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AIR BARRIER SYSTEMS: SILICONE SOLUTIONS TO REDUCE BUILDING AIR INFILTRATION

BY: DOW PERFORMANCE SILICONES

Course #0DOW009

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Air barrier systems: Silicone solutions to reduce building air infiltration

By: Dow Performance Silicones

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Approved for:

1

General CE hours

LEED-specific hours



COURSE DESCRIPTION

This course will define types of air barriers and describe the different solutions currently on the market for sealing penetrations and transitions to create a complete air barrier system. It provides an overview of the basic requirements air barriers must meet, and identifies key areas within a wall system where detailing is important to system success.



LEARNING OBJECTIVES

- Define the basic requirements that air barriers must meet
- Describe the different types of air barriers on the market and their key differences
- Identify key areas within a wall system where detailing is important to system success
- Describe the different solutions currently on the market for sealing penetrations and transitions to create a complete air barrier system





Requirements for

air barriers?

BASIC STANDARDS FOR AIR BARRIERS

- Air barriers are called out in code based on three key properties
 - Material properties
 - System properties
 - Whole-building properties
- Referenced by codes such as the IBC, IECC and IgCC and standards such as LEED
- Local code requirements will vary by adoption



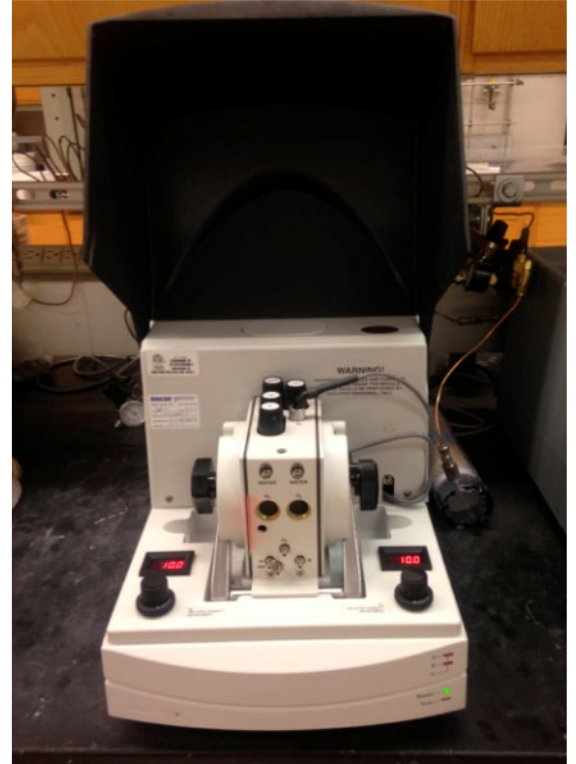
MATERIAL TESTS

ASTM & CAN/ULC

- ASTM E2178 Standard Test Method for Air Permeance of Building Materials
 - ✓ Measures the air infiltration rate of 1 m² of material
 - ✓ Key data point for all air barriers
- CAN/ULC S741 Standard for Air Barrier Materials – Specification

ASHRAE

- ASHRAE 90.1-2010 requires an air infiltration rate of <0.02 L/s·m² at 75 Pa (<0.004 cfm/ft² at 1.57 psf)



SYSTEM TESTS

ASTM & CAN/ULC

- ASTM E2357 Standard Test Method for Air Barrier Assemblies
- CAN/ULC S742 Standard for Air Barrier Assemblies – Specification

ASHRAE

- ASHRAE 90.1-2010 requires air leakage rates of less than 0.2 L/m² at 75 Pa (<0.04 cfm/ft² at 1.57 psf)



OPTIONAL SYSTEM TESTS

Whether a liquid sealant or pre-cured extrusion, the solution should be tested to the same standards as the air barrier

- ASTM E283 Assembly Air Infiltration
- ASTM E330 Assembly Structural Loading
- ASTM E331 Assembly Water Infiltration

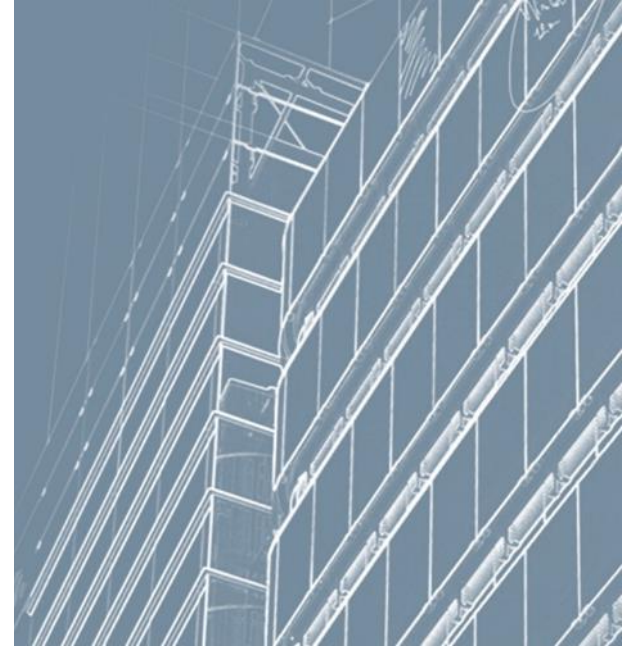


WHAT IS A SUCCESSFUL SYSTEM?

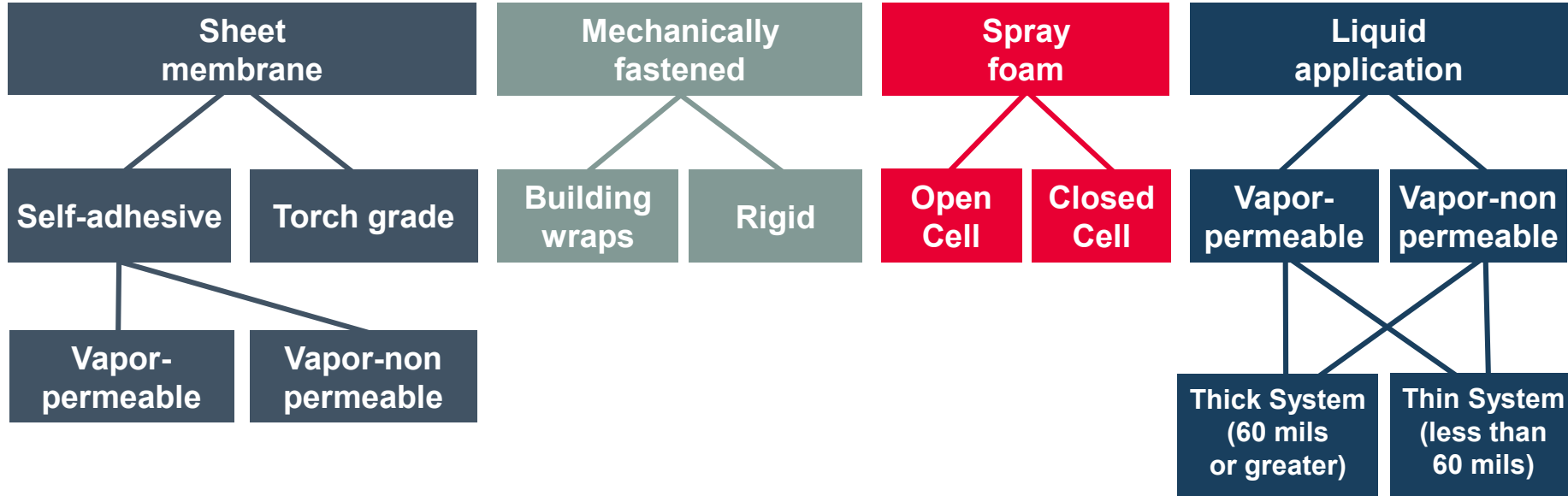
- Air infiltration must meet system criteria of 0.04 cfm/ft² at 1.57 psf
- No water infiltration can be seen either before or after structural loading
- Water can be harder to pass when adding pressure and structural movement

WHOLE-BUILDING TESTING

- ASTM E779 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
 - Tests a whole building envelope for air infiltration after construction
- U.S. Army Corps of Engineers required $<0.25 \text{ cfm/ft}^2$ at 1.57 psf
- Required in LEED v4 for the Building Commissioning credit



TYPES OF AIR BARRIERS



LIQUID APPLIED

- Primer not required on most substrates
- Applied in uniform coat – no seams or edges
- Detailing can be done with liquid sealant – no complex shapes need to be cut or applied
- Some liquid-applied air barriers can take movement at joints
- Must take quality control measures to ensure proper thickness of material



SELF-ADHERED MEMBRANE/SHEET APPLIED

- Primer typically required
- Known thickness – not part of workmanship
- Must detail joints with liquid and/or reinforce with another layer of sheet
- Concern about edges of material not being sealed properly
- Must ensure no wrinkles in application – must be fully adhered
- Mechanically fastened sheets are punctured during application
- Difficult details at penetrations and corners
- Does not allow movement at joints – difficult detailing and termination at joints



