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Accelerated Weathering and Actual Exterior Exposure

By Denise Breard, Member *Academy of Screen Printing Technology*

Our printer members often ask about weathering and accelerated weather testing for screen-printed items they have produced. This topic becomes even more relevant when members are printing warranty work, and they need to be able to explain to their customers and end-users about what it means when a supplier indicates that such and such has been exposed to a certain number of hours in a weathering test chamber.

Both ink and substrate manufacturers will normally be able to give printers good information on weatherability of their products. This may be in the form of a statement indicating that "this product has been tested in accelerated weathering test chambers and has withstood *xxxx* hours with no appreciable evidence of deterioration or color change."

So what does this mean? The process begins with customer specifications.

The customer must be clear about the expected placement and life of the printed product, whether an indoor sign that at worst may be exposed to a bit of window cleaner, or a transit decal that may be expected to last for seven years of full sun exposure in the New Mexico desert… and also needs to be resistant to gasoline, road salt, motor oil, industrial detergents, rocks and debris thrown from the road, and even graffiti.

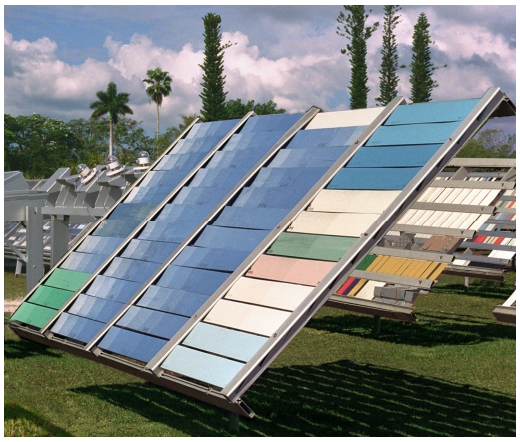

Photo courtesy of **Q-Panel Lab Products**.

Members will typically consult with substrate manufacturers to select the proper material according to the necessary properties. Then they consult with ink manufacturer to choose a suitable ink system and curing chemistry to match the substrate and customer expectations for durability and outdoor life. Printers will normally keep certain kinds of records and controls in place for jobs that have specific durability requirements. For warranted work, screen-printers may submit finished pieces to ink and/or substrate manufacturers for weather testing.

Behind the scenes, manufacturers use various types of equipment to test how well products will withstand weather. The simplest and most effective method is to perform actual live weathering in the given climate. The decal or other printed piece will be placed outside, while a portion of the piece in retained indoors or covered to prevent exposure to the elements; this piece is used for comparison later.

An example is to mount the printed material on the roof at a 45° angle facing southward … perhaps in Florida or Arizona if extreme conditions are needed. While this real-life weather testing is the most accurate method, it is also the most time-consuming, and of course our customers are not normally in a position to wait that long for results!

An effective alternative to real-time weather testing is accelerated weathering, in which printed pieces are cut to a specified size and placed into equipment that can simulate sun exposure, dew, rain, humidity, heat, and even corrosive conditions. A number of manufacturers produce weather-testing equipment; but in our industry, the standards have evolved around two basic types that standardize panel exposure to light, humidity, and temperature. Standardized equipment by its very nature cannot perfectly duplicate outdoor conditions that vary widely according to latitude, temperature, seasonal variations, print orientation, altitude, acid rain, pollution, and other variables.

With weathering equipment, different operating cycles can be selected with various temperatures, hours of condensation, hours of light or darkness, and even specific UV lamps or filters. The UV portion of the light spectrum will generally have the most destructive effects against printed materials outdoors.

The light source in the weathering unit is a significant source of difference; think of how an exposure unit puts off lots of intense UV radiation when it is new compared to when it has been used for several hundred hours and the UV output is diminished even though plenty of visible white light is still emitted.

The QUV, or Fluorescent UV chamber, does not attempt to reproduce the sun, just the damaging short-wave portion of the spectrum. Fluorescent chambers are generally recommended for testing physical property changes such as gloss loss. Photo courtesy of **Q-Panel Lab Products.**

It must be emphasized that accelerated weathering data is comparative and not absolute. Many ink and substrate manufacturers use an internal rule of thumb that, say, 500 hours on their selected weathering cycles may relate to about one year of outdoor exposure in a temperate climate. That does **not** mean that one can simply divide the reported number of hours tested by 500 and come up with the number of years of expected outdoor life! Weathering is not a linear process, and instead occurs along a curve over time.

However, the results are very accurate in predicting the effects of a change in the process. For example, accelerated weathering may indicate that Ink X on Substrate Y will last up to 1500 hours … but with a certain overprint clear, it will last up to 4500

hours. This does not mean that the end user will now get nine years durability instead of three; it simply means that the change in the process (the overprint clear) will increase normal durability by about three times.

The two current main types of accelerated weathering equipment used in our industry are fluorescent lamp units and xenon arc lamp units.

