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1617 Cole Boulevard  
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A national laboratory of the U.S. Department of Energy  
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## **ABSTRACT**

This document provides an overview of the structure and function of typical product certification/laboratory accreditation programs. The overview is followed by a model program which could serve as the basis for a photovoltaic (PV) module certification/laboratory accreditation program. The model covers quality assurance procedures for the testing laboratory and manufacturer, third-party certification and labeling, and testing requirements (performance and reliability).

A 30-member Criteria Development Committee was established to guide, review, and reach a majority consensus regarding criteria for a PV certification/ laboratory accreditation program. Committee members represented PV manufacturers, end users, standards and codes organizations, and testing laboratories.

## Acknowledgments

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The additional time and effort contributed by members of the PV-3 subcommittee were appreciated. Members of this subcommittee were Don Aldrich (Siemens Solar Industries), Jerry Anderson (Sunset Technology), Moneer Azzam (Mobil Solar Energy Corporation), Chuck Whitaker (ENDECON), John Wohlgemuth (Solarex), Steve Hogan (Spire Corporation) and Mark Genard (Texas Instruments).

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## EXECUTIVE SUMMARY

### ES.1 Background

Third party product certification involves a formal process of licensing a manufacturer to use a certificate of conformity. Such a certificate can take the form of a tag, label, nameplate, or document of specified form and content, affixed or otherwise directly associated with a product or service, attesting that the product or service is in conformity with the referenced standards or specifications. The Underwriters Laboratories (UL) label commonly found on nearly all household electrical appliances is an example of such a label. Such labels often find themselves as requirements, e.g., through government legislation or contractual agreements.

In this report, the term *third party* is used to indicate an organization which issues a certification license to a manufacturer. The certification organization (or *certification body*) is a third party in the sense that it is neither a manufacturer nor an end user.

The accreditation of a laboratory represents an official recognition that the laboratory has the necessary personnel, physical resources, and quality assurance needed to perform a specific testing activity. The process of accreditation involves the assessment of a laboratory's capability by an authority using criteria that are generally accepted as the essential requirements for a laboratory's performance. This accreditation process helps instill confidence in suppliers, manufacturers, and users that the laboratory's test results are accurate and valid.

For photovoltaic (PV) products, there are two qualities that can benefit from a certification/accreditation program—module electrical performance and module reliability. At the present time, no certification/accreditation programs exist in the PV industry. Buyers and end users of PV modules must either accept what manufacturers specify for the performance and reliability of their products, find an independent laboratory capable of performing the necessary testing, or attempt to perform the testing themselves. Consensus standards that specify how PV modules should be tested for such a certification program do not exist. This situation is a natural consequence of the young age of the PV industry in which products are continually being introduced and changed.

There are three options (see Figures 3-2, 3-3, and 3-4) that are used for product certification programs: certification body assessment (option 1), independent assessment (option 2), and testing laboratory certification (option 3). In option 1, a certification body assesses the test laboratory(s) and certifies products. Option 2 is similar to option 1, except that the test laboratory accreditation is performed by an independent assessment agency, such as the American Association of Laboratory Assessors (A2LA) or the National Voluntary Laboratory Assessment Program (NVLAP). The assessment agency uses the requirements of the certification body to perform laboratory assessments. For option 3, a single test laboratory certifies products through its own certification program. An example of option 3 is Underwriters Laboratories.

Several test laboratory options are available for product testing in a certification program: a single full-service laboratory, multiple full-service laboratories, and multiple partial-service laboratories. There are advantages and drawbacks for each of these, which are discussed in Section 5.

## **ES.2 Criteria**

This report, via industry participation and consensus, defines the applicable standards, equipment, facilities, quality assurance procedures, and technical expertise required for a laboratory to become accredited. It also provides a model for a third party certification program for nonconcentrating PV modules and recommends the testing necessary for a PV module design to be certified. The criteria for a possible photovoltaic module testing, certification, and labeling program are contained in three documents (see Figure ES-1) attached to this report as Annexes A, B, and C.

## Figure ES-1. Criteria Documents

- PV-1. Criteria for a Model Quality System for Laboratories Engaged in Testing Photovoltaic Modules
- PV-2. Model for a Third party Certification and Labeling Program for Photovoltaic Modules.
- PV-3. Testing Requirements for a Certification and Labeling Program for Photovoltaic Modules

These documents are based on International Standards Organization and International Electrotechnical Commission (ISO/IEC) standards, as well as Institute of Electrical and Electronic Engineers (IEEE), American National Standards Institute (ANSI), and American Society for Testing and Materials (ASTM) standards. They are also consistent with accepted practices of existing national and international accreditation and certification programs.

PV-1, PV-2, and PV-3 have been developed as individual, stand-alone documents to aid the formation of a possible future certification body for PV modules. Revision, modification, and adoption of the documents would then become the responsibility of the certification body.

### ES.2.1 PV-1

Document PV-1, like ISO/IEC Guide 25<sup>1</sup> from which it was developed, is a guide for a laboratory quality system program that could be employed by laboratories engaged in testing PV devices to design, develop and implement a quality system that meets the criteria for accreditation. Conversely, it is also the criteria against which laboratories would be examined for the purpose of accreditation, and would thus be used by accreditation agencies and their assessors.

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<sup>1</sup> ISO/IEC GUIDE 25: 1990 (E) General requirements for the competence of calibration and testing laboratories. Complete lists of referenced documents are located in the References sections of PV-1, PV-2, and PV-3.

## **ES.2.2 PV-2**

The purpose of PV-2 is to define a third party certification system for determining conformity with product standards through initial testing, and assessing a manufacturer's quality management system. Initial assessment is followed by periodic surveillance of both the quality management system and samples from the production line as well as the open market. PV-2 has been developed so that it is applicable to any of the product certification options, i.e., certification body assessment, independent assessment, or testing laboratory certification.

## **ES.2.3 PV-3**

Document PV-3 recommends the testing and reporting requirements for qualification and baseline performance value measurements of PV modules that may be used in support of a PV module certification and labeling program. It includes specifications for testing requirements of PV products, laboratory equipment, and general requirements for facilities, staffing, and personnel qualifications.

## **ES.3 Criteria Development**

An iterative process was used to develop the criteria documents PV-1, PV-2, and PV-3. This process consisted of enlisting the services of a team of experts<sup>2</sup> to develop the first draft of the documents. Each document was then subjected to three review cycles by a 30-member criteria development committee of manufacturers, users, and testing laboratories<sup>3</sup>. While the committee was reviewing one document, the team of experts was developing or revising the other two documents. All comments were reviewed and either accepted or rejected (with explanation). By the third (and final) draft, full consensus had been reached. Further details of the criteria development process are given in Annex D. This technical report was prepared from the final report of the criteria development program.

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<sup>2</sup>Byard D. Wood, Charles E. Backus, Gene Zerlaut, and Robert V. D'Aiello.

<sup>3</sup>The membership of the criteria development committee is listed on page ii of this report.

## ES.4 Recommendations

The bulk of the efforts of the PV module certification/laboratory accreditation criteria development program have been directed toward the criteria documents PV-1, PV-2, and PV-3. Therefore, these documents define the recommendations for a possible PV module certification and labeling program. These recommendations can be summarized as follows.

PV-3 specifies that module designs be tested to IEEE Project Authorization Request (PAR) 1262, *Recommended Practice for Qualification of Photovoltaic (PV) Modules*. This qualification test program represents the most up-to-date methods of subjecting modules to simulated and accelerated environmental stresses that have been developed.

PV-2 delineates the structure, functions, and processes a certification and labeling program should have. Although not part of PV-2 (because it is written to be applicable to all three options), a major recommendation of the criteria development program is that option 2, independent assessment, is the most appropriate option for a possible future PV module certification and labeling program.

Laboratories accredited for testing PV module designs must develop, and have in place, a quality system that meets the requirements specified by PV-1, which recommends that solar radiation instrumentation used for module testing be traceable to the World Radiometric Reference (WRR).

Work on the criteria development program has been enthusiastically supported by the 30 criteria development committee members. Manufacturers, in particular, have endorsed this effort and have been very responsive in reviewing and commenting on the draft documents. Although the PV industry does appear to have organizations that are interested in becoming accredited testing laboratories, there are not yet any legal entities that have been identified and could serve as a certification body. Such an entity could be an existing certification body, a new body created by a PV trade association, or a new body organized by a PV industry segment.



Regardless of which of these options might be selected, additional work remains before a certification program could be initiated. These tasks include: selection of a particular laboratory accreditation agency, development of incorporation documents and a budget for a certification body, and formation of a certification body, including selection of the staff and members of the various functional committees. At some point in this process, the PV industry as a whole must decide when and if the time is right to begin a third party certification program. The possibility exists that the answer to this question may be that now is not the time to begin such a program. In this case, it is hoped that this report would be used at a time in the future when the need for a PV certification program is greater. Using the criteria in this report could avoid having to start from the beginning of the implementation process.

# Section 1

## INTRODUCTION

### 1.1 Background

In March 1993, the National Renewable Energy Laboratory (NREL) issued a request for proposal<sup>1</sup> to develop the criteria for photovoltaic module certification and laboratory accreditation. The NREL-stated objective was to:

“ . . . produce a document detailing the equipment, facilities, quality assurance procedures, and technical expertise an accredited laboratory needs for performance and reliability testing of concentrating<sup>2</sup> and nonconcentrating PV modules. This document shall also detail the specific test standards necessary for a module design to be certified.”

The statement of work consisted of two tasks—Criteria Development Committee Formation (Task 1) and Certification/Accreditation Criteria Development (Task 2)—all to be completed within 12 months. These tasks were:

Task 1: Establish a committee which consists of PV manufacturers, end users, standards and codes organizations, and testing laboratories. The committee was charged with the development of the certification/accreditation criteria document and delineation of the approach necessary to accomplish the required work.

Task 2: In addition to the general development of the criteria document, the statement of work required two criteria development committee meetings, the first to be held within 16 weeks after the project start date and the second within 36 weeks after the project start date.

Arizona State University was awarded a subcontract from NREL in October 1993 to develop the required criteria. This document was prepared from the final deliverable produced under this subcontract.

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<sup>1</sup> Request for Proposal No. RAH-3-13301; “Laboratory Accreditation Criteria Development”; Issue date: May 25, 1993; Due date: June 29, 1993.

<sup>2</sup> The requirement to include concentrating modules was eliminated in March 1994.

## 1.2 Need

As the PV industry matures, there is an ongoing need to continually instill confidence that PV products meet minimum standards for performance, reliability, and durability. Such confidence is generally instilled by qualification testing, warranties, and product certification and labeling (e.g., Underwriters Laboratories listing and labeling).

At present, PV module manufacturers provide product warranties and, in nearly all cases, in-house qualification testing. No formal certification program is currently in existence for PV modules. Therefore, buyers must either have their own specifications for qualifying a product prior to purchase or use the specifications of past purchasers. This situation requires buyers to have an intimate knowledge of PV module testing, which for most buyers is not practicable.

The majority of module qualification testing has been performed by the manufacturers (as opposed to independent testing laboratories), primarily because of: (a) economic reasons, (b) a lack of standardization, and, (c) a lack of qualified laboratories to perform the tests. Also, some manufacturers have developed in-house qualification testing capabilities as part of product development and warranty offerings. Accredited, independent testing laboratories would allow these manufacturers to reduce their need for facilities to perform routine testing of proven products and manufacturing processes, thereby reducing costs. Manufacturers' liability costs would also be reduced as liability is transferred from manufacturers to the product certification body.

It is expected that a certification/laboratory accreditation program would enable manufacturers to certify products through a single process, avoiding the current situation of the multiple standards required for different markets, different customers, or both. This would reduce the cost to the manufacturers and ultimately to the buyers of PV modules.

The initial step toward the establishment of a certification/accreditation program in the PV industry is the development of the criteria that specify what testing needs to be done to certify that a particular PV module product meets the required standards. Along with this, the equipment and facilities required by a laboratory for module certification testing needs to be identified.

### **1.3 Objectives of this report**

The primary objectives of this report are to define: (a) the applicable test standards necessary for a module product to be certified, and, (b) the criteria for laboratory accreditation for both performance and reliability testing of nonconcentrating PV modules. These objectives are defined by documents PV-1, PV-2, and PV-3. An additional objective is to provide a source of information about third-party certification in general, with emphasis on the special needs of the PV industry.

### **1.4 Consensus**

The goal while developing and reviewing the three criteria documents was to achieve 100% agreement among all committee members on all aspects of each document. Unlike standards committees that can take years to develop a standard, the criteria development committee had only 10 months to develop the three draft documents. Further, the draft documents will be reviewed and probably revised by any future certification body that elects to use them. Committee members understood these constraints and were more willing to compromise.

Each committee member had the opportunity to review and comment on each of three drafts (Annex D contains details of how the criteria documents were developed). The team of experts (see p. ES-4) reviewed all comments and either accepted or rejected each comment. By the third (and final) draft of PV-1 and PV-2, consensus had been reached.

PV-3, however, was by far the most controversial of the three documents and required more discussion and negotiation with committee members than PV-1 and PV-2 did. A consensus was also reached with the final draft, but with the understanding that it is a draft likely to evolve further in the future.



## Section 2

### TERMINOLOGY

#### 2.1 Introduction

The terms defined in this section include a consolidation of terms used and defined in documents PV-1, PV-2, and PV-3 (Annexes A, B, and C, respectively) and terms that apply to accreditation, certification, and standardization programs in general.

#### 2.2 Acronyms, abbreviations, and symbols

A2LA	American Association for Laboratory Accreditation
AAMVLA	American Association of Motor Vehicle Laboratory Accreditation
AM	Air mass
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASQC	American Society of Quality Control
ASTM	American Society for Testing and Materials
BCS	British Calibration Service
CASCO	Council Committee on Conformity Assessment
CEC	Commission of the European Communities
CERTICO	Certification Council (ISO/IEC)
CRM	Certified Reference Material
dc	Direct current
DOE	Department of Energy
EC	European Community or European Commission
EOTC	European Organization for Testing and Certification
ERDA	Energy Research and Development Administration
ESTI	European Solar Test Installation
GATT	General Agreements on Tariffs and Trade
ICBO	International Congress of Building Officials
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ILAC	International Laboratory Accreditation Conference
$I_{MP}$	Current at maximum power point
ISCC	Interstate Coordinating Council
$I_{SC}$	Short-circuit current
ISO	International Standards Organization
I-V	Current-voltage
LAP	Laboratory accreditation program
NATA	National Association of Testing Authorities (Australia)
NBS	National Bureau of Standards
NIST	National Institute for Standards and Technology
NREL	National Renewable Energy Laboratory
NVLAP	National Voluntary Laboratory Accreditation Program (NIST program)
PAR	Project authorization request
$P_{MP}$	Power at maximum power point

RAB	Registration Accreditation Board (ASQC)
RCL	Rating, Certification and Labeling (solar hot water collector program)
SEIA	Solar Energy Industries Association
SEREF	Solar Energy Research and Education Foundation (SEIA program)
SNL	Sandia National Laboratories
SRC	Standard Reporting Conditions
SRCC	Solar Rating and Certification Corporation
STC	Standard Test Conditions
TAG	Technical Advisory Group
TQM	Total Quality Management
UL	Underwriters Laboratories
$V_{MP}$	Voltage at maximum power point
$V_{OC}$	Open-circuit voltage
WRR	World Radiometric Reference

## 2.3 Definitions

**Air Mass:** The ratio of the mass of atmosphere in the actual observer-sun path to the mass that would exist if the observer was at sea level, at standard barometric pressure, and the sun was directly overhead. Note—(sometimes called air mass ratio.) Air mass varies with the zenith angle of the sun and the local barometric pressure, which changes with altitude. For sun zenith angle,  $Z$ , of  $62^\circ$  or less and local atmospheric pressure,  $P$ , where  $P_0$  is standard atmospheric pressure,  $AM = \sec Z(P/P_0)$ . [ASTM E 772]

**Air Mass 1.5 standard reference spectrum:** The solar spectral irradiance distribution (diffuse and direct) incident at sea level on a sun-facing,  $37^\circ$  tilted surface, as defined by ASTM E 892. The atmospheric conditions for AM 1.5 are: precipitable water vapor, 14.2 mm; total ozone, 3.4 mm; turbidity (base e,  $\lambda = 0.5$  mm), 0.27.

**Baseline performance value:** Initial values of  $I_{SC}$ ,  $V_{OC}$ ,  $P_{MP}$ ,  $V_{MP}$ ,  $I_{MP}$  measured by the accredited laboratory and corrected to Standard Test Conditions, used to validate the manufacturers' performance measurements provided with the qualification modules per IEEE 1262 [PV-3].

**Blocking Diode:** A diode used to restrict or block reverse current from flowing backward through a module. [UL 1703]

**Bypass Diode:** A diode connected across one or more solar cells such that the diode will conduct if the cell(s) become reverse biased. [UL 1703]

**Calibration:** The set of operations which establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and the corresponding known values of a measured quantity. The results of a calibration permit the estimation of errors of indication of the measuring instrument, measuring system, or material measure, or the assignment of values to marks on arbitrary scales. A calibration may determine other metrological properties. The result of a calibration shall, for the purposes of this model, be recorded in a document, which may be either an internal or external calibration certificate, or a calibration report. The results of calibration operations recorded as values may be referred to as "calibration factors," or, if a series of calibration values, as a "calibration curve." [PV-1]

**Certificate of conformity:** A tag, label, nameplate, or document of specified form and content, affixed or otherwise directly associated with a product or service on delivery to the buyer, attesting that the product or service is in conformity with the requirements of the certification program (e.g., with the referenced standards and specifications). [PV-2]

**Certification:** The procedure by which written assurance is given that a product or service conforms to a specification. A *third-party* certification is one that is rendered by a technically and otherwise competent body other than one controlled by the *producer* or the *buyer*. [PV-2]

**Certification body:** An impartial body or organization possessing the necessary competence to develop promulgate, finance, and operate a certification program and to conduct certifications of conformity. Note: A certification body may operate its own testing and inspection activities or it may oversee these activities carried out on its behalf by other bodies, e.g., an independent testing laboratory. [PV-2]

**Certification mark:** A generic term intended to include the Listing Mark, Classification Mark, Recognized Component Mark and Recognized Marking of [the Laboratory]. Authorized use of a Certification Mark by a manufacturer is the manufacturer's declaration that the product was produced according to [the Laboratory's] requirements. "Label" is synonymous with "Listing Mark," "Classification Marking," or "Certification Mark."<sup>1</sup>

**Certification mark:** The sign or symbol owned and controlled by the certification body that is used exclusively by the third-party certification program to identify products of services as being certified and is registered as a certification mark with the U.S. Patent Office under the Trade Mark Act of 1946. [PV-2]

**Certified reference material:** A reference material, one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying body, e.g., a *standard reference cell*. [PV-1]

**Current at maximum power:** The current at which maximum power is available from a module (for the purpose of this document, the "rated" current at maximum power will be defined as  $I_{MP}$  at STC). [UL 1703]

**I-V data:** The relationship between current and voltage of a cell [or module] in the power-producing quadrant, as a set of ordered pairs of current and voltage readings in a table, or as a curve plotted in a suitable coordinate system such as a Cartesian one. [ASTM E 1036]

**Interconnect:** A conductor within a module or other means of connection which provides an electrical interconnection between the solar cells. [UL 1703]

**Interlaboratory testing:** Organization, performance, and evaluation of tests on the same or similar items or materials by two or more laboratories in accordance with predetermined conditions. [PV-1]

**Laboratory or testing laboratory:** A body or organization that performs tests and provides a formal, written report of the results. In cases in which the laboratory forms part of an organization that carries out activities in addition to testing and calibration, the term laboratory refers only to that part of the organization that actually performs the testing of photovoltaic modules. [PV-1]

**Mark of conformity:** See *Certification mark*.

**Maximum Power:** The point on the current-voltage (I-V) curve of a module under illumination, where the product of current and voltage is maximum. For the purpose of this document, "rated" power is defined as  $P_{MP}$  at STC. [UL 1703]

**Metrology:** The science of weights and measures or of measurement.

**Producer:** The manufacturer, distributor, supplier, or other party providing the product or service to be purchased and employed by a *user*. The producer is responsible for assuring conformity with all requirements of the certification program. [PV-2]

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<sup>1</sup> From *Glossary of UL Terms and Acronyms*. Copyright 1990, Underwriters Laboratories Inc.



