ARIZONA STATE UNIVERSITY

PV & CPV: Product Standards

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Outline

PV & CPV Product Standards:

- Major Standards Organizations
- Existing and Under Development
- Current Study Areas
- Potential Study Areas – GAP ANALYSIS

PV & CPV Product Standards:
Major Standards Organizations

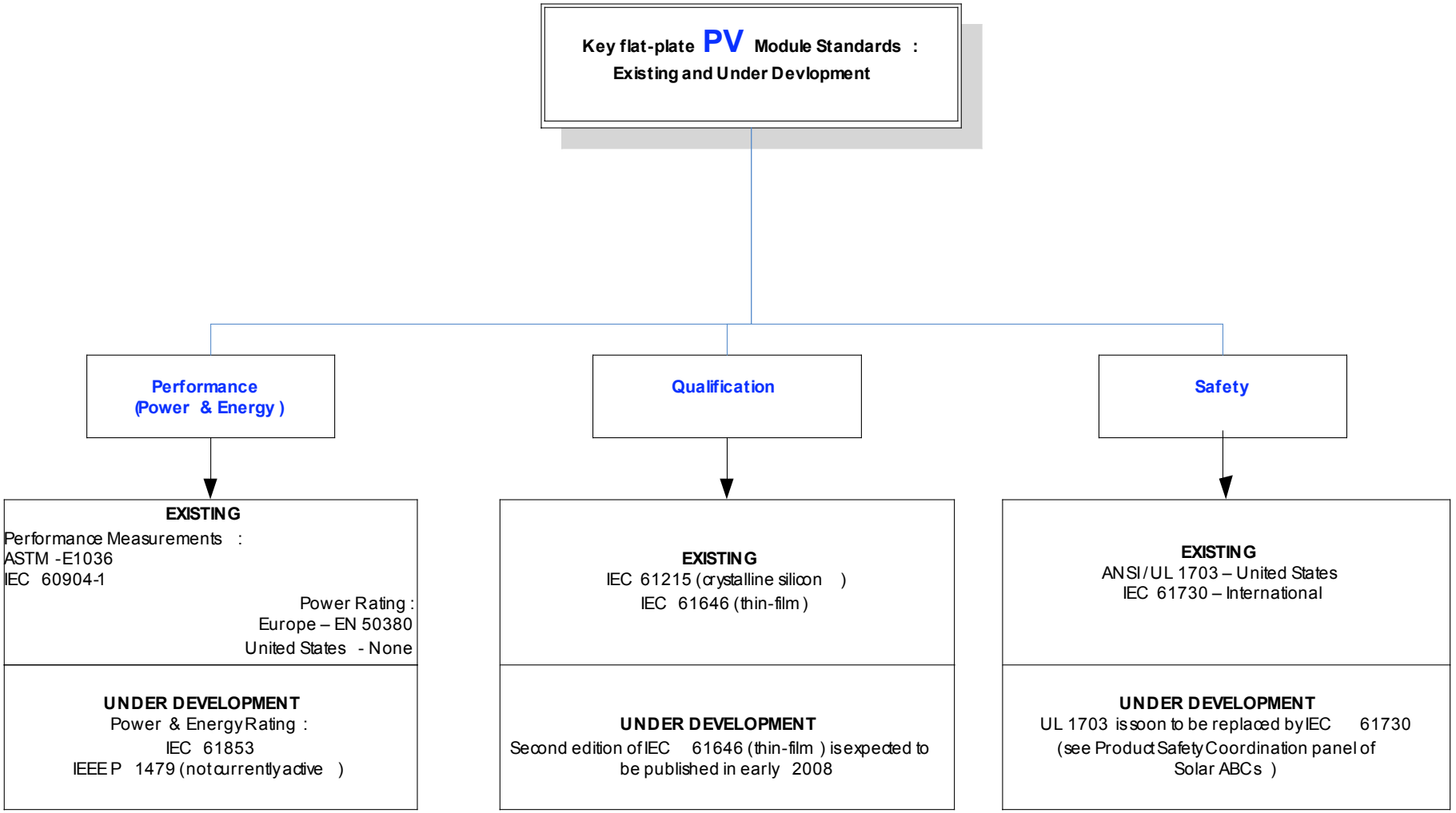
1. **ASTM International: American Society for Testing and Materials**
   - **Technical Committee E44.09: Photovoltaic Electric Power Conversion**
   - **Major use in PV industry: Test Methods**

2. **IEEE: Institute of Electrical and Electronics Engineers**
   - **Standards Coordinating Committee SCC21: Fuel cells, Photovoltaics, Dispersed Generation and Energy Storage**
   - **Major use in PV industry: Grid interconnection, Pass/Fail qualification for reliability, …..**

