Effects of UV on air barriers

Understanding and Minimizing the Impact of UV on WRB Performance

After testing numerous WRBs for the impact of UV exposure on performance, it is clear that leaving WRBs exposed for the manufacturer's recommended time can result in loss of up to 90% of the water penetration resistance.

In any building project, it takes a combination of products and skills to achieve a high-performing building system. In the case of the building envelope, air- and water-resistive barriers are vital components. What many manufacturers' data sheets fail to make clear are the consequences of exposure to UV light on the performance of WRBs. Unfortunately, the impacts can be significant. After testing numerous WRBs for performance after UV exposure, it's clear that leaving products exposed for as long as considered allowable by some manufacturers can result in as much as 90% loss of the original water resistance of the product as reported on the manufacturers' data sheets. That's a significant loss that can have an enormous impact on the performance of the building and can call to account the decisions of Architects and Contractors.

Deciding on the best air- and water-resistive barrier for a project should rely on more than the information provided in manufacturers' marketing materials. This is why Dörken had independent testing done to measure the amount of damage to barriers when left exposed to UV for as long as many manufacturers claim. Architects, Contractors, and Owners all have a vested interest in understanding the impact that UV exposure can have on performance, and making product and scheduling decisions to minimize it.

Achieving the Perfect Wall

Achieving the perfect wall means creating a building envelope that includes effective water, air, thermal, and vapor control layers between the exterior finish and the interior structural wall. Whether designing the wall, building it, or paying for it, you expect that the wall will maintain its full function for the lifetime of the building, meaning 50 years or more. This means that each component of the wall needs to function effectively during that time.

WRBs are fundamental to the perfect wall structure as they protect sheathing, allow for the escape of moisture from inside wall cavities, and, when installed as part of an air barrier system, some WRBs can resist air movement both out of and into the building. The ideal WRB is vapor permeable, air tight, and water tight. *(see Figure 1)*

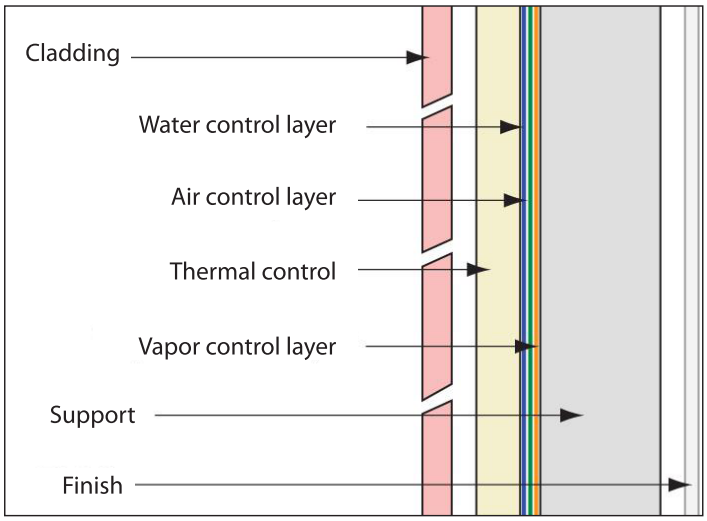

Figure 1: The Perfect Wall

It's not enough to review the data sheet of a WRB when deciding on a brand for your project. A designer should also understand the unwritten impact the sunlight will have on the exposed product.

WRBs come in many different forms including felt-based, paper-based, and polymeric-based. There is an expectation that a WRB is durable enough to withstand the day-to-day environment of a construction site. However, exposure to site conditions, especially UV light, begins to have an impact on the long-term performance of the product from the minute it is installed until the moment it is covered with the exterior cladding. Manufacturers provide documents and data sheets for their products which define product performance, installation requirements, and maximum UV exposure times. To completely understand if the designer's perfect wall will live up to expectations for its lifecycle, it's not enough for the designer to simply familiarize themselves with these WRB data sheets. The designer must also understand how site conditions and installation have an impact on its long-term performance. Once a WRB is enclosed behind the wall, it's difficult and expensive to assess its condition and performance.