**Proficiency testing:** Regular, periodic determination of the laboratory testing or calibration performance of *unknowns*, usually by means of interlaboratory comparisons. [PV-1]

**PV module (flat-plate):** The smallest environmentally protected, essentially planar assembly of solar cells and ancillary parts, such as interconnects, terminals, [and protective devices such as bypass diodes] intended to generate dc power under unconcentrated sunlight. The structural (load carrying ) member of a module can either be the top layer (superstrate), or the back layer (substrate). [UL 1703]

**Qualification test (PV):** A procedure applied to a selected set of PV modules involving the application of defined electrical, mechanical, or thermal stress in a prescribed manner and amount. Test results are subject to a list of defined requirements. [PV-3]

**Quality manual:** A document stating the quality policy or policies and the quality system and quality practices of an organization. [PV-1]

**Quality system:** The organizational structure, responsibilities, procedures, processes, and resources for implementing quality management. [PV-1]

**Reference material:** A physical material, or substance, one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. [PV-1]

**Reference standard:** A physical standard, generally of the highest metrological quality available to the test laboratory, from which measurements made at that location are derived. [PV-1]

**Standard reporting conditions:** A fixed set of conditions to which the electrical performance data of a photovoltaic module are translated from the set of actual test conditions. [ASTM E 1036]

**Standard test conditions:** Conditions under which a module is tested, consisting of: (1) irradiance intensity of  $1000 \text{ W/m}^2$ , (2) AM1.5 solar reference spectrum [see Section 2.1.2], and (3) a cell [module] temperature of  $25^\circ \pm 2^\circ\text{C}$  [IEC 1215]

**Test and calibration procedures manual(s):** A written document, or documents, which contain the specific instructions, preferably in active voice, imperative mood, for carrying out the tests or calibrations. [PV-1]

**Test method:** A documented technical procedure for performing a test. The test method may be called out in either internal documentation, or, whenever possible, in a published consensus standard. [PV-1]

**Test sequence:** A set of one or more qualification tests applied in a specified order to a selected group of PV modules. [PV-3]

**Third-party certification:** A form of certification in which the producer's claim of conformity is validated, as part of a third-party certification program, by a technically and otherwise competent body other than one controlled by the producer or the buyer.

**Third-party certification program:** An organized system (1) under which similar products or services of any number of producers may be certified as conforming to the reference standards or specifications on a uniform and equitable basis, (2) which uses or is operated by a third-party inspection/testing body, and (3) which authorizes the use of controlled certification marks or certificates of conformity as evidence of conformity.

**Traceability:** The property of a result of measurements whereby it can be related to appropriate physical standards maintained by the U.S. National Institute of Standards and Technology (NIST), or the appropriate international standards body, through an unbroken chain of comparisons. [PV-1]

**Verification:** Confirmation by examination and recording of physical evidence that specified requirements have been met. In connection with the management of measuring equipment, verification provides a means for checking that the deviation between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation, or specification peculiar to the management of the measuring equipment. The result of verification of equipment and measuring instruments leads to a decision either to maintain the item(s) in service, restore to service, or to perform adjustments, or to repair, or to downgrade, or to declare obsolete. In all cases it is required that a written trace of the verification performed be kept on the measuring instrument's individual record. [PV-1]

**Voltage at maximum power:** The voltage at which maximum power is available from a module. (for the purpose of this document, the "rated" voltage at maximum power will be defined as  $V_{MP}$  at STC). [UL 1703]



## Section 3

# THE PRODUCT CERTIFICATION PROCESS AND LABORATORY ACCREDITATION

### 3.1. Introduction

#### 3.1.1 Introduction and overview of the certification process

*Product certification* is a process by which written assurance is given by an authoritative body that a product conforms to a reasonable, but formalized, set of requirements, or specifications. Third-party certification is a process that is controlled, and written assurance given, by a body other than one that is controlled either by the producer, or manufacturer, or by the purchaser, or user, of the product. Product certification programs involve the use of formal quality system criteria for the manufacturer, the certification body, the test laboratory, and the laboratory-accreditation body, and are designed to tie these various requirements together. Certification programs usually involve the issuance of conformity documentation to attest to the fact that the product meets the requirements of a prescribed set of criteria, or specifications. Documentation issued is often both a *certificate of conformity* and a *certification mark* (usually affixed to or imprinted on a label).

Product certification programs make use of third-party testing and inspection organizations whose competency is assured by a process of quality assessment termed *laboratory accreditation*. Hence product certification programs are often referred to as *product testing, certification, and labeling programs*.

Although domestic criteria *standards* have been developed for both product certification and laboratory accreditation processes, they are based on international, consensus-developed requirements that are embodied in International Standards Organization and International Electrotechnical Commission (ISO/IEC) quality systems standards and guides.

Two sets of *international standards* cover essentially all of the quality requirements that

pertain to laboratory accreditation, product certification, and the manufacture of quality products. They are: (a) the ISO/IEC Guides, prepared under the auspices of ISO/CERTICO, the ISO Certification Council, and approved by the Council Committee on Conformity Assessment, with input from ISO and IEC member nations, and (b) the ISO 9000 series of quality assurance standards, prepared under the aegis of ISO Technical Committee 176, also with participation by member nations. The various international standards relating to general product certification programs, including laboratory accreditation requirements, are presented in Table 3-1 (along with their domestic counterparts where they exist).

### **3.1.2 Overview of laboratory accreditation**

The American Society for Testing and Materials (ASTM) Committee E36 on Laboratory Accreditation provides input to the American National Standards Institute's (ANSI's) representative on CERTICO and has recently prepared U.S. comments on ISO Guide 25, "General Requirements for the Competence of Calibration and Testing Laboratories." Committee E36 also has an ASTM version of Guide 25. Several of the ISO Guides relating to *laboratory conformity assessment criteria* have been developed by the ISO/IEC Certification Council (CERTICO) based on extensive input from the International Laboratory Accreditation Conference (ILAC). Guide 25 is the principal document used by various organizations in the United States to assess and accredit testing laboratories. An early version of Guide 25 formed the basis for the laboratory accreditation portion of the Solar Rating and Certification Corporation (SRCC) solar thermal collector certification program insofar as it was used in the first draft of the Solar Energy Industries Association (SEIA) proposal furnished to the Energy Research and Development Administration (ERDA) / U.S. Department of Energy (DOE) to fund the Solar Energy Research and Education Foundation (SEREF), which developed the certification program for SEIA and SRCC.

The two national laboratory accreditation programs are: (a) the American Association for Laboratory Accreditation (A2LA), a private-sector accrediting body that now accredits several

**Table 3-1. International Quality Standards of Importance to Product Certification Programs and their U.S. Domestic Counterparts**

International Standards		U. S. Domestic Standards	
ISO/IEC	Abbreviated Title	Type	Abbreviated Title
Guide 23	Methods of indicating conformity with standards for third-party certification		
Guide 25	... requirements for the competence of calibration and testing laboratories	ASTM E 548	General criteria for evaluating testing laboratories
Guide 28	General rules for a model third-party certification system for products	ANSI Z34.1	Third-party certification program
Guide 38	General requirements for the acceptance of testing laboratories		
Guide 39	General requirements for the acceptance of inspection bodies		
Guide 40	General requirements for the acceptance of certification bodies	ANSI CA-1	ANSI Policy and Criteria for accreditation of certification programs
Guide 41	Development and operation of laboratory proficiency testing		
Guide 54	... laboratory accreditation ... : ... acceptance of accreditation bodies		
Guide 55	... laboratory accreditation ... : general recommendation for operation		
ISO 9000	... Guidelines for selection and use	ANSI/AS -QC Q90	... Guidelines for selection and use
ISO 9001	Quality systems: model for design, production, installation, service	Q91	Quality systems: model for design, production, installation, service
ISO 9002	Quality systems: model for quality in production and installation	Q92	Quality systems: model for quality in production and installation
ISO 9004	Quality management and quality system elements—guidelines	Q94	Quality management and quality system elements—guidelines
		ASTM E 1322	Guide for selection, training, evaluation of assessors for laboratory accreditation

hundred laboratories annually, and (b) the National Voluntary Laboratory Accreditation Program (NVLAP), a program of the National Institute for Standards and Technology (NIST). The A2LA program<sup>1</sup> is the more generic of the two in that it is discipline oriented (i.e., mechanical testing, chemical testing). On the other hand, the NVLAP program<sup>2</sup> is largely product oriented, and

<sup>1</sup> "General Requirements for Accreditation." American Association for Laboratory Accreditation, Gaithersburg, MD 20878-1409, May 1993

<sup>2</sup> J. L. Cigler and V. R. White, Eds., "Procedures and General Requirements," National Voluntary Laboratory Accreditation Program, NIST Handbook 150, Gaithersburg, MD, March 1994

requires a notification of need to be established, as well as notice in the *Federal Register*, prior to the establishment of a laboratory accreditation program.

Various other organizations, often trade associations, also accredit laboratories on an industry-sector basis. Examples are: General Motors Corporation (whose laboratory accreditation program for automotive suppliers has recently been phased into the A2LA program), the International Congress of Building Officials (ICBO),<sup>3</sup> the American Association of Motor Vehicle Administrators laboratory accreditation program (AAMVA),<sup>4,5</sup> and the SRCC,<sup>6,7</sup> among others.

### 3.1.3 Overview of the product certification processes

A schematic of the interrelationships between accredited laboratory testing and product certification is depicted in Figure 3-1 for the case in which all of the quality requirements are defined in terms of international standards. In this scenario, the essential elements are, as follows: (a) the manufacturer's quality system is registered to the requirements of ISO 9001, (b) the manufacturer's internal testing and inspection laboratory is independently accredited to ISO Guide 25 by a nationally recognized and nationally accepted accreditation body, (c) the third-party test laboratory whose test results are used in the certification program is accredited to ISO Guide 25 by a recognized and accepted accreditation body, (d) the accreditation body is itself accredited by ANSI,<sup>8</sup> and (e) the certification program (e.g., body) is accredited by ANSI.<sup>9</sup> Note that ISO 9001 is one standard in the ISO 9000 series that covers quality systems and that an

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<sup>3</sup> "Rules of Procedure for Testing Agencies Listings," ICBO Evaluation Service, Inc., Whittier, CA 90601, September 1991

<sup>4</sup> AAMVA is defunct now; A2LA has replaced AAMVA as the accrediting organization.

<sup>5</sup> "Application for Compliance Notification: On-Site Laboratory Inspection," Form EA-3, American Association of Motor Vehicle Administrators, Arlington, VA 22203, January 1992

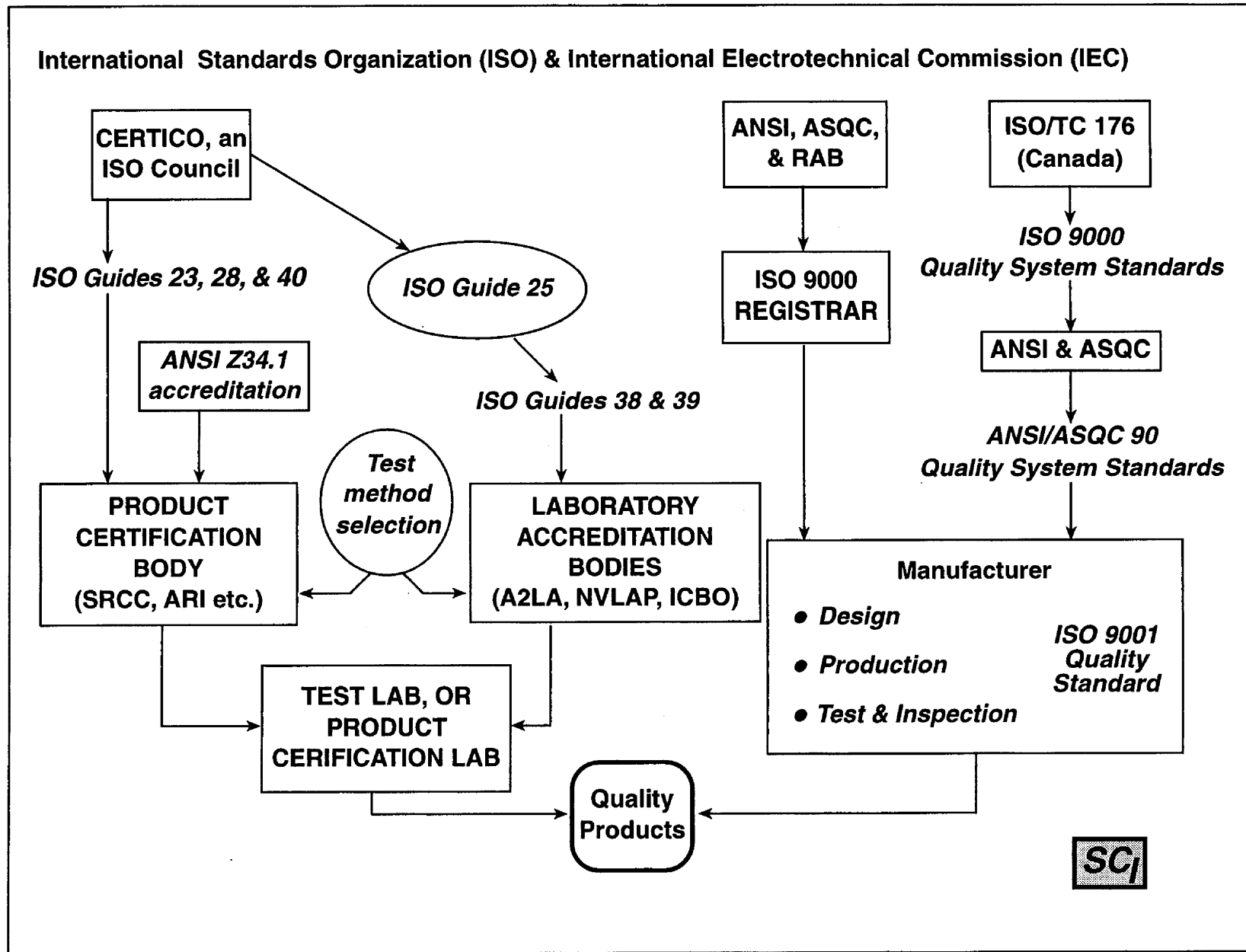
<sup>6</sup> "Operating Guidelines for Certifying Solar Collectors," SRCC Document OG-100, Solar Rating & Certification Corporation, Washington DC 20036, September 1981

<sup>7</sup> "Test Methods and Minimum Standards for Certifying Solar Collectors," SRCC Standard 100-81, Solar Rating and Certification Corporation, Washington DC 20036, September 1981

<sup>8</sup> A process that is not possible because a national program of certification, or accreditation, of laboratory accreditation bodies, is not yet in existence.

<sup>9</sup> Which is possible and is discussed in some detail elsewhere in this report.

Figure 3-1. Hierarchy of Product Quality Assurance Regimens





accreditation body that accredits a third-party laboratory may or may not be the same body that accredits a manufacturer's laboratory.

The hierarchy presented in Figure 3-1 shows the relationship between the testing laboratory and both types of accrediting bodies—one that accredits laboratories for product certification programs and the other that provides a more generic laboratory accreditation function. In both cases, the test methods must be identified and selected prior to assessment of the laboratory for accreditation.

In the product certification scheme, test methods are often used to determine the product's performance for quantitative rating purposes, and to determine the reliability and durability of the product. In generic laboratory accreditation schemes (except for most of the NVLAP programs), the selection of test methods is performed in conjunction with the laboratory. The accreditation process then identifies those individual tests the laboratory is competent to perform.

Historically, product certification programs have not required manufacturers either to be registered or to conform to the international standards, but only that they conform to *some system* of quality standards. Although the ISO 9000 series is not required by the model photovoltaics product certification program presented in this report, it is identified here because it more than fulfills the minimum requirements established in PV-1, and because there is a current worldwide emphasis for manufacturers to participate in ISO 9000.

From consideration of the various possible relationships that are depicted in Figure 3-1, one can readily conclude that *truly* quality products are more apt to result when manufactured under such a system of quality requirements, rather than when neither manufacturing nor testing is required to be performed to accepted quality standards.

#### **3.1.4 Laboratory accreditation—what is ISO Guide 25?**

The world's first broad, umbrella-type laboratory accreditation scheme was established in Australia in 1947 under the authority granted to its National Association of Testing Authorities. It wasn't until 1966 that the next national laboratory accreditation program was developed with

the establishment of the British Calibration Service.

In the early 1970s, a number of other countries established national laboratory accreditation systems as a result of the perceived need in terms of the implications of the General Agreements on Tariffs and Trade (GATT). Chief among these were Denmark, France, Indonesia, New Zealand, Sweden and the United States. In the United States, NVLAP was formed by the then National Bureau of Standards in 1976, and A2LA was organized in 1978. By the end of 1986, a total of 20 nations had established national laboratory accreditation organizations.

Nations with existing and developing accreditation programs met in 1975 to form the ILAC, a forum that resulted in the formulation of an accreditation-requirements document which, after promulgation by ISO, became ISO Guide 25-1978. ISO Guide 25 has since undergone two major revisions, one in 1982 and the last in 1990.

ISO Guide 25-1990 is analogous with ISO 9001, but relates more cogently to laboratory quality systems management. Hence, Guide 25 has adopted a quality systems approach and, as such, it is a *quality systems standard* and makes use of the word *shall* exclusively throughout (in spite of its title as a Guide). Like the ISO 9000 standards, ISO Guide 25 requires:

- The documentation of the quality system (in a *quality assurance program manual*)
- The preparation and use of supporting documentation
- Periodic internal reviews
- Periodic outside audits (laboratory assessments) and corrective actions.

However, their differences, particularly as they related to laboratory accreditation requirements, have been detailed by Locke<sup>10</sup> in a review of quality standards for laboratories.

ISO Guide 25 also requires, to name several important tenets:

- Clear lines of authority
- Clear lines of communication
- Clear lines of responsibility
- Clear documentation (test and calibration methods, procedures, work instructions)

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<sup>10</sup> John W. Locke, "Quality Standards for Laboratories," *Quality Progress*, pp. 91-93, July 1993

- Documentation control (standards, internal and external reports)
- Training and cross training.

Very importantly, ISO Guide 25 provides both the framework for developing a laboratory quality system and a schedule for the assessment of the laboratory for the purposes of accreditation.

### **3.1.5 Product certification and the ISO Guides**

ISO Guides 23, 28, and 40 cover the requirements for establishing and operating product certification systems, and product certification bodies that will administer the system (Table 3-1 lists these documents).

ISO Guide 23 provides procedures for indicating conformity with standards for third-party certification systems. As such, it specifies methods for indication of conformity to the two types of standards that pertain to product testing in support of product certification:

- Comprehensive product standards—standards that have the objective of specifying the essential characteristics and requirements necessary to enable a product to serve its intended purpose
- Standards for specific properties—these are standards that deal with specific properties, often those related to safety aspects of the product, or to specific durability aspects not otherwise covered by comprehensive product standards.

Guide 23 also specifies the two methods of indicating conformity:

- *A mark of conformity*
- *A certificate of conformity.*

A certificate of conformity usually identifies the certification body, the manufacturer, the lot, batch serial number, model, or type to which certification applies, references the appropriate standard(s) used to determine conformity, and contains the certificate's date of issue and the body's authorizing signature.

A major requirement of Guide 23, and one that is also a part of ANSI accreditation procedures of product certification systems, is that the mark, or certificate, be understandable to the user,

purchaser, or consumer. ANSI procedures for accreditation of product certification programs, and certification bodies that administer the programs, are discussed in a subsequent section of this report.

ISO Guide 28 provides a model for third-party product certification systems and requires that the Certification Body itself be organized and operate in conformity to Guides 24 and 25.

Guide 28 specifies procedures for:

- Initial inspection of a manufacturer's plant and its quality management system (which may conform to ISO 9000)<sup>11</sup>
- Selection of samples to be tested (usually from production lots)
- Initial testing regimens and follow-up testing as required
- Making provision for the manufacturer to license the use of the certification body's mark, or certificate of conformity
- Continuing, periodic surveillance, or periodic retesting (including a requirement for the manufacturer to maintain a record of complaints received on products so certified and marked)
- Permitting the manufacturer to use the mark, or certificate of conformance, in published form such as reports, data sheets, and advertisements
- Corrective actions and withdrawal of certification when required.

Guide 28 contains specimen checklists for the process of certifying a manufacturer's product, applications for license, a questionnaire for initial factor assessment, certificate of conformity, and licensing agreements.

ISO Guide 40 provides the general requirements for accreditation of certification bodies *themselves*. In the United States, ANSI operates a system for accreditation of product certification bodies and laboratory accreditation bodies. Guide 40 provides the requirements for the administrative structure, organizational structure, documentation control, records control, confidentiality, publications, and appeals procedures of certification bodies.

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<sup>11</sup> ISO 9000 is usually not a requirement, but a formal program is required by this standard, whether it is one of the Military Standards, a Total Quality Management (TQM) program, a Malcolm Baldrige-type program, or other program.