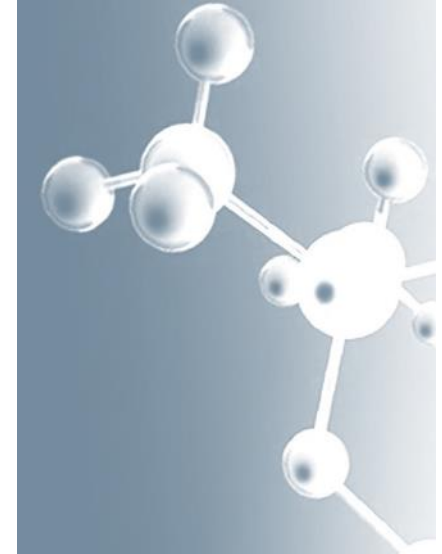
AIR BARRIER CHEMISTRIES

- There are two broad categories of chemistries available:
 - **Organic**, which consist of a carbon-based polymer (-C-C-O-C-C-)
 - Latex
 - Butyl
 - Asphaltic emulsions
 - Rubberized asphalt
 - **Inorganic**, which consist of non-carbon-based polymer (-Si-O-Si-O-Si-)
 - Silicone



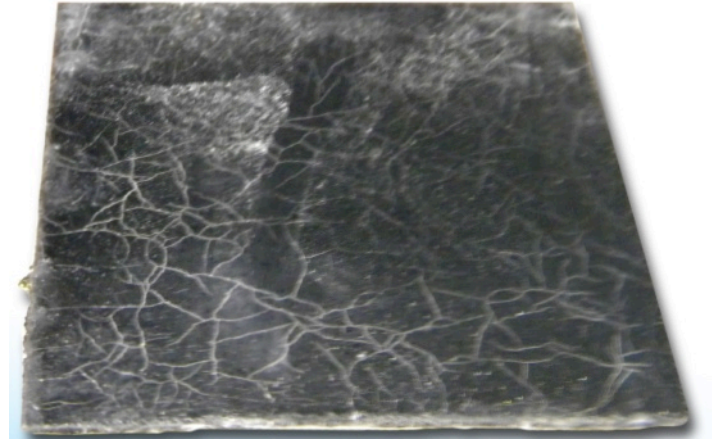
SILICONE ADVANTAGES FOR AIR BARRIERS

- UV stability
- Fire resistance
 - ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components
- Simplicity of a system/ease of application
- Compatibility with other construction components
- Movement capability – can apply air barrier over moving joints
- Will stay flexible in temperature extremes



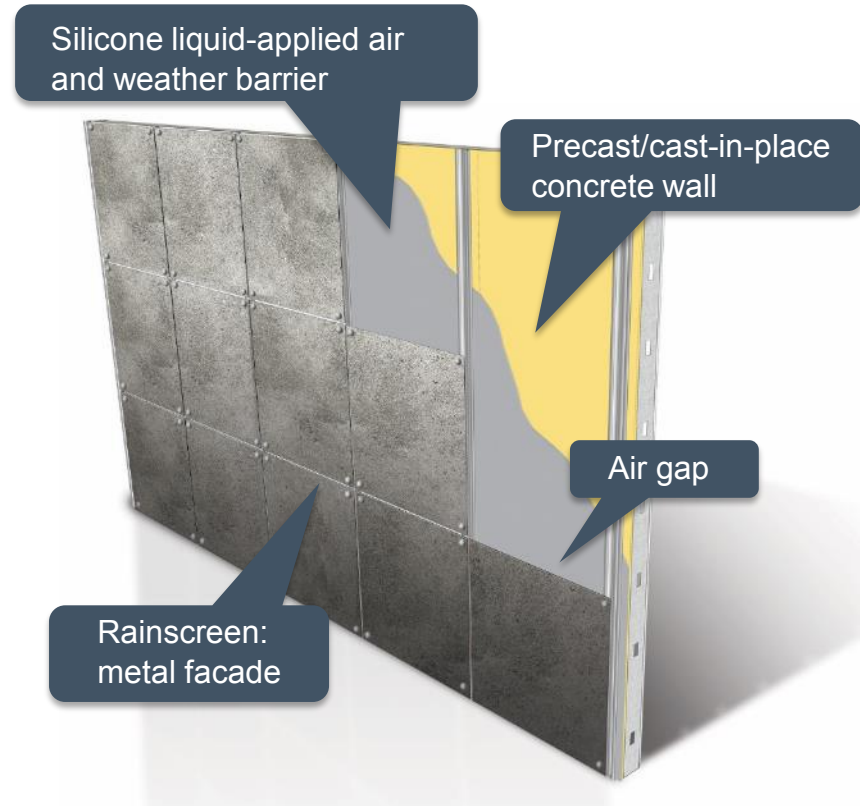
UV STABILITY RELIES ON CHEMISTRY

- Ultraviolet (UV) light will degrade the carbon-carbon or carbon-oxygen bond of an organic material
- There is not enough energy in UV light to degrade the Si-O bond of a silicone material
- Therefore, an organic air barrier will degrade in sunlight, and a silicone air barrier will be virtually unaffected



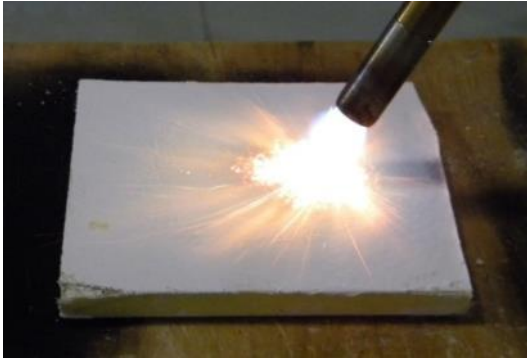
UV RESISTANCE – LONG-TERM/UNLIMITED

- Delays in construction causing the air and weather barrier to be exposed longer than anticipated can limit the performance of many air barriers
- Open-joint rainscreen applications require the air and weather barrier to always be exposed

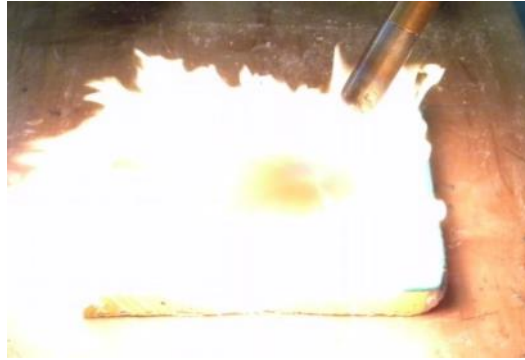


FIRE RESISTANCE

- Fire resistance is both a material property and a system property
- ASTM E84 is a material property test that measures flame spread and smoke developed
 - Test data is used for NFPA and UBC classifications



Silicone Liquid-Applied
Air Barrier



Acrylic Liquid-Applied
Air Barrier



Asphalt-Acrylic Liquid-
Applied Air Barrier

NFPA 285

- Wall system test
 - Dependent on façade coating
 - Results vary greatly based on insulation
- Engineering judgments can be made based on properties of cladding and air barrier
- Required for air barriers per IBC 2012
 - May be removed in next version of I-Codes



POST-NFPA 285 INSPECTIONS

What pieces contribute to the fire, and what others do not?



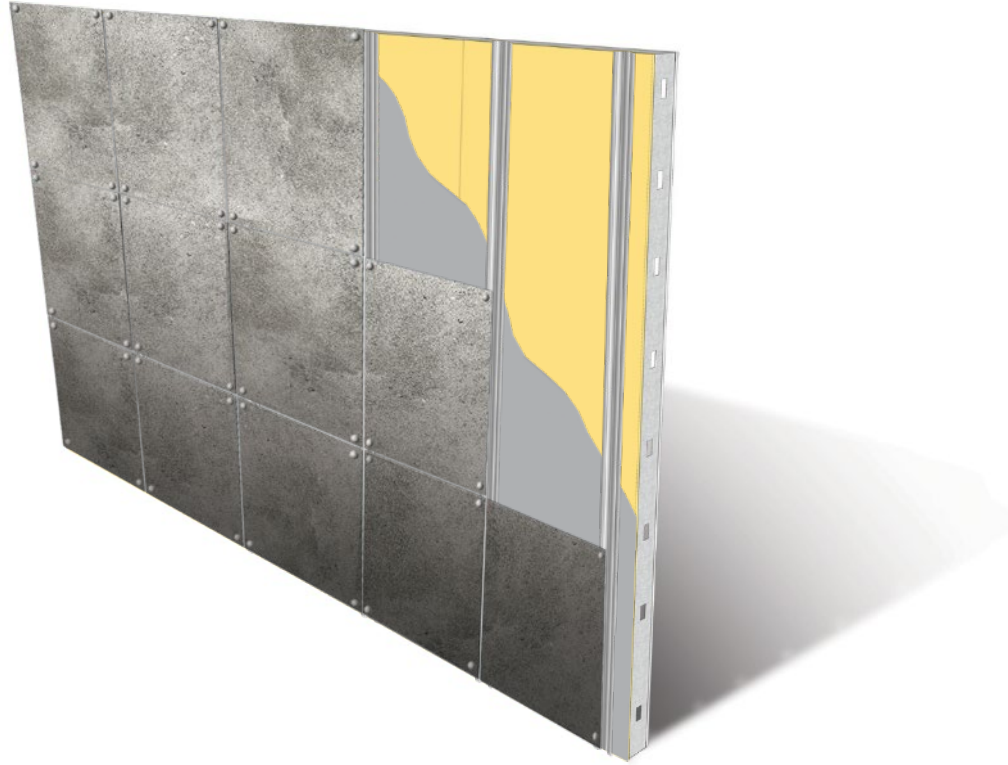


**Buildings aren't
built flat:**

**Creating an air
barrier system**



CREATING AN AIR BARRIER SYSTEM



DETAILING AND INSTALLATION

No two buildings are exactly the same, and having a flexible system to create an airtight envelope is important.

