How to Run a Test Comparing Accelerated Test Instruments

Andy Francis
Bill Tobin
Dave Duecker
Sean Fowler

Q-Lab

View Recorded Presentation

Q-Lab's New Webinar Series

Today is the first of four new webinars this summer from Q-Lab on specialized weathering and corrosion topics

All upcoming and archived webinars can be accessed at:
q-lab.com/webinars

Date	Topic
29 May	How to Perform a Comparison Test
12 Jun	New Developments in Testing Standards
01 Jul	Q-PANEL Standard Substrates
17 Jul	QUALICOAT

Administrative Notes

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!

The Situation

- You are purchasing a new weathering or corrosion test instrument for your laboratory

©Q-Lab

We make testing simple.

The Situation

- You are purchasing a new weathering or corrosion test instrument for your laboratory
- You want to ensure that you will get:
  - Same chamber conditions as your existing equipment
  - Same test data (gloss, color, strength) as your existing equipment
  - Same pass / fail results for qualification and QC as your existing equipment
- To gain confidence in this new tester, you want to run a **comparison test**

We make testing simple.

The Challenge

- Comparison testing is commonly based on two incorrect assumptions:
  - Testing results from one's current chamber will perfectly match other chambers of the same model or family
  - Latest models of a given tester will match the results from legacy models simply because it is the same brand.
- Weathering and corrosion test chambers do not deliver perfect *repeatability*
  - precision of a test on identical material running identical test methods in a single lab
- This makes it more challenging to deliver good *reproducibility*
  - precision of a test on identical material running identical test methods in different labs
- Any tester comparison program must ensure that these parameters are tested for rigorously and fairly

The Approach

How to Structure a Scientifically-Valid Comparison Test

1. Match test parameters
2. Match evaluation procedures
3. Agree upon acceptance criteria
4. Implement good lab practices

