Water Delivery in Accelerated Weathering Testing

Q-Lab Corporation

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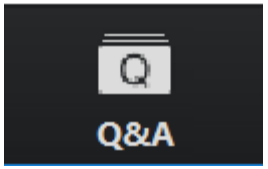
Click here to view the morning presentation.

Click here to view the afternoon presentation.

Before we begin…

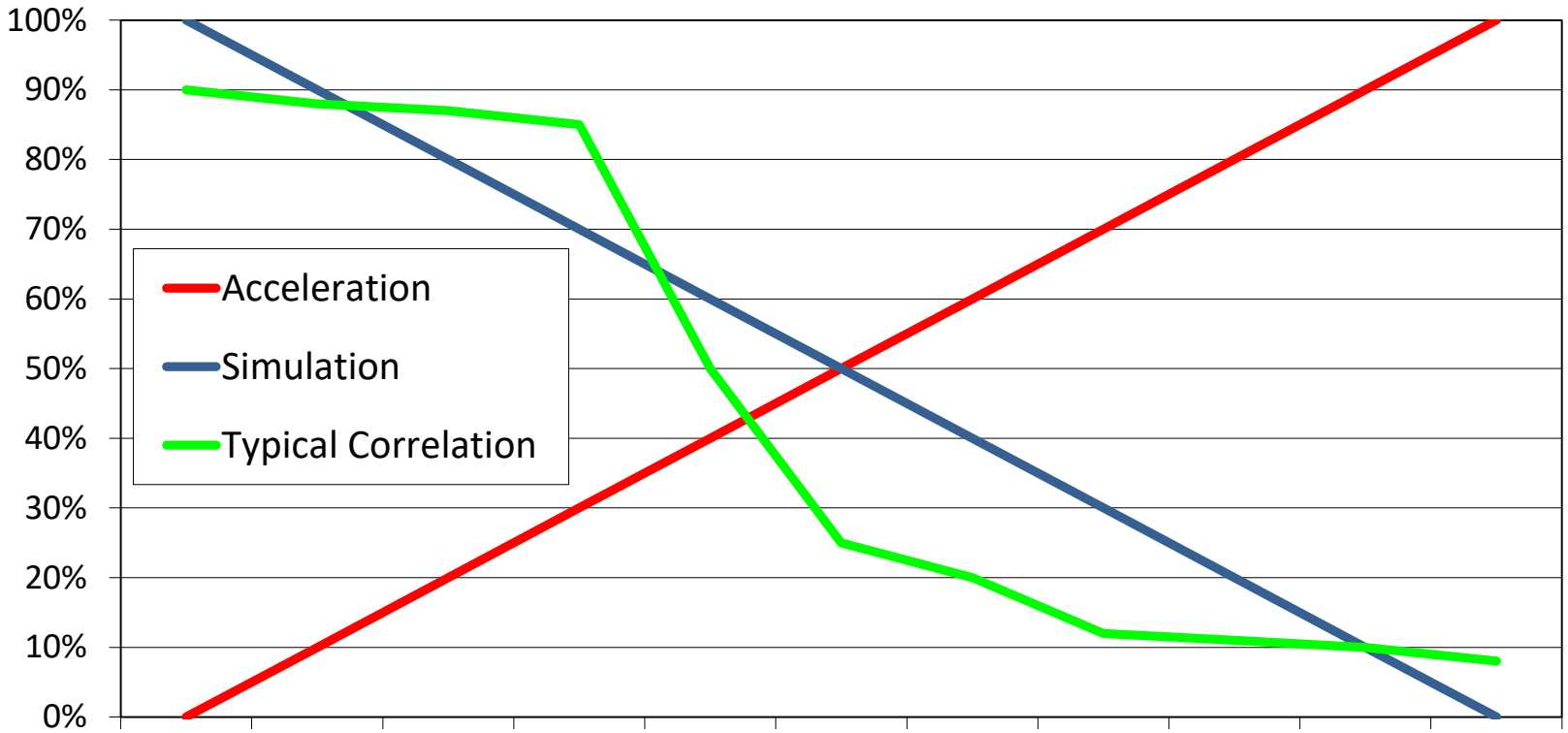
- In the coming days, a follow-up email will be sent which includes a link to a survey and as well as where you can download the webinar slides.
- Our ongoing webinar series can be found at q-lab.com/webinars
- Use the Q&A feature at the bottom of the screen to ask question



- If you have any follow up questions after the presentation, send them to *info@q-lab.com*

Accelerated Testing

Simulation, Acceleration, and Correlation



Forces of Weathering

Sunlight

Heat

Water

How are these accelerated in laboratory testing?

Sunlight in Laboratory Weathering Testing

Defined light source

Plastics — Methods of exposure to laboratory light sources —

Part 2:

Xenon-arc lamps

Irradiance values, control points, and tolerances

Irradiance[b]	
Broadband (300 nm to 400 nm) W/m²	**Narrowband (340 nm)** W/(m²·nm)
60 ± 2 60 ± 2	0,51 ± 0,02 0,51 ± 0,02

Spectral requirements

Spectral passband (λ = wavelength in nm)	Minimum[c] %	CIE No. 85:1989, Table 4[de] %	Maximum[c] %
λ < 290			0,15
290 ≤ λ ≤ 320	2,6	5,4	7,9
320 < λ ≤ 360	28,2	38,2	39,8
360 < λ ≤ 400	54,2	56,4	67,5

Heat in Laboratory Weathering Testing

Black panel temp with tolerances

Black-standard temperature °C
65 ± 3 —

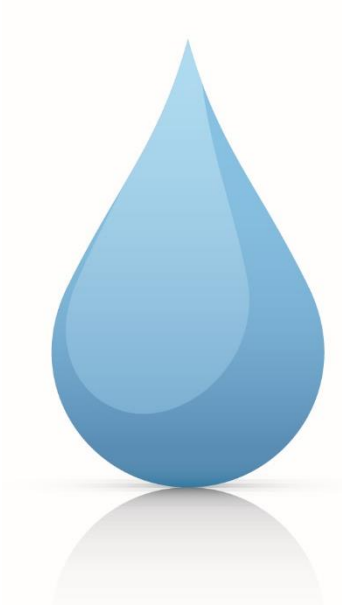
Ambient temp with tolerances

Chamber temperature °C
38 ± 3 —

Thermal Cycling

Step Number	Step Minutes	Black Panel Temperature Set Point[A]	Chamber Air Temperature Set Point[A]
1	240	—	40°C
2	30	50°C	42°C
3	270	70°C	50°C
4	30	50°C	42°C
5	150	—	40°C
6	30	—	40°C
7	20	50°C	42°C
8	120	70°C	50°C
9	10	—	40°C

Water in Laboratory Weathering Testing



What part of “18 minute water spray”
didn’t you understand?

