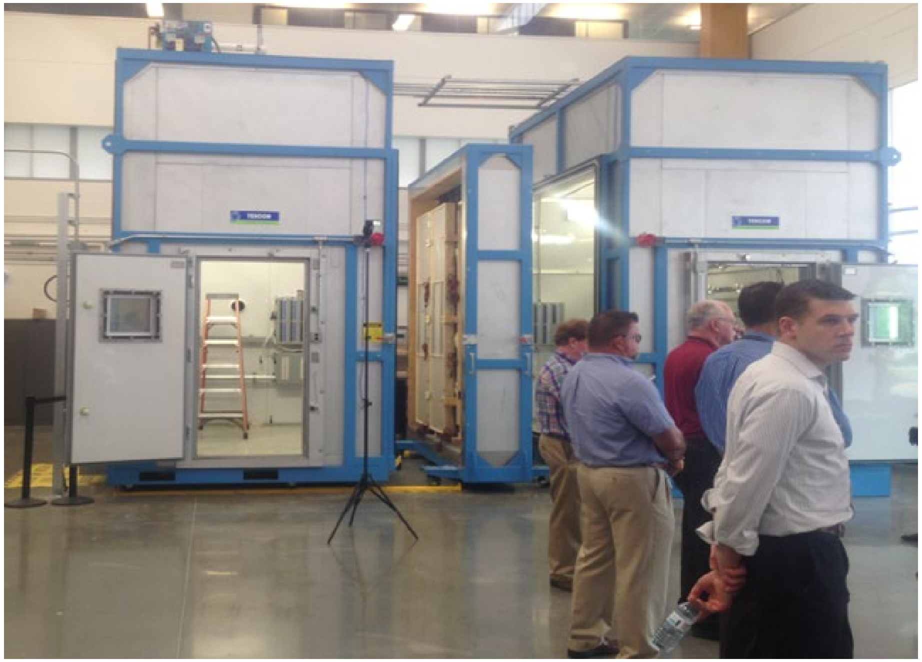
- ***Doors***
- ***Windows***
- ***Skylights***
- ***Curtain walls***
- ***Etc.***

SPFA
SPRAY POLYURETHANE FOAM ALLIANCE

How do we test water vapor transmission of building assemblies?

Same principal as ASTM E96, uses an environmental chamber (guarded hot box)
at steady state conditions

Water vapor transmission rate of building assemblies can be done but only applies to that specific wall assembly

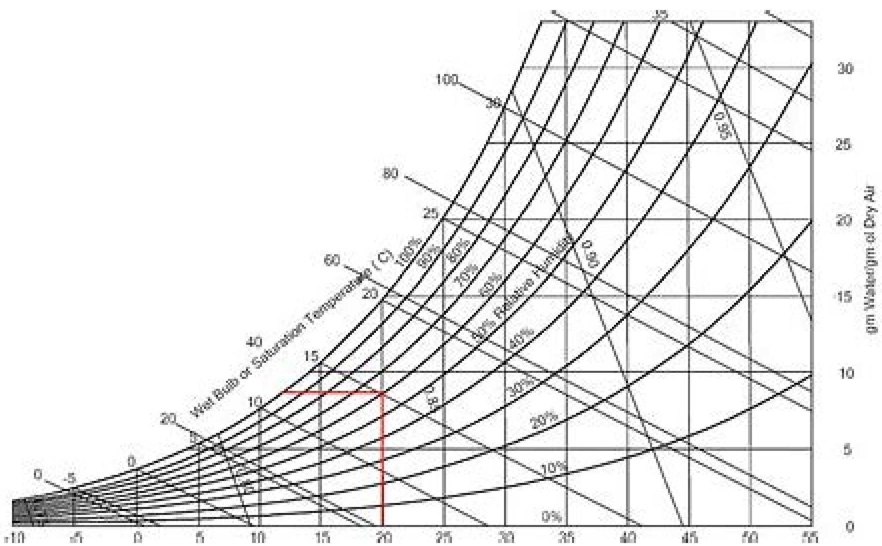


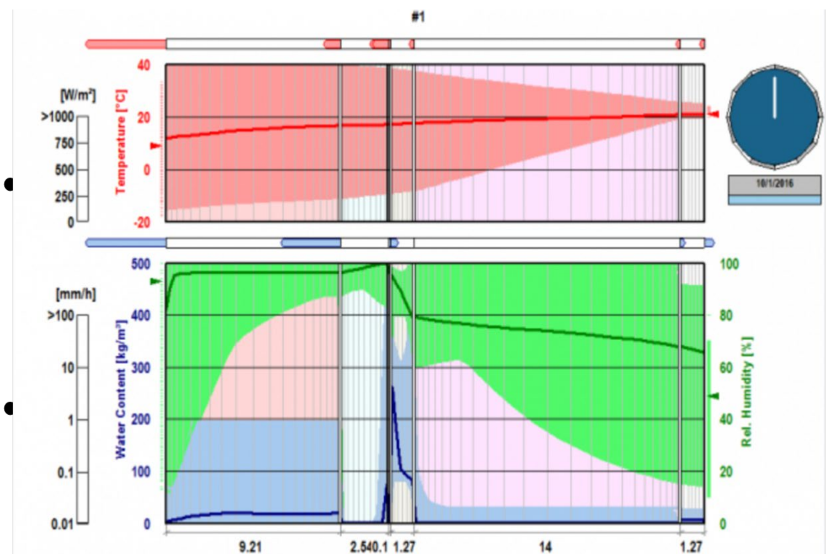
How do we model water vapor transmission of building assemblies?

More realistic approach is to use WUFFI modeling from ORNL which uses real weather data to produce realistic conditions

Uses WVTR of individual materials

Requires multiple data points to determine the curve





SPRAY POLYURETHANE FOAM ALLIANCE

How do we model water vapor transmission of building assemblies?

Have test method for building assemblies

Test expensive and generally used to validate modeling

Modeling uses real weather data

Results show wetting and drying of an assembly and when you cross the “critical” moisture content

How do we test water –resistive barriers in building assemblies?

Water ingress into a building assemblies is the predominate reason for degradation of a building

SPRAY POLYURETHANE FOAM ALLIANCE

How do we test water–resistive barriers in building assemblies?