Impacts of a Damaged WRB/Air Barrier

A less-than-perfect building envelope can have an enormous impact on the performance of a building. Damaged and under-performing WRBs cause costly failures and long-term inefficiency of the building:

- Damage to insulation, wood, and other structural components due to moisture infiltration
- Mold and air quality concerns from wet wall systems
- Increased energy costs and discomfort for building occupants due to air leaks
- Architects and Contractors also should consider the impact of a poorly performing building on their business. Buildings that don't perform up to standards only a few years after construction can affect not only their reputation, but can also bring costly investigations, repairs, replacements, warranty claims, and litigation.

The Hidden Impact of UV Damage

Damage to a building's exterior finish, or holes, cracks, or tears in the WRB prior to it being enclosed, can be seen and repaired. Damage to WRBs from UV light, however, may not appear until well after the exposure has happened and often when the wall is completely enclosed. As a result, a building can be performing poorly without any immediate visual evidence of why.

A WRB with prolonged UV exposure will degrade and fail before its expected 50-year lifespan.

Because UV exposure occurs from the time of installation until the WRB is covered with the exterior insulation or cladding, UV radiation causes it to start to age and deteriorate almost immediately. If this process is accelerated, the product can begin to underperform within a few years, despite the fact that an Architect, Contractor, or Owner might have the expectation that a WRB will perform for the life of the building (50 years or more).

How UV Breakdown Occurs

When WRBs age and break down due to UV exposure, the damage occurs at the molecular level. The rate and amount of the damage of any individual brand of WRB is determined by many factors including additives like color pigments, antioxidants, UV stabilizers, flame retardants, and others. How the WRB is manufactured can also have an impact on the degree of break down. Manufacturing processes with excessive thermal or shear stresses can initiate the degradation of the WRB.

Research shows that oxidation has a significant impact on aging and breakdown of WRBs, which can occur as a result of exposure to heat, certain chemicals, or UV light. Manufacturers combat some of this vulnerability through the addition of antioxidants and UV stabilizers in their products. Regardless of the WRB product, however, all will experience aging when exposed to UV radiation, humidity, freeze and thaw cycles, and extreme cold or hot temperatures.

Understanding the Unseen Damage

The American Society for Testing and Materials (ASTM) provides standards for testing of products like WRBs for a wide range of characteristics including tensile strength, breaking force, water resistance, water-vapor transmission, and air tightness. They also offer standard accelerated aging testing procedures including the mandrel bend test and a basic UV exposure test.

The basic UV exposure test uses WRB samples and exposes them to light from UV sun lamps for 10 hours per day for a total of 21 days. The test is designed to mimic the conditions that naturally occur in a typical construction site, but it is not at all representing some of the extensive exposure times that some manufacturers allow in their product literature (as high as 180 days).

Dörken commissioned an accredited laboratory to complete a series of accelerated aging tests on vapor permeable self-adhered (peel and stick) WRBs using much more extensive UV light exposure. The samples were tested for strength, elongation, and water resistance before being exposed to the UV light to establish a baseline. The samples were then retested after 500 hours of UV exposure and again after 1000 hours of UV exposure.

How UV Exposure Tests Translate to the Real World

The UV radiation a WRB receives on a construction site is different from the amount received during the UV testing done in a controlled environment. In the real world, factors like water droplets or particles in the atmosphere, ozone levels, the angle of the sun to the surface, humidity, temperature, clouds, and aerosols all have an impact on the amount of radiation a WRB will experience on a construction site. The location of the site is also important. Conditions in Miami, Florida will not be the same as those in Minneapolis, Minnesota.

Standard testing processes include a calculated value or exposure time equivalency that accounts for these differences between the lab and the real world. Table 1 demonstrates the exposure time equivalent in Everglades, Florida and Toronto, Ontario for both the 500 hour and 1000 hour test periods. It shows that the 500 hours of UV exposure in the lab is equivalent to between 85 and 250 days in Florida, and between 177 and 321 days in Ontario. The 1000 lab hours equate to 171-500 days in Florida, and 354-642 days in Ontario.

