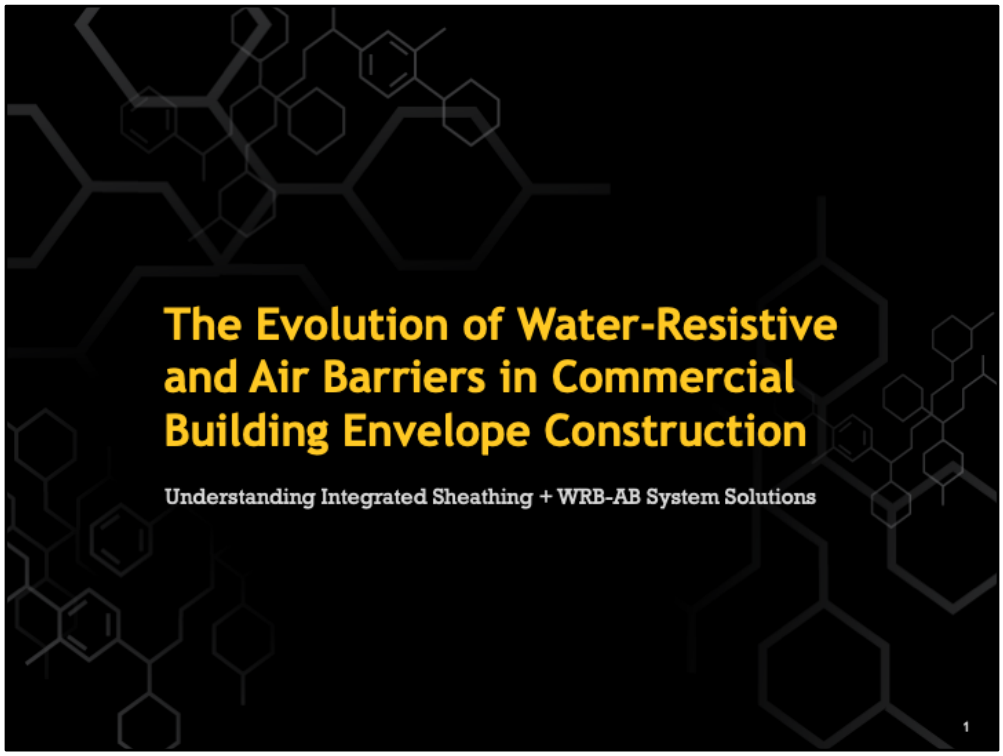
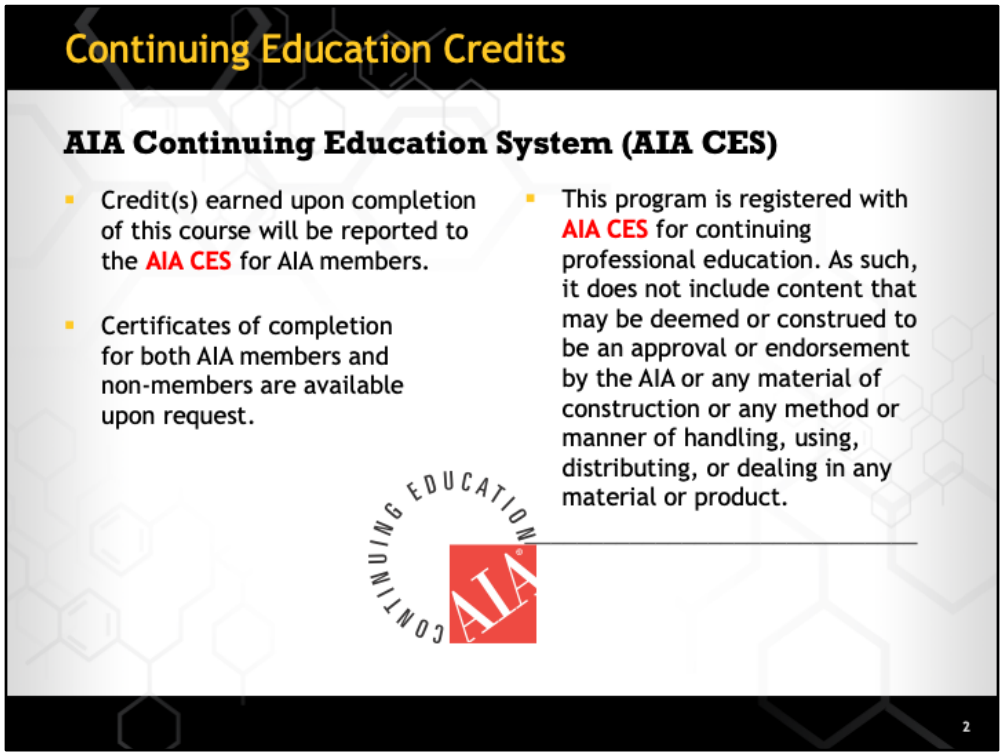


Welcome to Georgia-Pacific Gypsum's continuing education course, "The Evolution of Water-Resistive and Air Barriers in Commercial Building Envelope Construction – Understanding Integrated Sheathing and WRB-AB System Solutions."



After completing the course, if you're an AIA member, we'll report the credits you've earned to AIA CES.

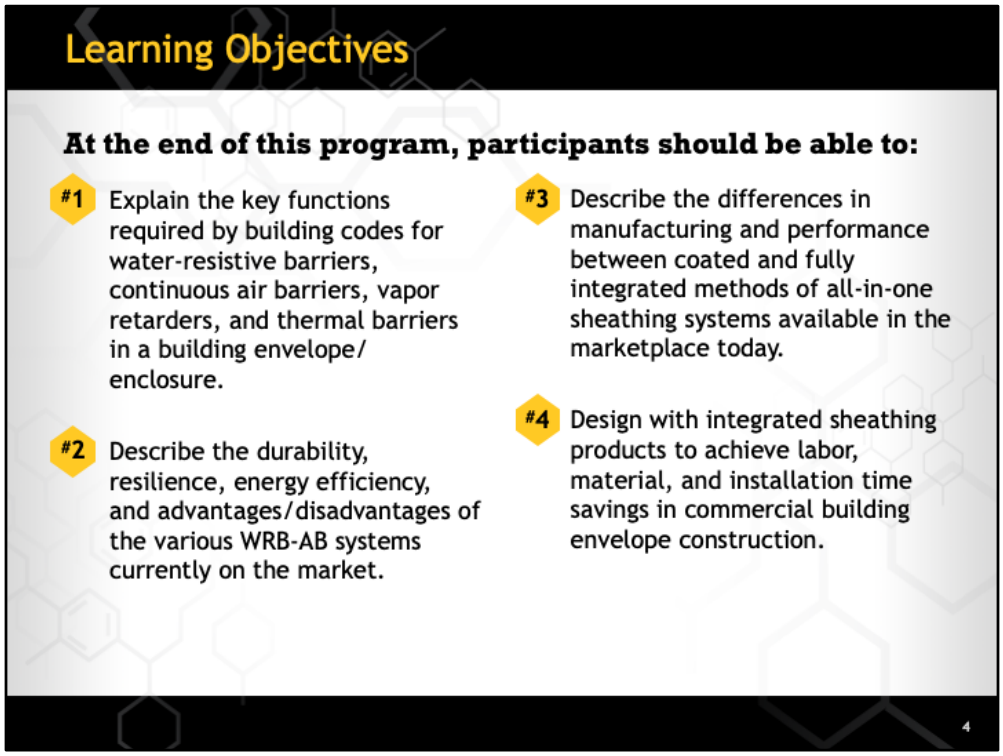
Certificates of completion are available for both AIA members and non-members upon request. If you'd like one, please let me know at the end of the course.

This course is registered with AIA CES for continuing professional education. Per their guidelines, it doesn't include any content that could be interpreted as an approval or endorsement of any construction product or material, or any method of handling, using, or distributing any product or material by the AIA.

Finally, I'll address any questions related to specific materials, methods, and services at the end of the course.

The purpose of this course is, first, to take a look at the evolution of water-resistive and air barriers—we'll refer to them as WRB-ABs for short—in commercial building envelopes.

And second, to introduce new, all-in-one integrated gypsum sheathing and WRB-AB systems as viable alternatives to traditional systems.



Our course has five learning objectives.

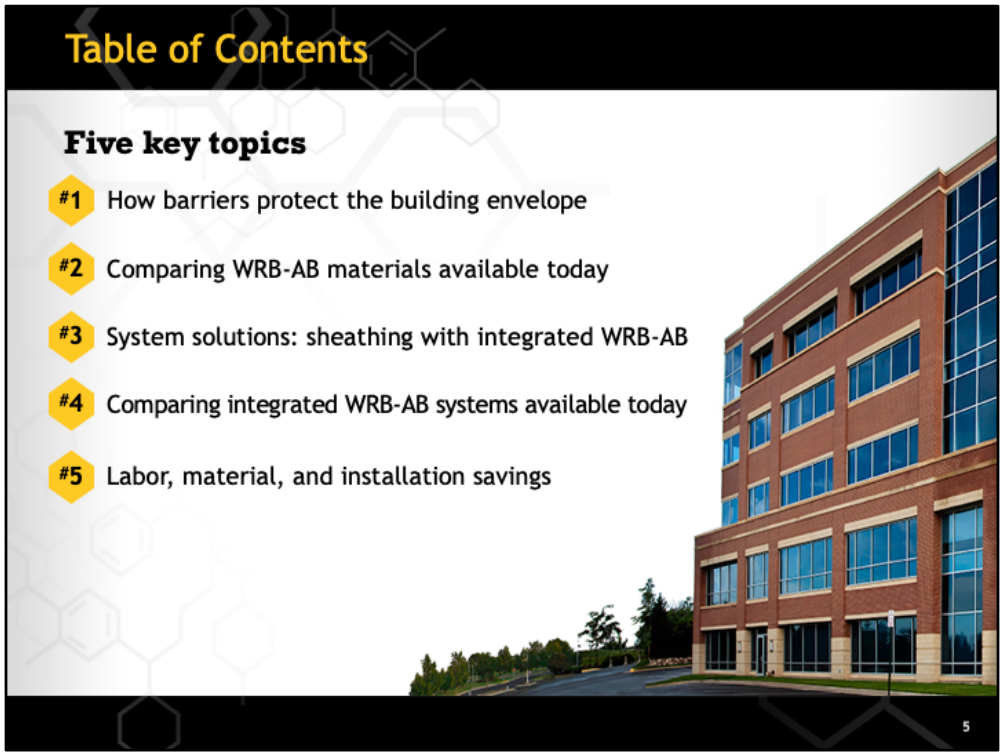
First, by the end of our course, you will be able to recognize the function of WRB-ABs in a commercial building envelope.

Second, you'll be able to understand the advantages and/or disadvantages of the various WRB-AB systems currently on the market.

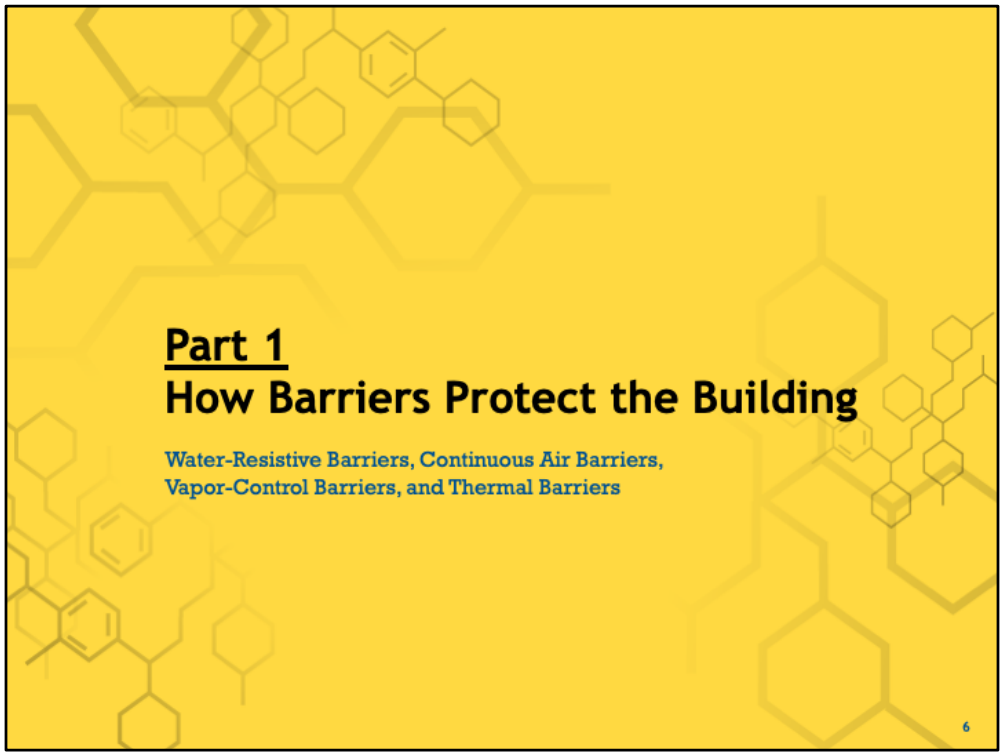
Third, you'll be able to tell the differences between all-in-one WRB-AB systems, where the WRB-AB is integrated into the sheathing and traditional WRB-AB systems.

Fourth, you'll be able to identify the differences between two all-in-one WRB-AB systems that are currently available.

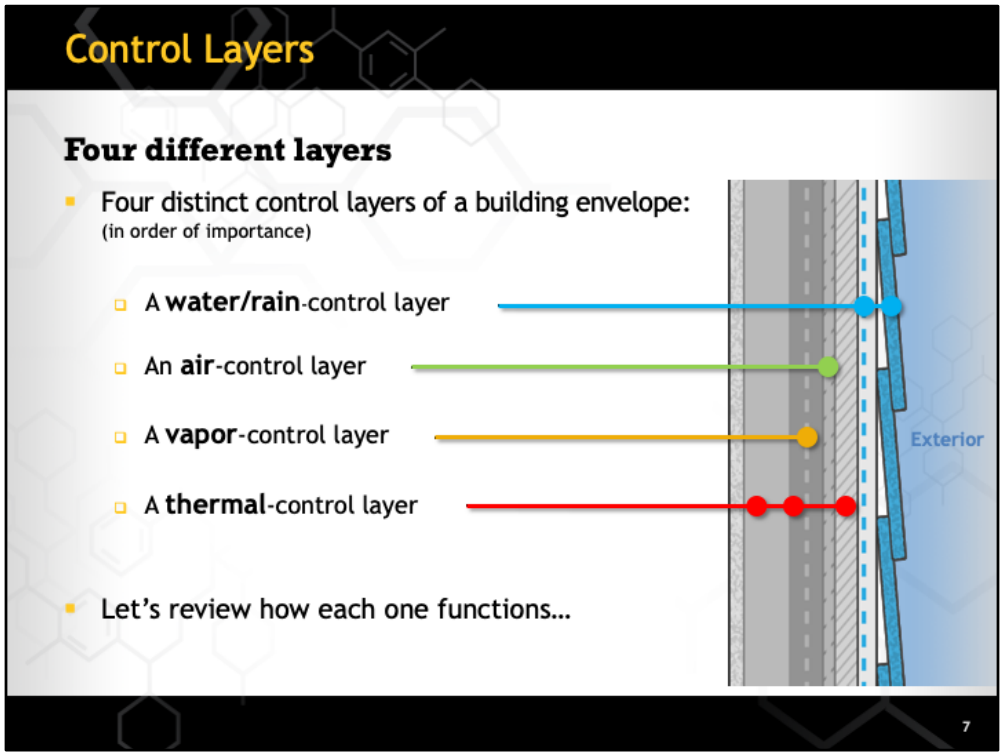
And finally, you'll be able to design future building envelope projects in a way that helps you save on labor and material costs as well as time—you'll be able to finish the job more quickly.



Here's our table of contents for you to refer to during and after the course. As you can see, it has five parts that cover how barriers protect the building envelope, a comparison of WRB-AB materials currently available, an introduction to new Integrated WRB-AB solutions, a comparison of the WRB-AB systems currently available, and how integrated WRB-AB systems can help you save on the cost of labor and materials as well as installation time.



Okay, so let's dive right in with Part 1: How Barriers Protect the Building Envelope. We'll be talking about four different types: water-resistive barriers, continuous air barriers, vapor-control barriers, and thermal barriers.



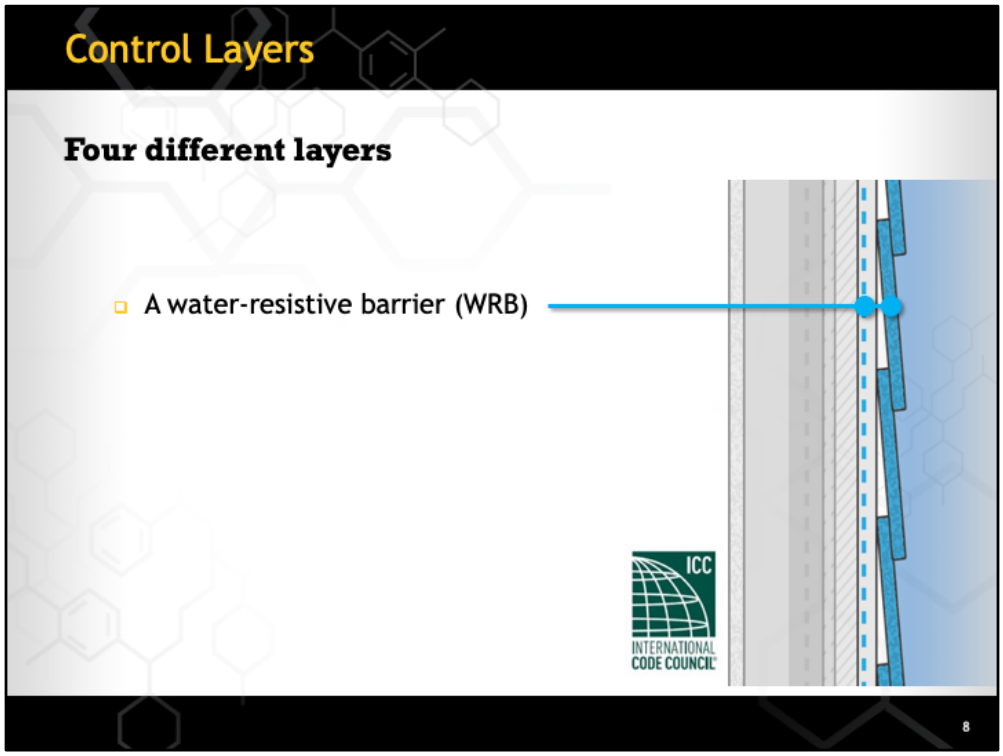
So, the building envelope is made up of four different control layers.

In order of importance, first we have a water-control layer, which is designed to block bulk water from entering when it rains or snows.

Next, we have an air-control layer, which is designed to prevent unwanted air movement and can be air leaking out of the building from the inside or vice versa.

Next, we have a vapor-control layer, which is designed to prevent or control the speed at which vapor can move through the building envelope.