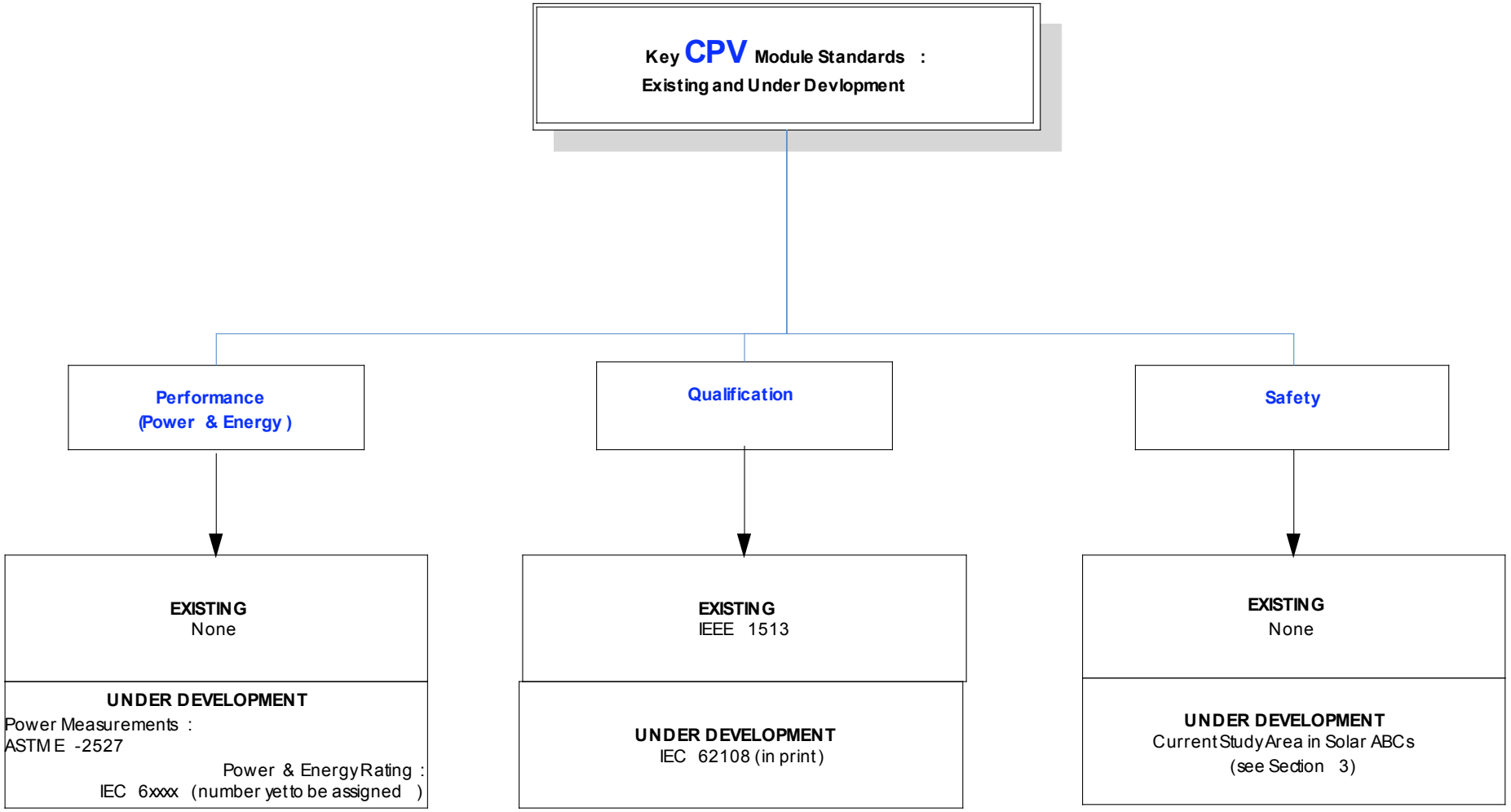
3. **IEC: International Electrotechnical Commission**
   - **Technical Committee 82: Solar Photovoltaic Energy Systems Working Groups (WG)**
     - **WG 1 : Glossary**
     - **WG 2 : Flat-plate PV (PV)**
     - **WG 3 : Systems**
     - **WG 6 : Balance-of-system components**
     - **WG 7 : Concentrator PV (CPV)**
   - **PV industry use: Test methods, pass/fail qualification for both reliability and safety, inverter??, …, System??, …**

4. **UL: Underwriters Laboratories**
   - **Technical committee:???**
   - **Major use in PV industry: Safety standards**

