

Thirsty

THURSDAY

QUENCH YOUR THIRST FOR **TECHNICAL KNOW-HOW**



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TECHNICAL KNOW-HOW

Natural Outdoor Weathering Testing



Ron Roberts
Q-Lab

NGA UPCOMING EVENTS

NGA Glass Conference: Ann Arbor
Sept 29-Oct 2, 2025

GlassBuild America
Nov 4-6, 2025

Glazing Executives Forum
Nov 4, 2025

NGA GLASS CONFERENCE™ ANN ARBOR

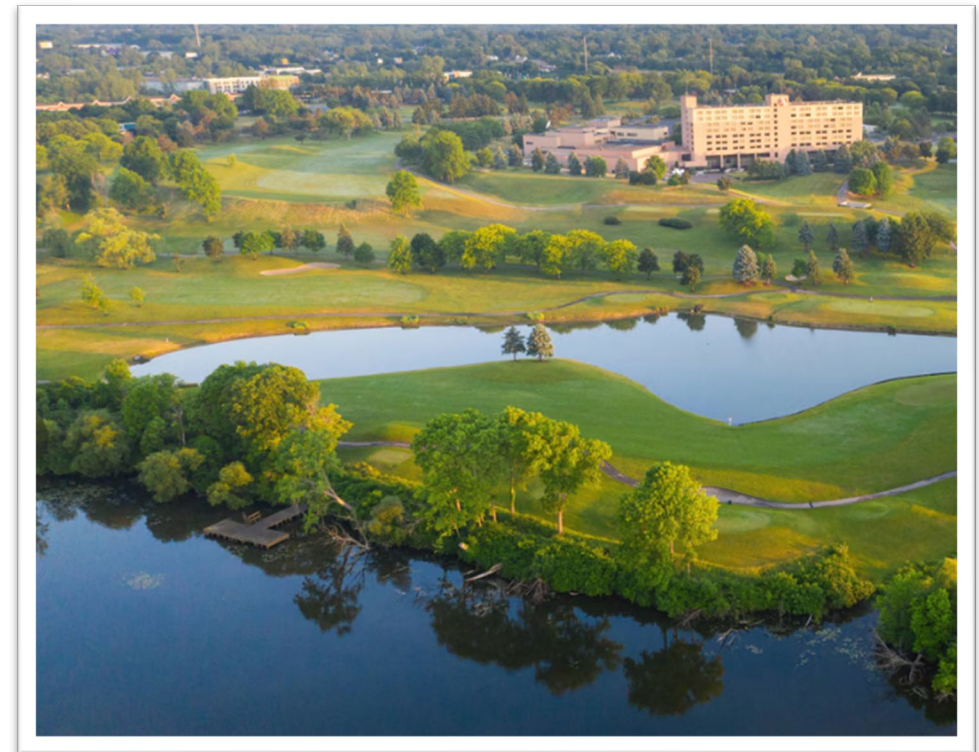
NGA NATIONAL
GLASS ASSOCIATION
with GANA

Sept 29-Oct 2, 2025

Ann Arbor Marriott Ypsilanti at
Eagle Crest



Registration Open!



glass.org/nga-glass-conference-ann-arbor

BUILT ON

GlassBuild 
AMERICA

THE GLASS, WINDOW & DOOR EXPO

NOV 4-6, 2025 | ORLANDO, FL
ORANGE COUNTY CONVENTION CENTER





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Natural Outdoor Weathering Testing



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Natural Outdoor Weathering Testing

Q-Lab Corporation

Westlake, Ohio

Bolton, UK

Saarbrücken, Germany

Shanghai, China

Q-Lab Test Services

Homestead (Miami), Florida

Buckeye (Phoenix), Arizona

Saarbrücken, Germany

Weathering Testing

- **Accelerated tests**

- Exposure in test chambers in the laboratory
- Controlled conditions
- Artificially-created light and simulated condensation/rain



- **Outdoor Tests**

- Exposure on outdoor test racks in large fields
- Uncontrolled conditions
- Natural sunlight and real weather conditions





