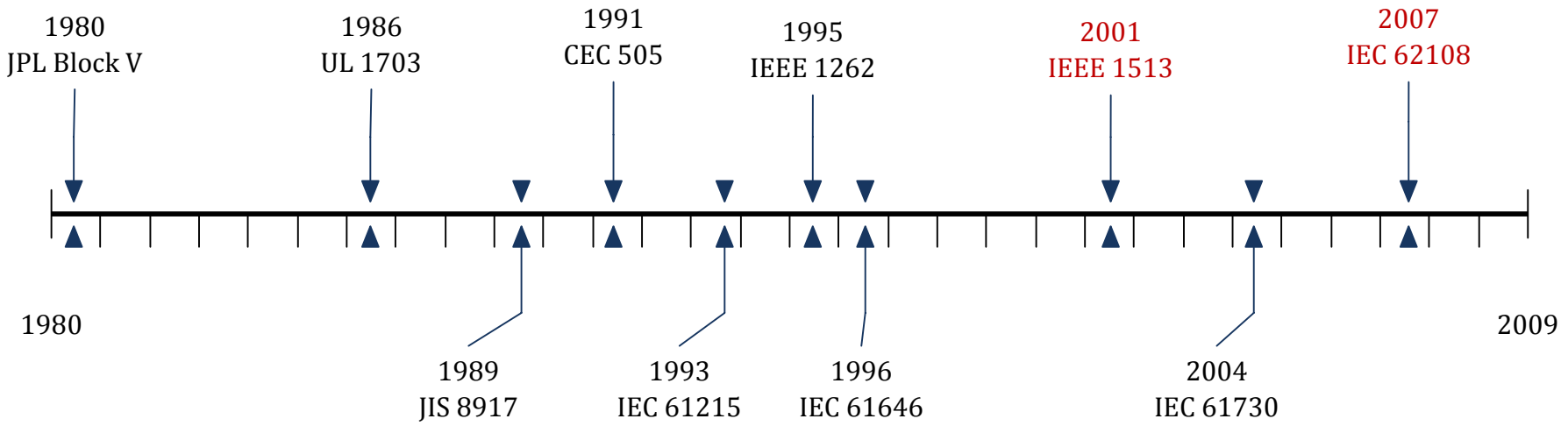
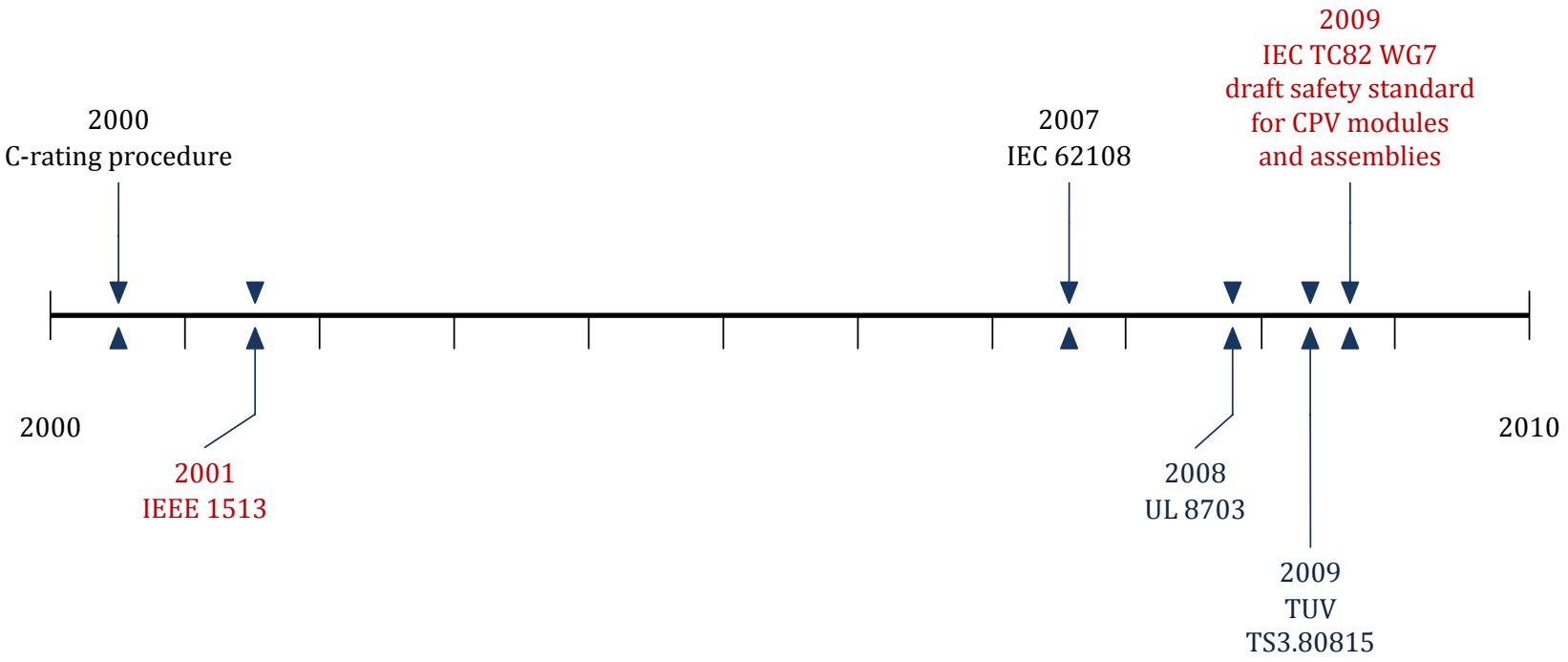
Summary of Emerging CPV Safety Standards