PV Product/Module Standards: Existing and Under Development



CPV Product/Module Standards: Existing and Under Development



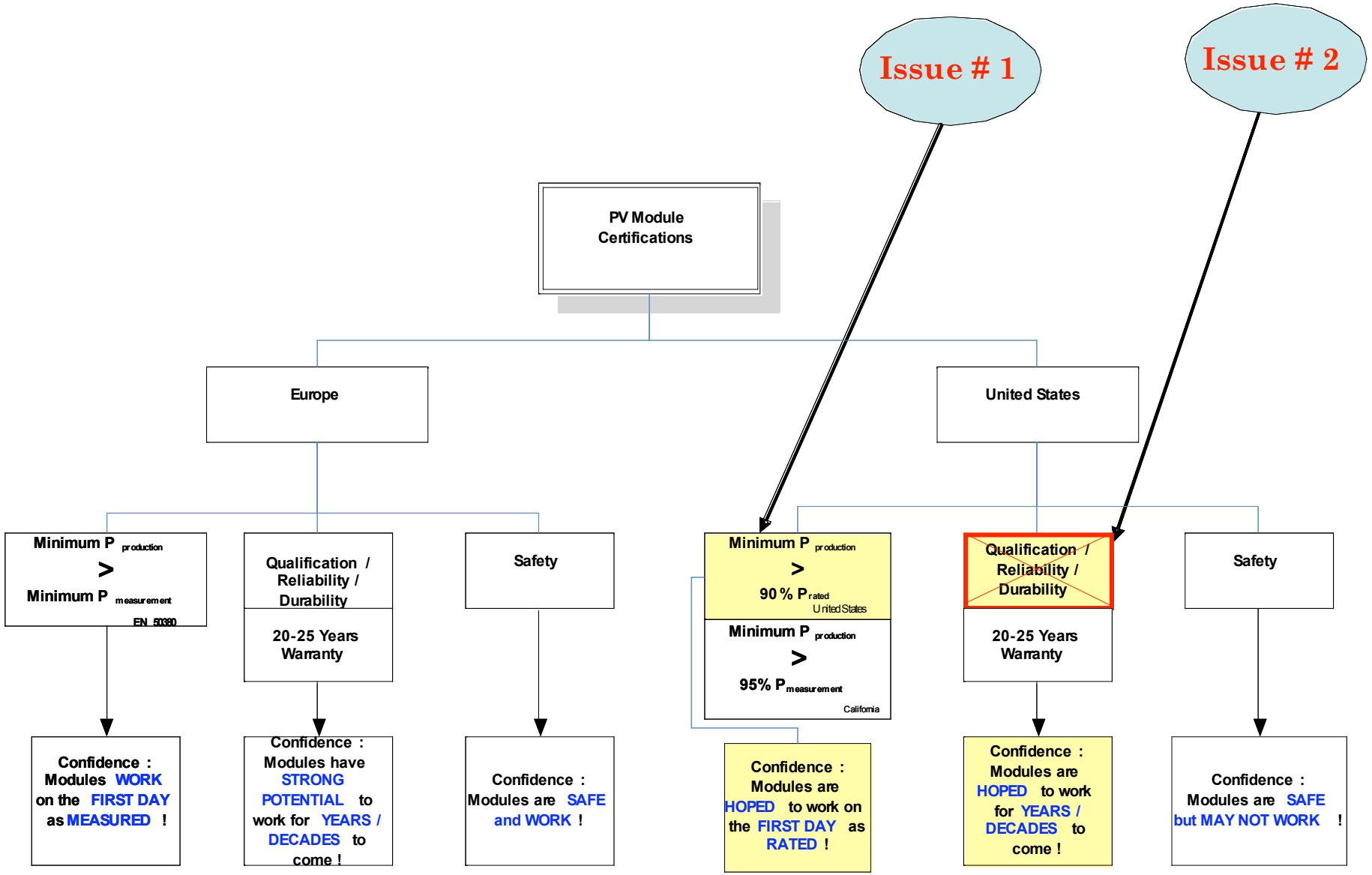
PV & CPV Product Standards:
Current Study Areas

1. **PV Cell Performance Study**
   - ➢ Assist **flat-plate PV** manufacturers:
     - ☒ Issue: **No supply chain standard available**
       - ☒ Identifying suitable alternative sources and establishing supply chain
     - ✓ Eventual Goal: **A standard for PV cell supply chain pre-qualification**
     - ✓ Deliverable in this study area: Develop standardized test procedures and minimum requirements to pre-qualify PV cells through evaluating the performance and form factor of PV cells
       - ▪ To be recommended/implemented in an IEEE/IEC standard development
2. **CPV Safety Study**
   - ➢ Assist **CPV** manufacturers:

