

Modern Automotive Weathering Testing: ASTM D7869

Standard Practice for Xenon Arc Exposure Test with Enhanced Light and Water Exposure for Transportation Coatings

Q-Lab Corporation

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Q-Lab's Weathering Webinar Series

- Today is the 2nd of our five-part webinar series on special weathering testing topics
- Our upcoming and archived webinars are hosted at: q-lab.com/webinars

Date	Topic
14 Apr	Automotive Interior and Exterior Weathering Testing
21 Apr	Modern Automotive Weathering Test: ASTM D7869
28 Apr	Light Stability Testing of Home and Personal Care Products
05 May	Water Delivery in Accelerated Weathering Testing
12 May	Correlation in Accelerated Weathering and Corrosion Testing

Administrative

- You'll receive a follow-up email from info@email.q-lab.com with links to a survey, registration for future webinars, and to download the slides
- Use the Q&A feature in Zoom to ask us questions today! We'll stay on after the presentation is completed to answer all questions



Thank you for attending our webinar!

We hope you found our webinar on ASTM D7869 to be helpful and insightful. The link below will give you access to the slides and recorded webinar.

You can help us continue to provide valuable and high quality content by completing our [3-question survey](#) about your webinar experience. Every piece of feedback is carefully reviewed by a member of our team.

We consistently hold seminars and webinars about weathering, corrosion, standards and more. The best way to keep up with news and events is by following us on [Facebook](#), [Twitter](#) and [LinkedIn](#).

What is Weathering?



Changes in material properties resulting from exposure to the radiant energy present in **sunlight** in combination with **heat** (including temperature cycling) and **water** in its various states, predominately as humidity, dew, and rain.

Why Do Weathering Testing?



High gloss and color integrity

OR



Fading, cracking, peeling

Weathering testing can mean the difference between happy customers and ... the customer on the right

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Qualification / Correlative Testing

Accelerated Test Type	Result	Test Time	Results compared to
Quality Control	Pass / fail	<ul style="list-style-type: none"> • Defined • Short 	Material specification
Qualification / validation	Pass / fail	<ul style="list-style-type: none"> • Defined • Medium-long 	Reference material or specification
Correlative	Rank-ordered data	<ul style="list-style-type: none"> • Open-ended • Medium 	Natural exposure (Benchmark site)
Predictive	Service life Acceleration factor	<ul style="list-style-type: none"> • Open-ended • Long 	Natural exposure (Service environment)

Historical Xenon Test Standards

- Carbon Arc and Xenon arc weathering testing have been performed for over 100 years
- Xenon testers reproduce full-spectrum sunlight
- Hardware-based “102/18” light / light+spray standards were the first widely-used weathering standard tests
 - Almost 100 years old but still in use
 - Most common examples are ISO 4892-2 and ASTM G155
 - *Not realistic!*

Accelerated Weathering Tests

Commonly Used on Automotive Parts

International standards

- ASTM G154/G155
- ISO 4892-2, -3
- SAE J2412
- SAE J2527
- ASTM D7869

Automaker standards

- Renault D27-1911
- VW PV 1303, PV 3929
- Daimler DBL 5555
- Fiat 50451
- Ford BO 116
- Toyota TSL 3600G

Most are for QC/Qualification purposes

The Industry Standard: SAE J2527

- SAE J2527 introduced in 1980's
 - Authors researched light, water, heat
 - Test replicated gloss loss seen in Florida
- Standard was well-researched but did not match real-world weathering factors
 - Light spectrum
 - Water delivery
- As a result, test does not always predict Florida outdoor field failures
 - Chemical changes
 - Physical changes

Why Develop a New Standard?

- SAE J2527 was developed to reproduce common failures of coatings in that era, primarily color fade and gloss loss.
- Over years, coatings became very resistant to color fade and gloss loss, and SAE J2527 doesn't reproduce more common failures in modern coatings, primarily cracking and delamination.

