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Joining the Pieces Together: A New Weatherbarrier Sealant to Ensure Energy Retention of Commercial Buildings

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ABSTRACT

Many new materials have been introduced over the past 5-10 years with the purpose of flashing and sealing through-wall building penetrations in such a way to avoid water leaks and air infiltration. Air barrier materials and weatherproofing membranes have made great advancements. Of these flashings and barrier materials, those with a polymer surface provide a difficult substrate for traditional sealants to adhere, creating the challenge of integrating the new materials with standard construction substrates. Joining the building wrap material to the flashing and to the substrate in the opening is critical so that all components together create the weather tight opening required for a high performance energy efficient building. Without a sealant to reliably adjoin the interface of these dissimilar building materials for the life of the building, buildings are at risk for air and/or water infiltration, reducing the energy performance of the building.

This paper discusses the building codes driving requirements for air barrier materials for commercial construction. This paper then introduces a new sealant which came onto the market in 2010 that addresses these adhesion concerns, offering a solution by which through wall penetrations in buildings can be flashed and sealed reliably to ensure that air and water leakage are prevented—not just at the time of installation, but for the life of the building. The sealant offers a solution by which membrane and flashing materials can be joined seamlessly together in a weather tight fashion and the flashing assembly can then be sealed to its adjacent substrates. This reliable sealing system—weather barrier membranes plus sealant—is critical to attaining the projected energy efficiency of the building.

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INTRODUCTION

It has become of paramount importance in the construction industry to protect buildings from air infiltration in order to decrease the energy required to heat and cool commercial buildings. Further, it has always been important to flash openings in the façade correctly to minimize air infiltration and avoid water intrusion. Building codes and high-performance building requirements and standards have increased the use of weather barriers in the commercial construction market. Dow Corning introduced *Dow Corning*® 758 Silicone Weatherbarrier Sealant for the purpose of consistently adhering to weather barrier materials. Weather barrier substrates include products generally referred to as “Air Barriers”, “Vapor Barriers”, “Peel and Stick Membranes”, “Foil Face Flashing”, “Fluid Applied Membranes”, and “Tyvek®”. Tyvek® is a brand name associated with different specific materials manufactured by DuPont but is many times used generically to refer to air barriers.

This sealant is a silicone polymer/resin blend which offers robust adhesion to wide variety of polymer surfaces, including HDPE, polyethers, bitumen and asphaltic membranes, and spun bound polyolefins. Additionally, it offers aggressive adhesion to metal and cementitious substrates.

The polymer/resin blend sealant is applied in the field in the same manner as a traditional one part sealant. It is available in 20 ounce sausages and is installed using standard sausage guns. Applicators may find the new sealant to be more viscous than a traditional sealant due to its unique chemistry and resin content. However after numerous projects across the US, market feedback has been very positive regarding its ease of use.

Weather Barrier Membrane Materials

Self adhered flashings (SAF) have become very common and provide a type of polymer based facing, typically high density polyethylene (HDPE). Foil face flashings are also available. Other common air barrier or wall wrap materials may be fluid applied or have a spun bound polyolefin face. Hybrid polymer materials are available as well. The “Peel and Stick” category of materials, generally referred to as self-adhered flashings (SAFs), primarily includes asphaltic-based membranes with a polymer sheet face such as polyethylene. The adhesive side (traditionally asphaltic side) of the material is easy to apply to building surfaces while the top sheet allows the product to be utilized in rolls and be applied cleanly in the field. These SAF materials are used at building openings, particularly around windows and doors, but can also be applied around heating vent openings and any other through-wall building penetrations. SAFs serve to “flash” the opening and direct water away from the interior of the building; they often replace metal flashing. The polymer face material on these SAFs is a low energy surface, making it difficult to adhere to with standard construction sealants.

In part to address poor sealant adhesion and in part to provide a more durable material, foil face flashings were introduced. Foil face flashing materials are also used at building openings, and they have an asphaltic adhesive back layer. The face of the material is foil instead of plastic, making it easier for traditional sealants to adhere. These flashings have become a popular technology but are more expensive than polymer faced SAFs.

Air barriers are another subcategory of weather barrier membranes. These materials are intended for wall surfaces and may or may not be used in window openings. Air barriers can be made of a variety of materials, including spun bound polyolefin—a paper like material that is generally mechanically fastened to the wall. The most well known brand of these spun bound polyolefins is Tyvek® by DuPont. Other air barrier technologies include liquid and sheet applied materials.

BACKGROUND

Buildings in the United States account for 39% percent of all energy usage; this is more energy than is used in both industry and transportation (US DOE 2005). This information has caused many groups to take a close look at how to reduce the energy use of buildings. When the total energy use of buildings is broken-down by use, 36 percent of the energy used in buildings is for heating and cooling of the space. This is far more than any other segment; lighting comes in second at 18% (US DOE 2005). Taking a closer look, the two highest percentages of heating loads are a result of energy lost through walls (21%) and energy lost in conduction through windows (22%). Air infiltration is third, contributing 18% of the energy loads that must be offset by a building's heating system to maintain a set interior temperature (US DOE 2005).

