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CPV Solar Cell Qualification Standard

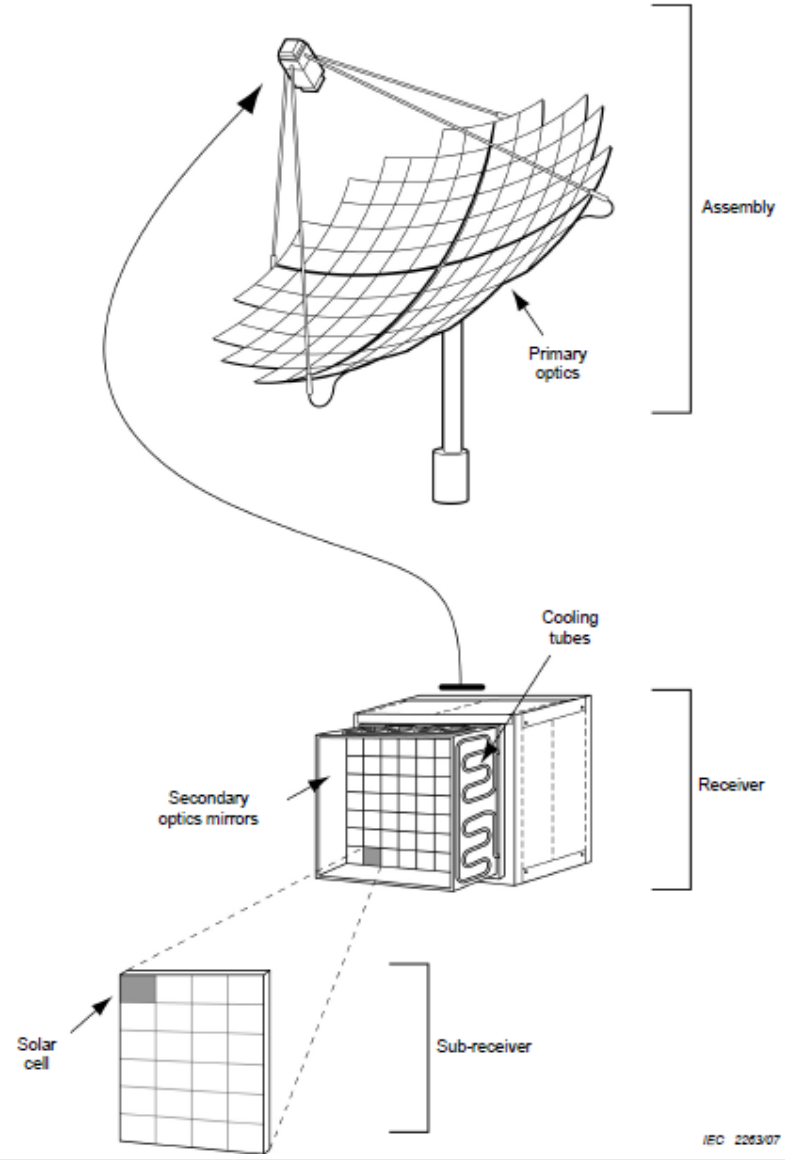
NREL PVMW 17-Feb-2011

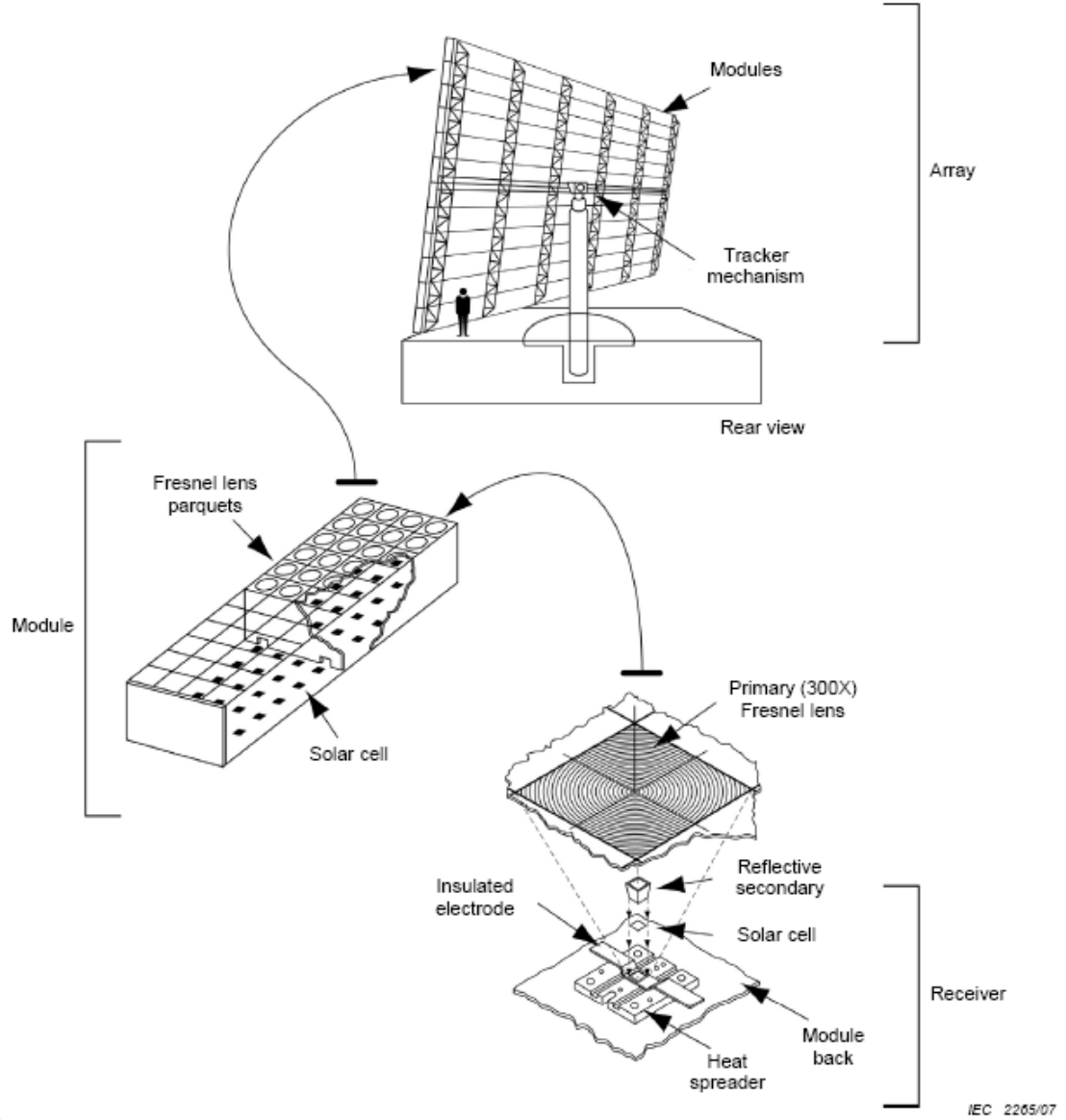
IEC TAG-82 WG-7

Outline

- Intro
- Review of PV Qualification Standards
  - National
  - International
  - Relationship with Other IEC Standards and Drafts
  - PV Cell Standards
- Proposed CPV Solar Cell and Receiver Package Qualification Standard
- IEC WG-7 Survey Results
- Open Discussion

