



## 16: AIR BARRIERS, TESTING & THE MISSING LINK

by Amanda Gibney Weko

Information provided by Marcy Tyler, Technical Marketing Manager, Tremco



# DEVIL'S DETAIL

## WHY AIR BARRIERS?

Building envelope repair and replacement in North America has become a multi-billion-dollar industry, with 70 percent of all construction litigation related to facade leakage. Building envelope failures can result from numerous causes ranging from improper documentation or human error to poor quality or inappropriate material selection.

Premature deterioration of building enclosures due to air and moisture damage led to the adoption of air barrier building codes. Lack of continuity in the envelope played the primary role in damage, with windows, roofs, and soffit intersections proving the most problematic areas. The connections between different elements of the building enclosure are critical to meeting high performance requirements of a project. This Devil's Detail highlights the challenges of air barriers. Emphasis is placed on the "missing link" connections to windows and curtain wall systems, and the different technologies and testing methods up for consideration.



Architects and specifiers recognize the importance of an effective air barrier for a building's long-term durability and energy efficiency. Air barriers reduce building enclosure moisture problems, improve indoor air quality, reduce building heating and cooling costs, and support sustainable, durable buildings.

## AIR BARRIERS, COMPONENTS, AND ASSEMBLIES

Air barriers are materials or assemblies designed to control airflow between conditioned and unconditioned space. By definition, air barriers have an air permeance not greater than 0.02 liters per second per m<sup>2</sup> with a pressure differential of 75 pascals (approximately equal to a 25-mile-per-hour wind).

Air barrier components include elements such as windows and doors installed within the wall. Accessories (e.g. primer and sealants, backer rods, transition membranes) contribute to the assembly's ability to maintain air tightness between the air barrier materials and components.

**Air barrier assembly = air barrier material + components + accessories**

Connecting the air barrier assembly to other building enclosure components is critical to ensure long-term performance of the entire building. Appropriate connections to the waterproofing, fenestration and penetrations, balconies and decks, and roofing systems make a building whole. Design and construction professionals should collaborate to make sure appropriate connections are specified, discussed during preconstruction, demonstrated and verified in the mock-up phase, and installed correctly. After all, a properly functioning building enclosure is the objective for installing an air barrier in the first place.



Property/ Requirements	Air Impermeability	Continuity	Structural Integrity	Durability
Air Permanence	✓			
Water Resistance				✓
Self Sealability	✓	✓		✓
Pull Adhesion			✓	✓
Crack Bridging	✓	✓	✓	✓

The chart at left indicates which physical properties can be associated with each air barrier requirement.

The following reference tests form a good starting point:

Air permanence: ASTM E2178

Water resistance: AATCC 127

Self sealability: ASTM D1970 (Section 8.9)

Pull adhesion: ASTM D4541

Crack bridging: ASTM C1305

## CONTROLS

It is important to ensure the selected air barrier assembly provides four control layers of protection: rain control, vapor control, thermal control, and air control. Without the protection of the air barrier assembly, a building's facade, insulation, and inner structure are placed at risk. Falling bricks, cracks, efflorescence, damaged sills, etc. may be only the beginning of costly repairs, ongoing maintenance, or potential replacement of interior building elements.

For insights into different wall types and the "perfect" placement of air barrier components, read Dr. Joseph Lstiburek's "The Perfect Wall" (see resources). His humorous and well researched narrative is packed with illustrations that cover wall, roof, and slab details.

To comply with the industry recognized definition, an air barrier must meet four primary requirements. It must be impermeable to air, continuous (installed in such a way that in a detail drawing, you could take a pen and trace the air control layer from below grade, up the wall, and to the roofing air barrier connection), provide structural integrity to stay adhered and function properly, and be durable to perform over the life of the building.

## CHOOSING AN AIR BARRIER

Without an air barrier ASTM guide specification similar to the ones available for sealants or waterproofing, and with numerous manufacturer and product options on the market, the choice of air barrier may be confusing.