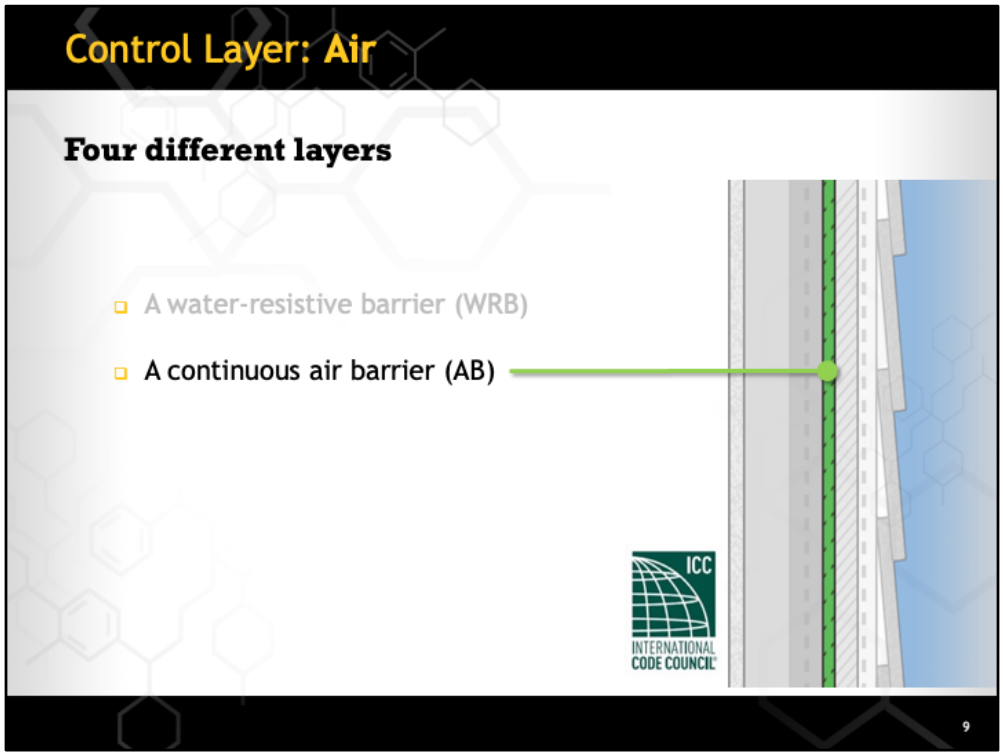
And last, we have a thermal-control layer, which is designed to insulate the envelope so the temperature inside stays comfortable no matter what the weather is like outside. This layer is also important to help make the building energy efficient and keep heating and cooling costs down.



We'll start with the first control layer, which is our water-resistive barrier, or "WRB." This layer lies directly beneath the exterior cladding and channels water down the outside surface of the WRB.

Its job is to block bulk water that makes its way beneath the cladding during a storm from getting into the interior of the building. When water hits the WRB, it runs down its surface, then flows through a drainage gap between the barrier and the cladding and drains out of the building. This helps to prevent moisture from building up in the wall cavity, which can cause mold, mildew and corrosion.

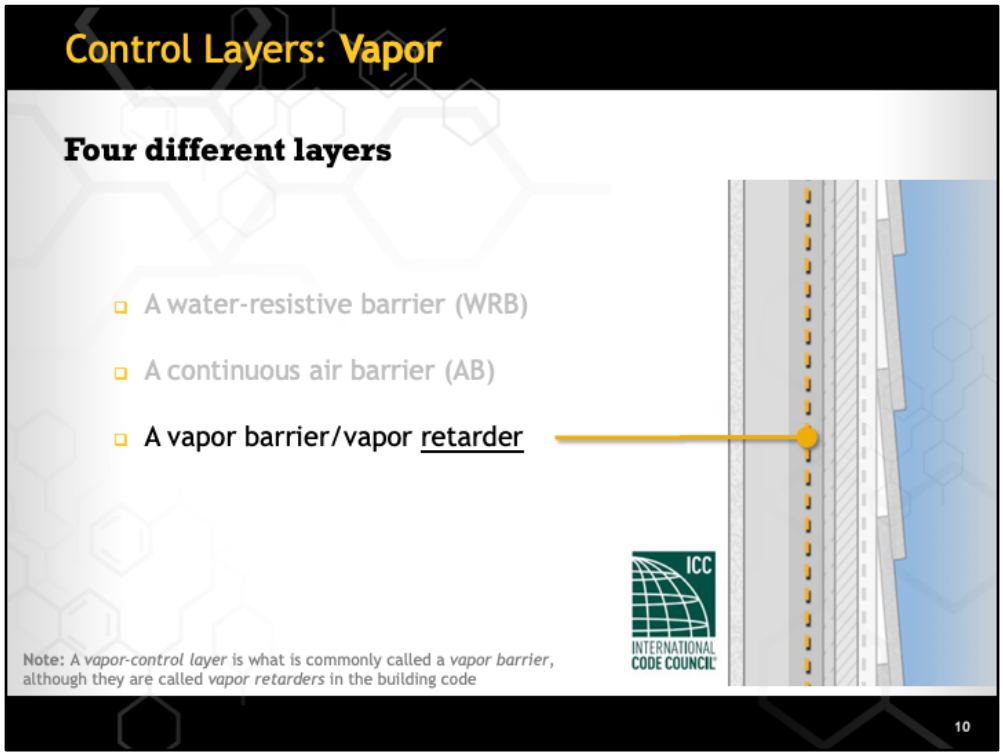
There are two code requirements that the WRB needs to meet: the International Building Code, or IBC, and the International Residential Code, or IRC.



The next control layer is the continuous air barrier, or “AB.”

The AB is typically located beneath the cladding on the face of the sheathing, but it can be made up of a combination of materials and assemblies in the interior or exterior wall, and its purpose is to essentially “wrap” the building shell to prevent air passing from the outside to the inside due to wind, building “stack effects,” or mechanical ventilation pressure differences.

The International Energy Conservation Code now has very specific, mandatory requirements for providing continuous air barriers in building envelopes aimed at restricting or preventing the passage of air in order to assure minimum levels of code-required energy performance. The code leaves it to the architect to determine the best location of the AB, whether on an interior or exterior side of a construction assembly, but does say that it needs to follow the same line as the building thermal barrier.



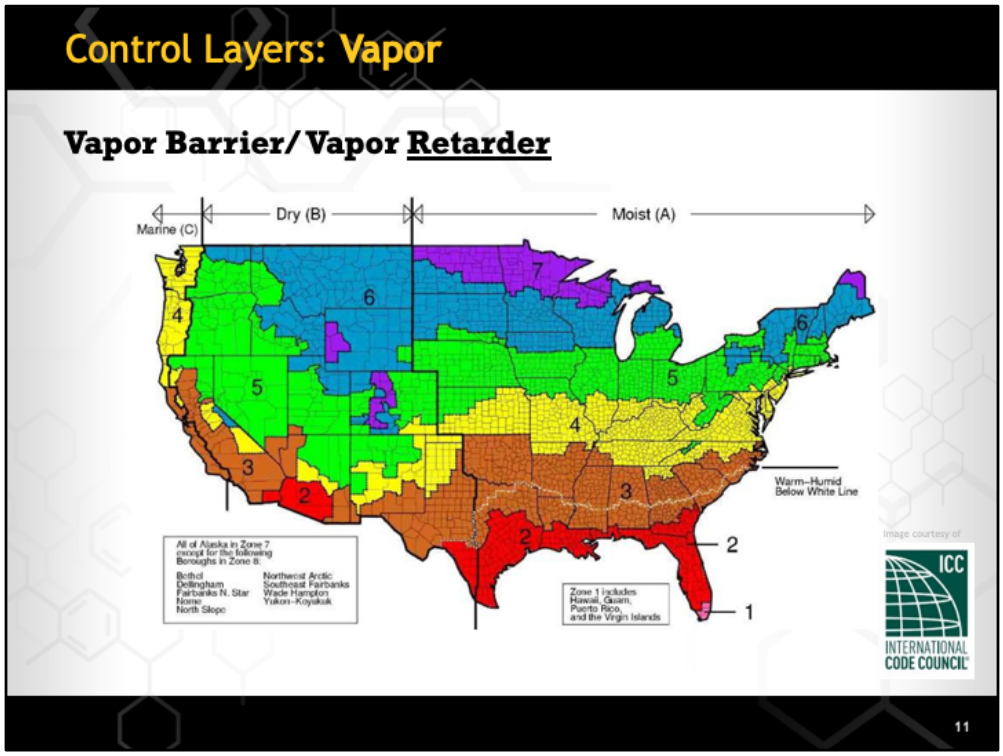
While WRBs address bulk water and ABs address airborne moisture from one side of an assembly, there is also a concern for vapor penetration from the other side of the assembly. For that reason, the IBC and IRC require the use of vapor retarders to protect the building construction on both sides of an assembly.

A vapor retarder is most often required in colder climates and should be installed on the interior face of an exterior wall, roof, or floor assembly. The intent is to prevent warm, moist air from penetrating into the assembly and condensing into liquid water that can become trapped and cause damage. The determination of whether or not a vapor retarder is required is based on the location of the building within any of the eight climate zones identified and cross referenced in the IECC energy code. Then, depending on the location, one of three types of vapor retarders may be required.

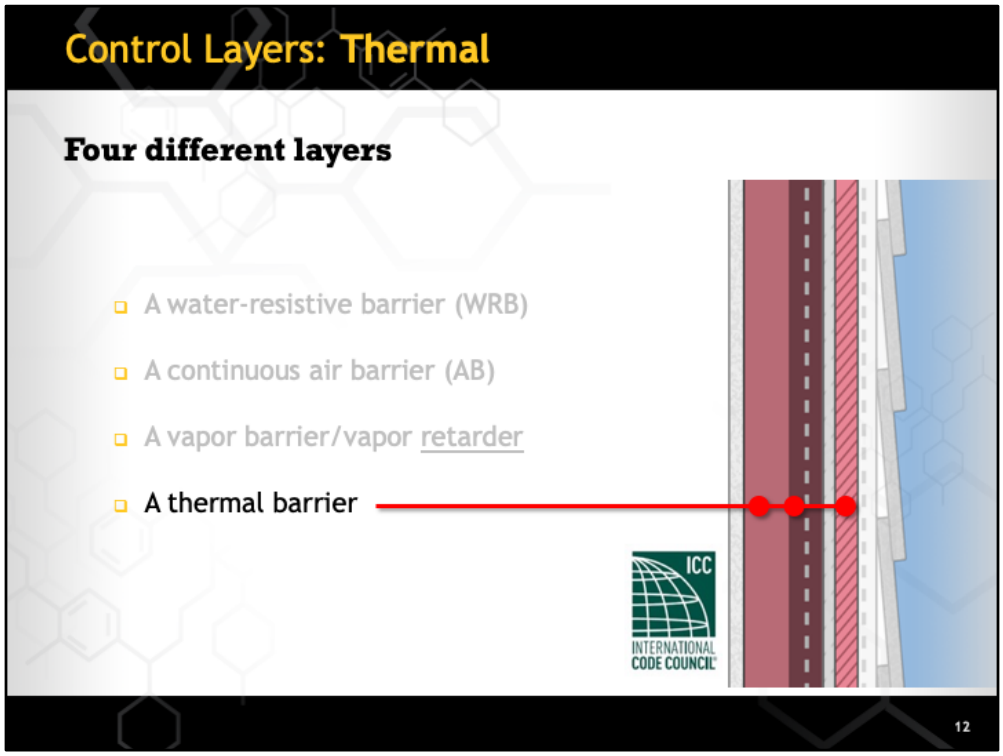
Many cases do not need a complete barrier, simply a reduced rate of diffusion

Code Requirements:
A Type I retarder provides virtually no permeability of vapor, while a Type II allows some permeability.
A Type III vapor retarder slows the passage of vapor, or diffusion, but allows

more permeability than either Type I or Type II. In this case, the assumption is that any vapor that enters will also exit and not condense due to warmer average conditions.



This map defines the climate zones.

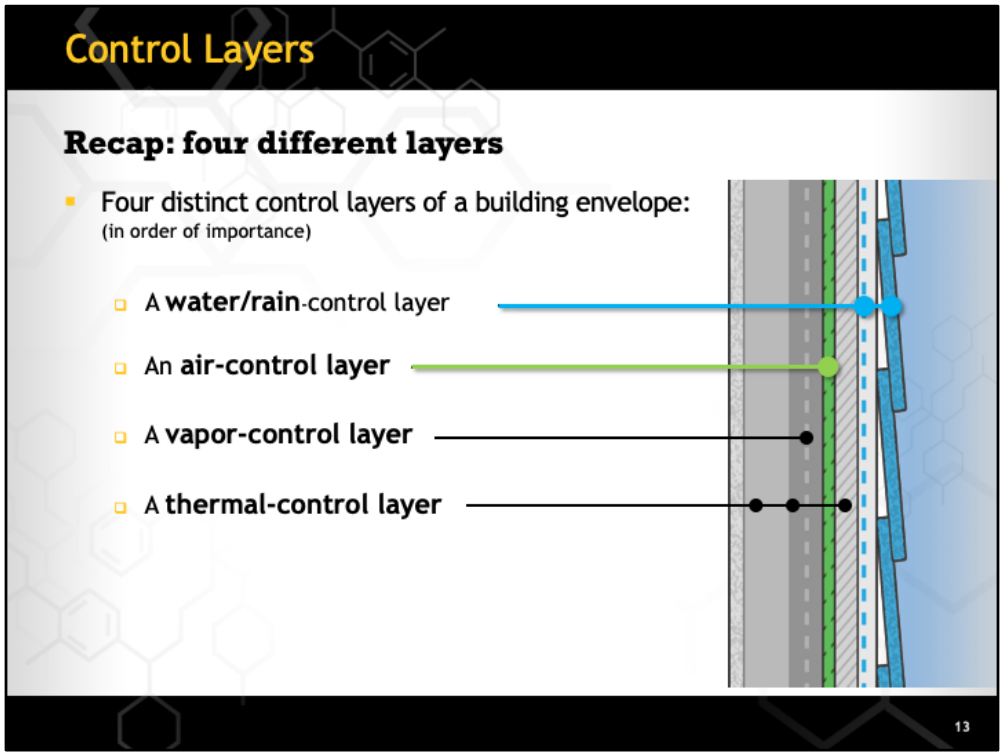


The thermal-barrier layer is typically comprised of insulation products (ex. foam, fiberglass bat, mineral wool, etc.) or radiant barriers in the wall assembly

Its purpose is restricting the transfer of heat through a building envelope—for example, from inside to outside during heating season or from outside to inside during cooling season—is critical to good energy performance in a building. For that reason, the IECC requires a continuous thermal barrier to control heat energy flow and reduce energy usage.

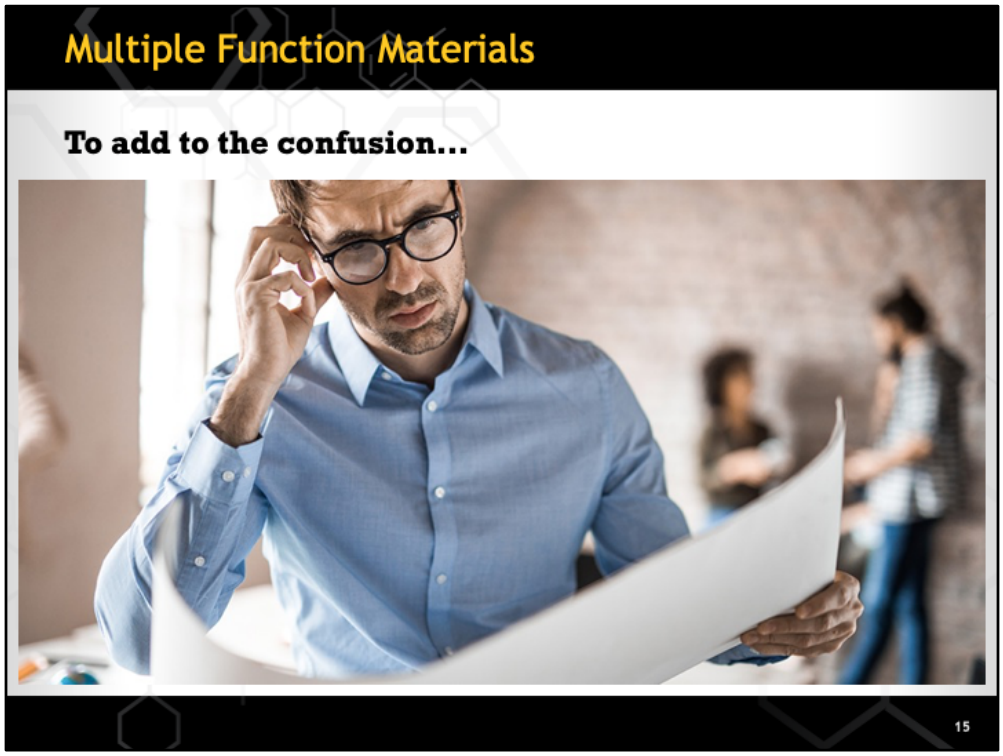
The level of performance of this barrier is expressed in tested R-values for insulation products or based on a U-factor analysis of an entire assembly. In practice, that means that insulation is used to form the thermal barrier and can be placed between studs and framing or installed continuously either on the inside or outside face of an assembly. The specific assembly and the materials used can be quite varied, but it's usually made up of insulation products like foam, fiberglass batting and mineral wool, or radiant barriers in the wall assembly. Ultimately, the design and material choices are left up to the architect based on the needs of each particular building.

Whatever the design, however, the building's thermal performance must be detailed and demonstrated to show code compliance.

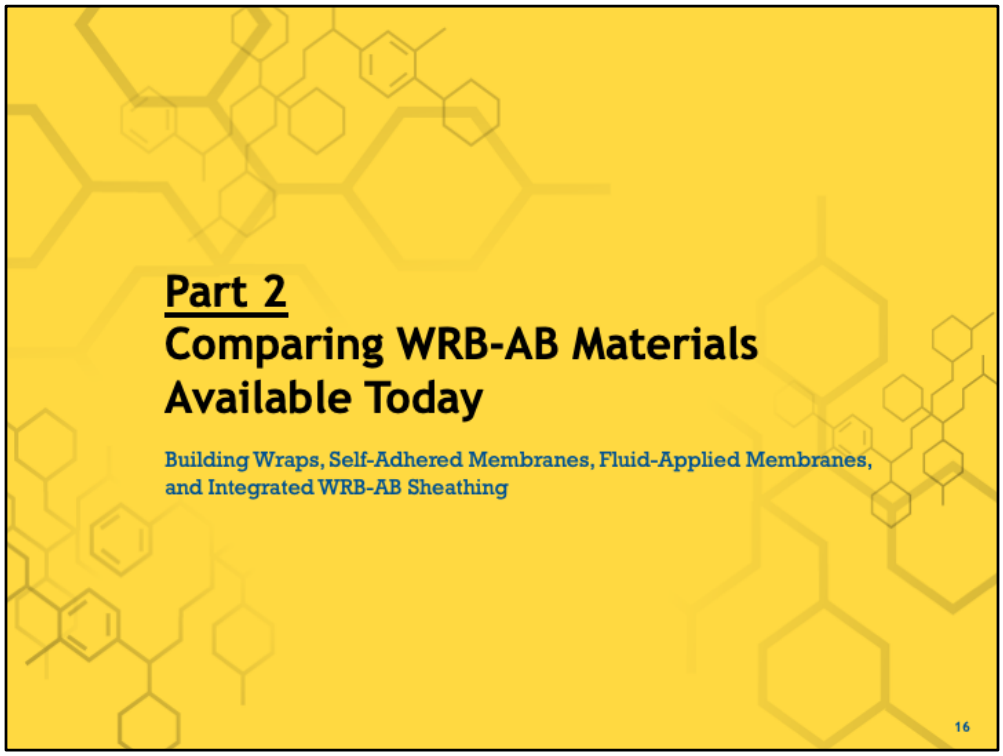


So, there you have the four different building control layers. But for the purposes of our course, we're going to focus specifically on the water- and air-control layers.