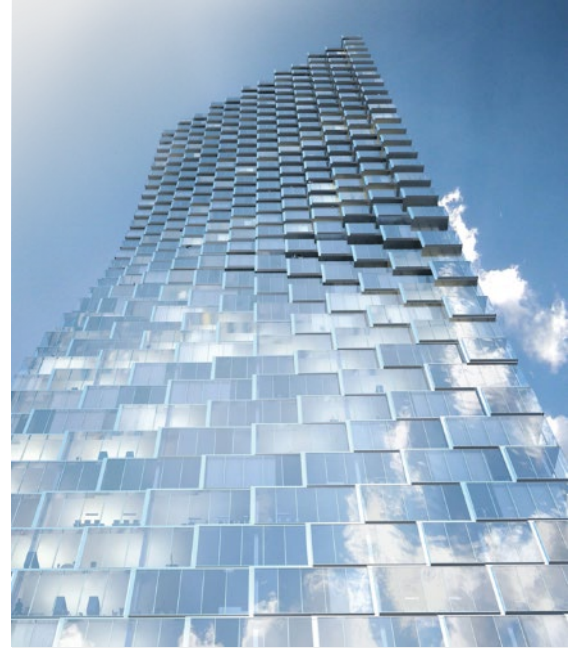
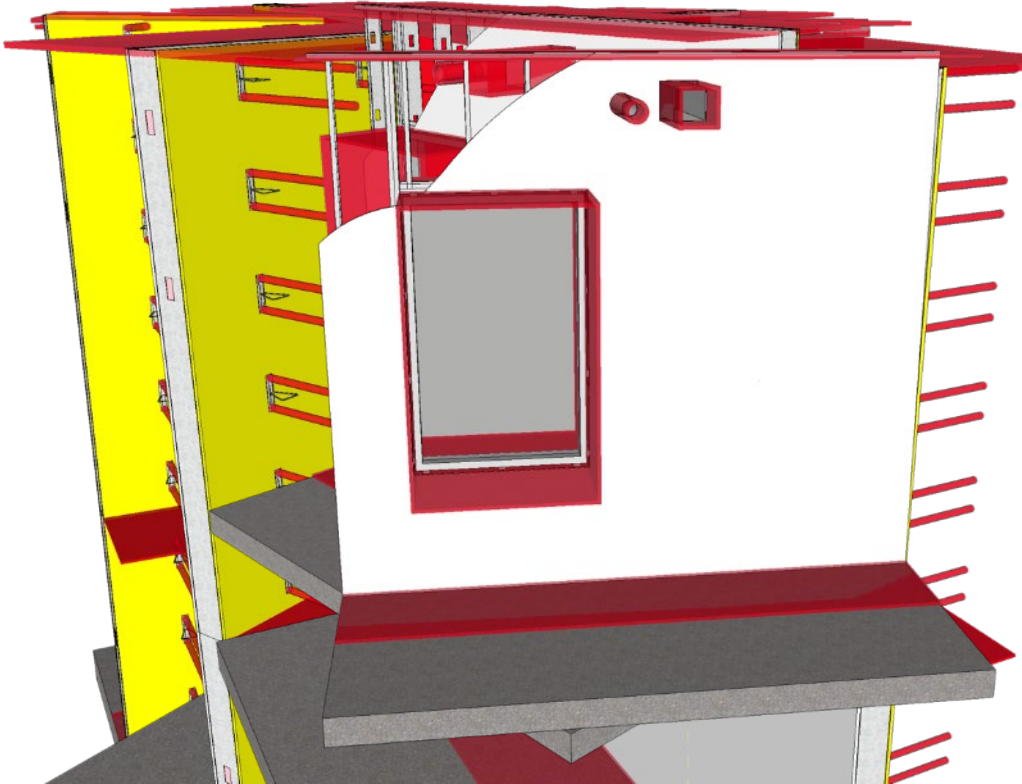


Photo courtesy of BIG

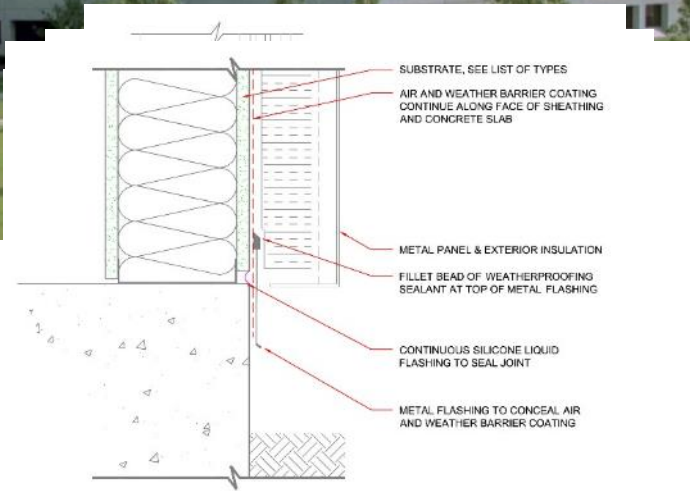
AIR PATHWAYS IN A STANDARD WALL



THE PERFORMANCE OF YOUR AIR BARRIER SYSTEM RELIES ON DETAILS



- Foundation
- Window opening
- Parapet
- Penetrations



KEYS TO DETAILING

- Simplification
 - If a detail is hard to draw, it's probably difficult to install in the field
- Minimize the number of materials
 - Lower probability that the contractor can use the wrong material
 - Easier to specify



SEALING AROUND PENETRATIONS

- Joints and penetrations must be:
 - Airtight
 - Watertight
 - Durable
 - Flexible
 - Compatible
- Allow for building movement
 - Pre-cured elastomeric flashing to span wide joints while allowing for movement



THIS IS CALLED OUT IN THE CODES

- ASHRAE 189.1-2009 Normative Appendix B subsection B1.b: “The air barrier component of each assembly shall be joined and **sealed in a flexible manner** to the air barrier component of the adjacent assemblies, **allowing for the relative movement** of these assemblies and components.”
- ASHRAE 189.1-2009 Normative Appendix B subsection B1.c: The **continuous air barrier** “shall not displace adjacent materials under full load.”
- Section 606.1.2.1 of the IgCC v2.0, 11-2011: Requires that “the *building thermal envelope* shall be **durably sealed** to limit infiltration. The sealing methods between dissimilar materials shall **allow for differential expansion and contraction.**”



CURRENT PENETRATION SOLUTIONS

Material solutions

- Self-adhered membranes/flashing
- Liquid membranes with embedded mesh
- Pre-cured extrusions
- Liquid sealant



SELF-ADHERED FLASHING

- Must be cut properly to fit around objects and into corners without bulging
- Primer is typically required
- Must be looped to allow movement
- Adhesion can be difficult when transitioning to interfaces with fenestration
- Cannot be easily used in areas without a continuous supporting substrate
- Foil-faced version transitions with roofing and foundation membranes where movement is not anticipated

LIQUID MEMBRANE WITH EMBEDDED MESH

- Multiple steps:
 - Layer of membrane is put on substrate
 - Mesh is cut to fit around penetrations and in openings and embedded into coating
 - Second layer of membrane is applied over the mesh
- May use same membrane or require separate membrane for openings
- Cannot be used over moving joints
- Cannot be used to transition to other membranes (e.g., roof or foundation)