Lab Exposure	Everglades, Florida	Toronto, Ontario
500 hours UV exposure	85 – 250 days	177 – 321 days
1000 hours UV exposure	171 – 500 days	354 – 642 days

Table 1: Exposure Time Equivalency (Days)

Self-Adhering WRB Results

Five self-adhering WRBs were tested and all saw a reduction in performance with respect to strength, elongation, and water resistance. Strength of the products declined for some barriers as much as 80% after the full exposure of the test, with Product A performing best with only a 10% reduction. However, 2 of the 5 saw a reduction of 40% or more after only 500 hours of UV exposure and 3 of the 5 reduced in strength by more than 50% after 1000 hours. *(see Figure 2)*

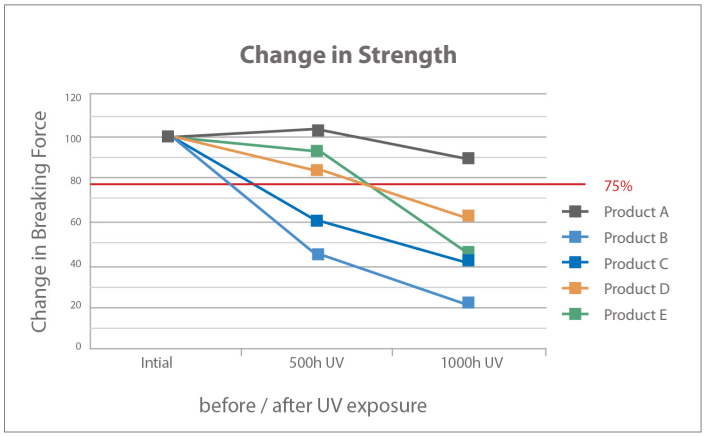

Figure 2

Elongation results also declined considerably for most of the products after the full 1000 hour exposure with 4 of 5 experiencing a reduction of more than 50%. The 1000 hour exposure results range from a loss of between 20 and 60% of the elongation functionality of the self-adhering WRBs tested. *(see Figure 3)*

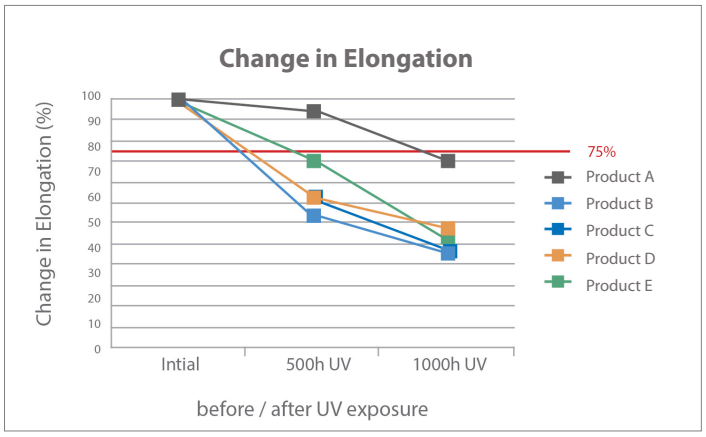

Figure 3

Most significant were the results for 2 of the products when tested for water resistance. Products B and E both declined by 90% from their pre-exposure water resistance after just 500 hours of UV exposure and continued to decline during the remaining exposure hours. To put that into perspective, if one of those products was used in Florida under high UV radiation conditions, it could have lost 90% of its water resistance after as few as 85 days. Two of the other products also saw declines of between 40 and 50% after 1000 hours. *(see Figure 4)*