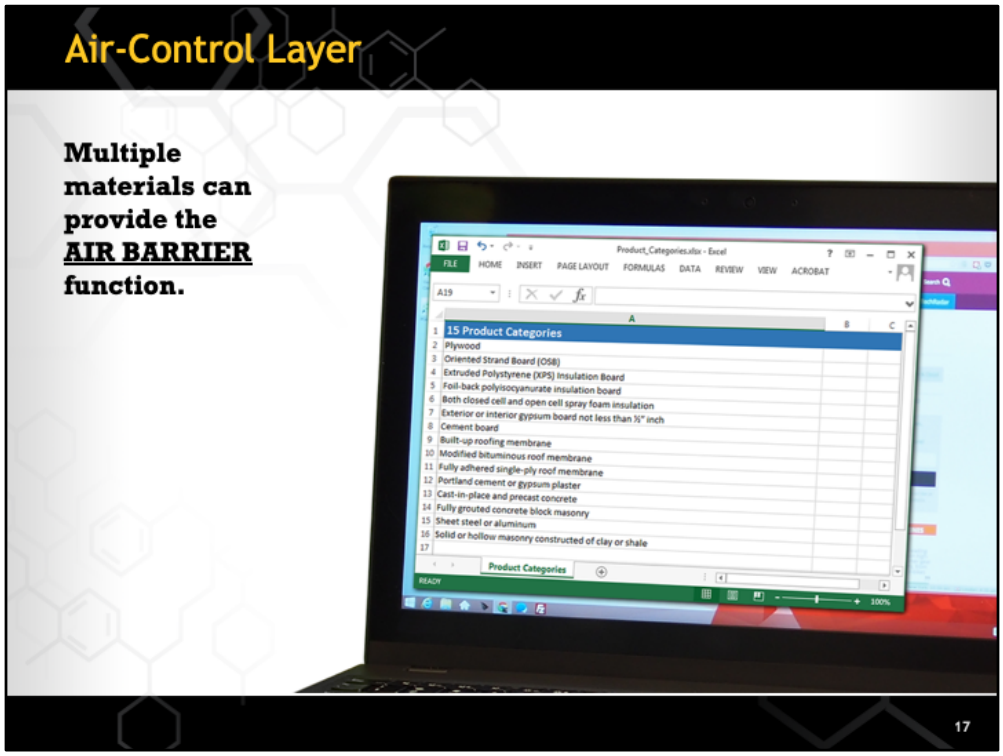
Now, here's where things can get a little confusing: air barriers can ALSO be water-resistive barriers, and water-resistive barriers can ALSO be air barriers.



Adding to the confusion, certain construction materials can function as some combination of a water-resistive, air, vapor and thermal barrier, which is why design professionals need to understand these separate functions so they can correctly specify them as a component of a building envelope.



Okay, in Part 2, we're going to compare the different WRB-AB products that are currently available, including building wraps, self-adhering membranes, fluid-applied membranes, and integrated WRB-AB sheathing systems.



The IECC lists 15 different product categories in various thicknesses and densities that that can function as an AB *when the joints and openings are properly sealed* with air-barrier accessory materials.

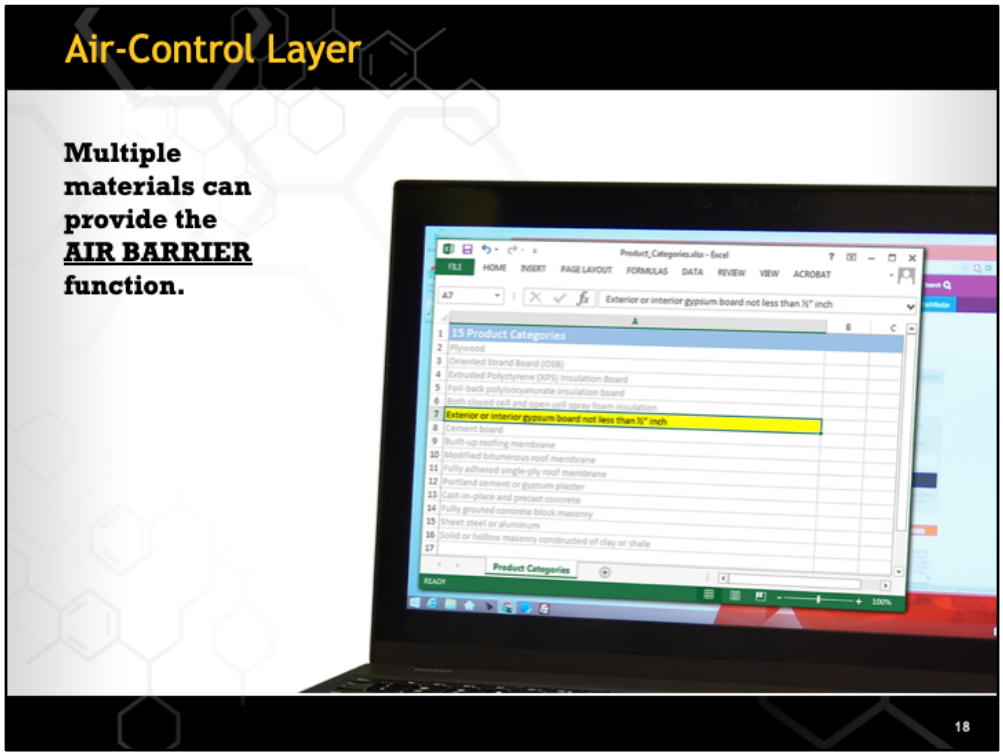
It's important to note that materials not on the list may also qualify as air barriers if they comply with the requirements described in the code for both materials and assemblies. The materials must meet the 0.004 cfm/ft^2 @ 75 pascals requirement as tested per ASTM E2178.

The 15 product categories are:

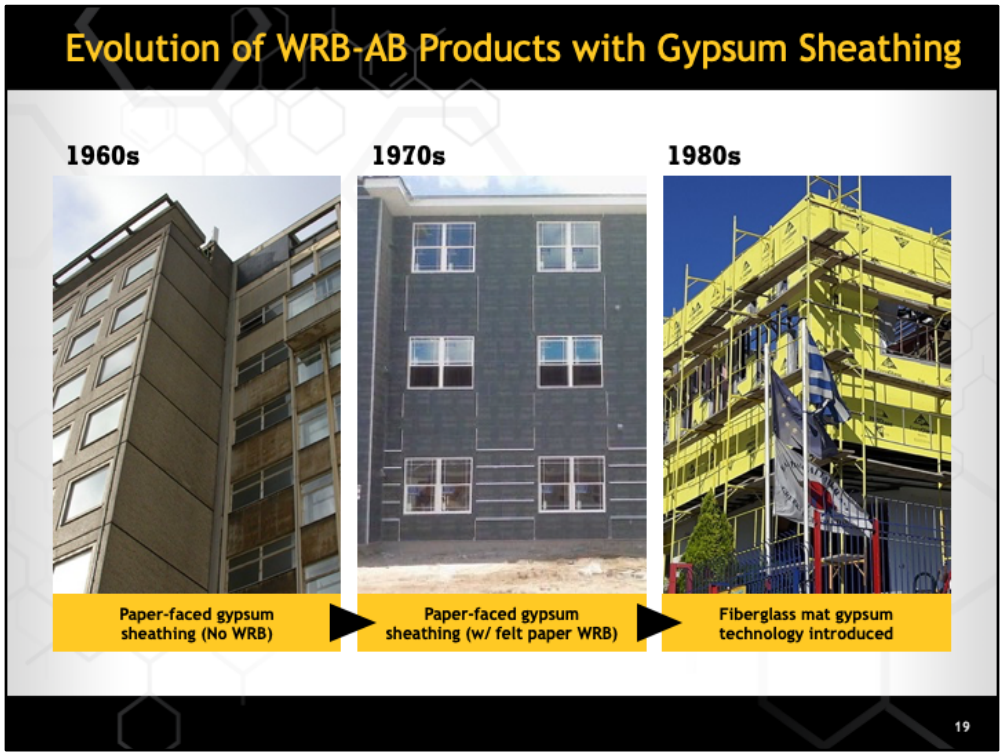
- Plywood
- Oriented strand board (OSB)
- Extruded polystyrene (XPS) insulation board
- Foil-back polyisocyanurate insulation board
- Both closed-cell and open-cell spray foam insulation
- Exterior or interior gypsum board not less than ½ inch

- Cement board
- Built-up roofing membrane
- Modified bituminous roof membrane
- Fully adhered single-ply roof membrane
- Portland cement or gypsum plaster
- Cast-in-place and precast concrete
- Fully grouted concrete block masonry
- Sheet steel or aluminum
- Solid or hollow masonry constructed of clay or shale

Note: Materials that are not listed in the IECC may qualify as an air barrier if they comply with the air-barrier requirements described in the code for both materials and assemblies. (Materials shall meet 0.004 cfm/ft^2 @ 75 pascals as tested per ASTM E2178.)



For our next example, let's use gypsum board as the common continuous air-barrier material.



One of the most common building envelope construction types for commercial and residential buildings is based on using wood or metal framing to create exterior walls. That framing is then covered on the outside face with a sheathing panel secured to the framing studs with openings cut for windows, doors, and other openings as needed. This sheathing has formed the basis for most of the water resistance and air resistance in wall assemblies since the 1960s. In commercial construction, the most common sheathing that has been used are gypsum based products, which, as we have seen, are recognized by codes to serve as an air-barrier material. In order to make that air barrier continuous and create a full water-resistant barrier too, there have been a continuous series of innovations over the past seven decades.

In the1960s, paper-faced gypsum sheathing was the norm without the use of any particular WRB. This provided fire resistance in exterior wall assemblies and a basic air barrier, but it had problems related to water and moisture, including delamination of the paper.

In the 1970s, asphalt saturated felt paper was identified in building codes to be installed as a WRB. Today, it is still the only code-listed product for a WRB while allowing others that meet tested performance criteria. While adding felt paper over gypsum board is effective at shedding water and protecting

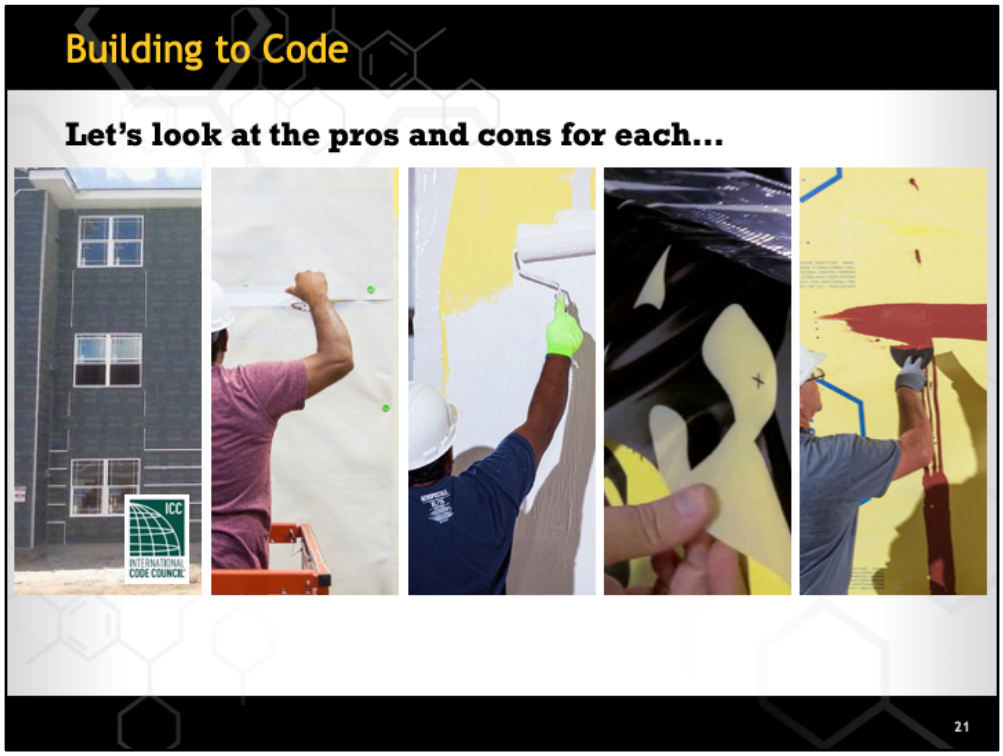
the paper surface, it is not effective as an air barrier, meaning that the joints and seams of the gypsum panels all needed to be sealed.

As concerns about energy conservation and product durability emerged in the 1980s, several innovative products came onto the market. The first was gypsum board sheathing that replaced the paper facing with a fiberglass mat facing. This meant that the amount of time that gypsum sheathing could be exposed to normal weather was dramatically increased compared to paper-faced sheathing. The fiberglass mat surface also provided a basic but effective WRB surface.

The second innovation in the 1980s came in the form of fibrous building wraps used on both residential and commercial construction to create primarily an air barrier, although some provided a WRB as well.

While building wraps remained popular over most sheathings, they had some significant limitations with installation that raised concerns about their ability to be truly continuous. In response, in the 2000s, some other materials such as heavier adhered membranes applied in the field over the sheathing were sometimes used. In other cases, fluid-applied membranes that were sprayed or brushed over fiberglass mat gypsum sheathing became preferred to assure performance. Most of the fluid-applied membranes required a thick, measured layer to be field applied, but they offered full continuity as both a WRB plus an AB since they could easily conform to any irregularities or variations in the underlying substrate. Adhered membranes, on the other hand, were bulky and more labor intensive to install over any irregular areas.

As the technology for fluid-applied membrane barriers developed in the 2010s, they became more effective. Testing revealed that they could be applied with thinner mil thickness without reducing their performance. But they were still applied in the field, and their effectiveness depended on the skills of the applicators.



Surprisingly, the only WRB currently on the market listed in both the IBC and IRC building codes is building felt or an equivalent product.

There are, however, other products that aren't listed in the codes but meet the code requirements. These include attached building wrap, fluid-applied membranes (over the entire surface of the exterior wall), self-adhering membranes (over the entire surface of the exterior wall), and rigid board stock.

Let's take a look at the pros and cons for each.

We'll start with building wraps and asphalt felt.

On the plus side, these products: ***(Each click of the mouse or right arrow will reveal a blue checkmark corresponding to the advantage.)***

1. Are cost-effective
2. Are simple to install
3. Work well as WRBs
4. Can be installed in almost any weather
5. Are vapor permeable

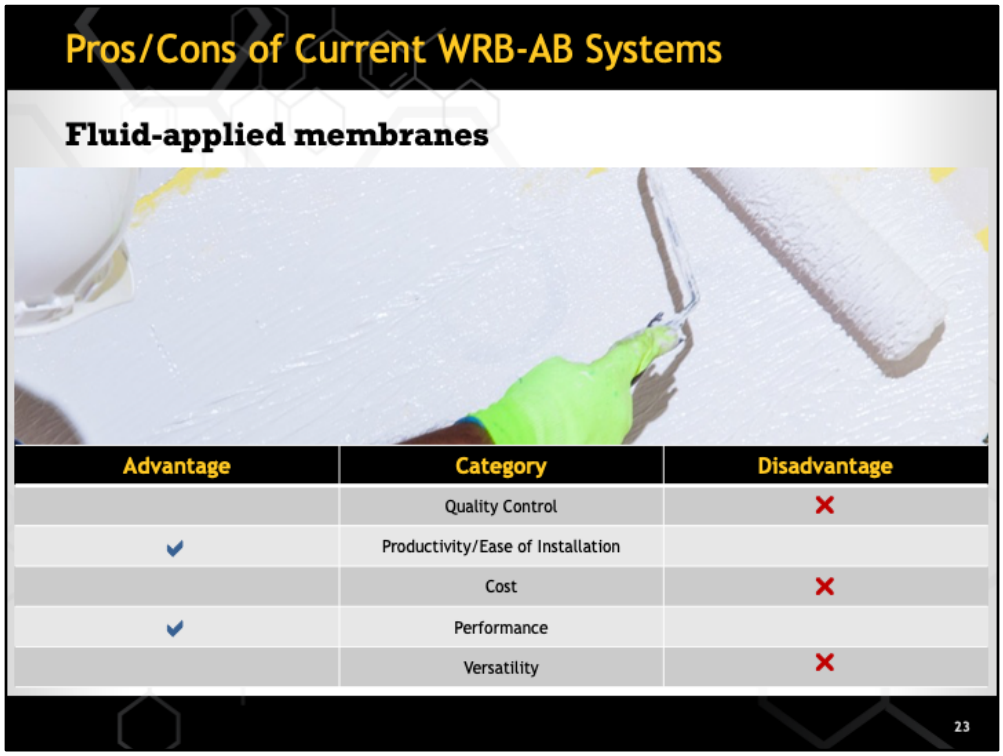
But they also have disadvantages: ***(Each click of the mouse or right arrow will reveal a red "X" mark corresponding to the disadvantage.)***

1. They're hard to seal to be an effective air barrier.

2. They're prone to blow off during prolonged installations.

3. They require fasteners that pierce holes in the membrane, allowing moisture or air to penetrate.

4. When installed incorrectly (with staples, for example) their WRB effectiveness is compromised.



Next, we have fluid-applied membranes.

Their advantages include: ***(Each click of the mouse or right arrow will reveal a blue checkmark corresponding to the advantage.)***

1. **Two in one:** They can serve as both a WRB and an AB when covering sheathing

2. **Faster installation:** Spray or roll-on application

3. **Easy availability:** Large selection of manufacturers

4. **And a high level of functionality:** Seals rough openings well (example: window and door openings)

But they also have their downsides: ***(Each click of the mouse or right arrow will reveal a red "X" mark corresponding to the disadvantage.***

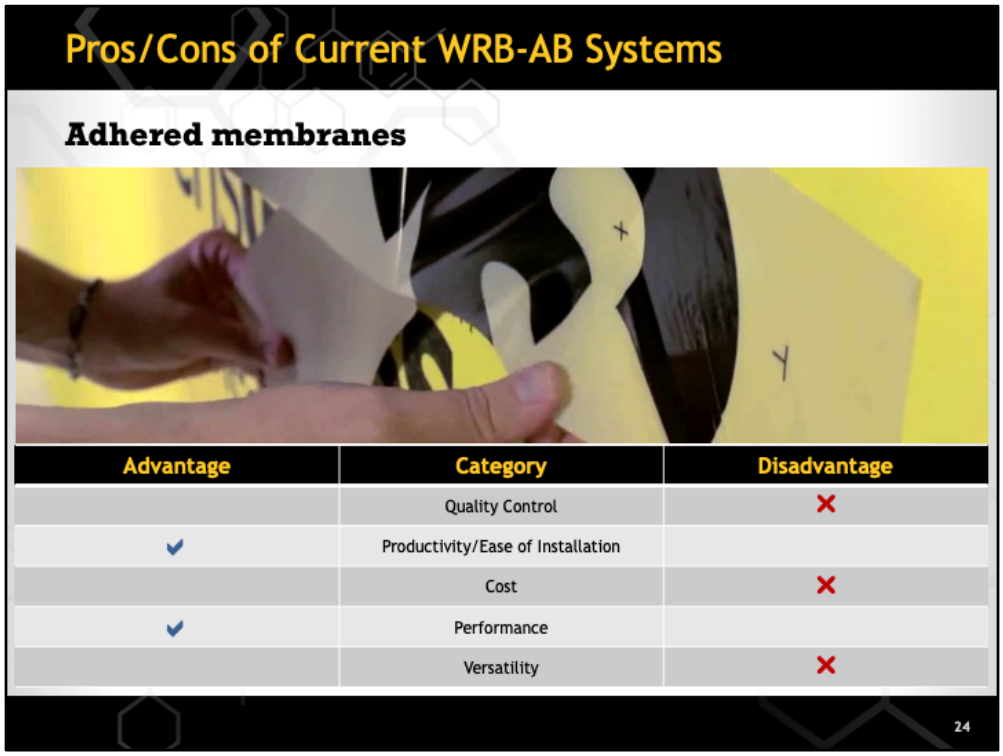
1. **Performance variance:** Their performance can vary based on how they're

applied. If the thickness isn't consistent, it can compromise their effectiveness. And joints and fasteners may need to be sealed before they're applied to the sheathing.