Forces of Weathering

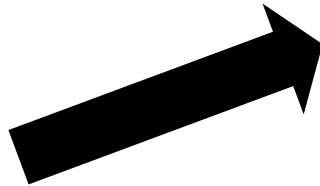
Accelerated

- Light
- Heat
- Condensation
- Humidity
- Spray

Outdoor

- Sunlight
- Temperature
- Condensation
- Humidity
- Rain
- Biological
- Acid Deposit
- Dirt Pickup

Outdoor testing adds other
weathering factors





Outdoor Weathering Myths

- Accelerated tests are 100% repeatable
 - All tests (outdoor and accelerated) have variability
- Any degradation is good
 - The wrong degradation mode can be misleading
- It takes 5 years to obtain outdoor test results
 - Outdoor testing can yield useful data in 12 months
- Weathering test data is absolute
 - A single test will not yield a perfect correlation
- Ranked data is weak data
 - Ranked data can be powerful if correctly applied
- Outdoor testing is too expensive...



Why Outdoor Testing Is Often Ignored

- Time pressures force accelerated testing for rapid results
- Many specifications, companies, and product development efforts utilize only accelerated methods believing some of the myths on the previous slide
- Ignoring outdoor testing represents a critical missed opportunity!



Why Outdoor Testing Is Important

Outdoor testing is an important and inexpensive complement to accelerated testing

- Gives confidence that degradation modes are not unintentionally changed
- Test reliability issues or experimental mistakes (human errors) can be identified
- Can give rapid, realistic results
- Establishes a working **Correlation Factor**



Outdoor Testing Costs

- Cost of Testing
 - Only \$500 - \$1,000 per test per year
 - Ongoing tests build a library of highly valuable data, at low cost
- Cost of Not Testing
 - Product recalls? Unhappy customers?
 - Less confidence in results



Global Benchmark Outdoor Exposure Locations

Florida Subtropical

Arizona Desert Sunshine

Q-Lab Outdoor Weathering Sites

Florida



Arizona



Ohio



Q-TRAC



Test sites available in many different climate types

Why Florida?

- High UV irradiance
- High temperatures
- High time of wetness (TOW)
- High humidity



Florida Is Accelerated But Not Extreme

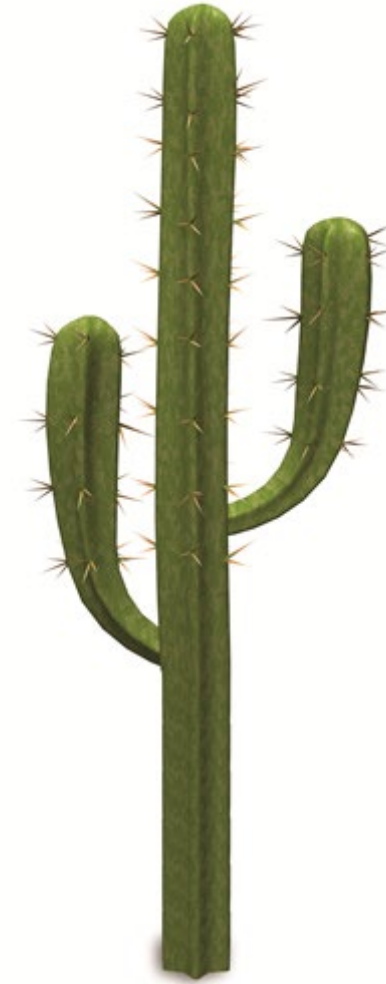
- Same noon summer sun spectrum as temperate regions, but present in Florida for more of the year.
- Consistently hot, but max temperatures are not extreme (no 100 °F days)
- Florida's **summer** is just like summer in temperate regions
- Florida's **winter** is ... also like summer in temperate regions
- *The same weather as the rest of the world, just “more of it”*





Why Arizona?