ASTM E331 Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

ASTM E1105 Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference

How do we test water –resistive barriers in building assemblies?

SPRAY POLYURETHANE FOAM ALLIANCE

How do we test water –resistive barriers in building assemblies?

How do we test water –resistive barriers in building assemblies?

Good news – we have assembly tests for water intrusion

Bad news – they determine when water gets inside the building, we need to know when water gets past the water-restive barrier

Research project being carrier out by ABAA

Why do we have problems?

A single material can provide more than one function

Some materials can provide one function - air barrier

Some materials can provide two functions – air barrier and vapor barrier

Some material can provide three functions– air barrier, vapor barrier and water-resistive barrier

Some material can provide four functions– air barrier, vapor barrier, water-resistive barrier and thermal barrier (insulation)

Why do we have problems?

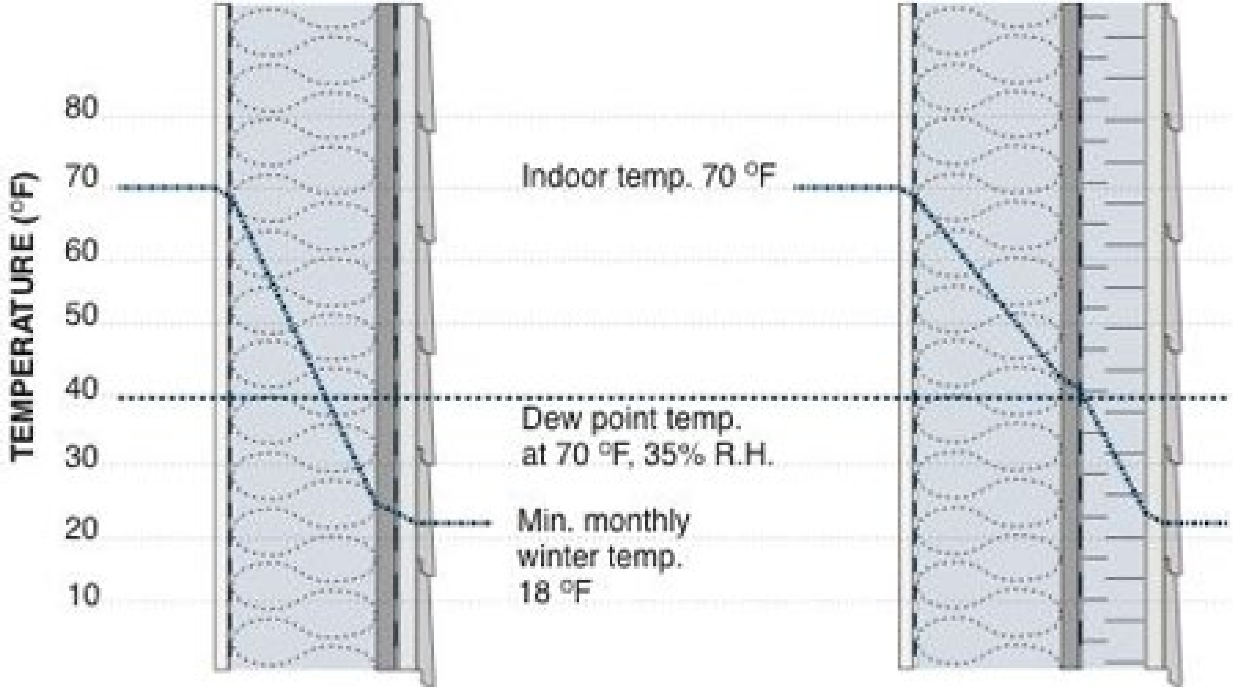
If a material can provide more than one function, do they automatically provide those functions?

NO – not unless they are designed and installed to provide that function

Why do we have problems?

Each material that is part of a wall assembly must be considered in the environment they are placed

Moving a material to a different place in an assembly with change the performance of the assembly

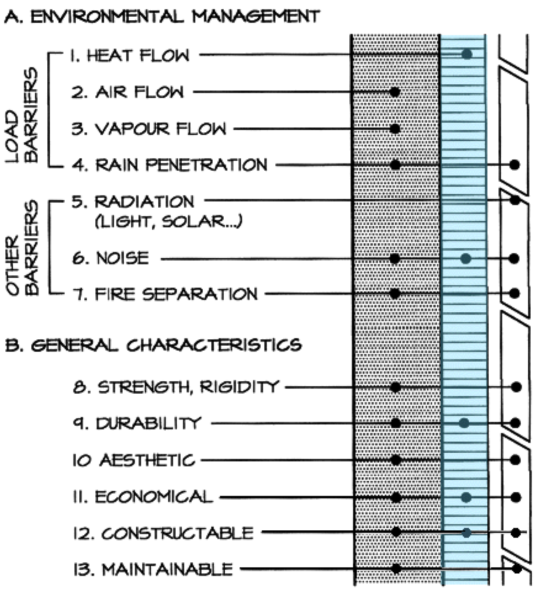


Why do we have problems?

