Exceptional service in the national interest

Sandia National Laboratories

Photovoltaic BOS Connector Accelerated Test for Reliability Model Development and Arc-Fault Risk Assessment

Benjamin B. Yang, Jay Johnson, Kenneth M. Armijo, Jason M. Taylor, N. Robert Sorensen

Introduction

Adverse effects of BOS connector degradation include:

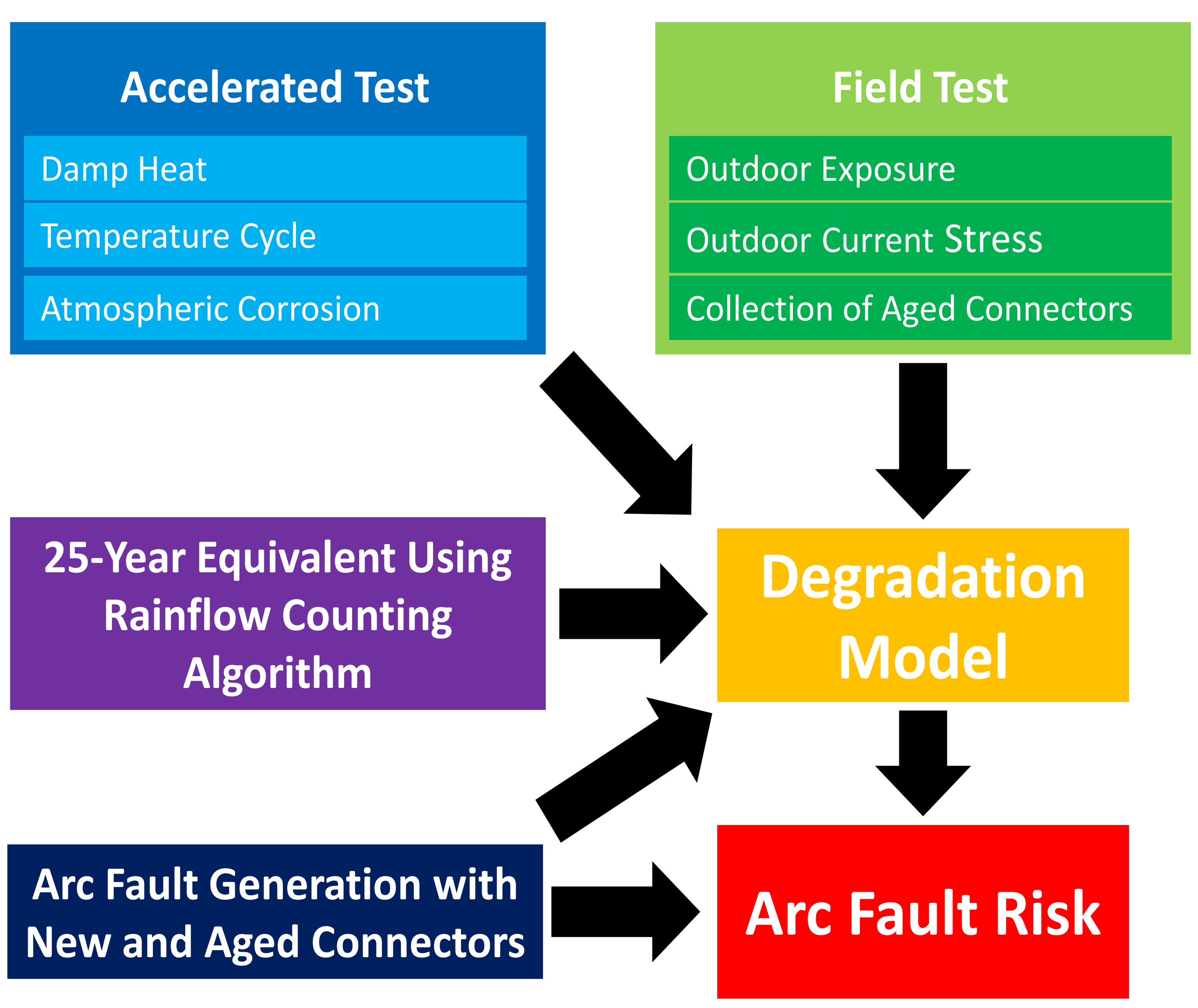
- Ohmic loss
- Increased series arc fault risk

This project aims to:

- Develop a model of resistance degradation using accelerated test and field data
- Study the effects of connector resistance on arc fault risks

Example of connector arc fault event [1].