No really, just spray water
“Sir, yes sir!”

Exposure period

18 min water spray

Why is this important?

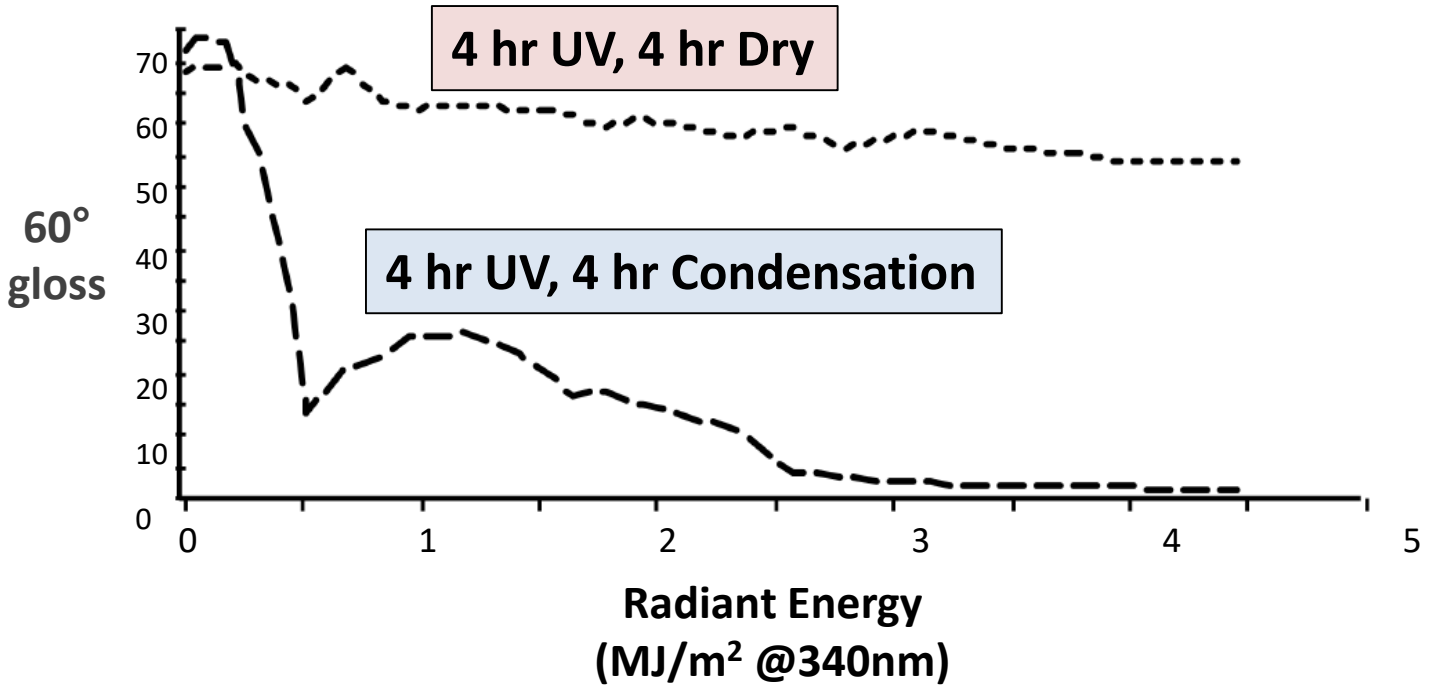
Water Delivery in Accelerated Lab Testing

