



# ASQ CRE Prep course

Lesson V. B. 1.

Accelerated Life Tests

# The Best Test





# Cautions about ALT

- **Masked failure mechanisms**
- **New failure mechanisms**
- **Different models at different stresses**



- **Respect constraints**
  - Time, expenses, sample size, accuracy
- **Use use conditions**
  - Environment, frequency, loading
- **Minimize assumptions**
  - Statistical, modeling, variability
- **Focus on failure mechanisms**
  - Stress, damage, measurement

A silhouette of a lighthouse and its associated building against a dramatic sunset sky. The lighthouse is tall and cylindrical with a lantern room at the top. The building is smaller and has a chimney. The sky is filled with clouds, and the sun is low on the horizon, creating a warm, golden glow.

# Guiding Principles

# With no constraints

- **Build products and deploy, measure time to failure for every unit.**
  - Real time
  - Real stresses
  - Real variability
  - “Customer” defines failure







# No Constraints

- **Benefits**
  - Perfect results
  - No assumptions
- **Problems**
  - Takes time
  - No Sales, or
  - Customer risk

# Time Compression

- **Use product more often**
  - Increase use cycles per day
  - Maintain other stresses at use levels
  - Measurement system detects specific failure

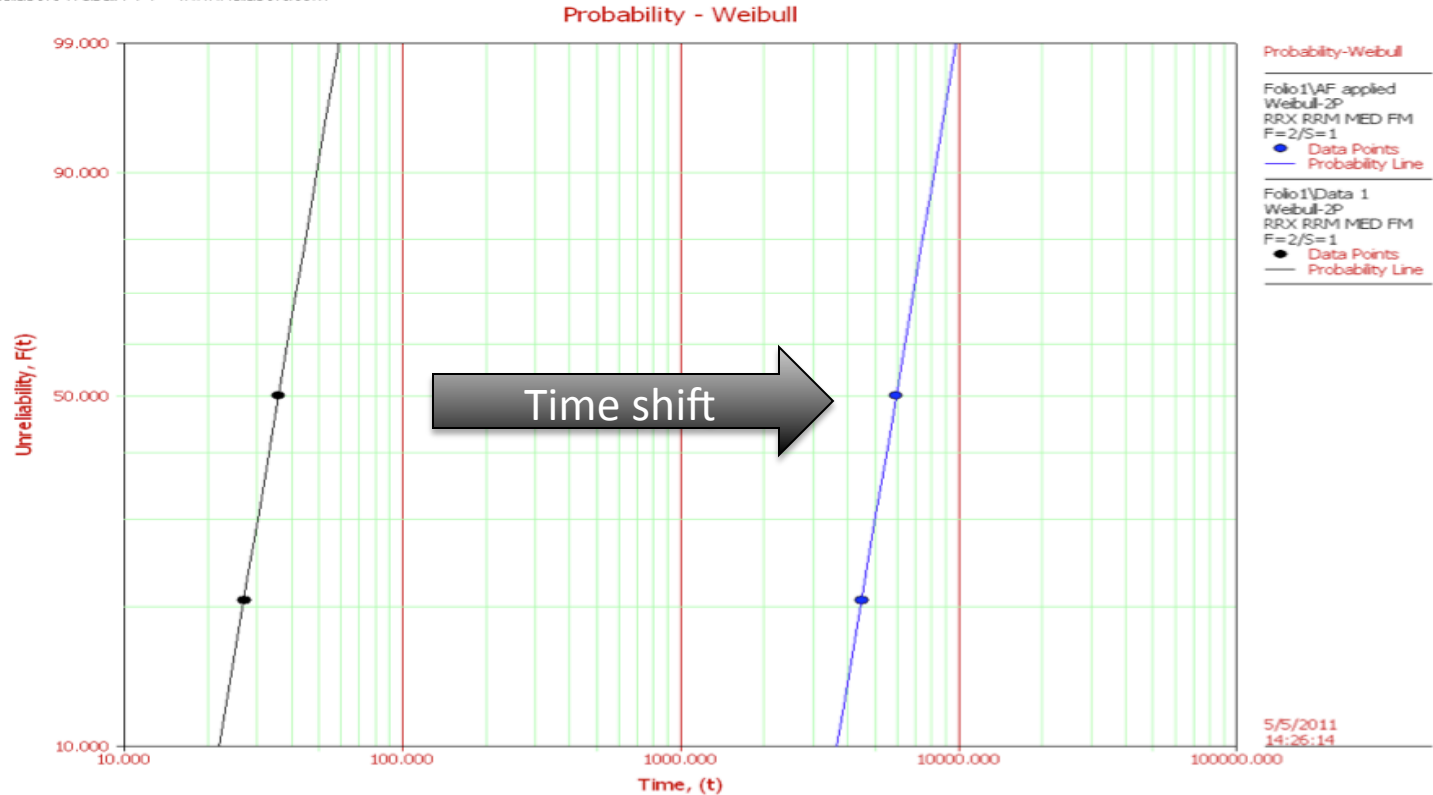
**Assumes specific action leads to failure**