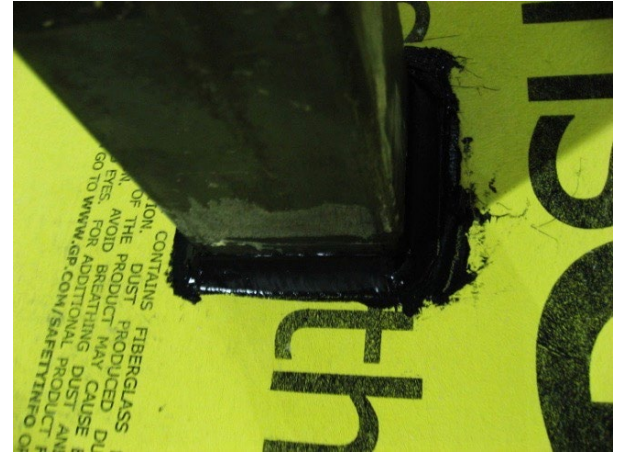
PRE-CURED SILICONE EXTRUSIONS

- Provide durability of silicones
- Allow for movement of large joints and transitions
 - Window perimeters
 - Floor slabs
- Easily spans across areas without a supporting substrate
- Flexibility to span between roof, foundation and wall systems
- If required at all details, can have difficulty cutting and folding around penetrations

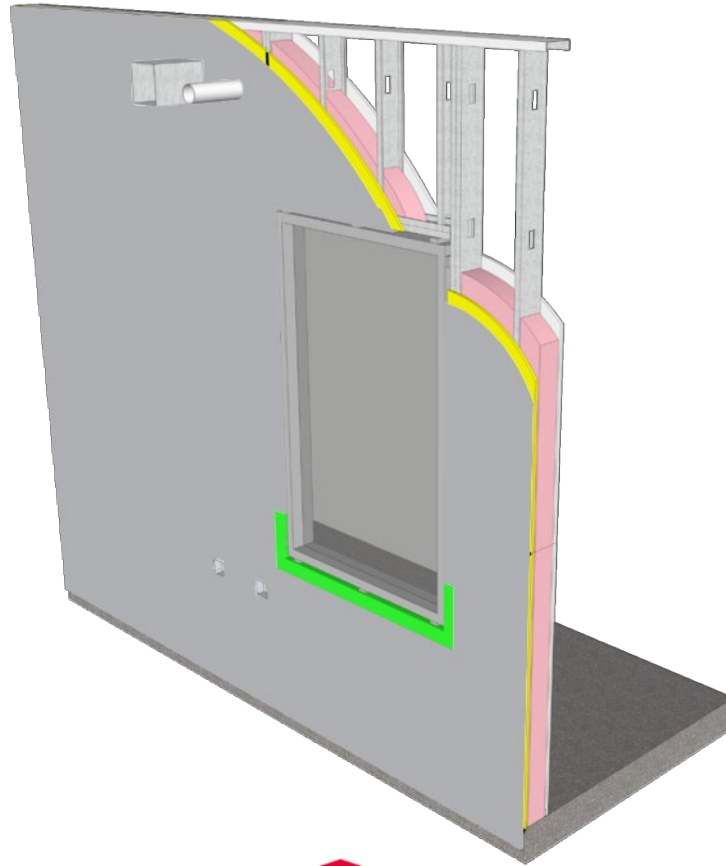


SEALANTS

- Only one material required
- Can be used both for moving joints and for sealing nonmoving areas
- Contractors are familiar with use
- Flexibility for problem-solving difficult penetrations such as pipe clusters, etc.



SOLUTION FOR AIR AT PENETRATIONS



AIR BARRIER SYSTEM DETAILS MUST BE...

- Easily installed by contractors in the field
- Robust enough and simple enough to be able to problem-solve solutions to unique situations in the field
- Extensively and accurately detailed
 - Remember, not all details can be found in the “standard set”





Known

problem areas

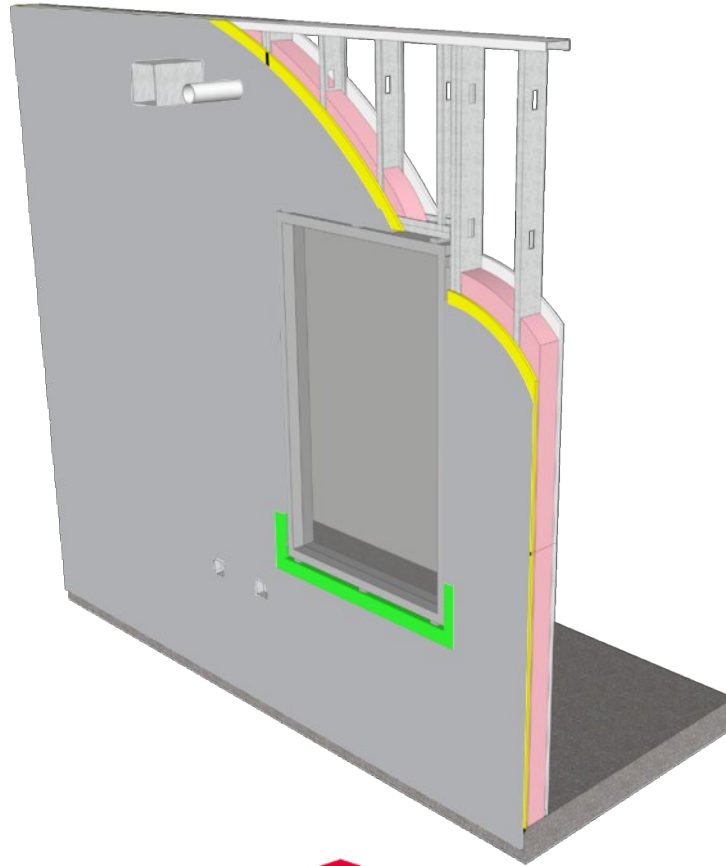


KNOWN INDUSTRY ISSUES

- Flexibility at moving joints
- Compatibility with window sealants and other system components
- Sheet materials must be cut or folded to create airtight and watertight systems
 - Reverse lapping
- Some systems require *numerous* products to detail joints – confusing for contractors



