

Photovoltaics:

Testing of Modules and Systems



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Photovoltaic Testing Laboratory (PTL)

An ISO 17025 accredited testing laboratory

Established in 1992

Accredited by: A2LA

Standards development

Participates standards development committees

Services

Performance testing
Qualification/Reliability testing
Safety testing
Prototype/Engineering testing;
Long-term outdoor exposure testing

Test standards used

IEC 61215; IEC 61646; IEEE 1262; UL 1703; IEC 61730; IEEE 1513; IEC 62108

Providing service worldwide

USA, Europe, Canada, Japan, China, India, ...
Served more than 200 clients/manufacturers

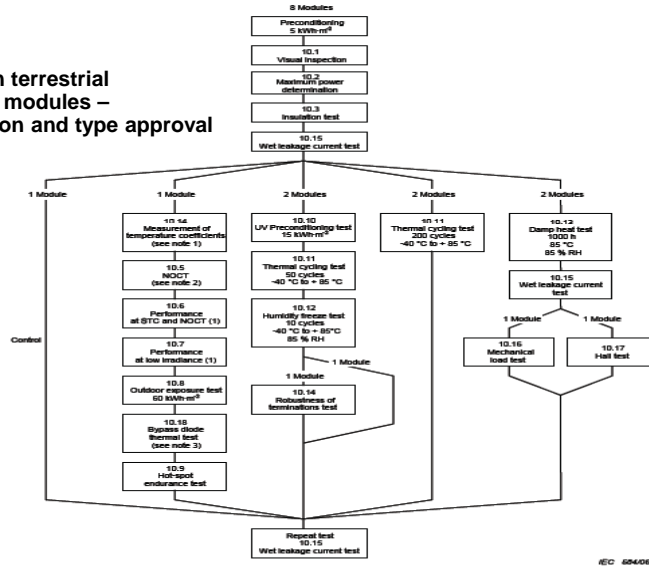
Certifications

More than 4000 modules tested!
More than 300 qualification certificates issued!



IEC 61215 (2005)

Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval



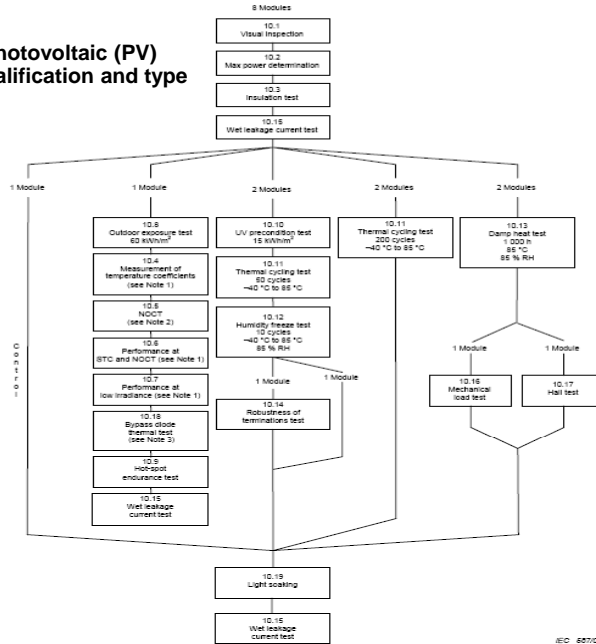
NOTE 1 May be omitted if IEC 61853 has been performed.
 NOTE 2 In the case of modules not designed for open-rack mounting, the NOCT may be replaced by the equilibrium mean solar cell junction temperature in the standard

Figure 1 – Qualification test sequence



IEC 61646 (2008)

Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval



IEC 62108 (2007) Concentrator photovoltaic (CPV) modules and assemblies – Design qualification and type approval

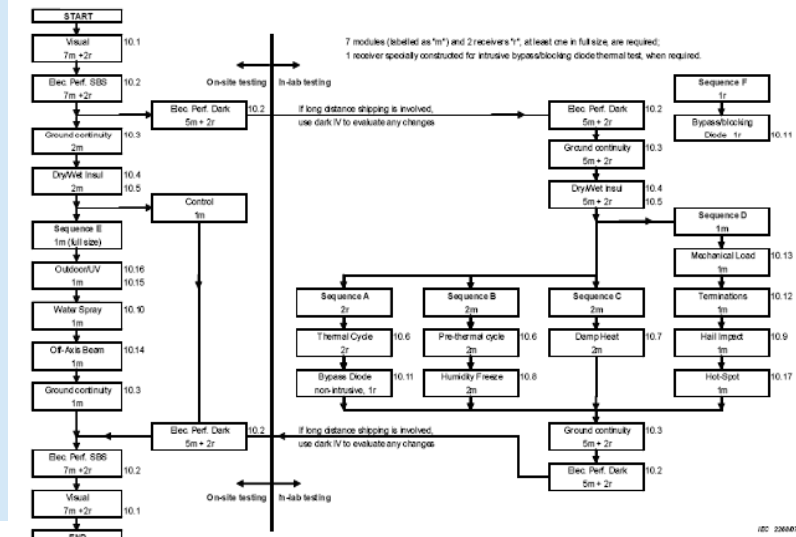


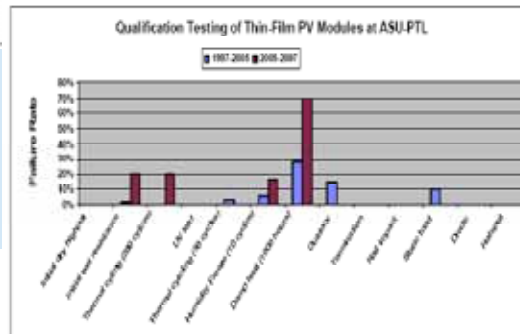
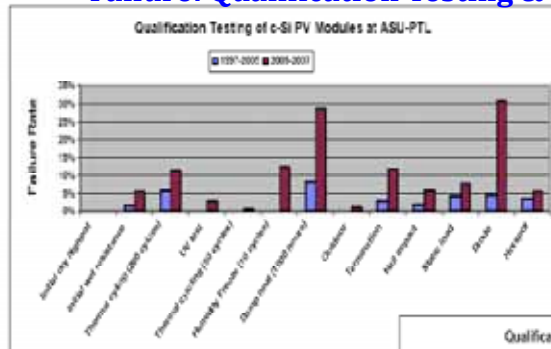
Figure 6 – Qualification test sequence for CPV modules

Failure: Qualification Testing & Certification at ASU

- **Both Technologies:** Failure analysis on the design qualification testing was done on both technologies, crystalline silicon and thin-films
- **Two Periods:** Failure analysis was done for two periods, 1997-2005 & 2005-2007.
- **1997-2005:** In the first period, the industry was growing at a slower rate and the qualification testing of c-Si technologies was primarily conducted per Edition 1 of IEC 61215 standard.
- **2005-2007:** In the second period, the industry was growing at an explosive rate, and the qualification testing of c-Si was primarily conducted per Edition 2 of IEC 61215
(Major new tests: Wet leakage current and Diode tests; Major modified tests: TC200 with current injection).
- **Modules Tested:** About 1200 modules (1997-2005); About 1000 modules (2005-2007)
- **Module Technology Ratio:** 90% crystalline silicon; 10% thin-films



Failure: Qualification Testing & Certification at ASU



Conclusions on Qualification Testing

- A large increase in the failure rates for the 2005-2007 period, as compared to the 1997-2005 period, is observed for both c-Si and thin-film technologies
- c-Si: The higher percentage of failure in the 2005-2007 period is attributed to....
 - ... the market entry of a large number of new manufacturers
 - ... Major test failure: Post-stress wet resistance test
 - ... Significant test failure: Post-stress performance test
- Thin-films: In the 2005-2007 period ...
 - ... a large percentage of modules failed primarily due to the market entry of new manufacturers
 - ... 70% of the modules fail in the post-damp heat test
 - ... 20% of the modules fail in the post-thermal cycling test
 - ... 17% of the modules fail in the post-humidity freeze test
- A large fraction of the modules fails due to the failures of bypass diodes in the chambers and in the diode thermal test. A pre-qualification of bypass diodes may be warranted.



Damp Heat and Thermal Cycling Testing at BP Solar

All these modules passed the qualification test
but 8 out of 10 failed in reliability test!

Competitors Modules in BP Solar Qualification Test			
Manufacturer	DMLC/TC/HF	1250 DH	500 TC
A	P	F	F
B	P	F	P
C	P	F	F
D	P	F	P
E	P	F	P
F	P	P	P
G	P	F	P
H	P	P	P
J – module 1	P	F	P
J – module 2	P	F	P

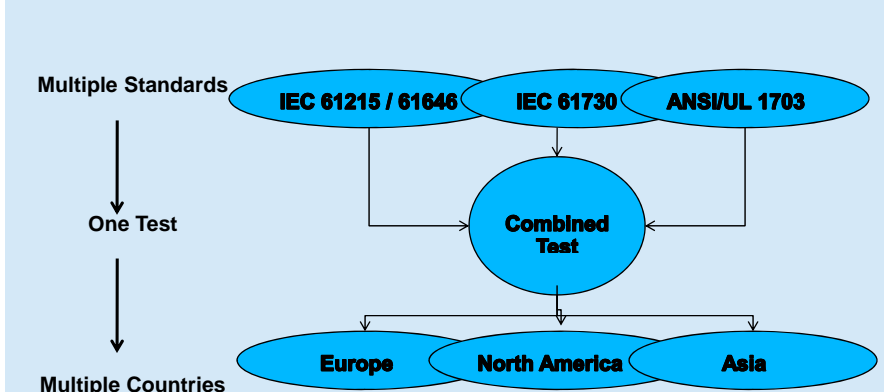
23rd European PVSEC Sept. 5, 2008



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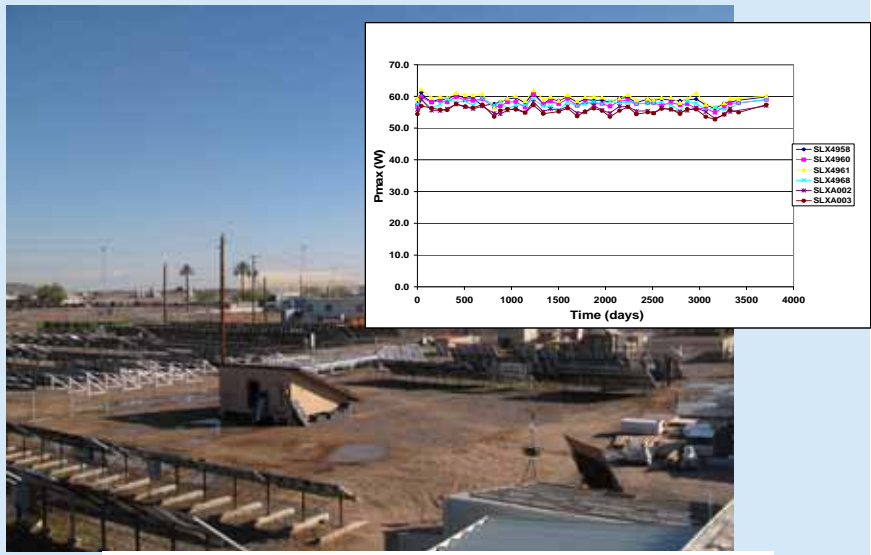


SHORT TURNAROUND TIME & ONE-STOP SERVICE



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Long Term Outdoor Testing & Monitoring

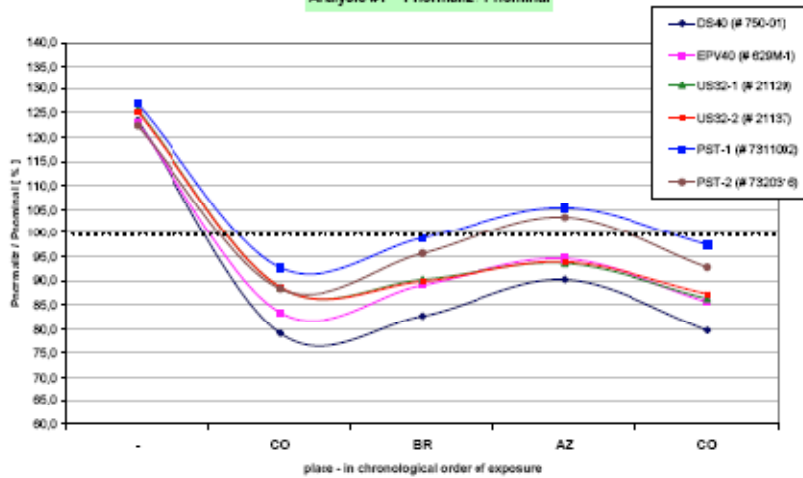


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Amorphous-Silicon Brazil-NREL-ASU

Set A - SPIRE
Analyse #1 - Pnormaliz / Pnominal



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Simulated Roof Showing Mounted PV Test Modules at various Air Gap Spacing

Evaluates the impact of air gap spacing and effect of ambient temperature on the performance of roof top photovoltaic system.

Reference Cell (Outdoor)	Manufacturer 1 (30°C/100)	Manufacturer 2 (30°C/100)	Manufacturer 3 (20°C/100)	Manufacturer 4 (20°C/100)	Manufacturer 5 (20°C/100)	Manufacturer 6 (20°C/100)
4" Air gap	50.6					
3" Air gap	57.5					
2" Air gap	84.4					
1" Air gap	96.8					
0" Air gap	106					

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Precisely Right.

Questions?

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