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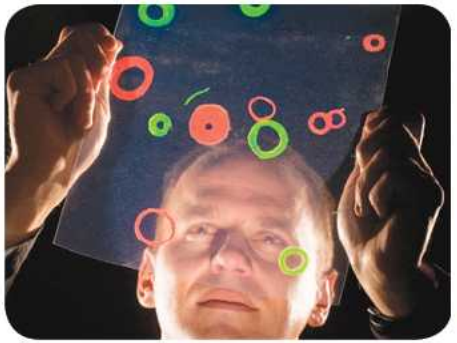

Reliability Model Development for Photovoltaic Connector Lifetime Prediction Capabilities

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U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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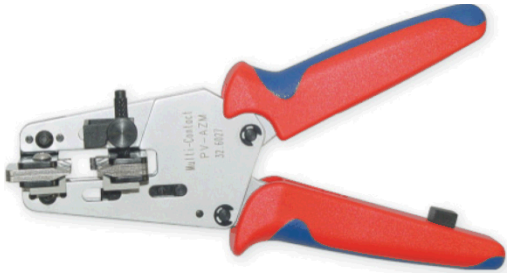
Connector Overview

- Chose three popular manufacturers representing different contact materials and ingress protection rating.

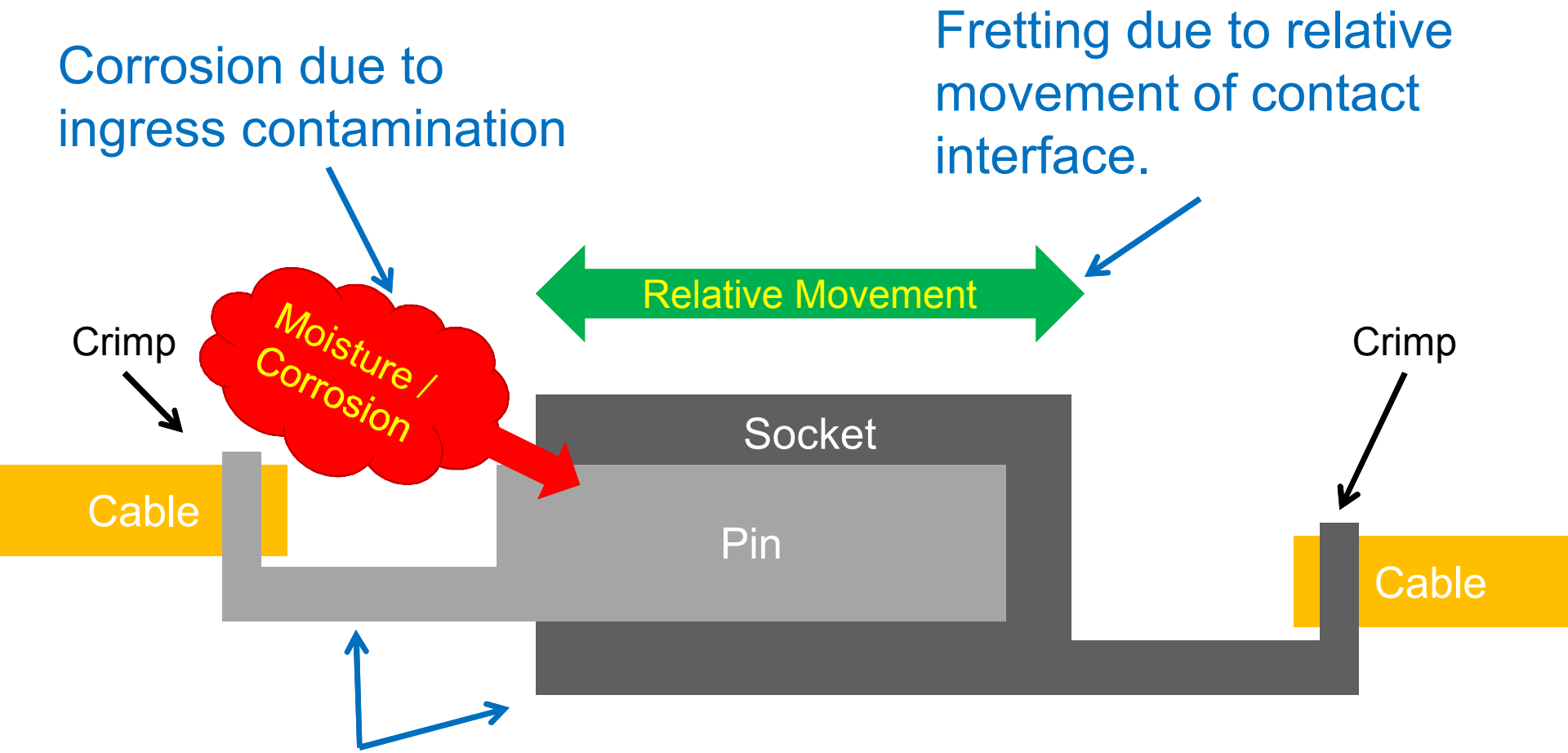
	Contact Material	Ingress Protection
Amphenol Helios H4	Tin-plated copper	IP 68
MultiContact MC4	Tin-plated copper	IP 67*
Tyco SOLARLOK	Tin-plated silver	IP 67