Bill Shisler
TUV Rheinland PTL, LLC

Some major PV module standards – Released in recent years



CPV module/assembly standards



Other drafts, standards, or plans may exist – but were not found in the preparation of this presentation.

CPV Safety - Current Status

For market acceptance, there is no one clear CPV safety standard available. In lieu of this, test plans and procedures have been developed, amalgamated, and reviewed to meet local regulatory requirements.

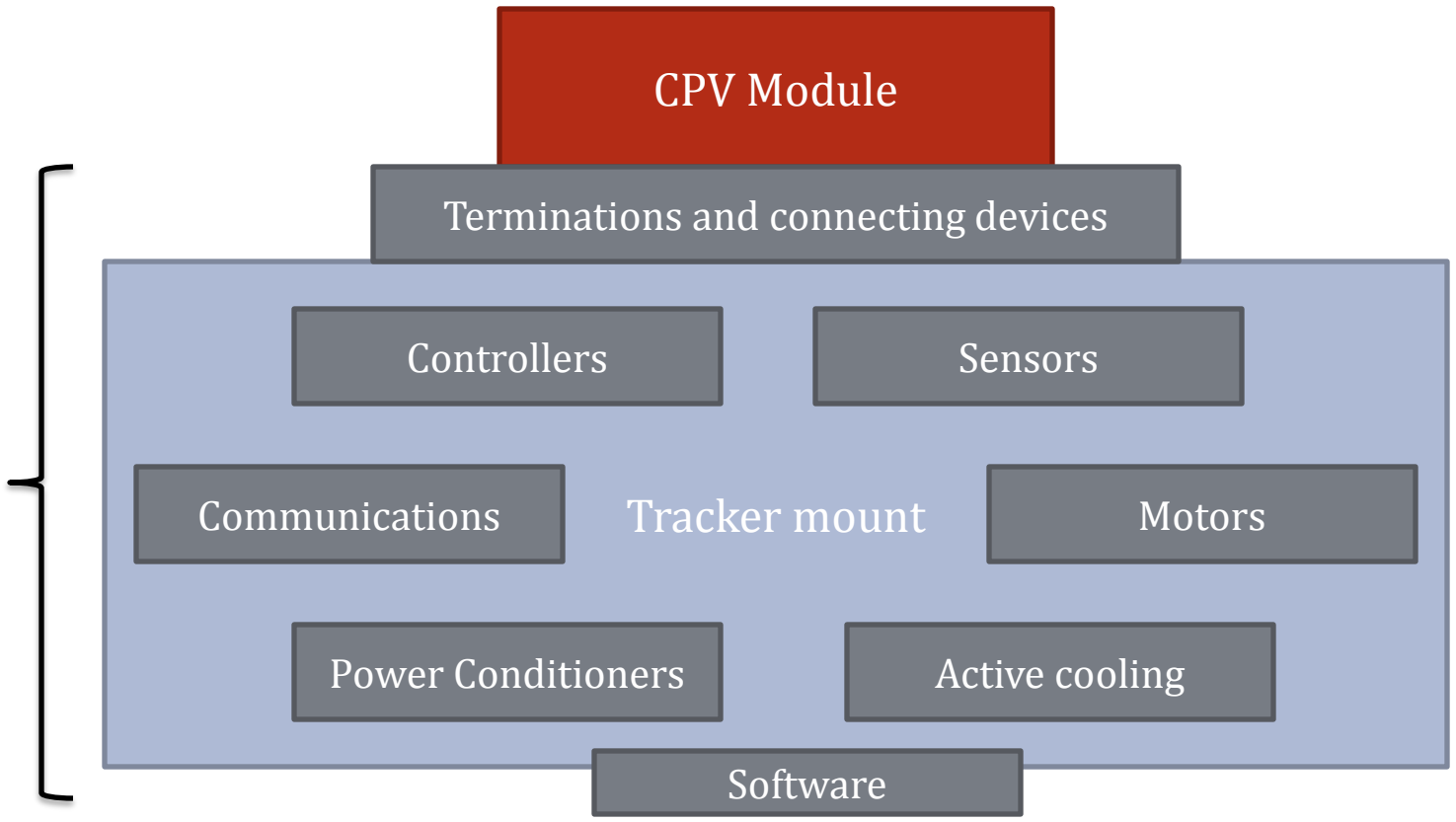
The IEC 62108 design type approval standard for CPV modules and assemblies was published in December 2007. A safety group was recently formed to establish an international safety standard compatible with IEC 62108.