ROUGH OPENINGS

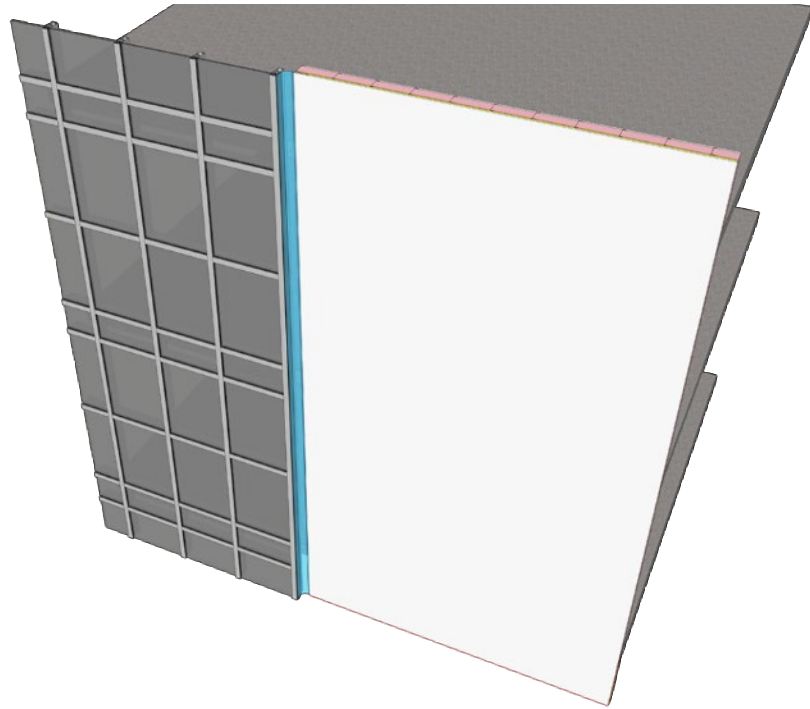


PROBLEM: WIDE GAPS

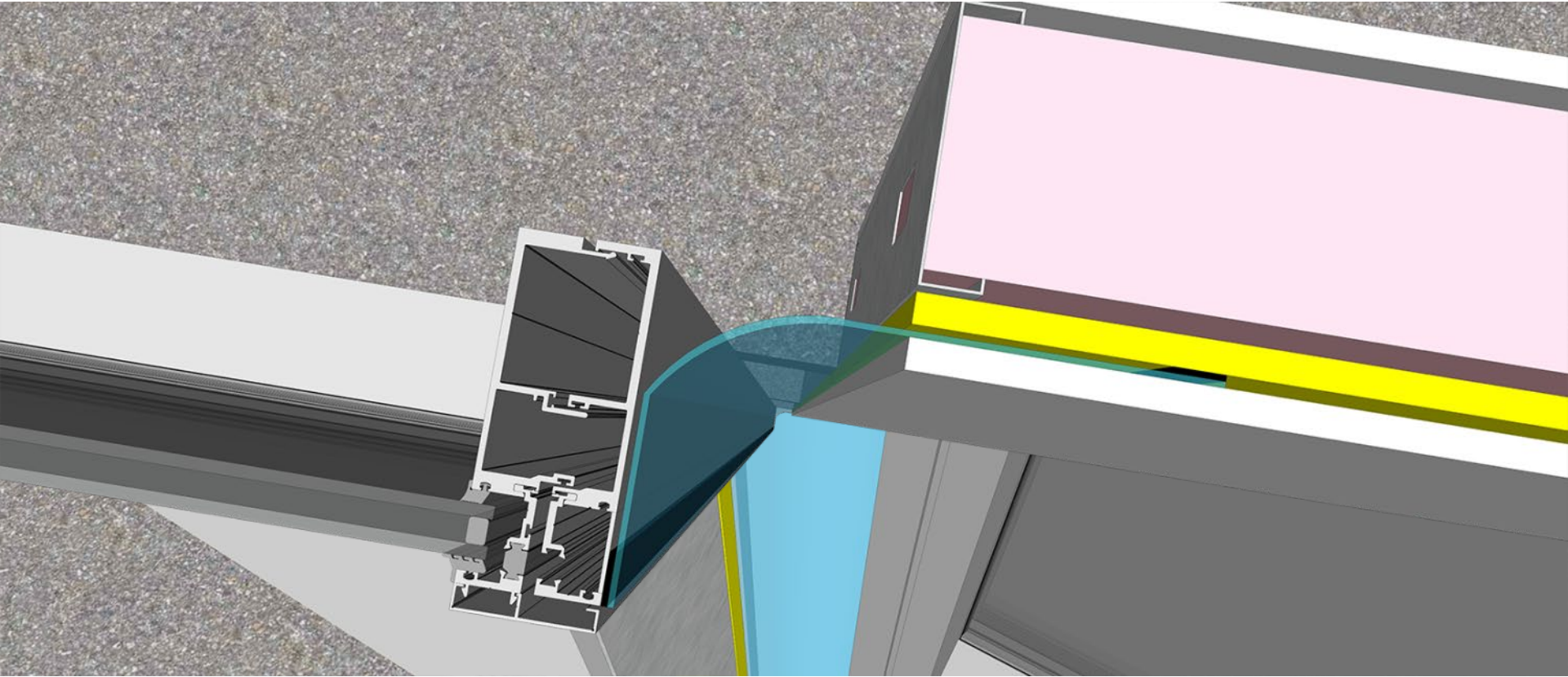
- Need a material to span wide gaps
 - Adhesion is important
 - Often, movement capability is required
- Traditional self-adhered flashing does not provide movement
 - Must be installed with a loop to provide “give”
 - Challenging to install properly



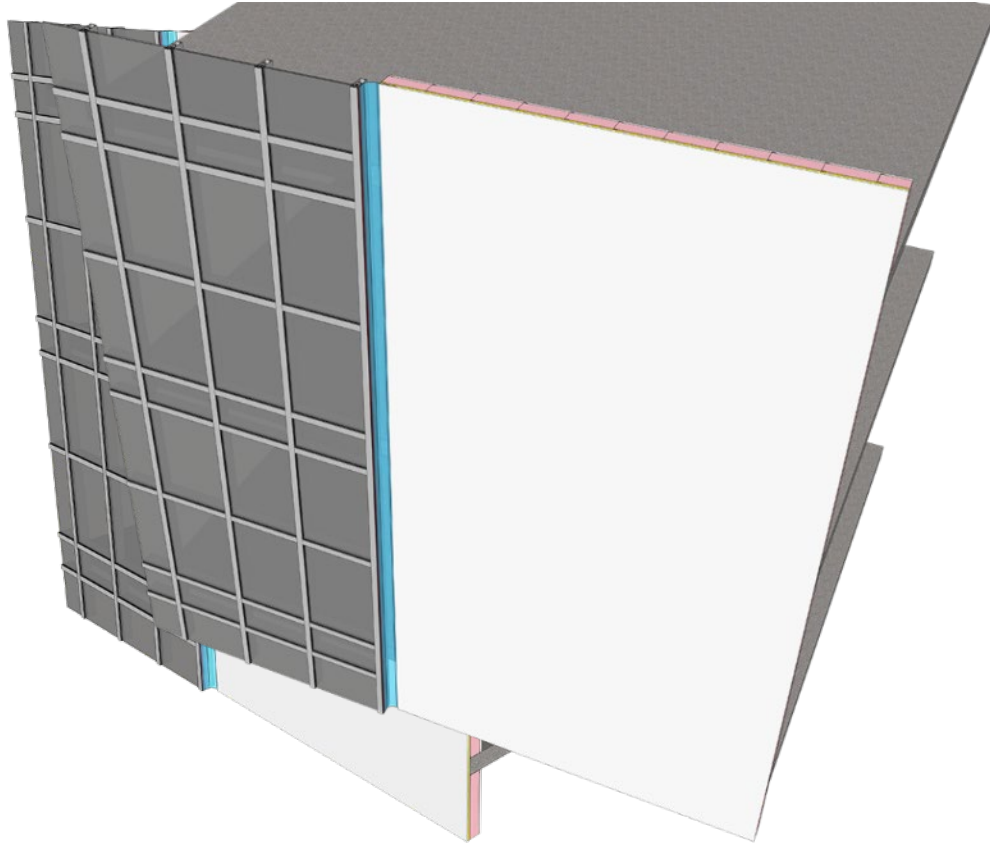
CONNECTING CURTAINWALL TO WALL SHEATHING



CONNECTING CURTAINWALL TO WALL SHEATHING DETAIL



CONNECTING CURTAINWALL TO WALL SHEATHING



SOLUTION: PRE-CURED SILICONE STRIPS

- Pre-cured silicone strips can span wide gaps
- Use any sealant that achieves adhesion
- Ideal for gaps greater than 3 inches
- 300% shear movement without adhesion loss
- Excellent tear resistance
- Transitions: Window, wall, foundation, roof weatherproofing sealant
- Quality control
 - See sealant through extrusion
 - High green strength
 - No mechanical attachment needed



CHALLENGE: CONTINUOUS AIR BARRIER

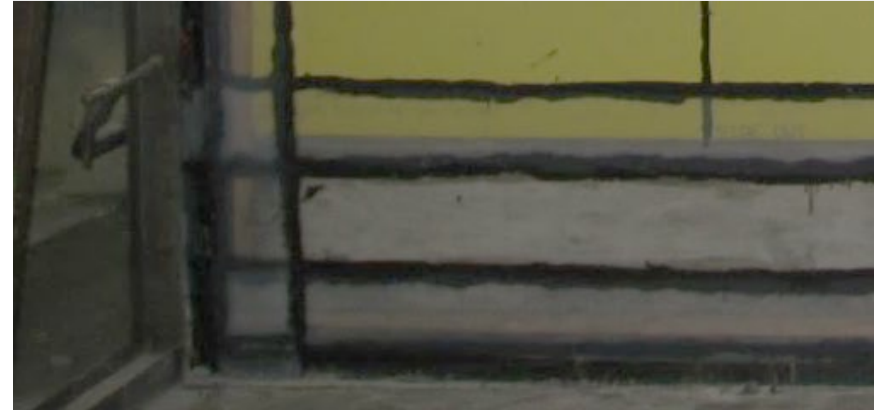
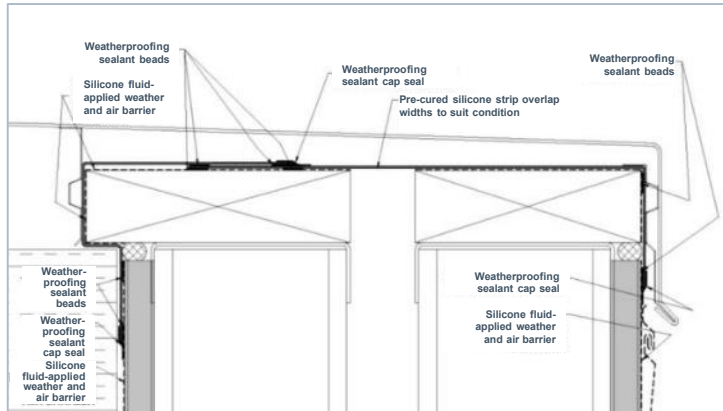
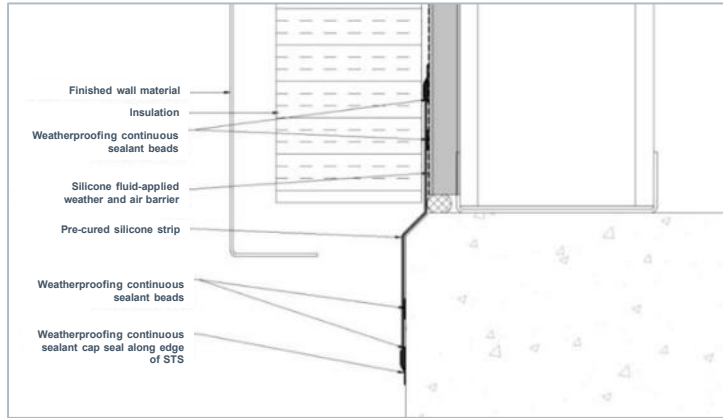


CONTINUITY

- Air barrier on flat walls must be continuous
 - Lapping of joints if using a sheet-applied material
 - Elastomeric, liquid-applied air barriers do not require in-plane joints
- A continuous air barrier includes the foundation and roofing systems as well as the wall
- An air barrier for the wall must be able to tie into these other systems
- One manufacturer will likely not make all systems
- This is a critical point for detailing



SOLUTION: ROBUST TRANSITION DETAILS



These details can both be completed in a similar manner with the same material, making them simple for the contractor to install.