2. **Specification details:** Realized permeability after application may not be the same as described by manufacturer. They also require careful review of the manufacturer's information to be sure that their level of permeability and performance match expectations.

3. **Weather limitations:** And they also have weather limitations. If the substrate on which the barrier is being applied is too humid or moist, it can lead to incomplete bonding between the materials.

4. Cost: Costlier because more tools are required for install and an additional tradesperson is needed on-site.



On the plus side, adhered membranes: ***(Each click of the mouse or right-arrow will reveal a blue checkmark corresponding to the advantage.)***

1. **2-in-1:** *May* serve as both WRB and AB when covering sheathing

2. **Consistent performance:** Don't have the mil-thickness issue that fluid-applied WRB-ABs have

3. **Less tools:** Require fewer tools since they don't require fasteners

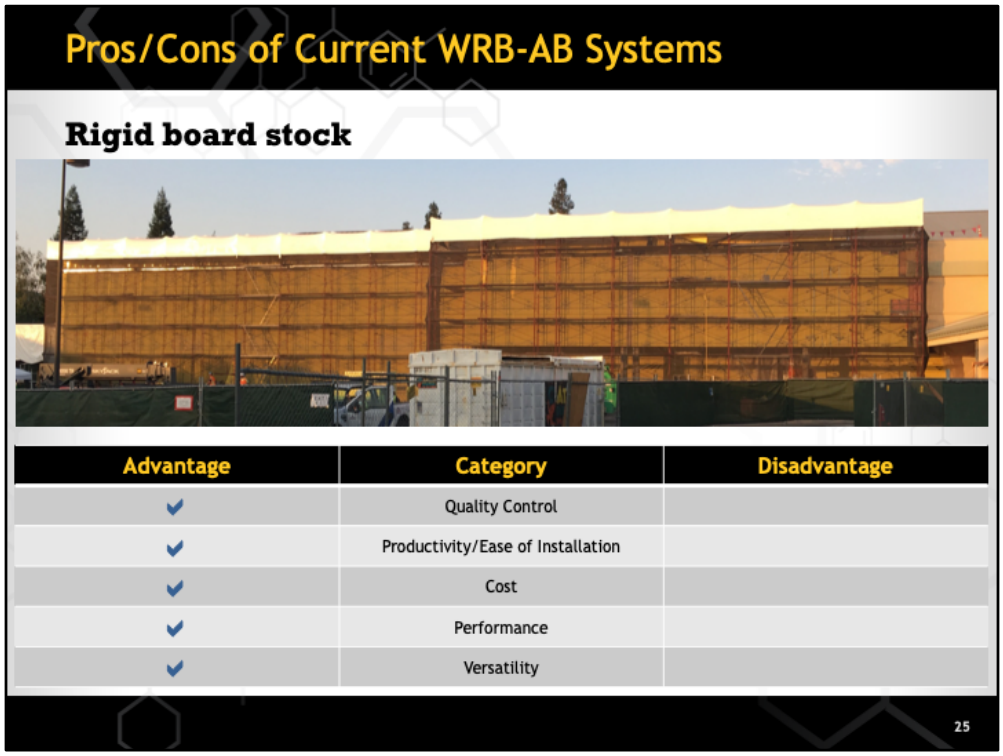
4. Don't require that sheathing joints be sealed prior to installation

On the other hand, adhered membranes: ***(Each click of the mouse or right-arrow will reveal a red "X" mark corresponding to the disadvantage.)***

1. Are labor intensive to apply. They usually need at least a two-man crew to put on properly, and they generally require a primer that can make the membrane wrinkle or compromise their adhesion to the substrate.

2. **Permeability constraints:** Primers can also reduce their permeability.

3. **Weather limitations:** And like fluid-applied membranes, adhered membranes also have weather constraints. If the substrate on which the barrier is being applied is too humid or moist, it can lead to incomplete bonding between the materials.



Finally, we have rigid board stock.

On our advantages list, these products: ***(Each click of the mouse or right arrow will reveal a blue checkmark corresponding to the advantage.)***

1. **Visual Inspection:** The liquid flashing contrasted with the sheathing color allows for faster visual inspection of the WRB-AB

2. **Three in one:** *May* perform as many as three barrier functions when their joints are sealed: a water-resistive, air, and thermal barrier

3. **Easy installation:** They're lightweight, and taping the seams goes quickly, making them easy to install.

4. **Energy-code compliant:** They're energy-code compliant, meeting continuous installation codes set by ASHRAE 90.1.

5. **Labor savings:** While the cost of the board is more expensive than traditional sheathing, the system delivers considerable labor and material savings.

6. **Works well with others:** They are compatible under most cladding types, including

EIFS, which allows for easy transitions across the envelope.

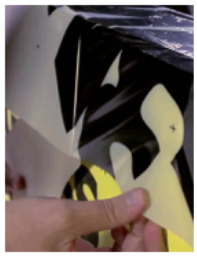
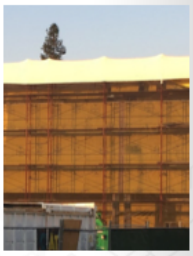
They do have their downside, though: ***(Each click of the mouse or right arrow will reveal a red "X" mark corresponding to the disadvantage.)***

1. **Components:** They can sometimes require special fasteners and treatments to the fasteners.

Pros/Cons of Current WRB-AB Systems

Barrier types



	Building Wrap/Felt	Fluid-Applied Membrane	Adhered Membrane	Rigid Board Stock
Water-Resistive Barrier	✔	✔	✔	Can be
Air Barrier	Building Wrap – Can be	✔	✔	Can be
Vapor Barrier	High perm	Both high and low perm available	Both high and low perm available	Low perm
Consistent Thickness	✔	Applicator dependent	✔	✔

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Here we have a side-by-side comparison of all four types. All four types are or can be a water resistive barrier and an air barrier. Each type also functions as a high perm, low perm or both high and low perm vapor barrier. In terms of consistent thickness, fluid-applied membranes are applicator dependent to achieve a consistent thickness, where building wrap or felt and adhered membrane and rigid board stock have a consistent thickness for consistent vapor permeability.

Pros/Cons of Current WRB-AB Systems

Installation

	Building Wrap/Felt	Fluid-Applied Membrane	Adhered Membrane	Rigid Board Stock
Wet weather	✔	✘ Generally no, depends on manufacturer	✘	✔
Cold weather (Below 40°F)	✔	✘ Generally no, depends on manufacturer	✘	✔
Does NOT require special fasteners	✘	✔	✔	✘
Does NOT require sheathing joints and fasteners to be sealed	✘ Does, when used as an air barrier	✘	✔ Does not, but does require gypsum sheathing to be primed	✘ Does, for joints
Does NOT require cladding fasteners to be sealed	✔	✔	✔	✔
Long-term exposure allowed before cladding is installed	✘	✘	✘	✘

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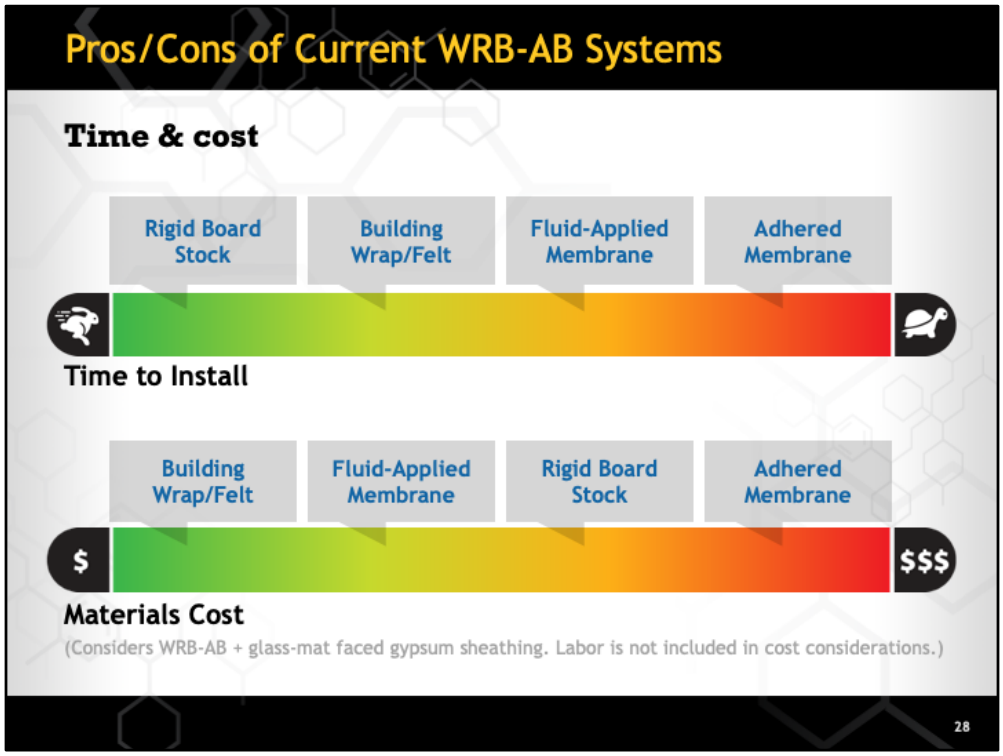
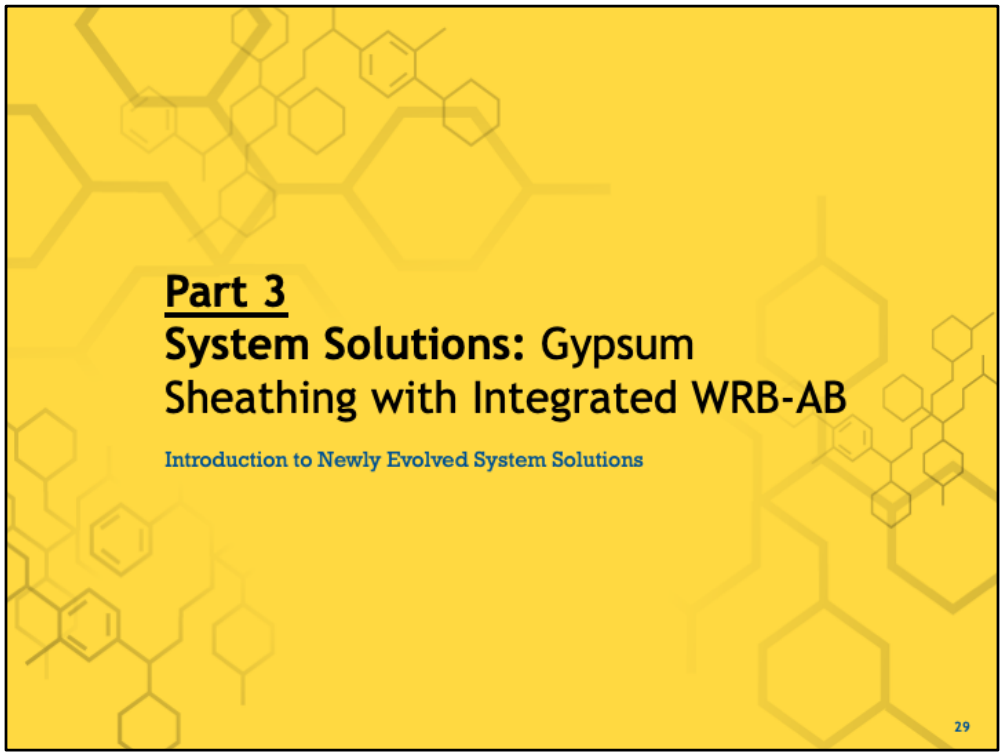
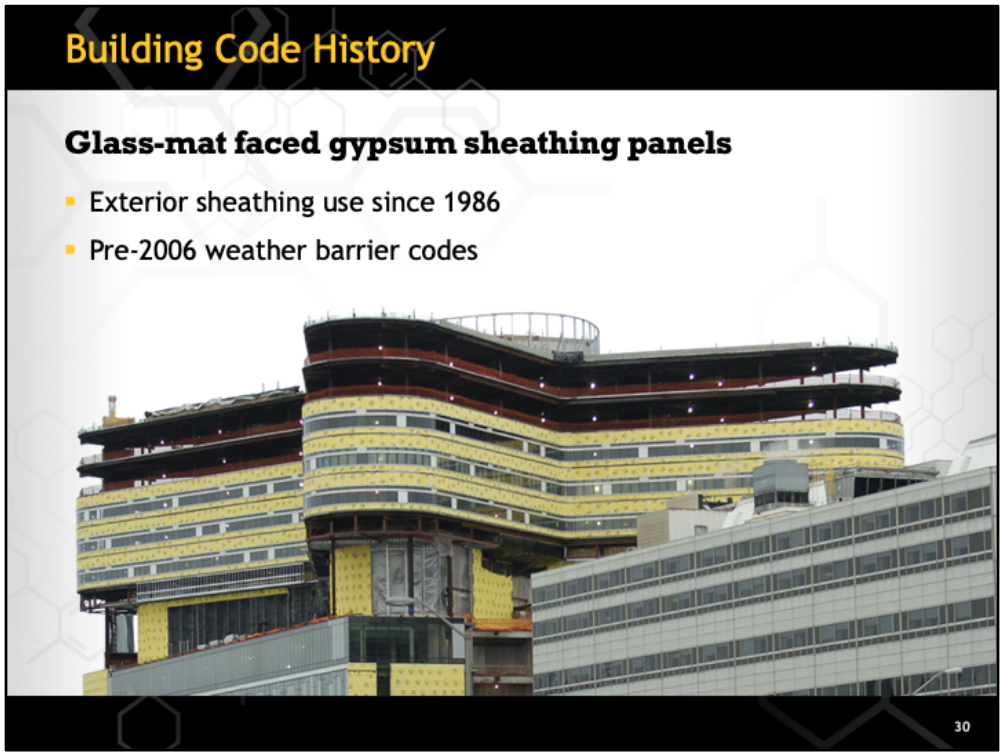
In short, while all of the above common choices may meet the material requirements for different barriers, a closer look at their installation and suitability for different projects can reveal some significant limitations.



They will also have variations in the time they take to install and their corresponding costs. This chart only displays material cost of the product; what isn't shown is the significant savings made through one fewer trade on the job site and a shorter installation time, which can lead to faster project timelines and ultimately means opportunity for the building owner to make money faster.



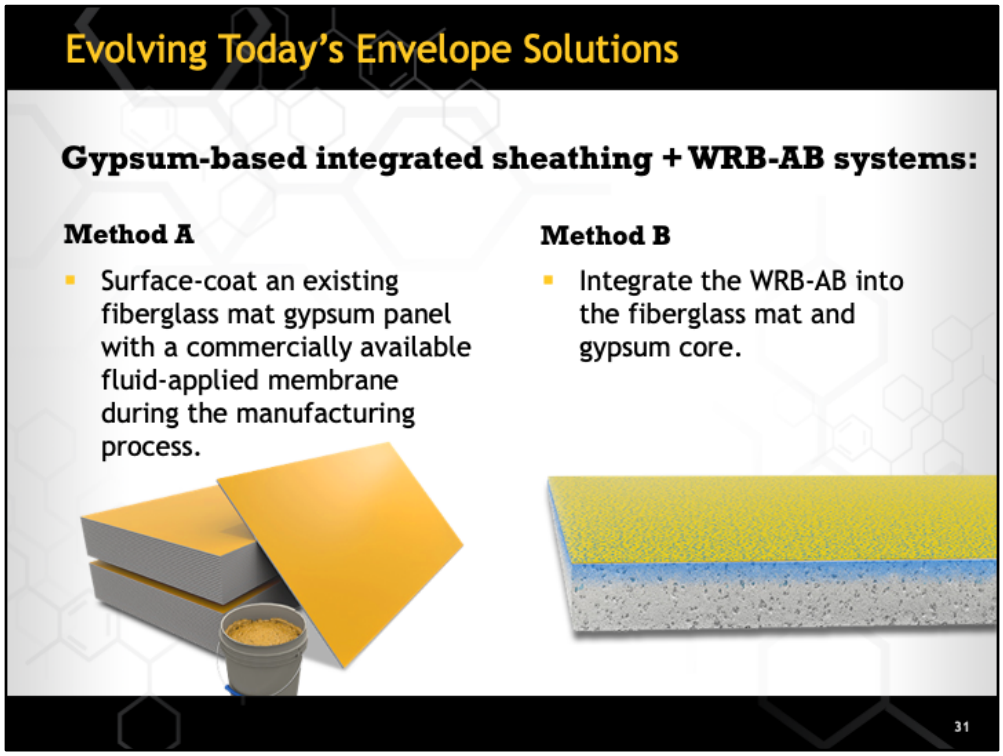
Having considered all of these other options, we will next take a more detailed look at the most current technology: integrated sheathing.



The ability of glass-mat faced gypsum sheathing to provide a fire- and weather-resistant substrate for multiple types of exterior cladding has made it a popular and cost-effective choice for many commercial buildings since the mid-1980s.

Up until the year 2006, it was also considered to be an acceptable WRB if the joints and seams were caulked, but some seam failures of some products led to more current code requirements for WRBs and ABs.

As energy efficiency evolved, water infiltration in building structures gained more attention, resulting in today's use of water-resistive and air barriers.