Conventional building design of a building envelop often refers to a building's need to "breathe". Designing a building this way allows air and moisture vapor to migrate through a façade system. This flow of molecules affects two key parts of the building – the loads on the heating, ventilation and air conditioning (HVAC) systems are increased and the *possibility* of mold and mildew inside the walls affects indoor air quality. Air which passively enters a building increases the load put on the HVAC systems as the new air brought into the system has to be fully circulated through the building before it is filtered and heated or cooled. By having full control over where and how much air is entering the building, it is possible to reduce the strain on the HVAC systems. This control can occur through proper design of the intake/outtake sections of the HVAC systems and by stopping the flow of air and moisture through the building envelope.

The prevention of air and moisture entering the envelope is achieved using a continuous air barrier. A number of associations and committees have begun to write standards addressing air infiltration in a building in order to increase the energy efficiency of buildings. This is done primarily by mandating the use of continuous air and vapor barriers in the building envelope. ASHRAE defines a continuous air barrier as "the combination of interconnected materials, assemblies and sealed joints and components of the building envelope that minimizes air leakage into or out of the building envelope" (ASHRAE 2010). The attributes and permeability rates of the air and vapor barriers varies slightly in each standard. As these standards are adopted by code agencies and jurisdictions, numerous air barrier and flashing materials have been introduced into the market.

The many different standards and codes which have put forth guidelines related to the requirement for air barriers and their maximum air leakage rates for different types of wall systems and entire building envelopes is a cause for some building professionals as they cross into different jurisdictions. A summary of these different standards is found here.

ASHRAE 90.1-2010 Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE 90.1-2010 is commonly cited as the leading standard for decreasing the amount of air infiltration into a building. Section 5.4.3 of ASHRAE 90.1-2010 states that "The entire building envelope shall be designed and constructed with a continuous air barrier." This requirement applies to all buildings in all climate zones (as defined by the US Department of Energy) covered by this standard. Under this standard all opaque segments of the building envelope must use materials that have an air permeance of less than 0.004 cfm/ft^2 under a pressure differential of 0.3 inch water gauge (w.g.) when tested according to ASTM E 2178. The other option is to have the full envelope assembly (including sealants, tapes, etc.) obtain an average air leakage rate less than or equal to 0.04 cfm/ft^2 under a pressure differential of 0.3 in. w.g. when tested to one of the following standards: ASTM E 2357, ASTM E 1677, ASTM E 1680 or ASTM E 283.

Note: ASHRAE 90.1-2010 is the most recently published version of this standard. The 2007 version of the standard is currently the most often referenced by other codes and certifications such as LEED® 2010 by the United States Green Building Council (USGBC). The 2007 version of the standard has a similar requirement for air barriers and maximum air infiltration for the opaque portion of a building envelope as that in the 2010 version. The 2004 version of the same standard does not have these requirements.

ASHRAE 189.1-2009 Standard for the Design of High-Performance Green Buildings (Except low-rise residential buildings).

ASHRAE 189.1-2009 is the sustainable building standard written in conjunction with the USGBC. It is formatted similar to the LEED® standards, but is written in language that can be adopted by code writing agencies and jurisdictions. The intent of the standard was to reduce total energy usage of a building by ten percent compared to a baseline of a building built according to ASHRAE 90.1-2007**.**

Subsection 7.4.2.10 of this standard states that the building envelope must be "designed and constructed with a continuous air barrier…to control air leakage into, or out of, the conditioned space." Normative Appendix B of the standard clarifies in detail the requirements that the continuous air barrier must meet. The two compliance paths outlined in ASHRAE 90.1-2010 are available as well as a standard for the entire building envelope. The entire completed building may be testing in accordance to ASTM E779 and must demonstrate an air leakage rate not greater than 0.4 cfm/ft^2 in 0.3 in. w.g. (1.57 lb/ft^2).

CERTIFICATIONS

LEED® 2010 for New Construction and Major Renovation

Prerequisite 2: Minimum Energy Performance under the Energy and Atmosphere section outlines 3 different options to comply with the prerequisite. Option 1 states: "To achieve points using this credit, the proposed design must…comply with the mandatory provisions in Standard 90.1-2007." These provisions include Section 5.4, in which is found the requirements for a continuous air barrier. In order to meet this prerequisite, a baseline building performance rating must be determined for a building which meets ASHRAE 90.1-2007. The procedure to determine the building performance rating is outlined in Appendix G of ASHRAE 90.1-2007. The design team must then show that the proposed building has reduced the building performance rating by 10% for new construction or by 5% for major renovations. Further reduction in the building performance rating may result in one or more credits under EA Credit 1: Optimize Energy Performance. One way to help achieve this energy reduction may be to decrease the air infiltration rates in the ASHRAE 90.1-2007 standard.

CODES

International Energy Construction Code 2012 (IECC 2012)

The International Energy Construction Code 2012 has adopted ASHRAE 90.1-2010 as the standard of choice for building façade design relating to air infiltration and energy efficiency. As of publication of this paper, this standard has yet to be adopted by any jurisdiction in the United States. The information on air infiltration aligns with the requirements for ASHRAE 90.1-2010 and can be found in Section 502 of the IECC.

International Green Construction Code - Public Version 2.0, November 2011 (IgCC v2.0, 11-2011) [This standard is still under public review and is expected to be published in March 2012. Upon release of the final version of this model code, this section will be updated.] As this model code is yet to be formally published, it has not yet been adopted by any jurisdictions.