- Used manufacturer-supplied, UL-approved hand tools



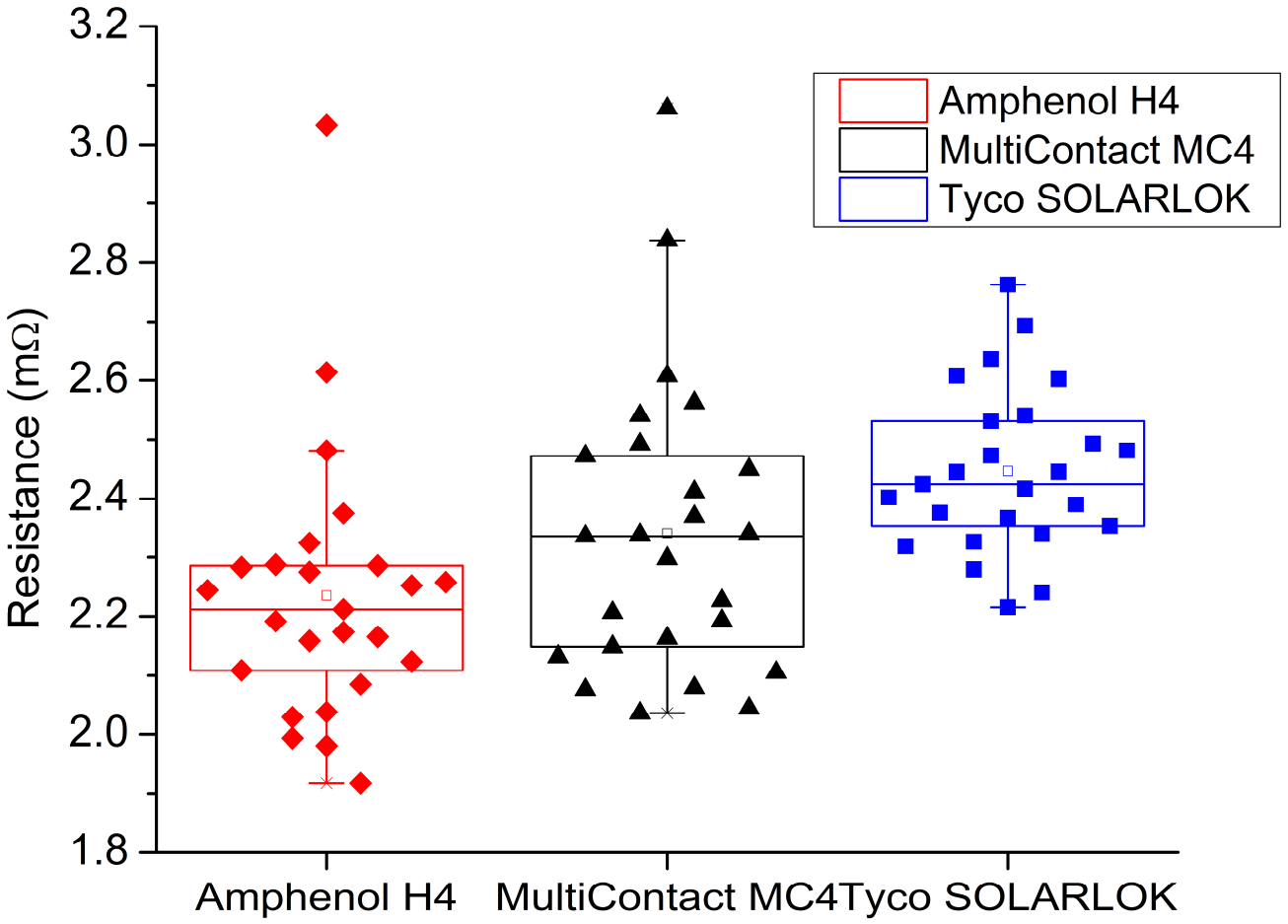
*** MC4 is IP 68 rated for 1 min**

