All Modules Are Not the Same...
It Takes Years of Real World Experience

presented by Derick Botha, Vice President of Sales and Marketing, Motech Americas

		Module Assembly Operation	Quality Control
1	Stringing	Connect cells to form strings	• Chip detection • Pull test • Cell spacing
2	Lay-Up	Place strings on glass and connect	• String spacing • Edge spacing • String alignment
3	IR Inspection	Inspect cells for damage	• Inspect cells for damage
4	Final Lay-Up	Final preparation of cells and backsheet before lamination	• Visual inspection • Edge spacing • EPE location and spacing
5	Lamination	Vacuum and temperature laminates glass, cells and backing	• GEL test • Visual inspection
6	Trim	Trimming EVA and backsheet	• Visual inspection • Edge spacing • String and cell spacing
7	Power Test	Calibrated light source to verify voltage, current, and power	• Calibrated light source to verify voltage, current, and power
8	Framing	Install aluminum frame	• Visual inspection
9	J-Box	Attach J-Box	• J-Box location • Visual inspection • Diode test
10	Final Test	Test the module to ensure good electrical connection	• Continuity test • Hi-potential test
11	Clean	Clean front & back side of module	• Visual inspection
12	Package	Package module as finished good	• Visual inspection

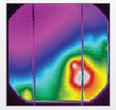
Quality and Reliability

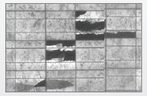
Materials Can Pass Certification... but Fail in the Environment
A Module is Only as Strong as its Weakest Link

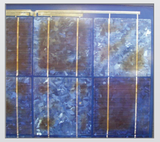
To Understand Drivers of System Lifetime & Performance, We Must Understand Failure Modes

Cells	Micro cracks Corrosion Hot spot PID
Glass	Staining Delamination
Encapsulant	Delamination Yellowing
Backsheet	Delamination Cracking Yellowing Penetration
Tabbing	Separation Lifting Burning/Charring
Adhesive	Frame Separation J-Box Separation Leakage Current
InterConnect	Moisture Electrical Resistance Open Circuit
Frame	Separation Bending Cracking
J-Box	Diode Failure Separation Leakage
Wire	Wire Handling Shorting

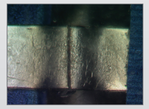
Cell Corrosion

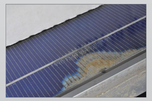

Cell Hot Spots


Broken Cells


Encapsulant Discoloration

Front Side Glass Delamination


Broken Interconnects


Cell corrosion due to backsheet failure

Backsheet Delamination

Structural Failure of Module Frame

Catastrophic Power Loss (Reliability) → Accelerated Power Loss (Durability) → Safety Failure/ Risk

Imported Module vs. JPL Compliant Module

	Imported Module	JPL Compliant Module
Module Construction & Exposure	Glass/EVA/Si/EVA/**PPX**, residential rooftop array	Glass/EVA/Si/EVA/**TPT™**, residential rooftop array
Visual Inspection	**Localized delamination** between PET–PET backsheet interlayers.	Some localized **frontside encapsulant delamination** at tabbing wires.
EL Imaging	Fine line interruptions and **many** cracked cells	Fine line interruptions and a **few cells not operating at optimum efficiency,** contributing to the small amount of power loss.
Power Loss	**15% below nameplate** after ~12 years. (Doesn't account for nameplate variance)	**9% below nameplate** after ~12 years. (Doesn't account for nameplate variance)
Wet Leakage Current Testing	Resistance of <1MOhm/m2	

Source: DuPont North America PV Application Development Lab, Fielded Module Analysis, 2012

15% DEGRADATION RATE over 12 years

9% DEGRADATION RATE over 12 years

Difference in Degradation Rates Would Result in a 6.7% Difference in Revenue

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