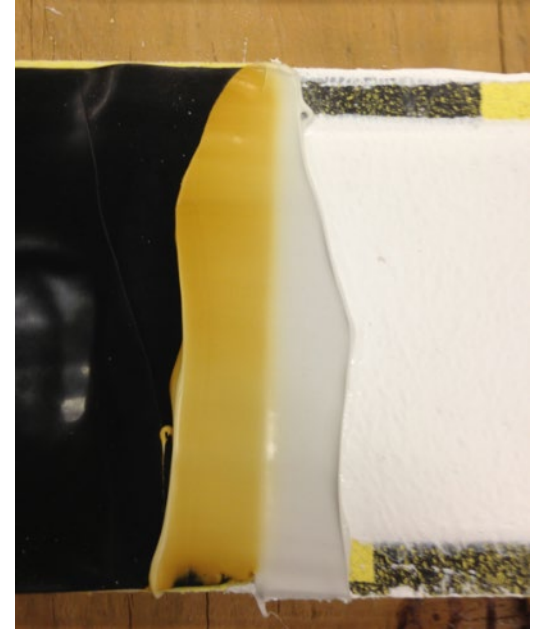
PROBLEM: COMPATIBILITY BETWEEN COMPONENTS

- It is critical that all pieces of a system be compatible for them to perform long-term
 - No unexpected material interactions
 - Especially when exposed to UV light
- Compatibility must also include:
 - Robust adhesion between components
 - Allowance for movement between components



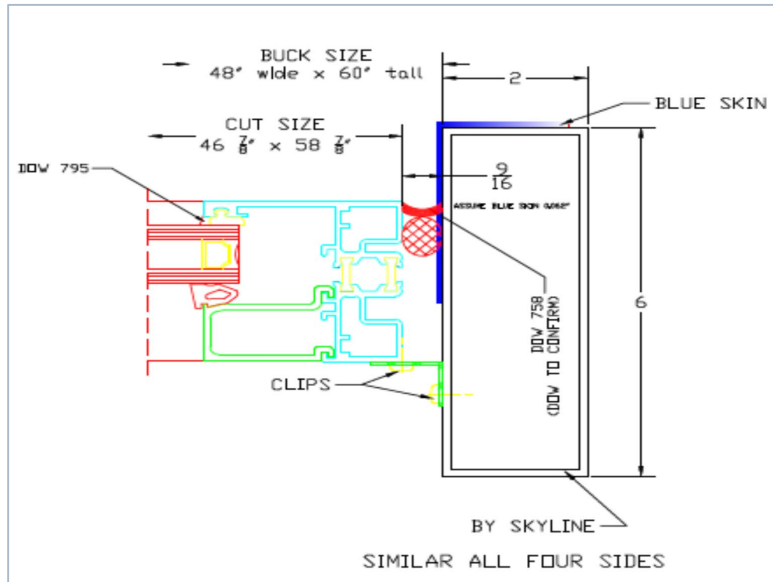
SOLUTION: CHEMISTRY

- Use similar chemistries for all components whenever possible
- Compatibility testing between components (ASTM C1087)
- Minimize number of products and manufacturers
- Consider environmental effects on materials



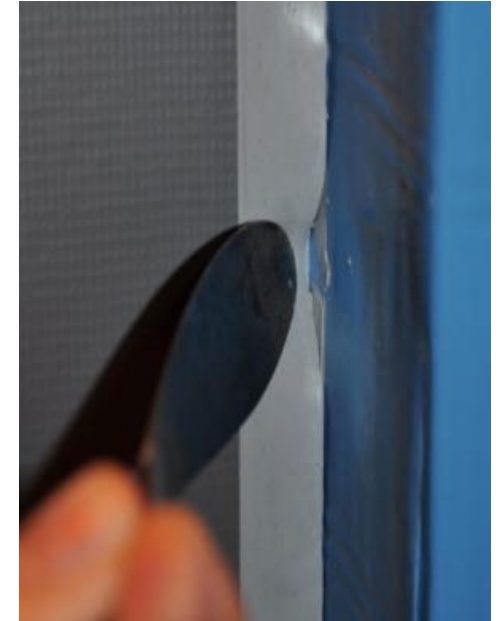
PROBLEM: ADHESION AT INTERFACES

- Does a sealant that adheres to the substrates really make a difference?
- Tested a system to ASTM E283-04



WITH AND WITHOUT ADHESION

Pressure	Initial Tare, cfm	Infiltration		Exfiltration	
		With sealant adhered	Without sealant adhered	With sealant adhered	Without sealant adhered
25 Pa (0.52 psf)	0.11	<0.01	0.12	<0.01	0.1
50 Pa (1.04 psf)	0.22	<0.01	0.19	<0.01	0.18
75 Pa (1.57 psf)	0.33	0.01	0.27	<0.01	0.24
100 Pa (2.09 psf)	0.42	<0.01	0.34	<0.01	0.31
150 Pa (3.13 psf)	0.61	<0.01	0.45	<0.01	0.4
250 Pa (5.22 psf)	0.94	<0.01	0.67	<0.01	0.58
300 Pa (6.27 psf)	1.08	<0.01	0.74	0.01	0.64

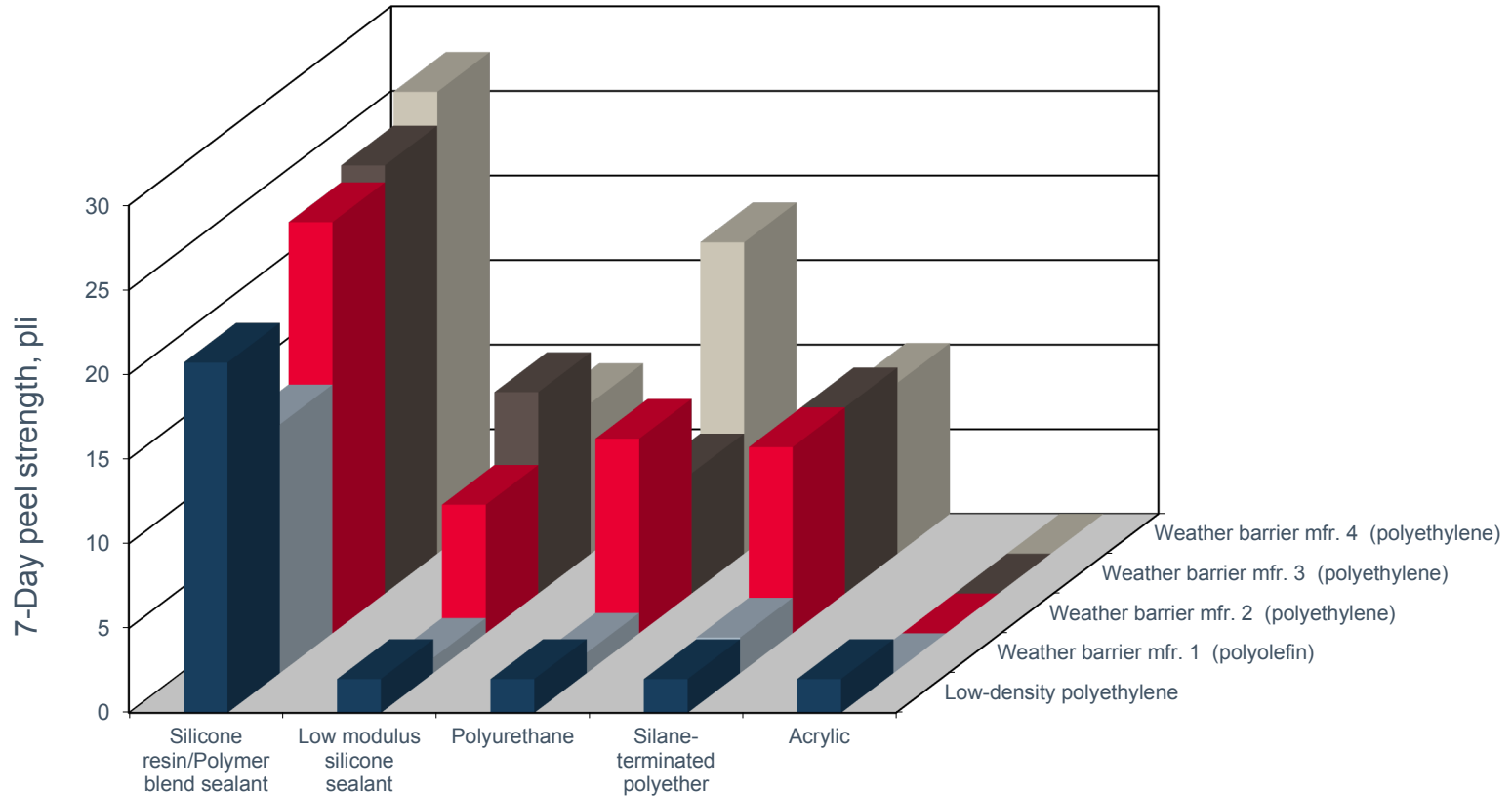


SOLUTION: ROBUST SEALANT ADHESION

- Sealant that ...
 - Is designed to adhere to low-energy surfaces
 - Remains flexible under long-term loading
 - Does not tear apart the fragile air barrier materials
- Looked beyond traditional silicone polymers to the world of resins
- A mixture of a traditional silicone polymer with a silica resin