☒ Issue: **No safety standard available**

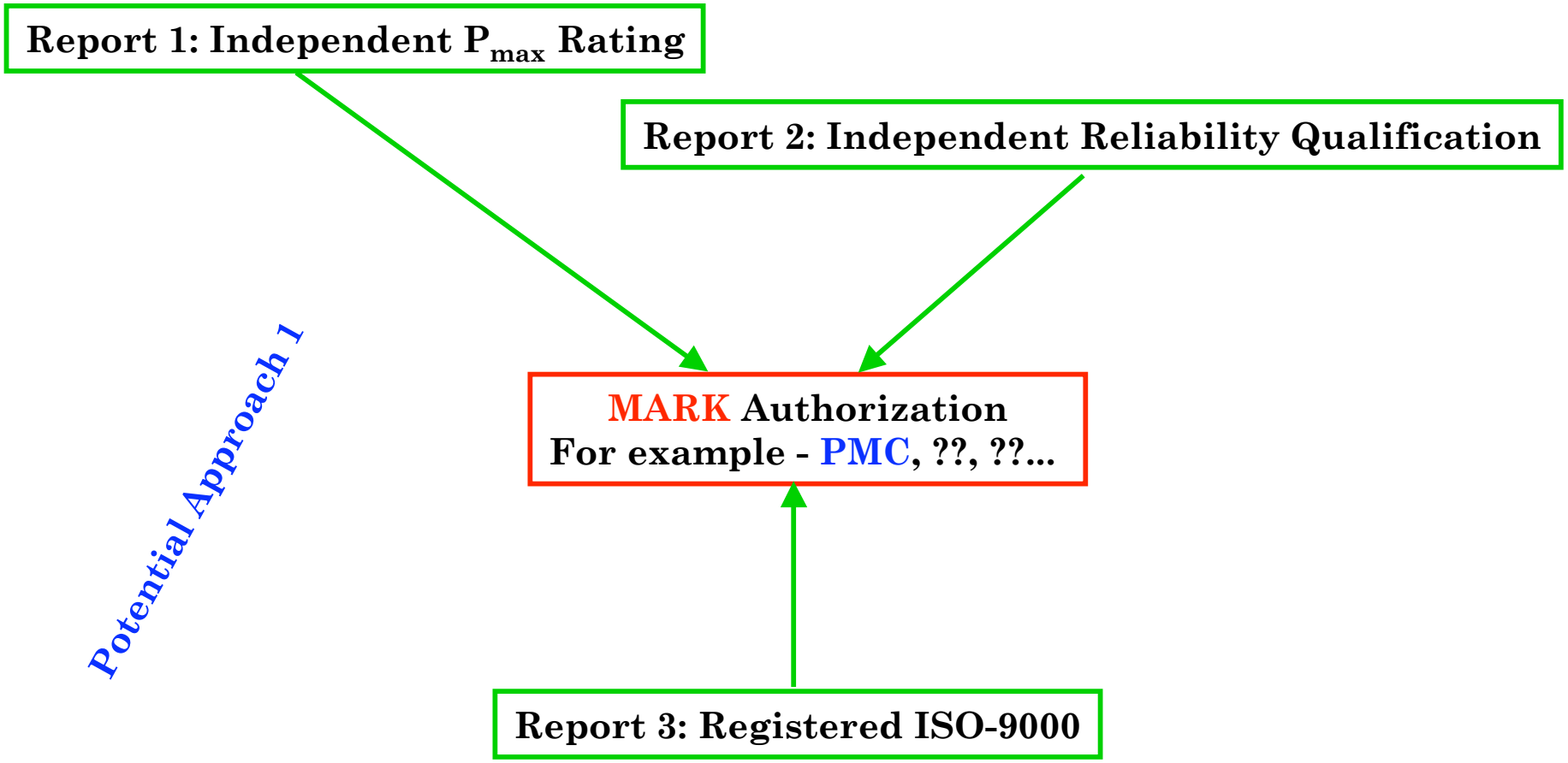
- ✓ Eventual Goal: **A standard for CPV safety testing**
- ✓ Deliverable in this study area: Develop standardized test procedures and minimum requirements (to be implemented in an IEEE/IEC standard development) for evaluating the safety of Concentrator PV products (ala UL 1703/IEC 61730/IEEE 1513/IEC 62108).
  - ▪ To be recommended/implemented in an IEEE/IEC standard development