While the foregoing has dealt with the generally accepted requirements of certification bodies, ISO Guides 54 and 55 deal with the widely accepted requirements of laboratory accreditation bodies. A discussion of Guides 54 and 55 is presented together with that of Guides 23, 28, and 40, because it is unusual for the product certification body and the laboratory accreditation body to be operated independently of each other; they are often the same organization (a special case exists when the certification body is also the test laboratory).

Guide 54 specifically addresses such issues as:

- Access to the laboratory accreditation system
- Organization of the laboratory accreditation body
- Formation of developmental and standing technical committees
- The requirement that the laboratory accreditation body itself possess an internal quality systems program
- Procedures for granting, maintaining and withdrawing accreditation
- Appeals procedures
- Contractual arrangements
- Confidentiality
- Staffing requirements
- Record keeping requirements
- Liability.

Guide 55 more specifically addresses the operation of the laboratory accreditation system by the Laboratory Accreditation Body. In addition to general requirements, it contains procedures for:

- Determining and accepting the scope of accreditation of testing laboratories
- Application by a laboratory for accreditation
- Delineating the information that will be required of the laboratory
- Determining the qualifications of assessors and lead assessors

- Selection of assessors and lead assessors
- Performing pre-assessment review of the laboratory's furnished information
- Performing on-site audits and laboratory assessments, and the requirements of the assessor's report.

Although covered more fully by Guide 25, Guide 55 also mentions proficiency testing, test laboratory reporting requirements, and subcontracting.

### **3.1.6 Elements of the suggested approach**

ISO Guide 25, along with several important changes suggested by members of ASTM Committee E36, and appropriate requirements taken from the ISO 9001 Quality Systems Standard, has been used as the basis to establish the minimum requirements for the test laboratory or laboratories that will compete for the photovoltaic (PV) module testing portion of the proposed product certification program defined by PV-1. It is emphasized, however, that this criteria document for laboratories will require some modification prior to implementation to account for those unique facets of PV products.

Nonetheless, to ensure that U.S. PV products are accepted outside of the United States, it will be necessary that the laboratory accreditation scheme, and the certification procedures and requirements, meet, as a minimum, the requirements of Guide 25 and the requisite provisions of the ISO 9001 standard; PV-1 attempts to meet this necessity. This does not purport to say that these standards are currently mandatory in international commerce dealing with energy products in general or PV in particular. Rather, it is the pressures in the international marketplace that have forced U.S. producers to ensure that they meet these emerging quality standards, chief among which are the ISO 9000 Quality Systems Standards. To emphasize this point, the European Community (EC) has, in establishing the European Organization for Testing and Certification (EOTC), constructed the framework for various levels of product certification, called *modules*. Eight levels of these modules have been established ranging from *self-*

*assessment* to full *third-party certification* that require the EC mark.<sup>12</sup> Again, the extent to which these modules have been adopted for use in the Commission of the European Communities's (CEC) PV testing and certification program is unknown, but mid-level modules will likely be adopted in future revisions of the CEC program.

## **3.2 The PV module testing, certification, and labeling program**

### **3.2.1 General philosophy—overview**

A product certification program that is based on third-party testing is comprised of four organizational entities: They are:

- Manufacturers
- One or more testing laboratories
- A laboratory accreditation body
- A certification body.

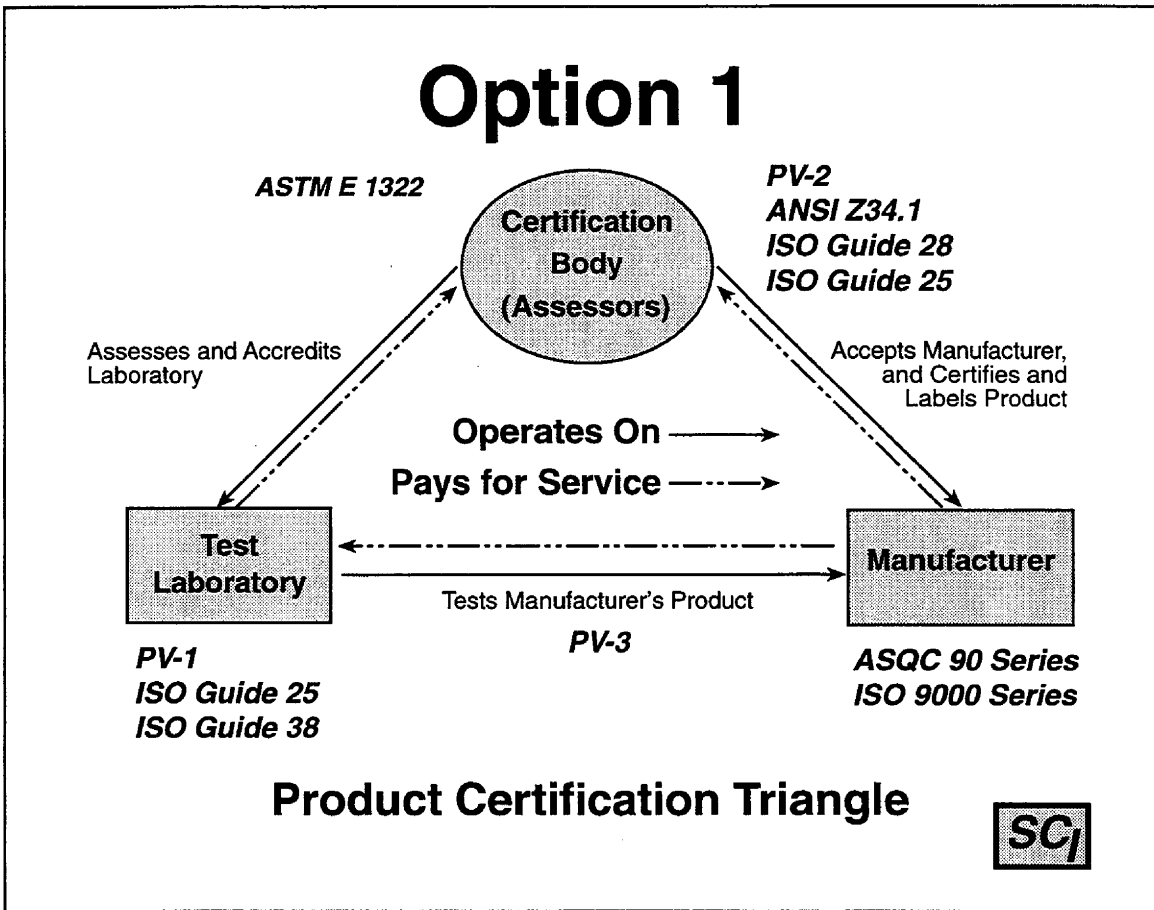
Both the international and the U.S. domestic product certification standards, ISO Guide 28 and ANSI Z34.1, respectively, permit a testing laboratory to also be the certification body, providing fairly rigorous requirements are met. The possible organizational relationships are depicted in the form of product certification triangles presented in Figures 3-2 through 3-4 as options 1, 2, and 3, respectively.

Option 1 (Figure 3-2) represents the case in which the certification body is also the laboratory accreditation body. This was the option chosen by the SRCC when it was formed. The laboratory accreditation body can be an existing body, such as A2LA, which is engaged for the purpose of assessing PV laboratories for the PV certification program, or it may be formed for that purpose alone. In either case, it must either use its own laboratory assessors (i.e., auditors) or employ outside assessors on a contract basis. Although the development and structuring of the operational guidelines and rules of procedure for such a laboratory

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<sup>12</sup> The problems faced by the U.S. in establishing reciprocity with the EOTC through the creation of Memoranda of Understandings (MOUs) are beyond the scope of this discussion. Suffice it to say that these problems can be solved.

Figure 3-2. Option 1: Certification Body Assessment



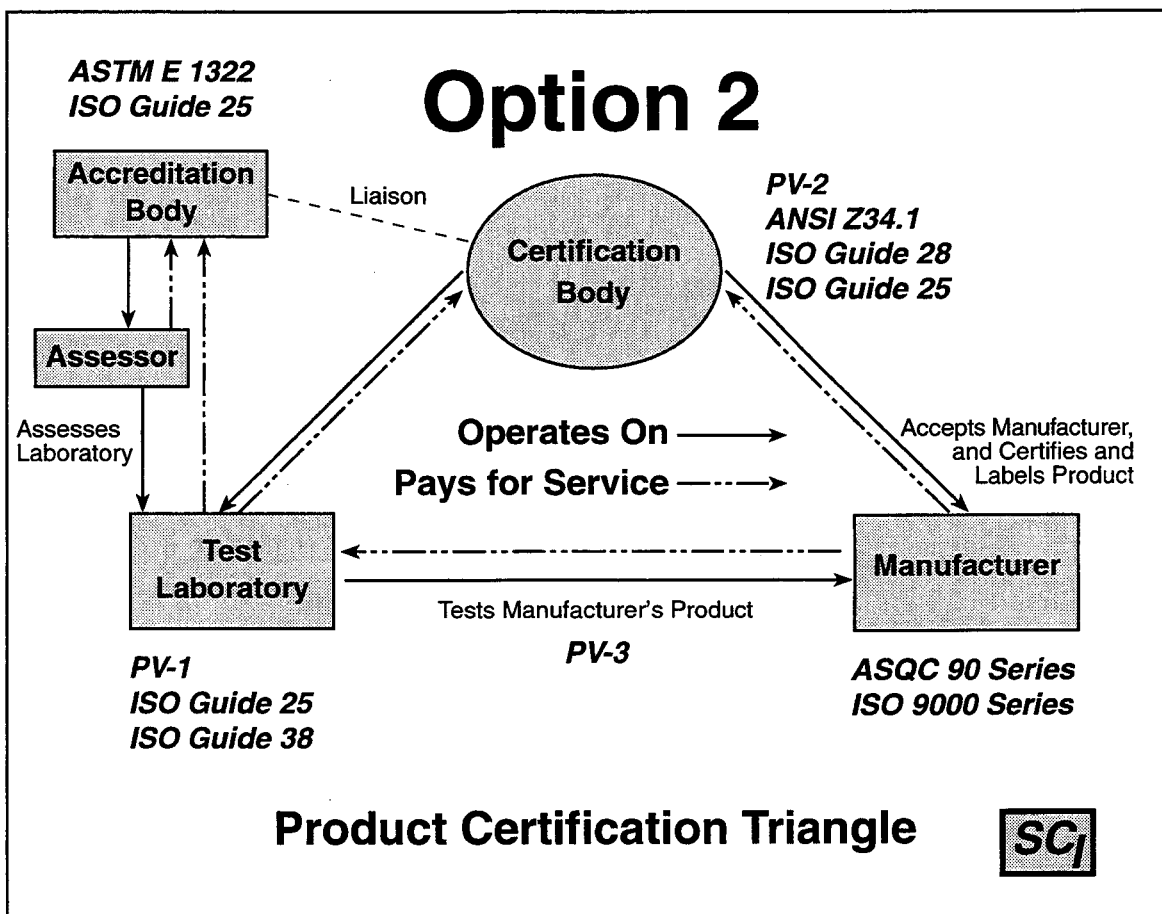
accreditation body is outside the scope of the present program, the organizational structure and the rules of procedures would have to be based on Document PV-1.

However, it would certainly not make sense to form a one-discipline, one-product, wholly independent laboratory accreditation body for a PV product certification program. Hence, option 1 is not recommended for a PV module testing, certification, and labeling program. One compelling reason to avoid option 1 is cost: (a) within the context of today's legal climate, the viability of such a laboratory accreditation program is not favorable in the context of any process that is less than thoroughly rigorous, (b) a rigorously operated laboratory accreditation program is expensive to a certification body not facile in its management (and would therefore be expensive to the participants), and (c) use of an existing laboratory accreditation program, such as that offered by A2LA, would be comparatively much less costly to the certification program, and thus to the participating manufacturers.



Option 2 represents the most likely scenario for a PV testing, certification, and labeling program. In this option, the acceptance by the certification body of a testing laboratory is predicated on meeting the requirements of PV-1 on the basis of an assessment performed by independent, contract quality assessors hired by the accreditation body and performed at the expense of the laboratory. Module producers then apply for participation and a license to use the label. If accepted for participation in the program, their module designs are tested at the expense of the manufacturer by a certification body-approved laboratory using procedures specified in PV-3. Having successfully met the test requirements of PV-3, the manufacturer's product is certified by the certification body within the framework of the certification requirements represented by PV-2, and a license is granted to the manufacturer to use the certification body's mark (normally affixed to or a part of an official label).

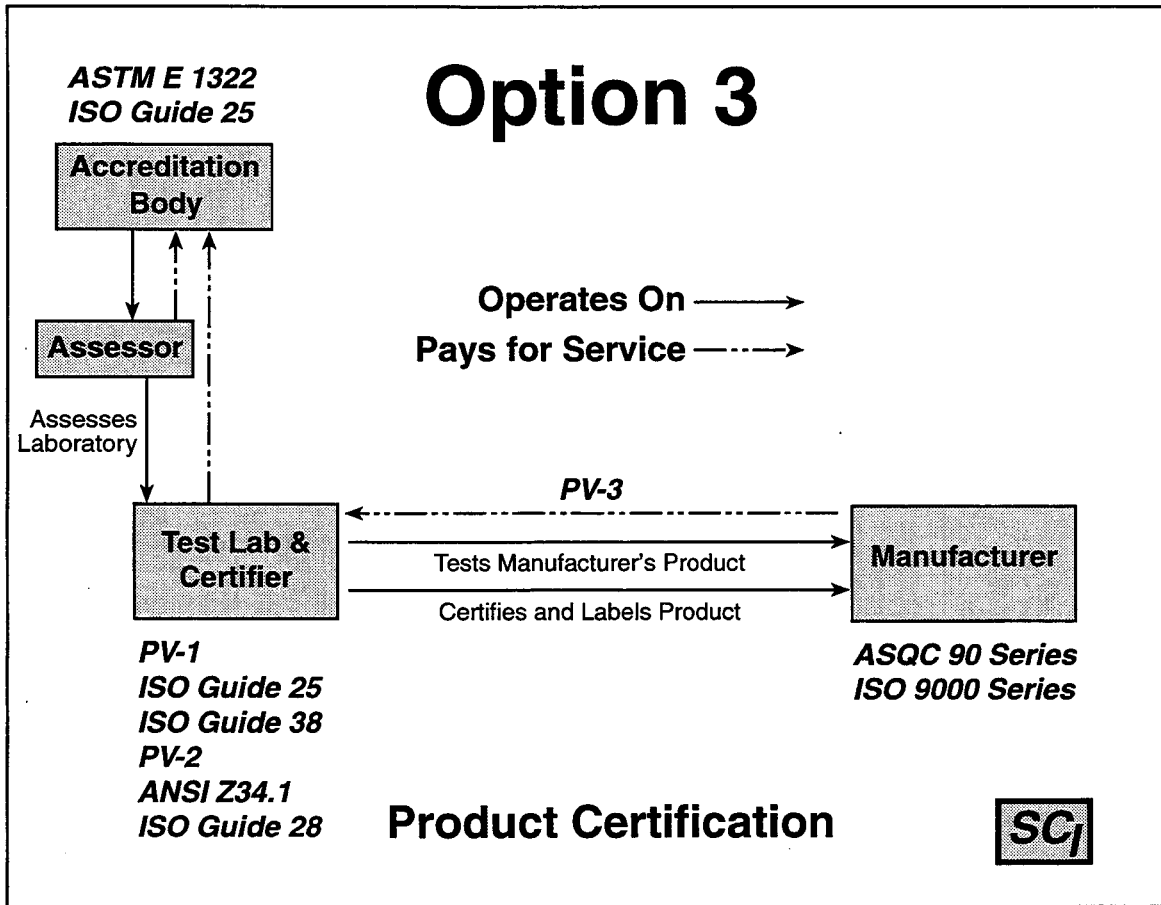
**Figure 3-3. Option 2: Independent Assessment**



Option 3 (Figure 3-4) depicts the case in which the independently accredited laboratory forms its own certification body and hence its own product certification program. This scenario has been employed increasingly in recent years and has the characteristic of not requiring a coalition of broad industry and public sector consensus, or agreement, to be a success. The major factors for ensuring the success of this option are: (a) acceptance by the marketplace, that is, the user segment of the market and (b) industry participation in terms of having a significant percentage of the manufacturers who join the certification program.

For options 1 and 2, the PV certification body must be formed for the purpose of operating the certification program unless arrangements are made with an existing body that meet the criteria of PV-2. Regardless, the governing body will always consist of representatives chosen from the manufacturing sector and from whatever other sectors are relevant to PV, particularly purchasers. Such a body will usually have standing committees to oversee its operations: A *laboratory accreditation committee* that works closely with the laboratory accreditation body; a *test standards committee* that reviews and approves of all test method changes, additions, and exclusions; a *certification committee* that reviews all test results and submissions from the manufacturer for certification; an *audit and finance committee* that reviews and audits the basis for levying fees to the manufacturers for the right to represent that their product is certified; and a *quality function*, of some sort, that reviews the manufacturers' quality programs, and its own internal quality program. Although the development and structuring of the operational guidelines and rules of procedure for a certification body were outside the scope of the present program, some specific requirements for the organization of the certifying body, and its most important committees, are presented in Section 5 of this report. It should be noted, however, that the organizational structure and rules of procedures must be based on, and compatible with, PV-2.

Figure 3-4. Option 3: Testing Laboratory Certification



### 3.3 Rationale for the structure and format of document PV-1

The development of a laboratory accreditation program consists of at least four major tasks, or phases:

- (1) Development of laboratory accreditation criteria in the form of PV-1, which are requirements that will be placed on the laboratory
- (2) Selection, or selection and training, of one or more laboratory assessors, with proven knowledge in PV
- (3) Assessment of the laboratory by a *laboratory quality system assessor* who performs an official audit of the laboratory's quality system and determines its technical competence to perform the tests required by PV-3 (in the present case)

- (4) Formation of, or use of an existing, accreditation body whose function is to evaluate the assessors' report, interact with the laboratory to correct deficiencies found, render a decision as to the suitability of the laboratory to perform the tests required, and issue a document accrediting the laboratory.

Once announced, or advertised, the conferring of *accreditation* on a laboratory creates an inducement for manufacturers to rely on both the act of accreditation and the laboratory's status as *an accredited laboratory*, and to employ the services of that laboratory. Because of the chain of liability inherent in the laboratory accreditation process, a considerable body of deliberations on all four phases of laboratory accreditation (above) has developed during the last 15 years in the international community (the ISO/IEC guides on conformity assessment), and in the United States (ASTM Committee E36, A2LA, and NVLAP).

Experts in laboratory accreditation from countries throughout the world have crafted ISO Guide 25 (and the associated Guides) that are now the standards used throughout the world to develop and set up specific laboratory accreditation programs. ISO/IEC Guide 25 is the cornerstone of A2LA's laboratory accreditation, the only independent multidisciplinary laboratory accreditation program in the United States. The requirements of NIST's NVLAP program are now conforming closely to Guide 25.

The structure of Document PV-1 is based largely on Guide 25; it contains no major provisions not found in Guide 25, and it follows an essentially identical format. However, it contains: (a) certain clarifications to Guide 25 being employed by A2LA (as clarifications of requirements placed on laboratories), (b) certain clarifications proposed by ASTM Committee E36 to ANSI for transmittal to the ISO/IEC Guide 25 Secretariat, and (c) other clarifications that are believed to be necessary at this stage. These clarifications have been employed, where relevant, to improve the usability of the document and aid in decreasing the probability that a large number of deficiencies would be found during the first audit of any laboratory that might request accreditation as a PV testing laboratory.

The requirements of Guide 25 are applied to large and small laboratories alike, whether they are two-person or 100-person laboratories. However, according to the guide, the procedures and policies, documentation, and record keeping are greatly simplified for small laboratories, and assessors are trained to recognize the distinction. In spite of these considerations, it is important to the accreditation body that its laboratory accreditation requirements and procedures hold up to scrutiny with respect to third-party challenges (whether the challenges occur in the marketplace or in the courts), and this need is even more cogent when the laboratory accreditation process is an element of a product certification program. To meet such scrutiny, there can be no gradation in the application of the accreditation requirements from one laboratory to another within either a laboratory certification program, or, more importantly, within a product certification program.

Lastly, while structuring a PV laboratory accreditation program to Guide 25 is no guarantee of immunization from eventual legal challenges to the system, conformance will certainly lessen the likelihood that damages would be found in the event that the program's design and operation are brought into question either directly, or peripherally (in first- and second-party damage actions).

### **3.4 Rationale for the structure and format of document PV-2**

The implications associated with conferring on a product the status of *certified* also necessitates adherence to carefully developed and comprehensive rules and procedures on the part of the certifying body.