The International Green Construction Code Public version 2.0, November 2011 has adopted ASHRAE 189.1-2009 as the sustainable building and energy efficiency standard of choice for air infiltration. All building thermal envelopes must comply with Section 502 of the IECC in addition to Section 606.1.2.2 of the IgCC. This section of the IgCC states that the building envelope must have an air leakage rate less than 0.25 cfm/ft^2 at a pressure differential of 0.30 in. w.g. when tested according to ASTM E779. The test must be completed after the installation of all penetrations into the building envelope.

Executive Order No. 13514 – Federal Leadership in Environmental, Energy and Economic Performance

This executive order has implemented the “Net Zero by 2030” policy mandating all federal agencies evaluate all buildings larger than 5000 sq. ft. and develop a plan to reduce their greenhouse emissions. This executive order also requires that all new Federal buildings that enter the planning process in or after 2020 are designed to achieve zero-net-energy by 2030. This is to be achieved by following the *Guiding Principles of Federal Leadership in High Performance and Sustainable Buildings,* also referred to as the Guiding Principles.

The Energy Efficiency section of the Guiding Principles requires that all new construction reduce the energy cost budget by 30 percent when comparing to a baseline building designed according to ASHRAE 90.1-2004.

United States Army Corp of Engineers (USACE)

The USACE has a standard maximum air leakage criterion of 0.25 cfm/ft^2. In 2011, this standard was reduced from 0.40 cfm/ft^2. The enforcement of this standard will be based on the passage of an air leakage test at a pressure differential of 0.3 in. w.g. (or 1.57 psf).

Table 1. Summary of Codes and Standards

Standard or Code	Section Containing Requirements on Air Infiltration	Examples of Jurisdictions Adopted	Air Leakage Rates at 0.3 in. w.g. (1.57 lb/sqft, 75 Pa)	Tests Cited
ASHRAE 90.1-2010	Section 5.4	Massachusetts IECC-2012	Material: 0.004 cfm/sqft Assembly: 0.04 cfm/sqft	ASTM E 2178, ASTM E 2357, ASTM E 1677, ASTM E 1680, ASTM E 283
ASHRAE 90.1-2007	Section 5.4	LEED® 2010	N/A	ASTM E 2178, ASTM E 2357, ASTM E 1677, ASTM E 1680, ASTM E 283
ASHRAE 189.1-2009	Subsection 7.4.2.10, Normative Appendix B	IgCC-2012	Material: 0.004 cfm/sqft Assembly: 0.04 cfm/sqft Building: 0.4 cfm/sqft	ASTM E 2178, ASTM E 2357, ASTM E 1677, ASTM E 1680, ASTM E 283, ASTM E 977
IECC - 2012	Section 502	None	Material: 0.004 cfm/sqft Assembly: 0.04 cfm/sqft	ASTM E 2178, ASTM E 2357, ASTM E 1677, ASTM E 1680, ASTM E 283
IgCC-v2, 11-2011	Section 606.1.2	None	Envelope: 0.25 cfm/sqft	ASTM E 977
USACE			Envelope: 0.25 cfm/sqft	

SEALANT PERFORMANCE

As use of weather barrier materials for reducing air infiltration increases, it is critical that a sealant be chosen which adheres to the substrates being used to weatherproof building openings. Upon completion of a market assessment of current sealants, it was found that a sealant that was both flexible at low temperatures and had acceptable adhesion to the polymer faces of these materials was not available.

Adhesion must not be the only criteria considered when developing a new sealant to address the use of weather barrier materials. Structures need room to react to the many loads acting on them including but not limited to dead, live, thermal and wind loads. With expansion joints put into the facade to accommodate this movement and joints found between adjacent dissimilar substrates, it is important to have a sealant that can accommodate the movement, adhere to the membrane materials and keep the building air and water tight. Another consequence of the installation of air barriers is the development of a pressure-equalized façade. The air barrier reduces the pressure differential across the building façade, thereby reducing the primary force of water penetration through the façade during wind-driven rain (Ruggiero et al.1991). In order for the design to be successful, it is vital to seal the continuous air barrier at all openings, joints and seams using a sealant that will not disengage from the substrate nor cause the substrate to fail within itself. ASHRAE 189.1-2009 includes this requirement in 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.” Subsection B1.c continues with: 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.”

Dow Corning moved to develop the new sealant to address this market need. This sealant is a silicone polymer mixed with a resin which provides adhesion to low energy surfaces such as spun bound polyolefin and polyethylene sheet materials. Figure 1 illustrates the adhesion of the polymer/resin blend sealant on common building substrates in comparison to other currently available sealants. Figure 2 illustrates the adhesion of the polymer/resin blend sealant to common weather barrier substrates.