This new safety standard will cover only PV modules and assemblies, and will not include balance of system, such as trackers, controls, motors – integrated or separate.

The Challenge

To establish a consensus set of standards, interchangeable to the design variations encountered in CPV systems, which meet both international and domestic codes/compliance. The ultimate test plan should be easily adaptable or supplementary to address any climate.

Components of a CPV module -- system



The CPV module "support group"

This is a generic example. Components will vary based on the design.

Some standards/protocols to consider

- Module
- Controllers
- Communications
- Terminations/ connections
- Motors/tracker
- Power Conditioners

- IEEE 1547
- IEC 62109
- IEC 62116
- IEC 61727
- EN 50178
- ANSI/UL 1741
- ANSI/UL 508C

Examples only. Not necessarily the prescribed test methods.

Some standards/protocols to consider

- Module
- Controllers
- Communications
- Terminations/ connections
- Motors/tracker
- Power Conditioners

- IEC 61010
- UL 1740
- EN 60204
- ISO 10218-1
- ISO 14121-1
- ISO 13849-1
- UL 467
- IEC 60335

Examples only. Not necessarily the prescribed test methods.

Some standards/protocols to consider

- Module
- Controllers
- Communications
- Terminations/ connections
- Motors/tracker
- Power Conditioners

- EN 50521
- 2Pfg 1169-2007
- DIN V VDE V 0126-5
- UL 1977
- UL 83
- UL 50

Examples only. Not necessarily the prescribed test methods.

Some standards/protocols to consider

- Module
- Controllers
- Communications
- Terminations/ connections
- Motors/tracker
- Power Conditioners

- EN 61000
- MAC
- Zigbee
- IEEE 802.15.4
- FCC 47 CFR
- EN 50081
- EN 50082
- ETS 300 328

Examples only. Not necessarily the prescribed test methods.

Some standards/protocols to consider

- Module
- Controllers
- Communications
- Terminations/ connections
- Motors/tracker
- Power Conditioners

- IEC 61010
- ANSI/UL 1741
- IEEE 1547
- ANSI/UL 508A
- ANSI/UL 1740
- ISO 14121-1
- ISO 13849-1

Examples only. Not necessarily the prescribed test methods.

Some standards/protocols to consider

- Module
- Controllers
- Communications
- Terminations/ connections
- Motors/tracker
- Power Conditioners

Examples only. Not necessarily the prescribed test methods.

- IEC 62108
- IEC 61215
- IEC 61730
- ANSI/UL 1703
- UL 8703
- New IEC draft CPV module safety standard

▪ Component recognition of polymers, terminations and connecting devices employed with the module may also need to be addressed here.

▪ Interfaces of components , such as the module on a tracker mount, also must be considered.

Concentrator Photovoltaic (CPV) Module and Assembly - Safety Qualification

Under development by IEC TC82 WG7

This draft standard is derived from applicable pieces of existing flat-plate and CPV standards and test methods. The first draft standard for CPV module and assembly safety is in progress. Goal for submission of first draft is Sept 28, 2009 (next WG7 meeting).