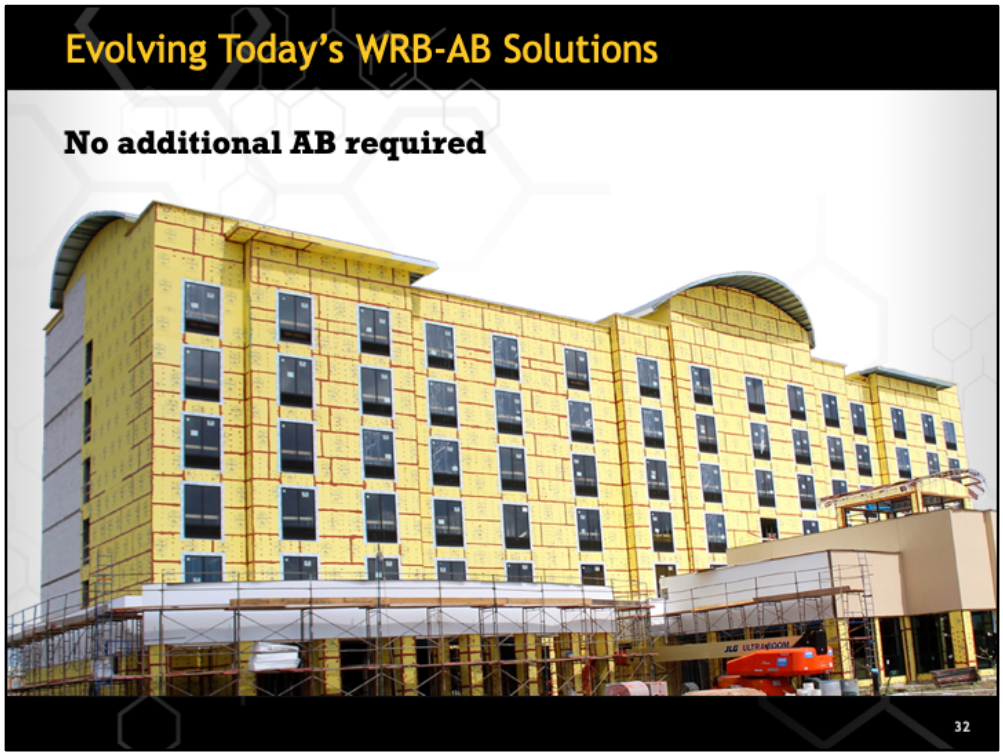


Manufacturers have responded with not just one but two different types of innovative sheathing products with integrated, code-approved WRB-AB systems.

First, we have coated panels. This approach is based on an added manufacturing step of coating one face of fiberglass-mat faced gypsum panels with a commercially available fluid-applied membrane under controlled conditions in the factory.

Next, we have core-integrated panels. This process integrates the WRB and AB into the fiberglass mat and gypsum core to create a hydrophobic, monolithic surface that blocks bulk water but allows vapor to pass-through.

Both methods meet the performance requirements for use as a water-resistive and air barrier when the joints, sheathing fasteners, penetrations, opening, and material transitions are sealed to the manufacturers' installation instructions.



No AB required. That means that once it's been sealed with a brand-specific flashing product, the fiberglass mat gypsum sheathing of these integrated products serve as both a continuous drainage plane for bulk water that finds its way beneath the exterior cladding and a continuous air barrier. Additionally, this liquid flashing allows for a simpler QC inspection because you can see where the flashing has or hasn't been applied.

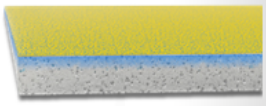
Good design practices always promote drainage behind cladding.

Note: Currently brand-specific fluid-applied flashing products are used to seal these openings for water- and air-barrier compliance.

See individual manufacturer's installation instructions.

Fiberglass Mat Gypsum Integrated Sheathing

Surface-coated vs. integrated core



ASTM C1177 Criteria	Method A Surface Coated WRB Fiberglass Mat Gypsum Sheathing	Method B Fully Integrated WRB Fiberglass Mat Gypsum Sheathing
Flexural strength	✔	✔
Humidified deflection	✔	✔
Core, end, and edge hardness	✔	✔
Nail-pull resistance	✔	✔
Water resistance/absorption	✔	✔
Effective stiffness	✔	✔
Effective modulus of rupture	✔	✔
Compressive strength	✔	✔
Impact resistance (soft body)	✔	✔
Negative wind load resistance	✔	✔
Dimensional stability	✔	✔

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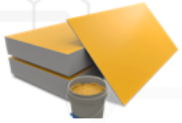
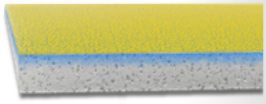
Both methods of producing integrated sheathing meet the same mechanical and physical properties of traditional gypsum sheathing. These include meeting or exceeding the requirements of ASTM C1177: Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing for characteristics such as flexural strength; humidified deflection; core, end, and edge hardness, nail-pull resistance; and water-resistance and absorption. They also meet or exceed the gypsum board requirements for effective stiffness, effective modulus of rupture, compressive strength, soft-body impact resistance, negative wind-load resistance, and dimensional stability.

The products also share the same properties as other gypsum board products for racking strength, thermal properties, weight, and overall performance.

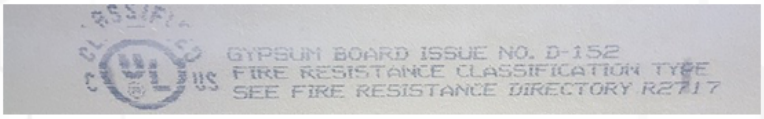
Fiberglass Mat Gypsum Sheathing

Surface-coated vs. integrated core





Fire-Resistant Properties	Method A Surface-Coated WRB Fiberglass Mat Gypsum Sheathing	Method B Fully Integrated WRB Fiberglass Mat Gypsum Sheathing
ASTM E84 surface-burning characteristics	✔	✔
ASTM E136 noncombustibility	✔	✔
ASTM E119 or CAN/ULC-S101 fire-resistance requirements	✔	✔
UL Classification (5/8" Type X) for use in fire-rated assemblies: UL fire-rated assemblies	✔	✔
UL Classification (5/8" Type X) for use in fire-rated assemblies: ITS fire-rated assemblies	✔	✔



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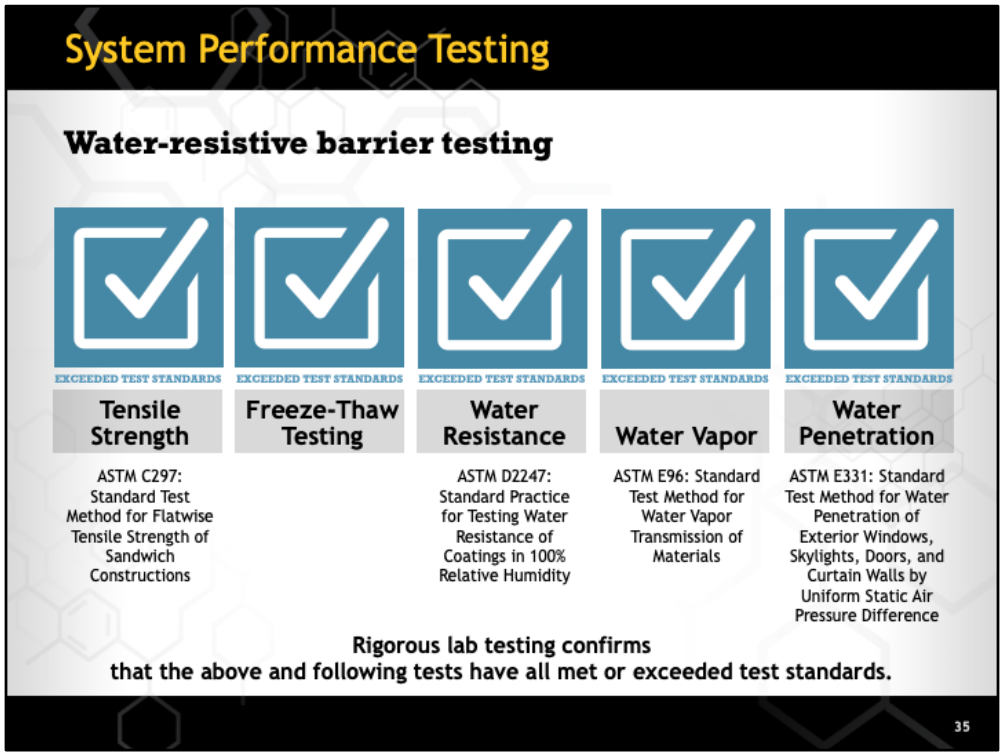
In terms of fire-resistance, both types of integrated sheathing provide the same properties as other gypsum board products. These include maintaining fire-resistant properties under ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials, ASTM E136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 C, and ASTM E119: Standard Test Method for Fire Tests of Building Construction and ASTM E119 or CAN/ULC-S101. When 5/8-inch Type X gypsum sheathing is specified, it also meets the criteria for UL and ITS fire-rated assemblies.



Now that you understand that the sheathing component of an integrated system meets the same performance criteria as traditional fiberglass mat gypsum panels, let's review how the WRB-AB component performs once integrated onto or into the sheathing. Both currently available system solutions (Methods A and B) have received an evaluation for code acceptance.

Among the various WRB tests that these integrated sheathing systems have passed, several are worth noting.

ASTM C297: Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions is a tensile bond or tensile strength test to measure the bond of a water-resistive barrier to the substrate.

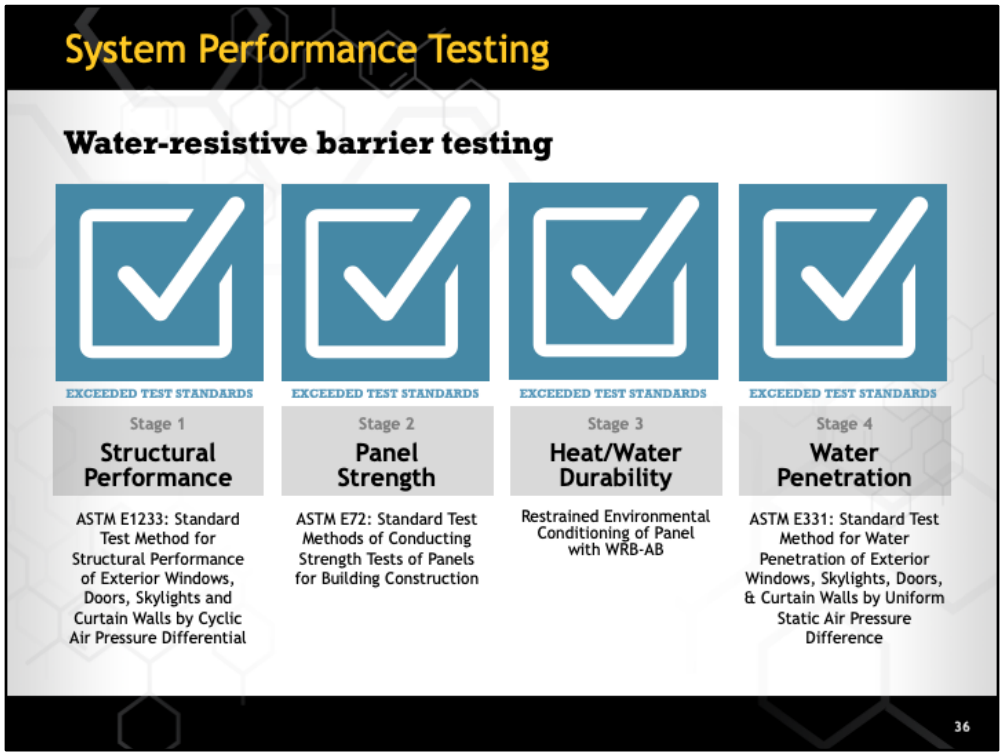
Freeze-Thaw Testing tests the durability of the panel's water-resistive barrier.

ASTM D2247: Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity is an extreme condition test for water penetration at a treated joint.

ASTM E96: Standard Test Method for Water Vapor Transmission of Materials

tests the panel’s ability to allow water vapor to pass through.

ASTM E33: Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference is a four-stage, multiple-step, water-penetration chamber test using air pressure to force sprayed water through any openings and through the material itself.



The four stages of ASTM 33 test for water penetration AFTER structural, racking, and restrained environmental testing.

Stage 1, ASTM E1233: Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Cyclic Air Pressure Differential is a panel deflection test to determine if water-resistive barrier will crack or separate from panel.

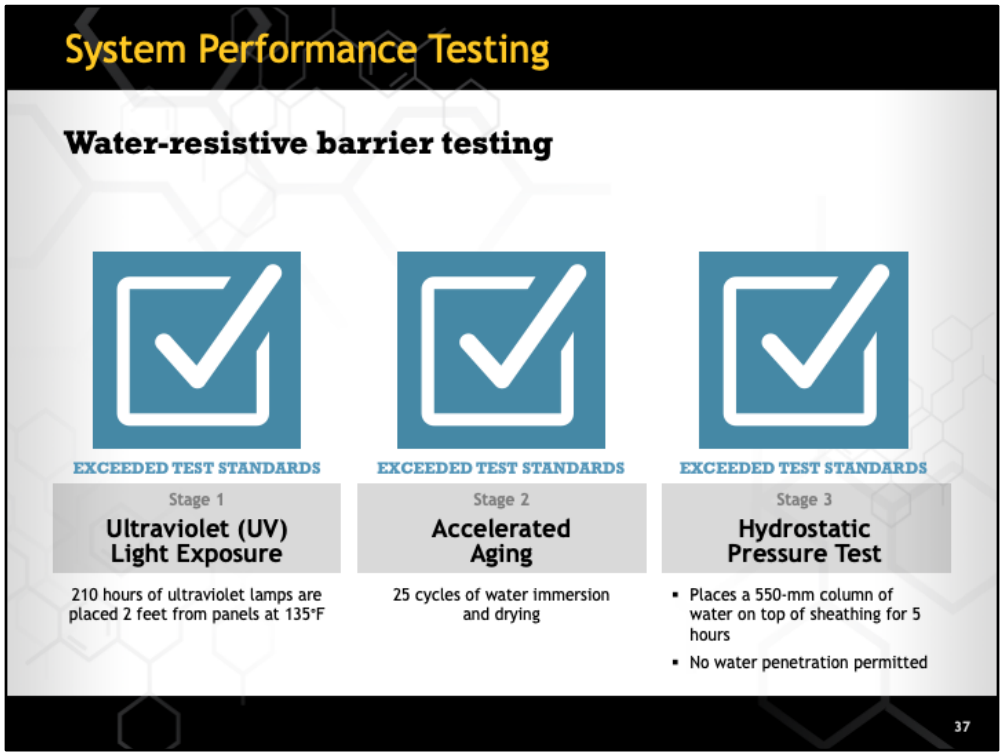
Stage 2, ASTM E72: Standard Test Methods of Conducting Strength Tests of Panels for Building Construction is a panel strength test, which also determines if the water-resistive barrier will crack or separate from the panel.

Stage 3, Restrained Environmental Conditioning of Panel with WRB-AB is a panel durability test with 24 hours of extreme heat exposure and water spray to determine if a water-resistive barrier will crack or separate from the panel.

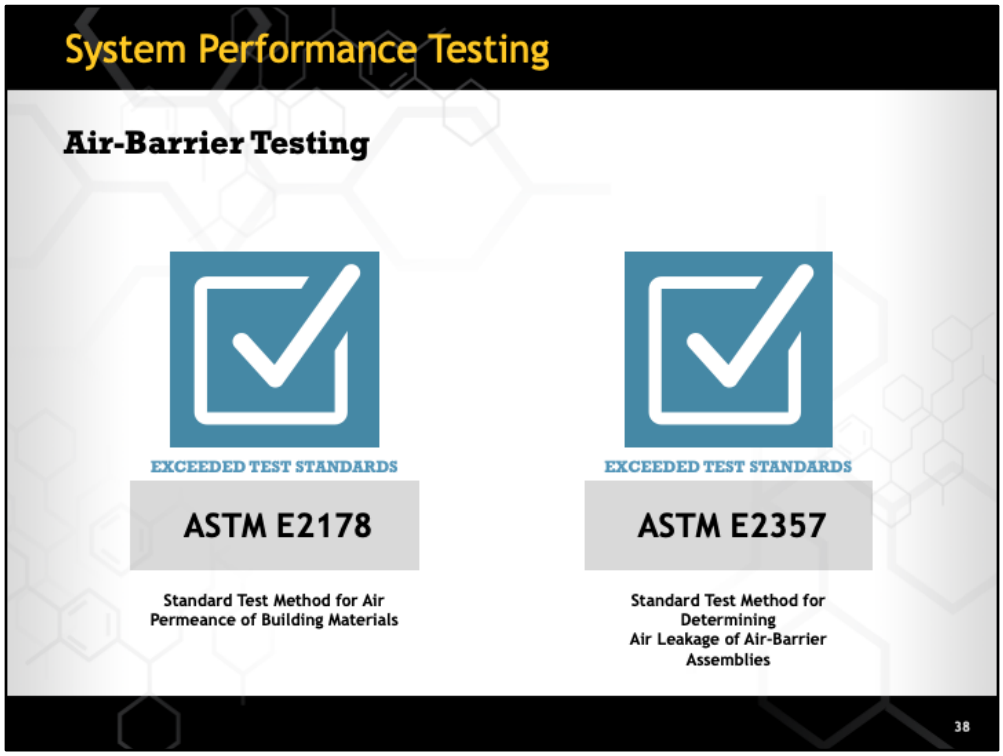
And finally, Stage 4, ASTM E331: Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference is a water-penetration test using the SAME panels as tested in Stages 1 through 3, but in this case, the panels are tested as an

assembly.

Water is sprayed on panels at a rate of 5 gallons per hour with an air pressure of 2.86 psf. After 15 minutes, the back of the panels are examined for water leaks.



Both currently available WRB-AB systems also passed a three-stage multiple step Hydrostatic Pressure Test AFTER UV Light Exposure and Accelerated Aging.

