DETERMINING QUV LAMP TESTING TO SIMULATE NATURAL WEATHERING

ACCELERATED WEATHERING'S IMPACT ON PERFORMANCE OF SHERWIN-WILLIAMS COIL COATINGS

FOR COIL AND EXTRUSION BUILDING SYSTEMS

White Paper

SHERWIN-WILLIAMS Coil Coatings

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Accessibility Statement

Sherwin-Williams Coil Coatings (formerly Valspar) has been an industry leader, formulating coatings rugged enough to withstand the harshest of conditions, while maintaining their high-quality appearances. Exposure to sunlight, moisture and humidity, high temperatures, and temperature fluctuations can have a significant impact on the performance of a coating over time.

As part of the ongoing coating development process, scientists at Sherwin-Williams evaluate the performance of its coatings. Using a variety of tests, measures, and field performance feedback, Sherwin-Williams ensures coatings withstand the damaging forces of nature and provide the excellent long-term durability customers have come to expect.

THE SCIENCE BEHIND OUTDOOR WEATHERING

Sherwin-Williams has over 47 years of history of outdoor exposure testing on its coil coatings. After initial exposure, coatings are typically measured for chalk and fade at three- to five-year intervals. Outdoor Florida exposure angles may include 45°, 90°, 5°, and the latitude of the exposure site location – all facing south. The most common exposure angle is 45°.

CHALKING

Degradation of pigments and the resin system causes a formation of powder chalk on paint. As a resin system breaks down, resin particles take on a powdery appearance. Testing of this phenomenon is performed by ASTM D4214 test procedures and is measured by rubbing a soft fabric over the exposure. The amount of powder picked up by this fabric is calculated on a scale of 1 to 10, with 1 being poor and 10 being excellent.

FADING

Loss of paint color is caused by ultraviolet (UV) degradation of the pigment and resin system. Color is calculated in Hunter units, according to ASTM D2244, and uses Delta E values, which is noted as ΔE. One ΔE is the minimal difference visible to the naked eye.

WEATHERING TESTING

Sherwin-Williams uses several methods to measure how weathering conditions impact coatings. Weather damage can include color change, loss of strength and gloss, chalking, cracking, crazing, hazing, blistering, embrittlement, and oxidation.

Three main types of weathering tests are available:

- **Natural Outdoor Weathering Testing:** Sherwin-Williams owns a world-class ISO 17025 Accredited Florida Exposure Site with the same certifications as third-party testing sites.[1] This real-world test site has more than 100,000 panels on exposure– some dating back to the 1960s. Florida is considered an excellent location to expose coatings to key factors that contribute to coating degradation – high humidity, strong sun, and salty air. Sherwin-Williams uses third-party test labs when required.
- **Accelerated Outdoor Weather Testing:** Natural Solar Concentration Devices are the preferred accelerated method to test coatings.[2] These outdoor devices concentrate natural sunlight, using reflective coated mirrors with the intensity of five to eight times the amount of sunlight achieved in natural conditions. By exposing coating test panels to the full spectrum of sunlight, these devices provide one of the most realistic accelerated tests available. It only takes about six weeks to simulate a full year of Florida weathering. Sherwin-Williams uses this type of testing frequently for product research and formulation.
- **Accelerated Indoor Weather Testing (QUV):** Sherwin-Williams uses QUV Testing in its global Applied Science and Technology labs. Coated panels are placed inside a QUV Testing unit, where they are exposed to alternating cycles of UV light and moisture at controlled, elevated temperatures.

QUV LAMPS WEATHER TESTING

Coated panels are placed inside a testing cabinet for QUV Testing. The two primary types of QUV Testing employ the same method for simulating dew and rain, using condensing humidity and/or water spray. However, the tests vary greatly in the spectrums of UV light used, causing markedly different results — no lamp captures the full wavelength of sunlight. Only natural sunlight and accelerated natural sunlight have that capability.

