

# Natural Weathering Testing

## A Basic Introduction on How to Perform the Best Natural Weathering Test

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# Scope

- Products left outdoors lose performance and aesthetic properties
- Weathering tests are used to determine how well a product, or material, will resist the effect of long term outdoor exposure
- Accelerated testing is now the *most common* method for estimating service life, but ...
- Natural Weathering is the *most accurate* method for doing durability testing

# Significance

- Natural outdoor weathering is the most accurate way to understand the durability
- One widely-held myth is that natural weathering is slow
  - Product development cannot afford to be slow
- Accelerated weathering is first choice
  - But accelerated weathering can give misleading results
- Outdoor weathering is never wrong
  - Benchmark testing can be reasonably quick too

# Different ways to get outdoor results

- Field surveys
  - But you don't know the full history of exposure and usage
- Review a history of customer complaints
  - Generally this is too late to be of any use except for reference
  - Need to know before it becomes a complaint
- Put a sample of your product outdoors and see what happens
  - Depending where you are, this might influence the relevance
  - Might not be a good representation
- Consider sending specimens to an accredited third-party commercial test facility

# Why Use a Third-Party Site

- Commercial test sites operate in recognized benchmark climates so that companies can get most relevant data
  - Commercial test sites provide unbiased results on the durability performance of their product
  - Commercial test sites have trained personnel to ensure the testing is done correctly
  - Commercial test sites provide all the specified documents and reports
- Commercial test sites have the experience to recommend the best methods
- Commercial test sites have all the proper equipment for exposures and evaluations

# Choosing a test procedure

- There is no single “one-size-fits-all” standard exposure test
  - All options in a test must be reviewed and selected
  - Each option may affect the outcome of the test
  - Choose the options that best suits the end use of the product

## • Options

Location (where to test)

Backing or no backing

Evaluations

Type of Exposure

Duration

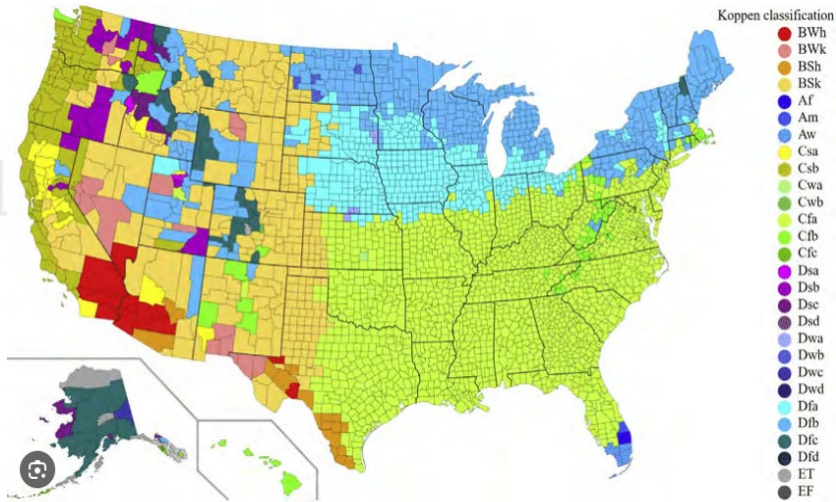
Type of Specimen

Angle of Exposure

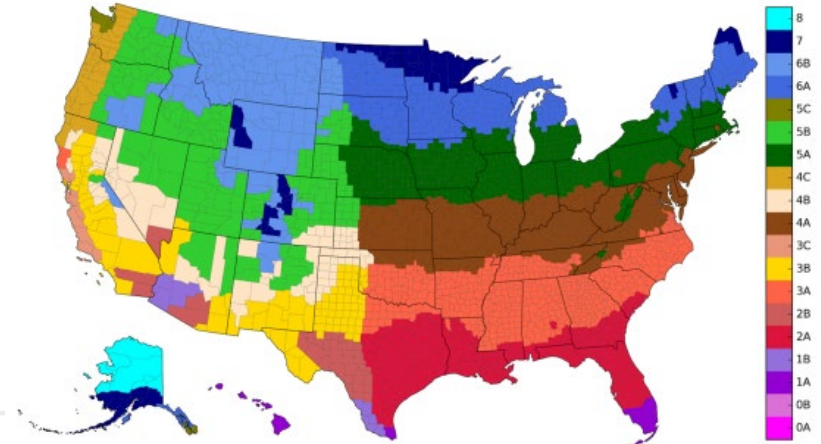
Services (washing?)