©Q-Lab

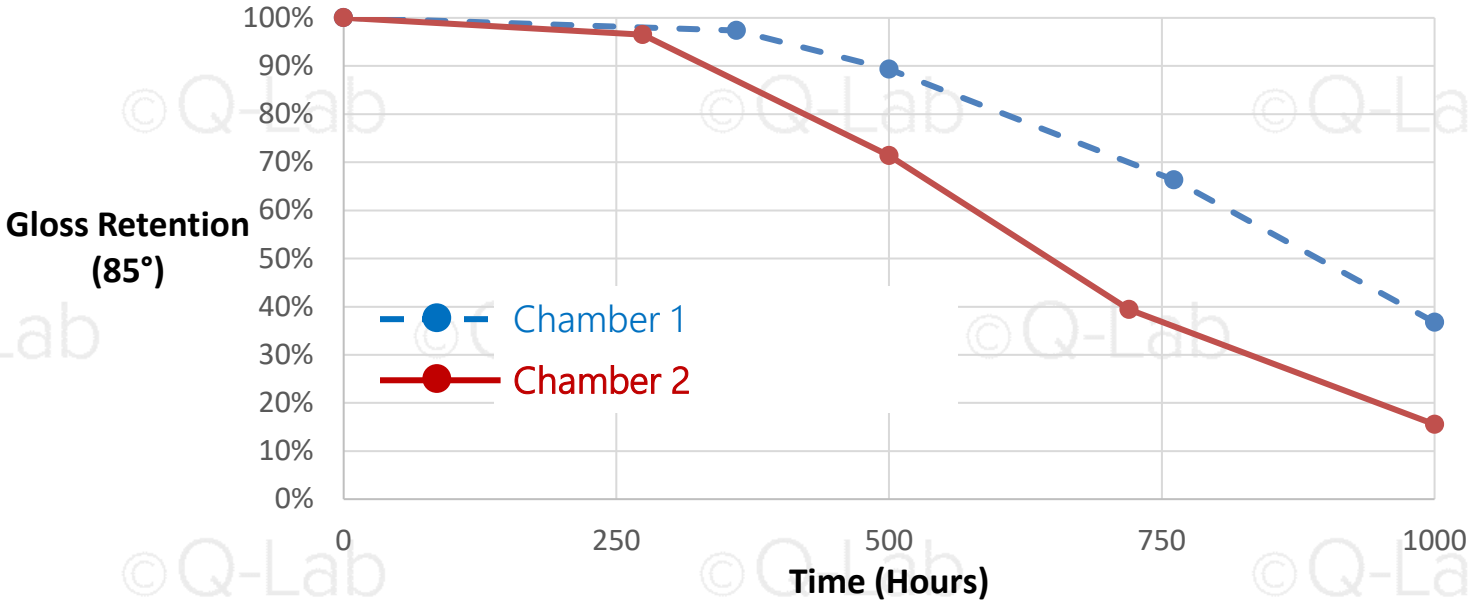
Step 1:
Match Test Parameters

Run the SAME test in every tester

- Light Spectrum
  - Lamp types for UV fluorescent (UVA, UVB)
  - Optical filter for xenon (Extended UV, Daylight, Window)
  - Irradiance control point (340 nm, 420 nm, TUV)
- Temperature
  - Black Panel Type (insulated, uninsulated)
  - Chamber air
- Moisture / electrolyte
  - Humidity, water spray
  - Corrosive or other solution
- Test cycle programming - step times and transitions
- *Any other subtle or unique test standard details – there are LOTS of them*

We make testing simple.

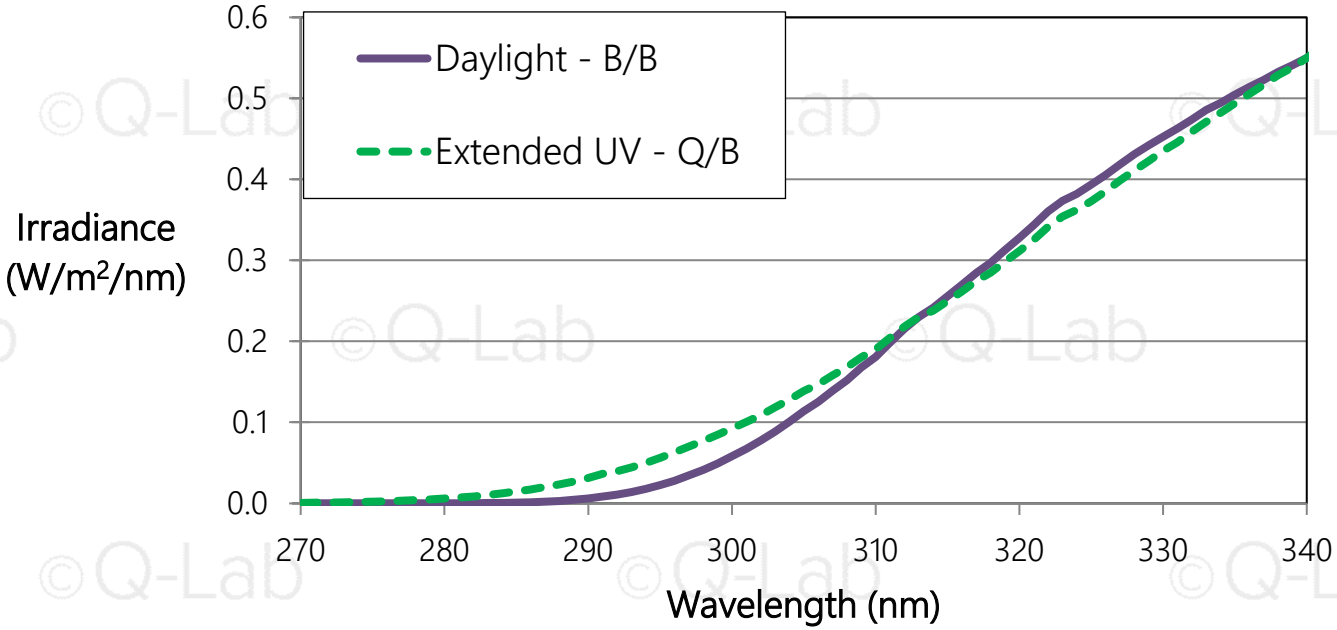
Example: Differences in Gloss Retention



Seemingly identical testers and conditions: very different results

We make testing simple.