Degradation Mechanisms Overview



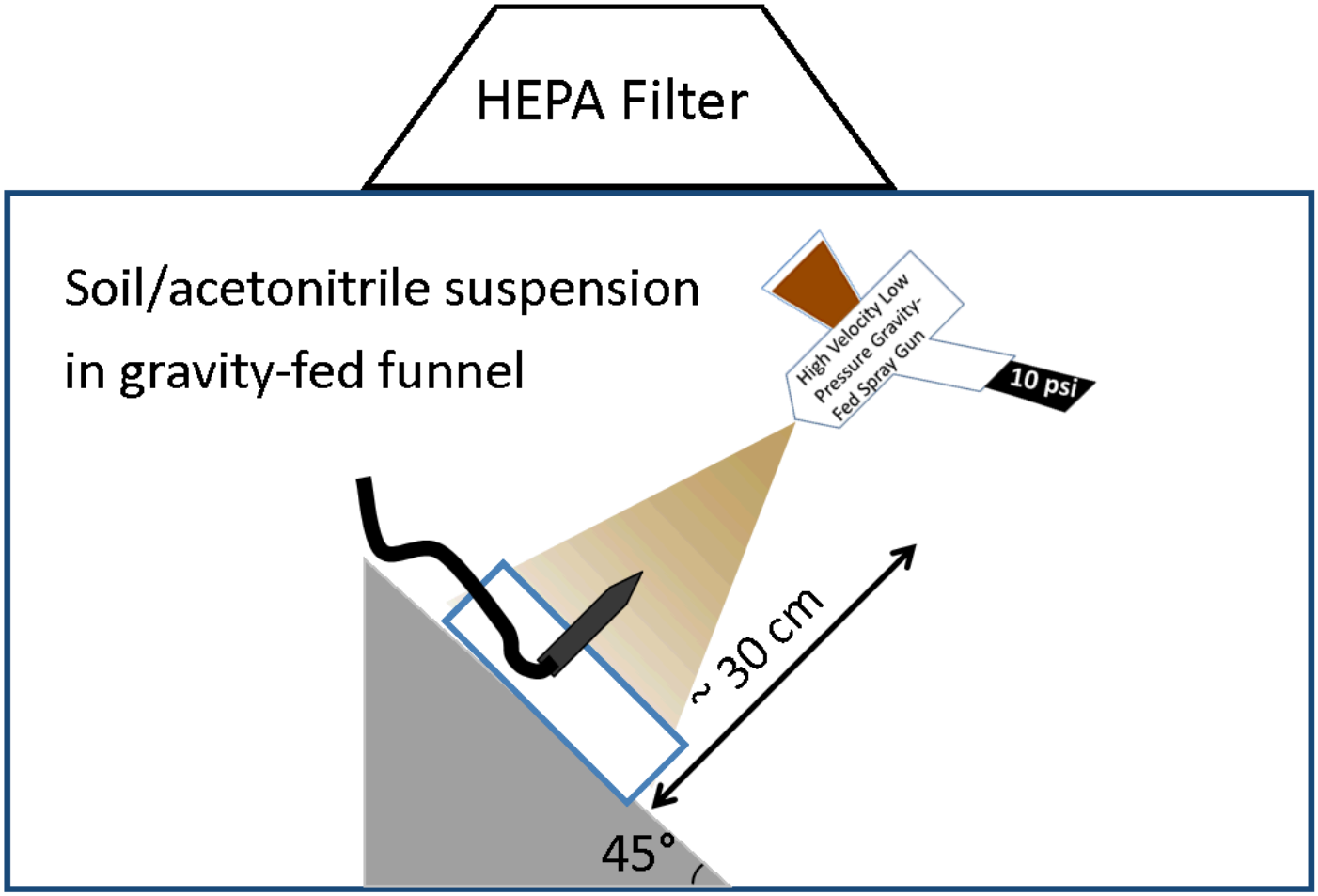
Note: These mechanisms can also take place at crimps