Methods

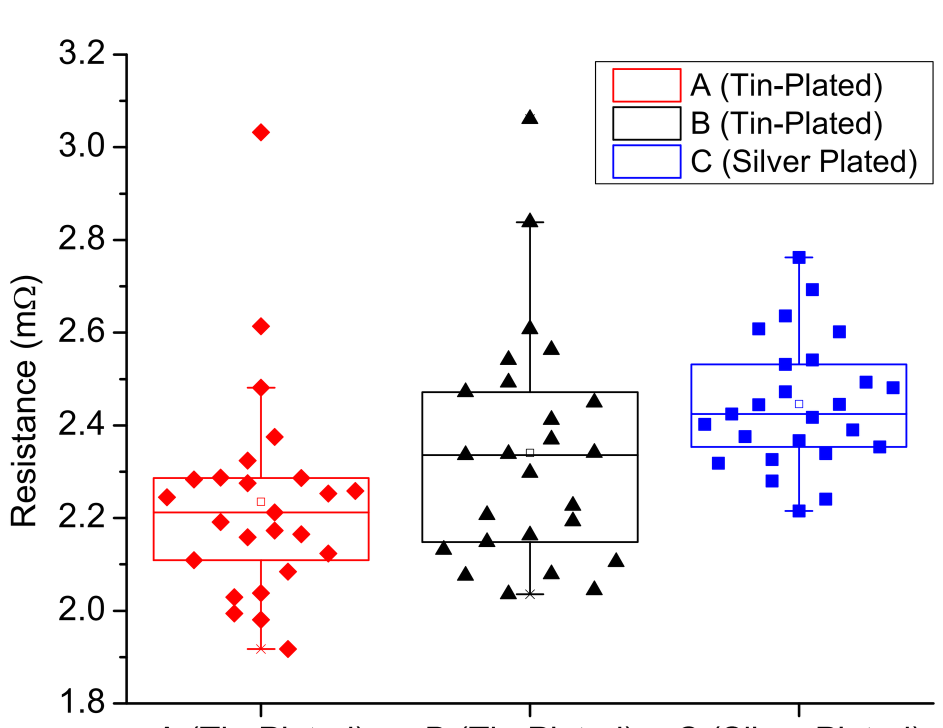


The research approach is outlined in the above figure. Key features include:

- A degradation model based on accelerated test and field data
- Arc fault risk assessment by subjecting new and aged connectors to an arc fault generator

The arc fault generation experiments establish a suitable failure criterion while the degradation model translates the results into BOS connector lifetime.

Current Results



A study of unstressed contact resistance variation by brand shows a manufacturer dependence on statistical variations [2].

Silver-plated connector had the tightest distribution.

