



the standard in safety

Solar Durability Workshop

How PV Standards Developed

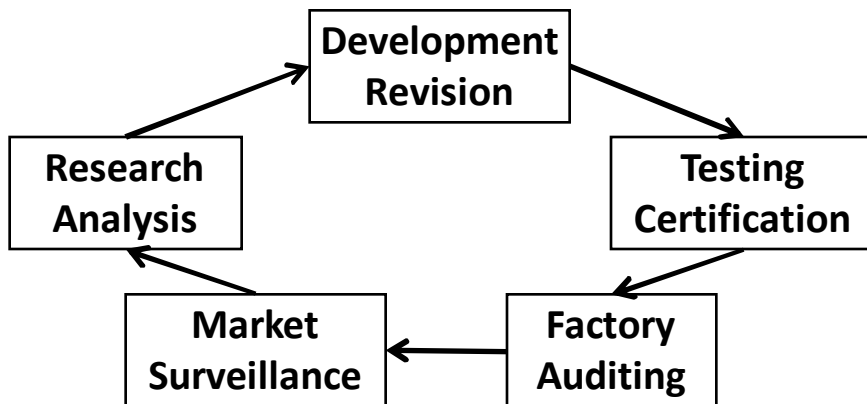
Case Study: Hot Spot Endurance Test

Liang Ji
Corporate Research, UL LLC

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Case Western Reserve University, Cleveland, Ohio

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Standard Development Cycle



UL have all 5 pillars in this cycle.



PV Test Standard

PV test standards have several challenges.

For example:

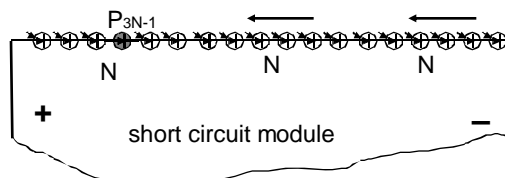
- Fast moving technology vs. lengthy standard development process;
- R&R: Repeatability and Reproducibility, especially for outdoor testing;
- Long system operation lifetime vs. demand for quick certification to market;
- Highly accelerated stress test vs. keeping in the similar failure mode.



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Hot Spot and Bypass Diode

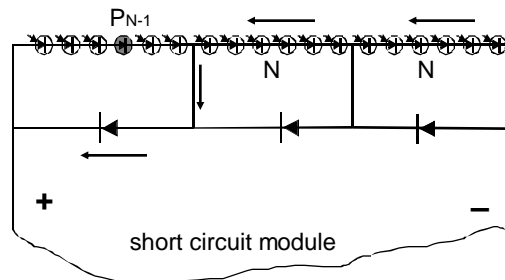
Without bypass diode, the heat dissipation Q from shaded cell is:
 P_{3N-1}



$$P \sim \eta$$

$$Q \sim \Delta T, A$$

With 3 bypass diodes, the heat dissipation Q from shaded cell is reduced to: P_{N-1}

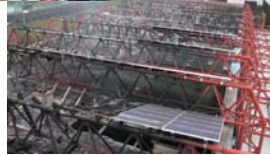


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Field Failures

Before JPL Block V, 1981

- No requirement for hot spot

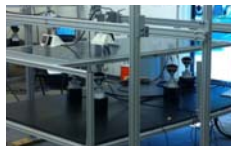


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UL1703: Test Equipment

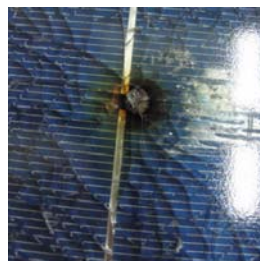
UL 1703 Ed.1-1986, Ed.2-1993, Ed.3-2002

- Three cells, 1hr on - 0.5hr off
- Total 100hrs on time
- Indoor test with temperature control
- Use external power supply to provide maximum heat dissipation energy.



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UL1703: Test Failures



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IEC 61215 History and Current



**Very few test failures.
Not reflect field failure problem.**

IEC 61215 Ed.1-1993

- One cell, 1hr on - 0.5hr off, total 5hrs

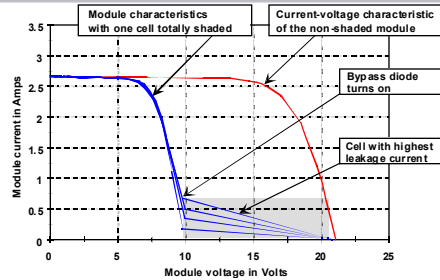
IEC 61215 Ed.2-2005

- One cell, 5hrs on - no off (may in two days)



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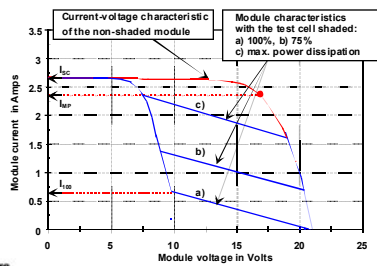
IEC61215 Ed.3 (Draft 2011-11)



Test 4 cells:
3 with lowest R_{shunt} ,
1 with highest R_{shunt} .

Adjust shaded area to get maximum power dissipation.

On time: 1-5 hours.



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Contact

Liang Ji (季良俊)
Research Engineer
Corporate Research, UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096 USA
Phone: +1 847 664 1200
Email: <liang.ji@ul.com>
Web: www.ul.com



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