The offer for sale by a manufacturer of *certified product*, however represented, creates an inducement to the purchaser, or consumer, to rely on the quality of the product and the claims by the manufacturer. This reliance creates a chain of potential liability that now encompasses the certification body, the laboratory, and the accreditation body, in addition to the manufacturer's responsibility. In point of fact, existence of these programs has the effect of transferring some of the risk from the manufacturer to other entities in the overall certification process.

Historically, ANSI Standard Z34.1 has been the standard around which U.S. product certification programs have been constructed. More recently, ISO/IEC Guides 22, 28, and 56, dealing with product certification are being used as the models for certification systems in the United States and throughout the world. Indeed, ANSI Standard Z34.1 has just undergone a revision to encompass by normative reference nearly all of the ISO/IEC Guides on Conformity Assessment (these include the guides mentioned above and those cited as non-normative references in PV-1)<sup>13</sup>. ANSI Standard Z34.1 was scheduled for publication in early 1994.

ANSI Standard Z34.1, either itself, or by normative reference to ISO/IEC Guide 28 and others, covers the requirements placed on the certification body, criteria for development of a certification process (or system), the supplier's (or manufacturer's) quality system, initial inspection of the supplier's quality system, initial testing of the supplier's product, marks of conformity (e.g., labels), surveillance and periodic retesting, complaints, and appeals. These have all been embodied in PV-2. ISO/IEC Guide 28 was the major resource for crafting PV-2.

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<sup>13</sup> Normative references represent standards, and procedures that must be employed. Non-normative references are those that should be considered for a complete understanding of a procedure, process, or idea (i.e., they are for informational purposes).



## Section 4

### DOCUMENT DESCRIPTION AND USE: PV-1, PV-2, AND PV-3

#### 4.1 Introduction

Documents PV-1, PV-2, and PV-3, collectively, address the totality of the criteria and requirements of a photovoltaic (PV) module testing, certification and labeling program. In this section, each of these documents is briefly described and its use within such a program is detailed.

#### 4.2 Document PV-1

PV-1, *Criteria for a Model Quality System for Laboratories Engaged in Testing Photovoltaic Modules*, like International Standards Organization and International Electrotechnical Commission (ISO/IEC) Guide 25 from which it was developed, serves as the basis for designing and implementing quality systems in laboratories and for recognizing the competence of laboratories by accreditation. PV-1, however, provides amplification and clarification of Guide 25 and is specific to PV module testing laboratories. Requirements of American Society for Testing and Materials (ASTM) Standard E 548 on evaluating testing laboratories and ISO/IEC Guide 38 on conformity assessment have also been incorporated. PV-1 could be employed by:

- Laboratories engaged in testing PV devices to design, develop, and implement a quality system that meets the criteria for accreditation
- Assessment bodies, and their assessors, as the criteria against which laboratories are examined for the purpose of accreditation.

PV-1 covers:

- The criteria for organization and management of the laboratory
- The design of its quality system
- The minimum content of its quality assurance manual



- The implementation of internal auditing of its quality system
- Internal quality checking of the laboratory's data and instrumentation
- The general qualifications of its management and testing personnel
- The external and on-the-job training requirements of its test personnel
- The laboratory's general accommodation and environment criteria
- The general requirements for scientific and test instrumentation.

The document specifies the minimum requirements an accredited laboratory must have for:

- Calibration instrumentation and traceability of instrumentation and data
- Generic requirements for use of calibration and test methods
- Handling of items for test
- Documentation and record requirements (including retention requirements)
- Minimum requirements for issuance of test reports
- Vendor qualification for subcontracting of services and purchasing of supplies
- Handling of complaints.

### **4.3 Document PV-2**

*PV-2, Model for a Third-Party Certification and Labeling Program for Photovoltaic*

*Modules* was developed for use by:

- Organizations wholly independent of all PV product testing activities who are selected, formed or otherwise approved to administer a PV module certification and labeling program
- Laboratories engaged in the dual role of testing PV modules and product certification and labeling.

This model encompasses the structure of a third-party product certification system for determining the conformity of PV modules with a series of performance, durability/reliability, and performance standards contained in PV-3. Significant portions of American National Standards Institute (ANSI) Z34.1 and ISO/IEC Guide 28 have been adopted in PV-2.

The purpose of the PV-2 model is to define a third-party certification system for determining conformity using product standards through initial testing and assessment of a factory quality management system that is required for acceptance of a manufacturer. This is followed by surveillance that takes into account the factory quality management system and the testing of sample from the factory and the open market.

It is **not** the purpose of this document to address the requirements of either the operation of a laboratory that is accredited or otherwise approved to perform the testing, or to define the technical testing requirements that will result in creation of the information and data that will be used by such a product certification and labeling program.

#### **4.4 Document PV-3**

PV-3, *Testing Requirements for a Certification and Labeling Program for Photovoltaic Modules*, defines the testing and reporting requirements for reliability qualification and baseline electrical performance value measurements of PV modules that would be used in support of a PV module certification and labeling program. It includes minimum testing requirements for PV products, laboratory equipment (Appendix A of PV-3), and requirements for staffing and personnel qualifications (Appendix B of PV-3). It covers:

- program of evaluation and testing,
- performance methods,
- equipment guidance, and
- personnel, organization, and training.

PV-3 specifies that module designs be tested to Institute of Electrical and Electronics Engineers (IEEE) Project Authorization Request (PAR) 1262, *Recommended Practice for Qualification of Photovoltaic (PV) Modules*. This qualification test program represents the most up-to-date methods of subjecting modules to simulated and accelerated environmental stresses that have been developed. Although PAR 1262 is not yet a published IEEE standard, at the time of this writing, it is in the balloting stages necessary for final approval.

#### **4.5 Use of PV-1, PV-2, and PV-3**

Documents PV-1, PV-2, and PV-3 are intended to be used as model documents that could serve as the foundation for a certification program. These are draft documents that can be used “as is” or modified as required by the certification body, once formed. Thus, the certification body will have ultimate responsibility for the content of the documents and will need to have procedures and protocol for modification of the documents.

PV-1, PV-2, and PV-3 define customary requirements for a certification/accreditation program, and specific requirements for a PV program. As such, they serve to inform the PV industry of customary practices and provide a common knowledge base for those organizations and individuals interested in establishing a certification/accreditation program.

PV-1 and PV-3 will aid organizations in preparation for establishing an accredited laboratory. Although these documents may be modified by the certification body, they should be representative of the final documents. These two documents provide laboratory guidelines for an internal quality assurance program and required equipment, facilities, and personnel.

## Section 5

### RECOMMENDATIONS

#### 5.1 Introduction

The bulk of the efforts of the photovoltaic (PV) module certification/laboratory accreditation criteria development program have been directed toward the criteria documents PV-1, PV-2, and PV-3. Therefore, these documents define the recommendations for a possible PV module certification and labeling program. Because PV-1, PV-2, and PV-3 were developed in conjunction with the criteria development committee, a large portion of the PV industry is now familiar with the requirements of a product certification program. It is hoped that this familiarity and enthusiasm can be used to maintain the present momentum and continue efforts toward implementation.

The members of the criteria development committee, and manufacturers in particular, have been supportive of the certification/accreditation criteria development program thus far. A question should now be asked: "How can a product certification program for PV products be implemented?" This section attempts to answer this question by identifying what needs to be done prior to the actual formation of a certification body, along with the structure and functions the certification body should have. At some point in this process, the PV industry as a whole must decide when and if the time is right to initiate a third-party certification program. The possibility exists that the answer to this question may be that now is not the time to begin such a program. In this case, it is hoped that use of the criteria in this report at a future time could avoid having to start from the beginning of the implementation process.

In any event, a great deal of work remains before a PV certification program can be initiated. Corporation papers and a budget for a certification body need to be developed, and a laboratory accreditation body must be selected. Funding necessary for initiation of a certification body needs to be located, and the eventual certification body must be incorporated. Finally, the certification body staff will need to be hired, and membership for the various functional committees must be recruited.

## 5.2 Implementation overview

Any discussion of implementation of a product testing, certification, and labeling program for PV modules quite naturally rests on the basic premise that there is a need for such a program and that such a program will benefit both the manufacturing and consumer, or user, sectors. If this need exists, it is then entirely axiomatic that some segment of one of these sectors must be willing to invest the time and energy and the costs associated with the program's implementation.

The catalysts for initiating product certification programs are usually either the manufacturing industry involved, or a laboratory that perceives both a need and an opportunity, or a federal government entity representing primarily the user, or consumer, sector. In the case of PV, NREL has perceived a potential need and has been the initial catalyst for developing the basic criteria documentation. It is now left to either the manufacturing community, a laboratory, or a major user segment (e.g., Department of Defense, electric utilities, Utility PhotoVoltaic Group, Electric Power Research Institute), to undertake the implementation of the product certification program.

The development of the criteria documents for laboratory assessment and accreditation (PV-1) and product certification (PV-2), and for selection of the relevant testing procedures (PV-3), has been accomplished with the goal that together they would form the initial foundation required for implementation of the module certification program.

The initial tasks that must be formalized as a part of the implementation plan are:

- Determination of the level of support for a module certification program within the PV manufacturing community
- Convening of a group of incorporators and incorporation of the certification body corporation (hereinafter termed the Photovoltaic Module Certification Corporation<sup>1</sup> [PMCC])
- Formation and structuring of PMCC
- Creation of a laboratory accreditation function within PMCC, or selection of an outside laboratory accreditation organization

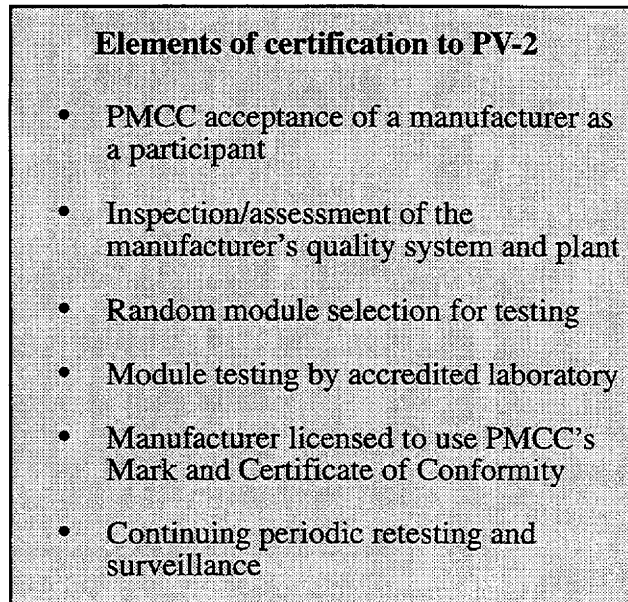
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<sup>1</sup> The name "Photovoltaic Module Certification Corporation" was selected as a convenient means to refer to the certification body in this report; it has no legal significance.

- Assessment and accrediting of one or more laboratories for the certification program
- Successfully promoting participation in the program of a sufficient number of manufacturers to ensure the viability of PMCC.

From the viewpoint of participating manufacturers of PV modules, the elements of the PV module testing, certification, and labeling program are presented in Figure 5-1. Although these elements generally represent the principle attributes of the module certification program from the standpoint of the manufacturer, the program provides for the use by the manufacturer the mark of conformity or the PMCC-designed label, or both, in the manufacturers reports, data sheets, advertisements, and other promotional material.

**Figure 5-1**



Additionally, certification programs provide for corrective action when manufacturer's are found to have missed satisfying any provision of the agreement between manufacture and PMCC. Unresolved issues would have the potential of leading to withdrawal of certification and loss of the right to use of the mark, when required.

### **5.3 Determine level of support for a certification program**

A small, core group of potential incorporators of the PMCC should prepare an information package that will summarize document PV-2, as well as documents PV-1 and PV-3, for distribution to all U.S. PV module manufacturers, as well as any overseas manufacturers known to market or contemplate marketing their product in the United States. This package should also summarize the pertinent rules of procedure for the certification program.

A brief questionnaire should be prepared and distributed with the information package to the senior executives, marketing and sales departments, and technical directors of module manufacturers. The purpose of the questionnaire should be to determine the level of interest in the module certification program within each company, and under what circumstances or conditions negative attitudes can be overcome.

#### **5.4 Incorporation of the certification body**

The core group of advocates should prepare articles of incorporation as a not-for-profit corporation in the state in which the office of the certification body is expected to be located. *Pro forma*, or draft, articles can be borrowed from other similar organizations and presented to legal counsel retained for the sole purpose of refining the articles and filing in the chosen state. Although it may not be essential that an attorney be retained for this purpose, or that the attorney retained be a member of the Bar in the state chosen for incorporation, it is essential that either the attorney or accounting firm chosen to help with incorporation be familiar with both the state and federal requirements for creating a not-for-profit corporation in the state chosen. In any case, it will be necessary that the incorporators nominate those officers of the corporation required by the state in which the PMCC is incorporated (usually a President and a Secretary, as a minimum).

#### **5.5 Formation and structure of the certification body**

##### **5.5.1 Formation**

After publication of the Articles of Incorporation and notification by the state of a date of incorporation, the President who was nominated by the Incorporators for the purposes of incorporation must convene the first meeting of the new corporation for the purposes of establishing the Board of Governors (or Directors). At this meeting, a Chairman of the Board should be elected, the President and the Secretary named as incorporators should be confirmed or

replaced, and any other officers that the Board believes to be appropriate should be elected (e.g., a Vice Chairman, Treasurer, and Vice President).

### 5.5.2 Structure

The certification body will consist of the President, who will be a member of the Board; a Secretary/Treasurer, who will also be a member of the Board; and an Executive Director (or Managing Director), who may be either an *ex officio* member or a regular member of the Board. The president will appoint, usually with the concurrence of the Executive Director and approval of the Board, the Chairpersons of the various standing committees. Other Board members must be elected, consistent with the anticipated bylaws.

The initial staff should consist of a full-time secretarial assistant in addition to the Executive Director (who will most likely be part time during the initial start-up phase of the certification program). It is envisioned that the duties of the Executive Director will encompass as a minimum those listed in Figure 5-2. It should be noted that other duties may be defined by the directives embodied in the PMCC rules of procedure, which are for use by PMCC staff and which should be the program's operational guidelines.

**Figure 5-2**

<b>Duties of the executive director</b>
<ul style="list-style-type: none"><li>• Manage certification program on a day-to-day basis</li><li>• Interface with Standing Committees and ensure their diligence. Should be <i>ex officio</i> member of all committees</li><li>• Implement Standing Committee directives on approval of Board and/or at direction of President</li><li>• Promote program in US and abroad</li><li>• Other duties as defined by President</li></ul>

It will be necessary to structure an executive committee, the purpose of which will be to: (a) coordinate program management with committee activities and decisions, (b) coordinate activities of the interdependent standing committee, and (c) resolve intercommittee disputes, which might include administrative, technical, and jurisdictional problems.



The executive committee should consist of: (a) the Executive Director, who ought to be the chairperson of the executive committee, (b) the President of the PMCC, (c) the chairpersons of all standing committees, and (d) the certification body's legal counsel for those meeting where the presence of legal counsel is advised or necessary.

Although it will not be possible to develop and implement a quality system and quality management program for the PMCC at the outset, a quality system must be in place when, and if, the PMCC applies to the American National Standards Institute (ANSI) for accreditation of its photovoltaic module testing, certification, and labeling program. The elements of the quality system that are required for ANSI accreditation are those required by ISO Guide 56,<sup>2</sup> and the rules for accreditation are given in ISO Guide 40.<sup>3</sup> Figure 5-3 lists the criteria specified in Guide 56.

### **5.5.3 Standing committee requirements**

Standing committees are required for a certification body to operate successfully, efficiently, and prudently. While all such committees will be active during the first two to three years, several will remain active over the lifetime of the PMCC. Those that are most important at the outset are listed in Figure 5-4.

It is emphasized that the titles given to the standing committees are for discussion purposes only, and the Board of Directors, Executive Director, and the standing committees themselves will be responsible for selecting the title that most aptly describes their function and scope. Furthermore, it will be the prerogative of each standing committee to adopt and modify its scope and rules of procedure.

Although every effort should be made to ensure that the committees are comprised of members who serve on only one, or at most, two committees, that may not be possible during the early phases of the certification program. Nonetheless, the necessity to ensure that committee

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<sup>2</sup> ISO Guide 56, "An approach to the review by a certification body of its own internal quality system," *Compendium of Conformity Assessment Documents*, 2nd Ed., International Standards Organization, Geneva, Switzerland, 1991

<sup>3</sup> ISO Guide 40, "General requirements for the acceptance of certification bodies," *Compendium of Conformity Assessment Documents*, 2nd Ed., International Standards Organization, Geneva, Switzerland, 1991

**Figure 5-3. Certification Program's Quality Requirements (ISO Guide 56)**

- **Documentation**
  - Rules of procedure (for all operations)
  - Other operational documentation
  - Manual covering:
    - Legal identification*
    - Responsibilities of the board*
    - Administrative structure*
    - Terminology*
    - Organizational chart*
    - Names, qualifications, duties of all parties*
    - Certification training of staff*
    - Procedures and staff instructions*
    - Management and control of documentation*
    - Records control and maintenance*
    - Procedures covering the control of marks and certificates of conformity*
    - Complaint procedures*
    - Procedures to ensure confidentiality*
    - Appeal procedures*
- **Testing laboratories**
  - Accreditation criteria:
    - Complete documentation if body does accreditation*
    - Relevant documentation if A2LA or NVLAP used for accreditation*
  - Criteria for selection of accredited laboratories
  - Information on laboratories used:
    - Their Quality Manual*
    - Their schedule of prices.*
- **Inspection services (procedures)**
  - Initial inspection of manufacturer's quality program and relevant information
  - Random sample selection procedures
  - Any surveillance procedures employed
- **Certification body's staff**
  - Qualifications
  - Job descriptions
  - Subcontracting and Purchasing Procedures
- **Self-assessment and internal audit procedures**
- **Records**

**Figure 5-4**

- Standing committees**
- Technical committee
  - Laboratory accreditation committee
  - Product certification committee
  - Committee on manufacturer's quality system compliance
  - Committee on licensing compliance
  - Audit and finance committee
  - Appeals board

members are free of conflicts of interest, and perceived conflicts of interest, will strain the ability of both the PMCC and the industry it represents to constitute the committees with an adequate number of participants. One impediment to the success of a PV certification program may be the lack of an adequate number of interested and qualified people to serve on the various standing committees that have been identified.

It will be necessary for members of standing committees to serve *pro bono* with respect to their time. However, it is customary for certification bodies to reimburse committee members for out-of-pocket expenses such as hotels, meals, and transportation.

#### 5.5.4 Technical committee

The technical committee, which in reality is a committee on standards and test methods, will be responsible for all technical matters to be considered in the certification program. These include, as a minimum, the responsibilities listed in Figure 5-5.

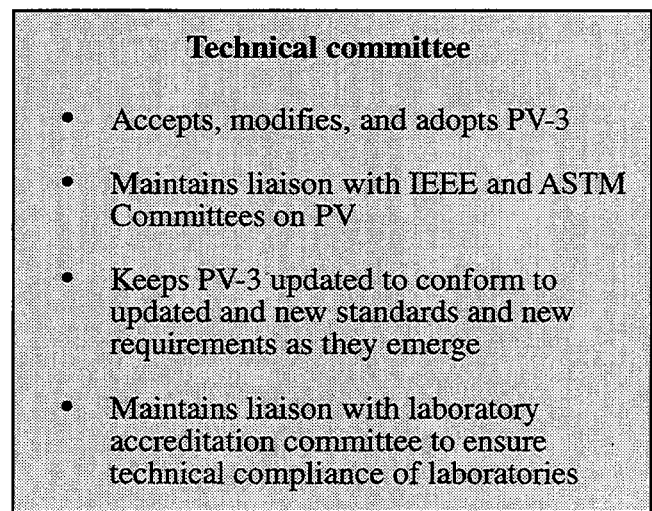
Members of the technical committee, subject to their own rules of procedure (which may require that their decisions be ratified by the Board of Directors), should

have the prerogative of adopting a modified set of certification standards and test methods.

However, because PV-3 has undergone close scrutiny by the members of the criteria development committee, including structuring of the requirements to affect a certain level on consensus, it may not require substantive changes, or modifications, prior to adoption by the laboratory accreditation committee (see 5.5.5).