CPV Systems and Subcomponents

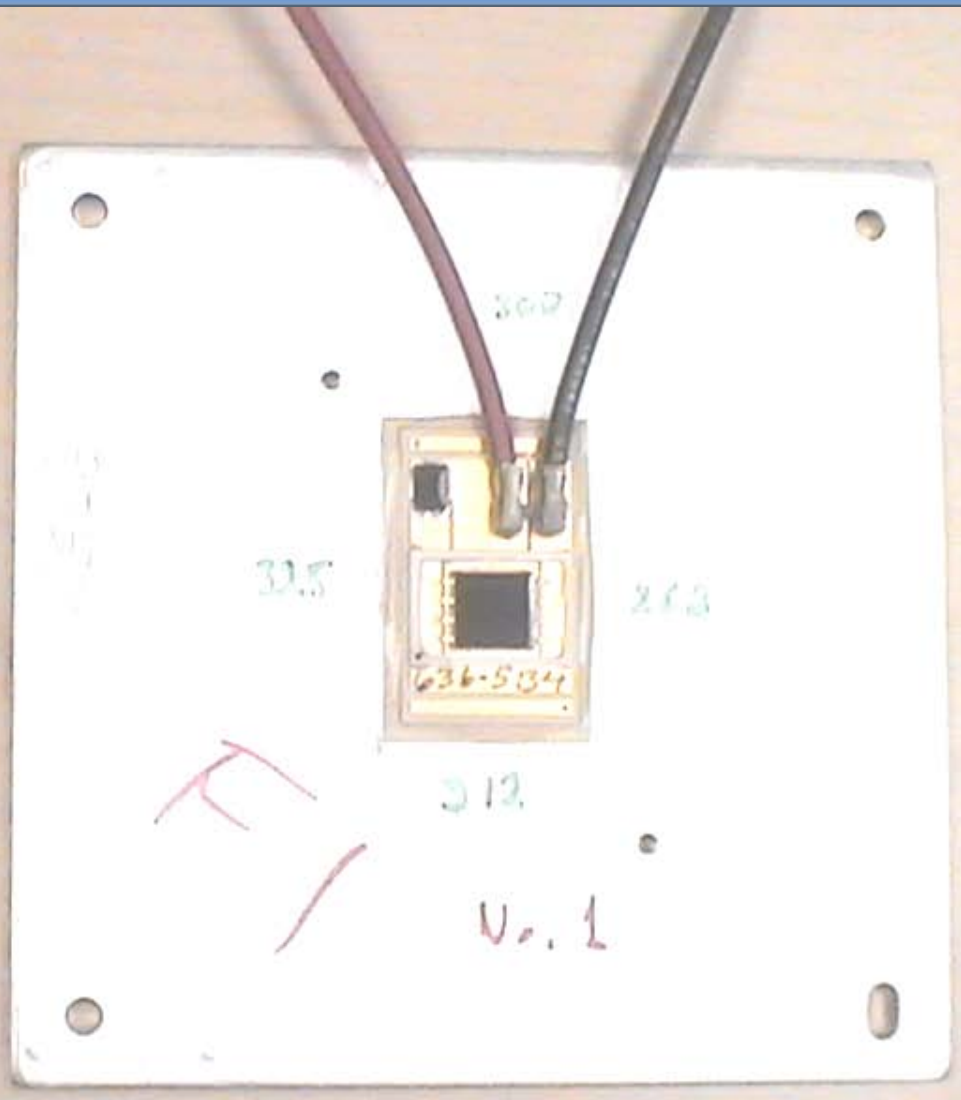




Definitions

Bare Cell
or
Device

Receiver
(Rx)



Receiver Assembly

Standards Overview

- **Electronic and Optoelectronics Component Qualification Standards**
  - Telcordia e.g. GR-468-CORE Issue 2, September 2004,
    - Reliability Assurance Requirements for Optoelectronic Devices Used in Telecommunications E
  - IEC e.g. 61751 ed1.0,
    - Laser modules used for telecommunication - Reliability assessment.
- **PV for Space Power Applications**
  - AIAA S-111-2005
    - Qualification and Quality Requirements for Space Solar Cells
  - ECSS-E-ST-20-08C
    - Photovoltaic assemblies and components
- **PV Cells**
  - Solar America Initiative (SAI) Procurement Specification Proposal
- **PV and CPV Modules and System Level**
  - IEC 61215 and IEC 62108
    - PV and CPV modules and assemblies – Design qualification and type approval.
  - IEEE Std 1513-2001
    - Recommended Practice for Qualification of CPV Receiver Sections and Modules

Relationships with other IEC CPV Standards

- IEC 62688 CPV Safety Standard
- Tracker Technical Specification
- IEC 62670 (CPV Module and Assembly Performance Testing and Energy Rating)
- CPV Performance based on 61853-2
- Acceptance test
- Energy Performance Ratio
- IEC 62108 revision
- Cell Qualification Standard
- Specification of Concentrator Cell Description
- Other standards and comments

- In addition, wherever possible, CPV standards mimic other IEC PV standards
  - (e.g. 62108/61215 and the c-Si cell procurement guidelines.)