This standard is divided into two sections. Both are included in one document:

1. Construction requirements; and

2. Test requirements.

Scope

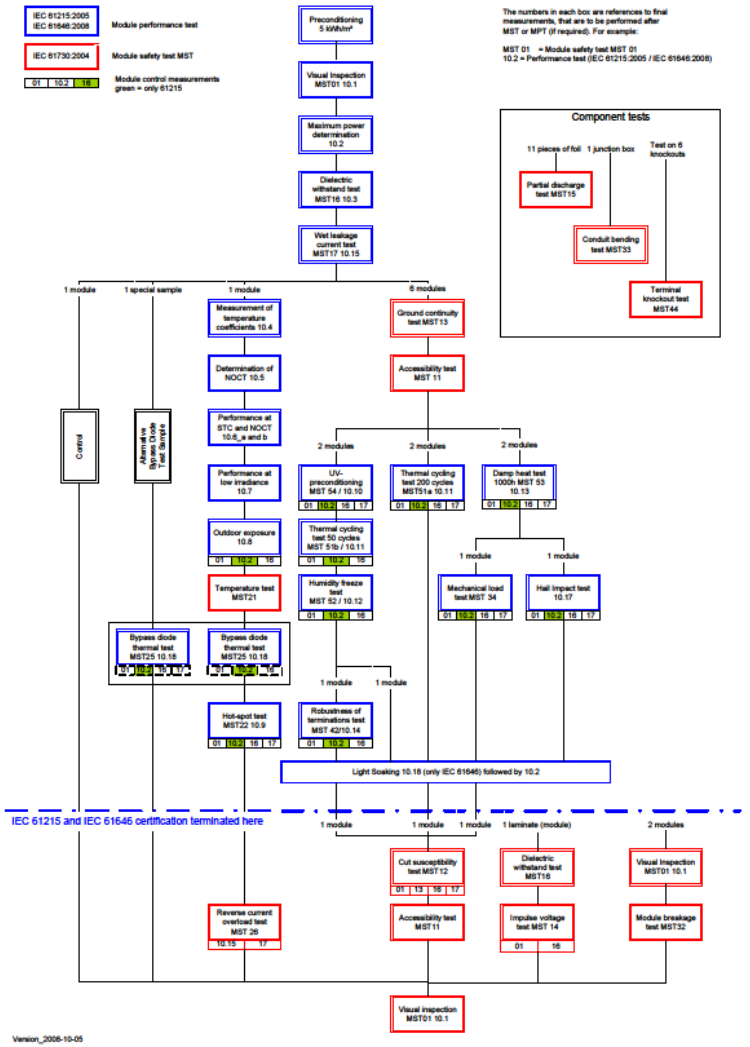
This international standard describes the fundamental construction and testing requirements for Concentrator Photovoltaic (CPV) modules and assemblies in order to provide safe electrical and mechanical operation during their expected lifetime. Specific topics are provided to assess the prevention of electrical shock, fire hazards, and personal injury due to mechanical and environmental stresses.

This standard attempts to define the basic requirements for various application classes of photovoltaic modules, but it cannot be considered to encompass all national and regional codes.

This standard is designed so that its test sequence can coordinate with those of IEC 62108, so that a single set of samples may be used to perform both the safety and performance evaluation of a CPV module and assembly.

Example

IEC 61215/61646/61730
test plan



Purpose

The purpose of this document is to provide basic guidance for safety approval of CPV modules and assemblies. These requirements are intended to reduce the risk of fire, electric shock and personal injury. The standard defines the basic safety construction requirements and additional tests that are a function of module and assembly applications.

Component requirements provide evidence of appropriate use of components in module and assembly construction.

NOTE: The additional construction requirements – outlined in relevant ISO and IEC standards, as well as national and regional codes which govern the installation and use of these modules and assemblies in their intended locations – must be considered in addition to the requirements contained within this document.

Unique Safety Concerns for CPV modules

Among others, the following are special safety concerns for CPV:

- Vision damage – for human (driver, pilot), or animals, such as birds
- Fire at focus point
- Broken lens pieces
- Off-axis focal beam damage
- Active cooling system – leakage of liquid, insulation
- Vibration
- Sharp edges
- Special Warning signs
- Distance to fence lines/land boundaries

* In cases where modules have integrated tracking, separate tracker or robotics standards must also be used by certification bodies and test labs.