Water contributes to material degradation in many ways

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

UV Fluorescent Weathering

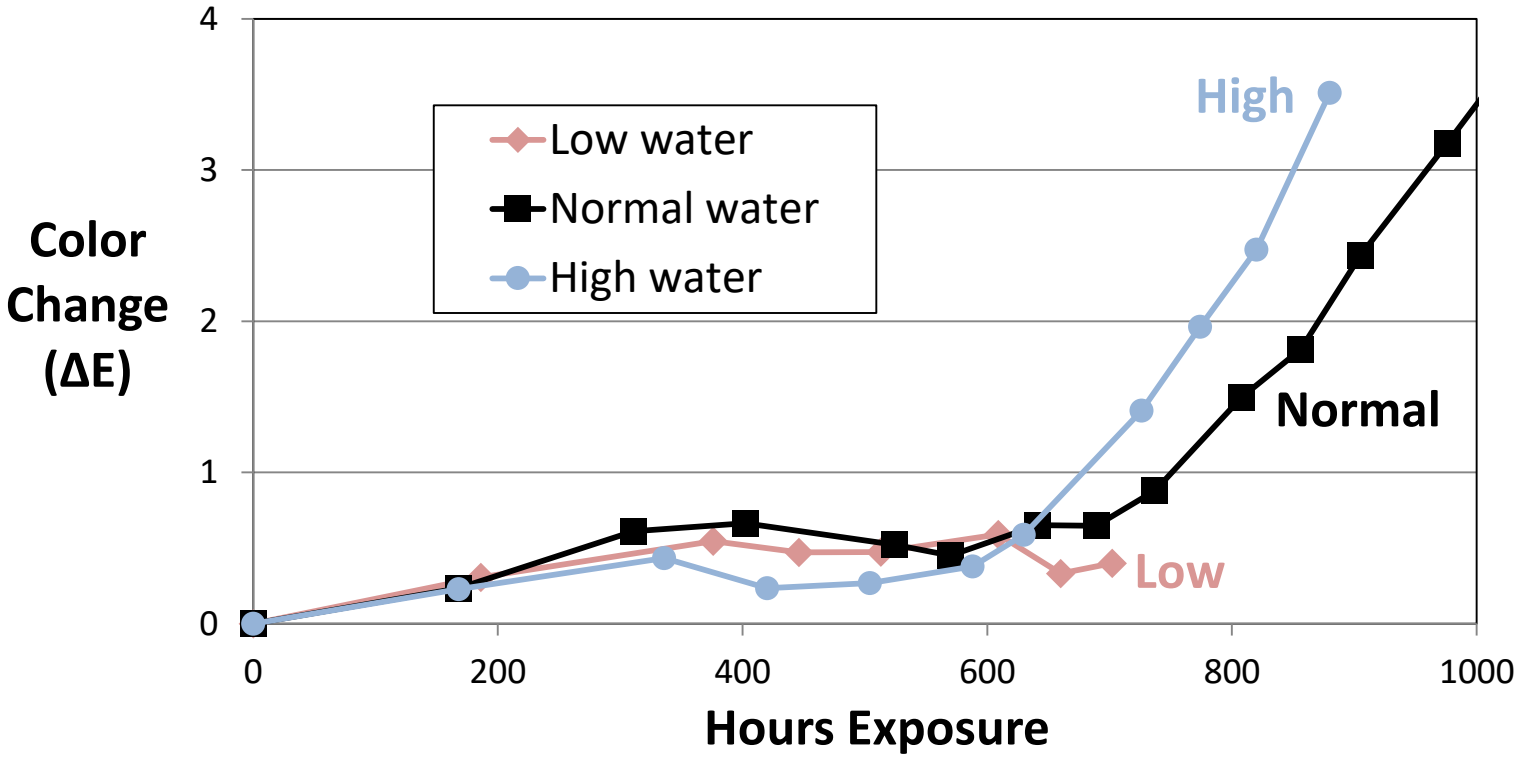
Water Delivery Accelerating Gloss Loss



Xenon arc Weathering

Water Delivery Accelerating Color Change

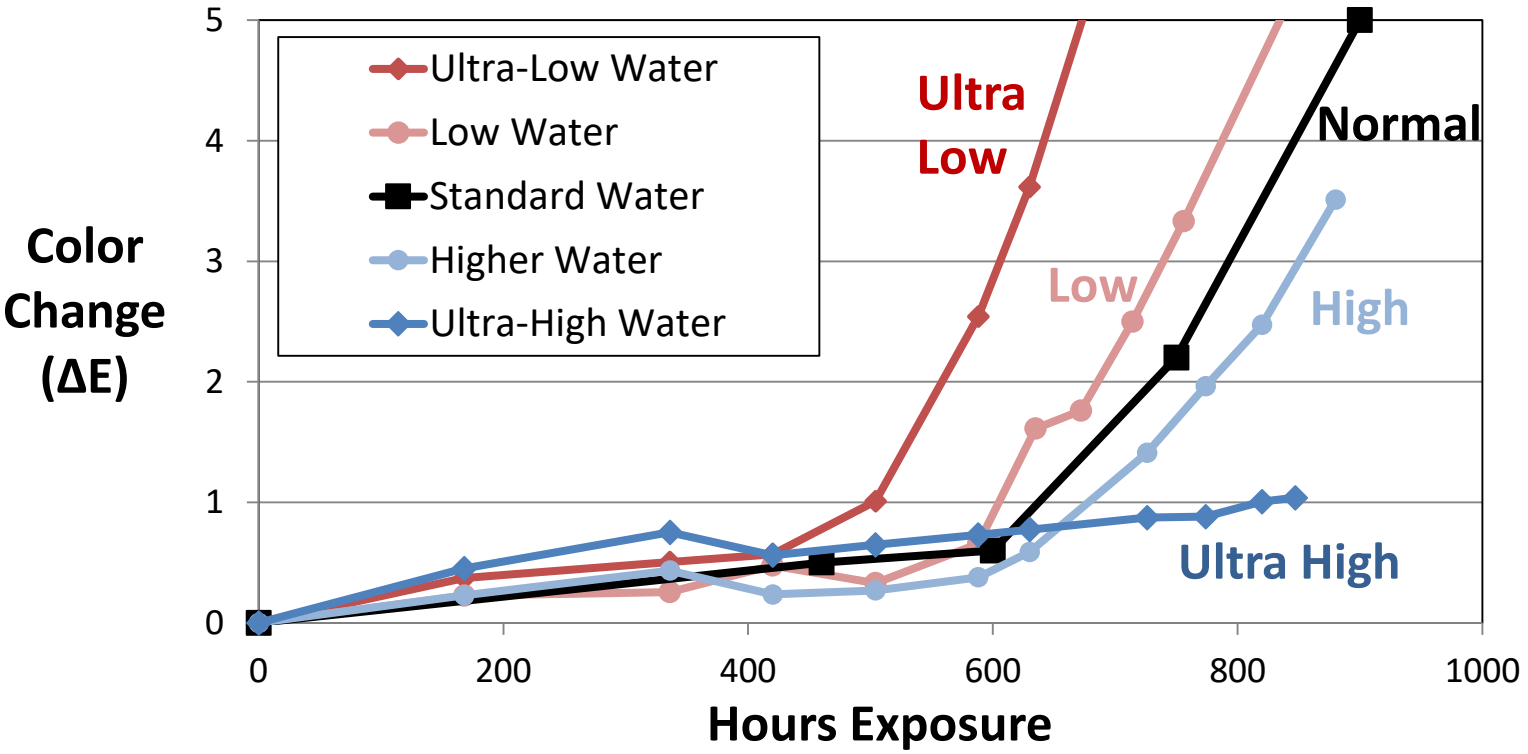
Polypropylene (Talc, Carbon Black, UV package 1)