- Higher UV irradiance
- Hot, Hot, Hot!
- High temperature swings – thermal cycling
- Low moisture

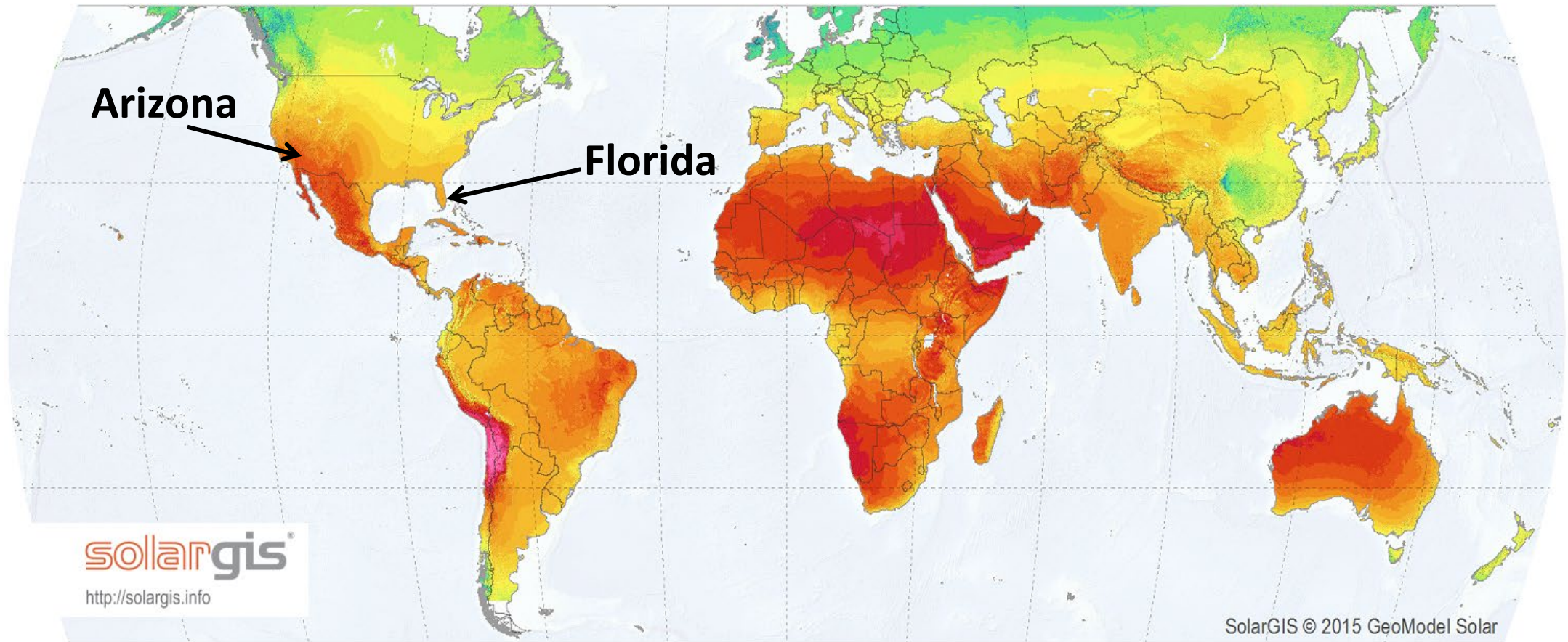




Florida & Arizona Comparison

Force	Parameter		Florida	Arizona
Sunlight	Annual Solar Energy (MJ/m ²)	TUV (295-385 nm)	320	350
		Total	6588	8004
	% sunlight (from sunrise to sunset)		69	85
Heat	Summer avg. Max Temp (°C)		32	40
	Thermal Cycling		Thermal shock from daytime thunderstorms	Large day/night temperature swings
Water	Humidity		High	Low
	Rainfall		High	Low
	Time of Wetness		High	Low

Annual Solar Energy Worldwide



Annual Solar Radiant Energy
[GJ/m²]