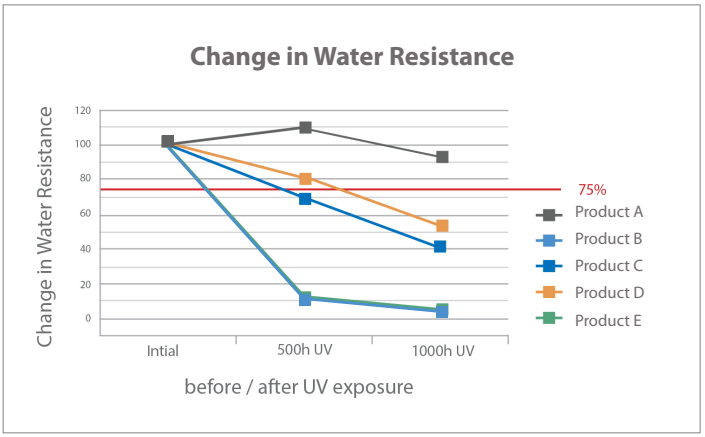

Figure 4

Two of the self-adhering WRBs tested saw a 90% decline in water resistance after the equivalent of as few as 85 days of UV exposure in Everglades, Florida. The manufacturers of the products suggest that a 3 to 5 month exposure time is acceptable.

Self-adhering WRBs

Products Tested	Manufacturer Allowed UV Exposure
Product A - spunbond PP / film / spunbond PP	6 weeks
Product B - spunbond PP / film / spunbond PP	Up to 3 months / 5 months
Product C - spunbond PP / film / spunbond PP	Up to 3 months / 5 months
Product D - spunbond PP / film / spunbond PP	Up to 6 months
Product E – 2 x spunbond PP / coating	5 months

Table 2

A Closer Look at Product A

Product A performed well especially in light of the manufacturer's recommendation for a maximum allowable exposure of 6 weeks. If you were to follow the manufacturer's recommendation, you'd expect to see results better than those of the 500 hour test results in both Florida- and Ontario-like conditions. This would mean minimal changes in strength, elongation, and water resistance. The important difference with Product A is not only does it perform well relative to other products, but it is also accompanied by conservative exposure recommendations from the manufacturer.

Product A Performance Estimates After Manufacturer's Allowed UV Exposure

		Florida and Ontario
6 weeks	Strength	90%
	Elongation	70%
	Water Resistance	95%

Table 3

A Closer Look at Product B and E

Product B is a spunbond PP/film/spunbond PP product with a manufacturer's recommendation for between 3 and 5 months of exposure allowance before covering. Product E is a 2-layer spunbond PP product with a coating. The manufacturer of Product E allows for up to 5 months of exposure after installation. A 3-5 month (91-152 days) exposure would expect to see results similar to the 500 hour exposure in both Florida and Ontario. In these examples, both products would expect to lose 90% of their water resistance even after following the manufacturer's exposure recommendations.

Product B Performance Estimates After Manufacturer's Allowed UV Exposure

		Florida and Ontario
3-5 months	Strength	40-45%
	Elongation	60%
	Water Resistance	10%

Table 4

Product E Performance Estimates After Manufacturer's Allowed UV Exposure

		Florida and Ontario
5 months	Strength	90-95%
	Elongation	75%
	Water Resistance	10%

Table 5

Applying The Results to Your Job Site

All of the WRBs would be expected to perform better with less time exposed to UV radiation on your job site. It's also important to note that many of the manufacturers' exposure recommendations are likely to result in significant performance failures. The sooner you cover the WRB after installation, the less degradation and aging of the product you can expect, and the better its long-term performance within the building envelope.

Regardless of manufacturers' acceptable exposure limits, prolonged UV exposure can be expected to reduce performance, especially water resistance.

The Problem with Manufacturers' Warrantees and Claims

The data sheets that accompany products like WRBs are vital documents for product evaluation, installation instructions, and understanding the performance expectations and warrantees. Designers, Contractors, and Building Owners often rely on these data sheets and their own personal experience to make decisions about crucial products like WRBs. A significant downfall of most WRB data sheets, however, is that they fail to provide two vital pieces of information about the impact of UV exposure on the long- term performance of their product. Without this information, it becomes difficult to choose the best WRB for a project.