Contact Resistance Distribution



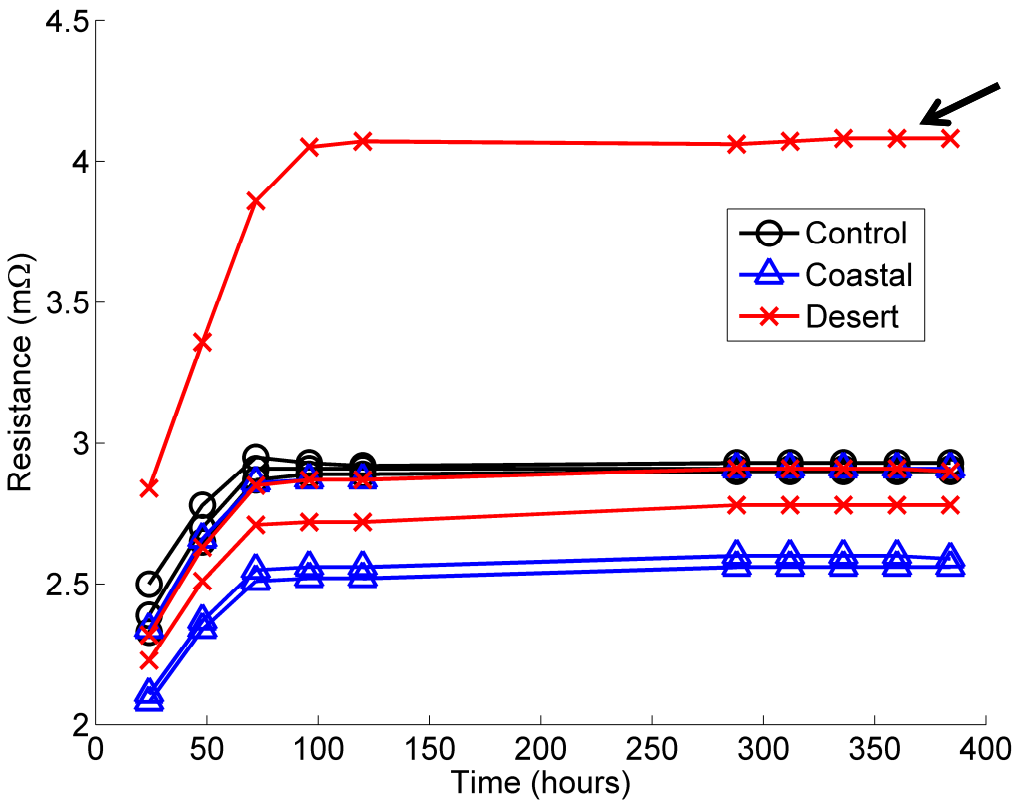
Overall, designers should expect an average contact resistance of 2.3 mΩ with standard deviation of 0.2 mΩ.