ASTM D7869: Modern Weathering Testing



Designation: D7869 – 13

**Standard Practice for
Xenon Arc Exposure Test with Enhanced Light and Water
Exposure for Transportation Coatings¹**

Development Process

- Outdoor weather data collected to understand real-world weather conditions: light, heat, and water
- Outdoor weathering test dataset collected to provide basis for correlation
- Accelerated test cycle developed to match those real-world conditions and degradation mechanisms
- Variety of materials and failure modes evaluated with accelerated testing to verify validity of test

Test Development

- Many years of experimentation
 - 1st group: BASF, Bayer, Ford, Q-Lab
 - 2nd group: Honda, Boeing, Atlas
- Dozens of different approaches
- Multiple runs of final test to ensure repeatability & reproducibility

Collecting outdoor weather data

Laying the groundwork for a new accelerated test

Outdoor weather data

Approach: collect outdoor weather data to better understanding the forces of natural weathering:

- Sunlight
- Heat
- Water



Goal: Obtain suitable body of field data to develop the Accelerated laboratory test

Outdoor Weather Data Collected

- Solar Radiation (Sunlight)
- Temperature
 - Air, Black Panel, Relative Humidity and Dew Point
- Wind
 - Speed and Direction
- Rain
 - Amount, Duration, Rate Accumulation
- Panel Weight
 - Wetness, Dew Events and Rain Events

Outdoor Weather Data Collection Sites

- Weather Station installed Jacksonville, FL (Bayer)
 - 2004 to 2007
- Moved to Homestead, FL (Q-Lab)
 - 2008 to 2014



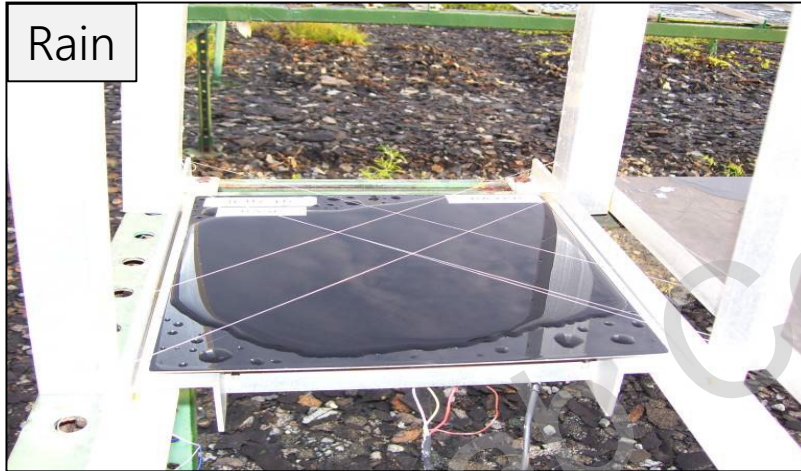
Outdoor Weather Water Data Measurements

- Mass of panel measured every 5 min
 - Panel + Water
- Calibrated regularly
- Care taken to ensure no animal or bird influence
- Able to see rain vs dew + water uptake