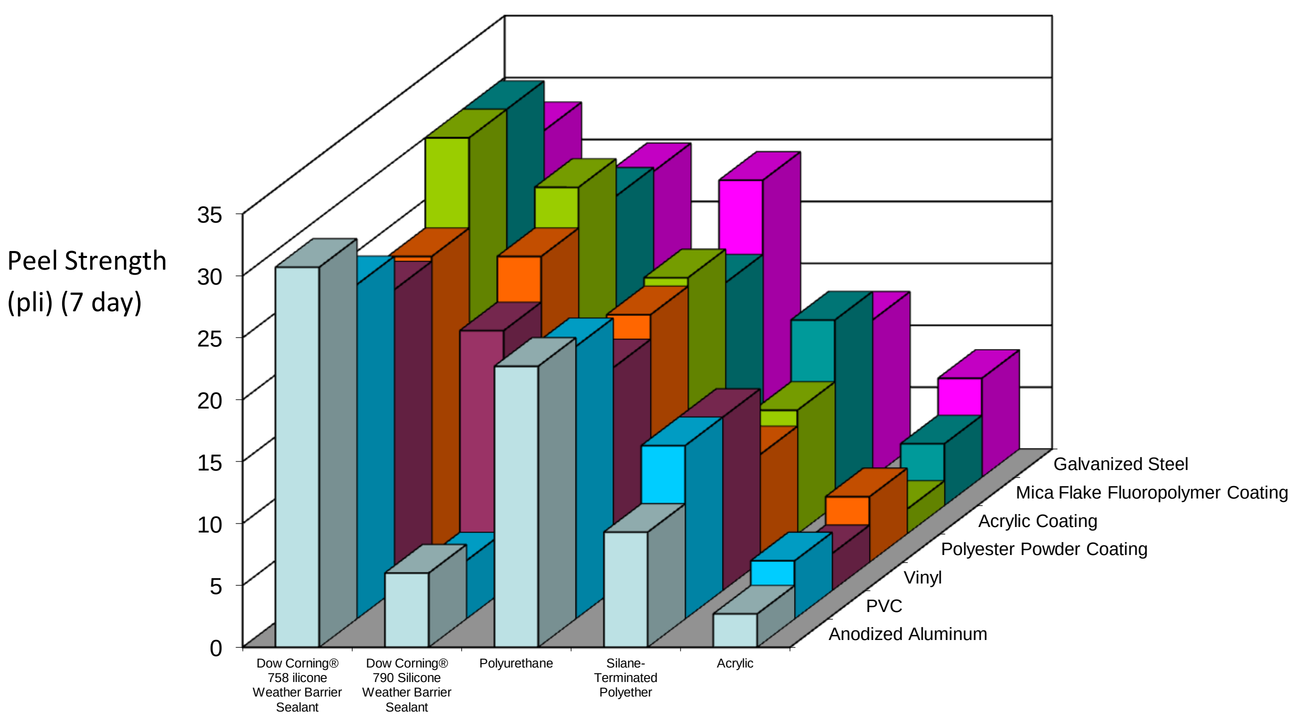

Figure 1: Adhesion of sealants to common building substrates.

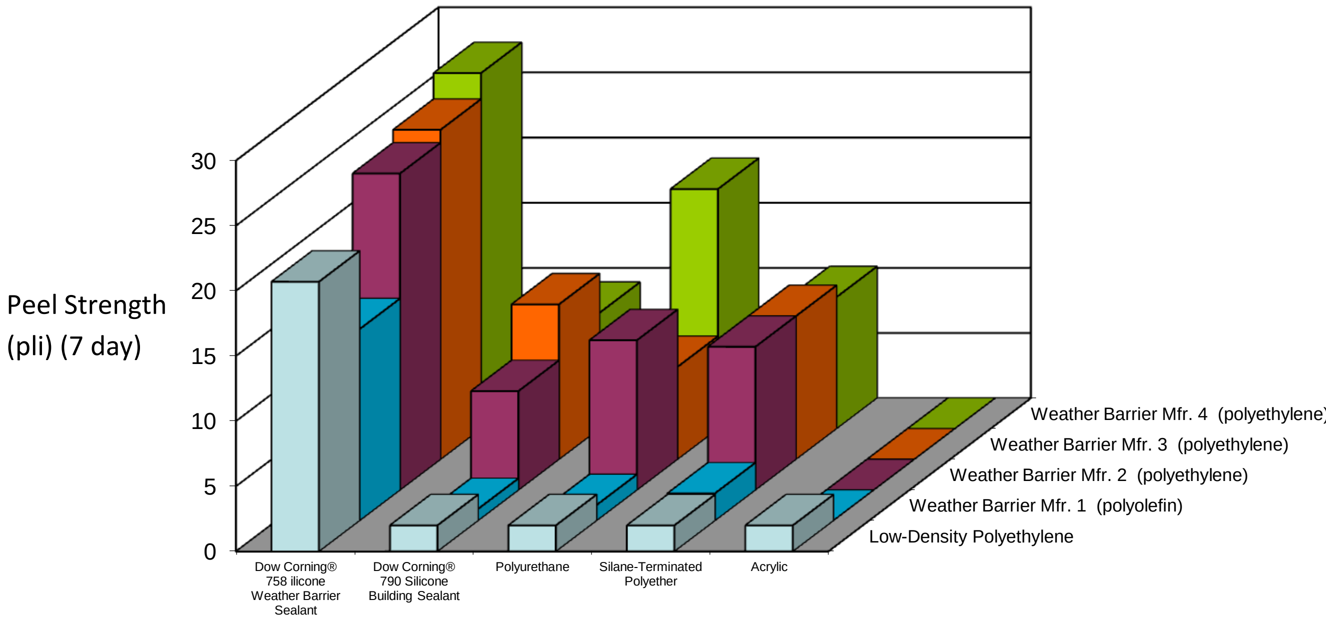

Figure 2: Adhesion of sealants to weather barrier substrates.

The new silicone polymer-resin sealant offers the same durability benefits as other silicone sealant lines produced by the same manufacturer. It has been evaluated after cold and hot climate exposures: 2 years of exposure in Phoenix and 2 years of exposure in Michigan. Additionally, the discussed sealant has been exposed to 10,000 QUV. Table 2 shows a comparison of the sealant properties before and after the weathering study. Figures 3 and 4 show examples of the durability of this sealant compared to other sealant technologies.

Table 2: Polymer Resin Blend Sealant Properties Before and After QUV Weathering

	7 Day RT*	1000 Hr RT*	1000 Hr QUV	5000 Hr RT*	5000 Hr QUV	10,000 Hr RT*	10,000 QUV	Reference traditional sealant value
Peel Strength on Glass (pli)	62	69	70	83	60	85	62	20-50
Durometer (A Scale)	NA	55	53	57	53	63	60	30-40
Tensile Strength (psi)	NA	399	334	459	332	424	301	150-250

*RT = Room Temperature

Figure 3: Silicone Polymer Resin Blend Sealant after 2 years in Phoenix Desert Outdoor Weathering Site. No cleaning or special preparation of the sealant. Substrate is a common SAF weather barrier membrane.

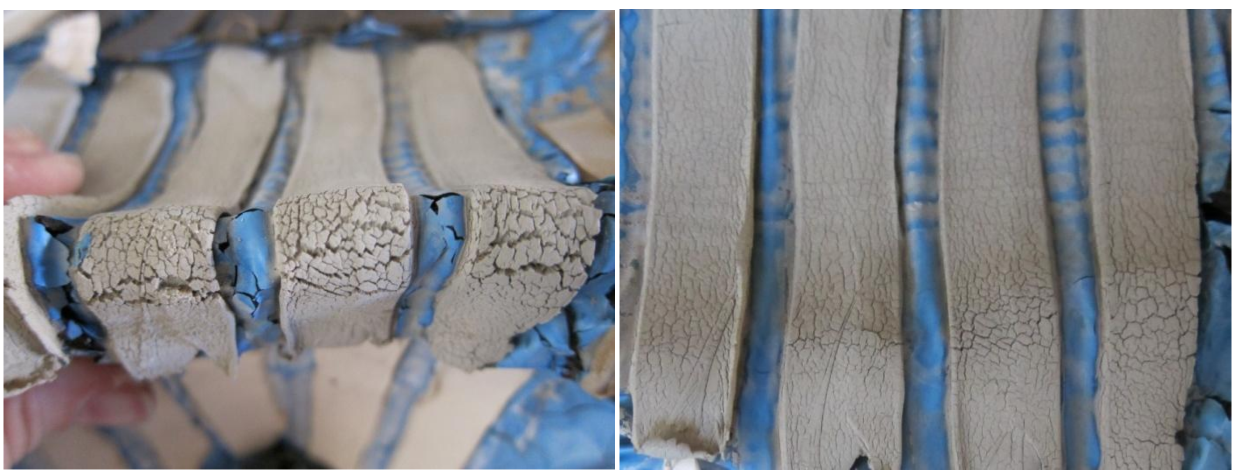

Figure 4: Organic technology sealant after 2 years in Phoenix Desert Outdoor Weathering Site. No cleaning or special preparation of the sealant. Substrate is a common SAF weather barrier membrane.

The new polymer/resin technology, standard silicone technologies and organic technologies were visually evaluated as shown in Figures 3 and 4; they were also tested for adhesion as shown in Figures 5 and 6. As the pictures illustrate, organic sealants may present durability questions under long term weathering conditions (Figure 4). Standard silicone technologies continue to show good durability as is well documented by the sealant industry (Wolf 1999). However, they do not adhere well to low energy surfaces such as spun bound polyolefins or HDPE. This creates concerns about the long term performance of the air seal at these critical interfaces. The clean adhesive failure seen in the right side photos of both results shown in Figures 5 and 6 were seen after pulling on the sealant using very minimal force; there was no sealant extension. In other words, the traditional silicone sealant easily peeled off the substrate under extremely low stress. Conversely the silicone polymer/resin sealant showed extension and required a much stronger pull force before either cohesively failing pulling the substrate apart.

Figure 5: Adhesion of polymer/resin blend sealant (left) and a common silicone sealant (right) after 2 years in Phoenix Desert Outdoor Weathering Site, to a common peel and stick weather barrier membrane with a high density polyethylene top sheet.

Figure 6: Adhesion of polymer/resin blend sealant (left) and a common silicone sealant (right) after 2 years in Phoenix Desert Outdoor Weathering Site, to a common spun bound polyolefin weather barrier membrane

This sealant has a third party validated movement capability rating of +/-25% (Architectural Testing Inc). The results of the third party testing are found in Table 3. Standard substrates were chosen for the third party validation testing. Additionally, the sealant manufacturer performed additional in-house testing using the same procedures referenced above, but the substrates were anodized aluminum on one side and a commonly available SAF with a HDPE top sheet on the opposite side. For comparison sake, the same sample set up was also tested with a standard silicone technology sealant. Results are compiled in Table 4 and illustrated in Figure 7.