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Solar America Board for Codes and Standards Report

Crystalline Silicon Terrestrial Photovoltaic Cells –

Supply Chain Procurement Specification Guideline

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March 2009

c-Si PV Cell Procurement Guideline

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PERFORMANCE PARAMETER	SYMBOL (UNIT)	
Short circuit current @ STC	I_{sc} (A)	
Open circuit voltage @ STC	V_{oc} (V)	
Current at maximum power @ STC	I_{mp} (A)	
Voltage at maximum power @ STC	V_{mp} (V)	
Maximum power @ STC	P_{mp} (W)	
Fill factor @ STC	FF (%)	
Cell efficiency @ STC	(%)	
Cell efficiency tolerance @ STC	(%)	
Production Tolerance @ STC	I_{sc} (%)	
	V_{oc} (%)	
	I_{mp} (%)	
	V_{mp} (%)	
	P_{mp} (%)	

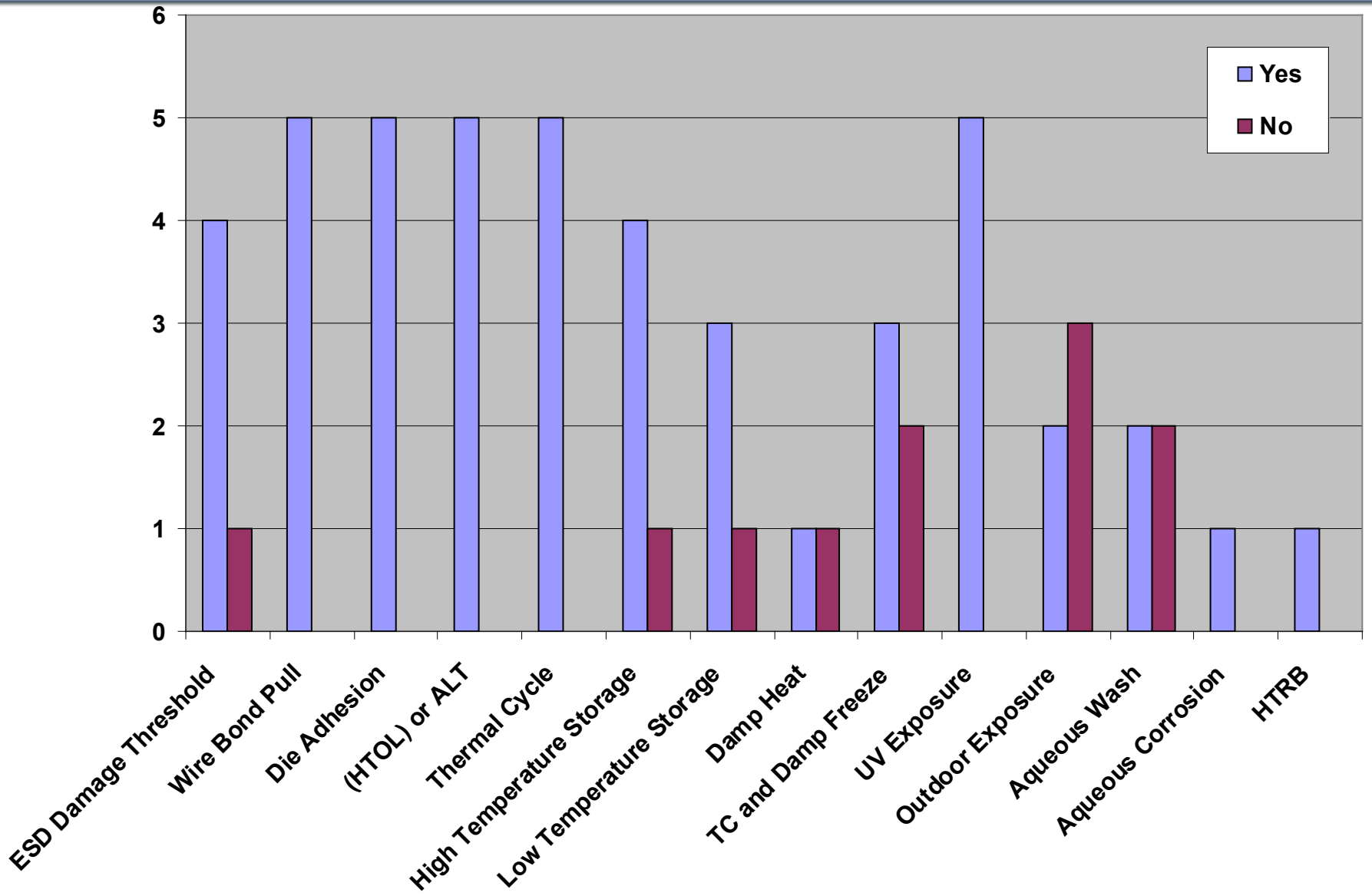
Proposed CPV Cell Qualification Tests

Stress Test Name	Cell Test Conditions
ESD Damage Threshold	Incremental Voltage tests for HBM and CDM to establish damage threshold. Dark IV.
Wire bond pull	Wire or ribbon bond, pull until failure, record mode and yield force.
Die Adhesion	Solder or adhesive die attach, pull to failure, record mode and yield force.
(HTOL) or ALT	T = T_{OP} (max), I = max tolerable, 5k hours. DIV (info only) and Flash test pre stress and at periodic pull points.