Air barriers can be classified into five different material types: board stock (e.g. rigid cellular thermal insulation board), factory bonded (membranes to sheathing), fluid-applied membranes, mechanically

fastened (commercial building wraps), self-adhered membranes, and sprayed polyurethane foam (medium density closed cell). Each material has features and benefits. Building type, location, and performance expectations should guide the decision.

## TESTING

The physical property testing of air barrier materials relates to the air barrier requirements. A combination of industry required and "real world" testing offers verification and documentation to install products in the correct way. Partnering with a manufacturer for this dialogue and analysis will ensure best results. The chart on the next page provides a reference:

- **Adhesion:** Air barriers are evaluated for adhesion using ASTM D4541, but compatibility is important. Consider connectivity testing via AAMA 713 for compatibility, and adhesion testing via ASTM C794 to ensure the performance requirements of the air barrier material and accessories are met.
- **Self Sealability:** If nail sealability is a concern, ask the manufacturer to evaluate the facade anchors to be used on your project – with the appropriate fastener and substrates – and test the self sealability of the system with a spray rack test on the assembly by requiring ASTM E331.
- **Air Permanence:** ASTM E2178 requires a free film. Confirm if it is ok for your project's performance to modify this test. Some air barrier technologies may not be able to be tested as a free film and may require testing on a substrate.
- **Air Leakage:** When requiring the assembly test for air leakage, ASTM E2357, then consider evaluating the actual facade anchors and connections to other building components specified on your project.

Description	Test Method	Issues	Consider
Adhesion	ASTM D4541 product and component	Compatibility not required	Connectivity testing AAMA 713 ASTM C794
Nail Sealability	ASTM D1970 (8.9) product and component	Smooth roofing nail, plywood, 5" head of water	Facade anchors Fasteners Substrates ASTM E331
Air Permanence	ASTM E2178 product	Free film required? Or modification?	Assembly testing
Air Leakage of the Assembly	ASTM E2357 assembly	Facade anchors Connections	ASTM E2357 with facade anchors, connections, facades

The chart at left indicates basic testing methodology for each of the four qualities of an air barrier, with issues and additional testing considerations.

- **Fire Resistance:** If fire resistance is part of the project specification, then the selected materials should be evaluated in an assembly. Ask for the components of the assembly in order to understand exactly what was tested – to be sure it does not differ from the components in your design. Ask your manufacturer if they have tested materials via ASTM E84 and ASTM E1354, and listed actual NFPA 285 tested assemblies in the UL directory.

Additional testing considerations are important to provide you with confidence that the selected air barrier material, components, and accessories will perform as expected and provide air impermeability, continuity, structural integrity, and durability.

If the evolution of testing – air permanence testing of individual materials, followed by air permanence testing of the assembly, and further water testing of the assembly – seems like overkill, consider this. The materials and accessories selected have big and important jobs to fulfill; they need to perform. System performance testing provides confidence that all air barrier materials, accessories, and components will perform as expected.

The UL Online Certifications Directory (see resources) contains all material and assembly test information available for fire resistance. The resource takes the guesswork out of research. You can use the UL Online Certification Directory to verify a UL listing, classification, or recognition; verify a UL listed product use; verify a UL recognized component use; or verify a product safety standard. Think of it like a recipe card for all of the materials, components, accessories, and facade elements that were evaluated according to NFPA 285.

## CRITICAL CONNECTIONS

What about the critical connections with other building components (e.g. roofing systems, firestopping solutions, deck coatings, sealants and waterproofing, glazing systems, etc.)? Connection point durability can be impacted by wind drift, deflection, creep, thermal movement, moisture expansion, and tolerances. Are the seals at connection points durable solutions? Will they withstand repeated pressurized cycling or major wind events without damage? Have issues of compatibility been addressed?

Turnkey glazing transition assemblies are solutions for critical connections that provide visible assurance of a secure, continuous seal without voids. Consisting of pre-engineered, finished aluminum and silicone materials that are assembled and attached to the window or wall assembly, these assemblies provide a watertight, flexible option for sealing connections, redefining air and moisture management at critical transitions.