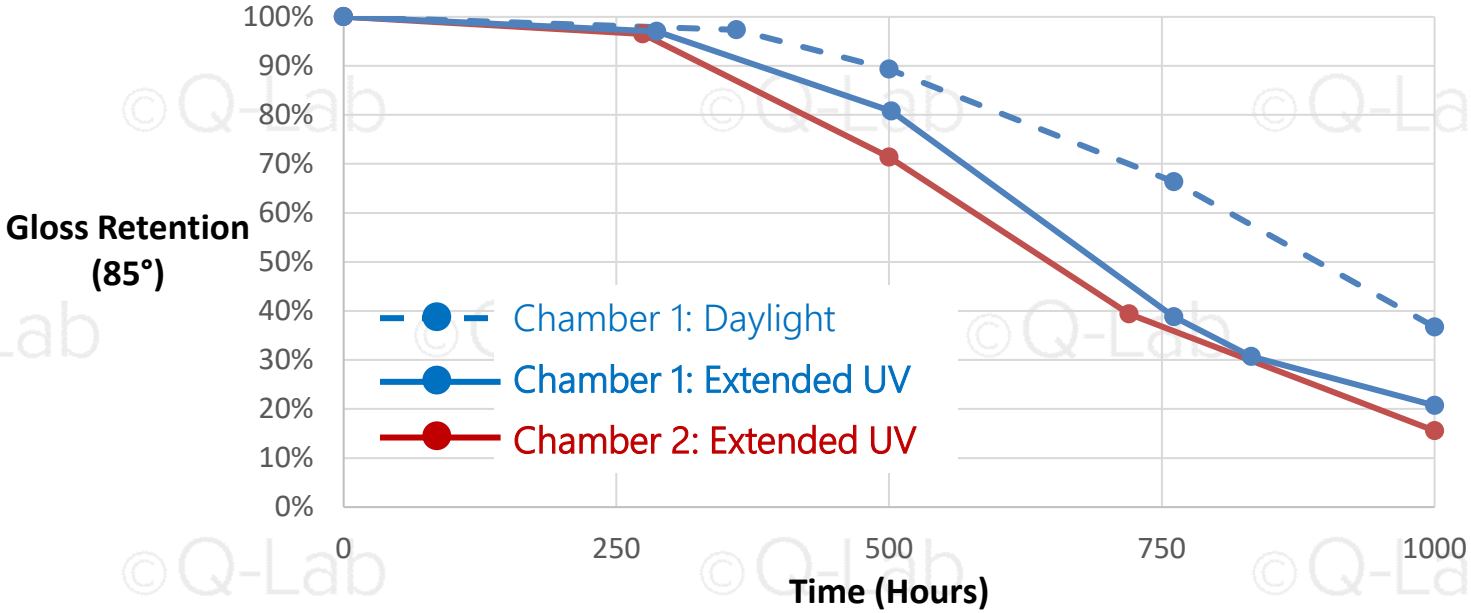
Different Optical Filters, Different Light Spectra



SAE J2527 allows either of these very different optical filters …

We make testing simple.

Light spectrum matters!

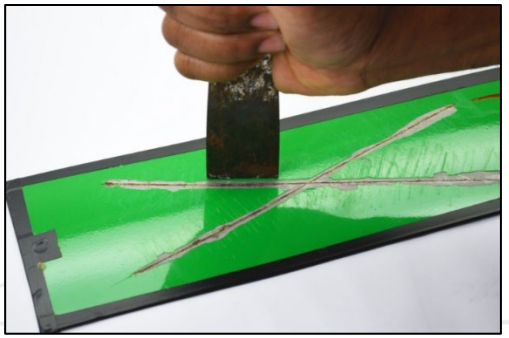


Gloss results matched much better with identical optical filters

Critical to get the details of the standard correct!

Example: Differences in Mass Loss

- Coatings manufacturer performing SAE J2334 to evaluate an industrial coating
  - Mass loss coupons used as determining factor
  - Formulation under test was a “known good”
- Differences between labs running “same test”
  - Lab #1 “passed” the formulation
  - Lab #2 “failed” the formulation
  - *Why would a good formulation fail?*



We make testing simple.