The four control layers must be considered together in the following order

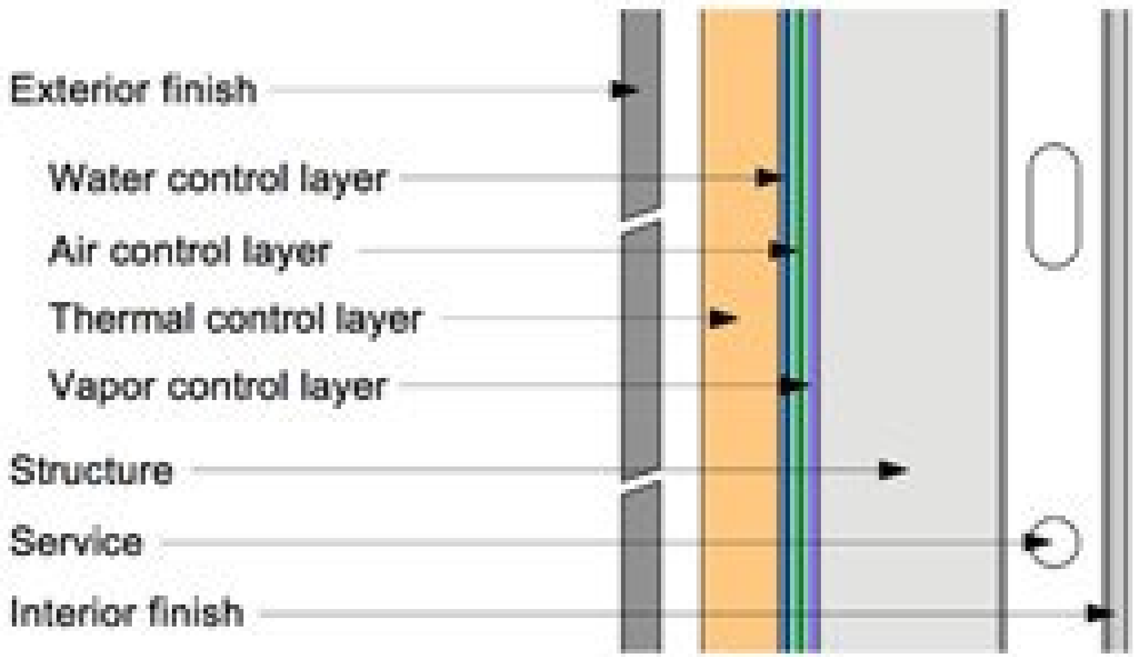
1. Rain penetration
2. Air Flow
3. Heat Flow
4. Vapor Flow

Yet we focus on the water vapor transmission of a single material



ENVELOPE REQUIREMENTS (PRIMARY FUNCTIONS)

A Simple Wall Construction

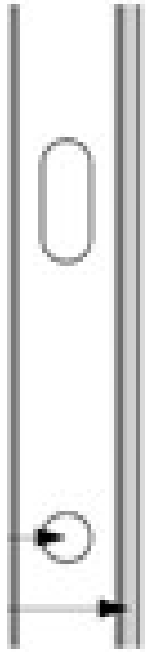


A Simple Wall Construction

Interior finish

- Gypsum boards can provide the airtight drywall approach
- Painted drywall can provide a Class II vapor retarder

Each will affect how the balance of the wall Will perform

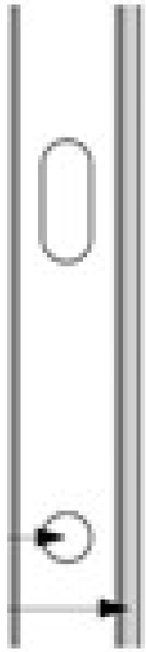


A Simple Wall Construction

Interior vapor retarder

- If polyethene film or other such material is used, it can be an air barrier and Class I vapor retarder

  The material will affect the interior finish and how the balance of the wall will perform

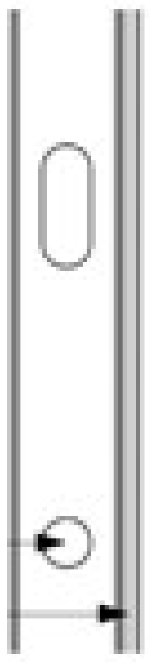


A Simple Wall Construction

Insulation between framing materials

- Insulation will result in a drop in temperature from one side of the insulation to the other
- If closed cell medium density insulation is used, it can be an air barrier material, Class II vapor barrier in addition to insulation

Insulation is affected by the interior finish and will affect the balance of the wall

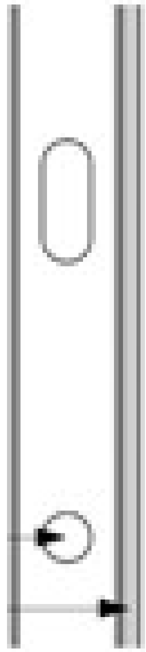


A Simple Wall Construction

Insulation between framing materials

- If the insulation is air permeable, without an air barrier warm moist air can move through the insulation and condensate on the cold side

  The gypsum could be the air barrier but **ONLY IF INSTALLED AS AN AIR BARRIER**

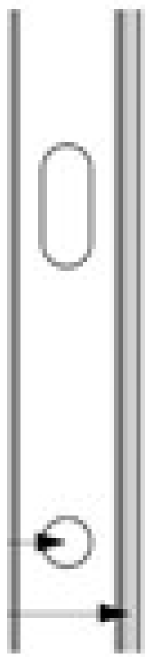


A Simple Wall Construction

Insulation between framing materials

- If the insulation is air permeable, without an air barrier warm moist air can move through the insulation and condensate on the cold side

  The polyethylene vapor barrier could be the air barrier but **ONLYIF INSTALLED AS AN AIR BARRIER**

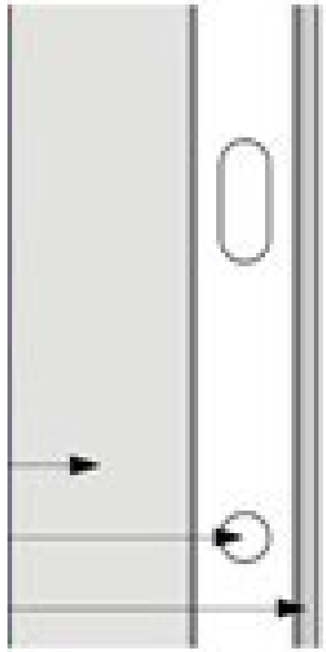


A Simple Wall Construction

Structure/backup wall/exterior sheathing

If gypsum boards, OSB at a minimum thickness or cast in place concrete, the exterior sheathing can be an air barrier

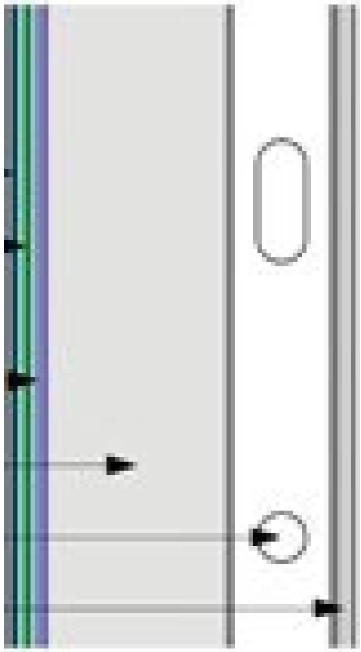
If CMU, the material is not an air barrier