Thermal Cycle	T = -40 C to Tmax. 1k cycles for T max = 85 C, 500 cycles for T max = 110 C, 2k cycles for Tmax = 65 C, periodic light bias or no bias, dwell >10 min within ±3°C of extremes. 10 to 18 cycles per day. DIV (info only) and Flash test pre stress and at end.
High Temperature Storage	Ts (max) or 85C for 2000 hours.
Low Temperature Storage	Ts (min) or -40C 72 hours.
Damp Heat	1k hours at 85 C, 85% RH or 2k hours 65 C, 85% RH, DIV (info only) and Flash test pre stress and at periodic pull points.
TC and Damp Freeze	Precondition per 10.06 for 200 cycles, Tmax = 85 C, 100 Cycles Tmax = 110 C, 400 cycles Tmax = 65 C, Tmax and 85% RH for 20 hours, ramp down to -40 C for 4 hours, 20 cycles for Tmax = 85 C, 40 cycles for Tmax = 65 C. DIV(info only) and Flash test pre stress, after precondition, and at end.
UV exposure	Expose to a total dose of 2.5 kWhrs/cm^2, Lambda < 400 nm. DIV (info only) and Flash test pre stress and at periodic pull points. (Concurrent with HTOL.)
Outdoor Exposure	Expose to a total dose of 5 kWhrs/cm^2, DNI > 30 W/cm^2. DIV (info only) and Flash test pre stress and at periodic pull points. (Concurrent with HTOL.)
Aqueous Wash	Dice saw or typical semiconductor conditions (160 F, 2 psi.)

