Module Quality Risk Considerations for PV Construction

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Background

Ensuring PV module quality is an essential component of meeting PV system expectations. Inadequate PV module quality may result in system underperformance and/or module failures. Mitigation of risks associated with PV module quality starts with selecting a reputable manufacturer and ensuring good factory quality control. However, what matters for long-term PV system performance is not the condition of the modules at the time they leave the factory, but the module condition after installation and during operation. It is important to understand and mitigate the risks of module damage during shipping, handling and installation. Additionally, module quality issues can result in construction and/or commissioning delays.

Methods

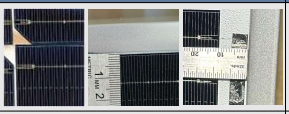
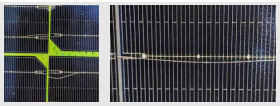
The examples and data presented in this poster are from data collected during CEA's module field testing inspections at sites across North America. The data presented is broken down into "pre-installation" and "post-installation". Pre-installation inspections are inspections of modules which have been transported from their manufacturing location (typically in Asia) to either a warehouse or PV site in North America. Post-installation inspections are inspections of modules conducted shortly after the modules have been installed on the racking. Inspections were conducted on a sample of modules for each site represented in the dataset.

Testing Method	Defects Detectable
Visual Inspection	Glass breakage, frame damage, manufacturing quality issues
Electroluminescence (EL) Inspection	Cell damage (microcracks), soldering anomalies
I-V Curve Tracing	Module underperformance, diode failure, substring failure

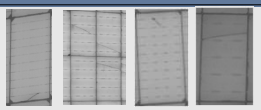
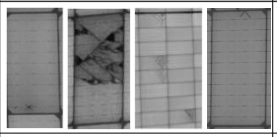
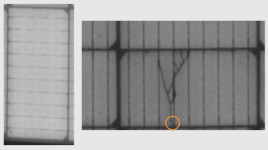
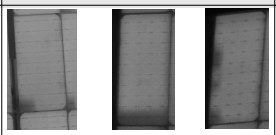
Visual inspections were utilized to identify quality risks detectable to the human eye that could pose a risk to the safe and reliable operation of the modules. Electroluminescence (EL) imaging was utilized to look for cell damage including microcracks and soldering anomalies. I-V curve tracing is a field measurement of the module I-V curve and Pmax and is utilized to identify module underperformance as well as quality issues affecting one or more of the module substrings such as a diode failure or internal soldering failure.

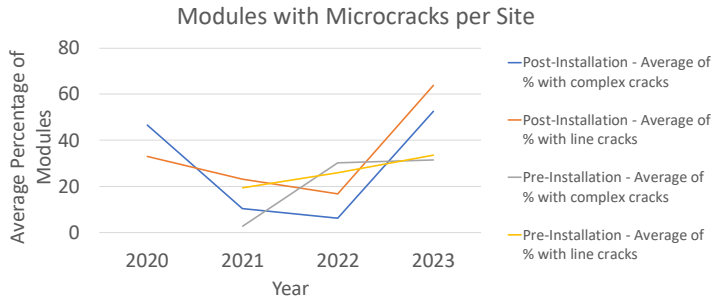
The testing methods utilized at each project were determined based on the site's needs and the client's goals for testing. Not all testing methods were utilized at each site. Some sites had only pre-installation testing, some had only post-installation testing and others both.

Common Visual Findings

Finding	Cause	Examples	Implications
Inadequate Creepage Distance	Manufacturing		Violation of IEC 61730-1 standard
Glass Breakage	Transportation, Handling		Moisture ingress, compromised electrical insulation
Misaligned Stringing Ribbon/Wire	Manufacturing		Module power loss
Laminate Bubbles	Manufacturing		Violation of IEC 61730-1 creepage distance
Frame Damage	Transportation, Handling		Installation issues, reduced mechanical strength

EL Findings

Finding	Cause	Examples	Implications
Line microcracks	Manufacturing, Transportation, Handling, Installation		Typically low performance risk
Complex Microcracks (X, Y, V and branch cracks)	Manufacturing, Transportation, Handling, Installation		Higher performance risk. Performance loss dependent on isolated area
Edge Ribbon Microcracks	Typically originate in manufacturing, exacerbated by handling and installation		Low impact on performance when small, risk of growth and higher power loss over time
Soldering Anomalies	Manufacturing		Performance risk increases with quantity of affected cells and area affected per cell



Mitigation

1. Procurement and Manufacturing

- Module Design
- Supplier selection
- Supplier quality assurance plan and factory acceptance criteria
- 3rd Party Quality Assurance

2. After Delivery

- Inspection of all pallets for damage upon delivery
- Detailed inspection and testing of a sample of modules

3. Installation

- Adherence to supplier installation manual
- Use EL inspection to validate installation procedures
- Installer training
- Validate installation procedures early in the module installation phase of construction

Conclusions

Module quality issues and module damage represent a significant risk to project performance and construction timelines. It is important for asset developers, owners and EPCs to be aware of the risks that module quality represents, including the financial costs of poor quality modules and module damage during installation. Inspections conducted by CEA have shown that module quality issues remain a challenge. Fortunately, there is much that can be done to mitigate these risks. Mitigation of module quality risks begins with procurement and manufacturing, but it is important to continue to mitigate risk of damage during shipment and installation.