Xenon arc Weathering

Water Delivery Inhibiting Color Change

Polypropylene (Talc, Carbon Black, UV package 2)



Xenon arc Weathering

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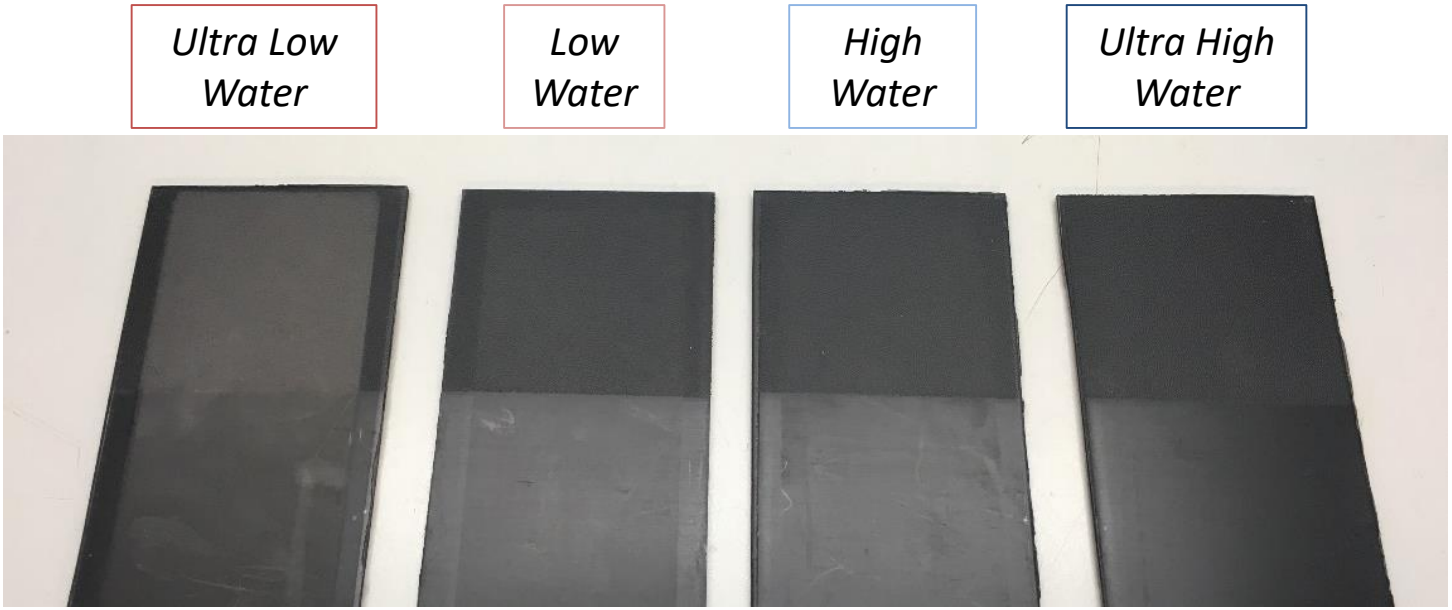


Water in Laboratory Weathering Testing

- Water significantly influences test results for many materials
- Compared to **Sunlight** and **Heat**, in lab testing **Water** is:
  - Less quantified
  - Less accelerated
- Today we will look at standards that ***do*** emphasize water
  - **ASTM G90** (solar concentrator)
  - **EN 927-6** (UV fluorescent)
  - **ASTM D7869** (xenon arc)

Water Delivery in Accelerated Outdoor Testing

ASTM G90

Standard Practice for Performing Accelerated Outdoor Weathering of Materials Using Concentrated Natural Sunlight

Outdoor accelerated testing

Natural solar concentrator

- 5× the UV light of natural exposure

- High temperatures from desert conditions and concentrated irradiance

Outdoor accelerated testing

Daytime water delivery

- Daytime spray dries quickly, causes thermal shock
- *Polymer matrices do not absorb any water!*

Outdoor accelerated testing

Nighttime water delivery

Test Cycle	Daytime			Nighttime		
	Spray duration	Dry duration	Cycles	Spray duration	Dry duration	Cycles
1	8 min	52 min	1 / hr	8 min		3 per night: 21:00, 00:00, 03:00
3	none			3 min	12 min	4 per hour (40 total) 19:00-05-00

- Frequent nighttime spray cycles = high Time of Wetness
- **Increased water uptake of coatings – more realistic test**

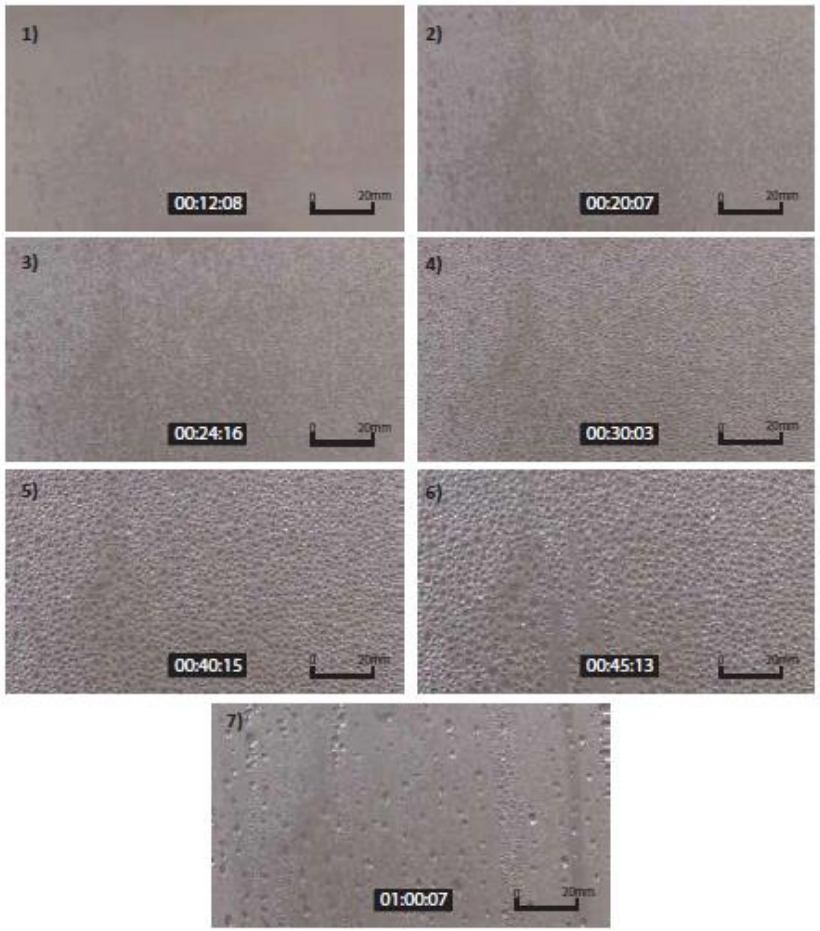
Water Delivery in Fluorescent UV Testing