Construction Evaluation

Notable differences from IEC 61730-1 (flat-plate construction requirements)

5 Polymeric materials

5.1 General

5.2.1 Material potentially exposed to concentrated sunlight

- a. Temperature
- b. **UV radiation**
- c. Humidity
- d. **Concentration level**

Question: How should we assess these? Is there empirical evidence to show that existing material characterizations, or ratings, are applicable to CPV modules?

5.2.2 Protection to prevent exposure to concentrated sunlight

5.2.3 Control to mitigate unsuitable temperature rises (e.g. – active cooling, movement off- axis)

5.6 Structural glazing materials – alternate test to ANSI Z-97 (not applicable for CPV)

10.5 Gaskets and seals

Meet Water Spray requirements before and after Humidity Freeze sequence, Damp Heat sequence (both samples)

Construction Evaluation

Notable differences from IEC 61730-1 (flat-plate construction requirements)

11 Marking
i. Hot surface temperature
EN61010 – hot to touch (<70°C) [polymeric (70°C), metallic (60°C)] or
UL 8703 [70°C metallic, 95°C non-metallic – casual contact]
A unit that exceeds the temperature limits specified above shall be legibly marked externally, where readily visible after installation, with the word "CAUTION" and the following or the equivalent: "Hot surfaces – To reduce the risk of burns – Do not touch."

ii. Eye hazard (reflected light – high intensity) – based on proximity, outside module enclosure "CAUTION: This module reflects light at high concentration – Use appropriate eye protection"

iii. A unit that allows access to concentrated irradiance above a maximum geometric ratio of 3X shall be marked in the vicinity of the hazard, where readily visible, with the word "CAUTION" □and the following or the equivalent: "Highly Concentrated Light - To reduce the risk of burns – Keep Away."

Test Requirements

Test Requirements (based on IEC 61730, IEC 62108, and IEC 61215)

a. Accessibility
b. Cut (if applicable)
c. Ground Continuity
d. **Impulse Voltage**
   - To be explored by labs (may be difficult to conduct)
e. **Temperature test**

Question: How do we correctly conduct the Temperature test for CPV? To what standard conditions?

Test Requirements

Test Requirements for Modules

f. Fire - General guidance for modules
g. Reverse Current Overload
h. Wet Leakage Current
i. Dielectric Withstand
j. Visual Inspection
Accumulation of water in module after period of time on sun (not yet specified) following humidity tests
k. Thermal Cycling/Humidity Freeze on module
l. Damp Heat
m. Off-Axis Beam Damage
n. Mechanical Load
o. Water Spray
p. Robustness of Terminations
q. Hot Spot Endurance
r. Bypass Diode Thermal
h. Outdoor Exposure/UV – potential modification (reduced number of hours)

Question: IEC 62108 Outdoor Exposure is not a reliability test. Can an understanding of operational behavior be derived in a shorter duration to assess safety concerns?

Test Requirements

Test Requirements for Modules

a. Blocked heat sink test
- Passive cooling around rooftop
- Active cooling

b. Impact test
- IEC 61721 (Accidental Impact) was withdrawn
- UL 1703, 6.78 J; or
- IEC 60068-2-75, 5 J or 10 J (three possible methods)

c. CPV Electrical Parameters test (UL 8703)
- Measure maximum Isc and Voc (absolute maximum power not needed)

Question: High DNI will be difficult for some test labs to attain. How large a range of extrapolation is acceptable? Can this test be performed indoors?

d. Push (UL 1703, IEC 60950)

e. Wiring Compartment Securement (UL 1703)
- DIN V VDE 0126-5, 40 N (under consideration for EN)

f. UV Irradiance test – discussion needed

Test Requirements

Test Requirements (other considerations)

h. Sharp Edge test (UL 1439)

i. Connectors

(EN 50521 – under consideration for IEC)

j. Cables

(IEC 60228) – Class 5 or 6

Must be flexible if used with connectors

k. Wiring compartments

(DIN V VDE 0126-5, IEC 60529, UL)

The Path

The completion and adoption of an international safety standard for CPV modules and assemblies is essential. We will work hard to get this standard completed and approved through IEC.

This CPV safety standard will be built on the backs of all the standards that precede it. Gratitude is due to those who have laid the foundation through years of dedication and commitment.

Thank you, and Sunny regards