# Climate Categories

**Köppen System**



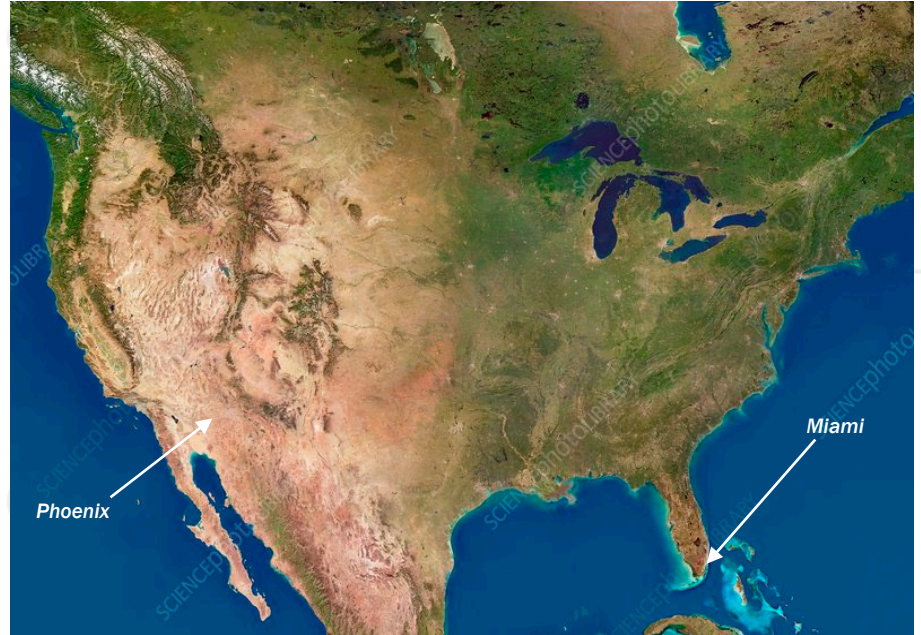
**ASHRAE System**





# Commercial Benchmark Locations

- Send your specimens to an accredited lab
- Use a benchmark climate
  - Florida, Arizona
  - Recognized, comparable
- Benchmark locations are there for a good reason
- For USA, two major geo-climatic regions



# Where to Test: Florida or Arizona

## Florida

- Primary Benchmark
- Hot, Humid, Sunny
- Represents most temperature locations
  - Eastern USA, Europe, East Asia, Africa, South America, China, India

## Arizona

- Primary Benchmark
- Very Hot, Dry, Sunny
- Represents most dry locations
  - Western USA, Middle East, North Africa

# Primary test locations



Arizona



Florida

# How to Test: Type of Exposure

## For Panels/Specimens

- Direct Exposure
- Black Box
- Under Glass
- Salt Spray
- Mildew
- Based on end-use position

## For Whole Products

- Service Position
- Special Projects
- In Use Environment
- Recreate the actual usage

# How to Test: Direct Exposure

- Most appropriate option
- Open to all weathering elements
- Specimens receive direct sunlight and rain
- Special exposure racks for mounting panels
- Choice of angles, facing direction, and orientation



# How to Test: Black Box

- Specimens are exposed at 5° south of the top surface of large metal box
- Box is 12 ft wide by 5.5 ft high and 9 in deep
  - 3.65 m wide × 1.65 high × 0.23 m deep
- Black Box retains heat from the radiant solar exposures
- Designed specifically for automotive coatings and used only in Florida
- Can also be used for any direct exposure that needs higher temperatures



# How to Test: Under Glass

- Specimens are exposed behind a sheet of glass
- Glass filters out some UV and protects from rain
- Specimens are 3" (75 mm) below glass cover



# High-Temperature Glass Box

- Under Glass Black Box
  - Used in Arizona to test automotive interior materials
- Q-Lab AIM Box
  - Automotive Interior Material
  - Sealed
  - Automotive glass cover
  - Temperature limited
  - 79, 85, 93, 102, 110 °C





# Salt Spray

- Originally designed for testing automotive parts for resistance to road salt
- Scribed panels are sprayed 2x per week with 5% salt
- Test usually runs only 10 to 20 weeks



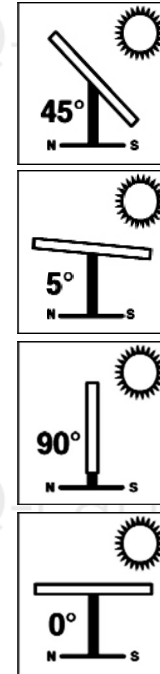
# Biological Exposure

- Mildew grows in shaded, sheltered locations
- Average RH between 70 and 85%
- Regular racks at 90° North
- Enhanced mildew rack faces North in trees
- Add extra water mist to get algae



# How to Test: Exposure Angle

- 45° used for majority of specimens
  - Industrial coatings, wood varnishes,
- 5° used for automotive coatings, flat roofs, decking
- 90° used for siding, architectural paints
- 0° horizontal used when water ponding is desirable
- Latitude angle (25° in So.Fla.) used for solar panels
- Variable angle (5, 25, 45°) maximizes solar radiation