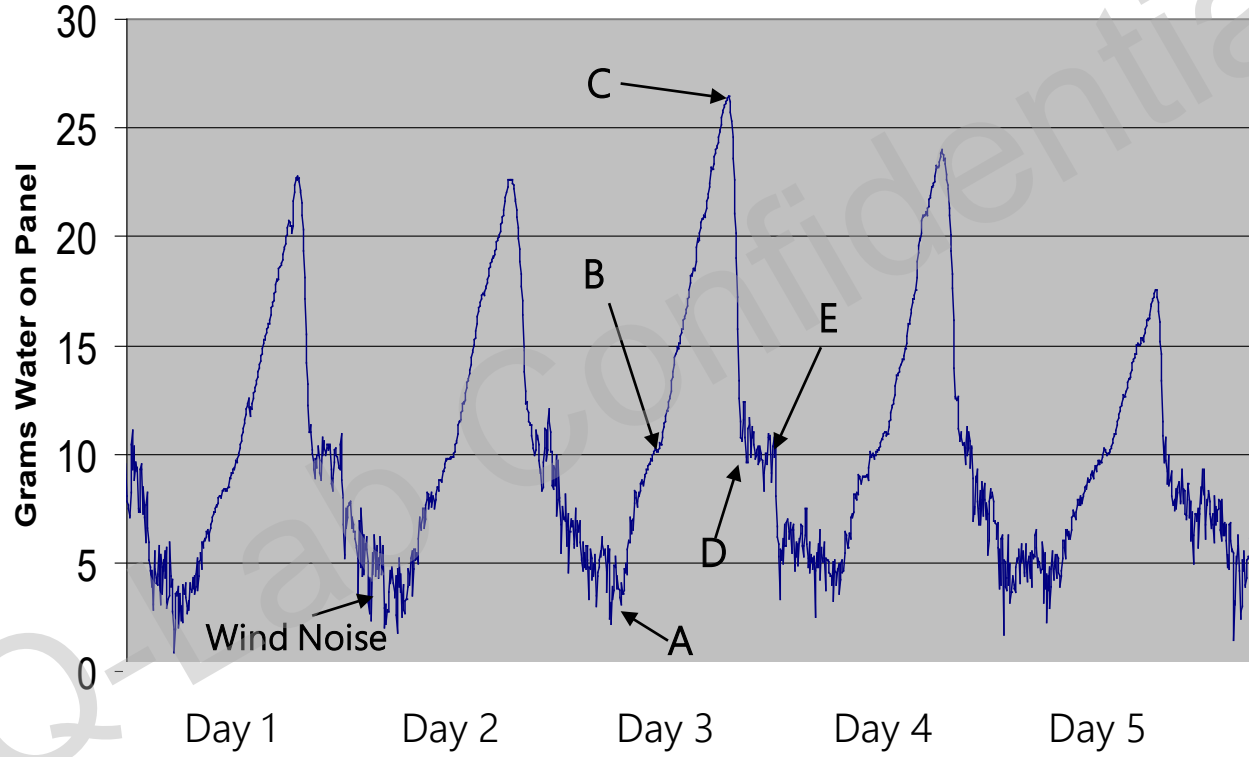
Example from Outdoor Data

Water on Test Panels



Materials outdoors are wet for longer than you think!

Dew on Painted Panels



Key Learnings from Outdoor Benchmark Testing

Key Factors in a Correlative Weathering Test

- Global benchmark location: South Florida
- **Light intensity:** use higher-intensity light with correct spectrum to increase acceleration
- **Heat:** Keep temperatures realistic, at or below service
- **Time of wetness:** Increase! Mimic real-world behavior - panels wet 12+ hrs/day in Florida
- **Water spray:** Never spray panels during light step; it never rains when sun is shining brightly!



Sunlight

- Explored different light sources
- Explored different optical filters
- Accelerated outdoor weathering (Q-TRAC) provided tantalizing results
- Better match to sunlight just might work, but be careful ...

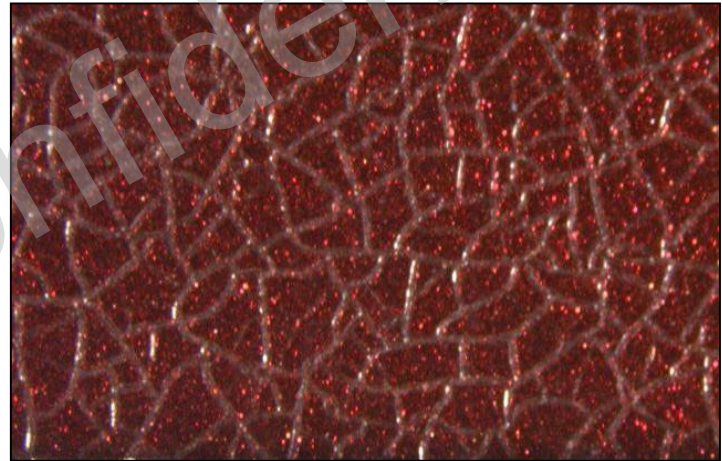


The wrong light source gives the wrong results!