PV & CPV Product Standards:
GAP ANALYSIS - Potential Study Areas/Issues



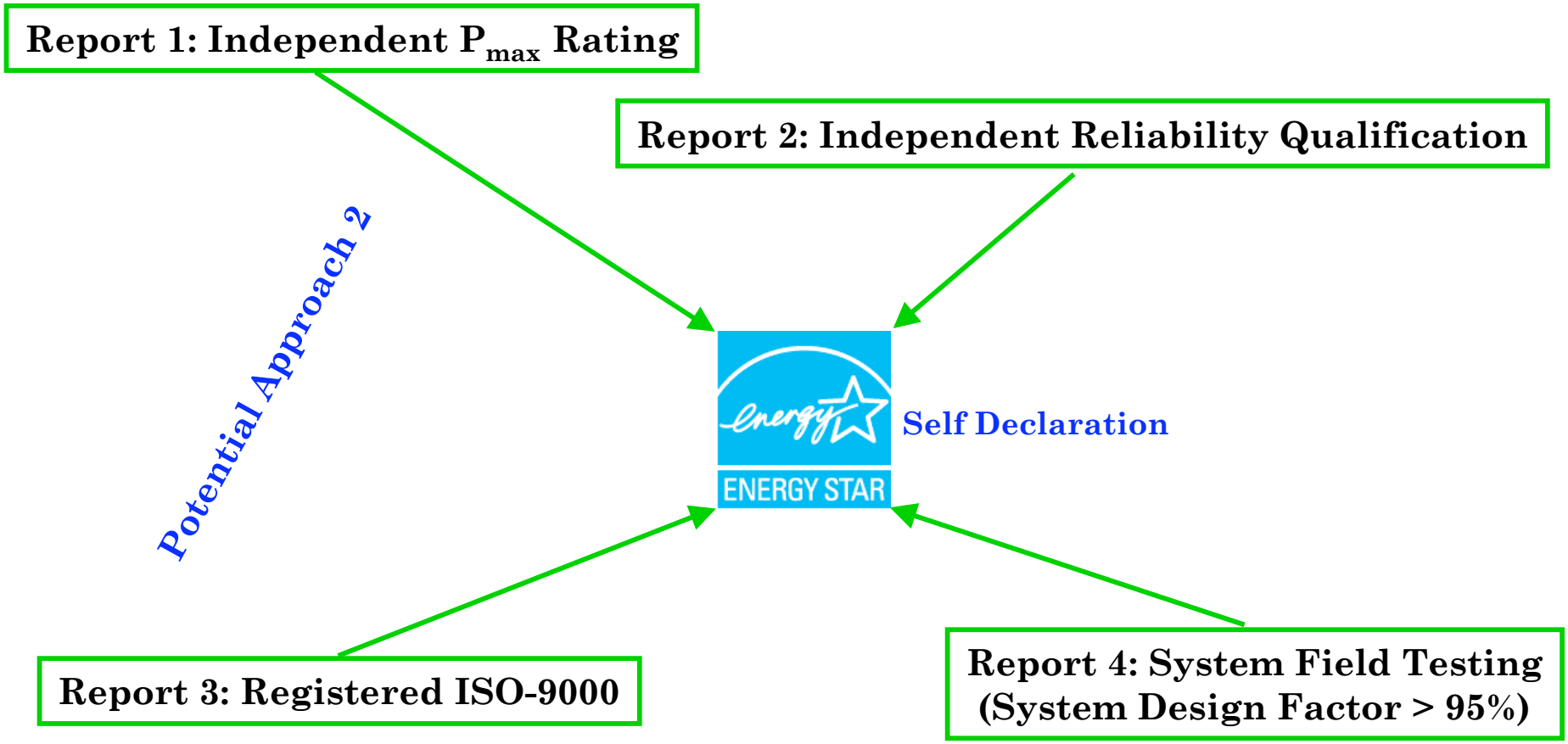
Issue # 3

MODULE Label: No MARK (logo) for Performance



Issue # 4

SYSTEM Label: No MARK (logo) for Performance



(**ENERGY STAR** mark issued by EPA/DOE approved partners such as manufacturers or private labelers/distributors/integrators)

QUESTIONS?

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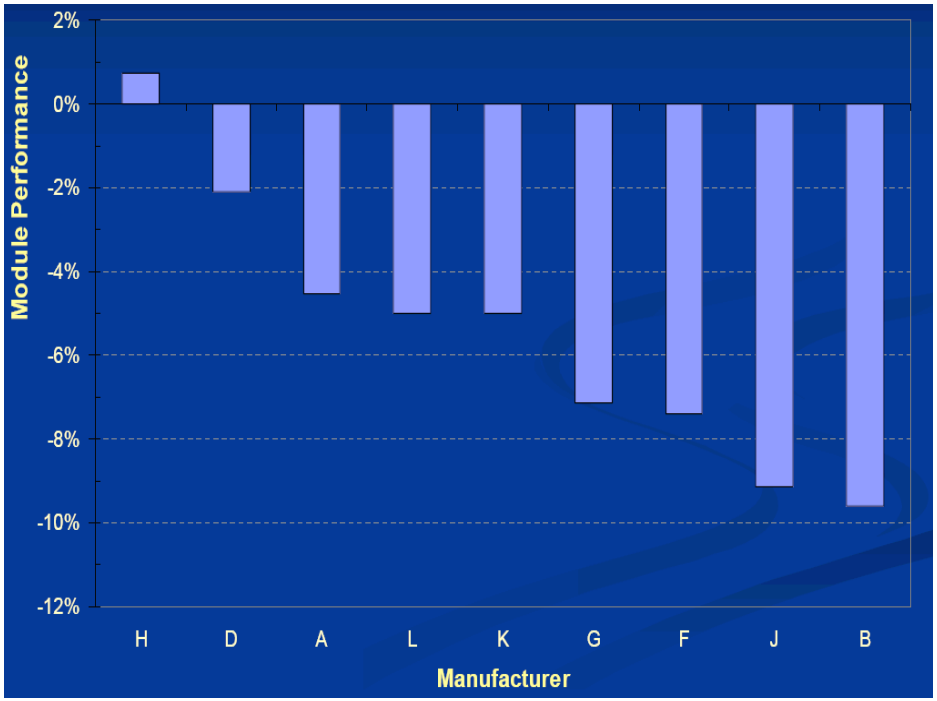
Slides for Discussion

