CPV STANDARDS: UPDATE OF THE CURRENT TESTING STANDARDS AND FUTURE DEVELOPMENTS

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ABSTRACT

IEC 62108[1] historically is the most important performance testing standard for concentrating photovoltaic (CPV) modules. UL 8703[3] has been issued as an Outline of Investigation and there is a new IEC safety standard 62688[2] due to be released in 2013.

For US market entry, UL Subject 8703 is required but other UL safety tests will be required for the solar tracker and the other applicable new UL standards that will be discussed.

For international market entry, CPV manufacturers must gain certification to IEC 62108. The test sequence for IEC 62688 is designed to coordinate with that 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. Incorporating UL Subject 8703 testing can be blended with the requirements of both IEC standards for performance and safety, and the combined testing offers manufacturers many benefits including faster access to the market and lower costs.

INTRODUCTION

IEC 62108 is one of the most important standards for performance testing for concentrating photovoltaic (CPV) manufacturers. CPV manufacturers have been doing performance testing to this standard since its formal release in December of 2007and its acceptance has been Worldwide. In the United States, UL Subject 8703 has been issued as an Outline of Investigation and currently had its third issue in May of 2011. The IEC 82 Technical Committee is developing a new safety standard due to be released in 2013 which is IEC 62688 for Safety Testing of CPV technology. Depending on where the CPV products are intended to be installed all or only specific standards will be required. Other New Standards for the tracker portion may also be required. There are additional CPV standards in development by the IEC 82 Working Group 7 which will be briefly reviewed.

Key CPV Standards

For market entry into the United States, CPV manufacturers are required to test and certify their CPV modules to UL Subject 8703, the official U.S. standard for CPV modules and assemblies, through an accredited Nationally Recognized Test Laboratory (NRTL). According to the National Fire Protection Agency (NFPA)'s, National Electrical Code (NEC), components such as inverters, photovoltaic modules, AC photovoltaic modules and charge controllers are required to be Listed for the application. The test sequence for UL Subject 8703 is designed to coordinate with that 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.

For market entry into Europe, the CE mark is the mandatory mark for products on the market in the European Economic Area (EEA). The CE marking ensures that the manufacturer's product conforms to the requirements of the European Commission (EC). The IEC Standards 62688 and IEC 62108 support the manufacturer's self certification of his products.

For International market entry, CPV manufacturers need certification to IEC 62108, the international standard for CPV modules and assemblies suitable for long-term operation in general open-air climates. The test sequence for IEC 62108 can be used to determine the electrical, mechanical and thermal characteristics of the CPV modules and assemblies to establish they are capable of withstanding prolonged exposure in these climates. As shown in Figure 1 below, the test sequence for IEC 62108, there are four major sequences or streams for testing. The left side is for the outdoor testing sequence where the modules are exposed to a total accumulated irradiance exposure of 1000 $kWhr/m^2$ which takes about six months. Also the CPV modules must have a cumulative UV exposure of 50 $kWhr/m^2$ which normally takes longer than a six month testing period. The outdoor testing takes the longest time of all the other tests sequences. The Sequence A shown in Fig.1 below is for the receiver assembly and the test involves temperature cycling at a fast rate of 10 to 18 cycles per day; and an overall number of cycles depending on the temperature that the receiver can withstand (65C, 2000 cycles or at 85C, 1000 cycles or at 110C, 500 cycles). Therefore the shortest total overall time in the chamber is 27 to 50 days depending whether 10 or 18 cycles per day are achieved in the chamber. Also in Sequence A there is current injection at the rate of 10 cycles per one thermal cycle - this is to stress the electrical connections. The Sequence B is for sequential testing of a module for Thermal Cycles from – 40C to (65C, 400 cycles; or at 85C, 200 cycles or at 110C, 100 cycles) followed by a Humidity Freeze (HF) Cycle from – 40 C to (65C, 40 cycles or at 85 C for 20 cycles) where one HF cycle takes 24 hours. The Sequence C is for Damp Heat exposure of the module and is for 1000 hours (42 days) at 85C and 85% humidity or for 2000 hours (84 days) if at 65C receiver temperature. The other key tests that are performed as part IEC 62018 are bypass diode thermal test, mechanical load, terminations, hail and hot spot. After completing outdoor testing the modules have the Water Spray and the Off Axis test performed. Visual and Electrical performance is performed before and after the outdoor testing and all the sequence testing and as well as ground continuity.

