

Sean Fowler discusses Q-Lab's involvement in a new and potentially revolutionary weathering standard, which has been published by ASTM International

# ASTM Standard is a revolution in weathering testing

A new and potentially revolutionary weathering standard has been published by ASTM International. Titled 'Xenon Arc Exposure Test with Enhanced Light and Water Exposure for Transportation Coatings', ASTM D7869 is the result of a decade of research by a consortium of leaders in the automotive, aerospace, coatings and weathering testing industries. The new standard was written by subcommittee D01.27 on accelerated testing of paints and coatings. Douglas Grossman, Subcommittee Chairperson and President of Q-Lab Corporation, calls ASTM D7869, "The most thoroughly researched weathering test procedure ever developed." What makes this new standard so special?

## HISTORICAL BACKGROUND

To answer this question, it is important to look at today's most commonly used weathering test method in the automotive coatings industry, SAE J2527. First published in 2004 to supplant SAE J1960, J2527 has been widely adopted and adapted by global OEMs and also is referenced by numerous non-transportation industries. While both methods shared the same test conditions, the old J1960 could be performed in only a small number of commercially avail-

able xenon test chamber models. Recognising that this hardware-based approach to test standards made progress difficult, SAE took the important step in re-writing the standard. The updated version included a technically robust description of test conditions instead of listing particular models and the required programming steps for each.

The old SAE method was widely adopted despite not having demonstrated good correlation to outdoor tests in south Florida for some critical coating performance properties. For example, accelerated tests performed under the SAE method failed to produce delamination of coatings that experienced catastrophic and extremely costly failures on consumers' vehicles. J2527 does, however, generally correlate well to Florida test results for colour and gloss. Thus, in the early 2000s, it appeared that xenon arc weathering was reasonably useful to coatings formulation chemists but it needed a technological boost to accommodate the increasing demands of the 21<sup>st</sup> Century.

## RESEARCH PART 1: IMPROVING THE LIGHT SPECTRUM

This boost came from a series of projects throughout the 2000s, some of which had roots in the late 1990s. The earliest of these projects took a careful look at the light spectrum of the old SAE tests, which included ultraviolet light wavelengths not present in natural sunlight. As performance-based standards began to replace older hardware-based ones, xenon optical filter system definitions emerged. The legacy optical filters of the old SAE tests, often called 'Quartz/Boro' filters, fell into a category called 'Extended UV' filters. Those having a better match to natural sunlight, such as the Daylight-Q optical filter from Q-Lab, were classified as 'Daylight' filters. The SAE tests were revised to accept these more realistic optical filter types, while continuing to reference the Extended UV type.

While these definitions provided a significant improvement over the older standards, coatings experts were often frustrated by a lack of reproducibility of results when using various 'Daylight' filters. Subtle differences in the short-wave portion of the spectrum, especially the cut-on wavelength, sometimes created different results when using a Daylight-Q versus a Daylight B/B system, for example.

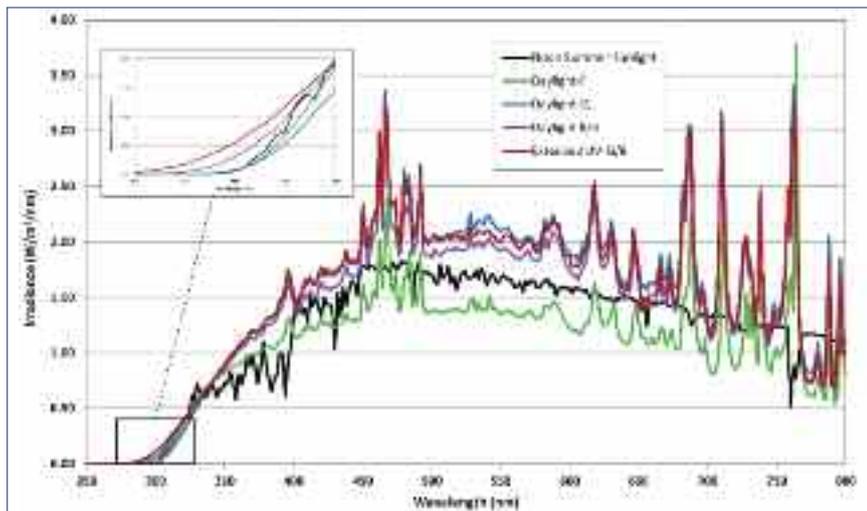
ASTM D7869 addresses this problem with a much tighter

The Q-SUN Xe-2 and Xe-3 xenon arc testers are fully compliant with the new ASTM D7869 standard



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Spectra of noon summer sunlight and various xenon arc Daylight filters, including the new 'Daylight-F'. Inset highlights the irradiance cut-on of each Daylight filter, showing significant differences between them

definition of the optical filter system. Based on work done by Ford and 3M Corporation, this new optical filter matches the spectrum of south Florida more closely than other Daylight filters. They are currently sold under trade names 'Daylight-F' and 'Right Light', although any manufacturer of xenon arc weathering chambers is free to adopt the new spectrum.