Mass loss results from Lab 2

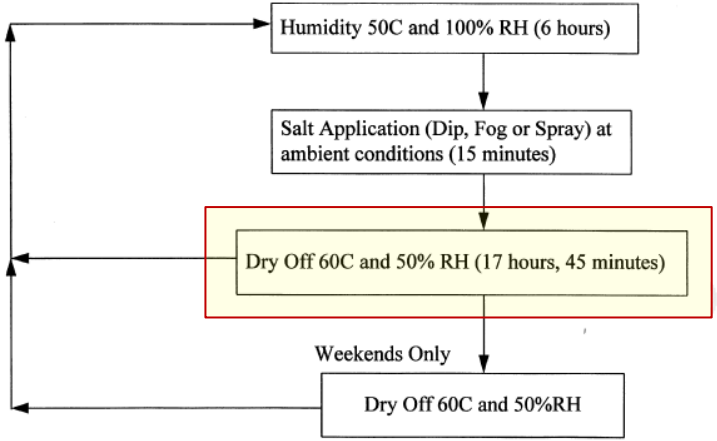
Acceptance band

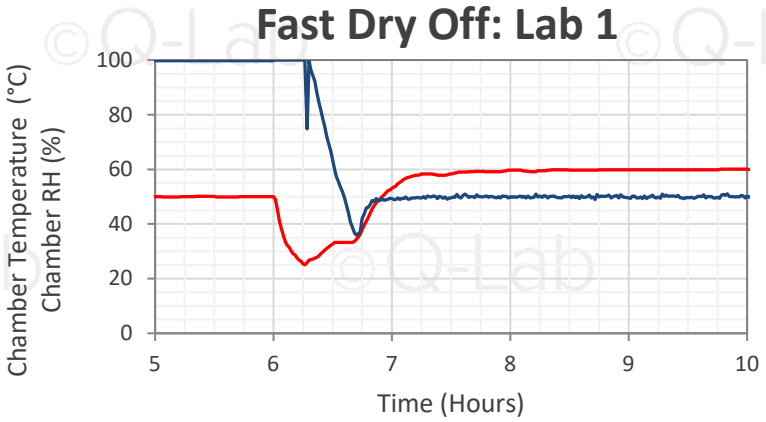
All samples exceeded allowable limits

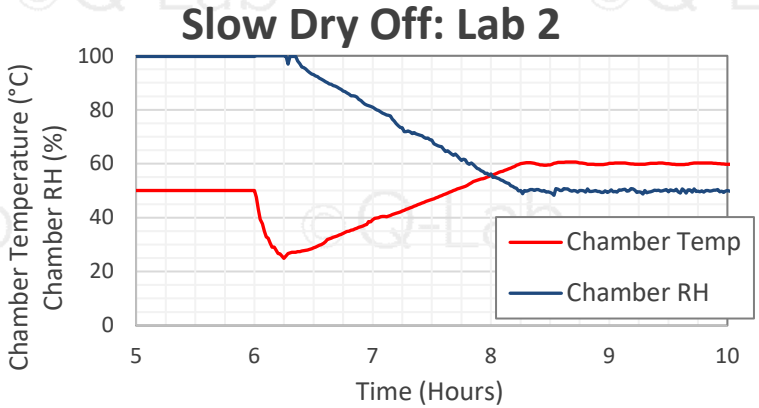
What's going on?

We make testing simple.

SAE J2334 Cycle







- Cycle does not specify transition times
- More wet = more rust!

We make testing simple.

Mass loss results – initial with slow dry

Acceptance band

Remember this from before?

We make testing simple.

Mass loss results - with fast dry

All samples passed when transition executed quickly

Test cycle consistency matters!

We make testing simple.

Consistency in Testing

- Verify that the test cycle being performed is *as close to exactly the same as possible* in all testers being compared
- Check even seemingly-minor details!
- Test instruments are very unlikely to give matching results if they aren't performing the same protocol

©Q-Lab

Step 2:
Match Evaluation Procedures

We make testing simple.