Issue # 1: Objective Evidence

$P_{marketplace}$ → -10%



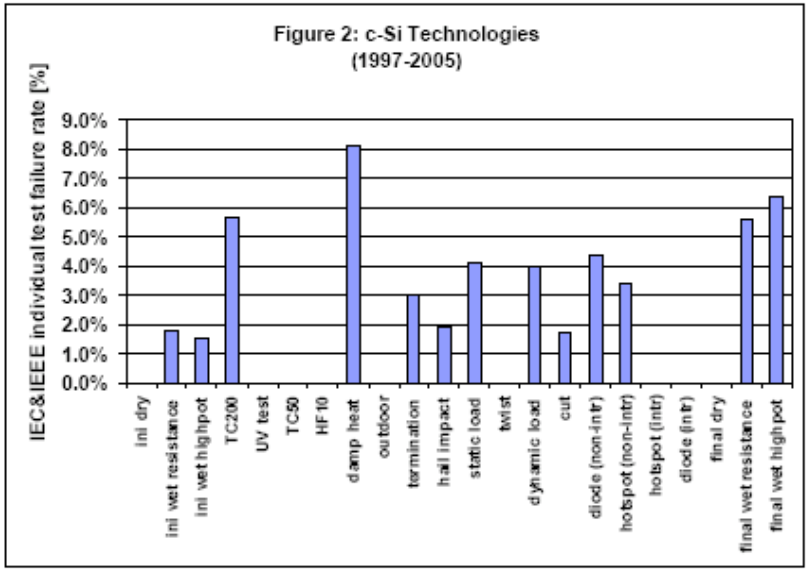
Rated *vs.* Measured

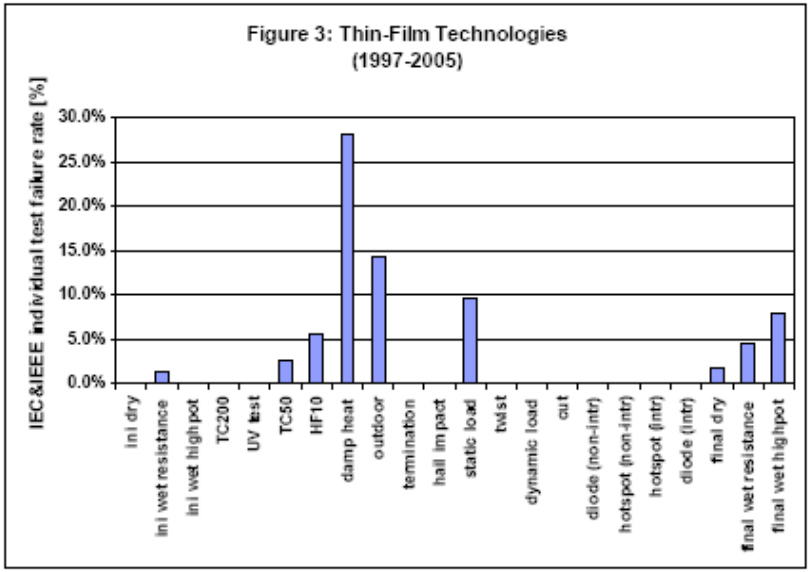
(Source: Florida Solar Energy Center)

Issue: All manufacturers are paid equal!

Issue # 2: Objective Evidence

Significant failure rate in qualification testing





Study Area: PV Cell Performance Standard

- Develop procedures and requirements for the pre-qualification of PV cells to establish:
  - a cell (supply chain) acceptance protocol for the MODULE (end product) manufacturers

Study Area: CPV Safety Standard

- Develop procedures and requirements for the safety qualification of CPV modules for:
  - Low concentration (for example, <10X and NOCT <50°C)
    - Testing requirements are less strenuous *(For example, similar to flat-plate)*
  - High concentration (for example, >10X or NOCT >50°C)
    - Testing requirements more strenuous

    (For example, CPV design qualification as pre-requisite with some additional tests from flat-late safety standard or vice-versa)

Study Area: PV Cell Performance Standard

A cell (supply chain) acceptance protocol for the MODULE (end product) manufacturers

Change in cell technology

r modifications such as:

- metallization materials and/or process,
- anti-reflective coating material,
- type of diffusion process
- semiconductor layer materials,
- order of cell process if the change involves the metallization system,
- change of manufacturing site of the solar cells not under the same QA system,
- use of cells from a different manufacturer and
- major reduction in cell thickness (greater than 25%).

Repeat:
Thermal cycling, 200 cycles (10.11),
Damp heat (10.13),
Outdoor exposure (10.8), and
Hot spot endurance (10.9).

IEC retests for the cell change in a module

Purpose:

To determine if the cells in the module are susceptible to breakage during shipping, installation and use.

Apparatus

1. Equipment for performing dynamic loading.
2. Equipment for thermal cycle test per IEC 61215 Section 10.11
3. IR Camera

Initial Measu rements

1. Take an I-V Curve of the module, measuring Pmax.
2. IR scan at twice Isc to identify cracked cells. Do we need a procedure for IR scanning?

