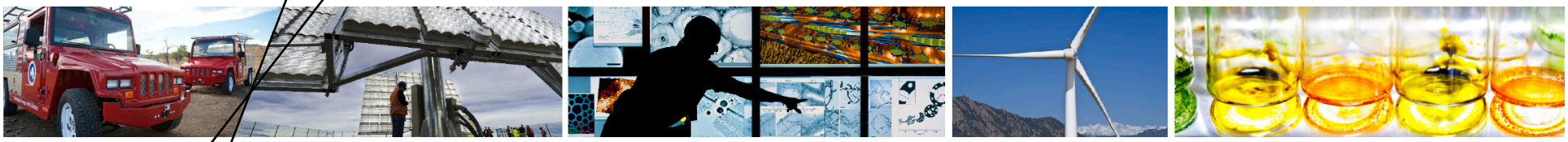
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

International PV Module QA Task Force



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September 14, 2012

Solar ABCs

PV Stakeholder Meeting

Introduction

Wish to perform accelerated stress tests to determine lifetime of PV modules

Problem is that we can't do that today:

- Don't know what accelerated stress tests to perform to predict lifetime.
- The lifetime depends on how and where we deploy the module because of different field stress levels.

Solution

- Need to understand PV module failure modes
- Have to determine acceleration factors between field conditions and accelerated stress tests conditions.

International PV Module QA Forum

Goals of International PV QA Task Force:

1. *To develop a QA rating system that provides comparative information about the relative durability of PV modules to a variety of stresses as a useful tool to PV customers and as a starting point for improving the accuracy of quantitative PV lifetime predictions.*
   1) Compare module designs
   2) Provide a basis for manufacturers' warranties
   3) Provide investors with confidence in their investments
   4) Provide data for setting insurance rates

2. Create a guideline for factory inspections of the QA system used during manufacturing.

PV QA Task Force

Task Group 1: Guideline for Manufacturing Consistency
Task Group 2: Testing for thermal and mechanical fatigue
Task Group 3: Testing for humidity, temperature, and voltage
Task Group 4: Testing for diodes, shading and reverse bias
Task Group 5: Testing for UV, temperature and humidity
Task Group 6: Communication of PV QA ratings to the community
Task Group 7: Wind Loading (New group)
Task Group 8: Testing of Thin Film Modules (New group)
Task Group 9: Testing of CPV Modules (New Group)

Task Group 1- Scope

- **Design a guideline that could be used as base document for a new IEC standard for PV or as a new ISO standard. The guideline is focused on PV manufacturing processes and procedures aiming to insure manufacturing quality and the consistency of the so produced photovoltaic modules to the warranties given by the producer.**
- **The ISO 9001-2008 standard is considered as starting point for drafting the guideline and an ISO-like structure must be reflected in the guideline.**

Task Group 2

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.

Activities

- **Mechanical stress applied before thermal cycling**
- **Number of thermal cycles increased and/or accelerated**
- **Proposal being drafted for submission to IEC TC82 WG2**