Visual and Instrumental Evaluations

Visual

- Technician reviews specimens and rates the degradation
- Training & verification reduces variability and bias

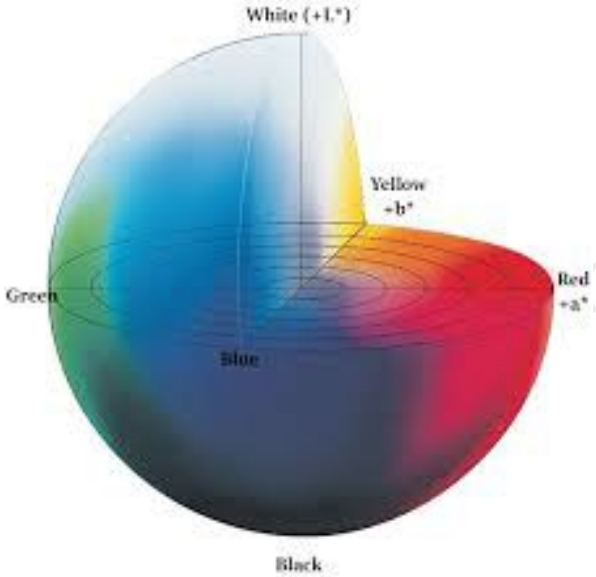
Instrumental

- Gives objective rating to a visual change
- Instrumental Color and Instrumental Gloss best examples
- Requires additional inputs for instrument settings
- Results are unbiased, continuous values

We make testing simple.

Example: Color measurement

- Color space
  - CIEXYX, HunterLab
- Instrument geometry
  - 45/0
  - 8° sphere
- Specular component
  - Included, excluded
- Standard illuminant
- Standard observer



We make testing simple.

Step 3:
Establish Acceptance Criteria

We make testing simple.

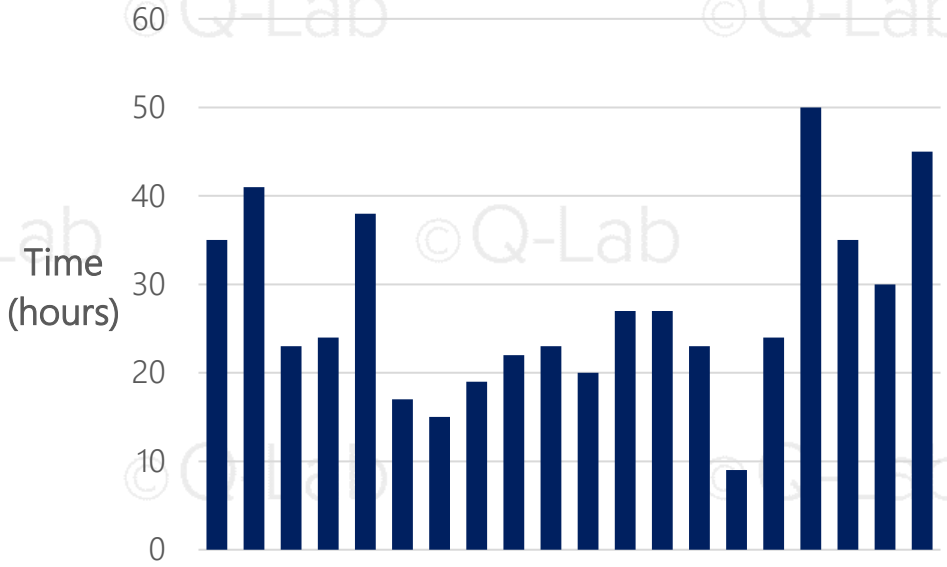
Statistically Significant Data Collection

- Replicates, replicates, replicates
  - Expose enough specimens for at least 3 evaluations
  - More is **always** better
- Multiple testers
  - At least three reference chambers desired
  - Not always feasible, but rules out an anomalous existing tester's bias
  - A single test in a single tester is less likely to be valid or succeed

We make testing simple.