A Simple Wall Construction

Water control layer

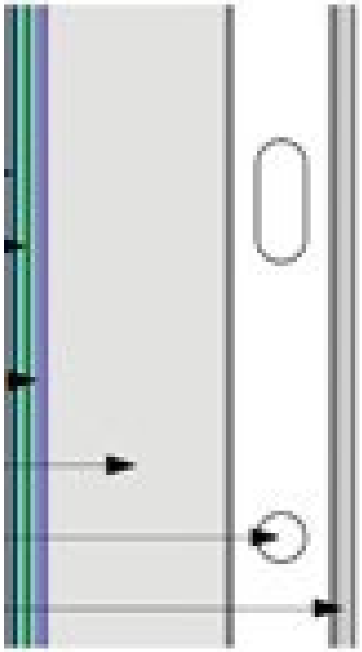
- Stops water ingress, must be continuous and combined with flashings
- Depending on the material, it could also be an air barrier, a vapor retarder or thermal insulation



A Simple Wall Construction

Air control layer

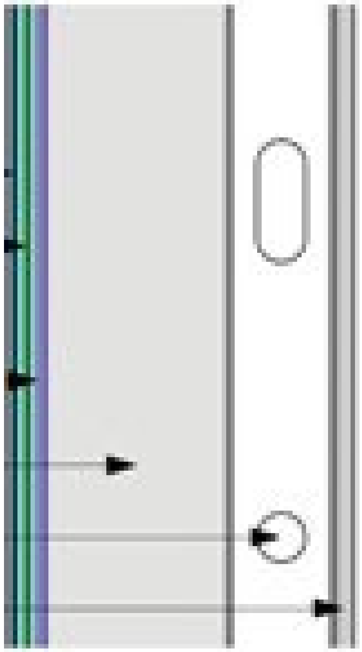
- Stops air leakage, must be continuous
- Depending on the material, it could also be a water-restive barrier, a vapor retarder or thermal insulation



A Simple Wall Construction

Vapor control layer

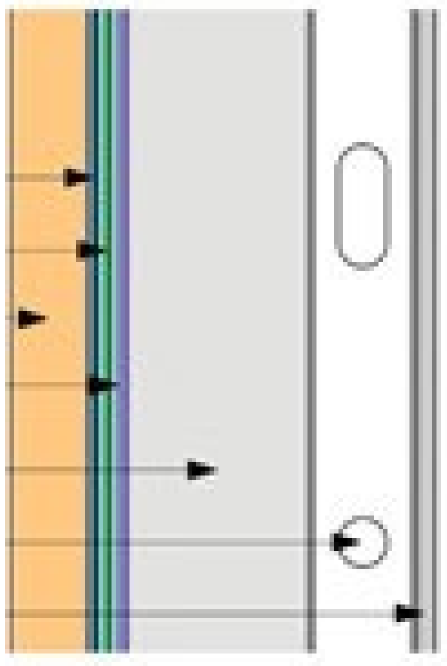
- Stops water vapor from moving **through** the material does not need to be continuous
- Depending on the material, it could also be an air barrier, a water-restive barrier or thermal insulation



A Simple Wall Construction

Exterior continuous insulation

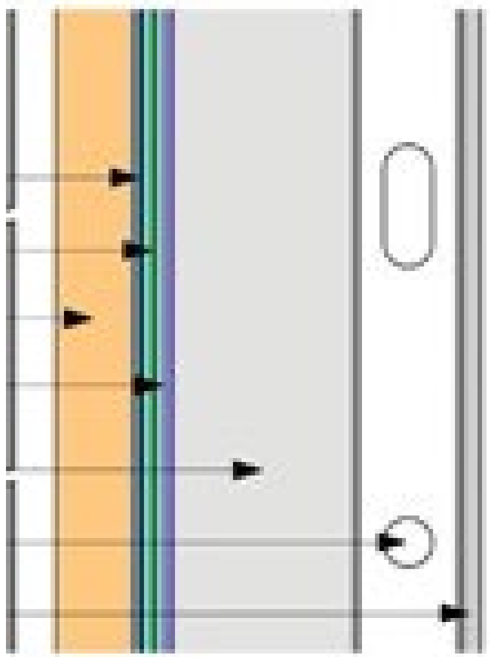
- Impacts the complete wall by changing the temperature gradient
- Depending on the material, it could also be an air barrier, a water-restive barrier or vapor retarder



A Simple Wall Construction

Airspace

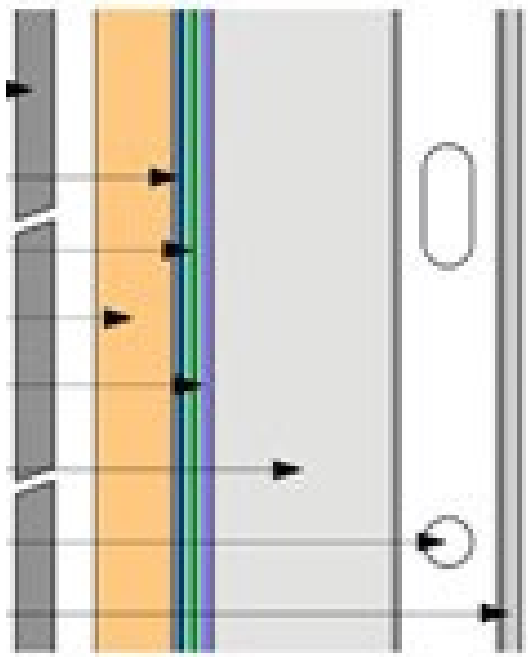
- Becoming an extremely important component is some wall assemblies
- Allows water to drain from the wall and ventilation promotes drying
- More insulation in a wall, the more important the cavity