Xenon arc chambers reproduce the full spectrum of sunlight and are generally recommended for testing color change and fade. Optical filters can be used to isolate the Daylight spectrum or Sunlight-Through-Window Glass. Photo courtesy of **Q-Panel Lab Products.**

Fluorescent-source equipment called QUV® Accelerated Weathering Testers from Q-Panel are the best known, and are the most likely to be found in printing plants that require durability testing. These fluorescent units are generally less expensive to purchase and easier to maintain than most of the next category of units: xenon arc lamp units, such as the ATLAS Ci4000 Xenon Arc Weather-O-meter® from Atlas and the Q-SUN® Xenon Test Chamber from Q-Panel. Within a few months, all of these units can cause print changes that might take years to show up in true outdoor conditions.

The third major type of accelerated weathering light source is the carbon arc. Several carbon-arc units can still be found in our industry, but these have become less common for the same reasons that carbon-arc exposure units have dropped in popularity; there are concerns about proper ventilation and exposure to the fumes from the burning (arcing) carbon rods. Other issues with the carbon arcs are the lack of moisture control, and the low resemblance to natural sunlight … along with the major objection: that the carbon arc test standard is obsolete. However, they still have advantages: carbon arc units have been in use for decades so there is a strong correlation with actual outdoor weathering, and the setup of the system can accommodate large samples.

Atlas Sunshine Carbon Arc

Regardless of light source, measurement of samples before exposure and at intervals during exposure will clearly indicate the degree of change that can be expected in terms of color, gloss, chalking, cracking, blistering, delamination, yellowing, hazing, and edge curl.

Since all three types of exposure sources will give the manufacturer or printer a good indication of how well products will weather, why can't we just pick one

standard unit for all of our screen printed products? The answer, of course, is that it depends. Some types of equipment give better information in certain areas, and not so good in others. Some manufacturers choose to use two or even three types of equipment in order to get the most complete picture short of actual real-life weathering.

A look inside the Sunshine Carbon Arc

So, if we leave out the carbon arc units, the question then becomes which is better: the fluorescent or the xenon?

Marr Carbon Arc Weatherometer

According to comparison testing by *Products Finishing* magazine in the USA and the Paint Research Association in the UK, the answer is … it depends. Fluorescent units can use different types of lamps and filters, so they can be better equipped to use short-wave UV, while the xenon arc units provide a much better simulation of long-wave UV and the visible portion of the spectrum. The fluorescent units appear to be better for simulating outdoor moisture, while the xenon arc cabinets seem to offer better control of humidity. Similarly, the fluorescent systems appear to give better information on polymer degradation (plastic substrates and inks) while the xenon systems have the edge on color changes and fading. The fluorescent units take the most aggressive characteristics of sunlight and simulate exposure to those areas: short wave UV, and outdoor moisture. The xenon units try to simulate more of the sunlight spectrum.

The best way to decide which is right for your facility is to consult the standards specified in your particular facet of the industry.

The fluorescent unit is used for these standards: ASTM D3994; ASTM D4587; NACE TM-01-84; Nissan M0007; and FED-STD-141B. The xenon is used for these: ASTM D3451; ASTM D3794; ASTM D6695; and ISO 11341.

At the end of the day, usage of any test equipment can contribute to our own rapidly accelerating age curves, but by working in concert with our manufacturers and testing facilities, we can gain much more predictable and reliable testing for our warranty print work.

ASPT Member Biography

Denise Breard
Inducted into the Academy in 2003

Denise Breard is a technical writer, consultant, and technical services provider. She joined the SGIA Technical Services Team in 2003, following her work as Technical Services Manger for Sericol (Hong Kong) Ltd. Prior to her position in China, she worked as the National Key Account manager for Sericol Australia, and as the Training Manager for Sericol at their US Corporate headquarters in Kansas City, Kansas. While in Kansas City, she developed and presented technical training curricula and served as a resource for Sericol's Technical Department. She is a speaker and workshop leader for industry shows and exhibitions, and contributes to industry publications with over 20 articles in print, in addition to her many special purpose articles for specific training programs.

Denise is a former member of the SGIA Board of Directors and has participated on various SGIA committees, including the Education Committee for which she served as chair. She has served on the Board of Advisors for various printing programs and as adjunct faculty for workshops and training programs, including those offered by the SPTF. Denise has often served as a technical judge in printing competitions including SGIA's Golden Image Competition and Imprinted Sportswear Shows. She has received numerous awards and commendations, but she is happiest about the prestigious Key Award, presented in 1999 by SGIA for her educational contributions to the industry, and about the peer recognition that led to her election in 2003 to ASPT.

Prior to joining Sericol, Denise was a technical sales representative, a regional sales manager, and a product manager for Autotype Americas, Inc. Denise is a foster mom, and an amateur naturalist, chef and scuba diver with a particular interest in marine environments. She lives and works near Philadelphia, PA.

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