EN 927-6

Paints and Varnishes - Coating Materials and Coating Systems for Exterior Wood

Fluorescent UV Accelerated Lab Testing

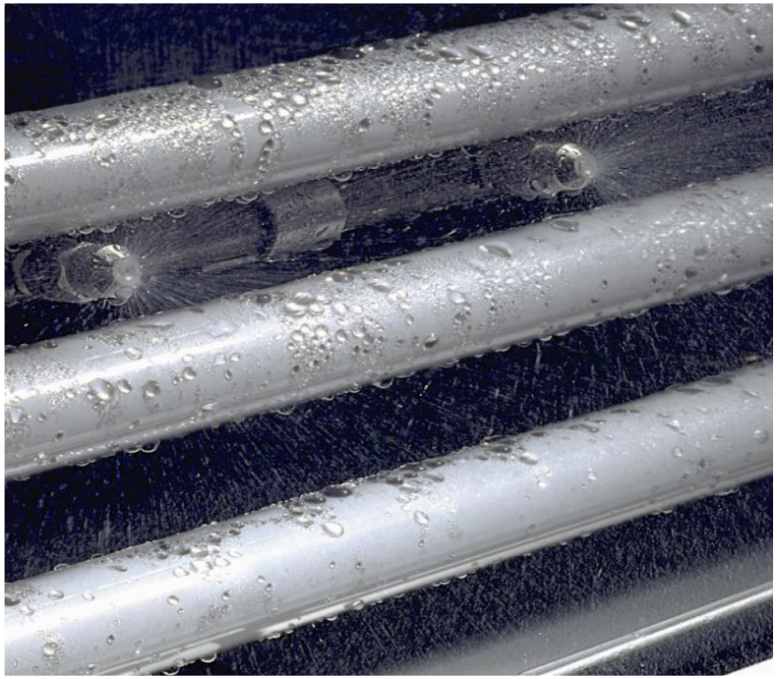
Condensation



- Condensation function an excellent simulation of natural dew
- Hot condensation (~50 °C) accelerates moisture attack

Fluorescent UV Accelerated Lab Testing

Water Spray



- Usually just short sprays for thermal shock
- EN 927-6 introduces longer, frequent water spray to reproduce erosion in wood coatings

Fluorescent UV

Erosion of wood coatings from water spray

"Improving of coatings durability on selected kinds of wood in the exterior applications", No. TH02020873 financed by TAČR