Liaison with the PV standards committees of both the Institute of Electrical and Electronics Engineers (IEEE) and the American Society for Testing and Materials (ASTM), as

**Figure 5-5**



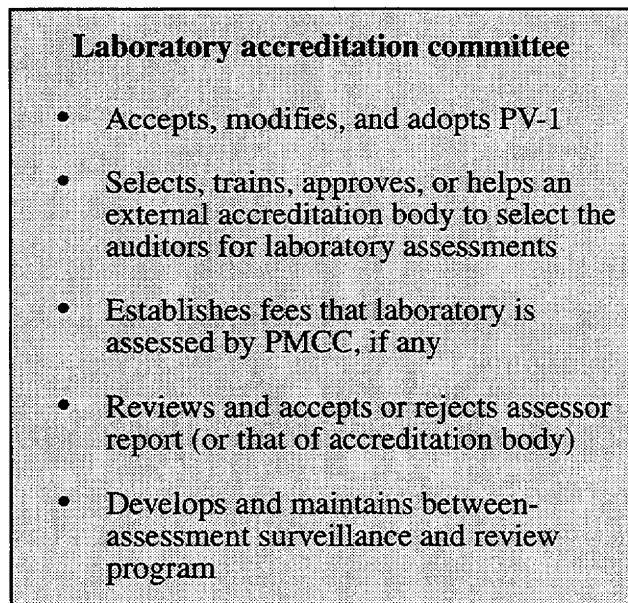
well as other standing committees of the PV module certification program, can be accomplished by one or more members who are also members of the applicable IEEE and ASTM standards committees. However, it is desirable that an *official liaison* be established wherever possible.

It should be recognized by all parties to the PV module certification process that document PV-3 ought to be maintained as a *living document*. That is, it should be maintained up-to-date with emerging needs, technical requirements, and scientific and technical advances. Changes, however, must be balanced against the requirement that neither the program participants nor their customers, the users, are unduly burdened by too frequent or too costly changes to the certification process.

### 5.5.5 Laboratory accreditation committee

The scope and workload of the laboratory accreditation committee will depend on whether or not the PMCC decides to undertake the entire laboratory accreditation process as an operating function of its certification program or whether it will employ the option of using an existing laboratory accreditation organization, such as the American Association of Laboratory Assessors (A2LA), to conduct the laboratory assessments. In any case, the laboratory accreditation committee has the responsibility of rendering the final decision as to the suitability of the laboratory. The overall scope of this committee is presented in Figure 5-6.

Figure 5-6



The payment of administrative fees by laboratories to the certification body, in addition to the costs of assessment rendered to the accreditation body, may be a point of contention with the

laboratories. However, such fees are appropriate for the administrative costs associated with review of a laboratory's accreditation status and the costs of maintaining a between-accreditation surveillance program (if PMCC chooses to adopt such a program).

The question of selection of the certification program's test laboratory or laboratories should be dealt with by the laboratory accreditation committee, as well as the PMCC Board of Directors, at the earliest possible time during the implementation of the certification program. At issue will be the use of any laboratory that meets the requirements for accreditation, versus the concept of using only one laboratory by fiat, much as has

been done by the Air-Conditioning and Refrigeration Institute in the certification and labeling of air conditioners, refrigeration systems, and solar collectors.<sup>4</sup> In contrast, the Solar Rating and Certification Corporation accredited multiple laboratories for testing domestic solar hot water collectors.<sup>5</sup>

Alternatively, it may be necessary to accredit two or more laboratories if no one laboratory possesses all of the capabilities necessary for performing all of the tests required by document PV-3. The issues of single versus multiple laboratories are detailed in Figure 5-7. The

**Figure 5-7**

<b>Laboratory scenarios</b>	
<b>Single laboratory offering complete services:</b>	
<b>POSITIVE:</b>	<ul style="list-style-type: none"> <li>• Easy to accredit and monitor</li> <li>• Systematic errors are not randomized between laboratories</li> </ul>
<b>NEGATIVE:</b>	<ul style="list-style-type: none"> <li>• Noncompetitive</li> <li>• Can become technically complacent</li> </ul>
<b>Multiple laboratories offering complete services:</b>	
<b>POSITIVE:</b>	<ul style="list-style-type: none"> <li>• Competition/reasonable prices</li> <li>• Competition/better service</li> <li>• Competition/less complacency</li> </ul>
<b>NEGATIVE:</b>	<ul style="list-style-type: none"> <li>• Greater complexity in administration of certification</li> <li>• Errors randomized between laboratories, leading to differences in test results</li> <li>• Lower volume/throughput may cause higher prices</li> </ul>
<b>Multiple laboratories offering partial services:</b>	
<b>POSITIVE:</b>	<ul style="list-style-type: none"> <li>• Easier accreditation for individual laboratories</li> </ul>
<b>NEGATIVE:</b>	<ul style="list-style-type: none"> <li>• Requires inter-laboratory transportation of modules</li> <li>• Increases cost and the risk of in-transit damage</li> <li>• Increased administration</li> <li>• May be only possibility for program initiation</li> </ul>

<sup>4</sup> Air-Conditioning and Refrigeration Institute, News Release "Certification Program for Solar Collectors," Air-Conditioning and Refrigeration Institute, Arlington, VA 22209, January 1978

<sup>5</sup> Solar Rating and Certification Corporation Document OG-100, op. cit.

actual scenario ultimately selected may be dictated largely by the candidate laboratories' perception of the economics.

Another issue that the laboratory accreditation committee would be well advised to consider (if not directed to do so by the President of the PMCC) is to develop a proficiency test module that will be used in the laboratory accreditation process (regardless of the organization used to accredit the PV test laboratory). One scenario for the committee to consider might consist of the following sequence of events:

- Select a module design or develop a specific module for proficiency testing
- Contract for the manufacture of the requisite number of modules required for evaluating the laboratories wishing accreditation
- Characterize the modules either by testing at a national laboratory such the National Renewable Energy Laboratory, Sandia National Laboratories, or the European Solar Test Installation or through a round robin characterization program that includes several manufacturers—the purpose of which would be to establish the characteristics of the module important to the program
- Have the applicant laboratory test the modules
- Determine the proficiency of the laboratory from an analysis of its test results.

#### **5.5.6 Product certification committee**

The certification committee is responsible for applying the rules of procedures adopted by the Board of Governors regarding the business of certifying the participating manufacturer's PV modules. This committee's responsibilities are presented in Figure 5-8.

With experience, this committee will be able to develop the procedural background and insights that will permit it to offer refinements and any necessary revisions to the overall certification program and the rules of procedure.

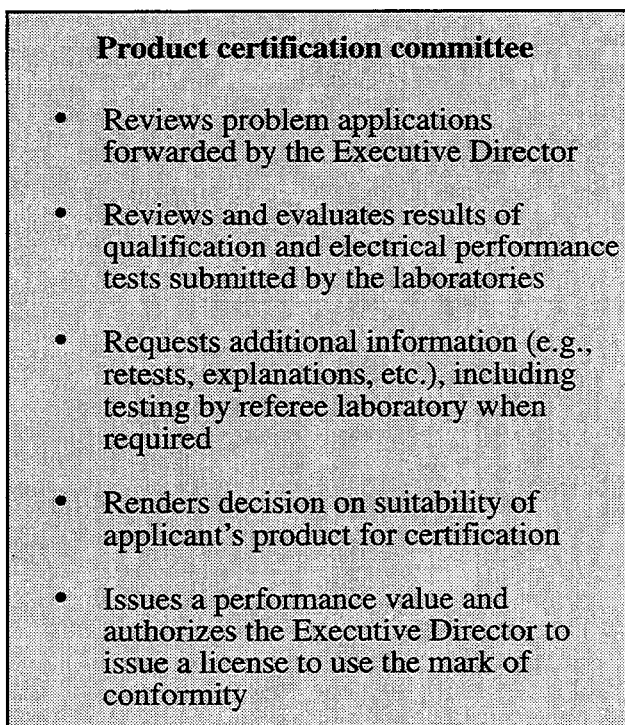
The product certification committee's scope requires that manufacturers be excluded from membership. Because the same restrictions will apply to the committee on manufacturer's quality

system compliance, committee members of one could logically serve on both committees. Indeed, during the initial stages of the certification program, combining the scopes of these two committees might make very good use of available expertise.

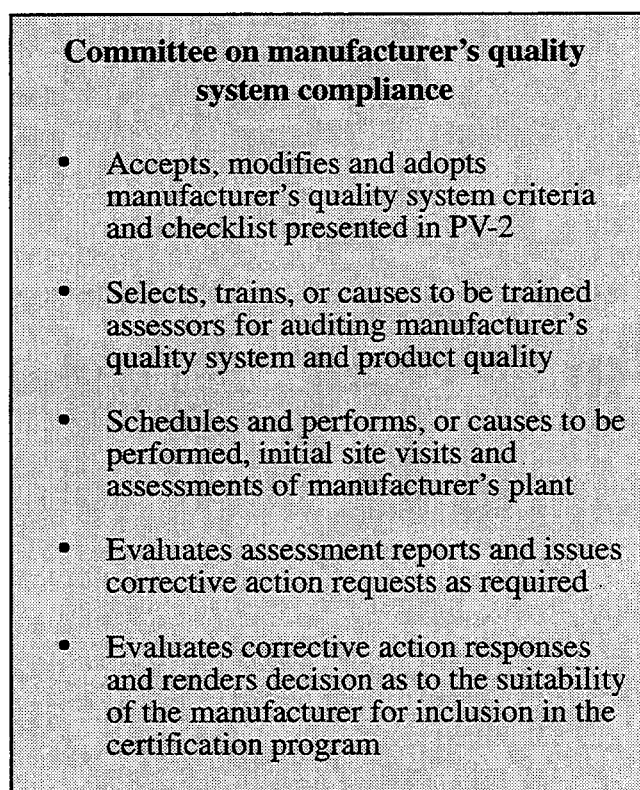
### **5.5.7 Committee on manufacturer's quality system compliance**

The subject and scope of this necessary committee will most likely always remain contentious to some manufacturers, whether carried out by a formal committee as presented herein, or handled by special or *ad hoc* committees appointed by the President of the PMCC or by the Executive Director. This is not expected to be the case for those manufacturers who have been registered to ISO 9000, or who otherwise meet the quality system requirements of the ISO 9000 series of quality standards; they are much less likely to object to the PMCC's quality system requirements for module certification. The overall scope of this committee is presented in Figure 5-9.

**Figure 5-8**

- 
- Product certification committee**
- Reviews problem applications forwarded by the Executive Director
  - Reviews and evaluates results of qualification and electrical performance tests submitted by the laboratories
  - Requests additional information (e.g., retests, explanations, etc.), including testing by referee laboratory when required
  - Renders decision on suitability of applicant's product for certification
  - Issues a performance value and authorizes the Executive Director to issue a license to use the mark of conformity

**Figure 5-9**

- 
- Committee on manufacturer's quality system compliance**
- Accepts, modifies and adopts manufacturer's quality system criteria and checklist presented in PV-2
  - Selects, trains, or causes to be trained assessors for auditing manufacturer's quality system and product quality
  - Schedules and performs, or causes to be performed, initial site visits and assessments of manufacturer's plant
  - Evaluates assessment reports and issues corrective action requests as required
  - Evaluates corrective action responses and renders decision as to the suitability of the manufacturer for inclusion in the certification program

The committee ought not to have difficulty in finding qualified quality systems assessors to carry out the level of assessments and surveillance that are envisioned for the PV certification program. For example, many manufacturing companies, and perhaps module manufacturers as well, have employees who are Certified Quality Assessors (CQAs), many with RAB<sup>6</sup> certification as Quality System Auditors (QS-A) and Quality System Lead Auditors (QS-LA) (these assessors and auditors would not be members of the quality system compliance committee).

A major issue will be the depth, or level, of the assessment that the certification body will require of manufacturers. The level required for ANSI accreditation of any product certification program is essentially that represented by the checklist presented in Appendix 2 of PV-2. Regardless of the level of quality system compliance that is ultimately required, the objective of assessment should not be to reject manufacturers or to eliminate them from the certification program. Rather, the assessment process should encourage compliance, and, hence, encourage participation of the largest possible number of manufacturers in the program. This is best accomplished through an equitable process of requiring corrective actions for deficiencies that are found during site visits and quality system assessments.

### 5.5.8 Committee on licensing compliance

Along with the audit and finance committee, the committee on licensing and compliance must develop equitable and innovative means to track compliance and at the same time avoid both the reality and the perception of requiring information that is proprietary and confidential to the manufacturer. The scope and responsibilities of this committee are presented in Figure 5-10.

<sup>6</sup> Registrar Accreditation Board: RAB is an American National Standards Institute/American Society for Quality Control organization

Figure 5-10

<b>Committee on licensing compliance</b>
<ul style="list-style-type: none"><li>• Approves, modifies, adopts certification body's licensing agreement as needed</li><li>• Develops appropriate procedures for monitoring licensing compliance by manufacturers</li><li>• Reviews complaints of licensing violations from external parties, or other manufacturers</li><li>• Requests manufacturer's response to violations, and immediate corrective action</li><li>• Recommends to Executive Director, President and Board of Directors cases where uncorrected violations require cancellation of a manufacturer's license</li></ul>



In 5.5.2, mention is made of the necessity for including legal counsel in certain meetings of the Board of Governors and meetings of the executive committee. Executive committee meetings, or board meetings, convened to render decisions on the revocation of licensing agreements and, hence, the right to use the PMCC's mark of conformity, are cases in point.

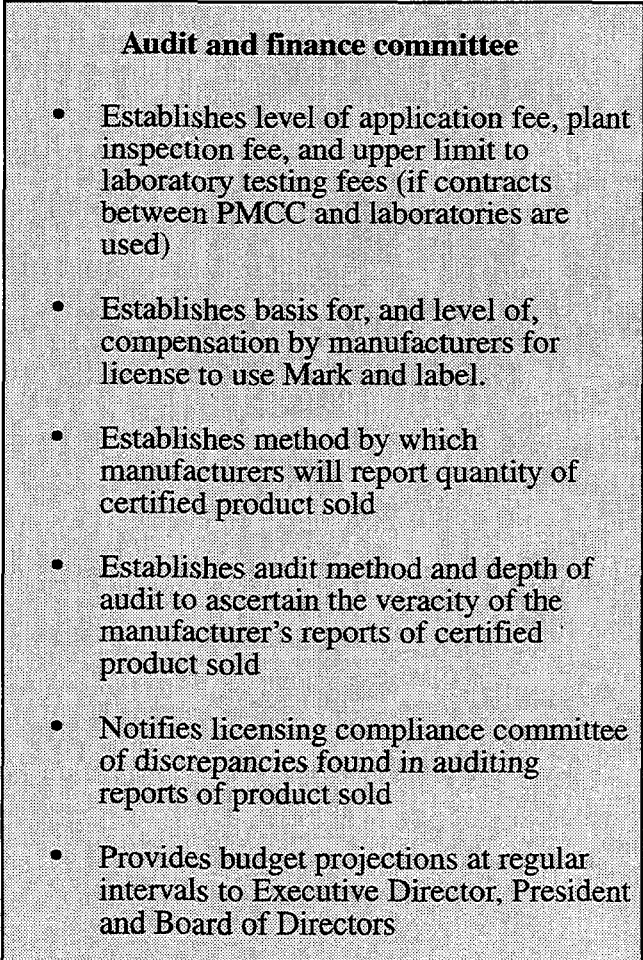
In developing rules of procedures for this committee, it will be essential that due process procedures be adopted for handling of sensitive issues such as complaints by one participating manufacturer against another. Adequate opportunity should be given for any manufacturer found to be misusing its license to take effective corrective action before the committee renders a decision to revoke its license and its right to use the mark of conformity.

### 5.5.9 Audit and finance committee

The only revenues that accrue to a certification body are derived from application and licensing fees. Usually application fees cover the administrative and direct costs of processing an application, arranging for site visits and assessing the manufacturer's quality systems. However, the majority of revenues result from the licensing fees related to the use of the mark of conformity and the certification label.

One of the more difficult tasks of this committee will be to develop equitable methods of auditing the manufacturers' representations of certified product sold, while remaining as noncontroversial as possible. Generally, the amount charged as an

**Figure 5-11**

- 
- Audit and finance committee**
- Establishes level of application fee, plant inspection fee, and upper limit to laboratory testing fees (if contracts between PMCC and laboratories are used)
  - Establishes basis for, and level of, compensation by manufacturers for license to use Mark and label.
  - Establishes method by which manufacturers will report quantity of certified product sold
  - Establishes audit method and depth of audit to ascertain the veracity of the manufacturer's reports of certified product sold
  - Notifies licensing compliance committee of discrepancies found in auditing reports of product sold
  - Provides budget projections at regular intervals to Executive Director, President and Board of Directors

application fee is not dependent on the size of the manufacturer in terms of the number of its employees, its revenues, the amount of product manufactured, or the manufacturer's stature and relative position in the market place. Rather, licensing fees are usually assessed on the basis of the number of units sold or the amount of product sold on an area basis. In the case of PV modules, the licensing fees could be based on the number of watts sold.

Discrepancies found in the manufacturer's report of product sold during the required annual audits are referred to the licensing compliance committee for resolution under the same rules of procedure that would be applied to other complaints. These and the additional responsibilities listed in Figure 5-11 represent the scope of the audit and finance committee.

### 5.5.10 Committee on appeals, complaints, and disputes

Essentially an appeals board, this committee should be comprised of members who are not on other committees, and thus should operate independently of the other standing committees. The suggested scope of the appeals board, and the types of appeals and complaints that it will hear, are presented in Figures 5-12 and 5-13. It should be noted here that the licensing contract between the participant and the PMCC should contain a provision, to which the participant agrees, that all decisions rendered by the appeals board will be final and binding.<sup>7</sup>

**Figure 5-12**

**Appeals board—scope**

**Scope:**

- Appeals of decisions affecting participants
- Disputes between laboratories and participants
- Disputes between participants and certification body
- Complaints from third parties
- Complaints referred from other committees

**Types of appeals accepted:**

- Denial of participation
- Denial of certification
- Test results
- Rated performance levels
- Audit findings of product sold

Complaints should be referred from standing committees such as the licensing compliance, audit and finance, and product certification committees, after other reasonable

<sup>7</sup> Except the right of the participant to voluntarily withdraw from the certification program.

avenues to affect a resolution have been exhausted.

The types of disputes that might be brought to the appeals board are listed in Figure 5-13. These represent disagreements between the participant manufacturer and the laboratory over, for example, specific test results, or with the random selection team over the sample selection process. They might involve disagreements over interpretation of results or over the laboratory's performance.

External complaints are generally the most difficult to deal with, particularly when they involve users and purchasers of the certified product. Although the contractual licensing agreement between the PMCC and the participating manufacturer may provide a binding resolution to problems between the certification body and the manufacturer, this contract will have no bearing on disputes between the manufacturer and the manufacturer's customers.

The help of attorneys familiar with licensing and certification law will be required to review, or help write, the rules of procedures for the appeals board and the licensing compliance committee.

**Figure 5-13**

**Appeals board—general disputes**

**General disputes:**

- Laboratory's performance of tests
- Random selection process
- Technical interpretation
- Technical disagreements between laboratory and manufacturer
- Technical disagreements between laboratories

**Types of external complaints:**

- One participant complains about another's results, rated performance, treatment, etc.
- Users or other participants complain about manufacturer's miss-labeling, or miss-representation of certification
- User complaints about certified product

**ANNEX A**

**PV-1. Criteria for a Model Quality System  
for Laboratories Engaged in Testing Photovoltaic Modules**

## DOCUMENT PV-1, Rev. d

### Criteria for a Model Quality System for Laboratories Engaged in Testing Photovoltaic Modules

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#### Glossary

ANSI	American National Standards Institute
ASQC	American Society of Quality Control
ASTM	American Society for Testing and Materials
ISO	International Standards Organization
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
NIST	National Institute of Standards and Technology
UL	Underwriters Laboratories

## FOREWORD

It is intended that the requirements of a Laboratory Quality System presented in this document be employed (1) by laboratories engaged in testing photovoltaic devices as a guide to designing, developing and implementing a quality system that meets the criteria for accreditation, and (2) by assessment bodies, and their assessors, as the criteria against which laboratories are examined for the purposes of accreditation. The criteria established in this document represent minimum acceptable guidance, and an expanded quality system beyond that required by this document is encouraged.

This model is one of a series of three documents that together purport to address the totality of the criteria and requirements of a photovoltaic device testing, certification, and labeling program. The other documents in this series are:

- PV-2 Model for a Third-Party Certification and Labeling Program for Photovoltaic Modules
- PV-3 Testing Requirements for a Certification and Labeling Program for Photovoltaic Modules: Test Standards, Test Methods, and Instrumentation and Facilities

In crafting the requirements set forth in this model, the relevant requirements of ASTM Standard E 548 on evaluating testing laboratories, ISO/IEC Guides 25 and 38 on conformity assessment have been largely adopted.