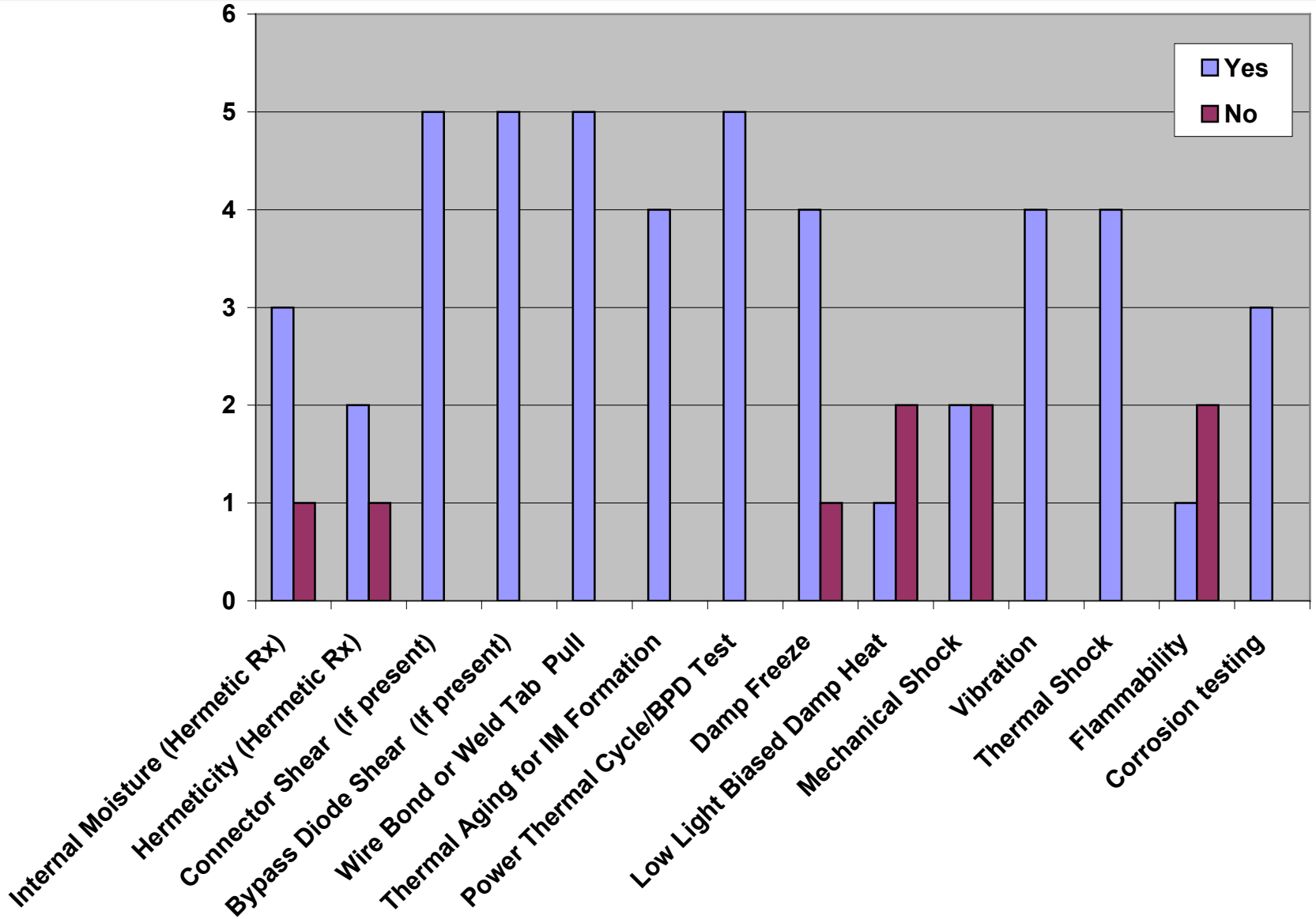
Proposed Receiver Package Qualification Tests

Parameter	Conditions
Internal Moisture (Hermetic Rx)	Bake at >100°C for 16 to 24 hours, RGA
Hermeticity (Hermetic Rx)	He bomb, leak detector
Connector shear (If present)	Shear tool
Bypass Diode shear strength (If present)	Shear tool
Wire bond or weld tab pull strength	Pull tool
Thermal aging for intermetallic formation	300C for 1 hour aging
Power thermal cycle/bypass diode thermal test	-40C to 110C for 500 cycles, IR or joule heating subcycles
Damp Freeze	Same sample as power temp cycle (for required TC preconditioning), 85C/85% RH for 20 hours, ramp down to -40 C for 4 hours, 20 cycles.
Low Level Light Biased Damp heat	Light Biased to ≥ 0.9 Voc, 85C/85% RH for 1000 hours
Mechanical Shock	Terminal peak sawtooth of amplitude 30gs and duration of 15 mSec (See figure 516.5-10 and Tables 516.5-III and IV.)
Vibration	Random vibration exposure.
Thermal Shock	Storage temperature extremes, > 60°C/min rate, 1 min dwells
Flammability	For packages with flammable components only.