Example: Matching a Single Tester

Blue Wool #2 Fading to Grayscale 4

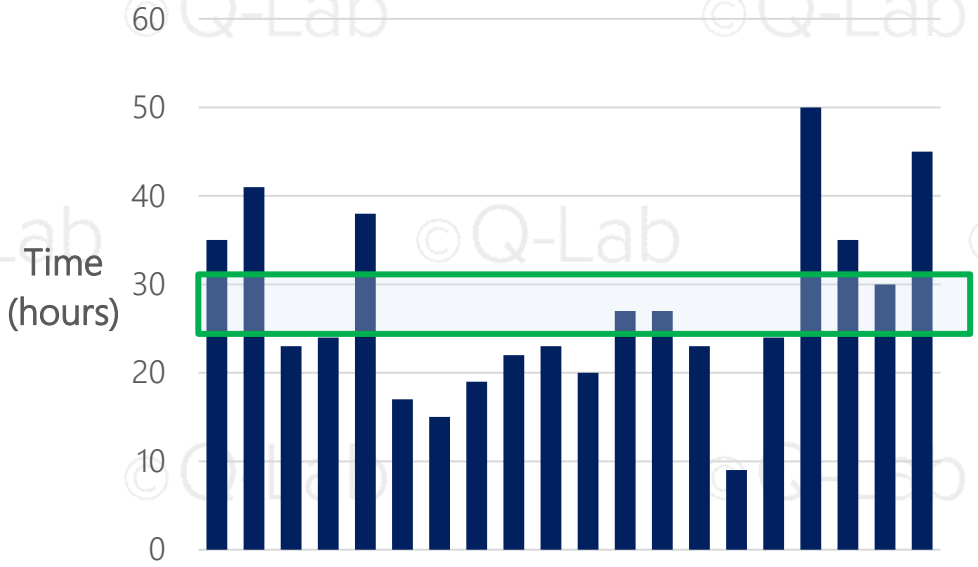


- Interlaboratory comparison study from ISO 105-B02
- 20 test chambers of similar manufacture included in this study
- Observe the differences

We make testing simple.

Example: Matching a Single Tester

Blue Wool #2 Fading to Grayscale 4



- Interlaboratory comparison study from ISO 105-B02
- 20 test chambers of similar manufacture included in study
- *How likely are you to match any given tester with a ±10% variability limit?*

We make testing simple.

SAE Polystyrene Qualification

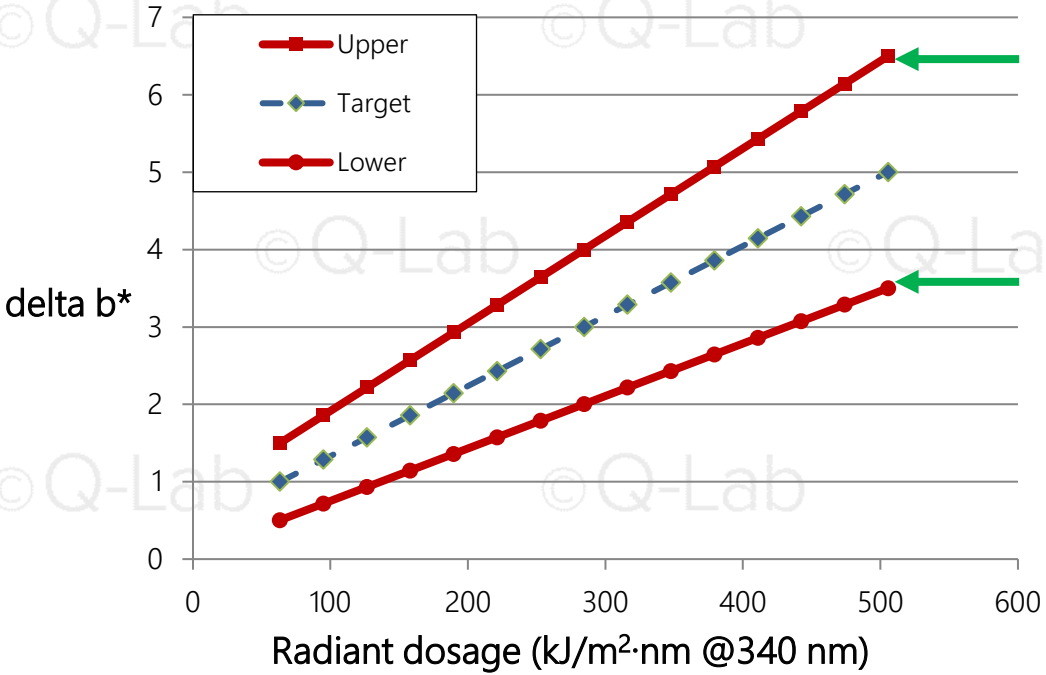
- SAE Interlaboratory Comparison (ILC)
  - Also called “Round Robin” or “Ring study”
- ASTM G156 provides framework for qualification of materials
- For Polystyrene “Lot 9” Qualification
  - Multiple accredited Labs conducted the tests
  - Multiple chamber models, designs, architectures were used

We make testing simple.

How good is good enough?