### 1. Introduction

- 1.1 All laboratories accredited, or otherwise approved, for the purpose of performing testing of photovoltaic modules shall be required to comply with these criteria.
- 1.2 A laboratory is said to conform to these criteria if it fulfills all of the requirements defined herein. To aid the assessment of laboratories to these requirements, only those requirements that can be objectively and independently verified are contained in this document
- 1.3 When conformance to this model is claimed, all provisions of the criteria and requirements set forth in this document shall be met.
- 1.4 Laboratories meeting the requirements of these criteria comply, within the context of their testing activities, with the requirements of ASTM Standard E 548 and ISO Guide 25, and with the relevant requirements of the ISO 9000 series of quality standards.

## **2. Scope**

- 2.1 This document sets forth the minimum requirements with which a laboratory shall comply and operate to demonstrate its competence to test photovoltaic modules.
- 2.2 In addition to its use as a model for the development of a laboratory's quality system, and for maintaining the quality of a laboratory's services, these criteria are for use in aiding the assessment of a laboratory's quality program and services.
- 2.3 This document covers the organization and management criteria of the laboratory, the design of its quality system, the minimum content of the laboratory's Quality Assurance Manual, the implementation of internal auditing of its quality system, and internal quality checking of its data and instrumentation.
- 2.4 This document also covers the general qualifications of its management and testing personnel, the external and on-the-job training requirements of its test personnel, the laboratory's general accommodation and environment criteria, and general requirements for scientific and test instrumentation.
- 2.5 This document also sets forth the minimum requirements for calibration instrumentation and traceability of instrumentation and data, generic requirements for use of calibration and test methods, handling of items for test, documentation and record requirements (including retention requirements), minimum requirements for issuance of test reports, vendor qualification for subcontracting of services and purchasing of supplies, and handling of complaints.

## **3. References**

- 3.1 ASTM E 548:  
"General Criteria for Evaluating Testing Laboratories"
- 3.2 ASTM E 882:  
"Guide for Accountability and Quality Control in the Chemical Analysis Laboratory"
- 3.2 ASTM E 1187:  
"Terminology Relating to Laboratory Accreditation"
- 3.3 ASTM E 1322:  
"Standard Guide for Selection, Training and Evaluation of Assessors for Laboratory Accreditation Systems"
- 3.4 ASTM E 1579:  
"Standard Guide for Ensuring Data Integrity in Highly Computerized Laboratory Operations"
- 3.5 ISO Guide 25:  
"General requirements for the Accreditation of Calibration and Testing Laboratories"
- 3.6 ISO Guide 38:  
"General requirements for the acceptance of testing laboratories" (in revision)

- 3.7 ISO 9000 and ANSI/ASQC 90:  
“Quality management and quality assurance standards—Guidelines for selection and use”
- 3.8 ISO 9001 and ANSI/ASQC 91:  
“Quality systems—Model for quality assurance in design/development, production, installation and servicing”
- 3.9 ISO 9002 and ANSI/ASQC 92:  
“Quality systems—Model for quality assurance in production and installation”
- 3.10 ISO 9004 and ANSI/ASQC 94:  
“Quality management and quality system elements—Guidelines”
- 3.11 ISO 8402:  
“Quality—Vocabulary”
- 3.12 ISO TAG 4:  
“Guide to the Expression of Uncertainty in Measurement” (draft)
- 3.13 ANSI/ASME PTC 19.1-1985, Part 1  
“Measurement Uncertainty—Instruments and Apparatus”

#### 4. Definitions

- 4.1 The relevant definitions from the referenced documents, including ISO 8402 on vocabulary, are repeated for use and clarification of the requirements of this document. Additional clarifications have been added to several definitions to aid in meeting the specific requirements of this model.
- 4.2 *Laboratory, or testing laboratory:* A body, or organization, that performs tests and provides a formal, written report of the results. In cases in which the laboratory forms part of an organization that carries out activities in addition to testing and calibration, the term laboratory refers only to that part of the organization that actually performs the testing of photovoltaic modules.
- 4.3 *Calibration:* The set of operations that establish, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and the corresponding known values of a measured quantity.

The results of a calibration permit the estimation of errors of indication of the measuring instrument, measuring system, or material measure, or the assignment of values to marks on arbitrary scales.

A calibration may determine other metrological properties. The result of a calibration shall, for the purposes of this model, be recorded in a document, which may be either an internal or external calibration certificate, or a calibration report.

The results of calibration operations recorded as values may be referred to as “calibration factors,” or, if a series of calibration values, as a “calibration curve.”



4.4 *Test method:* A documented technical procedure for performing a test. The test method may be called out in either internal documentation, or, whenever possible, in a published consensus standard.

4.5 *Verification:* Confirmation by examination and recording of physical evidence that specified requirements have been met.

In connection with the management of measuring equipment, verification provides a means for checking that the deviation between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation, or specification peculiar to the management of the measuring equipment.

The result of verification of equipment and measuring instruments leads to a decision either to maintain the item(s) in service, restore to service, or to perform adjustments, or to repair, or to downgrade, or to declare obsolete.

In all cases it is required that a written trace of the verification performed be kept on the measuring instrument's individual record.

4.6 *Quality system:* The organizational structure, responsibilities, procedures, processes, and resources for implementing quality management.

4.7 *Quality manual:* A document stating the quality policy or policies and the quality system and quality practices of an organization.

4.8 *Reference standard:* A physical standard, generally of the highest metrological quality available to the test laboratory, from which measurements made at that location are derived.

4.9 *Reference material:* A physical material, or substance, one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

4.10 *Certified Reference Material (CRM):* A reference material, one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying body, e.g., a *standard reference cell*.

4.11 *Traceability:* The property of a result of measurements whereby it can be related to appropriate physical standards maintained by the U.S. National Institute of Standards and Technology (NIST), or the appropriate international standards body, through an unbroken chain of comparisons.

4.12 *Proficiency testing:* Regular, periodic determination of the laboratory testing or calibration performance of *unknowns*, usually by means of interlaboratory comparisons.

4.13 *Interlaboratory testing:* Organization, performance, and evaluation of tests on the same or similar items or materials by two or more laboratories in accordance with predetermined conditions.

4.14 *Test and calibration procedures manual(s)*: A written document, or documents, which contain the specific instructions, preferably in active voice, imperative mood, for carrying out the tests or calibrations.

## **5. Accommodation and environment<sup>1</sup>**

5.1 Laboratory accommodation shall include the provision of regular, essentially permanent, ample work space for testing photovoltaic modules and for performing any necessary calibrations. Energy sources, lighting, heating, air-conditioning and ventilation shall be such as to facilitate the correct performance of tests and the internal calibrations required.

5.2 The environment in which these activities are undertaken shall not invalidate the results or adversely affect the required uncertainty level of any measurement. Particular care shall be taken when such activities are undertaken at sites other than a permanent laboratory facility.

5.3 The laboratory shall provide equipment for the effective monitoring, control, and recording of environmental conditions as appropriate. Due attention shall be paid, for example, to dust, electromagnetic interference, humidity, mains voltage, temperature, and sound and vibration levels, as appropriate to the tests and calibrations performed.

5.4 There shall be effective separation between neighboring areas in which there are incompatible activities.

5.5 Access to and use of all areas affecting the quality of measurement or testing activities shall be defined and controlled through documented procedures.

5.6 Adequate measures shall be taken to ensure good housekeeping and safety in the laboratory.

## **6. Organization and management**

6.1 The laboratory shall be legally identifiable. It shall be organized and operated in such a way that its permanent facilities, and any relevant temporary mobile facilities, meet the requirements of this model.

6.2 The laboratory shall:

6.2.1 Have managerial staff with the authority and resources needed to discharge their duties.

6.2.2 Have arrangements to ensure that its personnel are free from commercial or financial conflicts of interest and other pressures that may adversely affect the results of testing activities. The laboratory shall have a written policy relating to potential conflicts of interest, including the disclosure by staff of gifts from clients.

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<sup>1</sup> It is the laboratory's responsibility to comply with the relevant environmental, health, and safety requirements. These aspects are outside the scope of this model.

- 6.2.3 Be organized in such a way that confidence in its independence of judgment and integrity is maintained at all times.
- 6.2.4 Specify and document the responsibility, authority, and interrelation of all personnel who manage, perform, or verify work affecting the quality of testing or calibrations.
- 6.2.5 Provide supervision by persons familiar with the calibration and test methods and procedures, the objective of each such calibration or test, and the assessment of test or calibration results. The ratio of supervisory to nonsupervisory personnel shall be such as to ensure adequate supervision.
- 6.2.6 Have a technical manager (however named) who has overall responsibility for the technical operations of the laboratory. The technical manager must have sound knowledge of the principles of photovoltaic testing and must have the ability to make critical evaluations of test results.
- 6.2.7 Have a quality manager (however named) who has responsibility for the laboratory's quality system, its implementation and its maintenance. The quality manager's job may be a full-time or a part-time job, depending on the size of the staff and the technical scope of the laboratory in disciplines other than photovoltaic testing. The quality manager shall have direct access to the technical manager and to the highest level of management at which decisions are taken for the laboratory on policy or resources or both.
- 6.2.8 Nominate and document the staff members who shall have full authority in the absence of the technical or quality manager or both.
- 6.2.9 Where interlaboratory comparison or proficiency testing programs are either not available, or otherwise not appropriate, have an internal program to assess proficiency using one or more of the following: correlation charting, statistical techniques, independent measurements or periodic checks of measured conditions using calibrated instruments.

## **7. Personnel**

- 7.1 The laboratory shall have sufficient personnel having the necessary education, training, technical knowledge, and experience for their assigned functions.
- 7.2 Job descriptions of all personnel involved in photovoltaic testing shall be prepared and shall include position title, minimum requirements for the position, responsibilities and reporting relationships, and any supervisory responsibilities.
- 7.3 The laboratory shall ensure that the training of its personnel is maintained up-to-date. Procedures shall be developed to identify training needs, for training new personnel, and for developing and maintaining the expertise of existing personnel in all test techniques. Particular attention should be given to new or only occasionally used test methods, procedures, and techniques. Procedures for cross-training shall be developed and shall be implemented as needed.

7.4 Records on the relevant qualifications, training, skills and experience of the technical personnel shall be maintained by the laboratory. A list of all tests and calibrations that each staff member has been assessed for and found competent to perform shall be maintained. Cross-training records shall be maintained up-to-date.

## 8. The quality system

- 8.1 The laboratory shall establish and maintain a quality system appropriate to the type and scope of photovoltaic testing required by Document PV-3. All elements of this system as listed in 8.5 of this document shall be documented. The quality documentation, including up-to-date referenced test procedures and operating documents, shall be available for use by the laboratory personnel. The laboratory shall define and document its policies and objectives for, and its commitment to, good laboratory practice and the quality of testing services. The laboratory management shall ensure that these policies and objectives are documented in a quality manual and communicated to, understood by, and implemented by all laboratory personnel engaged in photovoltaic testing. The quality manual shall be maintained current under the authority and responsibility of the quality manager.
- 8.2 The laboratory's quality manual shall be specific to the laboratory physically involved in testing photovoltaic devices and shall therefore be unique to the laboratory; it shall not be a generic quality manual pertaining to a parent organization. The content, structure, and format of the manual shall reflect this uniqueness.
- 8.3 All copies of the manual shall be numbered, and a log shall be maintained with respect to the recipient of each control copy. The manual shall be a *living document*, i.e., each section shall be separately numbered, and each page shall contain the appropriate page number of that section and the following document control information: date of issue, authority, and amendment number.
- 8.4 The quality manual, and related quality documentation, shall state the laboratory's policies and operational procedures established to meet the requirements of this model.
- 8.4.1 Complete and detailed test and calibration procedures shall not be contained in the quality manual. The laboratory's specific requirements and wording of the procedures presented in Document PV-3 shall be maintained in a separate Test and Calibration Procedures Manual or in separate Manuals unique to the photovoltaic test laboratory.
- 8.4.2 Rules shall be developed and employed for the unique identification of all quality documentation, for changes to the documents, for their distribution, and for the registration of copies issued. The control information required on all documentation in the quality system shall include a unique identification of the document, the revision number, the date of issue, and the person authorizing the issuance of the revision so that the identity of the controlling document at any time is clear.

- 8.5 The minimum contents of the quality manual shall include the following:
- 8.5.1 A quality policy statement, including objectives and commitments, that is prepared, issued, and endorsed by top management.
  - 8.5.2 The organization and management structure of the laboratory, its place in any parent organization, and relevant organizational charts. The organizational charts shall include all positions and names. These should be consistent with job descriptions and training records.
  - 8.5.3 The responsibility, authority, and interrelation of all personnel who manage, perform, or verify work affecting the quality of tests and calibrations. These relationships should be identified further by use of a separate organizational chart.
  - 8.5.4 Procedures for control and maintenance of the quality system and related operating procedures documentation. These shall include, in addition to the requirements specified in Section 8.4.2:
    - (a) The procedures, responsibilities, and authorities for drafting, changing, approving, and issuing documents in the quality system, and documents for performing testing and calibration (test methods, calibration procedures, job orders and travelers).
    - (b) Procedures for preventing obsolete or superseded documents from being used shall be documented.
    - (c) Complete historical files of all quality documents issued shall be maintained and the location of these files shall be documented in the quality manual.
    - (d) The quality manual shall contain a master list of all quality documents with current issue dates and identities of copy holders (where relevant).
  - 8.5.5 The job descriptions of the management and key operating staff shall be listed in the appendix of the quality manual. Job descriptions of all other operating and support staff and training records shall be prepared and their location identified in the quality manual.
  - 8.5.6 The laboratory's approved signatories for test reports and certifications shall be identified. The criteria for selecting the approved signatories shall be as specified in Document PV-2.
  - 8.5.7 The laboratory's policy and reference to procedures, for achieving traceability of all measurements.
  - 8.5.8 Arrangements for ensuring that the laboratory reviews all new work to ensure that it has the appropriate facilities and resources before commencing such work. The manual shall describe policies or procedures to screen incoming test requests to determine whether it is within the laboratory's capacity to accept the job. Evidence of this review shall be documented.

- 8.5.9 The laboratory's scope of tests, listed in tables (whether in the body or an appendix of the manual) covering the test procedures in one, and the calibration procedures in another. The documents pertaining to test and calibration procedures, respectively, shall be identified and their distribution noted.
- 8.5.10 The procedures for handling test items. This policy shall describe the system of work flow through the laboratory and shall be supported by a flow chart indicating the key elements of the overall test program.
- 8.5.11 Reference to major test and calibration equipment used in the laboratory. This reference shall be supported by an appended listing, in tabular form, of all such instrumentation. Information provided in the listing shall include the items required in Sections 10.5.1 through 10.5.10.
- 8.5.12 Reference to procedures for the calibration, verification and maintenance of instrumentation and equipment.
- 8.5.13 Reference to current verification practices including interlaboratory comparison and proficiency test programs (if made available for photovoltaic testing), use of *reference materials* and *reference physical standards*, and internal quality control, or procedures.
- 8.5.14 Procedures to be followed for feedback and corrective action whenever testing discrepancies are detected, or departures from documented policies and procedures occur.
- 8.5.15 The laboratory management's policy and arrangements for exceptionally permitting departures from documented policies and procedures, or from standard specifications.
- 8.5.16 Policy and procedures for resolution of complaints received from clients or other parties about the laboratory's technical testing activities.
- 8.5.17 Procedures for protecting the confidentiality and proprietary rights of clients.
- 8.5.18 Procedures for audit and review of the quality system, as described in Section 9 of this document.
- 8.5.19 Procedures for training of the staff in the implementation and application of, and compliance with, the quality system and related operating procedures.
- 8.5.20 Copies of or reference to procedures for the management of personnel (staff) and personnel records, and their location.
- 8.5.21 If work is subcontracted, procedures to ensure that subcontractors are competent and comply with the requirements of this guide, as described in Section 16 of this document.
- 8.5.22 Copies of or reference to procedures to ensure that outside support services and supplies are of adequate quality, according to Section 17 of this document.

- 8.5.23 Copies of or reference to procedures for avoiding deterioration or damage to test and calibration items during storage, handling, preparation, and test.
- 8.5.24 Copies of or reference to procedures for the receipt and retention or safe disposal of test and calibration items, including all provisions necessary to protect the integrity of the laboratory.
- 8.5.25 Copies of or reference to procedures to ensure that purchased equipment, materials, and services comply with specified requirements when no independent assurance of the quality of outside support services or supplies is available.

**9. Audit and review, and verification practices**

- 9.1 The laboratory shall periodically, or as required under Section 18 of this document, conduct objective internal or contracted audits of its activities to verify that its operations continue to comply with the requirements of the quality system. Such audits shall be carried out by trained and qualified staff members who are, wherever resources permit, independent of the activity to be audited.
  - 9.1.1 Audits shall be carried out not less than annually.
  - 9.1.2 These audits shall include both general criteria (documents, records, and policies) and technical compliance (test methods and practices).
  - 9.1.3 Where the audit findings cast doubt on the correctness or validity of the laboratory's test results, the laboratory shall take immediate corrective action and shall immediately notify, in writing, any client whose work may have been affected, and shall provide a copy of all such information and correspondence to any product certification program body for which the testing is performed.
  - 9.1.4 The objectives of these audits are to discover:
    - (a) Whether management objectives (as defined by the quality system) are being achieved
    - (b) Whether designated duties are being carried out satisfactorily
    - (c) Whether appropriate calibrations of equipment, or materials, or both, are being properly carried out and whether the results are within the acceptable error limits for the quantities and properties being measured
    - (d) Whether procedures described in the quality system are being followed
    - (e) Opportunities for quality improvement.

- 9.1.5 The quality manager shall be responsible for ensuring that all components of the laboratory's activities are audited at least annually on behalf of management. The task of carrying out audits may be delegated to other staff with appropriate technical training and familiarity with the quality system. Additionally,
- (a) The laboratory shall have a planned schedule for the audits that includes all activities
  - (b) The audit procedures shall be documented
  - (c) The audits shall be carried out in accordance with the planned schedule and in accordance with the documented procedures
  - (d) The results of the audits shall be documented
  - (e) Effective corrective action shall be undertaken within a reasonable time frame with respect to all nonconforming items
  - (f) A record of all completed corrective actions shall be maintained.
- 9.2 The quality system adopted to satisfy the requirements of this model shall be reviewed at least once a year by senior management to ensure its continuing suitability and effectiveness and to introduce any necessary changes or improvements. The management review shall include the following:
- 9.2.1 Matters arising from the previous review
  - 9.2.2 Reports of any formal second- or third-party (e.g., external) assessments
  - 9.2.3 Reports of internal audits done since the last management review, including any corrective actions required and taken
  - 9.2.4 Results of participation in any interlaboratory comparisons or proficiency test programs (if available)
  - 9.2.5 Results of internal quality, data and instrumentation checks or verification procedures
  - 9.2.6 Details of any complaints from clients
  - 9.2.7 Staff training and cross-training (for both new and existing staff)
  - 9.2.8 Adequacy of resources (personnel, equipment)
  - 9.2.9 Future plans, new work requirements, new staff, new equipment.



- 9.3 All audit and review findings and any corrective actions that arise from them shall be documented. The Quality Manager shall ensure that these actions are discharged within the agreed timetable.
- 9.3.1 Corrective action shall be taken whenever evidence arises that the quality system is not functioning properly. Corrective action shall be taken under the following circumstances:
- (a) When there is a need to correct an immediate failure. This may require, as appropriate, retesting and withdrawing an invalid test report, and issuing a new test report.
  - (b) When there is a need to investigate the underlying cause of a failure. This may involve test personnel not being properly trained in the use of a new instrument or may involve the use of defective equipment or equipment found to be out of calibration.
- 9.4 In addition to periodic audits, the laboratory shall ensure the quality of results provided to clients by implementing independent checks. These checks shall be reviewed and shall include, as appropriate, but not be limited, to the following:
- 9.4.1 Internal quality control schemes using, whenever possible, statistical techniques (such as Spearman's rank correlation to discover reversals; x-y correlation coefficients between two measurements of an independent variable, or between measurements of two independent variables; Statistical Process Control (SPC) charting, uncertainty analyses, etc.)
  - 9.4.2 Participation in proficiency testing or other interlaboratory comparisons (if made available for photovoltaic testing)
  - 9.4.3 Regular use of certified reference materials or reference instruments, or both, in-house quality control using secondary reference materials, or reference test specimens, or both, including accepted calibrated standards for measurement of optical, electrical, thermal, and physical properties of items employed in the testing as detailed in Sections 10 and 11 of this document
  - 9.4.4 Replicate testing
  - 9.4.5 Retesting of retained test items
  - 9.4.6 Correlation of results for different characteristics of an item.
- 10. Equipment and reference materials, instruments, or standards**
- 10.1 The laboratory shall be furnished with all items of measurement and test equipment required for the correct performance of calibrations and tests. In those cases in which the laboratory needs to use equipment outside its permanent control, it shall ensure that the relevant requirements as described in Section 16 of this document are met.