### EXAMPLE: Self-Adhering Membranes and Sealants

Self-adhering air barrier membranes (SAM) have virtually no lateral movement capability and should not span gaps or voids more than one-quarter to one-half inch. They must be fully adhered and in compliance with the manufacturer's minimum lap requirement. They also present installation difficulties at three-way intersects. Although used in the past as a direct attachment to windows or curtain wall, SAMs may perform as a water shed when properly shingled but will still leak air, compromising the air barrier assembly. Membrane thickness can also rotate pressure bars on curtain wall systems.

Sealants, often used to compensate for connection points in the envelope, are limited by maximum and minimum operable joint sizes, by the amount of movement in the connection points, and by possible lack of compatibility with rubberized asphalt membranes or other sealants. Many sealants do not adhere to the polyethylene backing layer of many self-adhered membranes. Understanding performance of the polyethylene film of SAM is critical as polyethylene is a natural bond breaker for sealants, despite being technically compatible (no adverse effect on one another). Some manufacturers provide pre-engineered transition assemblies - flexible, pre-cured silicone membranes that provide the movement capabilities necessary for these connection points.

The ABAA suggests single source is best, ensuring that the selected air barrier system includes the proper sealant. When using sealants, be sure to understand the sealant type, joint size and shape, whether it is continuous or will be impacted by anchors, how it will adhere to the substrate, whether it can be installed as detailed, and if it is part of the air barrier manufacturer's system or provided by another manufacturer, and if so, is it warranted?

## COLLABORATION

Reach out to your manufacturer for options available to make these connections and for testing options they can provide for the entire selected air barrier system. Working together and understanding the limitations will have everyone building better performing buildings.

## RESOURCES

Lstiburek, Joseph. "BSI-001: [The Perfect Wall](https://buildingscience.com/documents/insights/bsi-001-the-perfect-wall)," Building Science Corporation. 15 July 2010. <https://buildingscience.com/documents/insights/bsi-001-the-perfect-wall>

UL Online Certifications Directory: <http://database.ul.com/cgi-bin/XYV/template/LISEXT/1FRAME/index.html>



## ABOUT TREMCO

Tremco provided information for this Devil's Detail. Tremco Commercial Sealants & Waterproofing (CS&W) is North America's foremost supplier of sealant, weatherproofing, and passive fire control solutions for commercial and residential construction and industrial applications. For generations, Tremco CS&W has successfully provided products and services to architects, engineers, home builders, contractors, and building owners worldwide. When it comes to protecting and weatherproofing the entire building envelope, Tremco CS&W is uniquely positioned to provide single-source products, services and solutions.

Tremco CS&W is part of Tremco Incorporated, employing over 3,500 people around the world. Tremco Incorporated consists of operating divisions specializing in the manufacture and sale of roofing materials and services, construction sealants, glazing and gaskets, waterproofing systems, firestopping systems, and a host of custom-designed products, programs, and services dedicated to the worldwide construction, maintenance and repair industries. Tremco Incorporated entities include Tremco Commercial Sealants & Waterproofing, Tremco Roofing and Building Maintenance and Tremco Barrier Solutions. All Tremco Incorporated facilities are ISO 9001/9002 Registered. Tremco Incorporated is a part of RPM International, Inc. whose subsidiaries employ 13,000 people worldwide, manufacturing high-performance coatings, sealants, and specialty chemicals in 116 facilities across 26 countries. For more information, visit <http://www.tremcosealants.com>.

Tremco offers a variety of additional examples and considerations available upon request.

## About the Devil's Details

The AGI educational series illustrates and describes common glazing challenges as a means to communicate best practices for the design and construction industry, not as a sole source for design guidance. AGI recommends design professionals consult with an AGI contractor regarding specific project challenges. AGI contractor profiles may be accessed at [www.theagi.org](http://www.theagi.org). To share a devilish detail of your own, contact [info@theagi.org](mailto:info@theagi.org).