All QUV lamps mainly emit ultraviolet rather than visible or infrared light. They are equivalent to an ordinary 40-watt fluorescent bulb, in terms of electricity. However, each lamp type differs in the total amount of UV energy emitted and in its wavelength spectrum. Fluorescent UV lamps are typically categorized as UVA or UVB lamps, based on the UV output wavelength.

UVA-340 TESTING

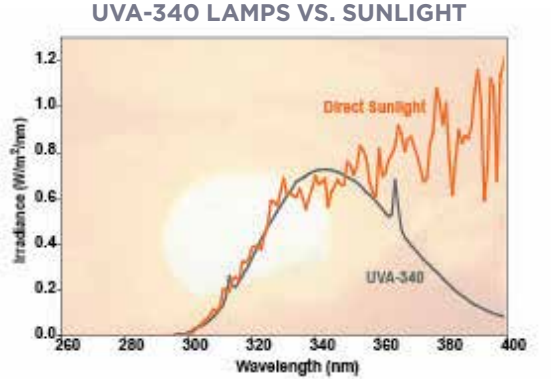
This testing replicates the effects of real sunlight with fluorescent ultraviolet UVA-340 lamps. These lamps provide an excellent simulation of sunlight in the critical short wavelength region, from 365 nm down to the solar cut-off of 295 nm. This type of UV lamp is recommended for QUV testing by the global ASTM G154 Standard. UVA-340 lamps are especially useful for comparison tests of different coating formulations.

UVB-313 TESTING

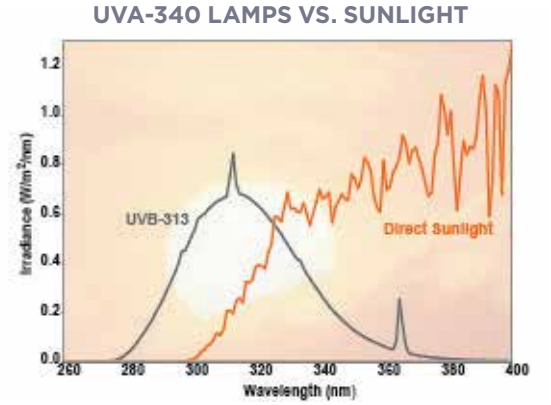
UVB-313 lamps are used to speed up acceleration testing. They produce not only the shortest ultraviolet rays that the sun emits, but they also emit unnaturally short wavelengths – below what is found on the earth's surface – which can produce anomalous results.

This type of UVB light can initiate chemical reactions to occur in the coating that would normally not be possible under natural, real-world sunlight exposures. This testing has been proven to have poor correlation to natural weathering. It can cause failures in good-quality coatings that would not occur in natural sunlight, and false positives in coatings that contain low-quality pigmentation.

QUV® Accelerated Weathering Tester photo provided by Q-Lab, www.q-lab.com



UVA-340 Testing: UVA-340 lamps are the best available simulation of sunlight in the critical short-wave UV region.



UVB-313 Testing: UVB-313 lamps produce mostly short-wave UV for maximum acceleration use UV rays not present in the earth's natural sunlight.

UVA-340 and UVB-313 charts provided by Q-Lab

QUV TESTING AND PIGMENTATION

Pigments are the key color ingredient in a coating formulation and can either enhance or degrade overall performance of the coating, depending on their quality. No type of QUV testing is considered a good performance indicator for coatings that use low-cost color pigmentation. Only natural outdoor weathering tests have been proven to detect the inferior performance that may result from the use of these pigments. Too often, detractors will use UVB measurements to make their inferior system appear to perform better. Real-world conditions are the only true indicators of a system's strengths and weaknesses.