# How to Test: Backing Types

## Open (Unbacked)



- Specimens are open to the atmosphere on all sides
- Most common type
- Rigid panels and boards
- Hard plastic specimens

## Mesh



- Supports flexible specimens: rubber-like
- Mounting 3D specimens
- Does not significantly raise temperature
- Does not affect wet time

## Solid



- Solid backing for textiles and fabrics
- Generally increases wet time and temperature
- End use simulation
- Insulation

# How long should the test last?

- Based on Specification
  - Time is set by a material specification, thus pass or fail
- Based on an arbitrary calendar duration
  - Example 6 months, 2 years, or 5 years
- Based on arbitrary solar radiation dosage
  - Example 1 Florida Sun Year, 5 years AZ ultraviolet
- Based on Critical Failure
  - When the specimen reaches a certain pre-set failure point
- Based on Comparative Evaluations
  - When enough difference between test and reference specimens

# Specimen Types

## Specimens

- Panels, coupons, swatches, plaques, boards, bars
- Single material
- Easier to handle
- Basic property data
- Surface appearance properties
- Preparation adds variability
- Generally test in multiples

## Objects

- Windows, wheels, doors, roofs, decks, cars, houses
- Component pieces
- Bigger, require more space
- More realistic data than specimens
- Taken from production line
- Generally tested as single item

# Best Sizes for Testing

## Too small?

- Big enough to handle
  - Small specimens need specialized hardware
- Will not fit into a standard frame
  - Mask area too big
- Mounting charges

## Too big?

- Harder to move
- Extra costs for exposure
  - Uses more rack area
- Mounting charges
  - If special frames must be constructed

*The "Goldilocks" specimen is a 10cm to 15cm x 30cm panel*

# Rigid Panels

Most specimens fall into this category

- Rigid, self supporting
- Metal or wood
- Flexible materials get backing





# Other Specimens

- Non-Panels
  - Fabric swatches, 3D objects, very small panels
  - Exposed on “sub-frames”



# No Size Restrictions for “Objects”



# Services

- Washing
  - Cleaning off the dirt and mildew
    - Allows more weathering effect on the surface
    - Physical damage possible (micro scratches on softer surfaces)
- Clipping
  - Cutting off a portion of the exposure specimen
- Masking
  - Covering a portion of the specimen to get a contrast

# Evaluations

- Data on the status of the Weathering
  - Visual Evaluations
  - Color Measurements
  - Gloss Retention
  - Physical Properties
- Progress reports
  - At least every 25% of the duration
- Final Report
  - Collate all documents for complete dossier



# Comparative Testing is the Best

- Compare two new products
  - Is it better, the same, worse?
  - Is it same performance but cheaper to make?
- Compare a new product to an old one
- Compare a product to a competitor
- Compare one batch to another
  - Quality control

# Weather Data

- Ambient temperature and humidity
- Rainfall amount and duration
- Wet Time
- Black and White Panel Temperature
  - Direct, Black Box and Under Glass Total
- Solar Radiation
  - 0, 5, 25, 45, 90 degrees South
- Total UV Radiation
  - 0, 5, 25, 45, 90 degrees South
- Under Glass radiation
- Wind speed and direction



# Uncertainty and Variability

- ASTM G141 lists variability
  - Seasonality
  - Year over year
- Specimen uniformity
- Uncertainty in Results
  - Evaluations
  - Sampling plans
  - Specimens

# Benchmark Advantages

- A test in a benchmark location is fast and accurate
  - A great test is both fast and accurate
  - Same results but faster is only acceptable outcome
- Data from a benchmark site is comparable to other tests
- Benchmark weathering data is readily acceptable
  - Already written into many specifications



# How much acceleration?

## Generalization at its finest

- Florida (compared to most *temperate* climates)
  - 2× for other southern locations
  - 3× for mid-latitude locations
  - 4× for northern temperate locations
- Holds true for all temperate regions ~ 25 to 60 ° latitude
  - With some exceptions
- Arizona (Compared to most *dry* climates)
- Acceleration data not as well published as that for Florida

# Outdoor compared to Accelerated

## Outdoor

- Slower
- More accurate
- Less Variable \*
- Any size specimens
- No quantity limitations
- Always correct\*\*
- Great value

## Accelerated

- Faster
- Some risk in every test
- Higher variability
- Only smaller specimens
- Quantity limitations
- Never 100% reliable

\* Short duration tests have variability issues

\*\* As long as the correct test protocol has been used

# Realistic Expectations

## Satisfaction increases with manageable expectations

- Outdoor weathering is slow but more repeatable
- Take advantage of the larger capacity and less expensive costs
  - More replicates, and more varieties
- Outdoor weathering is necessary to confirm accelerated results
- Interim evaluations and statistical proofing are absolutely needed
- *Comparative* testing is the most reliable method

Thank you for your time.

*Questions?*

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