Florida



Borosilicate filtered xenon arc



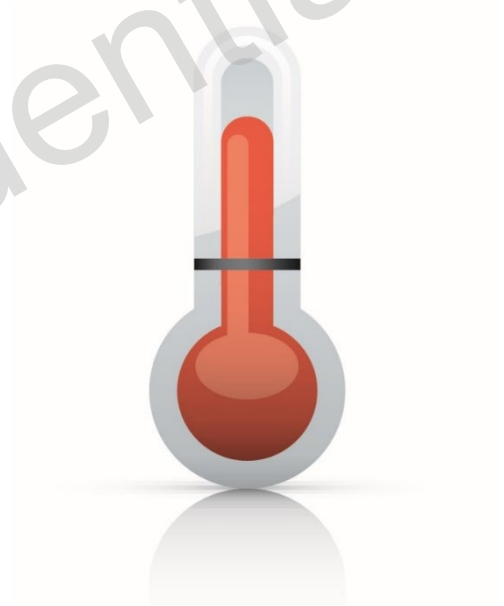
Peters/Misovski/Roberts/Lemaire/Fischer

Accelerated Light Source

- Light source must have very good match to the solar spectrum
- ASTM D7869 calls for a new optical filter
 - Daylight – F (Q-Lab)
 - Right Light (Atlas)
- Produces more realistic results
 - Higher irradiance
 - Better, more realistic acceleration

Heat

- High temperature serves primarily to accelerate water uptake.
- Two key guiding principles:
 - Do not exceed maximum service temperature
 - Use realistic temperatures to increase correlation



Water contributes to material degradation in many ways

- Plasticization
- Swelling
- Blistering
- Adhesion
- Mass transport
- Mass loss

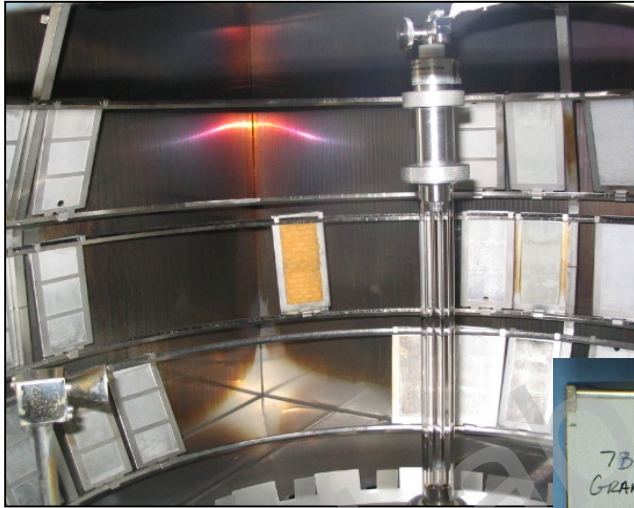


Water Delivery Calibration: Sponge Test

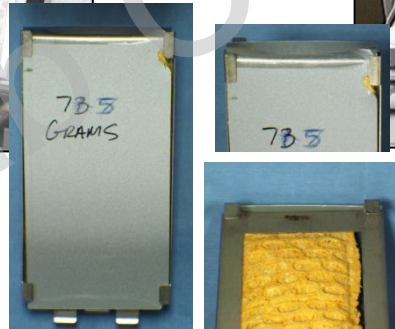
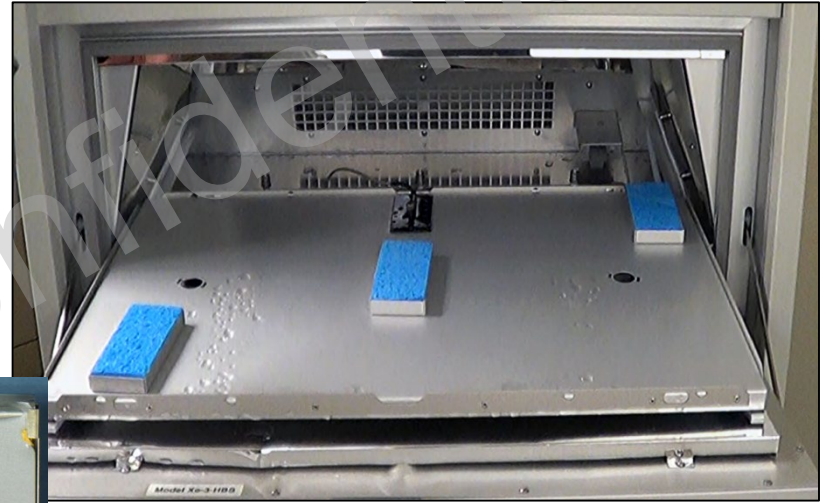
- Determine actual water delivery to specimens in both flat array & rotating drum testers
- Same sponge in both machines
- Results are **Repeatable & Reproducible**