Effect of Grime on Damp Heat - Methods



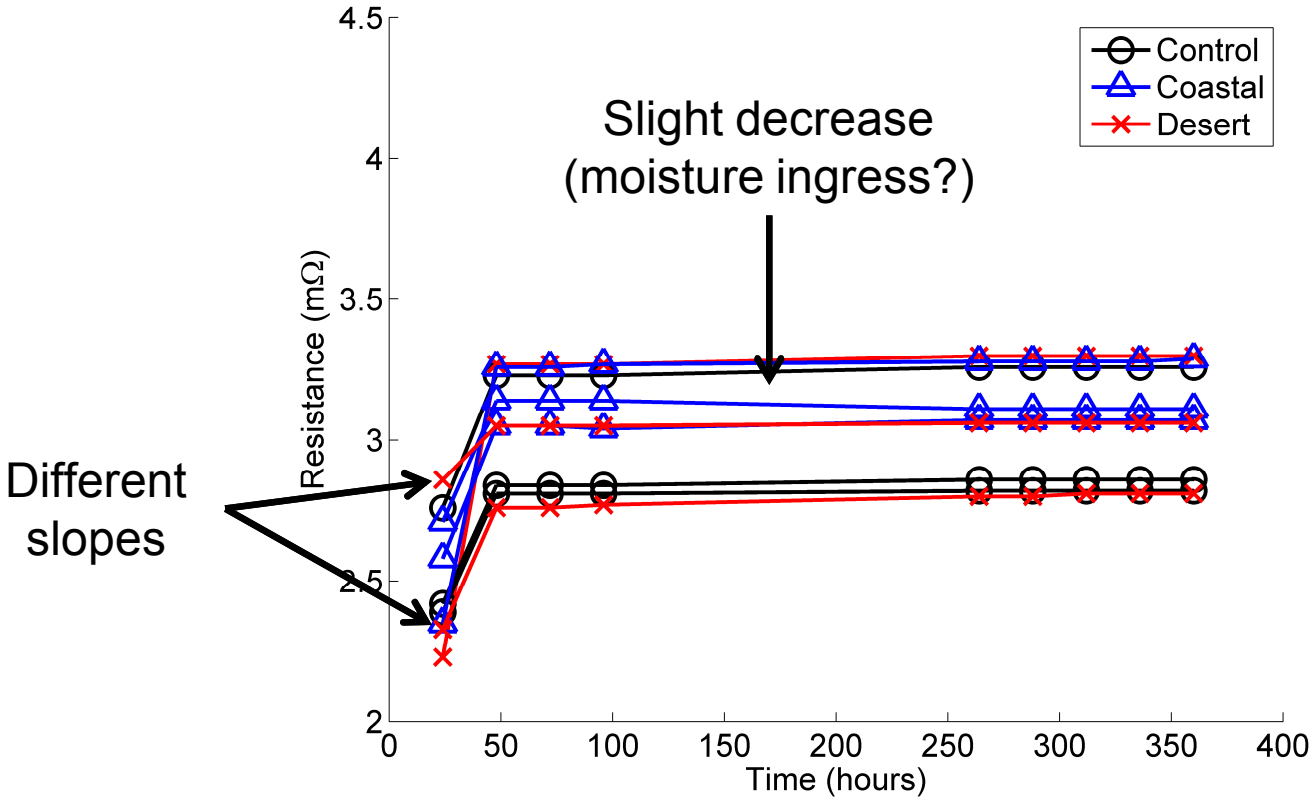
- Desert-simulating and coastal-simulating laboratory grime uniformly applied to connectors prior to mating.
- See P. Burton *et. al.* (Tuesday poster) for more details.

