TG2: Thermal and Mechanical Fatigue

Global TG-2 Leader: Nick Bosco (NREL)
TG-2 (JP) Leader: Tadanori Tanahashi (ESPEC)

in NREL PV Module Reliability Workshop 2014
2014/02/26 (Golden, CO)
**TG2: Thermal and mechanical fatigue including vibration**

**Proposed scope:**

Failures of cell interconnects and solder bonds have been identified as a key cause of long-term failure of PV modules.

The primary stresses affecting the failure rates have been shown to be thermal and mechanical.

There is evidence that vibration during transportation and/or caused by wind can contribute.

This task group will study how to best induce and quantify these failures.
Current Status

1. Recognition of Current Situation
   - TC 200 is not enough
   - Extended TC (ex. TC 600) may effective, but the long-term period is required.
   - In our experience, the interconnectors- / solder bonds- failures have been observed even in the moderate climate.
   - We need an option for subjecting the module to greater thermal-cycling stress than IEC 61215.

2. Requirements
   - Time Saving
   - Similar Failure Mode with Thermal Cycling
     -> Dynamic Mechanical Loading (DML) w/ or w/o TC
Massive Survey of PV modules Purchased from Market

- Model A (multi c-Si)
- Model B (multi c-Si)
- Model C (multi c-Si)
- Model E (multi c-Si)
- Model F (mono c-Si)

-5% Bypass Diode Breakdown In 3/5 Modules

Sample Size: 5~10 Modules/ Model


In the recently-designed PV modules, obvious power-loss was not induced even by TC600, except “Bypass Diode Breakdown”.
Efforts for the DML Testing w/ or w/o TC

1. NREL

Most of the interconnect ribbons may be strained through module mechanical loading to a level that will result in failure in a few hundred to thousands of cycles....... To evaluate the equivalence of DML to thermal cycling, parallel tests were conducted with thermal cycling.

2. TG-2 (JP)
DML-TC sequential testing may be effective to detect the solder-bond / interconnector failures.

NREL PV Module Reliability Workshop (Feb., 2013)
IEC TC82/WG2 Meeting (May, 2013)
Global TG-2: Discussion (Nov, 2013)

Discussion to follow separated the purpose of the DML/TC sequence and DML alone.

**DML/TC:** Break susceptible cells and realize that effect on module performance.

**DML:** Quick evaluation of ribbon interconnects fatigue resistance, will not assess cracked cells nor solder bonds.

Philosophy for DML loading level:

Should be equivalent to manufacturing/ use/ environmental loading. Therefore it may be reasonable to define a single loading level regardless of module size or shape.

Not attempting to produce equivalent deflection or strains:

Since smaller modules are naturally stiffer, they have a higher resistance to these types of failures.
# Global TG-2: Timeline (tentative)

<table>
<thead>
<tr>
<th></th>
<th>Qualification</th>
<th>QMS</th>
<th>Comparative Rating (TG-2)</th>
<th>Service Life Prediction</th>
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</thead>
<tbody>
<tr>
<td><strong>Current status</strong></td>
<td>Issued as standards</td>
<td>Revised NWIP submitted</td>
<td>Proposed as concepts</td>
<td>Concepts</td>
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<tr>
<td><strong>2014 goal</strong></td>
<td>Submit Ed 3 61215</td>
<td>Publish new TS</td>
<td>Enumerate tests</td>
<td>Develop criteria to</td>
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<td>Ed 2 61730</td>
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<td>Establish framework</td>
<td>evaluate QMS related to</td>
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<td>service life; NWIP</td>
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<tr>
<td><strong>2015 goal</strong></td>
<td>Publish new editions</td>
<td>Start use of the TS in</td>
<td>Complete drafts of set of</td>
<td>Complete CD</td>
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<td></td>
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<td>factory inspection</td>
<td>tests</td>
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<tr>
<td><strong>2016 goal</strong></td>
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<td>Revise QMS document</td>
<td>Revise rating system</td>
<td>Publish</td>
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<td>to reflect feedback</td>
<td>to reflect tests</td>
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<td><strong>Chamber test times</strong></td>
<td>Modules: ~ 6 weeks</td>
<td>TBD</td>
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<td>3 years ?</td>
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</tbody>
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- 2014 goal:
  - Submit Ed 3 61215 Ed 2 61730
  - Publish new TS

- 2015 goal:
  - Publish new editions
  - Start use of the TS in factory inspection

- 2016 goal:
  - Revise QMS document to reflect feedback

- Chamber test times:
  - Modules: ~ 6 weeks
  - TBD

- TBD:
  - TBD
  - 3 years?
Want to Volunteer!

To volunteer for TG-2, individuals may contact to TG-2 Leaders (Nick-san or Tanahashi) directly,

or request access to the website at

http://pvqataskforceqarating.pbworks.com/