Water Delivery in Xenon arc Testing

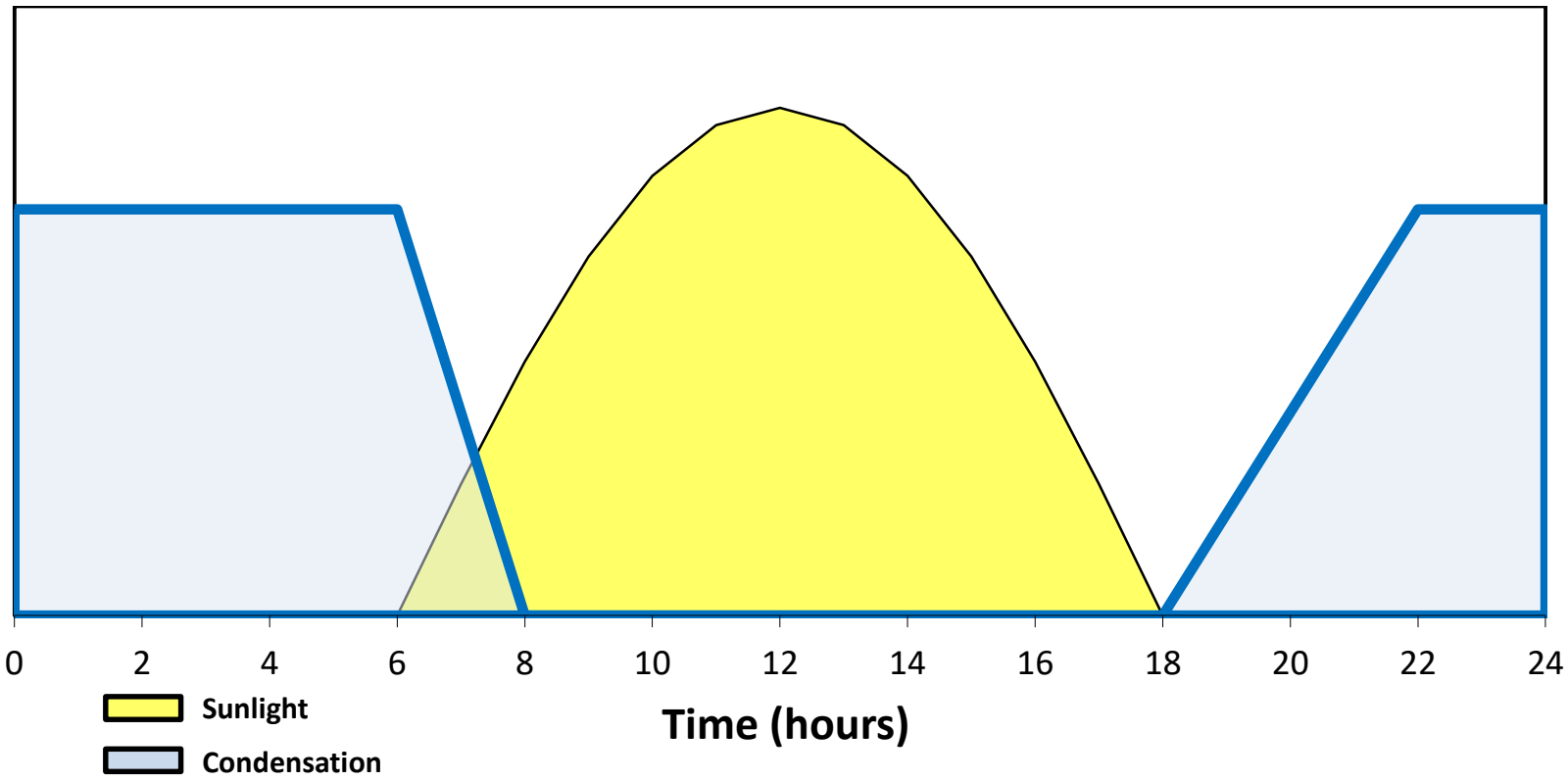
ASTM D7869

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

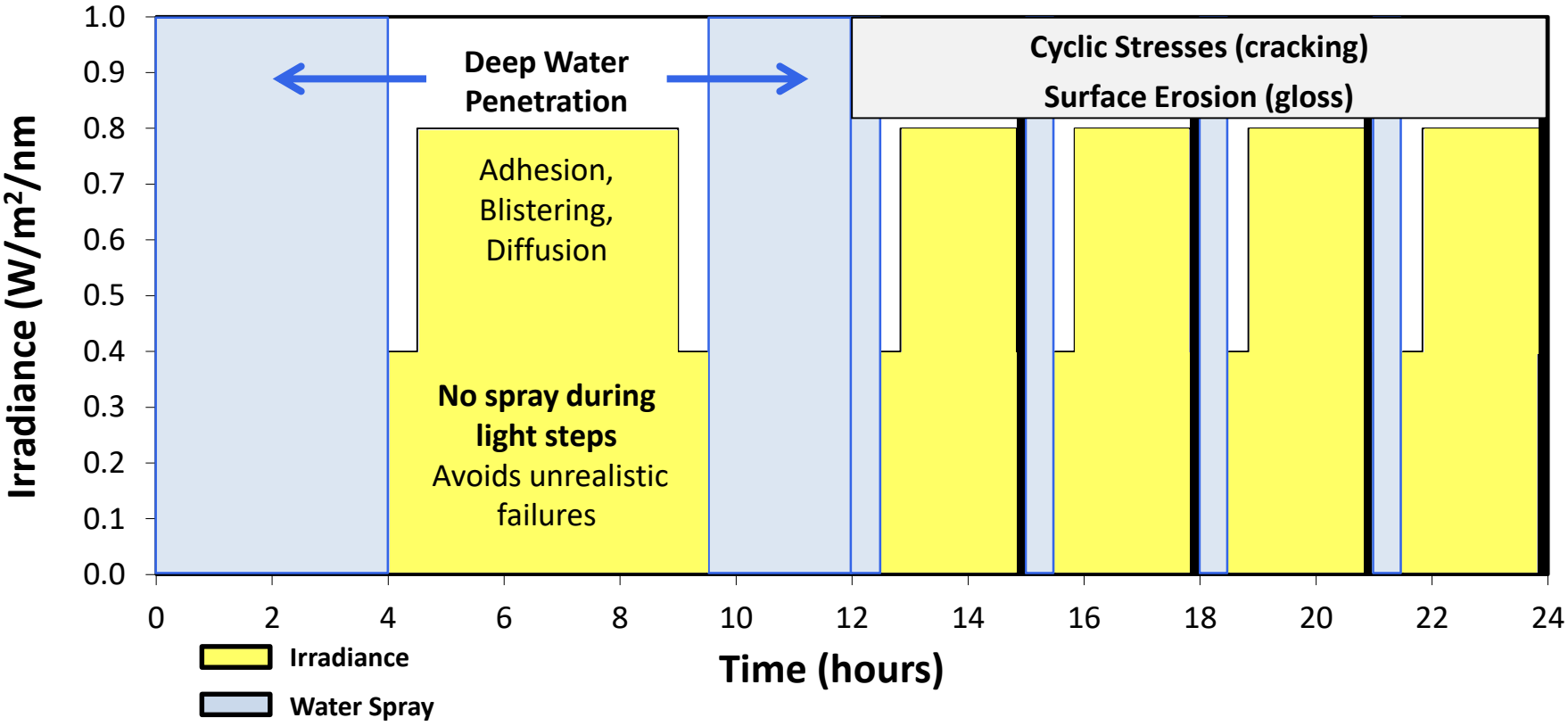
Xenon arc Accelerated Lab Testing
ASTM D7869

- ASTM D7869 ***simulates*** and ***accelerates*** Sunlight, Heat, and Water from outdoor weather
- Test **validated** by comparison to long-term outdoor weathering data from aerospace and automotive coatings
- Test is **realistic** - it reproduces faithfully *almost all* physical failure mechanisms.
- Test is **fast** – 30% acceleration over related test methods.
- Accelerated testing that **correlates** with outdoor test data for transportation coatings.
- Many companies and standards bodies are investigating this test cycle for weathering of plastics