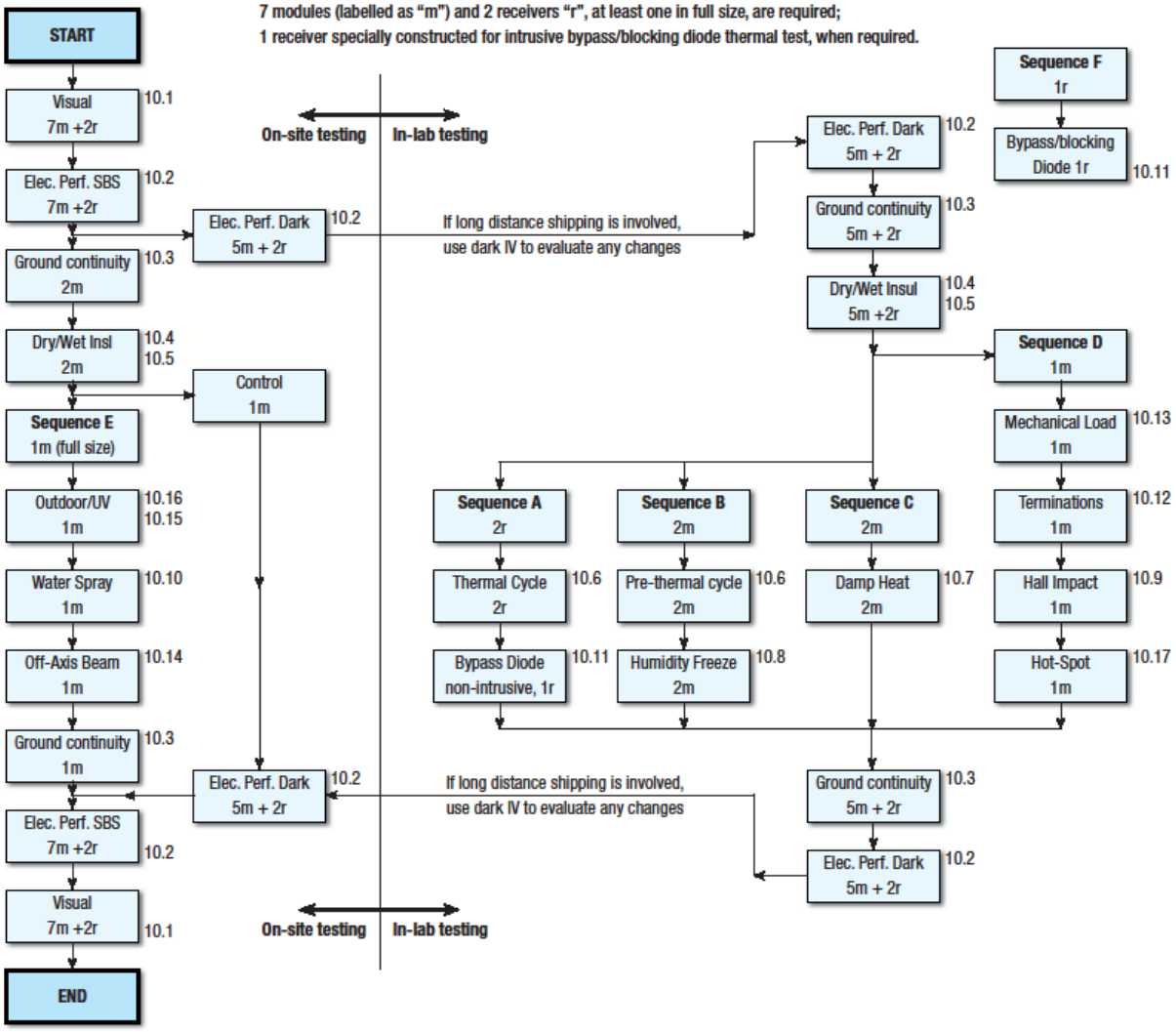

Fig. 1: IEC 62108 Qualification test sequence for CPV modules [1]