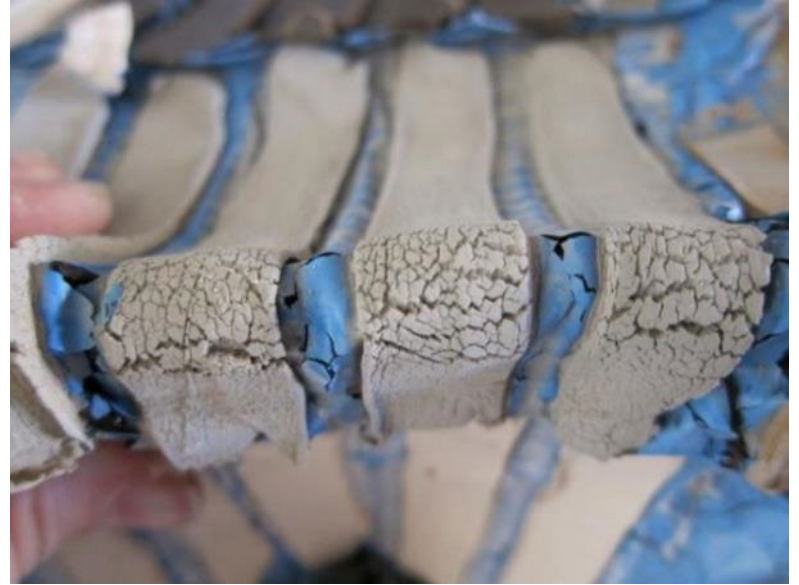
ADHESION PERFORMANCE OF POLYMER-RESIN SEALANT TO LOW-ENERGY SUBSTRATES



WEATHERING



Silicone polymer resin blend sealant after two years in Phoenix desert outdoor weathering site. No cleaning or special preparation of the sealant. Substrate is a common SAF weather barrier membrane.



Organic technology sealant after two years in Phoenix desert outdoor weathering site. No cleaning or special preparation of the sealant. Substrate is a common SAF weather barrier membrane.

WEATHERING AND ADHESION



Adhesion of polymer/resin blend sealant (left) and a common silicone sealant (right), after two years in Phoenix desert outdoor weathering site, to a common peel-and-stick weather barrier membrane with a high-density polyethylene top sheet.



Adhesion of polymer/resin blend sealant (right) and a common silicone sealant (left), after two years in Phoenix desert outdoor weathering site, to a common spun bound polyolefin weather barrier membrane.

ADHESION AND MOVEMENT

Polymer/resin blend sealant joint (left) and standard silicone sealant joint (right) after being tested for +/- 25% movement. Substrates are anodized aluminum and HDPE.



PROBLEM: CONSTRUCTABILITY CHALLENGES

- Order of installation
- Sequencing of trades
 - Air barrier contractor
 - Fenestration contractor
 - Waterproofing contractor
 - Insulation contractor
 - Other
- Timeline flexibility

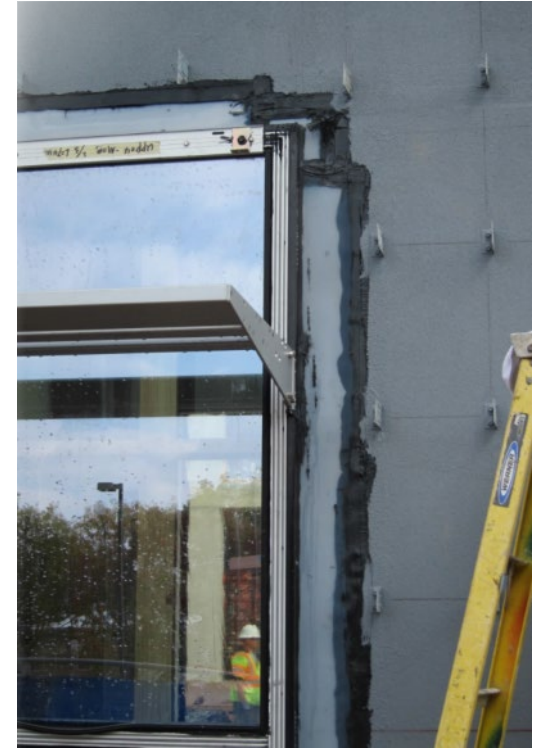


SOLUTION: CHOOSE A SYSTEM THAT PROVIDES FLEXIBILITY

- Flexibility in detailing to allow for complex building designs
- Flexibility in construction scheduling
 - UV stability to allow for extended construction schedules
 - Flexibility of order of installation
 - Components will adhere to each other
- Use of familiar materials and methods

PROVING THE SOLUTIONS: PRE-CONSTRUCTION MOCKUP TESTING

- Determine air infiltration rate
 - <0.04 cfm/ft² @ 75 Pa
 - Test per ASTM E283
- Determine water leakage
 - Test per ASTM E331
- Confirm:
 - Compatibility of components
 - Sequencing of trades
 - Order of installation of materials
 - Quality control procedure



SUMMARY

- Basic requirements for air barrier materials do not necessarily predict system success
- Creating a continuous air barrier system requires attention to detailing and transitions between building envelope components
 - Attention to adhesion between components is important
 - All components of the air barrier system must be compatible
- Details should be simplified, both for steps and number of materials, to ensure constructability
- Movement and weathering of joints must be considered when specifying a sealant for long-term adhesion





Any

questions?



THANK YOU

This concludes the American Institute of Architects Continuing Education System Program “Air Barrier Systems: Silicone Solutions to Reduce Building Air Infiltration.”

For more information, contact:
www.dow.com/construction



NEW BRAND NAME. SAME TRUSTED PRODUCTS.

- DOWSIL™ is the new product brand name for silicone-based building products from Dow Performance Silicones
- Products formerly branded *Dow Corning*® are now offered through the DOWSIL™ brand

DOWSIL™



silicones by 



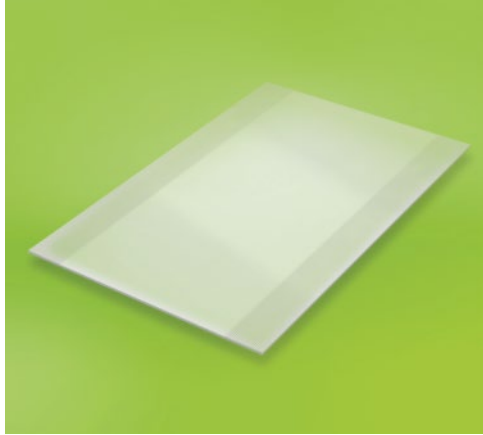
DEFENDAIR™ 200C AIR AND WEATHER BARRIER COATING

- 100% silicone liquid-applied air and weather barrier designed to protect against air infiltration and water penetration.
- Permeable air barrier used for new construction and renovation applications on many substrates, including concrete, OSB, exterior sheathing, preformed panels, plywood, wood or steel stud walls.