- **UV exposure times are provided without explaining the long-term impact on performance and durability of the product.**

While a WRB may not physically break down during the allowed exposure time, it's important to understand what happens to the product once it is covered by cladding. Often the UV exposure recommendations (some as long as 180 days) are marketing claims and are made based on the short-term performance of the product and user convenience rather than any testing results or research. In fact, the industry lacks any ASTM standard testing requirements to identify acceptable exposure limits. Without this information, manufacturers are failing to provide users with the data needed to understand the product's long-term performance.

- **Most products indicate a single UV exposure limit without any clarification on the impact of the location or season.**

Manufacturers' recommendations generally include a single acceptable time exposure for their product or a general time range. These recommendations don't include considerations for seasonal fluctuations or geographical differences. Winters in Ontario would expect to see significantly less exposure than summers in Florida so 6 months in both locations should not be considered equal.

What You Should Know Before Choosing a WRB for your Project

Whether you're the Designer of a building, a Contractor, or the Owner, you want to have all the information at hand when you choose a WRB for a project. WRBs play an important role in the long-term function of the building and you'll need to have the right product and installation process in order to achieve the perfect wall.

Beware UV

It's important to understand that UV exposure will impact the performance of the WRB you install. There are many different factors that influence how much that exposure will impact long-term results, but all the WRBs tested eventually experienced negative results.

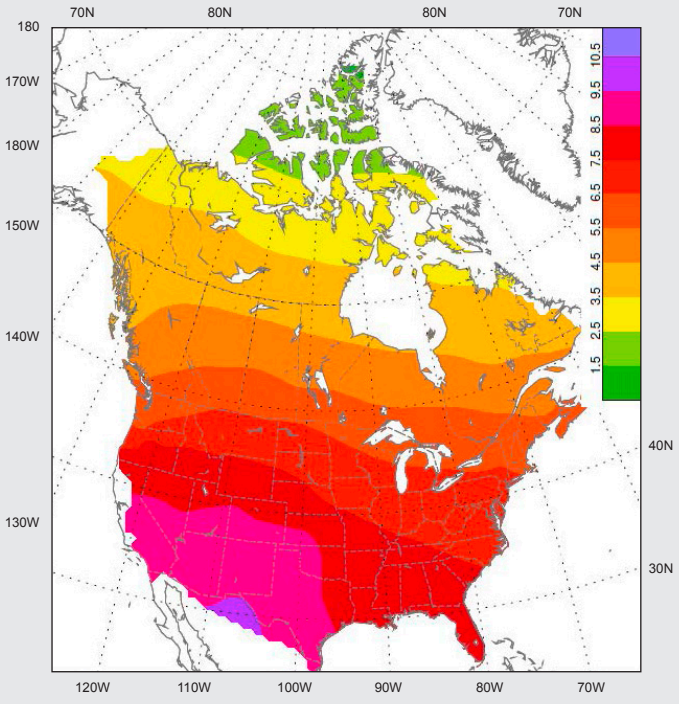

Figure 5: UV index in July for North America. (Source: WOUDC)

Understand your Environment

Figure 5 shows the UV index for North America in July. If you understand the UV radiation expectations at your site, you can consider your product and exterior cladding installation appropriately.

Minimize Exposure

Include specifications and schedule details to install the exterior cladding as soon as possible after the installation of the WRB. By minimizing exposure, the impact UV will have on long-term performance is limited. If the Owner or the Architect is concerned that the Contractor prefers to have more flexibility in their schedule, it will be important to communicate the impact only a few weeks can have on long-term performance.

Ask the Manufacturer for More Information

If you have a preferred product that you have worked with in the past, you should reach out to the manufacturer and ask them for more information. Some may have data specific to the long-term performance of their product given the UV exposure recommendations they provide. Others, however, may not have any test results.

Check your Own Records

If you've been in this business for several years, you may have experienced the impacts of failed WRBs in buildings you've been involved in. Ask yourself what product you used in those cases, and how long you tend to leave the WRBs exposed before covering them. It's also an option to ask other professionals in your area about their experiences with a specific product or process.

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