The test sequence for IEC 62688 is designed to coordinate with that 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. The indoor testing required is shown in Fig. 2 below. Despite the similarities between IEC 62688 and IEC 62108, there are some variations in the required testing. Key differences are additional safety testing which includes: Reverse Current Overload, CPV Temperature Test, CPV Electrical Parameters, Dielectric Voltage-Withstand Test, Impulse Voltage, Sharp Edges and Accessibility. The IEC 62688 Standard is eliminating the requirement for the Outdoor UV testing and will only require the total exposure for the 1000 kWhr/m2 but the UV Irradiance needs to be recorded. This new standard will include Burning Brand Fire Testing, a Blocked Heat Sink Test and a Locked Rotor Abnormal Operation Test.

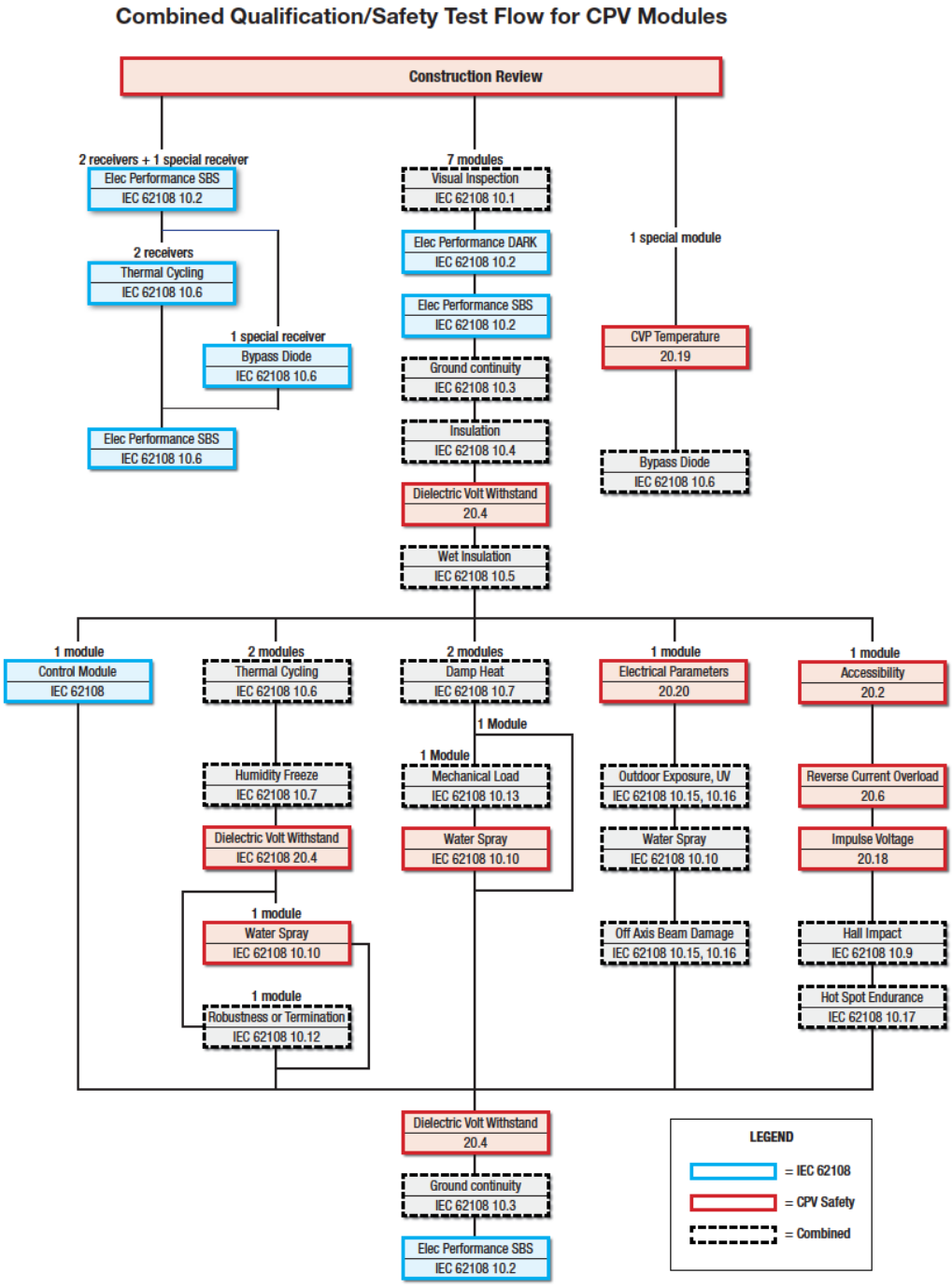

Fig. 2: Combined IEC 62108 and IEC 62688 test plan for CPV modules [4]

Incorporating UL Subject 8703 testing can be blended with the requirements of both IEC standards and combined testing offers manufacturers many benefits. The opportunity to minimize re-engineering of a CPV module to meet the requirements of multiple world areas saves manufacturers both time and money. Additional rigorous testing also helps manufactures produce a higher quality product that can be sold on the global market. Key difference in the IEC testing and the UL testing is shown in Table 1 below.

TABLE 1: SOME KEY DIFFERENCES BETWEEN IEC 62108/62688 AND SUBJECT UL 8703