SHERWIN-WILLIAMS PERFORMANCE IN QUV TESTING

Sherwin-Williams' weathering research is predicated on what will occur with natural weathering conditions. In UVA-340 Testing, Sherwin-Williams coatings perform well because they are formulated to perform adequately under real-world conditions. Sherwin-Williams Coil and Extrusion products would not be expected to perform particularly well under UVB-313 Testing. The UVB lamps unnaturally break down the resin composition, which can provide erroneous results compared to natural sunlight. Sherwin-Williams research is predicated on what will occur with natural-weathering, not what may occur in UV wavelengths that are not present in the earth's natural sunlight.

CORRELATION BETWEEN NATURAL AND ACCELERATED WEATHERING TESTING

When performing accelerated testing, the results must correlate to natural weathering data to be meaningful. Although there is no exact accelerated test that completely simulates natural weathering, expert data is available to help us choose the testing that is closest to actual weathering. Sherwin-Williams has thoroughly explored the correlation between natural outdoor weathering and QUV testing, and found UVA-340 testing superior to UVB-313 testing.

10-YEAR INDEPENDENT EXPOSURE STUDY

In 2005, a 10-Year Independent Exposure Study was initiated jointly by the National Coil Coaters Association and ASTM D01.53 Coil Coatings subcommittee. Independent, third-party weathering tests were performed by Commercial Weathering Sites and Laboratories using:

- 23 coatings and five chemistries
- Seven exposure protocols
- Five parameters for measurement

CONCLUSIVE STUDY RESULTS

The Spearman Ranking method — measuring the statistical dependence between two variables — was used to compare the data generated. This groundbreaking study was conclusive: no accelerated technique adequately predicts long-term, real-time exposure performance. One outstanding ranking difference can be seen in the following example.

COATING PERFORMANCE DISCREPANCY

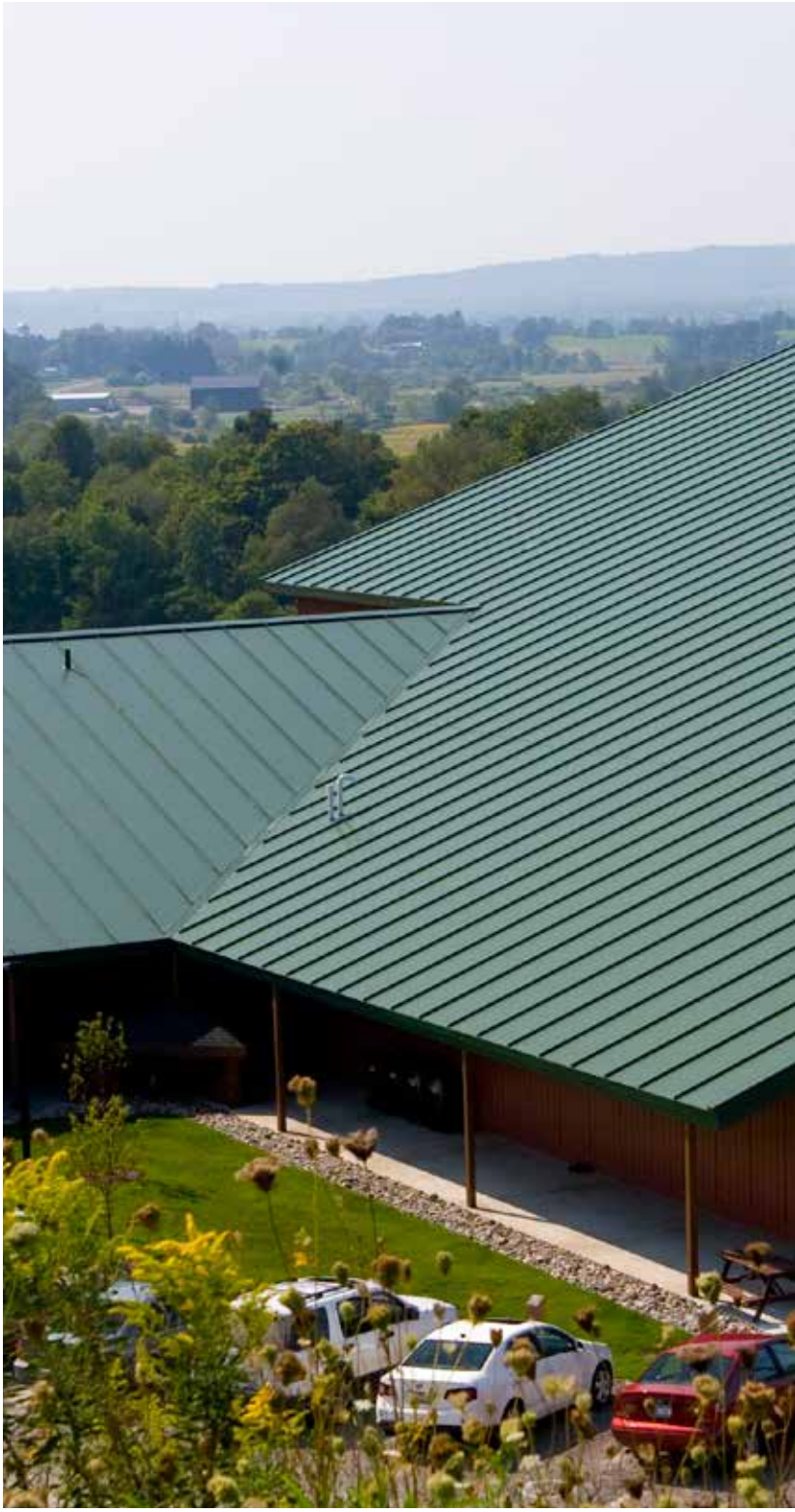
In this study, the exposure of Coating A ranked #1 in UVB-313 testing and received a #15 ranking in natural five-year, Florida Exposure testing. No correlation was found between UVB-313 and natural weathering.