A Simple Wall Construction

Exterior finish

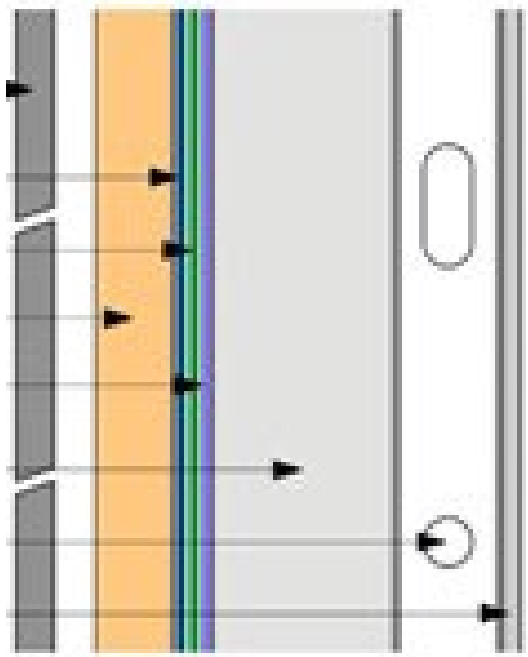
- The look of the building
- Sheds much of the bulk water
- Needs to be structurally
- Attached which can put holes in the water-restive barrier, air barrier and thermal bridging in the insulation



A Simple Wall Construction

Simple wall construction

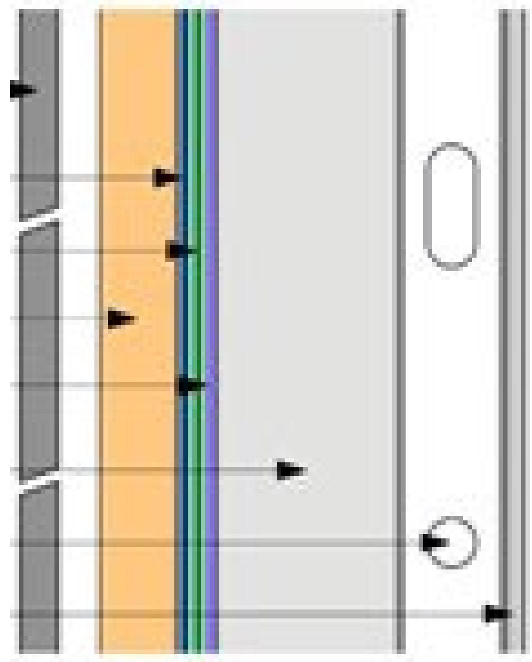
- No building assembly is simple
- Every layer in the assembly affects the other layers
- One value engineered change notice can result in major damage to the building envelope



A Simple Wall Construction

Simple wall construction

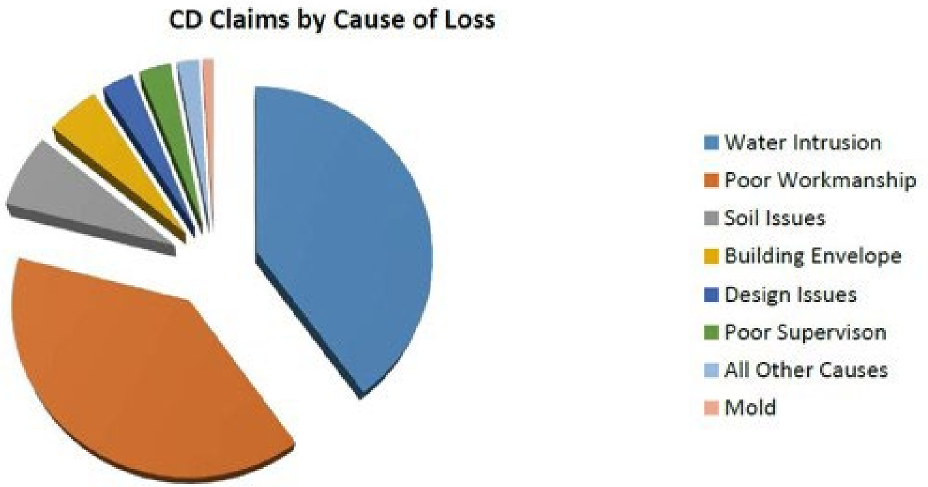
- The design professional can do a great design of a building assembly, but it will only work as intended, if installed properly



Installation

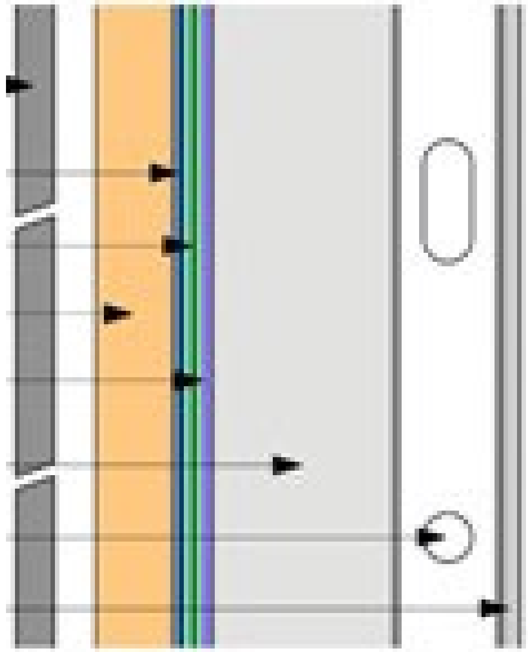
Zurich Construction Defect claims study results

ZURICH



Installation

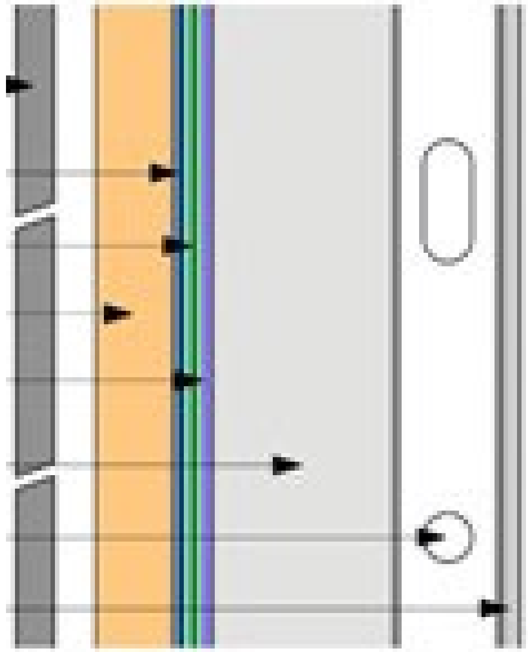
Many materials only provide the intended function only if installed as required for that function