Task Group 3

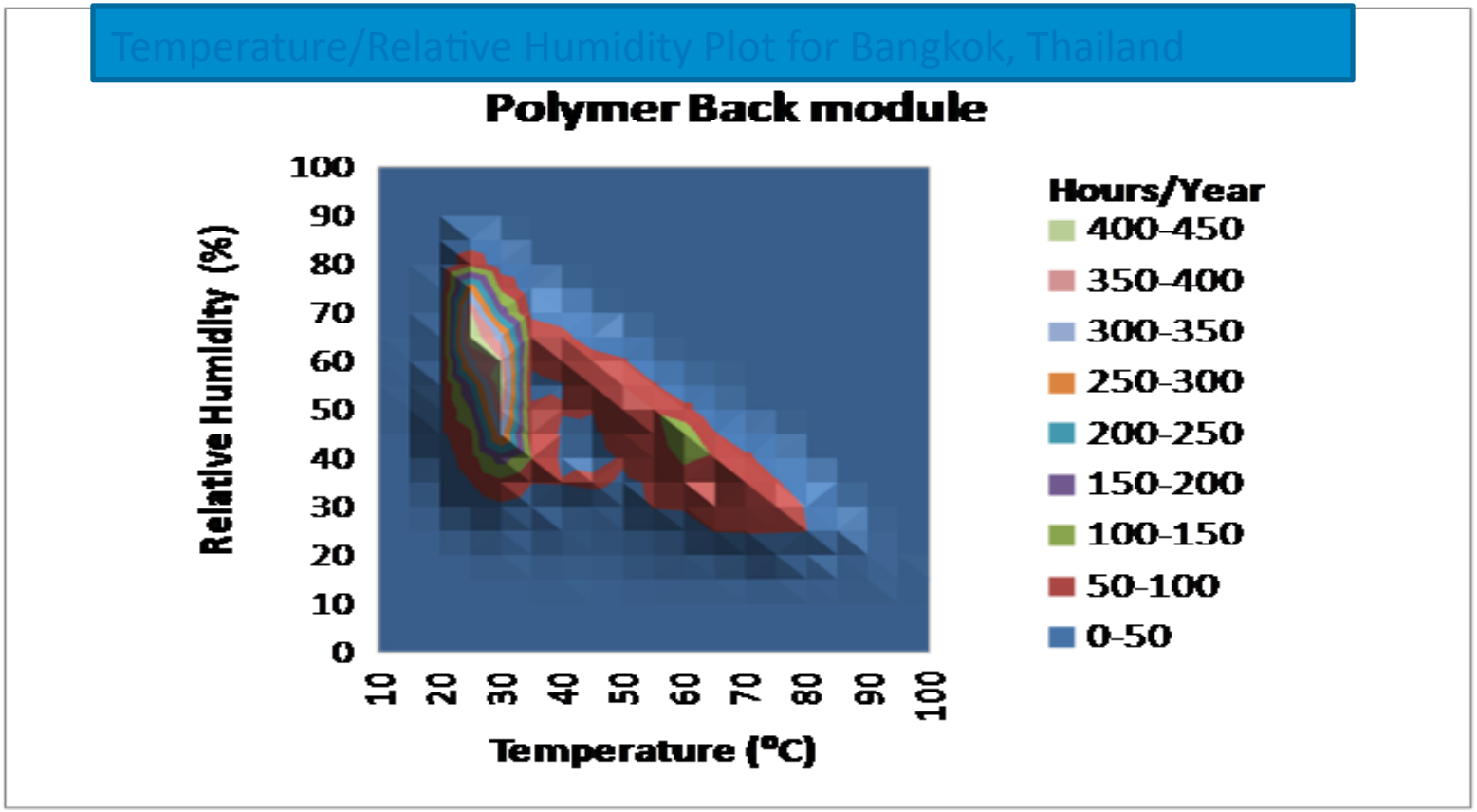
Scope

The ingress of moisture with or without electrical bias has been shown to cause corrosion and charge movement in PV modules. Temperature and humidity have been used as accelerated stress tests for PV modules for many years. There are multiple humidity and humidity/electrical bias degradation modes with widely varying acceleration factors. The group's development of true accelerated lifetime tests must take variation of environmental conditions into account.

Activities

- **NWIP to IEC for PID Testing**
- **Determining outdoor failure modes**
- **Trying to duplicate failures using accelerated tests**
- **Modeling water ingress in field versus test chamber and then how moisture leads to observed degradation in order to determine acceleration factors**

Modeling of Humidity Ingress into backside of Modules



Modeling of humidity levels in back of PV module with polymeric backsheet in Bangkok, Thailand.

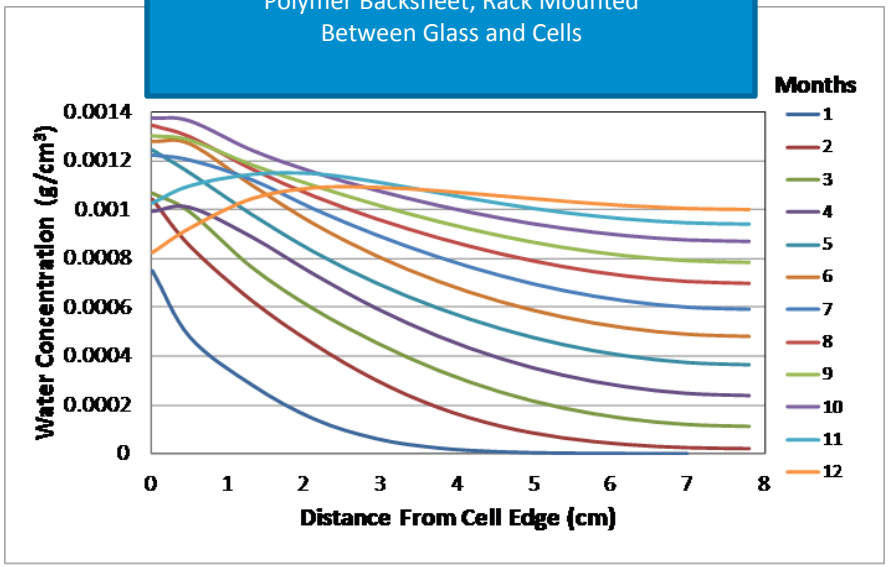
Damp heat test conditions (85/85) never occurs within module.