- Wear, fatigue, accumulation
- Must understand or assume failure mechanism



# Acceleration Factor (AF)

ReliaSoft Weibull++ 7 - www.ReliaSoft.com



Folio1\AF applied:  $\beta=3.8181$ ,  $\eta=6368.1902$ ,  $p=1.0000$   
Folio1\Data 1:  $\beta=3.8188$ ,  $\eta=39.6264$ ,  $p=1.0000$



# Time Compression

- **Benefits**

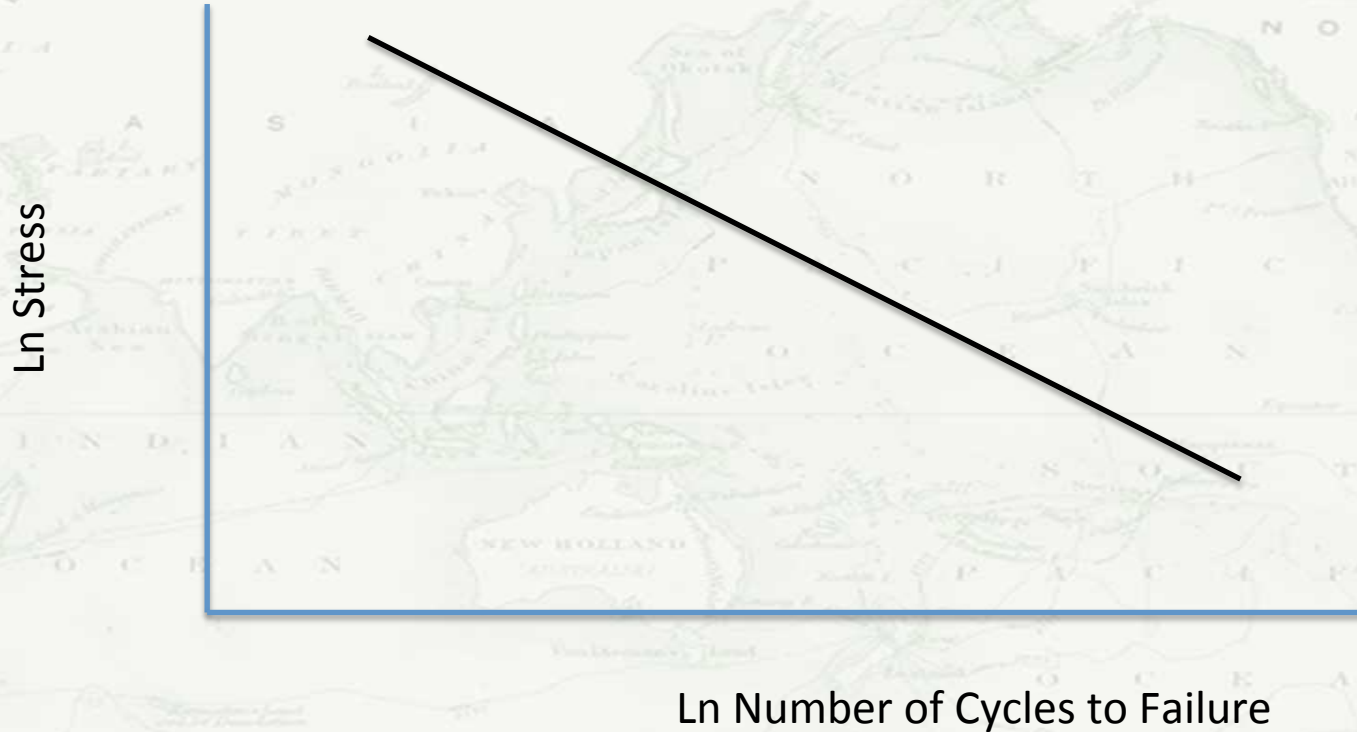
- Less time
- May use a sample
- Simple extrapolation