Table 3: ASTM C719 Testing of the silicone polymer/resin blend sealant to standard ASTM C920 substrates**

Substrate	Sealant/Primer	Cure Conditions	Specimen In Tact after 25% cyclic movement
Glass	DC 758/No Primer	38 C/95% RH for 7 days + 7 days standard lab conditions	Yes
Anodized Aluminum	DC 758/No Primer	38 C/95% RH for 7 days + 7 days standard lab conditions	Yes
Concrete	DC 758/No Primer	38 C/95% RH for 7 days + 7 days standard lab conditions	Yes

**Specimens were tested utilizing a Hockman Cycler (ICN 005612) operating at a speed of 1/8” per hour.

Table 4: ASTM C719 Testing of silicone polymer/resin blend and standard silicone sealant to a custom substrate configuration using anodized aluminum on one side and SAF on the other

Substrate	Sealant/Primer	Cure Conditions	Specimen In Tact after 25% cyclic movement
Anodized Aluminum/HDPE on SAF	DC 758/No Primer	21 days standard lab conditions	Yes/No adhesion loss
Anodized Aluminum/HDPE on SAF	Traditional silicone sealant/No Primer	21 days standard lab conditions	Yes/with adhesion loss

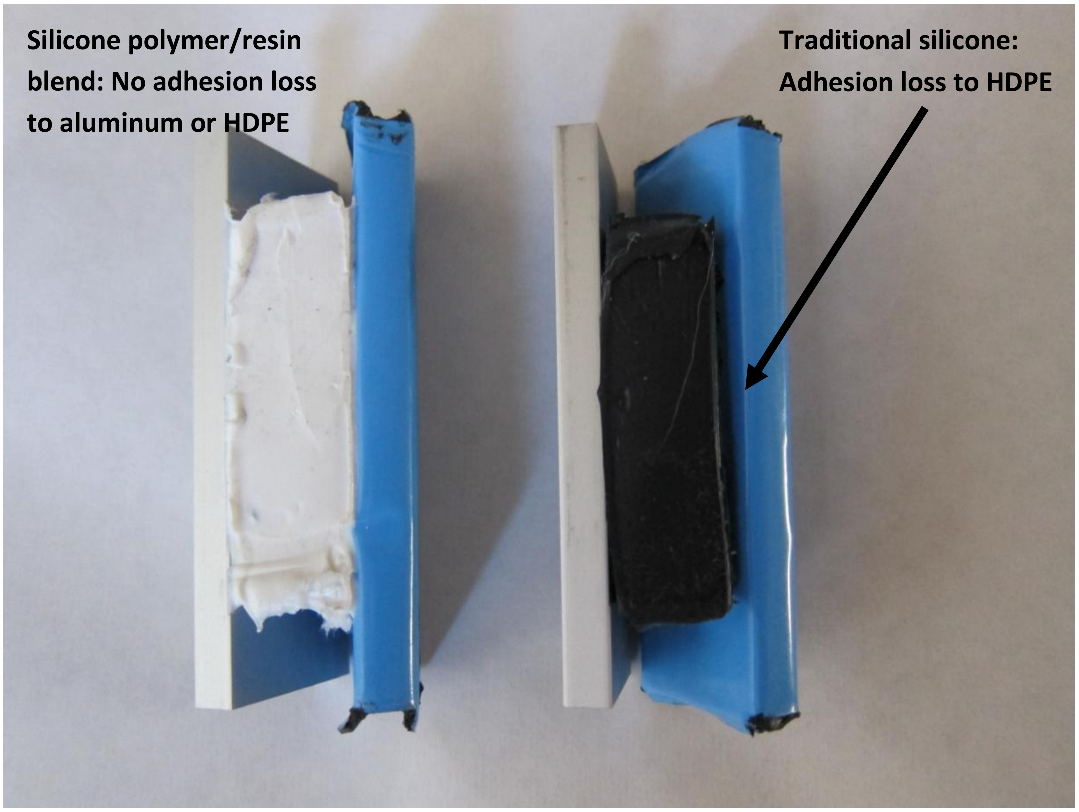

Figure 7: Polymer/resin blend sealant joint after being tested for +/- 25% movement (left) and standard silicone sealant joint after being tested for +/- 25% movement (right). Substrates are anodized aluminum and HDPE.

Table 5 shows a summary of substrates which have been tested for sealant adhesion using a procedure similar to that in ASTM C1521 Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant. All of the substrates listed have shown passing adhesion with the discussed sealant.

Table 5. Substrates to which Dow Corning® 758 has successful adhesion

Weather Barriers/Membranes	Weather Barriers/Membranes	Other Substrates
BASF Sonoshield HLM 5000 Liquid Applied Elastomer	HardieWrap Weather Barrier	EPDM Gasket
BEI Liquid Applied Membrane	Henry Air Block 33	Glass
Carlisle 860 Membrane	Henry Blueskin PE 200 HT Membrane	Kevlar
Carlisle CCW 705	Henry Blueskin SA	PVC
Carlisle CCW-705 HT	Henry Blueskin VP 160	Silicone Sheet
Carlisle Elastoform EPDM Membrane	Henry Foil Face	
Carlisle Peel N Seal Water & Ice Shield	Henry Liquid Applied	**Metal Finishes**
Carlisle WIP 300 HT Ice and Water	Hohmann and Barnard Textroflash Membrane	Anodized Aluminum
CETCO GF-40 Self Adhered Membrane	Hyload Membrane	Polyester Powdercoat
Dupont Commercial Wrap	Polyguard 400 Membrane	Duranar
Dupont Commercial Wrap D	Protecto Wrap BT25XL	Kynar
DuPont FlexWrap	Protecto Wrap Detail Tape	Galvanized Steel
Dupont Straight Flash	Protecto Wrap Foil Face (ProtectoSeal 45)	Stainless Steel
Dupont Tyvek Tape	Protecto Wrap Jiffy Seal Roofing Membrane	
EPDM Flashing and Roofing Membranes	Protecto Wrap Peel and Stick (PW 100)	**Porous Substrates**
Fasatan-Fix Membrane by Bosig	Protecto Wrap Safe Seal	Concrete (small and large aggregate)
Firestone Self Adhered Membrane	Protecto Wrap Super Stick	CMU Block
Forti Flash	Sonoguard Liquid Applied Membrane	Natural Limestone
Geoflex Roofing Membrane	Sopralene Flam 180 Base Sheet	Brick and Mortar
Grace Aluma-Flash Peel N Stick Membrane	Soprema Sopraseal Membrane	Densglass
Grace Ice and Water Shield	StoGuard Liquid Applied Membrane	
Grace Liquid Applied Membrane	SureFlash	
Grace Perm A Barrier Peel N Stick Membrane	TPO Membrane (thermoplastic polyolefin)	
Grace Perm A Barrier VPS	Tremco EXO Air 110 EPDM Membrane	
Grace Ultra	Vaproshield VaproAlumina Foil Face Peel N Stick	
Grace V40	Vaproshield Wrapshield SA Membrane	
Grace Vycor Plus	Versiweld Roofing Membrane	
Hardie Flex Wrap	Waterblock 40	

Adhesion testing methods and criteria for the polymer/resin blend sealant had to be modified because the weather barrier materials to which the sealant adheres are not rigid and have layers. If the standard of a set pli and 100% cohesive failure were the passing criteria when testing this sealant, it is possible to get false negatives because the top layer of some membranes were found to peel from the adhesive layer. The new sealant was therefore assigned a percent extension as a passing criterion in order to qualify as passing a field adhesion test: 200% extension with no loss of bond when the sealant is pulled from the substrate at 90 degrees. This is not a traditional 180 degree peel because it is more difficult to see the extension at 180 degrees. Further, adhesive failure was occasionally observed when testing at 180 degrees; this observation did not correlate to the high peel values seen on the same substrates using laboratory testing methods. Because of its resin component, this sealant can act like a true adhesive if pulled too quickly; it can "pop" off of the substrate. Users of this sealant are encouraged to pull the sealant slowly so as to not see a false negative result. Building movements from thermal changes and creep are typically slow, so this test method is applicable for those conditions.

Because of its performance when pulled quickly, users were concerned about the performance of the new polymer/resin blend sealant during a seismic event in which the stress on the sealant is applied rapidly. To address this concern, shear testing at the highest movement rate possible (10 in/min) was performed and the results were compared to those of a traditional sealant (Dow Corning® 795 Silicone Building Sealant) a proven performer in seismic events (Dow Corning 2006). Interestingly, during quick shear movement, both the proven sealant and the new polymer resin blend sealant maintain adhesion to the HDPE surface. However, as shown earlier, standard silicone technologies may lose adhesion during slow thermal movement. When viewing the results as a whole, the more robust sealant choice for performance on a low energy substrate is the polymer/resin blend.

Table 6: High Rate Shear results

Substrate	Sealant/ Primer	Cure Conditions		Peak Shear Force (psi)
Anodized Aluminum/ HDPE	Polymer/ resin blend sealant/ No Primer	21 days standard lab conditions		42
Anodized Aluminum/ HDPE	Dow Corning 795/No Primer	21 days standard lab conditions		65

In summary, this sealant has been tested for its ability to adhere to low surface energy substrates in both laboratory and extreme environmental conditions. Its performance has been validated in tension/compression testing using Hockman cycling, and its shear performance has been validated. Further, sealant durability has been demonstrated using accelerated weathering techniques in the laboratory and in real world extreme weathering exposures.

SYSTEM PERFORMANCE

Because of the outstanding adhesion performance of the polymer/resin blend sealant to weather barrier materials, it must be determined how a material that adheres well to the joint substrates will benefit a complete window installation. Air infiltration testing was completed in accordance with ASTM E283-04 using a punched-window system flashed with a popular SAF with HDPE backing and sealed with the polymer/resin blend sealant.

For this testing a 46⅞” x 58⅞” punch window was installed into a 48” x 60” steel buck leaving approximately a ½” perimeter sealant joint surrounding the window. The steel buck was primed and wrapped in the SAF before the window was placed. All substrates were then cleaned using isopropyl alcohol; a 1½” backer rod was then pushed into the joint and the sealant was installed and tooled. The sealant was then allowed to cure for 7 days prior to the air infiltration testing. Figure 8 shows the detail for the installation and Figure 9 shows the final assembly. The results of the E283-04 testing for the assembly sealed using the polymer/resin blend sealant are summarized in Table 7.