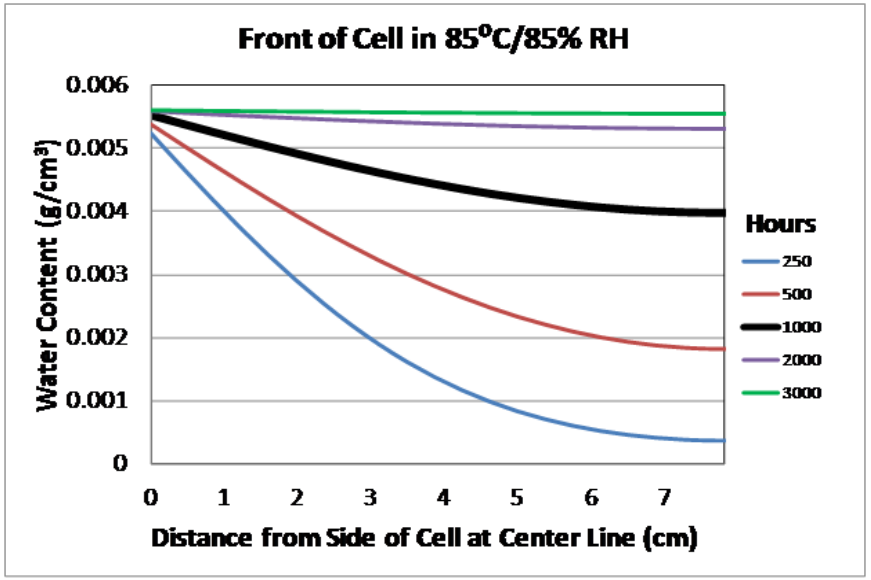
When module has high humidity it is cool.

When module is hot it has low humidity.

Modeling of Humidity Ingress into front side of Modules

Bangkok, Thailand
Polymer Backsheet, Rack Mounted
Between Glass and Cells





Task Group 4

Scope

There is increasing evidence that shading or other non uniformities in modules puts localized stress that can lead to overheating, and, in some cases, to fires. Not only is this failure a serious safety issue, but there is some evidence that aging modules show increasing non uniformity, implying that this may turn out to be a significant wear out mechanism. The details of the stresses that lead to these failures are not well understood but may be related to shading (and reverse bias operation associated with shading or other situations), high temperatures, and lightning.

Activities

- **Preparing standard for EDS testing of diodes**
- **Performing longer term thermal tests of diodes in both forward and reverse conditions to identify weaknesses**
- **Trying to identify causes for field failures.**

Task Group 5

Scope

Light (especially UV light) can cause changes in modules including solarization of the glass, light-induced degradation in the cells, discoloration, and decrease in adhesion. Unfortunately, application of light in large area is expensive, so a strategy has often been to apply the stresses to a smaller version of a module.

Activities

- **Identify useful light sources**
- **Observe and understand field failures**
- **Duplicate field failures using indoor light sources**
- **Establish acceleration factors**
- **Does humidity accelerate or inhibit UV degradation?**

Task Group 6

Scope

This group will discuss how to best communicate with PV customers, including financial investors, insurance companies, PV owners, etc.. The group can facilitate discussion between this broad spectrum of people and the engineers who are designing the tests. As the other task groups recommend test methods and the associated test results, this group will review these to confirm that the presentation of the results is in a format that is easily understood by the people wishing to access this information. This group may also proactively bring requests to the other groups regarding information that PV customers/investors are asking for.

Activities

- **Preference to discuss climates rather than stresses**
- **Proposed first step in new rating system**

Rating System Proposal – 3 New Labels

Label \ Stress	Humidity	High Temperature	Thermal cycling	UV
IEC 61215	IEC 61215	IEC 61215	IEC 61215	IEC 61215
Temperate	IEC 61215	IEC 61215	IEC 62XXX – 2 Task Group #2	IEC 62XXX – 3 Task Group #5
Hot & dry	IEC 61215	IEC 62XXX – 4 TGs 2, 3, & 5	IEC 62XXX – 2 Task Group #2	IEC 62XXX – 3 Task Group #5
Hot & humid	IEC 62XXX – 5 Task Group #3	IEC 62XXX – 4 TGs 2, 3, & 5	IEC 62XXX – 2 Task Group #2	IEC 62XXX – 3 Task Group #5

Summary

- **Task Groups 7, 8 and 9 just starting.**
- **All task groups are still looking for new members.**
- **Follow progress and sign-up on**

http://pvqataskforceqarating.pbworks.com/

- **Plan to have initial rating system proposal submitted to IEC as NWIP in 2012.**