Procedure

1. Place the test module in the dynamic loading system and cycle it 1000 times using a maximum pressu re of 15 to 20 lbs/ft^2 and a rate of 2 to 3 cycles per minute.
2. Redo the I-V curve looking for power loss and the IR scan looking for broken cells. Note the number of cells broken by the cycling.
3. Complete 25 thermal cycles between -40 and + 85 C without current flow.

Final Measurements

1. I-V Curve
2. IR scan at twice Isc to identify cracked cells. Identify the number of cracked cells.

Requirements

Power loss o f less than 5% from in itial.

Other potential tests for the cell change in a module

Study Area: CPV Safety Standard

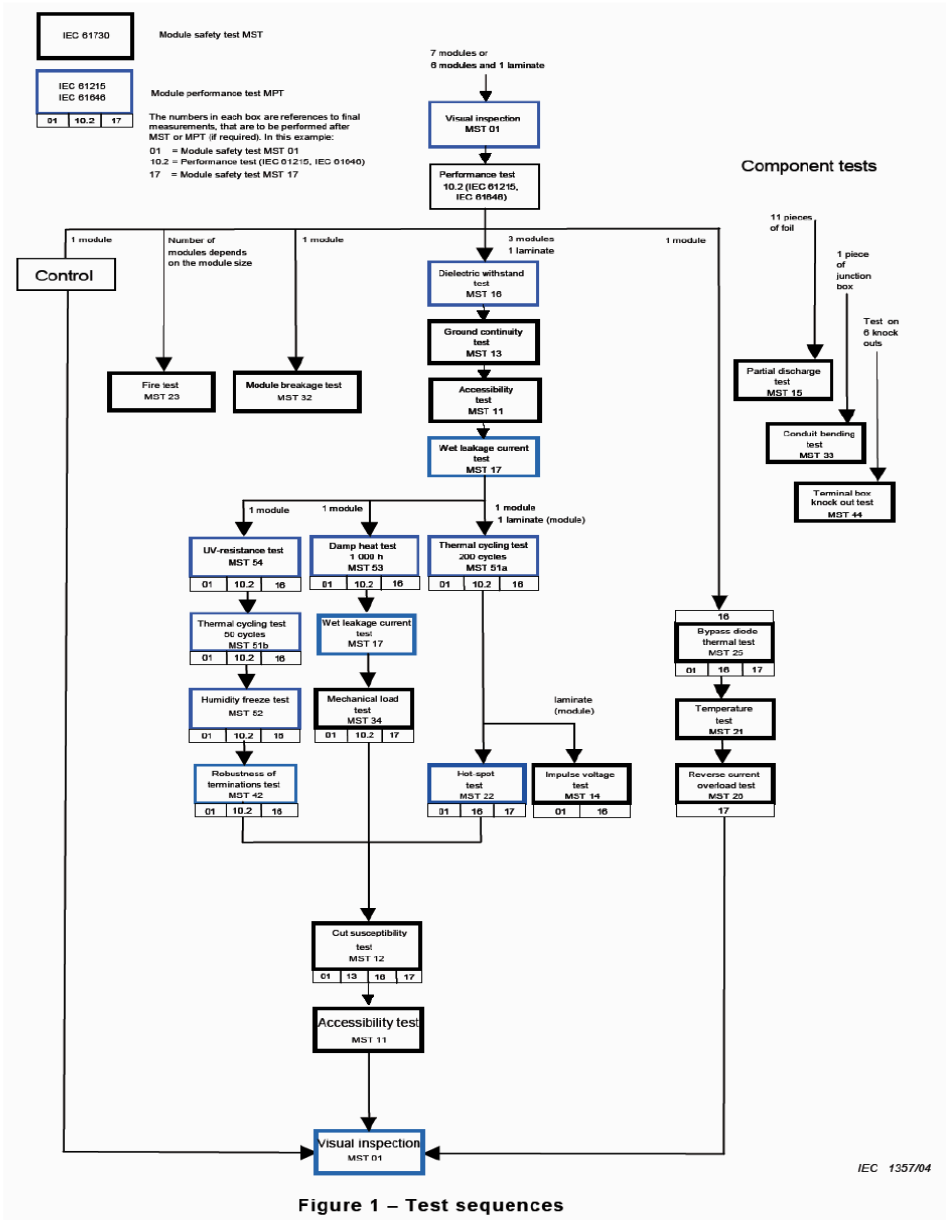
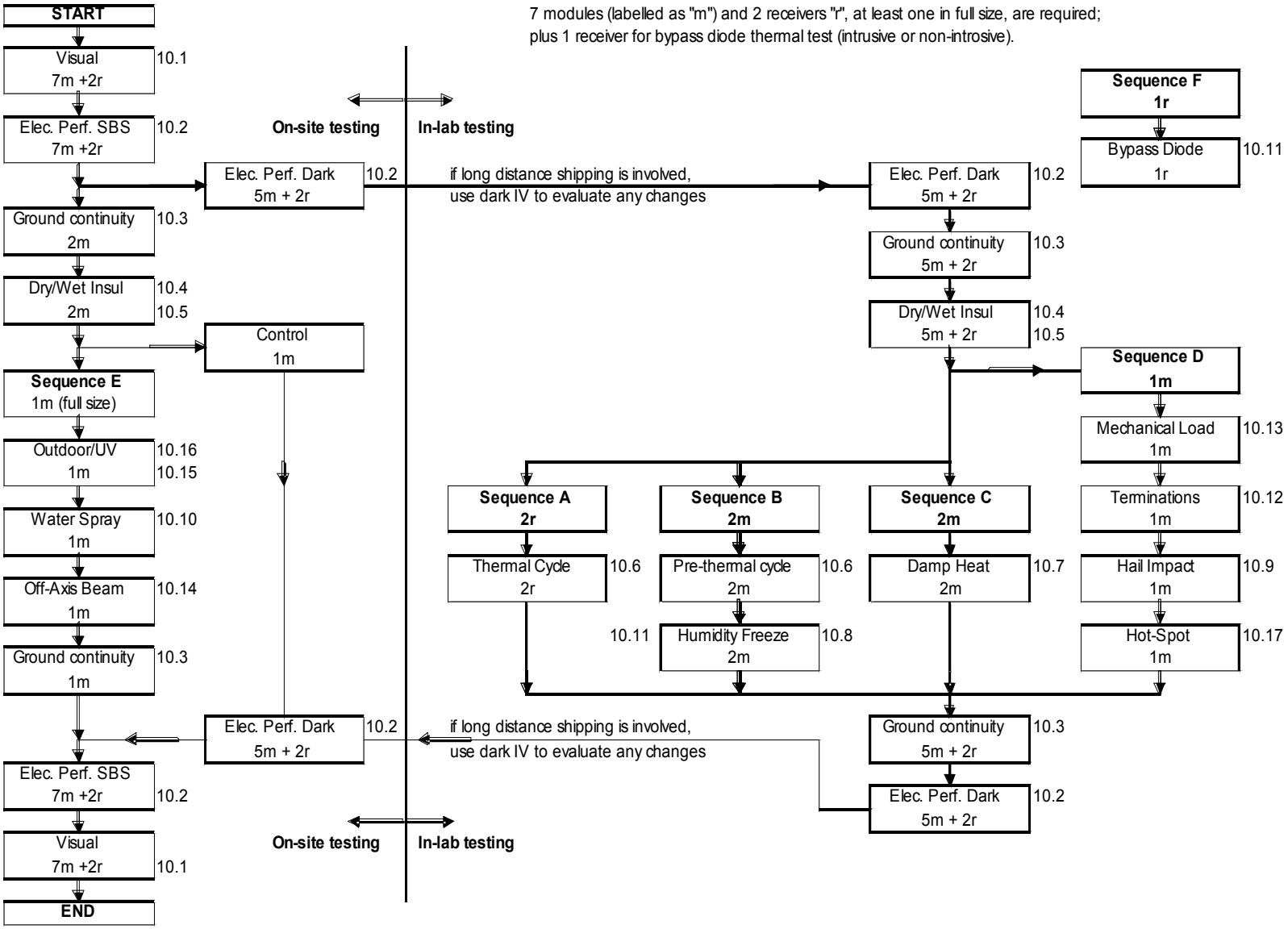