- 10.2 All significant items of test equipment (including data processing) and reference materials (and instruments) required to perform the tests (or calibrations), or control critical test conditions, shall be permanently and uniquely identified. This identification shall include, in addition to the requirements of the equipment list specified in Section 8.5.11, the use of a numerical or alphanumeric *asset number*, or *instrument number*, engraved on or printed on a label that is affixed to the item of equipment in a conspicuous place.
- 10.3 All measuring instruments and test equipment used to acquire data or control critical test conditions shall be properly maintained and their maintenance status clearly stated on an appropriate label or other record affixed thereto. Maintenance procedures shall be documented, preferably in a Maintenance Manual. Any item of equipment that has either been subjected to overloading (electrical, thermal, physical, or otherwise), or mishandling, or gives suspect results, or has been shown by verification to be defective, shall be taken out of service, clearly identified, and stored at a specific place until it has been repaired and shown by calibration verification or test to perform correctly. The laboratory shall examine the effect of this defect on previous tests or calibrations and, as required in Section 9.1.2 of this document, advise any clients whose reports or certificates may have been affected.
- 10.4 Each item of measuring instruments and test equipment used to acquire data or control critical test conditions, including reference materials, and reference instruments (e.g., reference standards), shall be labeled, marked, or otherwise identified to indicate its calibration status.
- 10.5 Records shall be maintained of each item of equipment and all reference materials, and reference instruments, significant to the tests performed. The records shall include as a minimum:
- 10.5.1 The name of the test equipment
  - 10.5.2 The manufacturer's name, type identification, model number, and serial number or other unique identification
  - 10.5.3 Date received and date placed in service
  - 10.5.4 Current location in the laboratory, if relevant
  - 10.5.5 Condition when received (e.g., new, used, reconditioned, out-of-service)
  - 10.5.6 Copy of the manufacturer's operating manuals and instructions, where available
  - 10.5.7 Dates and results of calibrations or verifications, or both, and date of next calibration or verification, or both
  - 10.5.8 Details of maintenance carried out to date and planned for the future
  - 10.5.9 History of any damage, malfunction, modification or repair

10.5.10 The following additional information should also be placed in the equipment records file:

- (a) Service agents and their contacts, including telephone numbers (for calibration and maintenance when outside vendors are employed)
- (b) Checking requirements, including the frequencies and procedures
- (c) Records of in-service checks
- (d) The performance capabilities of the equipment, such as measurement limits, ranges and scales, estimates of measurement errors, stability, repeatability
- (e) The identity of staff responsible for monitoring the calibration and maintenance of the equipment
- (f) Authorized users.

## **11. Test and calibration methods**

- 11.1 The laboratory shall follow documented instructions on the use and operation of all relevant equipment, and on the handling and preparation of items for testing or calibration, or both, where the absence of such instructions could jeopardize the tests or calibrations. All instructions, standards, manuals, and reference data relevant to the work of the laboratory shall be maintained up-to-date and be made readily available to the staff.
- 11.2 The laboratory shall use appropriate documented methods and procedures for all tests and calibrations and related activities within its scope of activities, including sampling, handling, transport, storage, and preparation of items to be tested or calibrated, and estimation of uncertainty of measurement or analytical error in the calibration or test data. If possible, errors should be divided into bias (systematic) and precision (random) error—i.e., uncertainty analysis (e.g., ANSI/ASME PTC 19.1-1985, Part 1, Measurement Uncertainty Instruments and Apparatus). These procedures shall be consistent with the uncertainty level required, and with any standard specifications relevant to the calibrations or tests concerned.
  - 11.2.1 Many, if not all, of the test methods required by the photovoltaic product certification program outlined in Document PV-2 and compiled in Document PV-3 will represent the documentation required in Section 11.2 of this document.
- 11.3 Where methods are not specified by the client or by the requirements of Documents PV-2 and PV-3, the laboratory shall select appropriate methods that have been published either as national or international standards (e.g., ASTM, IEEE, ANSI, IEC and ISO, or UL), or by reputable technical organizations, or in relevant scientific texts or journals. Reference to, and deviations from, the methods and procedures shall be clearly documented and made available to the laboratory test operator and client.

- 11.4 Where it is necessary to employ methods that have not been established as consensus standards according to Section 11.3 of this document, these shall be subject to agreement with the client, be fully documented and validated, and be available for examination by the client and other authorized recipients of the relevant reports.
- 11.5 Where sampling is carried out as part of a test method, the laboratory shall use documented procedures and appropriate statistical techniques to select samples.
- 11.6 Calculations and data transfers shall be subject to appropriate independent checking as noted in Section 9.4 of this document.
- 11.7 When computers or automated equipment are used for the capture, processing, manipulation, recording, reporting, storage, or retrieval of test and calibration data, the laboratory shall ensure that:
  - 11.7.1 Computer software is documented and validated as adequate for use
  - 11.7.2 Procedures are established and implemented for protecting the integrity of data; such procedures shall include, but not be limited to, integrity of data entry or capture, data storage, data transmission and data processing
  - 11.7.3 Computer and automated equipment is maintained to ensure proper functioning and provided with environmental and operating conditions necessary to maintain the integrity of test and calibration data
  - 11.7.4 Appropriate procedures are documented and implemented to maintain security of data, including the prevention of unauthorized access to, and amendment of, computer records
  - 11.7.5 The documented procedures to meet the foregoing requirements conform to the guidelines stated in ASTM E 1579.

## **12. Measurement traceability and calibration**

- 12.1 All measuring and testing equipment having an effect on the accuracy or validity of calibrations or tests shall be calibrated or verified, or both, before being put into service. The laboratory shall have an established program for the calibration and verification of its measuring and test equipment, including the use of necessary reference materials and reference standards and appropriate independent, between-calibration checks.
- 12.2 The overall program of calibration, verification, and validation of measurement and test equipment shall be designed and operated so as to ensure that measurements made by the laboratory are, with the exception noted in Section 12.2.1, either traceable to national standards of measurement or recognized natural physical constants, or are otherwise satisfactorily validated such as by a verified self-ratioing comparison mechanism.

- 12.2.1 Solar radiation measuring instrumentation employed in the program of photovoltaic testing shall be traceable to the World Radiometric Reference (WRR) through one or more of the absolute, self-calibrating cavity pyrheliometers that regularly participate in the International Pyrheliometric Comparisons held every 5 years at Physical Meteorological Observatory in Davos, Switzerland.
- 12.3 Calibration certificates shall indicate the traceability to national standards of measurement, or to the WRR as noted in Section 12.2.1, or to natural constants, or shall state other acceptable means of validation, and shall provide either the measurement results and associated uncertainty of measurement or a statement of compliance with an identified metrological specification. Calibration records shall clearly state the as-found values and the laboratory's tolerance limits for each instrument or device requiring calibration.
- 12.4 Should traceability to national or international standards of measurement or other direct means of validation not be possible or practicable, the laboratory shall provide other satisfactory evidence of verification of its measurement or test results, for example, by participation in a suitable program of interlaboratory comparisons or proficiency testing.
- 12.5 Reference standards of measurement held by the laboratory shall be used for calibration only and for no other purpose.
- 12.6 Reference standards of measurement shall be calibrated by a body that can provide certified traceability to a national or international standard of measurement.
- 12.7 The laboratory shall document and implement a program of calibration and verification for its reference standards.
- 12.8 As relevant, any reference standards, including on-site primary, transfer, or working standards, and designated measuring and testing equipment, shall be subjected to in-service checks between calibrations and verifications.
- 12.9 Reference materials shall be traceable to national or international standards of measurement or to national or international certified standard reference materials, unless it can be demonstrated that neither is possible.
- 12.10 All procedures for in-house calibration shall be documented, including an estimation of uncertainty. These should include acceptance criteria, and corrective action if equipment falls outside these criteria.
- 12.11 The staff member responsible for monitoring and for calibration program implementation for each item of equipment shall be identified.
- 12.12 There shall be a comprehensive calibration-scheduling program to alert staff of all calibration due dates.
- 12.13 Reagents shall be kept in properly labeled, clean containers. Their shelf life shall not have expired and they shall otherwise not be used after a reasonable period of time.

### **13. Handling of test items**

13.1 The laboratory shall follow documented procedures for the receipt, retention, or safe disposal, or return to client, of test items, including all provisions necessary to protect the integrity of the laboratory.

13.1.1 When the laboratory has total or partial responsibility for sampling, the laboratory shall follow the instructions for sampling given in Document PV-2.

13.2 To ensure that there can be no confusion regarding the identity of test items at any time, the laboratory shall have a documented system for uniquely identifying items to be tested.

13.3 On receipt, the condition of the test item, including any abnormalities or departures from standard conditions as prescribed in the relevant test method, shall be recorded. When there is any doubt as to the suitability of an item for test, or an item does not conform to the description provided, or the test required is not fully specified, the laboratory shall consult the client for further instruction before proceeding. The laboratory shall establish whether the item has received all necessary preparation, or whether the client requires preparation to be undertaken or arranged by the laboratory.

13.4 The laboratory shall follow documented procedures and use appropriate facilities to avoid deterioration or damage to the test item during storage, handling, preparation, and test. Relevant instructions provided with the item shall be followed. When items have to be stored or conditioned under specific environmental conditions, these conditions shall be maintained, monitored, and recorded where necessary. Where a test item or portion of an item is to be held secure (for example, for reasons of record, safety, propriety, or value, or to enable check tests to be performed later), the laboratory shall follow documented storage and security arrangements that protect the condition and integrity of the secured items or portions concerned.

### **14. Records**

14.1 The laboratory shall maintain a record system to suit its particular circumstances and comply with any applicable regulations, including the record requirements of Document PV-2 when the testing program defined by Document PV-2 applies.

14.2 The laboratory shall retain on record all original observations, calculations and derived data, calibration records, and a copy of the calibration certificate, test certificate or test report for a period of not less than 7 years. The records for each test shall contain sufficient information to permit their repetition. The records shall include the identity of laboratory personnel involved in sampling, preparation, calibration of equipment, and testing activities.

14.2.1 The laboratory shall maintain a system that provides a traceable link between the sample as received and the test report or test certificate that is eventually issued on that test item, including all raw data. This requirement shall apply to both manually accumulated and computer-acquired data. Information contained in the record shall include, as a minimum, the following:

- (a) A description of each sample, including its condition, model number, serial number, and detailed structure and composition of test item
- (b) The individual sample, or test item, identification
- (c) Identification of the test method, or test program, and any deviations
- (d) Identification of the specific equipment and instrumentation used in the tests, and any related calibration information
- (e) Original test data and observations
- (f) Typed or printed name and signature of the person performing the test
- (g) A copy of the test report as issued
- (h) Dates, times (where relevant), and location of tests performed.

14.2.2 Original observations shall be entered in ink at the time of the test into bound, numbered logbooks or onto properly designed work sheets that are permanently affixed to the logbooks.

14.2.3 Mistakes shall never be erased or deleted. Mistakes shall be noted by drawing a single line through the error and entering the correct value alongside, or in adjacent columns or rows. The line-out shall be initialed by the person making the change, and the reason for the change shall be noted in the margin or in a conspicuous and adjacent place.

14.2.4 The individual pages of the logbooks, or the work sheets, shall be provided with a place for dating and initialing by a higher authority.

14.2.5 Computer records shall be kept in accordance with the rules described in Section 11.7 of this document.

14.2.6 Any special instructions for completion of logbooks and work sheets provided by Document PV-2 shall be followed for tests and testing programs covered by Document PV-2.

14.3 All records (including those listed in Section 10.5 of this document, pertaining to calibration and test equipment), certificates, and reports shall be safely stored, held secure, and maintained in confidence to the client, except as provided by the disclosure requirements in Document PV-2.

## **15. Reports**

15.1 The results of each test or series of tests shall be reported accurately, clearly, unambiguously, and objectively, and in accordance with instructions in the test methods.

- 15.2 When applicable, the results shall be reported in a test report in accordance with the requirements of Document PV-2. In all other cases, each report shall include at least the following information:
- (a) A title, e.g., "Test Report," "Report of Test," and date of issue
  - (b) Name and address of the test laboratory, and the location where the test was carried out if different from the address of the laboratory
  - (c) Unique identification of the report (such as a serial number) and the total number of pages; pages shall be numbered consecutively, and each page shall also carry the report number and total number of pages
  - (d) Name and address of client
  - (e) Description and unambiguous identification of the item or items tested
  - (f) Characterization and condition of the test item(s)
  - (g) Date of receipt of test item(s) and date(s) of performance of test(s)
  - (h) Identification of each standard test method used or unambiguous description of any nonstandard method used (including reference to internal test procedure documentation)
  - (i) Reference to any *special* instrumentation or equipment used
  - (j) Reference to any relevant sampling procedure
  - (k) Any additions to, or deviations or exclusions from, the test method, and any other information relevant to a specific test, such as environmental conditions
  - (l) Measurements, examinations and derived results, supported by tables, graphs, sketches, and photographs, as appropriate, and any known failures identified
  - (m) A statement of either the estimated uncertainty of the test result(s) or the reason that no such estimate is possible, including reference to a more detailed error analysis, if required
  - (n) a signature and title or an equivalent identification of the person(s) accepting responsibility for the content of the test certificate or report, however produced, and the date of issue
  - (o) As relevant, a statement to the effect that the results relate only to the items tested
  - (p) A statement that the test report shall not be reproduced except in full, without the written approval of the laboratory.



- 15.3 Where the test report contains results of tests performed by subcontractors, these results shall be clearly identified as so performed.
- 15.4 Particular care and attention shall be paid to the arrangement of the test report. When the tests are performed in accordance with the program of testing specified in Document PV-2, the reporting format specified in Document PV-2 shall be followed.
- 15.5 Material amendments to a test report after it has been issued shall be made only in the form of a further document, or data transfer, which includes the statement "Supplement to Test Report, serial number ... [or as otherwise identified]," or an equivalent form of wording. Such amendments shall meet all the relevant requirements of Section 14 of this document.
- 15.6 The laboratory shall ensure that, where clients require transmission of test results by telephone, telex, facsimile, or other electronic or electromagnetic means (e.g., electronic mail), staff will follow documented procedures that ensure that the requirements of this model are met and that confidentiality is preserved.

#### **16. Subcontracting of testing**

- 16.1 When the laboratory subcontracts any part of the testing, this work shall be placed with a laboratory complying with the requirements of this document, or one that is accredited to ISO Guide 25. In an absence of accreditation, the laboratory shall perform a documented audit of the proposed subcontractor with reference to those aspects of the testing intended to be subcontracted.
- 16.2 The laboratory shall ensure and be able to demonstrate that its subcontractor is competent to perform the activities in question and complies with the same criteria of competence as the laboratory in respect to the work being subcontracted. The laboratory shall immediately advise the client in writing whenever it intends to subcontract any portion of the testing to another party.
- 16.3 The laboratory shall record and retain details of its investigation of the competence and compliance of its subcontractor laboratories and maintain a register of all subcontracted test activities.

#### **17. Outside support services and supplies**

- 17.1 When the laboratory procures outside services and supplies, other than those referred to earlier in this document in support of tests, the laboratory shall use only those outside support services and supplies that are of adequate quality to sustain confidence in the results of tests. Purchase requisitions for critical test materials shall contain sufficiently detailed descriptions of the material to assure conformance with the test specification.

- 17.2 When no independent assurance of the quality of outside support services or supplies is available, the laboratory shall follow documented procedures to ensure that purchased equipment, materials and services comply with specified requirements. The laboratory shall ensure that purchased support equipment and consumable materials are not used until they have been inspected, calibrated, or otherwise verified as complying with any standard specifications or requirements documented in the methods for the tests concerned.
- 17.3 Documented procedures shall be developed and implemented for any test materials requiring handling, storage, or disposal.
- 17.4 The laboratory shall maintain records of all suppliers from whom it obtains support services, support equipment, or supplies required for tests. These records shall include the brand names of consumables and the results of any acceptance tests performed, maintenance histories of frequently purchased instruments and tools used in testing, and the status of suppliers' registration to one of the ISO 9000 standards whenever possible or relevant.

## **18. Complaints**

- 18.1 The laboratory shall follow a documented policy and procedures for the resolution of complaints received from clients and other parties about technical testing activities. A record shall be maintained of all such complaints and of the investigations and any corrective actions taken by the laboratory.
- 18.2 When a complaint, or any other similar or equivalent circumstance, raises doubt concerning the laboratory's compliance with documented policies or procedures, or with the requirements of this document or otherwise concerning the quality of its tests, the laboratory shall ensure that those areas of activity and responsibility involved are promptly audited in accordance with Section 9.1 of this document or have records to indicate that the deficiency was detected and previously corrected.



## **Annex B**

### **PV-2. Model for a Third-Party Certification and Labeling Program for Photovoltaic Modules**

## Document PV-2, Rev. d

### Model for a Third-Party Certification and Labeling Program for Photovoltaic Modules

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## Glossary

ANSI	American National Standards Institute
ASQC	American Society of Quality Control
ASTM	American Society for Testing and Materials
ISO	International Standards Organization
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
NIST	National Institute of Standards and Technology
UL	Underwriters Laboratories



## FOREWORD

It is intended that the requirements for a Model for a Third-Party Certification and Labeling Program presented in this document be employed as a model by (1) organizations selected, formed, or otherwise approved to engage in the role of a photovoltaic module certification and labeling entity that is wholly independent of all photovoltaic product testing activities or (2) laboratories engaged in the dual role of testing photovoltaic modules on the one hand, and carrying out a product certification and labeling program, on the other.

It is not the purpose of this document to set forth the requirements for either the operation of a laboratory that is accredited or otherwise approved to perform the testing, or to set forth the technical testing requirements that will result in creation of the information and data that will be used by such a product certification and labeling program (or by an organization engaged in product certification). However, this model is one of a series of three documents that together purport to address the totality of the criteria and requirements of a photovoltaic testing, certification, and labeling program. The other documents in this series are:

- PV-1 Criteria for a Model Quality System for Laboratories Engaged in Testing Photovoltaic Modules
- PV-3 Testing Requirements for a Certification and Labeling Program for Photovoltaic Modules: Test Standards, Test Methods, and Instrumentation and Facilities

In crafting the criteria set forth in this model, the requirements of ANSI Z34.1, an American National Standard for “Certification—Third Party Certification Program,” and ISO/IEC Guide 28, “General Rules for a Model Third-Party Certification System for Products,” have been taken into consideration, and significant portions of both have been adopted.

### 1. Introduction

- 1.1 This document describes a model and the general rules for the model’s use in developing and implementing a third-party product certification program for photovoltaic modules.
- 1.2 The application and use of this document shall not contravene any federal, state, or local statutory requirements.
- 1.3 These general rules represent the generic criteria under which a producer is authorized to use the certification program’s *certificate of conformity* or the program’s *mark (certification mark)* as a *label* to indicate that the associated manufacturing process and the photovoltaic modules produced therefrom are in compliance with applicable test standards and specifications.



## 2. Scope

- 2.1 The model described by the criteria and requirements of this document encompasses the structure of a third-party product certification system for determining the conformity of photovoltaic modules with a series of performance and durability-reliability standards contained in Document PV-3.
- 2.2 This model is applicable to certification of conformity of photovoltaic modules to other test standards and specifications having a broad level of recognized acceptance, selected from time to time by the certification body's, or program's, Technical Committee, however named. These standards and specifications include revisions of the methods contained in Document PV-3, as well as new methods that become important to the operation of the certification program. Recognized acceptance of such standards and specifications shall be any of, or any combination of, the following:
- (a) An American National Standard
  - (b) A standard promulgated by ASTM, IEEE or any other domestic national standards organization
  - (c) An international standard promulgated by either the International Electrotechnical Commission (IEC) or the International Standards Organization (ISO)
  - (d) A standard or specification published by the federal, state, or local governments.
- 2.3 Conformity to the requirements of Document PV-3 shall be determined through initial testing and assessment of a factory quality management system and its acceptance followed by surveillance that takes into account the factory quality management system and the testing of samples from the factory and the open market.
- 2.4 A certification body operating a product certification or certification and labeling program for photovoltaic modules shall itself have in place a Quality Assurance System that meets the relevant requirements of Document PV-1.<sup>1</sup>
- 2.5 The certification body shall be responsible for selecting, or otherwise approving or accrediting, the laboratory or laboratories used for testing photovoltaic modules to the requirements of Document PV-3. Approval or accreditation of the laboratory or laboratories shall be based on the successful completion of an outside assessment of the laboratory's competence when audited against the criteria set forth in Document PV-1.
- 2.6 When conformance to this model is claimed, it shall pertain to the provisions of all criteria and requirements set forth in this document.