CONCLUSION

Weather testing is a critical component of formulating new coatings or improving current formulations. At Sherwin-Williams Coil Coatings, the Research and Development team puts all new formulations through rigorous testing at various stages of the development process to formulate the right coating for the right application – ensuring long-term durability and performance once the coating is applied.

Sherwin-Williams Coil Coatings uses all three types of testing described in this paper. Outdoor natural weathering tests provide the most real-life opportunity to see how coatings perform over years and decades. Accelerated outdoor weathering tests (e.g. Solar Concentrator) are critical when formulating and testing new coatings. Indoor cabinet testing is used not only for UV light exposure, but for testing coating performance with exposure to moisture, humidity, heat, and changing temperatures – all natural elements than can degrade a coating over time. For accelerated indoor UV light testing, Sherwin-Williams' scientists have found (and industry sources have corroborated) that the most valuable type of UV light testing for Coil and Extrusion coatings is the use of UVA-340 ultraviolet testing.

Although no accelerated test completely simulates natural weathering, there is substantial expert data to help coating manufacturers choose the right combination of comprehensive testing that is closest to actual weathering, depending on the stage of the coating development process.



INDUSTRY EXPERTS ON VALUE OF QUV TESTING

UVA MOST REALISTIC

"The QUV with the UVA-340 lamp produces the most realistic simulation of sunlight in the short wavelength portion of the spectrum. The result is a tester that provides excellent correlation with outdoor tests."

– Q-LAB Corporation, QUV Tester, www.q-lab.com

UVB TOO DESTRUCTIVE

"UVB testing is too destructive to resin systems and masks any effects from the pigments."

– BASF, Pigment Research, Germany

NO ACCELERATED TECHNIQUE ADEQUATELY PREDICTS

"The 2005 Final Report on the Subject of Accelerated Weathering 10-Year update to ASTM D01.53 was supported by and presented to the NCCA. The main conclusion was that no accelerated technique adequately predicts long-term, real-time exposure. With respect to UVA and UVB, these two methods exhibit the worst correlation, with UVB-313 being the worst. UVA-340 is closer to sunlight than UVB, but both exhibit poor correlation to five years in Florida."