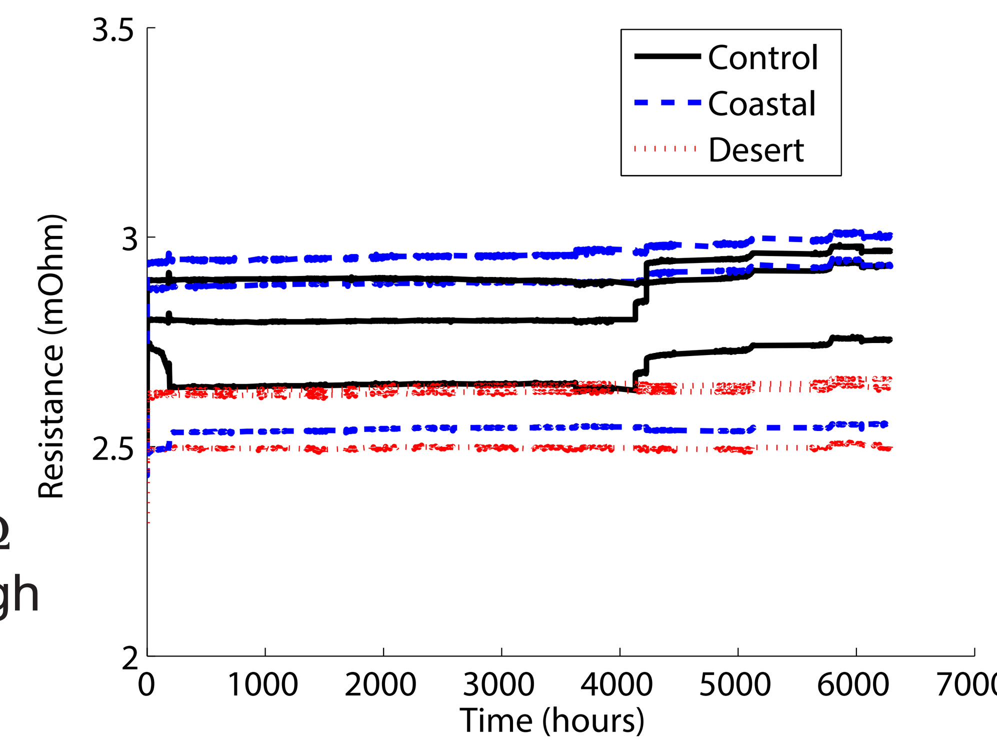
Current results suggest that system designers should expect contact resistance of 2.3 mΩ with a standard deviation of 0.2 mΩ.

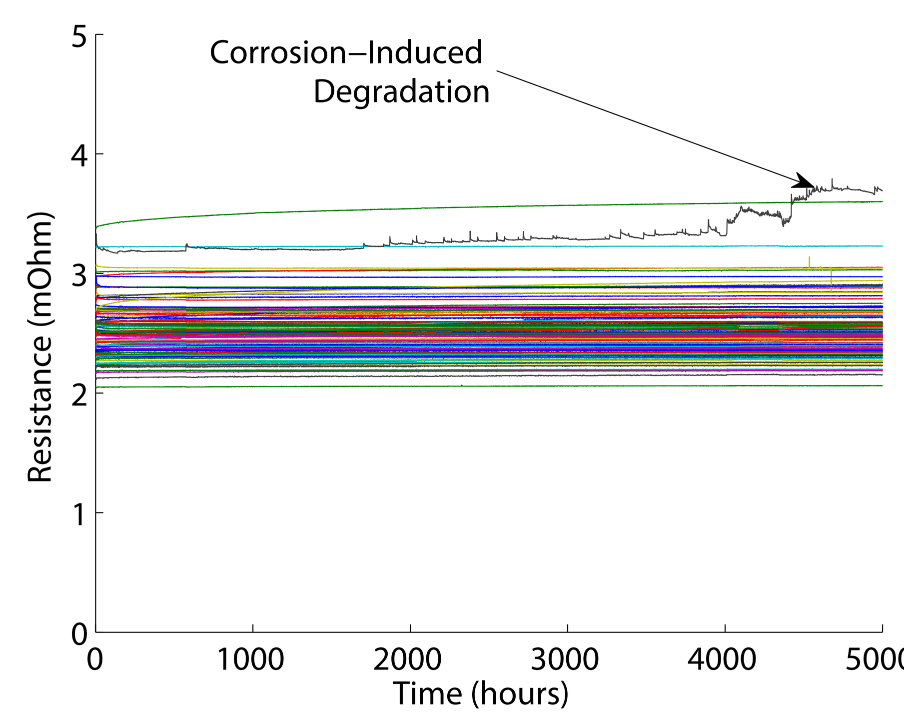
Over 6000 hours of damp heat test results are shown in the figure on the right.

A subset of the samples included contamination of coastal- and desert-simulating grime for comparison with a control group [3].

Resistance remained below 5 mΩ during time period shown, although variations begin to develop after 4000 hours.

Presence of grime has been a non-factor in this data set.





Contact resistance of 99 connectors as a function of exposure in a Class II corrosion chamber are shown in the left figure.

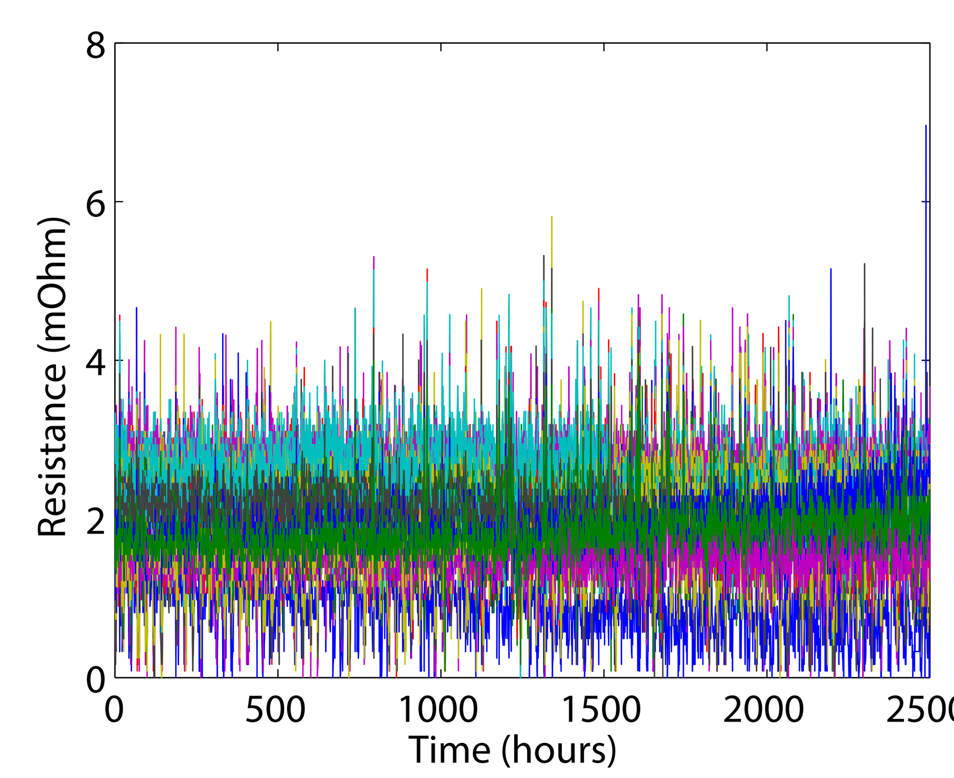
Corrosion-induced degradation is observable in one connector.

Continued monitoring as well as implementation of a Class III corrosion environment will provide additional information on the effects of corrosion-induced degradation.

Contact resistance of connectors exposured to an outdoor high-desert environment for over 2500 hours is shown in the figure to the right. The effects of daily temperature variation are visible.

Long-term exposure is likely necessary to achieve resistance change.

Outdoor exposure experiments coupled with field stress and analysis of aged connectors will provide more information.



Conclusions

A degradation model is being developed to assess arc fault risk and predict connector lifetime using accelerated tests and field data.

Current accelerated test results suggest that BOS connectors are robust to the stress factors studied, though degradation and resistance variation in some samples are observed.

Additional accelerated and field tests as well as arc fault experiments are in progress to generate the additional data needed.

Analysis of aged connectors is another crucial source of information. If you would like to assist with this effort by supplying connectors of known age and history for analysis, please contact the authors (Benjamin Yang <bbyang@sandia.gov>).

[1] J. Kalejs, J. Gadomski, and Z. Nobel, "Connector issues on reliability," presented at the NREL PV Module Reliability Workshop, 2013.

[2] Benjamin B. Yang, N. Robert Sorensen, et. al., "Reliability Model Development for Photovoltaic Connector Lifetime Prediction Capabilities", PVSC, 2013

[3] P. D. Burton and B. H. King, "Application and Characterization of an Artificial Grime for Photovoltaic Soiling Studies," IEEE Journal of Photovoltaics, vol. 4, no. 1, pp. 299–303, Jan. 2014.

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiaryof Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

SAND # 2014-1403C