Sponge Water Calibration Tests

Rotating Rack

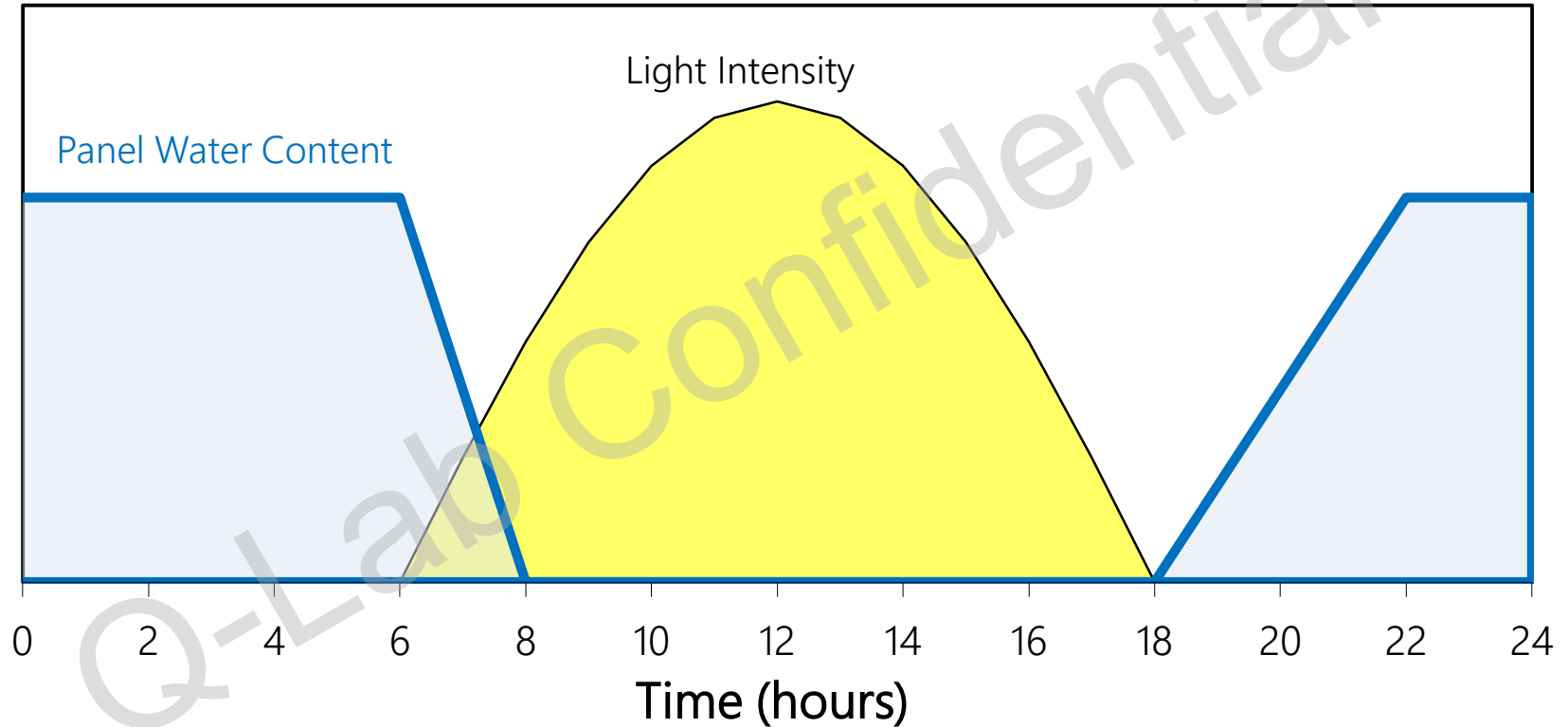


Flat Array



Shielded sponge holder

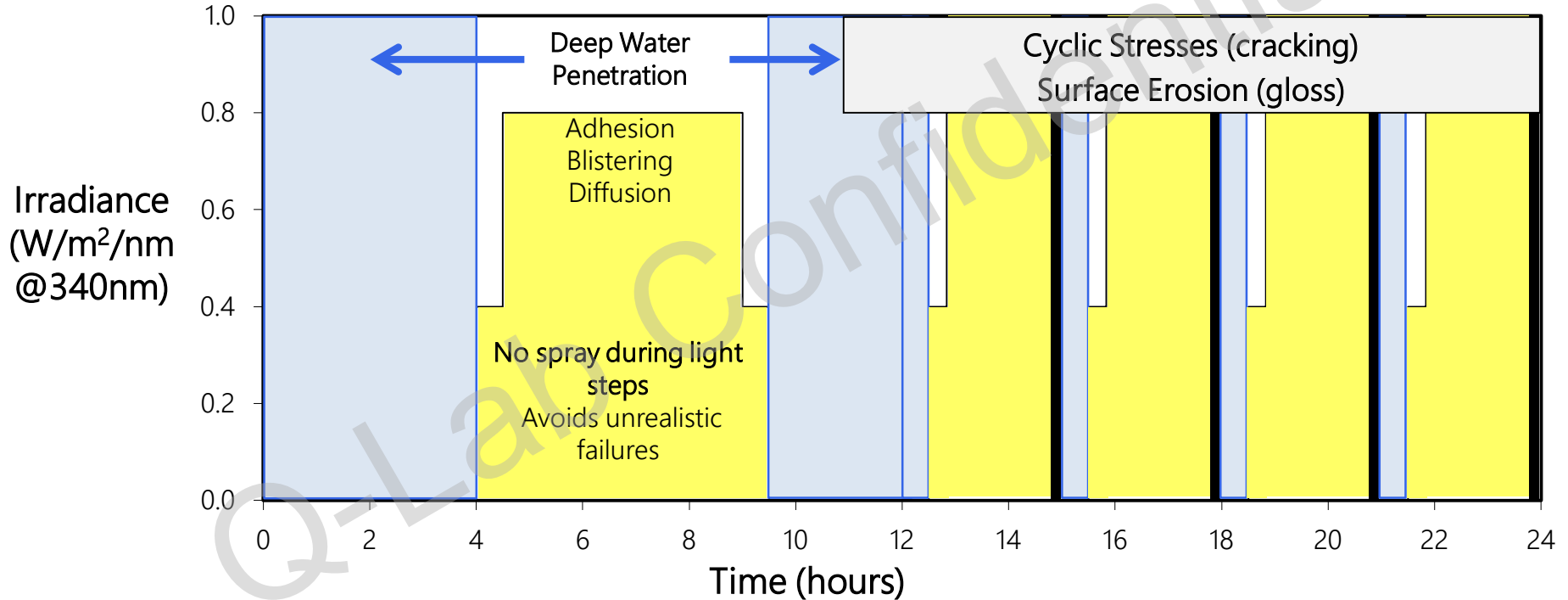
Florida outdoor daily cycle



ASTM D7869

Reproduces Natural Weather Cycles

Irradiance
Water Spray



Validating the test method

Putting the ASTM D7869 protocol to the test

Q-Lab Confidential

Paint Systems Tested

Automotive

- ~20 systems, multiple colors
- All systems were base coat / clear coat
- Fortified and unfortified
- Positive controls & known Florida exposure failure mechanisms