Example: SAE Polystyrene Interlaboratory Comparison

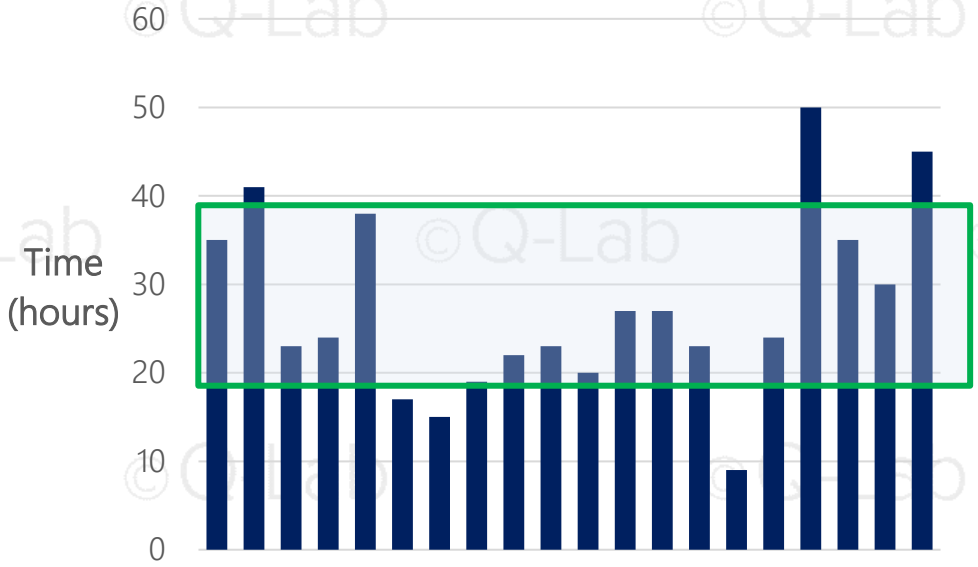
- ILC results established limits
- Limits applied were 2 StDev for a tester to be approved
  ±30% of average
- After a two week test, Δb of 6.5 and 3.5 are both OK!
  Would you accept this?



We make testing simple. Q LAB

Example: Matching a Single Tester

Blue Wool #2 Fading to Grayscale 4



- Interlaboratory comparison study from ISO 105-B02
- 20 test chambers of similar manufacture included in study
- *Even with ±30% as in the SAE test, success in a 1:1 comparison isn't a given!*

Establishing Acceptance Criteria

- Comparing results from only two of these chambers may suggest exposures are dissimilar.
- Interlaboratory Comparison Studies give some guidance on acceptable variance with well-known reference material
- Even a relatively wide tolerance of 2 standard deviations can make acceptance challenging if just 1 tester of each type is compared
- *Critical to set realistic expectations*

We make testing simple. | Q LAB

Step 4:
Implement Good Lab Practices

We make testing simple.

Consistency in Lab Practices

The Test Instrument is only one Source of Variability

- Material performance & manufacturing variability
- Specimen preparation
- Conditioning & storage
- Handling
- Laboratory personnel
- *All of these can introduce variability in testing results – be sure that they are consistent*