Installation

Water-restive barrier

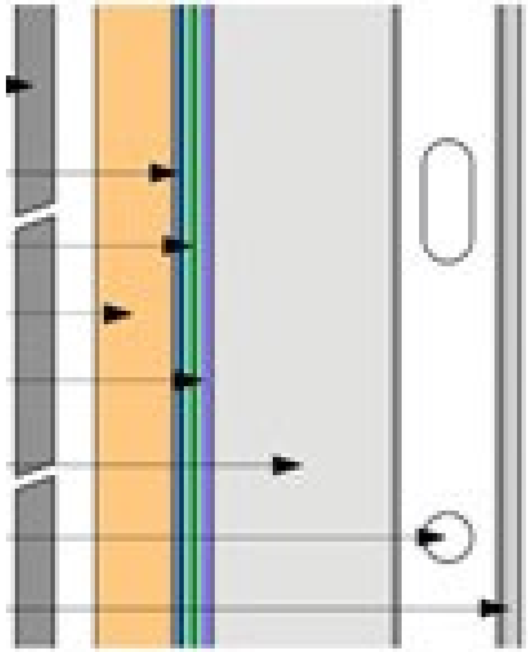
- Only keeps water out if installed continuously with no holes, even small ones



Installation

Air barrier

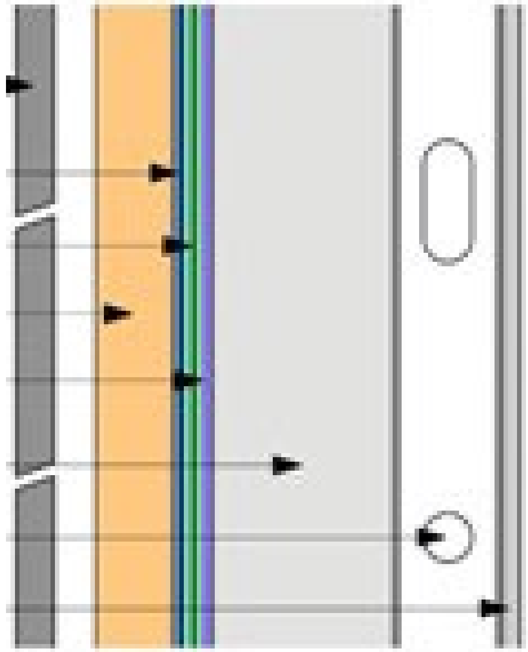
- Only an air barrier if installed continuously with no holes, even small ones



Installation

Thermal insulation

- Effectiveness reduced if air passes through, there are gaps between boards or thermal bridges through the material
- Leads to cold surfaces and potential for **condensation**

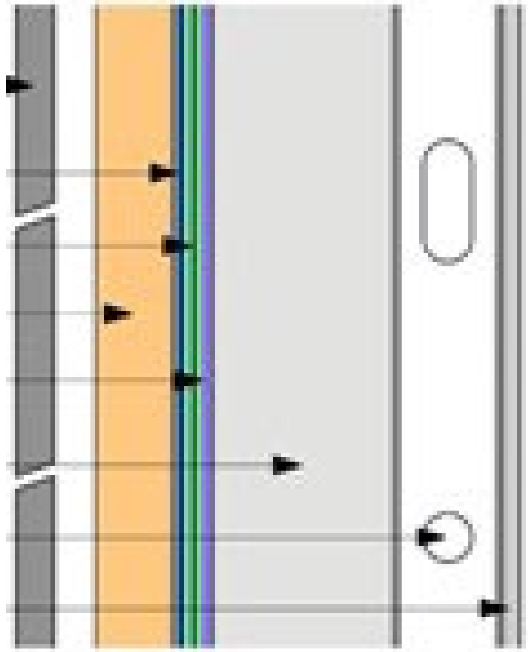



Nail every 16 inches.
Use line as guide.
BOARD

Installation

Vapor retarder

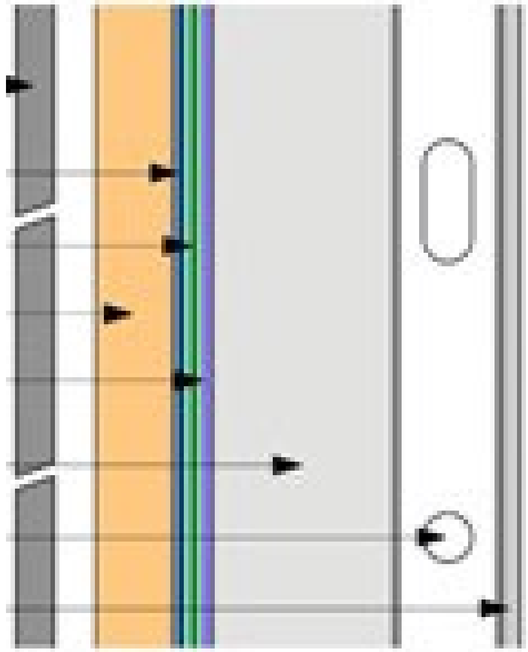
- Not affected as much by bad installation
- A large hole in the vapor retarder means more water vapor passing through, but not that much