Damp Heat Results: Amphenol Helios H4



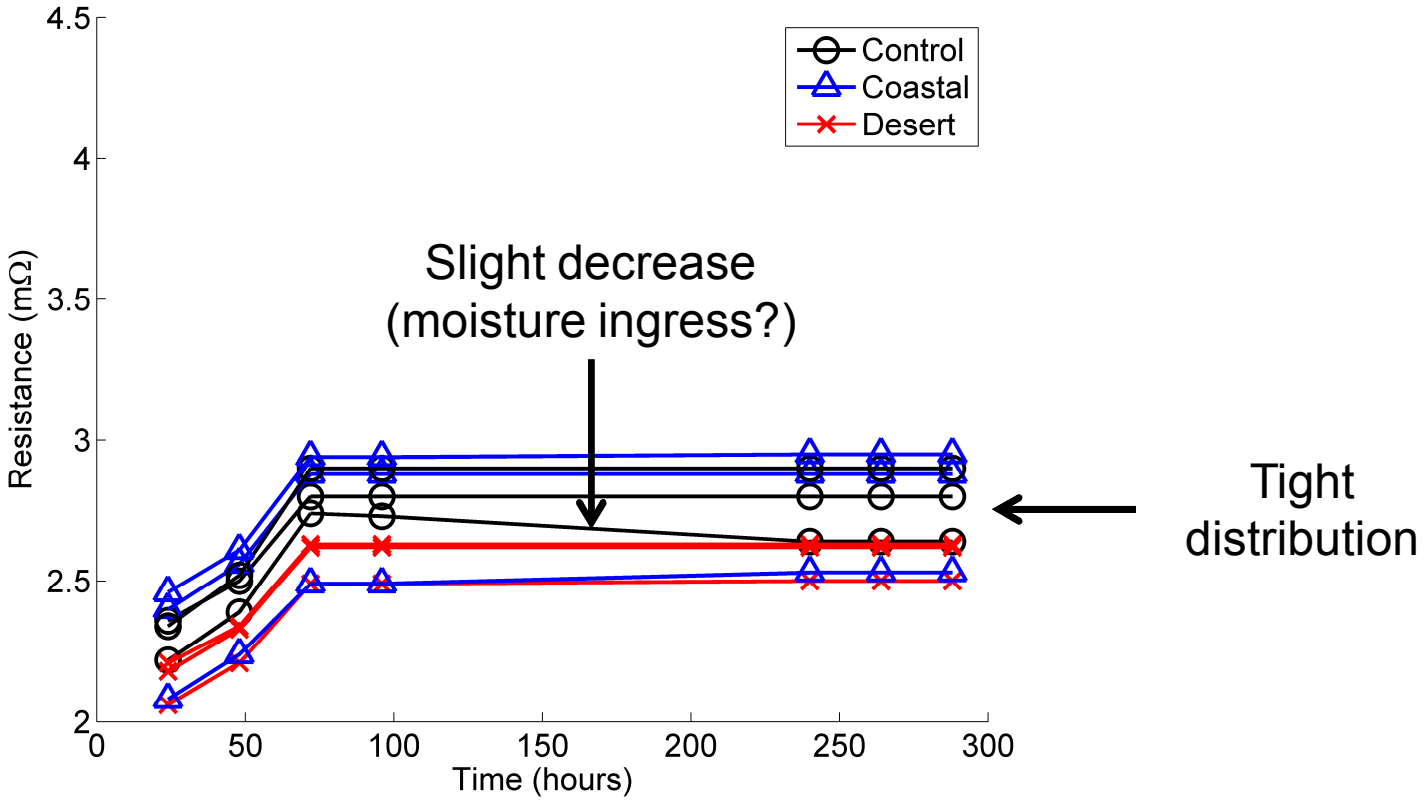
- Damp Heat = 75°C / 85% relative humidity (RH)
- Small (~0.5 mW) change in first 100 hours
- No significant difference between control/coastal/desert
- One sample experienced greater increase, still with acceptable levels.

Damp Heat Results: MultiContact MC4



- Small (~0.5 mW) change in first 100 hours
- No significant difference between control/coastal/desert
- One coastal sample experienced minor decrease in resistance
- Desert sample experienced different rates of increase in first 100 hours

Damp Heat Results: Tyco SOLARLOK



- Small (~0.5 mW) change in first 100 hours
- No significant difference between control/coastal/desert
- One control sample experienced a ~0.1 mΩ change in resistance between 100-250 hours

Test Plan

Sandia National Laboratories

Class II & Class III Corrosion

Damp Heat

Temperature Cycle

Accelerated Testing

Humidity Freeze

Reliability Model

Normal Outdoor Exposure

Summary

- Expected connector resistance distribution:
  - Average contact resistance of 2.3 mΩ
  - Standard deviation of 0.2 mΩ
- Connectors with coastal/desert grime in damp heat (85°C/85%RH):
  - No significant difference (< 2mΩ) after 200 hours damp heat
- Additional testing being implemented to develop a comprehensive connector reliability model