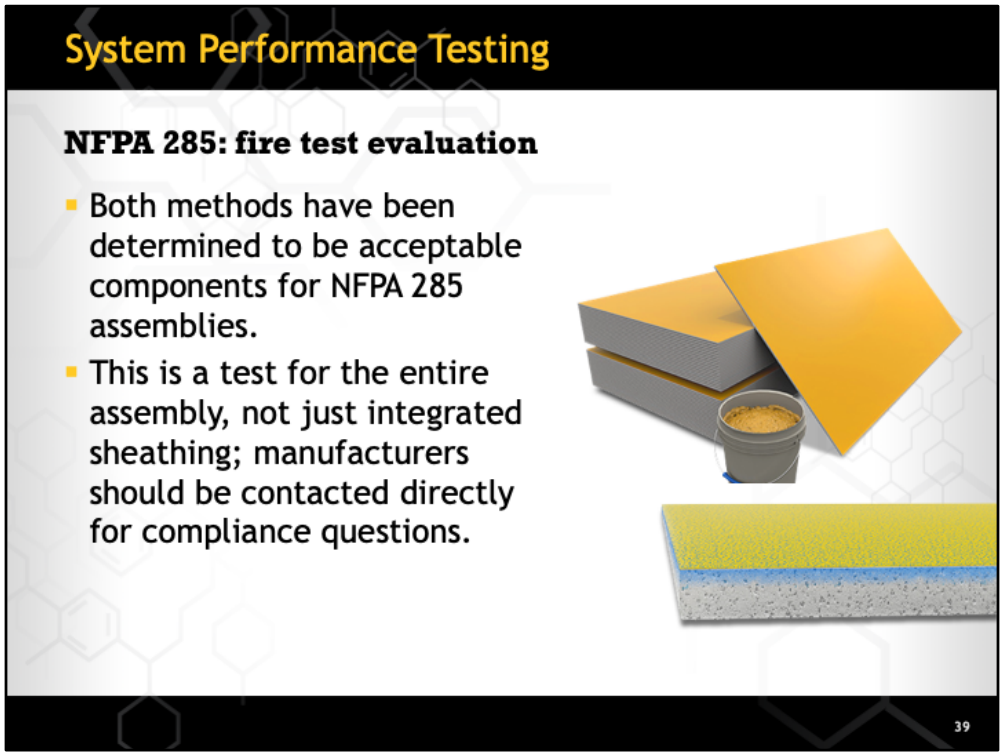


The same integrated sheathing products are also tested for their performance as an air barrier. These have included successfully passing:

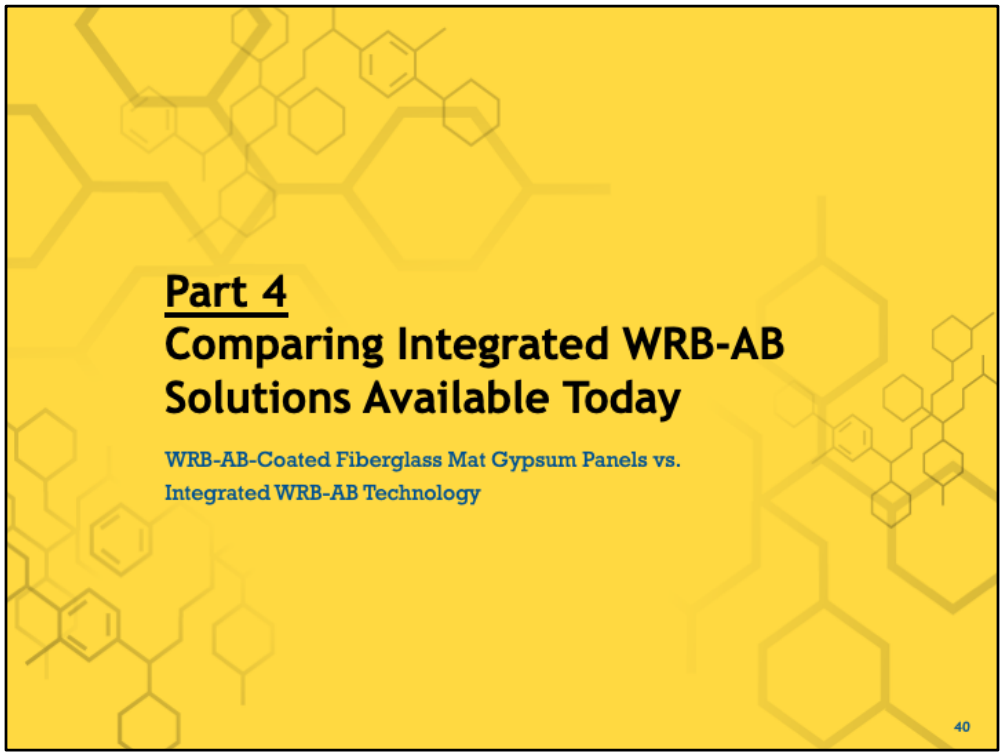
ASTM E2178: Standard Test Method for Air Permeance of Building Materials, which is an air-barrier test on products or materials to determine that the code requirements for air permeance has been met.

ASTM E2357: Standard Test Method for Determining Air Leakage of Air-Barrier Assemblies is testing designed to demonstrate that the product, as used in an assembly, meets code requirements for the air permeability of the assembly.

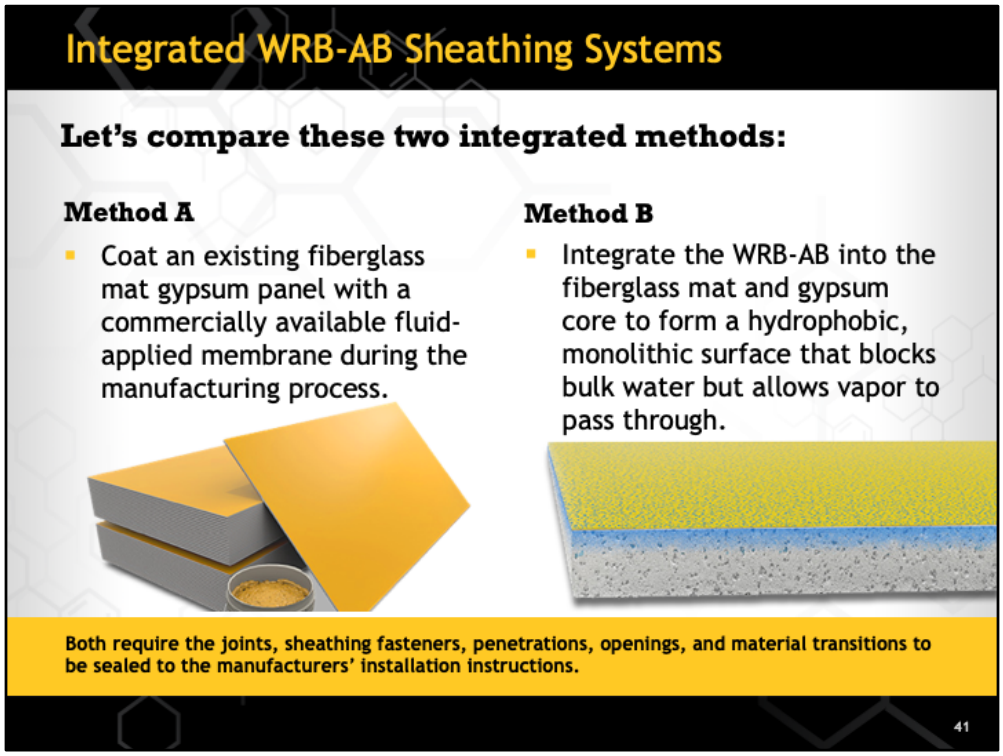
Rigorous lab testing confirms that the above tests have all met or exceeded test standards.



To determine which assemblies are NFPA 285 compliant, contact the integrated sheathing + WRB-AB system manufacturers directly.



As we have seen, both methods of producing integrated sheathing (coated fiberglass mat gypsum panels and integrated technology) are excellent choices for an effective and proven exterior sheathing with an integrated WRB-AB system. However, there are several performance differences between these two types of which design professionals need to be aware.



To review, Method A involves coating an existing fiberglass mat gypsum panel with a commercially available fluid-applied membrane under controlled conditions in a factory, while Method B integrates the WRB and AB into the gypsum core and the fiberglass mat of a gypsum sheathing panel.

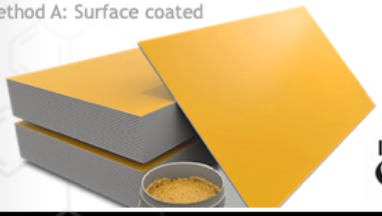
Both require the joints, sheathing fasteners, penetrations, openings, and material transitions to be sealed to the manufacturers' installation instructions.

Integrated WRB-AB Sheathing Systems

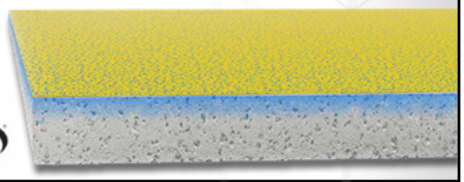
Surface-coated vs. fully integrated

- BOTH are effective sheathing + WRB-AB systems
- BOTH meet or exceed the requirements of ICC-ES AC212: Acceptance Criteria for Water-Resistive Coatings used as water-resistive barriers over Exterior Sheathing
- BOTH comply with model building codes:
  - IBC Chapter 14, Section 1404: Water-Resistive Barrier
  - IRC Chapter 7, Section 703: Water-Resistive Barrier

Method A: Surface coated



Method B: Fully integrated



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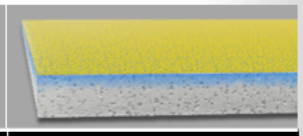
Integrated WRB-AB Sheathing Systems

Gypsum panel property similarities



Gypsum Panel Properties	Method A Surface-Coated WRB Fiberglass Mat Gypsum Sheathing	Method B Fully Integrated WRB Fiberglass Mat Gypsum Sheathing
Meets **ASTM C1177 and C1396** (gypsum standards)	✔	✔
Type X, per ASTM E119 (fire resistance)	✔	✔

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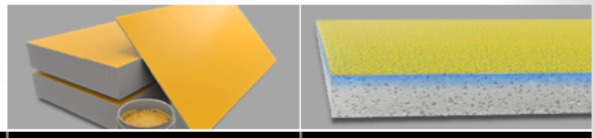
Core-integrated systems often provide superior performance over coated systems in a number of ways.

Integrated WRB-AB Sheathing Systems

Gypsum panel property differences



Gypsum Panel Properties	Method A Surface-Coated WRB Fiberglass Mat Gypsum Sheathing	Method B Fully Integrated WRB Fiberglass Mat Gypsum Sheathing
Fiberglass mat gypsum sheathing **water-absorption percent by weight**	10% Per ASTM C1177 (Based on PEI Evaluation Report PER-14070)	5% Exceeds ASTM C1177
Surface-burning characteristics (fire resistance) ▪ Flame spread ▪ Smoke developed	 20 15 Meets Class A (Based on PEI Evaluation Report PER-14070)	 0 0 Meets Class A

Note: Total panel water-absorption and surface-burning characteristics may differ between systems. Toll-coated glass-mat faced gypsum sheathing values may vary.

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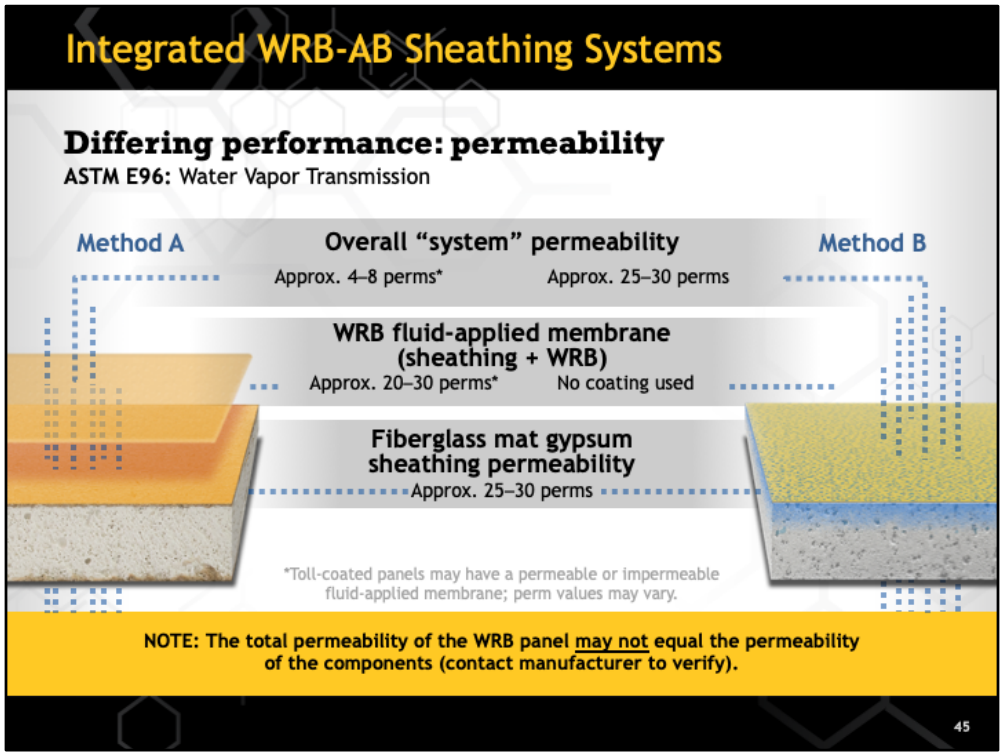
First, core-integrated systems have lower water-absorption rates than coated systems when compared by weight (five percent versus 10 percent, respectively).

And while both meet Class A fire ratings, core systems also have superior surface-burning characteristics, with zero flame spread and compared to 20 for coated systems and 0 smoke developed compared to 15 for coated systems.

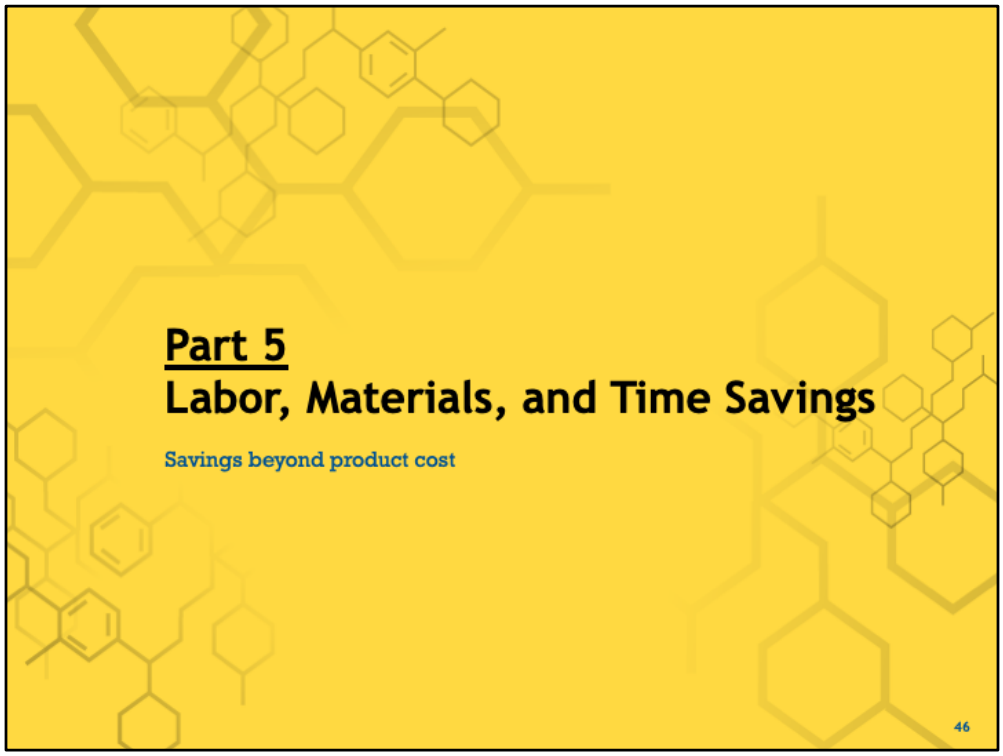


Note that for Method A: The thickness and permeability of the coating applied to the sheathing face will impact the permeability of the overall "system."

Also note that for Method B: No coating is applied to the sheathing face. The high permeability of fiberglass mat gypsum sheathing is maintained.

The permeability ratings have been shown to be very consistent on integrated systems since no coating is applied; the core-integrated sheathing provides the resistance.

Integrated systems allow more trapped vapor to escape, while coated systems tend to have lower perm rates, limiting vapor from escaping. It's important to note that variations exist between manufacturers on the sheathing panels and the rest of the flashing system too, so details should be verified based on manufacturers information.

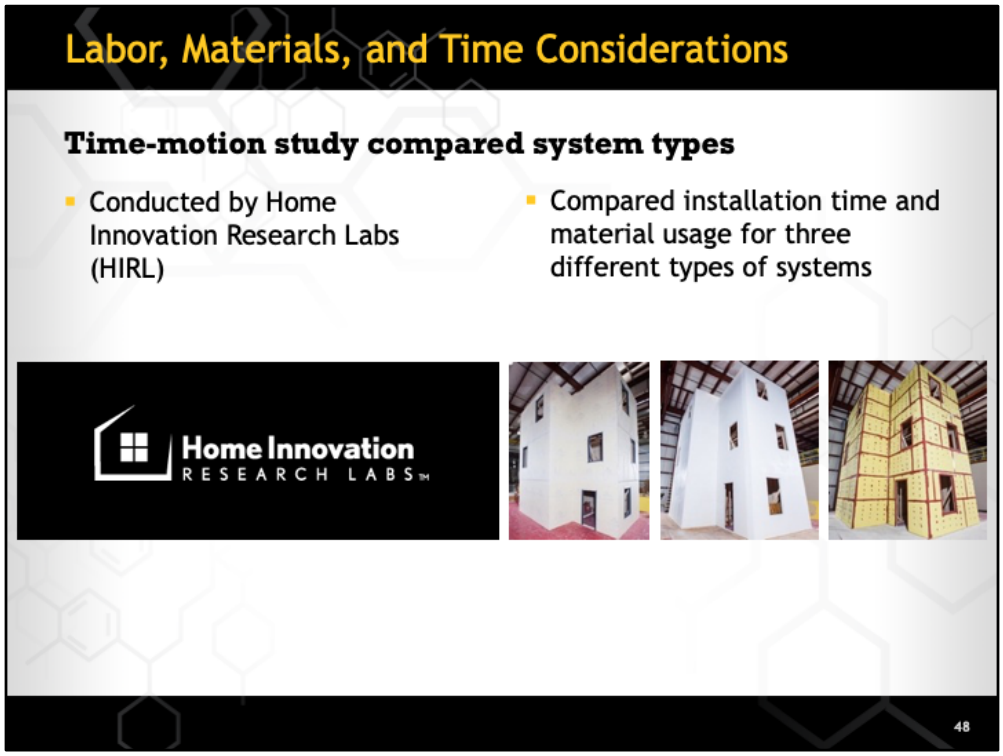


When using individual materials or systems to achieve the different barrier layers, more labor and time is usually needed for the installation, which adds up to more construction cost. When using integrated sheathing products, there is typically less time required since multiple barriers are installed at the same time. Integrated sheathing systems typically require less labor with fewer crew members because of the simplicity of installing and finishing them. And they usually require less specialized labor since any sheathing installer should be able to install integrated sheathing just as easily as standard sheathing.

Installing an integrated WRB-AB simply requires following the usual steps required to install standard sheathing and then sealing the joints, fasteners, penetrations, openings, and transitions for air-barrier compliance.

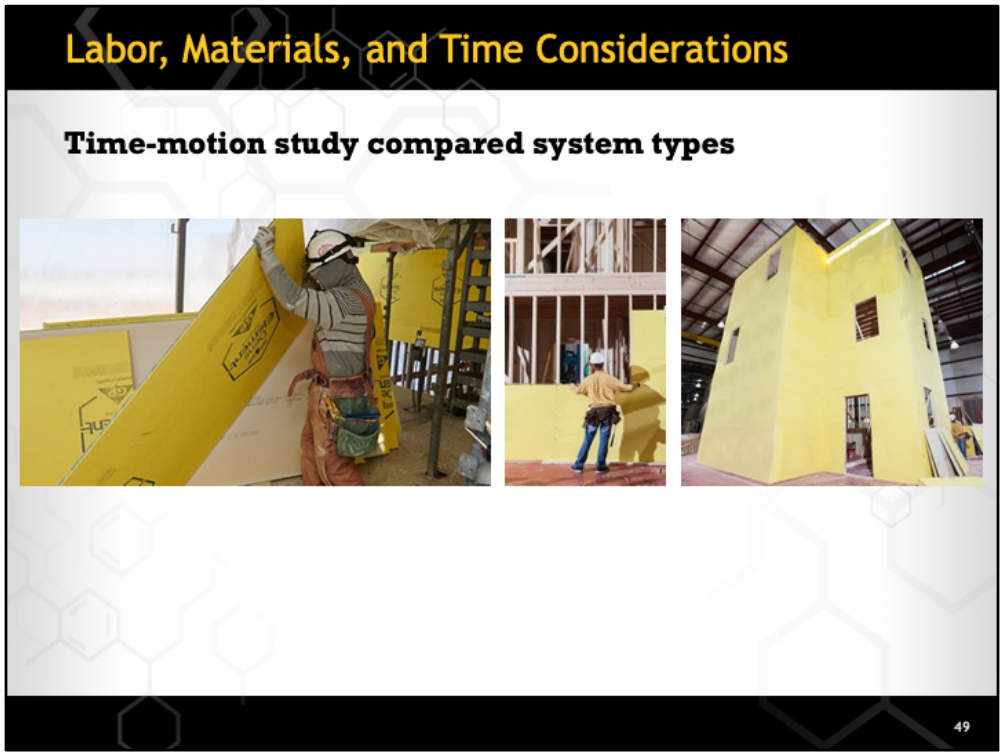
Eliminate traditional WRB products. No additional steps or products are required:

- No building wrap required.
- No application of fluid membrane required.
- No adhered membrane required.