Sample requirements	**IEC requires 2 samples per Test Stream** **UL requires 3 samples per Test Stream**
Additional Performance Testing Required for UL 8703	Dielectric Voltage-Withstand Test Leakage Current Test Wet Insulation-Resistance Test
UL 8703 Construction Requirements	Components certified by an NRTL to applicable UL standard

Manufacturers have the options shown in Table 2 below for a blended test program which will reduce costs, number of samples and testing times:

TABLE 2: THE MINIMUM SAMPLE REQUIREMENTS AND NOMINAL TEST TIMES REQUIRED FOR SEPARATE OR COMBINED TESTING TO IEC AND UL CPV STANDARDS FOR SAFETY AND PERFORMANCE

Specifications	Separate Testing (Samples Needed)	Nominal Testing Time if done separately (months)	Combined Testing (Samples Needed)	Nominal Testing for Combined Testing (months)
IEC 62108	7 Modules + 3 Receivers	6		
IEC 62688	8 Modules + 3 Receivers	6		
IEC 8703	10 Modules + 4 Receivers	6		
IEC 62688 + IEC 62108	15 Modules + 6 Receivers	12	8 Modules + 3 Receivers	6
IEC 62108 + UL 8703	17 Modules + 7 Receivers	12	10 Modules + 4 Receivers	6
IEC 62108, IEC 62688 and UL8703	25 Modules + 10 Receivers	18	10 Modules + 4 Receivers	6

Applicable UL Standards

For US market entry, UL Subject 8703 is required but other UL safety tests may be required which include UL 3703 for the solar tracker and there other applicable new UL standards shown in Table 3 below

TABLE 3: OTHER APPLICABLE UL STANDARDS[5]