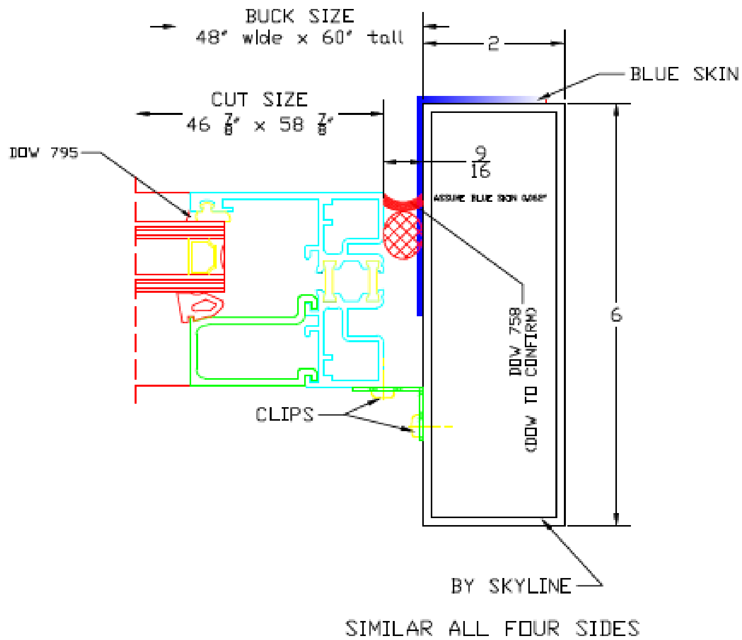

Figure 8. Sample Test Detail

Figure 9. Air Testing set-up of Dow Corning® 758 Silicone Weatherbarrier Sealant

Table 7. ASTM E283-04 Test Data for Window Sealed using Dow Corning® 758 Silicone Weatherbarrier Sealant

Pressure	Air Infiltration		Air Exfiltration	
	Installation Net (cfm)	Window Net (cfm)	Installation Net (cfm)	Window Net (cfm)
25 Pa (0.52 psf)	0.05	<0.01	<0.01	<0.01
50 Pa (1.04 psf)	<0.01	<0.01	<0.01	<0.01
75 Pa (1.57 psf)	0.01	<0.01	<0.01	<0.01
100 Pa (2.09 psf)	<0.01	<0.01	<0.01	<0.01
150 Pa (3.13 psf)	<0.01	<0.01	<0.01	<0.01
250 Pa (5.22 psf)	<0.01	<0.01	<0.01	<0.01
300 Pa (6.27 psf)	<0.01	<0.01	<0.01	<0.01

To reference how a traditionally sealed system performs during air infiltration testing, the same testing was completed on an identical window system utilizing a sealant known to not adhere well to the air barrier material. Through testing according to ASTM C719, it was shown that when a traditional sealant by the same manufacturer undergoes movement in a joint using the same SAF as the substrate the sealant loses adhesion (Figure 7). Using this data as a sample, sealant failure was purposely induced in the second window system by forcing the sealant to lose adhesion to the SAF (Figure 10). This was done to replicate the adhesion loss which was predicted in the movement testing. The resulting air infiltration of a poorly sealed system is at least 10 times that of a properly sealed system using a sealant like the one being discussed (Table 8). This data correlates to potential significant energy losses in a building.

Figure 10. Traditional sealant losing adhesion to the SAF.

Table 8. Comparison of a properly sealed system and a system with poor adhesion when tested in accordance to ASTM E283-04

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

CONCLUSION

As an increasing number of buildings are being expected to meet the exacting codes and standards of high performance building, it is important that they will actually meet these standards for the life of the building. For this to happen, it is essential to choose a sealant which shows excellent long-term adhesion to the substrates that are chosen. One essential part of energy efficient buildings is the sealant joint that meets the weather barrier membrane. In addition, it is important for the sealant to have the proven durability characteristics offered by a silicone.

The data developed through the air infiltration testing has shown a large difference in the amount of air infiltration between a sealant which adheres to the substrates long term and a sealant which does not. At the air pressure most often referenced in building codes and standards (75 Pa or 1.57 psf), the amount of air infiltration is 25 times greater when the sealant loses adhesion to the substrates, resulting in a system no longer meeting the required standards. This data can then be extrapolated to show that energy loss in a building can be greatly minimized using a sealant that achieves long-term adhesion to the substrates, such as the polymer/resin blend sealant discussed in this paper. This also shows that through proper design and selection of a sealant based on the substrates in the joint, a system initially designed to have minimal air infiltration will be able to maintain those standards long-term.

Dow Corning® 758 Silicone Weatherbarrier Sealant has been shown to achieve exceptional adhesion to the toughest substrates: HDPE, polyethers, bitumen and asphaltic membranes, and spun bound polyolefins. In addition, long-term adhesion to traditional substrates will ensure that the joints where these materials meet will remain sealed from air and water. It is the unique properties found in the combination of a traditional silicone polymer with a resin that makes this possible.

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