To put the two types of integrated systems to the test, Home Innovation Research Labs conducted a time-motion study. It compared installation time and material usage for three different types of systems:

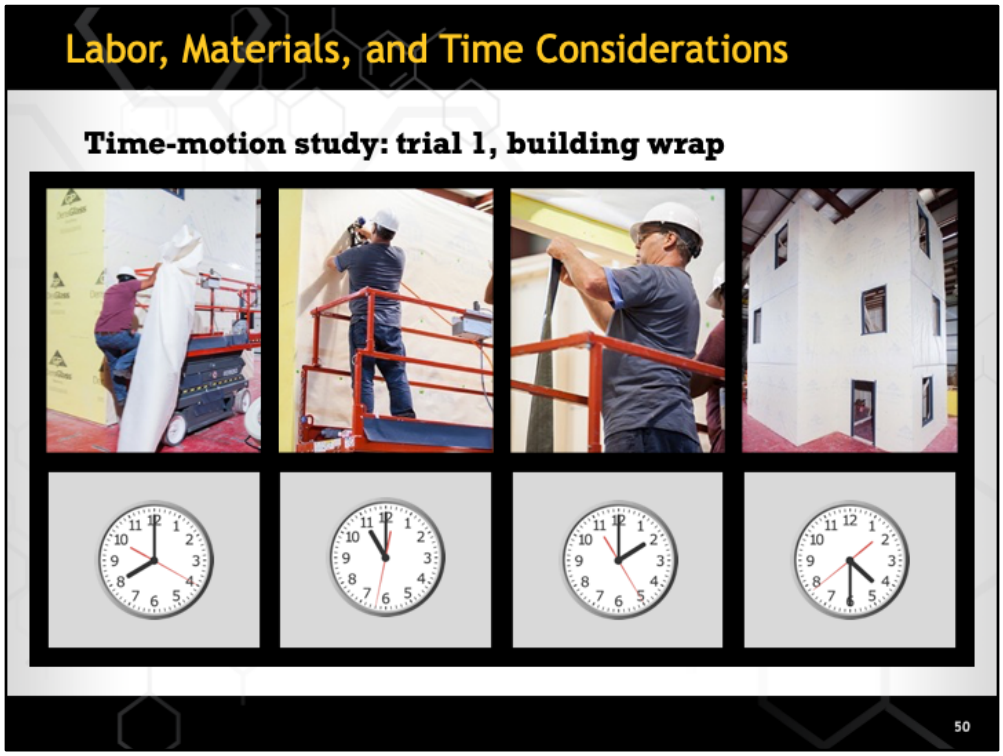
- Sheathing plus joint treatment plus building wrap
- Sheathing plus joint treatment plus fluid-applied membrane
- Integrated sheathing with WRB-AB system plus joint treatment



For the study, they constructed a three-story commercial building indoors in a controlled environment and hired an experienced crew to install the WRB-AB systems. You can see the specs of the building here.

Specifications:

- 28 feet tall, 88 feet of wall length
- Six window openings
- One door opening
- Inside/outside corners
- Sheathed exterior wall surface = 1,232 square feet per trial installation



The first trial, which included gypsum sheathing, tape flashing, and building wrap, took a total of 8 hours and 31 minutes to properly install.

Gypsum sheathing
+ Tape flashing (typical)
+ Building wrap

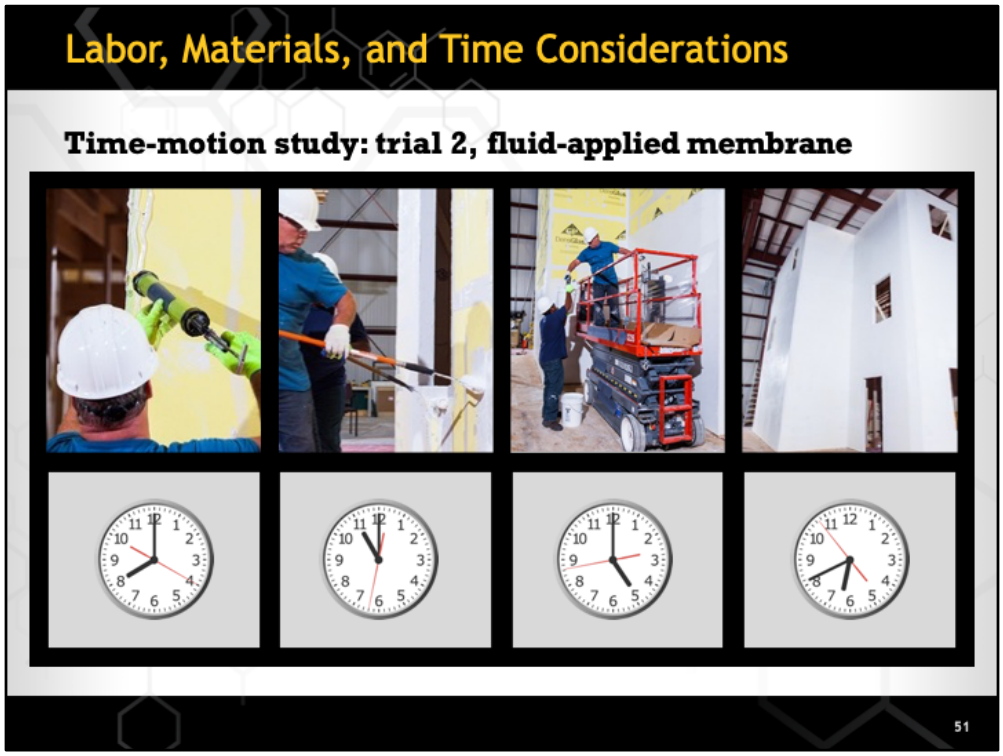
Building wrap fastened with pneumatic cap stapler

All wrap seams overlapped and sealed with 2 ½-inch flashing tape

6-inch self-adhered flashing on one door and six

window openings

Total installation time = **8 hours and 31 minutes**



The second trial, which used gypsum sheathing, a fluid-applied flashing and a fluid-applied WRB-AB membrane took a total of 10 hours and 41 minutes to complete.

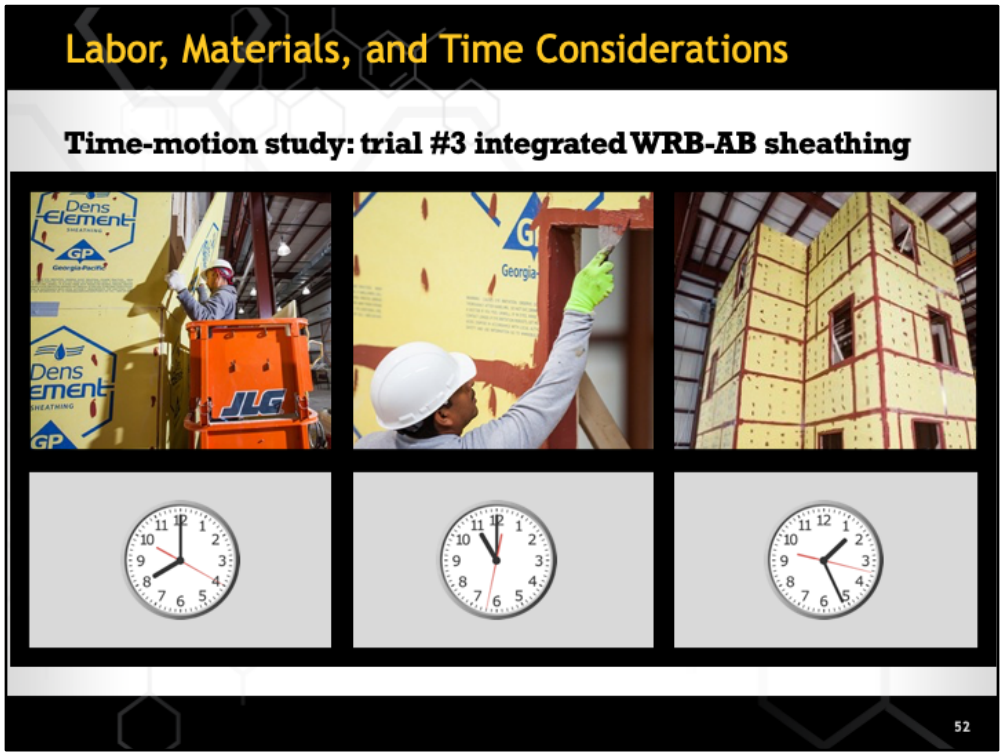
Gypsum sheathing
+ Fluid-applied flashing
+ Fluid-applied membrane

Fluid sealant in 20-ounce “sausage” guns applied to seams and fastener heads

One door and six window openings fully flashed with fluid sealant

Fluid-applied membrane roller applied over entire surface of sheathing

Total installation time = **10 hours and 41 minutes**



The third trial, which used gypsum sheathing with an integrated WRB-AB and fluid-applied flashing, took only 6 hours and 26 minutes to install completely.

Integrated WRB-AB
- Gypsum sheathing
- + Fluid-applied flashing

Fluid sealant in 20-ounce “sausage” guns applied to seams and fastener heads

One door and six window openings fully flashed with fluid sealant

NO TREATMENT required over surface of

sheathing

Total installation time = **6 hours and 26 minutes**

Labor, Materials, and Time Considerations

Time-motion study: summary

- An experienced water-resistive- and air-barrier crew installed these three different systems over the same structure with different completion times.
- The integrated WRB-AB gypsum sheathing system was completed FASTER than the other two methods.
- Integrated sheathing was installed 25 percent faster than the building wrap and 40 percent faster than the fluid-applied membrane.

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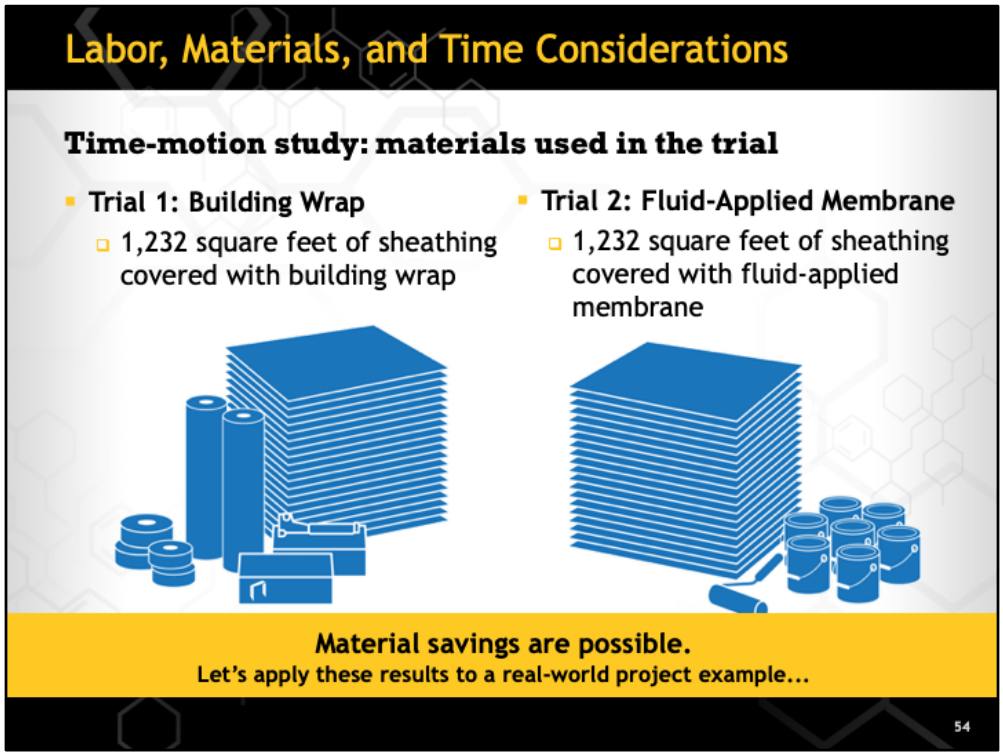
At the conclusion of the study, it was determined that the integrated WRB-AB gypsum sheathing system was completed faster than the other two methods and eliminated one installation step altogether.

It was also noted that the integrated sheathing was installed 25 percent faster than the building wrap and 40 percent faster than the fluid-applied membrane.



The building wrap and fluid-applied membrane systems also required significantly more materials for installation than the integrated WRB-AB gypsum sheathing system.

Trial 1 included:

- 141 linear feet of building wrap (using 10-by-100-foot rolls) = 1,410 square feet
- 880 cap staples
- 185 linear feet of sheathing tape
- 116.5 linear feet of flashing tape

Trial 2 included:

- 7 gallons of roll-on liquid membrane
- Rolled on at approximately 176 square feet per gallon

Using these findings, we can create a hypothetical project example based on a building with 20,000 gross square feet of wall area that used an integrated WRB-AB gypsum sheathing system instead of individual WRB-AB systems. Under that scenario, it can be projected that approximately 22,500 square feet of building wrap—plus tapes and staples—would not be needed. Similarly, compared to fluid-applied membrane systems, approximately 125 gallons for thin-mil fluid applications (160 square feet per gallon) or up to 267 gallons (75 square feet per gallon) for thick-mil applications would not be used. Other potential savings include equipment use and reduced safety risks since the additional steps aren't necessary.

Overall, labor, material and time savings have been projected as quite possible using integrated WRB-AB gypsum sheathing systems instead of traditional WRBs and ABs, all without jeopardizing performance. In fact, the manufactured nature of the barriers provides better quality control and reduces the risk of on-site mistakes and any compromise in performance.

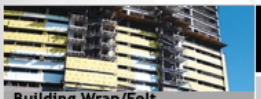
One less step versus traditional systems when using integrated WRB-AB gypsum sheathing systems.

Time savings were seen in third-party study:
Resulted in time savings ranging from ± 25 percent to ± 40 percent (compared to building wrap and full fluid-applied membrane systems in the study). Of course, results may vary.

Material savings can be significant:
- Fewer rolls of building wrap and tape
- Less material than full fluid-applied

Pros/Cons of Current WRB-AB Systems

Barrier types



	Water-Resistive Barrier	Air Barrier	Vapor Barrier	Consistent Thickness (for consistent vapor permeability)
Building Wrap/Felt	✔	Building Wrap – Can be	High perm	✔
Fluid-Applied Membrane	✔	✔	Both high and low perm available	Applicator dependent
Adhered Membrane	✔	✔	Both high and low perm available	✔
Rigid Board Stock	Can be	Can be	Low perm	✔
Method A Fiberglass Mat Gypsum Sheathing Coated with WRB Membrane	✔	✔	Low perm*	✔
Method B Fiberglass Mat Gypsum Sheathing with Integrated WRB Core Technology	✔	✔	High perm	✔

*Toll coated glass-mat faced gypsum sheathing permeability may vary. Check with manufacturer.

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This chart gives us a side-by-side comparison of all the WRB-AB systems currently available in terms of their effectiveness.

Pros/Cons of Current WRB-AB Systems

Installation

	Building Wrap/Felt	Fluid-Applied Membrane	Adhered Membrane	Rigid Board Stock	Method A Fiberglass Mat Gypsum Sheathing Coated with WRB Membrane	Method B Fiberglass Mat Gypsum Sheathing with Integrated WRB Core Technology
Wet weather	✔	✘ Generally no, depends on manufacturer	✘	✔	✔	✔
Cold weather (Below 40°F)	✔	✘ Generally no, depends on manufacturer	✘	✔	✔	✔
Special fasteners NOT Required	✘	✔	✔	✘	✔	✔
Does NOT require sheathing joints and fasteners to be sealed	✘ Does, when used as an air barrier	✘	✔ Does not, but does require gypsum sheathing to be primed	✘ Does for joints	✘	✘
Does NOT require cladding fasteners to be sealed	✔	✔	✔	✔	✔	✔
Long-term exposure allowed before cladding is installed	✘	✘	✘	✘	✔ Up to 12 months	✔ Up to 12 months

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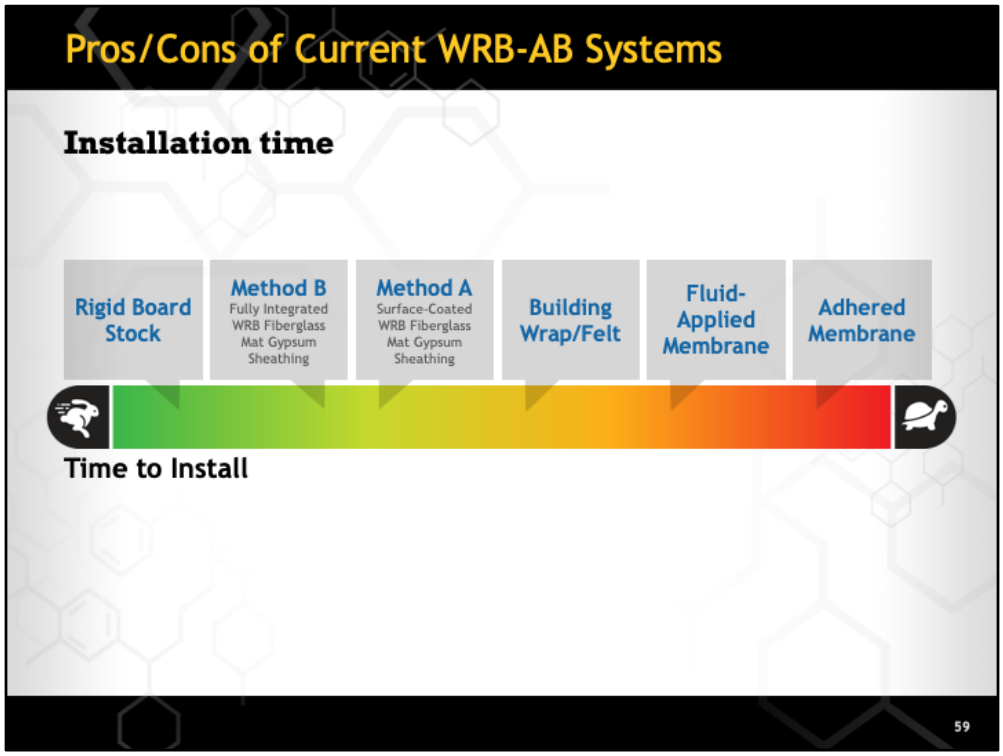
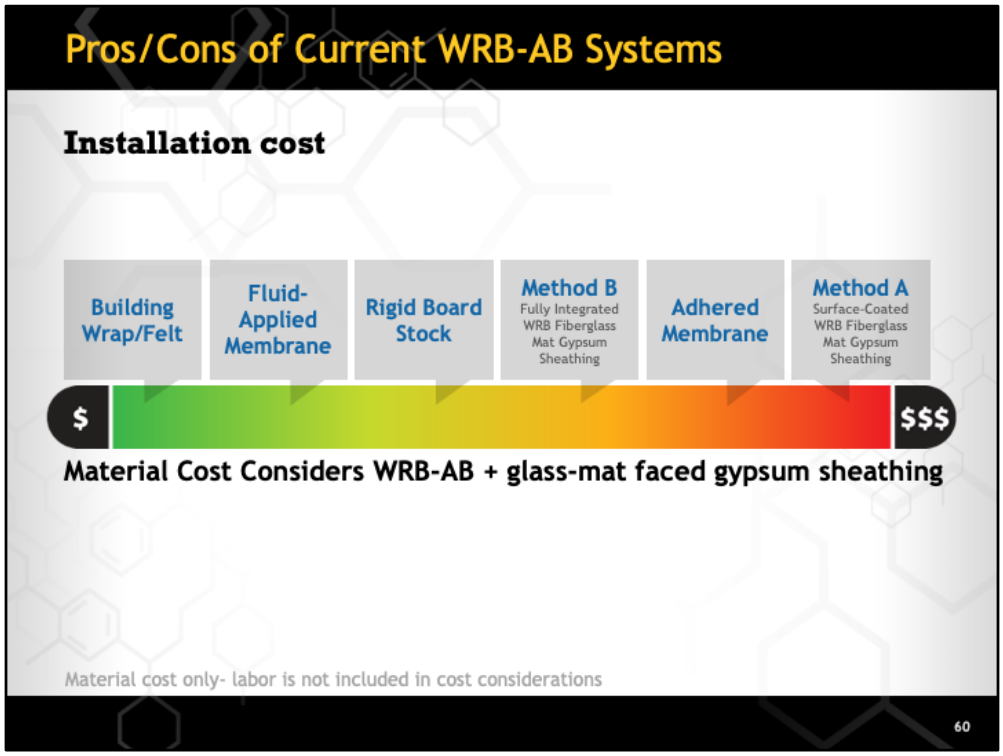
This chart gives us a side-by-side comparison of the installation pros and cons of all the WRB-AB systems currently available.