Aerospace

- Four systems, two colors (blue and white)
- Two monocoat systems, two base coat / clear coat systems
- Florida, and in-service performance known

Outdoor Testing: Sample selection

- Sample set includes both common field failures & controls
- 106 Combinations Prepared
 - 4 colors: Black, White, Blue, Red
 - Waterborne & Solventborne Base
 - Solventborne Clear
 - Different layering systems
 - With and without Stabilizers
- All Samples prepared by one lab



Outdoor Testing: Test Protocol

- Testing conducted per SAE J1976
- Evaluations every 6 months
- Exposure times
 - Full Set Summer 2006
 - Partial Set Summer 2007
 - Expose Until Failure



Reproducing Failure Mechanisms

- Chemical changes
- Cracking
- Blistering
- Adhesion loss
- Color
- Gloss loss

Important to “test the test” and validate that the scientific approach to standard development leads to good correlation with natural exposures

Control System

Florida Exposure



SAE
J2527

ASTM
D7869



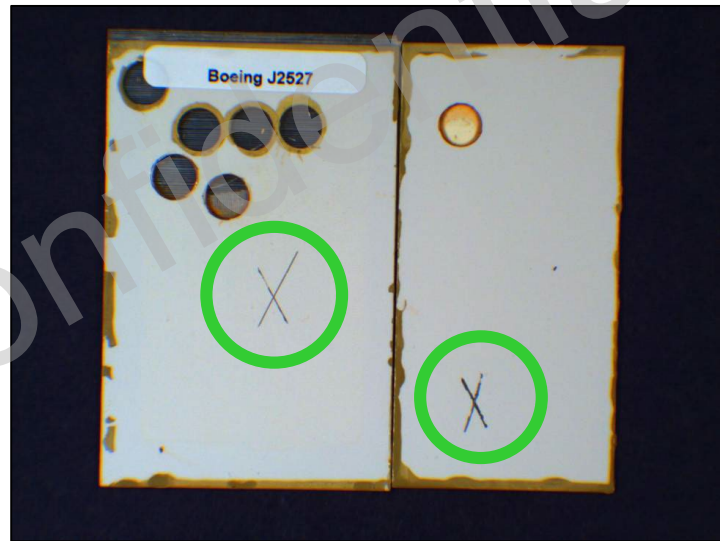
Expected Failure Mode: None – positive control
Observed: Excellent performance in all tests