Outdoor daily weather cycle

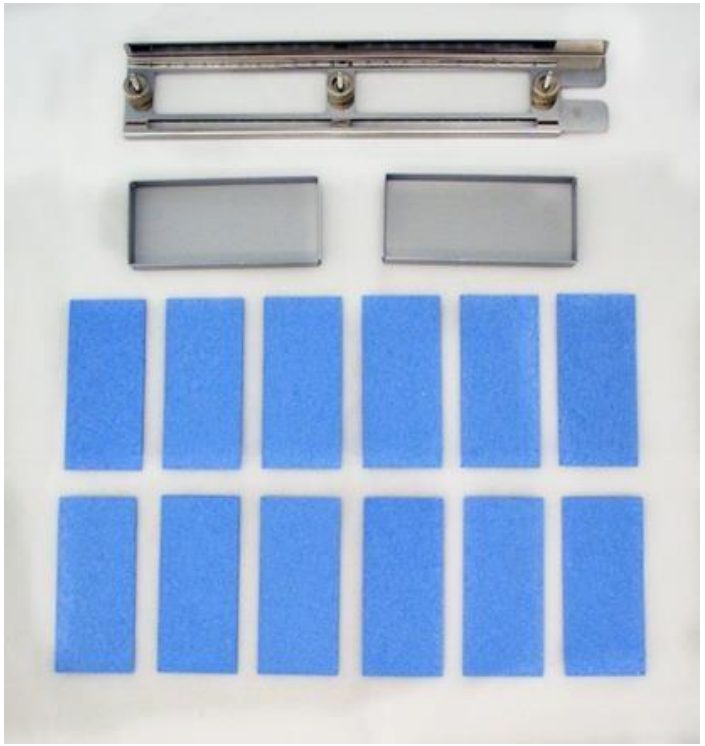


ASTM D7869 test cycle



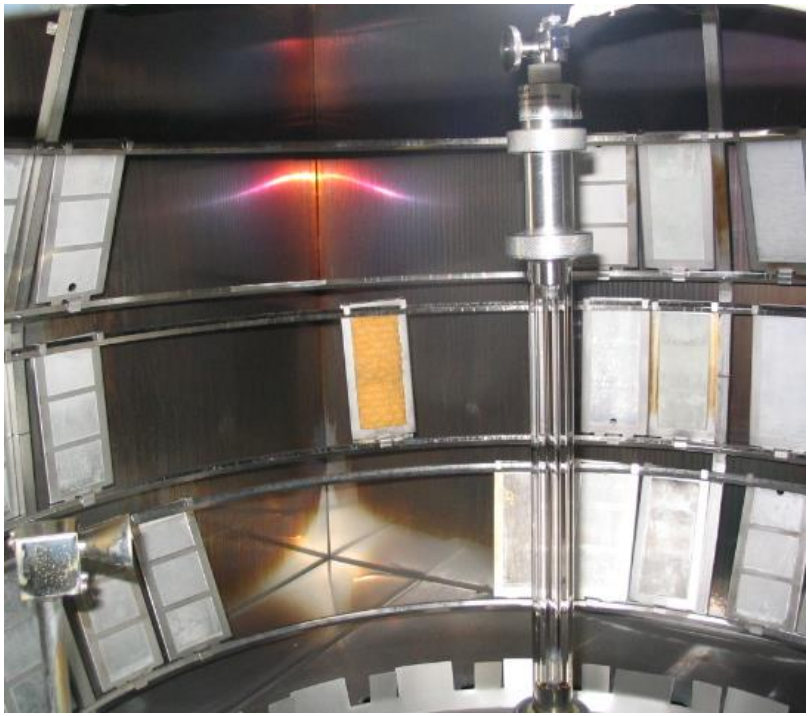
ASTM D7869 Water Delivery

Calibrated sponge used to ensure coating saturation from water delivery

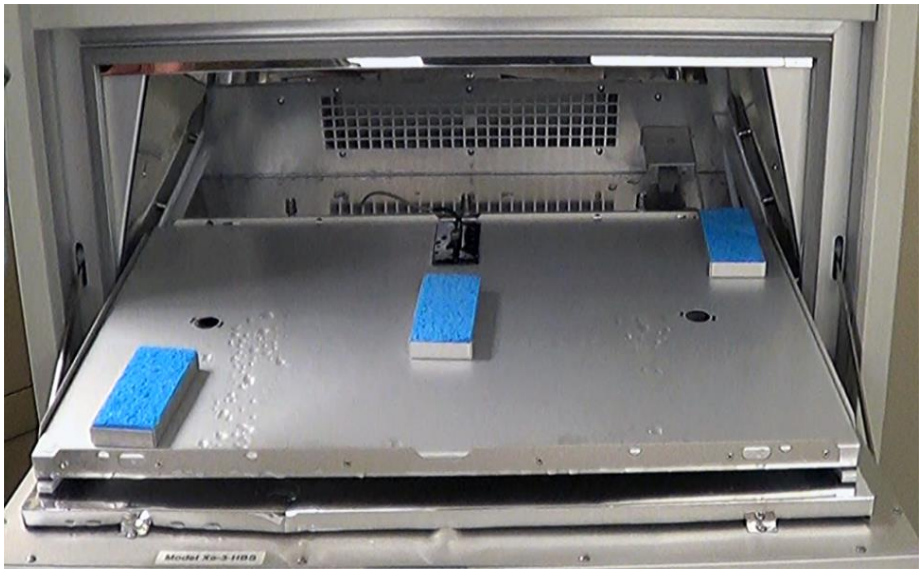


ASTM D7869 Water Delivery Calibration

Rotating Drum

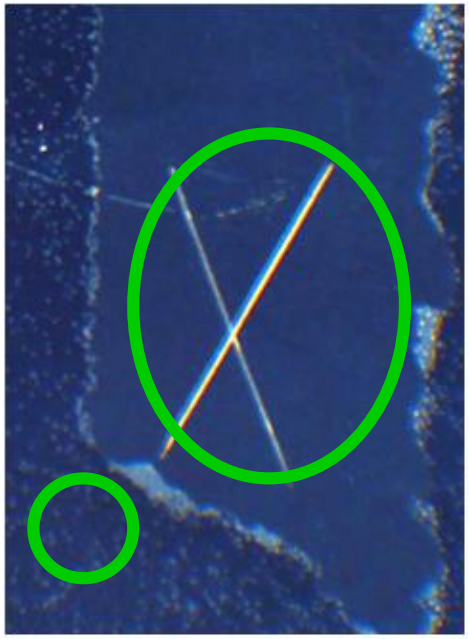


Flat Array

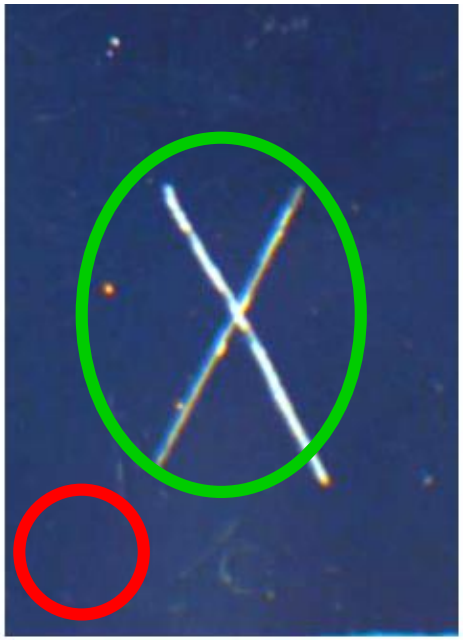


ASTM D7869 Test Result

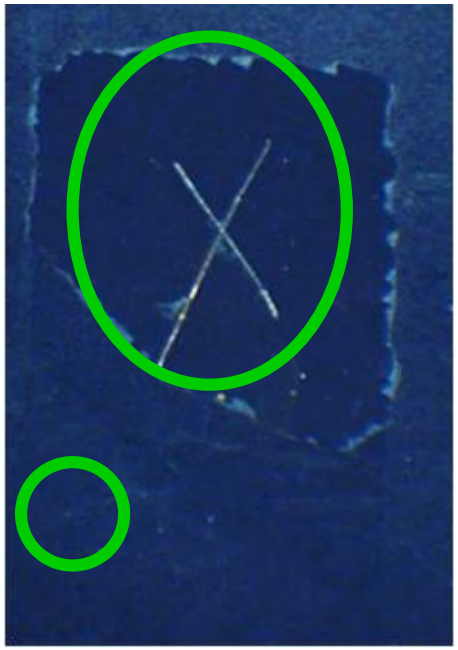
Florida Exposure



SAE J2527



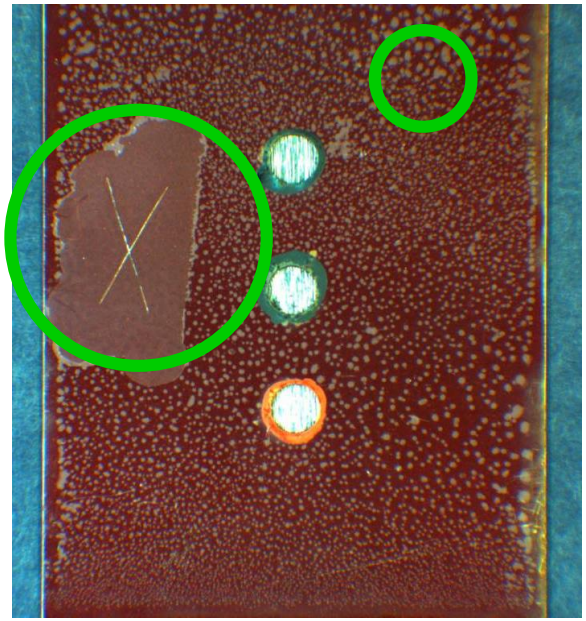
ASTM D7869



- Water-deficient tests reproduce some coating failure modes
- ASTM D7869 reproduces more, including water-based **blistering**

ASTM D7869 Test Result

Florida Exposure



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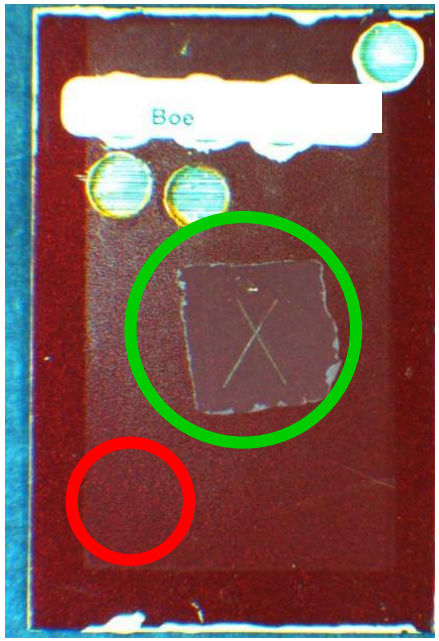
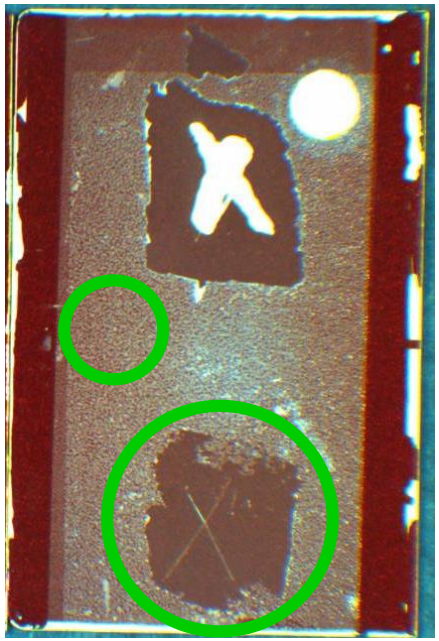


ASTM D7869



- Water-deficient tests reproduce some coating failure modes
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Conclusions

- **Sunlight**, **Heat**, and **Water** are all delivered to specimens during accelerated weathering testing
- **Water** contributes to many failure modes but is often *underspecified* and *underdelivered* in test standards
- Some modern test standards including ASTM G90, EN 927-6, and ASTM D7869 take greater care to accelerate water delivery
- Effect of water on testing is highly material-dependent – important to actually conduct the testing!

Thank you for your attention!

Questions?

info@q-lab.com