– Al Dunlop, Technical Director, NCCA

UVA MORE APPROPRIATE

"Historically, our pigments have found the most use in PVDF/acrylic systems, and this is how we do our weathering. We are starting to test more in polyester/melamine coatings and extruded acrylics as well as PVC. UVA is more appropriate for testing these systems"

– Mark Ryan, The Shepherd Color Company

UVB PROVIDES POOR CORRELATION

"UVB is no longer widely used in Europe because it often gives poor correlation with outdoor test results. UVA is far from perfect, but in that sense significantly better than UVB. The difference is due to the fact that the spectra of the UVA bulbs is closer to the spectra of the sunlight compared to UVB. UVB lamps emit mostly shorter wavelengths than the sun, causing faster paint degradation, but the type and speed of the degradation can be unrealistic as it is caused by a type of UV-radiation that is not present in natural sunlight."

– Annina Alanen, Technical Manager, European Coil Coating Association

QUV-A USE RECOMMENDED OVER QUV-B

"While it takes longer to effect changes in highly UV durable products with QUV-A, I feel its use is warranted over QUV-B, because the UV portion of energy distribution on QUV-A bulbs is much closer to the UV spectra present in natural sunlight. The QUV-B bulbs have a portion of the energy spectrum that does not exist (other than in outer space). Functionally, that means the QUV-B bulb artificially introduces levels of energy that may activate portions of the polymer chains. This "false" activation would create free radicals in the polymer that would not exist in natural exposure, creating false negative results on systems that would be good performers in the real world. This becomes increasingly important when comparing products that have significantly different compositions (resins, pigments, additives).

– Eric Fossen, VP Sales and Technology, Continuous Colour Coat Ltd/Metal Koting

QUV-A CAN BE USEFUL

"Fluorescent UV testers can be a useful type of artificial testing because the spectral intensities of the UVA-340 bulbs are very similar to natural sunlight in the shorter wavelength region."

– Atlas Material Testing Solutions, Weathering Test Guidebook (atlas-mts.com)

SOURCE

ALL REFERENCES IN THIS PAPER TO SPECIFIC ORGANIZATIONS AND COMPANIES ARE INCLUDED WITH EXPRESS WRITTEN PERMISSION.

- ASTM D01.53 Coil Coatings Subcommittee
- Atlas Material Testing Solutions
- BASF
- Continuous Colour Coat Ltd/Metal Koting
- European Coil Coating Association
- National Coil Coating Association (NCCA)
- Q-Lab Corporation
- Shepherd Color Company
- Sherwin-Williams Coil Coatings Global Technical Team, coil.sherwin.com

SOURCES

[1] Sherwin-Williams Coil Coatings Fort Myers, Florida Test Fence is the most accredited manufacturer's test facility in the coil coatings industry.

Site accreditations include:

- ISO 17025 Accredited by A2LA (American Association for Laboratory Accreditation) – Accredited for testing and accredited exposure site
- EPA 1st Party Laboratory - Roof Coatings, listed on Energy Stars Website
- Accredited Manufacturing Test Lab - CRRC (Cool Roof Rating Council)
- AAMA Verified Component Laboratory - American Architectural Manufacturers Association

Additional Sherwin-Williams Coil Coatings exposure testing facilities include Rochester, PA; Garland, TX; Bowling Green, KY; Marengo, IL; Queensland, Australia; Guangdong, China; and Shanghai, China. These facilities work together to test coatings in every condition possible by Sherwin-Williams' technical staff that has been evaluated, tested, and retested by Accreditation Bodies. During the process, factors relevant to a laboratory's ability to produce precise, accurate tests and calibration is assessed – including the testing environment and handling of test items to meet industry standards.

[2] Q-Lab® Corporation

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