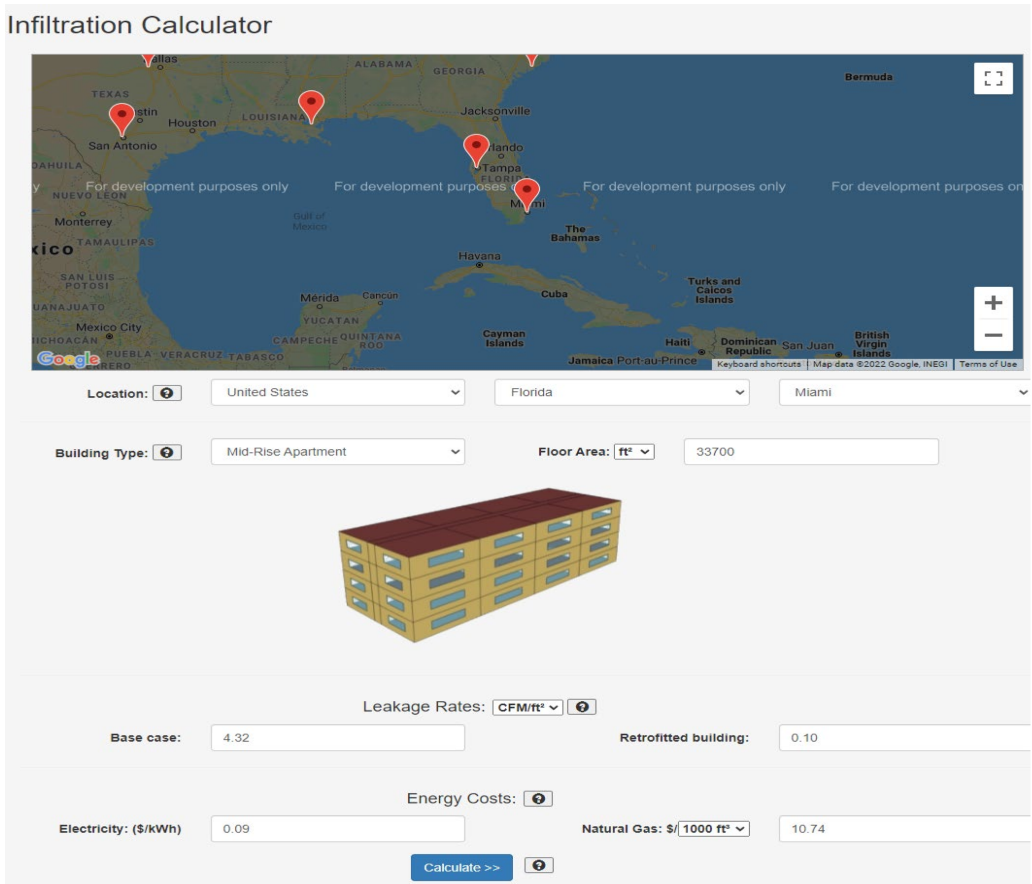
Installation

Vapor retarder vs air barrier

Which is more important to keep your building dry?

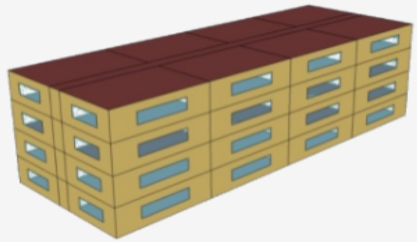


Water vapor transmission of materials



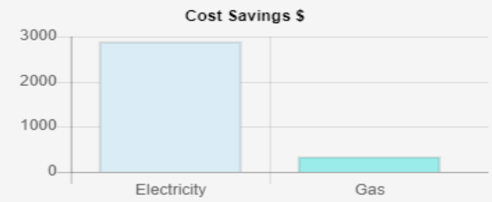
Infiltration Calculator Results

Building Type	Mid-Rise Apartment
Location	Miami FL USA
Floor Area	33700 ft²
Energy Price	Electricity 0.09$ /kWh, Natural Gas 10.74$ /1000 ft³

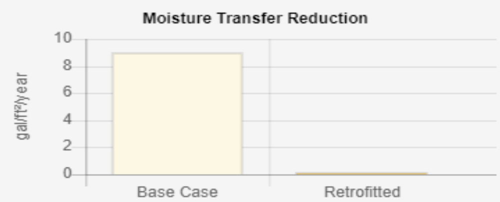


Leakage Rate		Equivalent Leakage Area	
Base Case	**Retrofitted Building**	**Base Case**	**Retrofitted Building**
4.32 CFM/ft² at 75 Pa	0.10 CFM/ft² at 75 Pa	42.40 ft²	0.99 ft²

Predicted Savings	Electricity	Natural Gas
Energy	32,029 kWh	32,317 ft³
Cost	$ 2,882.61	$ 347.08
Total Cost Savings	$ 3,229.69	



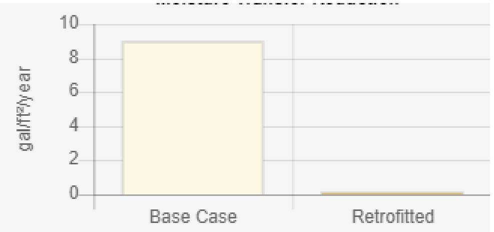
Moisture Transfer through the Wall Assembly due to Air Leakage	
Base Case	**Retrofitted Building**
9.00 gal/ft²/year	0.21 gal/ft²/year
303,221.39 gal/year	7,033.64 gal/year



SPRAY POLYURETHANE FOAM ALLIANCE

Water vapor transmission of materials

Moisture Transfer through the Wall Assembly due to Air Leakage	
Base Case	Retrofitted Building
9.00 gal/ft²/year	0.21 gal/ft²/year
303,221.39 gal/year	7,033.64 gal/year



Base 42.40 ft² = 6,105 in²

303,221 gallons ÷ 6,105 = 44.7 gallons/ in² per year

20 ounces / in² /DAY

Water vapor transmission 10 perm (570 ng/s · m²· Pa) – **16 oz/YEAR**

25 % more water by air transport through a 1 in² hole <u>per day</u> as water vapor transmission through a stud cavity (16” x 98”) <u>per year</u>

Water vapor transmission of materials

A perm is equal to **57.2 nanograms meter^{-2} second^{-1} Pascal^{-1}** .