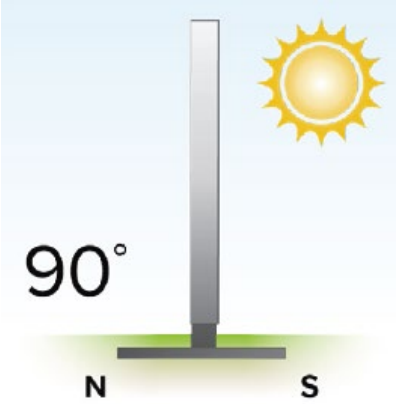
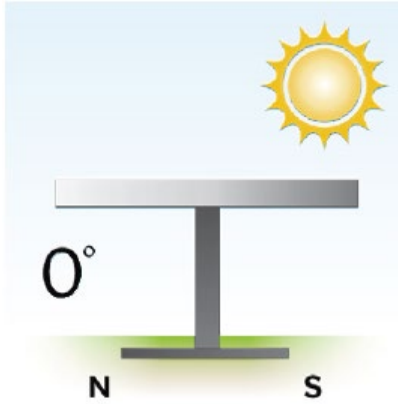


Natural Outdoor Exposure Variations

- Exposure Angle
- Backing
- Under-glass
- Black Box
- Mildew-enhanced
- Salt-accelerated
- Whole product



Exposure Angles

	45° South	90° South	5° South	0°
Graphic				
Orientation	Faces Equator (north in southern hemisphere)			Horizontal
Materials commonly tested	• Powder/coil coatings • Corrosion tests • Outdoor plastics • Vinyl siding	• Window profiles • Wood siding • Architectural coatings	• Automotive coatings • Roofing materials	• 3D parts • Roofing • Outdoor flooring
Comment	Most commonly used outdoor exposure	Reduced solar exposure Vertical end-use	Increased wet time	Highest time of wetness