SUBJECT 3703	Outline of Investigation for Solar Trackers Issue# 1, May 4, 2011
SUBJECT 2703	Outline of Investigation for Rack Mounting Systems and Clamping Devices, Issue # 1, October 4, 2010
SUBJECT 4703	Outline of Investigation for Photovoltaic Wire Issue# 4, SEPTEMBER 24, 2010
SUBJECT 6703	Outline of Investigation for Connectors for use in Photovoltaic Systems Issue# 1, March 25, 2010
SUBJECT 6703A	Outline of Investigation for Multi-Pole Connectors for use in Photovoltaic Systems Issue # 1, October 7, 2010
SUBJECT 9703	Outline of Investigation for Distributed Generation Wiring Harnesses Issue# 1, August 4, 2011

IEC 82 WG7 Working Group Activities

The IEC 82 WG 7 CPV Working Group is working on several standards which are listed in Table 4 below. The standards cover the range from specifying cells to indoor simulators to measurements for Power Plants.

TABLE 4: ADDITIONAL STANDARDS BEING WORKED ON BY THE IEC 82 WG 7 WORKING GROUP[4]

Standards	Objective/Scope	Key Contact
Tracker Design Qualification Standard	Both key components and for the complete tracker system	Matt Muller NREL matthew.muller@nrel.gov
IEC 62670-1, -3 (CPV Performance Testing – Standard Conditions and Power Rating Methods)	This Standard aims to define the procedure for assessing the power produced by a CPV (Concentrated Photovoltaic Module) under a standard set of conditions	Sandheep Surendran, Surya Design sandheep@suryadesign.com
CPV Performance based on 61853-2	To define spectral and other effects that are needed to extrapolate performance over a full range of conditions	Kenji Araki Daido Steel k.araki@ac.daido.co.jp
Acceptance Test	Definition of a technical specification which can be used for the acceptance of a plant once it is installed	F. (Paqui) Rubio ISFOC frubio@isfoc.com

Standards	Objective/Scope	Key Contact
Energy Performance Ratio IEC 62670-2	On-Sun measurement based method for determining the energy output and performance ratio of CPV arrays, assemblies and power plants	Tobias Gerstmaier Soitec Tobias.gerstmaier@soitec.com
IEC 62108 Revision	Update IEC 62108	Nacho Anton
Cell Qualification Standard	Bare cell specification is to provide a common set of product qualification cells and performance parameters for bare solar cells intended for CPV applications	Ian Aeby
Specification of Concentrator Cell Description	Define the information communicated on a concentrated cell data sheet in order to standardize the way the data is reported	Sarak Kurtz NREL Sarah.kurtz@nrel.gov
Solar Simulator Standard	Create a standard covering specification, characterization and classification of solar simulators for use with CPV	Steve Askins IES-UPM Steve.askins@ies-def.upm.es And Liang Ji, UL, Liang.ji@ul.com
CPV Primary Lens Specification	Develop a Primary Lens Specification	Steve Scott

SUMMARY

In Summary, the three key CPV module specifications for safety and performance testing are IEC 62108, IEC 62688 and UL Subject 8703. Manufacturers can capitalize on combined testing to increase speed to market while reducing costs. Manufacturer's can decrease the number of samples required for testing from 25 modules and 10 receivers to 10 modules and 4 receivers and complete the testing in 6 months instead of over 1.5 years if each standard is tested separately. A review of 10 additional standards being worked on by the IEC 82 WG7 working group is summarized in Table 4 above and other UL tests that may be required is shown Table 3.

REFERENCES

(1) IEC 62108, Concentrator photovoltaic (CPV) modules and assemblies – Design qualification and type approval, pages 1 -84, Edition 1.0, issued Dec., 2007

(2) IEC 62688, CPV Safety Draft J 20120901-1.docx, pages 1 – 75

(3) Subject 8703, Outline of Investigation for Concentrator Photovoltaic Modules and Assemblies, Issue Number 3, May 2, 2011, pages 1 -46.

(4) Welcome to WG7 Workspace/Wiki, http://iectc82wg7.pbworks.com/w/page/303583/FrontPage

(5) SAI Global, Standards Infobase, http://www.ili-info.com/cgi-bin/main_frames?DATA=50E1D415: