Accelerated Lifetime Testing:
Background Research and Protocol Development

Mani G. TamizhMani
Arizona State University

manit@asu.edu

Solar ABCs
PV Stakeholder Meeting

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It is a two-part study
Limited to crystalline silicon
Part 1: Background Research

• **Typical failures** *(not universal or specific climate)*

  • Identify field failures
    • *Visual/cosmetic/degradative & Catestrophic*

  • Classify field failures
    • *Failure Mechanism, Mode, Cause & Effect*
Typical failures – A few examples

- Delamination
- Bubble generation
- Encapsulant discoloration
- Interconnect discoloration
- Cell discoloration
- Broken interconnects
- Broken cells
- Corrosion
- Solder bond failures
- Broken glass
- Hot Spots
- Ground faults
- Junction box detachment
- Junction box arcing
- Interconnect arcing
- Cable/connector deterioration
- Backsheet cracking
- Backsheet burning
Part 2: Testing Protocol Development

- Typical protocol \textit{(not universal or specific climate)}
- Cost consideration
- Time consideration
Part 2 – Testing Protocol Development: An Approach

Field Stress Level

- $T_{max} = 52^\circ C$
- $\Delta T = 54^\circ C$

Accelerated Stress Level & Accelerated Power Loss

- $T_{max} = 85^\circ C$
- $\Delta T = 125^\circ C$

Change in Power for 6 modules at ASU

Determine lifetime

Statistical modeling
Part 2 – Testing Protocol Development:
Goal 1: Identify accelerated tests and test sequences (*Multi-stress: series/parallel/simultaneous*)

**Accelerated Testing Concept**

Pre-Stress Tests

Accelerated Stress Tests

Post-Stress Tests
Part 2 – Testing Protocol Development:
Goal 2: Identify required test equipment and test results

Test Equipment Used

- UV Testing
- Temperature/Humidity Testing
- Mechanical Testing

Pre- & Post-Test Results

Qualification Testing of 1225 c-Si Modules at TUV Rheinland PTL
Distribution of Failure Criteria (2007-2009)

Failure Rate After Stress

Before & After (EL)