45° South Exposure Angle



90° South Exposure Angle



5° South Exposure Angle



0° Exposure Angle





Backing Techniques

- **Open-Backed**

- Used for rigid specimens
- Painted metal
- Plastic lenses

- **Mesh-Backed**

- Flexible specimens
- Typically for 0° exposures

- **Plywood-Backed**

- Vinyl siding
- Roofing



Open-Backed

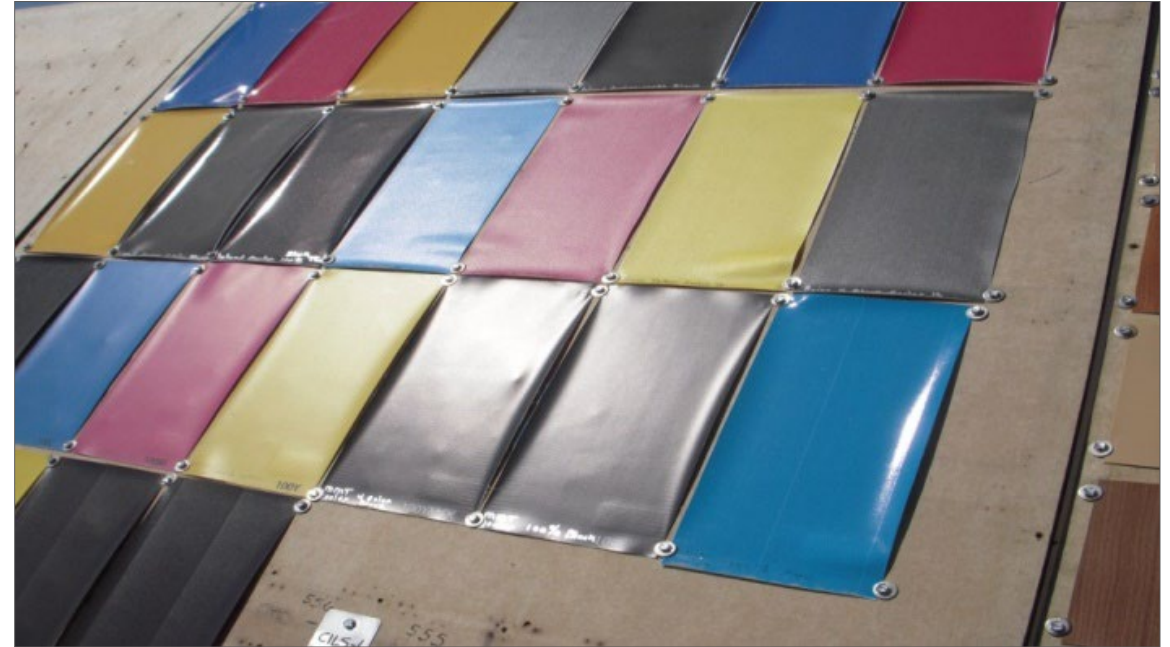


Mesh-Backed





Plywood-Backed



Under-Glass Exposure





Automotive Interior Testing: Under-Glass Exposures





Automotive Exterior Testing

Black Box



Enhanced Testing

Mildew



- 90° or 45° North facing
- Mildew-enhanced area of field
- Longest time of wetness

Salt (SCAB)



- ASTM D6675 / ISO 11474
- 5% Salt Solution
- Synergistic corrosion + weathering



Whole Product

- Entire vehicle, house, etc.
- Best simulation of the end use
- All parts, materials and components interact during the weathering process
- Thermal radiation studies commonly performed



Outdoor Weathering Testing Programs

Best Practices for Outdoor Weathering Testing

- **Test at benchmark sites**
 - Harsh environments accelerate degradation
 - Data from these sites is internationally accepted and comparable
- **Start new outdoor tests every year (or more frequently)**
 - Develop library of data
 - Compare old formulations to new; compare to competitors' materials
 - Value of test data increases over time – like compound interest
- **Qualify/validate your accelerated lab testing**
 - Develop better laboratory tests
 - Test the lab test against real data

Best Practices for Outdoor Weathering Testing

- Begin testing as soon as possible
- Use a balanced mix of specimens
- Use at least 3 replicates
- Evaluate regularly and often
 - At least 5 intervals per test
- Use control or reference specimens
- Typically 12 to 24 months sufficient for baseline results
- Perform repeat testing and test to failure





Experimental Design for Outdoor Testing

- Every specimen type should be in every test
- Use equal number of specimens in each test
- Use regular exposure periods
 - Except it is OK to schedule more evaluations in early periods (to catch early failures)
- Use the same evaluation techniques throughout



Replicates

- More specimens lead to better data analysis, & adding them is inexpensive
 - There is unlimited “chamber capacity” for outdoor testing
- At least three replicates allows mean and standard deviation calculation
- More specimens give higher confidence that small differences in test results are truly meaningful



Reference Materials

A reference (i.e. control) material is one with known performance

- Always expose one good and one bad “control”
- Use the reference material to compare different tests or different exposures
- The results from the reference materials can be used to “normalize” the results
- This “reference” material is often not a standard polystyrene chip - it is your own material



Repeat the Tests

- The first step in writing a standard test is to prove it can be repeated
- Prove the test method is correct by doing the tests again
- Determine and measure the unknown factors that will appear when testing



Test Duration

- Durable materials need to be exposed outdoor for years – maybe 1, maybe 10, maybe 50!
 - Paint
 - Signage
 - PV modules
 - Sealants
 - Roofing materials
- Some materials require shorter outdoor exposures:
 - Food and beverages
 - Cosmetics and personal care
 - Optical lenses

Always test to failure!

Summary



Example Test Program

Outdoor

1. Florida
2. 5° South
3. 60 months duration
4. Measure at 3 months
5. Color, Gloss, Visual
6. 300 × 150 mm panels

Accelerated

1. Xenon Arc
2. Daylight Filters
3. 3,000 hours
4. Measure at 250 hrs
5. Color, Gloss, Visual
6. 75 × 50 mm panels

Expose reference panels in each test, compare the type & rate of degradation to the reference panel, and ensure the accelerated test is providing the correct results

Putting it All Together



+



+





Conclusions

- Accelerated testing is a great way to get fast weathering results
- Outdoor testing complements and verifies accelerated testing
 - It is often overlooked, despite being inexpensive, fast, and easy to implement
 - It helps increase confidence and correlate results to real world experience



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Thank You for Attending!



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glass.org/webinars

NGA Upcoming Webinars

Safe by Design:
Security Glazing and High-Performance
Glass in Educational Facilities
September 11 at 2:00 pm ET