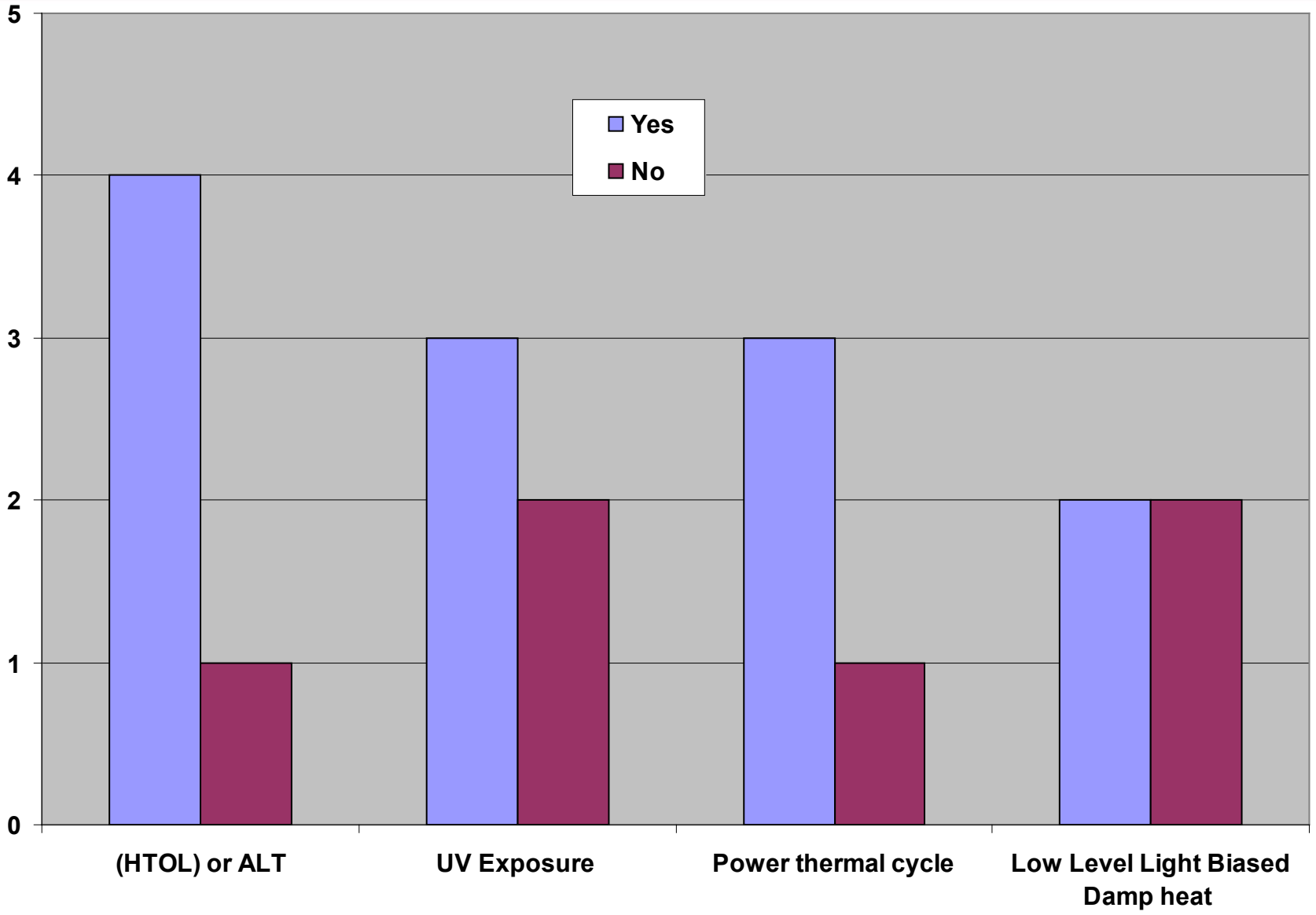
Cell Qualification Poll Results



Receiver Package Qualification Poll Results



Rx Package Qualification ALT Poll Results



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Will the proposed standard(s) meet your needs?