Coating Pick-Off

Florida Exposure

SAE
J2527

ASTM
D7869



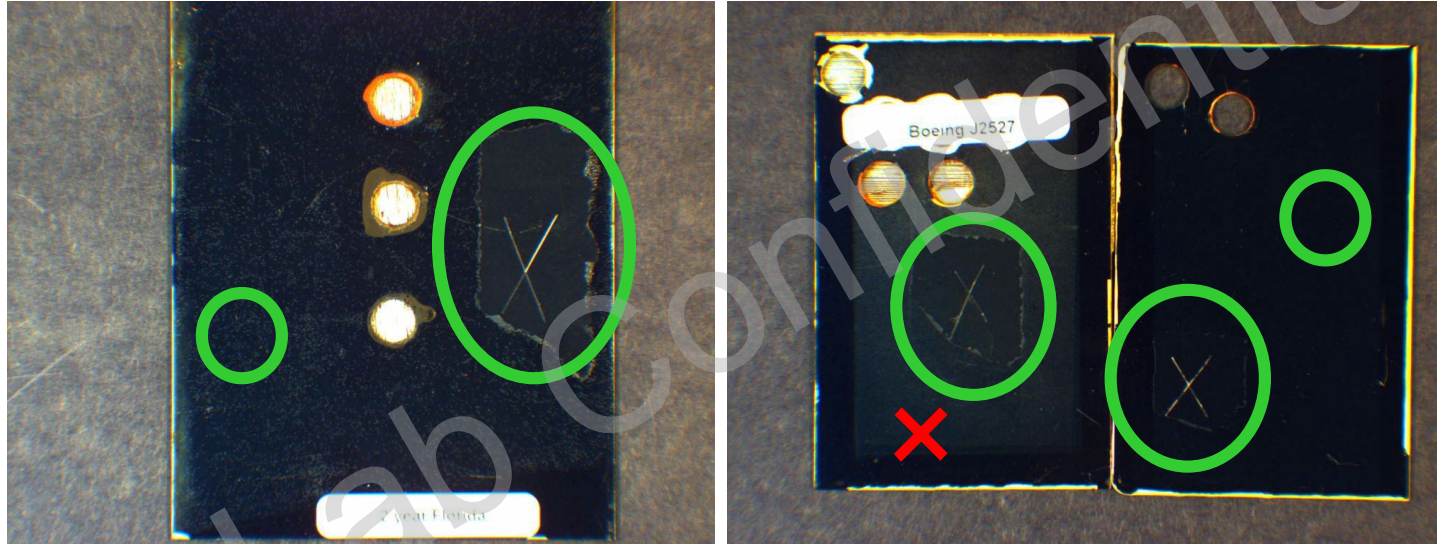
Expected Failure Mode: Slight BC/E-coat pick off
Observed: Slight BC/E-coat pick-off ASTM D7869, not SAE J2527

Gloss and Adhesion Loss

Florida Exposure

SAE
J2527

ASTM
D7869



Expected Failure Mode: Blistering, gloss loss, adhesion loss

Observed: Gloss and adhesion loss on both. Blistering ASTM D7869

Delamination

Florida Exposure



SAE J2527



ASTM D7869

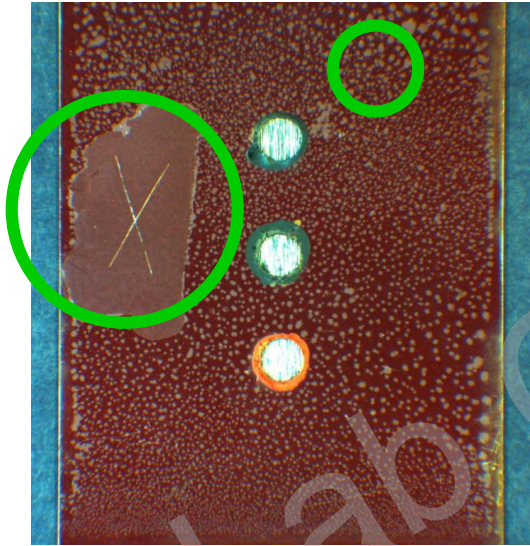


Expected Failure Mode: Blistering, gloss loss, adhesion loss

Observed: Gloss and adhesion loss on both. Blistering ASTM D7869

Blistering

Florida Exposure



SAE J2527



ASTM D7869



Expected Failure Mode: Blistering, gloss loss, adhesion loss

Observed: Gloss loss and adhesion loss seen on all panels. Blistering on ASTM D7869 mimics that seen in Florida

Evaluate Validation Testing

Example from ASTM D7869

- Chemical change correctly reproduced
- Cracking correctly reproduced
- Blistering correctly reproduced
- Adhesion loss correctly reproduced
- Color correctly reproduced
- Gloss loss correctly reproduced

Conclusions: ASTM D7869

- ASTM D7869 accelerated lab weathering test cycle is **thoroughly researched** - uses scientific understanding of outdoor weather – light, heat, and water
- Test cycle **validated** by comparing to long-term outdoor weathering data of a variety of coatings systems
- ASTM D7869 is **realistic** - it reproduces faithfully almost all physical failure mechanisms and is **40% faster** than current test method.
- Introduction of this new weathering protocol allows for more rapid and accurate accelerated weathering results. These can be **correlated** with outdoor test data to give powerful information.

Thank you for your attention!

Questions?

Send your inquiry to:
info@q-lab.com