- **Problems**

- Not suitable for time dependent failure mechanisms
- Nor, 24/7 loaded products



# Stress to Life Relationship



# Stress to Life Relationship

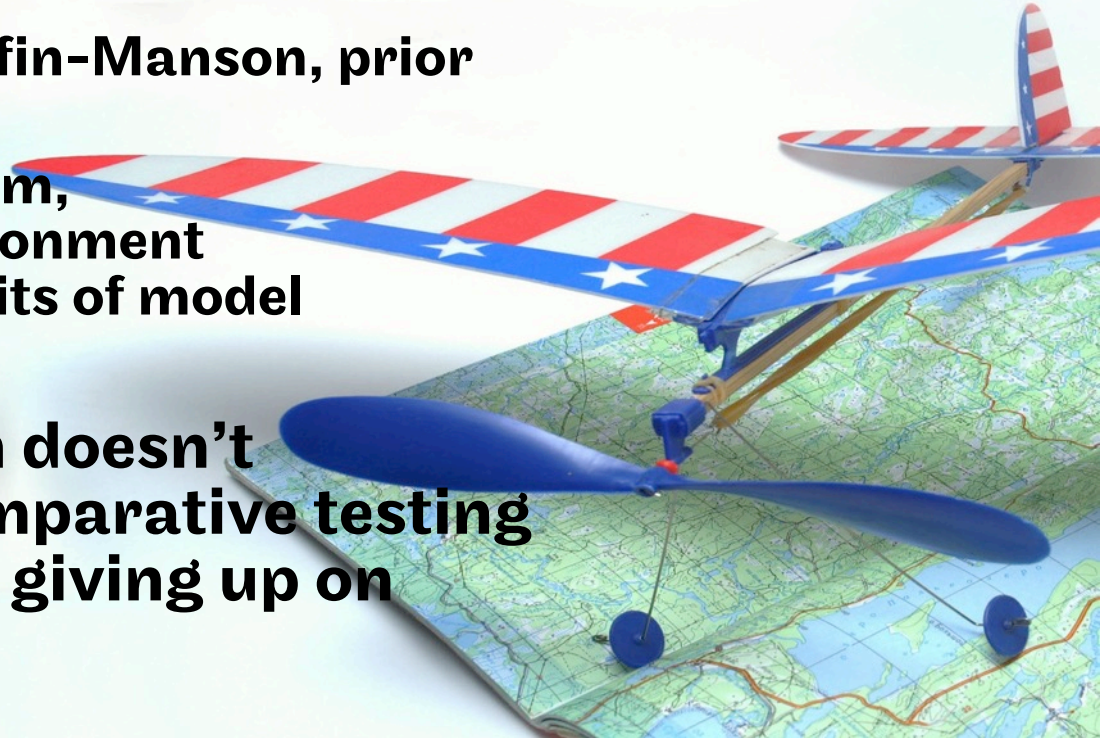
- **Benefits**
  - Creates AF model
  - Product of use specific
- **Problems**
  - 1 or 2 stresses or failure mechanisms
  - Logistically challenging





# Acceleration Model

- **A model exists describing the stress to life relationship**
  - Arrhenius, Peck, Coffin-Manson, prior work
  - The failure mechanism, use profile, and environment within applicable limits of model
- **If failure mechanism doesn't change, may use comparative testing in absence of model, giving up on accuracy of result.**



# Acceleration Model

- **Benefits**
  - **Single stress to apply**
  - **Fewer samples**
- **Problems**
  - **Assumptions multiplying**
  - **May miss new failure mechanism**



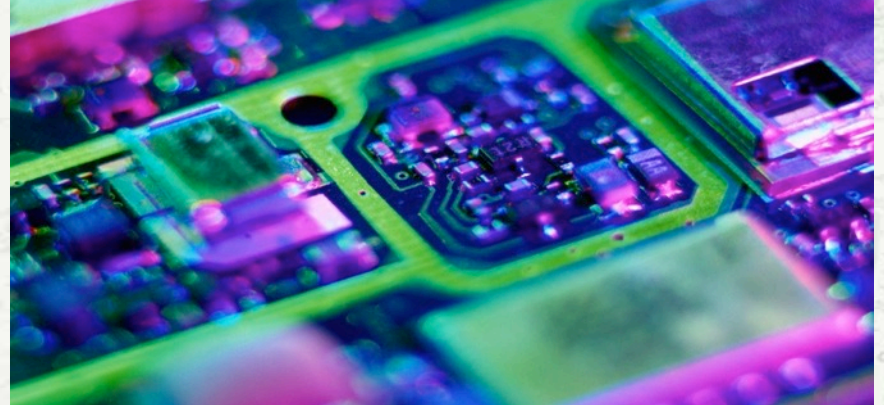
# ALT w/ AF model

- **Peck's Relationship**

$$AF = \left( \frac{RH_u}{RH_t} \right)^{-3.0} \exp \left[ \frac{E_a}{k} \left( \frac{1}{T_u} - \frac{1}{T_t} \right) \right]$$

- **Norris-Landzberg**

$$AF = \left( \frac{\Delta T_t}{\Delta T_u} \right)^{1.9} \left( \frac{f_u}{f_t} \right)^{1/3} \exp \left[ 1414 \left( \frac{1}{T_u} - \frac{1}{T_t} \right) \right]$$





# Step Stress

- **Variation of acceleration model ALT, with samples experiencing step increases in stress**
  - **Quicker than acceleration model method**
  - **May require more samples**
  - **Requires careful control of stress and failure detection**
  - **Best with accumulated damage failure mechanisms**



# Degradation

The background of the slide features a close-up photograph of several rectangular metal blocks, possibly concrete or steel, which are heavily corroded with a thick, orange-brown rust. In the upper right corner, a portion of a metal strip with a series of sharp, downward-pointing serrations is visible, also showing signs of rust.

- **Useful when performance decays over time in a measurable way**
  - **Often used with an acceleration model**
  - **Failure is defined by threshold value**
  - **Non destructive measurements permit repeated measures on samples**

Focus on the  
Failure  
Mechanisms?





# ASQ CRE Prep course

Lesson V. B. Bonus

A Few Models