Figure 1 – Test sequences

- **Low concentration**
(for example, similar to IEC61730)

- **High concentration**
(for example, IEC61730-IEC62108 hybrid)

IEC61730 – PV Module Safety Qualification



IEC62108 – CPV Modules and Assemblies: Design Qualification and Type Approval

Potential Tests for the High Concentrator PV Standard (highlighted cells)

	Sample No.	1	2	3	4	5	6	7	8	9	10	
IEEE P1513	Sample Config	CPV System	CPV System	Receiver 1	Receiver 2	Receiver 3	Receiver 4	Receiver 5	Receiver 6	Receiver 7	Receiver 8	UL1703
5.1	Visual inspection											
												19. Temp
5.2	Electrical Perf.											20. IV
												21. Leakage I
												22. Strain
5.3	Ground continuity											25. Ground
5.4	Dry hipot											26. Dielec
5.5	Wet resistance											
												28. Reverse I
5.7	TC250 (-40~110)											
5.7	TC100 (-40~110)											
5.1	Visual inspection											
5.8	HF20 (-40~85/85)											
5.10	Damp Heat (85/85)											
5.14	Outdoor Exposure											
5.4	Dry hipot											
5.11	Hail Test											
5.12	Intrusive Bypass Diode test											
5.5	Wet resistance											
5.1	Visual inspection											

Figure 4: Potential tests for the proposed high concentration CPV safety standard

• A global standard to test and certify all the high concentration CPV systems would be practically impossible and a case-by-case approach needs to be implemented by the certification bodies

• The hybridized safety standard may set the minimum requirements to be met by the high concentration system before any further safety investigation is carried out by the certification bodies