Since there are 31,536,000 seconds in a year,

2985Pa of vapor pressure at saturation,

1,000,000,000 Ng per gram

The vapor pressure for both the wet cup (100%-50%Rh) and dry cup (50%-0%RH) is 50% of the saturation vapor pressure or 1492Pa,

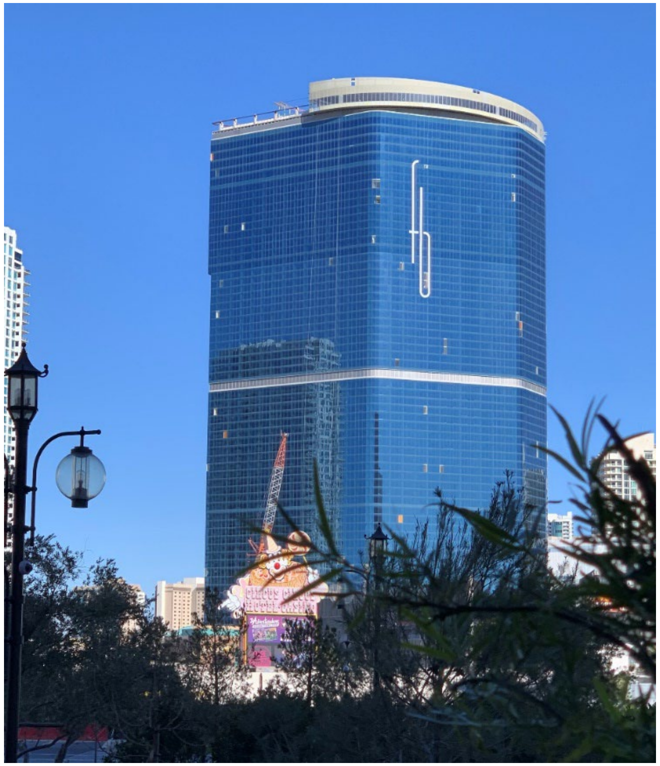
The weight of water vapor going through one square meter of a **0.1 perm (inch-pound)** in a year would be 0.1*1492*31,536,000/1,000,000,000 or 4.71 grams (0.166 ounces).

The weight of water vapor going through one square meter of a **1.0 perm (inch-pound)** in a year would be 1.0*1492*31,536,000/1,000,000,000 or 47.1 grams (1.66 ounces).

The weight of water vapor going through one square meter of a **10 perm (inch-pound)** in a year would be 10*1492*31,536,000/1,000,000,000 or 471 grams (16.60 ounces).

The Future

We build a lot of buildings right, some not so good



The Future

What we use to built | What we are building

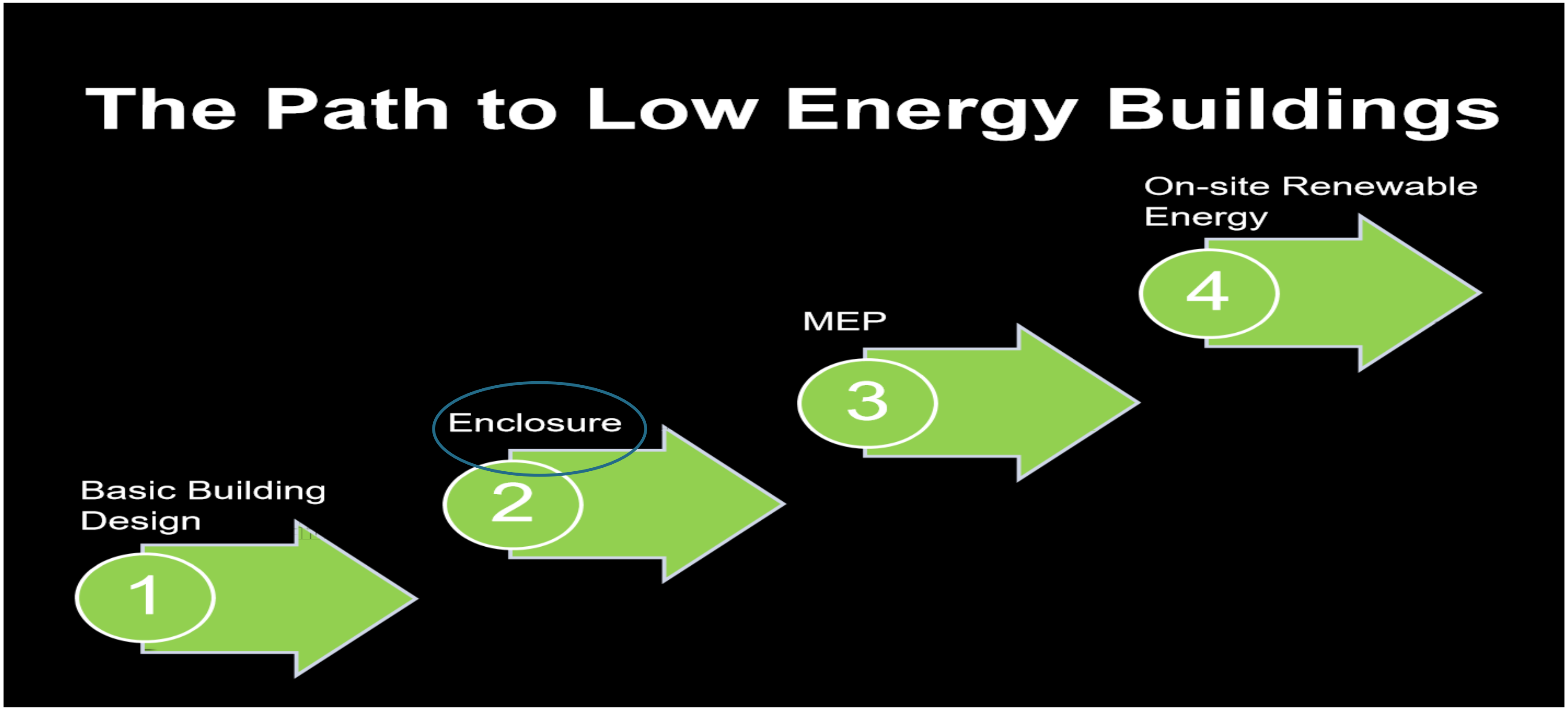
The Future

We are building the same, but buildings have changed

The Future

We are building the same, but our workforce has changed

The Future


The Path to Low Energy Buildings
Basic Building Design
1
Enclosure
2
MEP
3
On-site Renewable Energy
4

The Future

High performing building envelope are required

Designs need to work with assemblies with the whole building in mind

Manufacturers need to provide building assembly performance not just materials

Contractors need to upgrade the skill levels of new entrance to the workforce

Trust in construction practices but verify

Thank you for your time!

Laverne Dalgleish

Air Barrier Association of America

ldalgleish@airbarrier.org

Ph. 204-771 7351

SPFA

SPRAY POLYURETHANE FOAM ALLIANCE