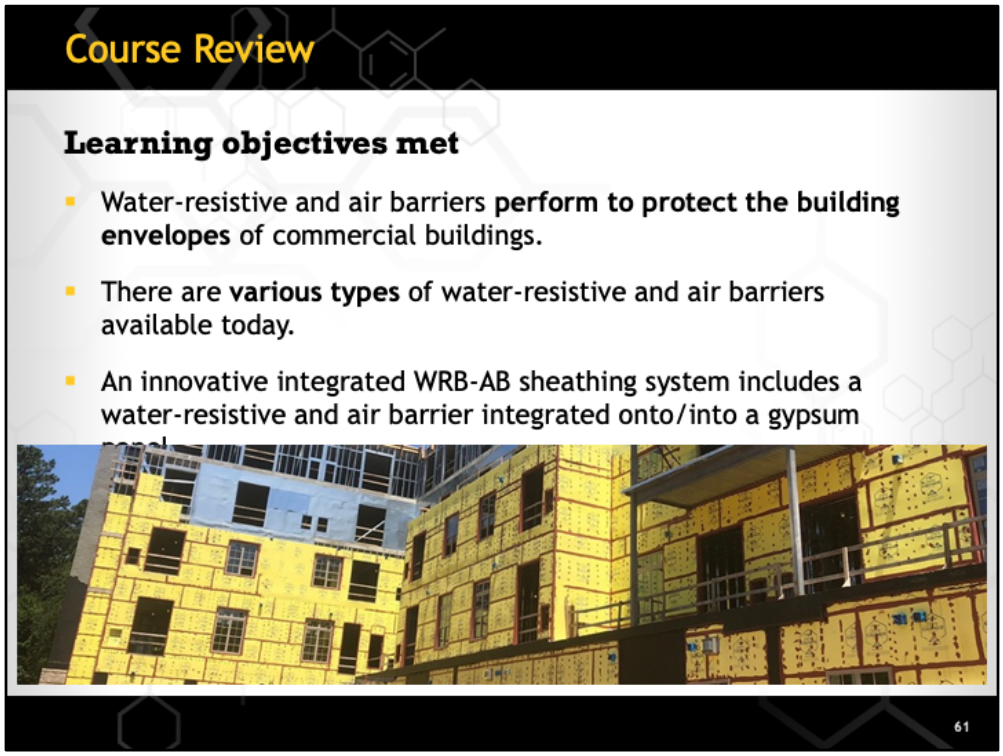


This chart gives us a comparison of all the different WRB-AB systems currently available in terms of installation time.

Note that cladding fastener sealing is required on fiberglass mat gypsum sheathing with integrated WRB technology.

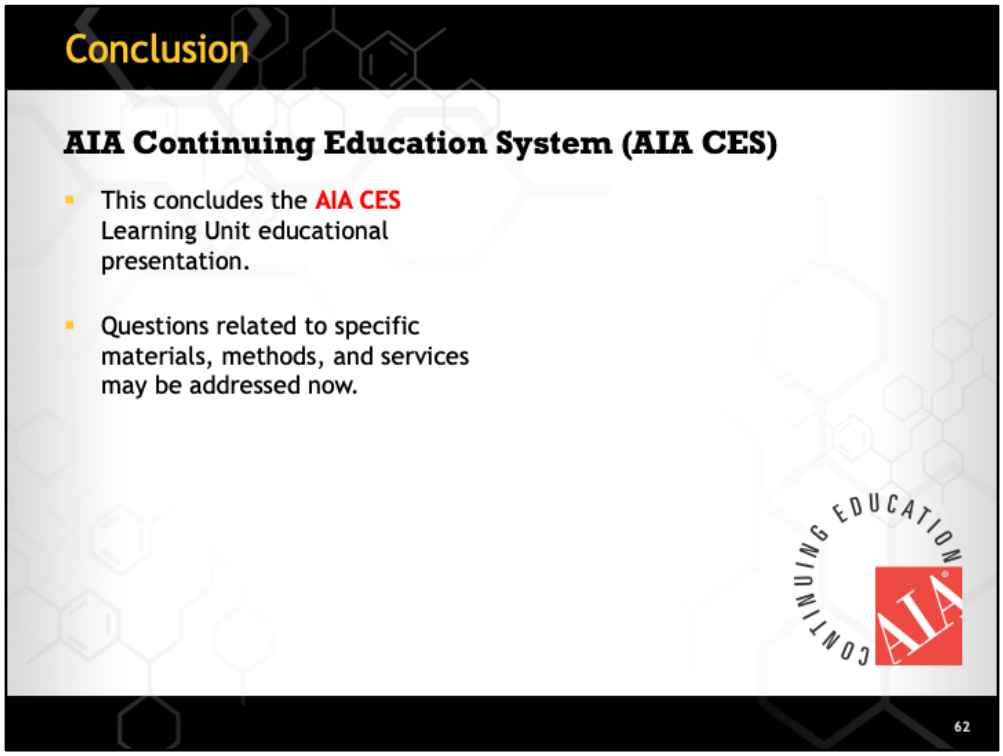


This chart gives us a comparison of all the different WRB-AB systems currently available in terms of material cost only (no labor). Integrated sheathing delivers cost savings by increasing the installation and therefore buying back time for the project. It also eliminates an additional tradesperson to coordinate on-site, which leads to significant savings.



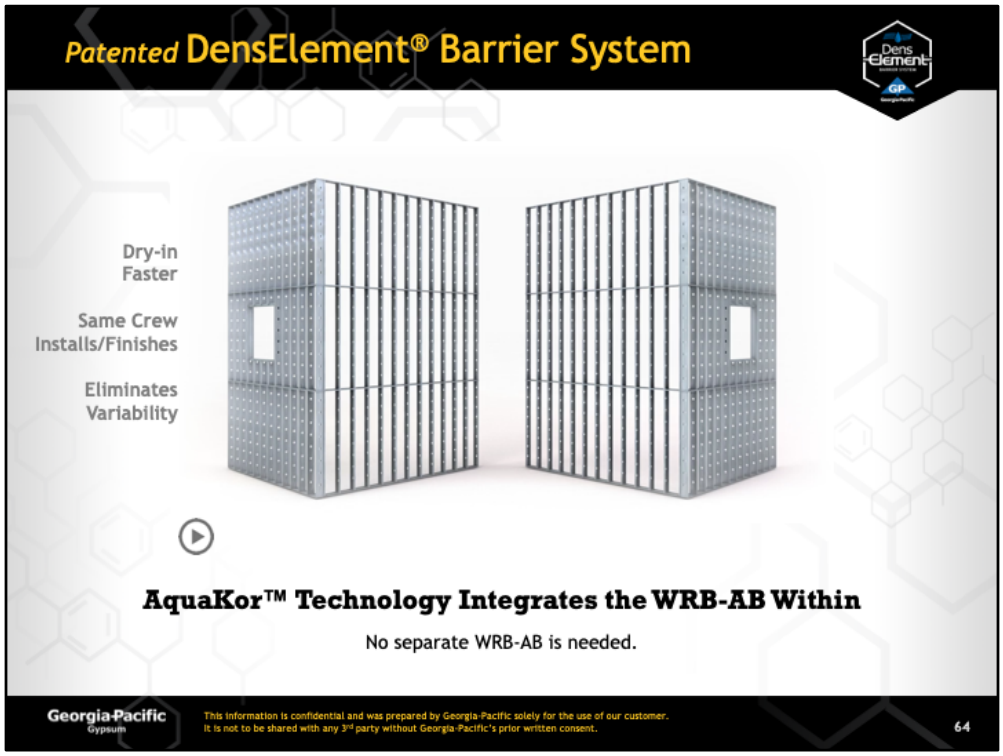
To recap, we've discussed:

- How WRBs and ABs function to protect the envelopes of commercial buildings.
- The various types of WRBs and ABs currently available on the market.
- The new integrated WRB-AB sheathing systems, which have a WRB-AB integrated into or onto a gypsum panel.
    - These systems compare favorably with traditional WRB-AB systems.
    - They provide both valuable performance differences and some significant labor, time, and material savings.
    - And they could provide a cost-effective performance solution compared to the alternative systems currently on the market.

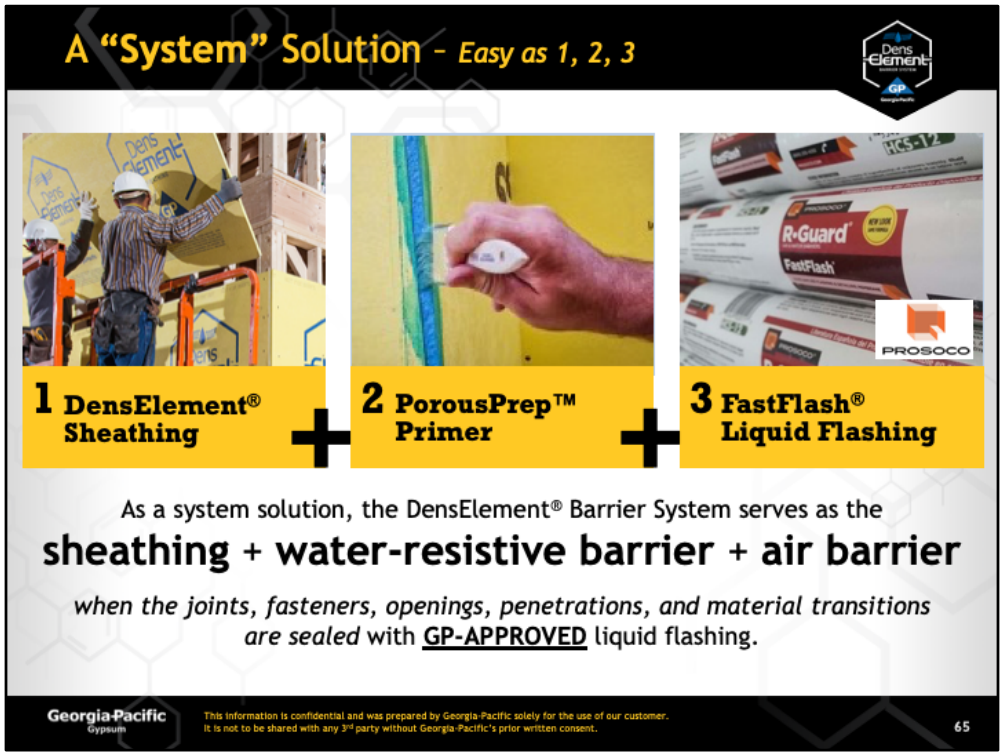


This concludes our AIA CES presentation. Just as a reminder, Georgia-Pacific Gypsum is a registered provider of professional development hours and GBCI and AIA Continuing Education System courses.

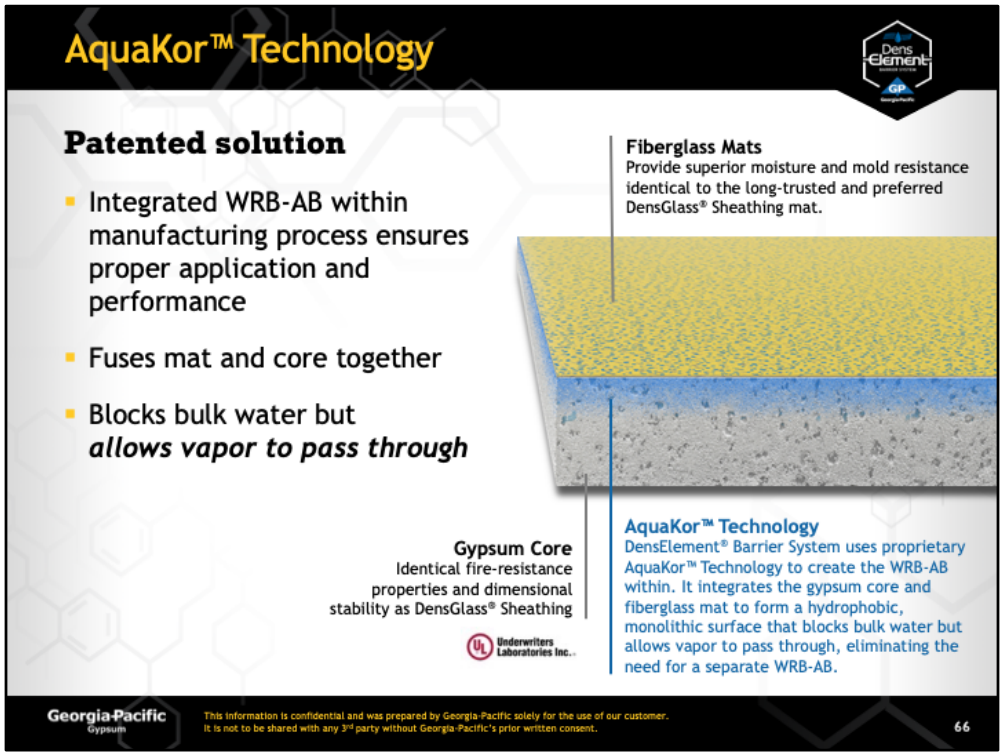
At this point, I'd like to talk briefly about the DensElement Barrier System from Georgia-Pacific Gypsum, which is our integrated WRB-AB gypsum sheathing system.



The patented DensElement Barrier System with AquaKor Technology redefines the typical water-resistive- and air-barrier (WRB-AB) system. Instead of installing a WRB-AB membrane over the face of a commercial or residential building's sheathing, the first component in the system solution—the DensElement Sheathing—has a WRB-AB integrated right into its gypsum core. This premium, all-in-one Dens® brand system is then finished with PROSOCO R-Guard® FastFlash® liquid flashing to fill and seal joints, fasteners, openings, penetrations, and transitions, completely eliminating the need for an additional WRB-AB such as a building wrap, fluid-applied membrane, or self-adhering membrane.



The DensElement® Barrier System serves as an integrated WRB-AB gypsum sheathing system when the joints, fasteners, openings, penetrations, and transitions are sealed with PROSOCO R-Guard FastFlash, the GP-approved liquid flashing membrane that can be applied to damp surfaces.



The chemistry that Georgia-Pacific Gypsum pioneered to ensure that the WRB-AB functions in a consistent manner from edge-to-edge of the DensElement Sheathing core is called AquaKor Technology. It's a proprietary formulation that integrates the gypsum core and fiberglass mat to form a hydrophobic, monolithic surface that blocks bulk water but allows vapor to pass through. The WRB-AB is protected between the same GOLD Dens® brand fiberglass sheathing mats trusted by architects and contractors for the last 30 years.

Project Profiles

Office building

- **Location:** Alpharetta, Georgia
- **Distributor:** Capitol Materials
- **Contractor:** Knight Construction

Educational facility

- **Location:** Macon, Georgia
- **Distributor:** Capital Building Materials
- **Contractor:** Rightway Drywall

Apartment complex

- **Location:** Portland
- **Distributor:** Building Specialties (L&W Supply)
- **Contractor:** Andersen Construction

Visit our Blog theGoldMine to learn more: denselement.com/blog/blog.aspx

Dens Portfolio of Solutions

Georgia-Pacific offers a full line of high-performance glass-mat gypsum panels.

Dens® Solutions are industry-trusted, high-performing fiberglass mat gypsum panels that deliver excellent strength and moisture resistance to your walls, roofs, ceilings, and floor projects.

DensElement® Barrier System with AquaKor™ Technology	For exterior sheathing under cladding or EIFS, integrates the WRB-AB into the board
DensDeck® Prime Roof Board with EONIC™ Technology	For roof substrate under virtually any commercial roofing system
DensGlass® Sheathing	For exterior sheathing under cladding or EIFS
DensGlass® Shaftliner	For mechanical areas, stairways, shafts, area-separation walls
DensShield® Tile Backer	For use behind tile in wet areas such as tubs or showers and as a tile baker in backsplashes, countertops, and floors (with wood subfloors)
DensArmor Plus® Interior Panels	For high-humidity areas such as kitchens, bathrooms (behind tub surrounds), laundry, and basements where paper-faced products are not preferred by the owner
DensArmor Plus® Abuse-Resistant Panels	For traffic areas such as classrooms, hallways, shopping centers
DensArmor Plus® Impact-Resistant Panels	For ultra-high-traffic areas such as dorm rooms, operating rooms, correctional facilities

Georgia-Pacific Gypsum

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The DensElement Barrier System is part of our full line of GP Gypsum's high-performance Dens family gypsum panels, which also includes:

- DensDeck Prime Roof Board with EONIC Technology for roof substrate under virtually any commercial roofing system
- DensGlass Sheathing, our fiberglass mat gypsum sheathing used under cladding or EIFS
- DensGlass Shaftliner, fiberglass mat panels for mechanical areas, stairways and area separation walls
- DensShield Tile Backer, our fiberglass mat backer board for use behind tile in wet areas such as tubs or showers and in backsplashes, countertops, and floors with wood subfloors
- DensArmor Plus Interior panels, which feature fiberglass mats on both sides of the board and are designed for high-humidity interior areas where paper-faced panels aren't the preferred option
- DensArmor Plus Abuse-Resistant panels designed for high-traffic areas such as classrooms, hallways, and shopping centers

- And DensArmor Plus Impact-Resistant Panels designed for ultra-high-traffic areas such as operating rooms and correctional facilities


Dens Element
BARRIER SYSTEM
GP
Georgia-Pacific
Thank You
DensElement® Barrier System
Approved liquid flashing:
PROSOCO
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