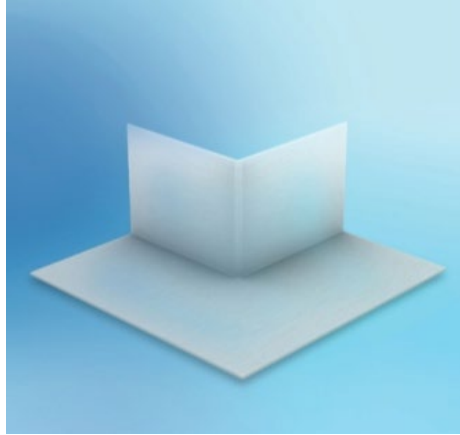
DEFENDAIR™ 200C Air and Weather Barrier Coating



DOWSIL™ SILICONE TRANSITION SYSTEM



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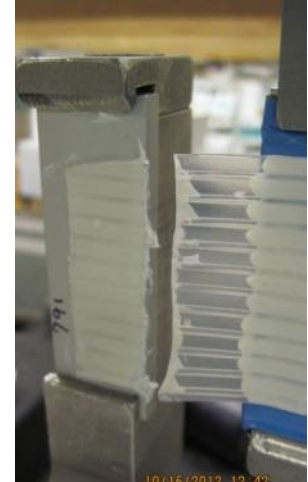
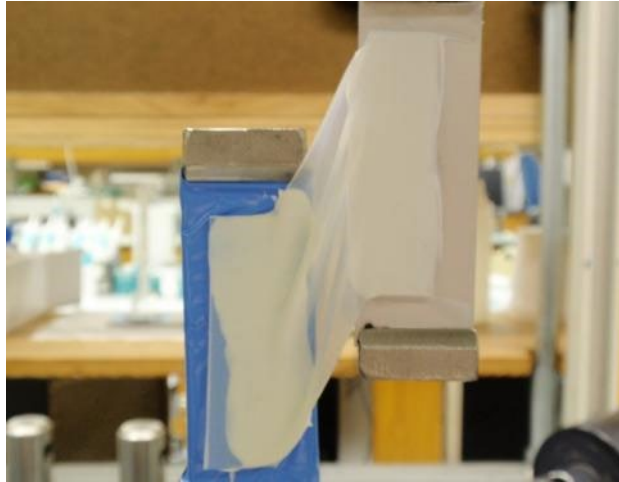


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DOWSIL™ SILICONE TRANSITION STRIPS

- Tear strength – 200 ppi
- Shear movement capability – 300% displacement (2"); no tears/no sealant or substrate release



STS Shear Test.AVI

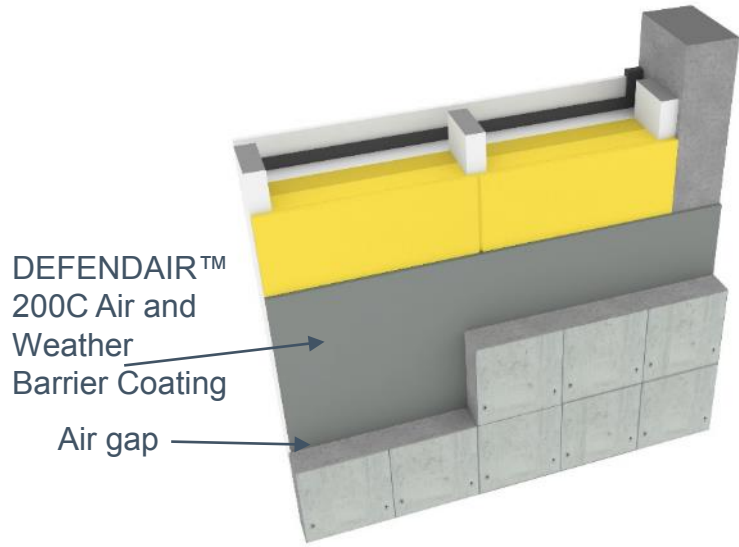


DOWSIL™ 778 SILICONE LIQUID FLASHING

- Liquid applied detailing sealant
 - Punched window openings
 - Other transitions
- Advantages
 - Fewer steps to detail (no primer)
 - Long tooling time
 - Good flow for tooling at complex geometries
 - High durometer/good toughness
 - Cost competitive
 - Available in two colors - green and gray



A COMPLETE AIR BARRIER SYSTEM



ASTM E2357	Assembly air leakage, class 1A per CAN/ULC S742		
	<0.01 cfm/ft ² @ 1.57 psf	cfm/ft ²	< 0.000006
	<0.05 L/s/m ² @ 75 Pa	L/(s·m ²)	< 0.00003

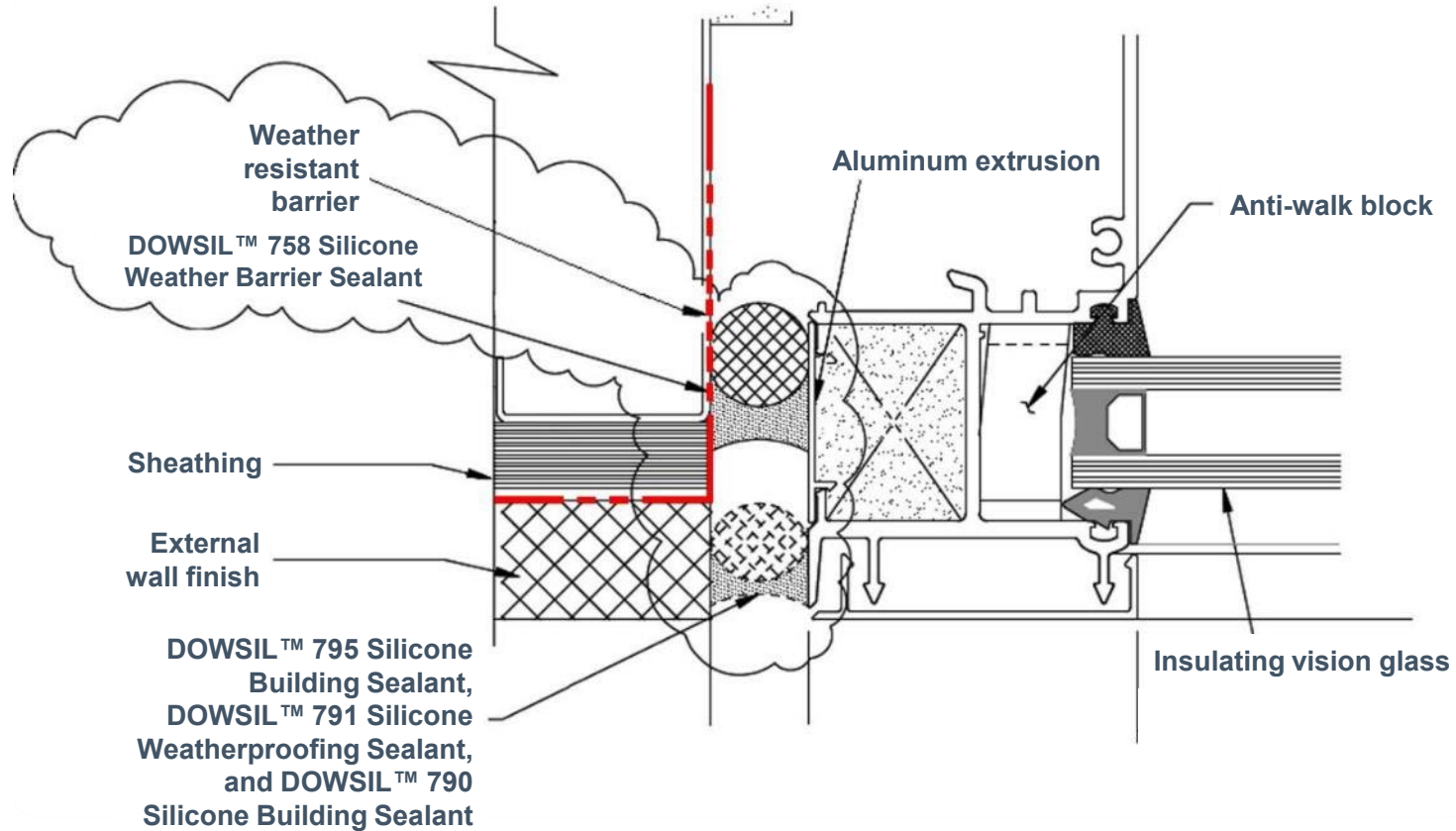


DOWSIL™ 758 SILICONE WEATHER BARRIER SEALANT

- Consistent adhesion to both low-energy and high-energy surfaces
 - Primerless adhesion to commercially available weather barriers
 - Spun bond polyolefin
 - Polyethylene
 - Primerless adhesion to common building substrates
 - Anodized aluminum
 - Fluoropolymer coatings
 - PVC
 - Galvanized steel
 - Mill-finish aluminum
 - Roofing membranes
- Other typical silicone sealant characteristics and durability
 - Passes 5,000 hours QUV
- Sealant passes 25% movement capability on glass, aluminum and polyethylene substrates



APPLICATION EXAMPLE



DOWSIL™791 SILICONE WEATHERPROOFING SEALANT

- Provides proven silicone weatherproofing performance. **±50%**
 - Economical, medium-modulus, general weatherseal sealant
- Applications:
 - Airtight sealing of seam joints when using DensGlass or other building boards
 - Perimeter sealing of windows, doors and other building penetrations
- Features/benefits:
 - Ideal for adhering DOWSIL™ Silicone Transition System to DEFENDAIR™ 200C Air and Weather Barrier Coating
 - Excellent weatherability – virtually unaffected by sunlight, rain, snow, ozone
 - Primerless adhesion to many common building substrates



LEARN MORE

Find more information at BuildaBetterBarrier.com
or dow.com/construction



DOW SERVICES

- 40+ year track record in construction
- Technical leadership (R&D, patents, ASTM)
- Authorized distributors
- Laboratory testing for adhesion, compatibility and staining
- Offering 20-year weatherseal, nonstaining and structural adhesion warranties
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