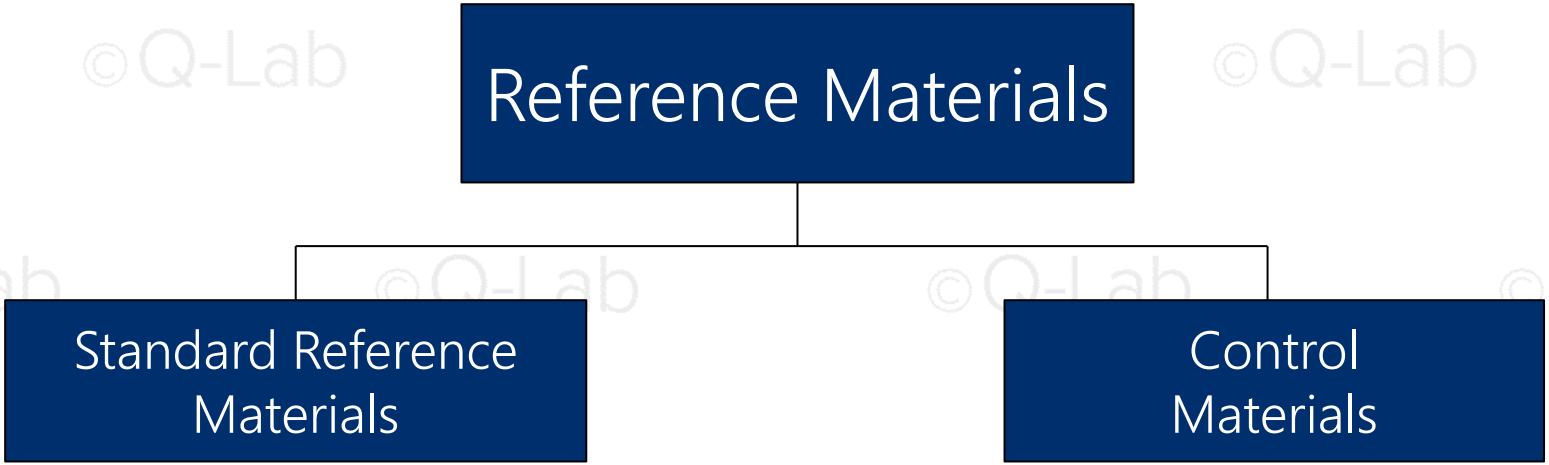
We make testing simple.

Follow Guidance from Test Standards

- ASTM E691 *Standard Practice for Conducting an Interlaboratory Study (ILS) to Determine the Precision of a Test Method*
  - General information for understanding a test protocol's inherent variability
- International standard ASTM G151 *Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources*, comments on *reproducibility*:
  - Assess **relative** performance, using **rank order** analysis
  - Use **Reference Materials** (standard and control) that have known performance

We make testing simple.

Reference Materials: Standard and Control



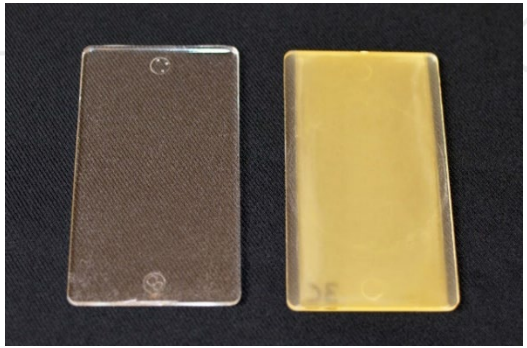
- Known performance in test environments
- Not necessarily similar to test specimens
- Performance may not match test specimens
- Verify that lab tester is operating properly

- Similar characteristics to test specimens
- May be your products or competitors'
- Give confidence in lab exposure

We make testing simple.

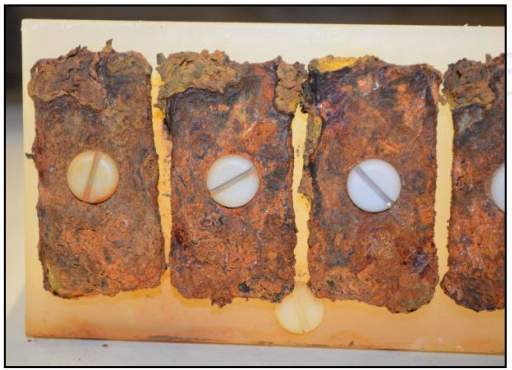
Standard Reference Materials

- ASTM G156-24 *Standard Practice for Selecting and Characterizing Weathering Reference Materials*
- Builds confidence in tester's ability to deliver comparable test conditions



Polystyrene
SAE Xenon arc historical

Blue Wool
ISO textile test timing



Mass-Loss Coupons
Widely used in corrosion testing

We make testing simple.

Control Materials

- Known durability
- Similar *composition* to test material
- Similar *degradation mode* to test material
- Best practice to include both weak- and strong-performing control materials
  - You don't learn much when everything passes or everything fails!

We make testing simple.

Summary

Four guidelines to run a good comparison test

1. Match test parameters
   - Test standards often have key details that may not be obvious
2. Match details of evaluations
   - Results depend on the technique and the evaluator
3. Agree upon acceptance criteria
   - Understand upfront what differences are acceptable based on existing research
4. Implement good lab practices
   - Consistent scientific protocols, use of reference materials

We make testing simple.

Thank you for your time.

Questions?

info@q-lab.com

We make testing simple.