### RESEARCH PART 2: IMPORTANCE OF MOISTURE

Although critical, the challenge of creating a better spectral match to Florida sunlight was simple compared to the daunting task of re-creating Florida moisture in an accelerated weathering chamber. Two of the companies that developed the new method were BASF and Q-Lab. They had previously worked together to develop a xenon arc method to reproduce acid etch of automotive clear coats, published as ASTM D7356. During this work, much was learned about measuring and characterising moisture from dew formation and rainfall in the harsh Florida climate.

Later, BASF partnered with Bayer to further investigate the critical role of water in accelerated testing of automotive coatings. As the research gained momentum, Boeing and Atlas became active participants in the efforts led by Ford. Honda of America, which had separately been doing similar work, began sharing data and joined in the discussions.

Moisture uptake of coated panels in Florida and their subsequent drying outdoors proved to be driving factors of degradation mechanisms previously unseen in the SAE accelerated method. The research showed that the SAE J2527 cycle, despite extensive use of water spray and high humidity, failed to result in water uptake sufficient to mimic the Florida exposures.

### RESEARCH PART 3: DEVELOPING THE NEW CYCLE

Although the emphasis in xenon arc testing is usually on the light exposure, the new cycle starts with a four-hour dark period with water spray and high humidity. The duration and temperature were chosen because they achieved the maximum amount of water uptake that was seen in the Florida exposures. This happens at night with clear skies, when maximum dew formation occurs. A critical departure from the SAE J2527 cycle is the absence of any water spray during light exposure. Water spray occurs only during dark portions of the cycle, again because wetness in Florida is

caused mainly by dew formation at night.

On days when maximum dew formation occurs, the early morning hours cause the coatings to dry out as the sun rises. The new cycle mimics this by transitioning from the dark period to bright light with an intermediate step at relatively low irradiance and black panel temperature. The black panel temperature is 50°C in this step because coatings in Florida are nearly dry before they experience any temperatures higher than this.

The cycle continues with a high temperature and irradiance step to mimic the bright sunshine and heat of Florida, followed by another low irradiance step to serve as a transition period similar to the end of the day, prior to night fall and dew formation. Another dark period of water spray precedes a subcycle of short steps designed to cause rapid thermal cycling. These steps were important in recreating the cracking and delamination that some coatings experienced in the Florida exposures completed in this study. The subcycle ends with a period of darkness with no water spray and comparatively low temperature and relative humidity. Excluding this 'relaxation' period may cause excessive, unnatural cracking or other unrealistic degradation.

### NEW PERFORMANCE CRITERIA FOR XENON ARC TEST CHAMBERS

The research revealed some new performance criteria for xenon arc test chambers that were previously ignored or under-emphasised in test standards. First, the water delivery system must be calibrated to ensure the chamber is capable of delivering enough water to the test specimens. Without enough water, the benefits of the new cycle will go unrealised and correlation to outdoor results will suffer. One of the researchers developed a simple yet reproducible method for measuring the water delivery, using a standardised sponge and weight scale. This method is described in the standard.

Also new is the requirement to reposition specimens in the chamber, regardless of the type of weathering tester. The research demonstrated that uniformity of results is the result of a complex interaction of several factors not just light. In practical terms, this means that repositioning specimens is critical in both rotating rack and flat array testers.

### STATE-OF-THE-ART IN WEATHERING TESTING

ASTM D7869 is the fruit of years of research, discussions and experimentation. It represents a leap in weathering testing technology because, for the first time, a laboratory test was able to replicate multiple degradation mechanisms in a variety of coatings materials and systems. The new standard holds the promise of accelerating product development by providing fast and reliable results. When companies have confidence that their laboratory results match what will occur in their products' actual service life, they can speed up development of more durable, cost-effective and environmentally friendly products. Weathering testing is now ready for the 21<sup>st</sup> Century.

ASTM D7869 is available for purchase at [www.astm.org](http://www.astm.org). For a limited time, Q-Lab Corporation has purchased electronic copies of the new standard and is distributing them on a complimentary basis to customers.

Visit [www.q-lab.com/newASTM](http://www.q-lab.com/newASTM) for details.

Sean Fowler joined Q-Lab in 1999 and has served in roles in service, sales and currently is a Technical Marketing Specialist, spending much of his time working in standards organisations.