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<sup>1</sup> Alternatively, conformity to the relevant requirements of ISO 9002 is acceptable.

### **3. References**

- 3.1 ANSI Z34.1:  
"Third-Party Certification Program"
- 3.2 ISO/IEC Guide 28:  
"General rules for a model third-party certification system for products"
- 3.2 ASTM E 548:  
"General criteria for Evaluating Testing Laboratories"
- 3.3 ASTM E 1322:  
"Guide for Selection, Training and Evaluation of Assessors for Laboratory Accreditation Systems"
- 3.4 ISO/IEC Guide 25:  
"General requirements for the accreditation of calibration and testing laboratories"
- 3.5 ISO/IEC Guide 23:  
"Methods of indicating conformity with standards for third-party certification systems"
- 3.6 ISO/IEC Guide 27:  
"Guidelines for corrective action to be taken by a certification body in the event of misuse of its mark of conformity"
- 3.7 ISO/IEC Guide 38:  
"General requirements for the acceptance of testing laboratories" (in revision)
- 3.8 ISO/IEC Guide 55:  
"Testing laboratory accreditation systems—General recommendations for operation"
- 3.9 ISO/IEC Guide 56:  
"An approach to the review by a certification body of its own internal quality system"
- 3.10 ISO 9001 and ANSI/ASQC 91:  
"Quality Systems—Model for quality assurance in design/development, production, installation and servicing"
- 3.11 ISO 9002 and ANSI/ASQC 92:  
"Quality systems—Model for quality assurance in production and installation"

#### 4. Definitions

4.1 The relevant definitions pertaining to testing, calibration, and verification contained in Document PV-1 are incorporated by reference and are not repeated.

4.2 Certification activities:

4.2.1 *Certification*: The procedure by which written assurance is given that a product or service conforms to a specification. A *third-party* certification is one that is rendered by a technically and otherwise competent body other than one controlled by the *producer* or the *buyer*.

4.2.2 *Certification program*: The system that relates to specific products, processes, or services to which the same particular standards and rules, and the same procedure, apply. Such a program uses or is operated by a *third-party* inspection/testing body or organization, and the program authorizes the use of controlled certification marks or certificates of conformity as evidence of conformity.

4.2.3 *Certification body*: An impartial body or organization possessing the necessary competence to develop, promulgate, finance, and operate a certification program and to conduct certifications of conformity.

NOTE: A certification body may operate its own testing and inspection activities or it may oversee these activities carried out on its behalf by other bodies, e.g., an independent testing laboratory.

4.2.4 *Producer*: The manufacturer, distributor, supplier, or other party providing the product or service to be purchased and employed by a *user*. The producer is responsible for assuring conformity with all requirements of the certification program.

4.2.5 *Certification mark*: The sign or symbol owned and controlled by the certification body that is used exclusively by the third-party certification program to identify products or services as being certified and is registered as a certification mark with the U.S. Patent Office under the Trade Mark Act of 1946.

4.2.6 *Certificate of conformity*: A tag, label, nameplate, or document of specified form and content, affixed or otherwise directly associated with a product or service on delivery to the buyer, attesting that the product or service is in conformity with the requirements of the certification program (e.g., with the referenced standards and specifications).

4.2.7 *License (for certification)*: Document, issued under the rules of a *certification program*, by which a *certification body* grants to a person, manufacturer, or producer, the right to use the *certificates* or *marks of conformity* for its products, processes, or services in accordance with the rules of the relevant *certification program*.

4.2.8 *Licensee (for certification)*: Person, manufacturer, or producer to which a *certification body* has granted a *license*.

4.3 Testing and inspection activities:

4.3.1 *Tests*: Technical operations that consist of the determination of one or more characteristics of a given product, process, or service according to a specified procedure.

4.3.2 *Testing*: Actions or the process of carrying out one or more *tests*.

4.3.3. *Testing/Inspection body (third-party)*: An organization (if a *testing body*, a *laboratory*) that possesses the necessary technical competence and that is other than one operated or controlled by a manufacturer, supplier, or buyer (*user*) of a certified product or service in that it has no organizational, financial, or commercial involvements with the *producer* or *buyer* that might pose a potential conflict of interest.

NOTE: An *inspection body* is an organization, often organized separately from the testing laboratory, and often a functional arm of the *certification body* (whether an organizational or a subcontracted entity) that performs initial inspections of a manufacturer's or producer's operations, including any subsequent surveillance procedures that may be required.

4.4 Conformity and standards:

4.4.1 *Conformity*: Fulfillment by a product, process, or service, of specified requirements.

4.4.2 *Conformity evaluation*: Systematic examination of the extent to which a product, process, or service fulfills specified requirements.

4.4.3 *Inspection*: Evaluation for conformity by measuring, observing, testing, or gauging the relevant characteristics as required by a specification or standard.

4.4.4 *Conformity surveillance*: Evaluation for conformity to determine the continuing conformity with specified requirements.

4.4.5 *Standard*: A prescribed set of conditions and requirements, established by authority or agreement, for continuous application. It takes the form of a document containing a set of conditions to be fulfilled, or an object of comparison. For the purposes of this document, the provisions as defined and used in this document shall be such as to be suitable to and capable of *certification*.

5. **Certification body**

5.1 The photovoltaic certification body whose name is identified with the certification and labeling program for photovoltaic modules shall be *one* of the following:

- (a) A trade association
- (b) An existing product certification body

- (c) A professional or technical society.
- (d) An organization of photovoltaic manufacturers or of laboratories engaged in testing photovoltaic modules
- (e) An organization oriented to the public, consumers, or users of photovoltaic modules
- (f) A third-party testing/inspection organization.

5.2 The photovoltaic certification body shall:

- 5.2.1 Comply with the general requirements for third-party certification as outlined in Sections 6 through 19 of this model
- 5.2.2 Have a structure that permits choosing its governance members, if it operates under either a governing board or board of directors, from among those interests involved in the process of certification without any single interest predominating
- 5.2.3 Have as a minimum an internal quality system and audit procedure in accordance with the requirements presented in Appendix 1 of ISO/IEC Guide 56, which is reproduced in full in Appendix 1 of this document
- 5.2.4 Be responsible for and assure that certification is based on:
  - 5.2.4.1 The results of actual tests of the characteristics of the photovoltaic modules performed by a laboratory in accordance with the requirements of Documents PV-1 and PV-3
  - 5.2.4.2 Formal reports of the results of the testing and inspection of the photovoltaic modules
  - 5.2.4.3 The furnishing of photovoltaic modules by the producers and/or distributors of such modules that are manufactured under a system of quality assurance in accordance with Section 6.2 of this model, such as ISO 9000 Series of quality assurance standards
- 5.2.5 Be responsible for:
  - 5.2.5.1 Assessment of, or causing to be assessed, those testing laboratories that make application and furnish their qualifications for accreditation by the photovoltaic certification body as a laboratory approved to perform the testing required in accordance with Document PV-3. The testing laboratory accreditation system shall be operated in compliance with the requirements of ISO/IEC Guide 55, and the assessment of candidate laboratories shall be carried out by qualified laboratory assessors in accordance with the requirements of Document PV-1

- 5.2.5.2 Levying, or otherwise approving, of the laboratory assessment fees in accordance with rules established by the photovoltaic certification program
- 5.2.5.3 Regular periodic reassessment and reaccreditation of laboratories initially qualified to perform photovoltaic testing with a frequency in accordance with rules established by the photovoltaic certification program
- 5.2.5.4 Initial inspection of the manufacturer's or producer's factory and assessment of its quality management system in accordance with the checklist presented in Appendix 2 of this document
- 5.2.5.5 Regular periodic reassessment and reapproval of the manufacturer's or producer's quality system with a frequency in accordance with rules established by the photovoltaic certification program.

## **6. Manufacturer's or producer's quality system**

### **6.1 Initial inspection and assessment**

- 6.1.1 To facilitate the inspection and assessment, a manufacturing and quality management system data form shall be developed that contains pertinent information needed to be acquired from the applicant. An example of the required data form is presented in Appendix 3 of this document, and an example of an acceptable application for participation in the photovoltaic certification program is presented in Appendix 4 of this document.
- 6.1.2 On receipt of the manufacturer's program data form and application requesting participation in the photovoltaic module certification program, the certification body shall seek any clarifications necessary to the determination that the manufacturer is likely to be approved as a certification program participant.
- 6.1.3 After confirmation of the acceptance of the program data form and application, the certification body shall make the necessary arrangements with the applicant for initial inspection and assessment in accordance with the established rules of the certification program. The certification body's assessor or the assessment team shall be persons who are knowledgeable in:
  - (a) The applicable photovoltaic testing standards and specifications (e.g., Document PV-3)
  - (b) Appropriate laboratory test procedures
  - (c) Quality assessment techniques and procedures
  - (d) The quality system elements required for photovoltaic certification.

- 6.1.4 The matters to be investigated by the assessment team at the manufacturer's factory shall include, as a minimum, the following:
  - 6.1.4.1 Determination that all the information provided by the manufacturer in the certification program data form is correct
  - 6.1.4.2 Determination that the manufacturer has the necessary equipment, staff, and facilities required for the production of a quality product and therefore for participation in the certification program
  - 6.1.4.3 Determination that the applicant demonstrates the quality control test procedures required of a manufacturer's quality assurance program
  - 6.1.4.4 Assurance that those quality system elements required for participation in the certification program, as detailed in Appendix 2, are being performed, or practiced as a routine part of the manufacturing process.
- 6.1.5 The certification body shall inform the applicant in writing of the results of the initial inspection of facilities and assessment of applicant's quality system.
- 6.1.6 If, on the basis of the inspection and assessment, the requirements for licensing are not met, the certification body shall inform the applicant in writing of those criteria in which the application has failed.
- 6.1.7 If the applicant can provide objective evidence that the required remedial action has been taken to remove the deficiencies found within the time period specified by the photovoltaic certification program, the applicant will be judged to have complied with the certification program's requirements for licensing.
- 6.1.8 If the applicant cannot provide objective evidence that the required remedial action has been taken, or evidence has not been provided in the time period required, the certification body will repeat that portion of the inspection and assessment for which remedial action was originally required. Failing either, the application shall be denied and communicated to the manufacturer in writing.
- 6.1.9 The fees and costs associated with the initial inspection shall be in accordance with the rules established by the certification body.
- 6.2 Manufacturer's quality management system
  - 6.2.1 Assessment of the manufacturer's quality management system shall form a significant portion of the initial inspection.
  - 6.2.2 The manufacturer shall implement a quality management system that meets, as a minimum, the requirements listed in Section 6.2.5.

- 6.2.3 All of the manufacturer's records produced for implementation of the quality management system related to photovoltaic certification shall be readily available for inspection by the inspectors or assessors, or both, assigned by the certification body.
- 6.2.4 The manufacturer shall appoint designated persons to be responsible for the quality management system and the company's contact person to the certification body for matters relating to certification. Ideally, they should be the same person. The quality manager, however named, shall be independent from production management.
- 6.2.5 The manufacturer's quality system shall have, as a minimum, the following elements (which are a synopsis of ISO 9001):
  - 6.2.5.1 A quality assurance manual containing the policies and procedures that relate, as a minimum, to the quality system elements presented in Sections 6.2.5.2 through 6.2.5.10
  - 6.2.5.2 Procedures to control and verify the design of the product, with emphasis on design changes
  - 6.2.5.3 Procedures that ensure that purchased product conforms to specified requirements
  - 6.2.5.4 Procedures that govern the control of manufacturing processes, document manufacturing work instructions, and document the operation of manufacturing and process equipment
  - 6.2.5.5 Procedures and documentation covering inspection and testing of product, including reporting of results, retention of test and inspection records
  - 6.2.5.6 Procedures for maintenance, operation, and calibration of inspection and testing equipment and instruments, including retention of records of calibration, out-of-calibration occurrences
  - 6.2.5.7 Procedures for control of nonconforming product and for nonconformity review and disposition
  - 6.2.5.8 Procedures for corrective actions relating to nonconforming product, customer complaints, discrepancies in manufacturing processes and deficiencies found in internal audits
  - 6.2.5.9 Procedures for handling, storage, packaging, and delivery of product
  - 6.2.5.10 Procedures for maintenance of quality records
  - 6.2.5.11 Procedures for performing internal quality audits.



## **7. Initial testing and periodic retesting**

### **7.1 Sample selection**

- 7.1.1 Photovoltaic test specimens shall be selected at random by an employee or an agent of the certification body from a lot of manufactured product either in the factory or in the field in accordance with rules and procedures established for the certification program.
- 7.1.2 The lot from which specimens are chosen shall be of sufficient size to eliminate the possibility of selecting compliant specimens that otherwise might not be representative of sold product.
- 7.1.3 The employee or agent of the certification body shall establish that the product chosen for initial test has been manufactured from production tools and assembled using methods established for production runs.
- 7.1.4 Where testing is based on prototype product, confirmation tests or examinations, or both, shall be made on production samples as soon as possible. When production samples are found not to meet the requirements for certification, labeling, and licensing, revocation of certification shall be in accordance with procedures established by the certification body.

### **7.2 Initial testing**

- 7.2.1 Initial testing shall be carried out by a laboratory accredited in accordance with the requirements of this model and Document PV-1, and the test procedures shall be those specified in Document PV-3.
- 7.2.2 Where the certification body chooses to use test data produced by laboratories other than one accredited by the certification body, such as in an international program of reciprocity of product certification, the certification body shall ensure that the test laboratory conducting the testing complies with all of the criteria of ISO/IEC Guide 25 and with those specific requirements of Document PV-1 established by the certification body for the purposes of reciprocity of test data.

### **7.3 Periodic retesting**

- 7.3.1 Periodic retesting shall be carried out in accordance with the frequency and rules established for the photovoltaic certification program.

## **8. Licensing**

- 8.1 When complete fulfillment of the requirements of the photovoltaic certification program has been established, the certification body will inform the manufacturer and will submit a licensing agreement for the applicant's signature. An example of a licensing agreement is presented in Appendix 5 of this document.

- 8.2 On completion of the licensing agreement, the certification body issues a license to the manufacturer for use of the certification body's certificate of compliance, or mark. An example of a license is given in Appendix 6 of this document.
- 8.3 A licensee wishing to extend a license to additional types or models of photovoltaic modules produced in the same factory should apply using the same application form that was used initially (an example form is given in Appendix 4 of this document). The conditions under which the certification body shall require full testing shall be defined in the rules for the certification program. For example, the certification body may institute procedures for *type testing* that eliminate the need for retesting modules whose only design change from a certified product is cosmetic (providing that objective evidence is submitted for consideration by the certification body).
- 8.4 If the licensee wishes to apply for certification of a photovoltaic module manufactured in another factory, an additional application must be made, the factory must be inspected, and the quality system must be assessed, completely independent of existing certifications and licenses.

## 9. Surveillance

- 9.1 The certification body may, in accordance with procedures established for the photovoltaic certification program, exercise surveillance procedures in lieu of frequent retesting of a licensed product. However, surveillance shall in no way contravene the requirement for periodic retesting of licensed product.
- 9.2 The certification body may use its own employee(s) or appoint an agent to carry out the surveillance under the authority of the certification body. In case the certification body exercises its prerogative to use surveillance techniques, permission to use surveillance shall be a provision of the licensing agreement.
- 9.3 The licensee shall be informed about the results of the surveillance.
- 9.4 The licensee shall inform the certification body of intended modifications to the licensed product, the manufacturing processes, or the quality management system that may have an effect on the product's compliance. On such notification, the certification body shall make a determination of whether to initiate a full inspection and test sequence or to schedule a surveillance visit.
- 9.5 Where the licensee has made modifications to the licensed product, the manufacturing processes, or its quality management system, regardless of whether the certification body has been so notified, the licensee shall not release certified products resulting from such changes until the certification body has given the licensee written permission to do so.
- 9.6 The licensee shall maintain a record of all complaints relative to the photovoltaic modules covered by the license, and shall make these available to the certification body on request

## **10. Use of the certificate of conformity, or mark of conformity, and marking**

### **10.1 General**

- 10.1.1 Certificates and marks of conformity shall be limited for use in the photovoltaic certification program to indicate that compliance with the standard is under the jurisdiction of the certification program.
- 10.1.2 The use of certificates and marks of conformity shall be described and controlled by the certification body in documentation separate from this model and from Documents PV-1 and PV-3.
- 10.1.3 The precise rules and procedures for use of representations of conformity shall be developed in accordance with the provisions of ISO/IEC Guide 23. The rules developed by the certification body shall specify whether certificates and marks are issued jointly, or whether they are issued separately for different purposes, or whether they are issued on the basis of preference expressed by the manufacturer.
- 10.1.4 The rules shall specify the exact conditions under which physical representations of conformity are permitted or used, specific limitations on their use, types and forms of certificates or marks, or both, and procedures for dealing with misuse, or misrepresentation, of certificates and marks of conformity.

### **10.2 Certificate of conformity**

- 10.2.1 The purpose of issuing certificates of conformity is to provide the end user information as to the standards covered by the certificate.
- 10.2.2 Certificates of conformity may relate to all of the requirements of a standard or to selected provisions only.
- 10.2.3 When issued, certificates of conformity shall contain as a minimum the following information:
  - (a) Name and address of the certification body
  - (b) Name and address of the manufacturer
  - (c) Identification of the photovoltaic module certified and model or type number, and the lot and serial-number series, if relevant, to which the certificate applies
  - (d) Reference to Document PV-3, or to appropriate provisions and sections of Document PV-3
  - (e) Coded reference to the test results such that there is a capability of relating the certificate to the test results on which it was based
  - (f) Date of issue of certificate

- (g) Signature and title of authorizing officer of the certification body.

The rules of the photovoltaic certification program may specify additional information to be included.

### 10.3 Marks of conformity

- 10.3.1 The mark of conformity, or certification mark, shall be designed such as to minimize the possibility of counterfeiting. It shall be in the form of a nontransferable label, or mark, in the sense that it cannot be removed from one photovoltaic device and placed on another.
- 10.3.2 If a formal certificate of conformity, issued in the context of Section 10.2, is not issued simultaneously with issuance of the mark, a separate certification shall be issued that lists the information required by Section 10.2.3.
- 10.3.3 When only certain components of a photovoltaic system bear a certification mark, care shall be taken to ensure that the user or consumer is not misled into assuming that the entire system is certified.
- 10.3.4 A mark of conformity shall be issued and used only where it relates to **all the requirements** of a standard and not to selected sections or characteristics.
- 10.3.5 When issued, a license for the use of the mark of conformity shall be issued to the manufacturer by the certification body only. No other source of the mark shall be authorized, or permitted.

### 10.4 Marking

- 10.4.1 The requirements, procedures, and instructions for use of the physical process of marking and the placement of the mark shall be included in the rules established by the certification body and shall be a part of the provisions of the documentation required by Sections 10.1.2 and 10.1.3 of this Document.

## 11. Misuse of a certificate or mark of conformity

- 11.1 The certification body shall operate a surveillance program as part of its program on licensing of the conformity certificate or mark.
- 11.2 Incorrect references to the certification system or misleading use of the mark found in advertisements, catalogues, or product literature, shall be handled in accordance with procedures established by the certification body, and the subject of suitable action, including corrective actions, shall be covered in the licensing agreement.
- 11.3 In cases of misuse of certificates or the mark of conformity by licensees, corrective action shall be taken.

## **12. Publicity by licensees**

- 12.1 Licensees of the photovoltaic certification program's mark of conformity, or certificate of conformity, shall have the right to publish that the licensed manufacturer has been authorized to issue a certificate of conformity or apply a mark of conformity for products to which the license applies.
- 12.2 Provision shall be made in the licensing agreement that requires the licensee to take sufficient and due care of his publications and advertising so that no confusion arises between certified and noncertified products.
- 12.3 If permitted by the rules established by the certification body, the manufacturer may publish parts of a test report that relate to the certification of his products except that the licensee may do so only with the written permission of the certification body.
- 12.4 The certification body is encouraged to establish rules requiring that licensees submit their proposed promotional, catalog, and advertising materials to the certification body for approval prior to publication.

## **13. Suspension of a license for a product**

- 13.1 The applicable tenets of this section shall be included in the licensing agreement.
- 13.2 The license applicable to a specific product may be suspended for a limited period under the following circumstances:
  - (a) If the surveillance, or required retesting, shows noncompliance with the requirements of such a nature that immediate withdrawal is not necessary
  - (b) If a case of improper use of the certificate or the mark, e.g., misleading prints or advertisements is not solved by suitable retractions and appropriate remedial measures by the licensee
  - (c) If there has been any other contravention to the rules and procedures of the certification program, or requirements of the certification body.
- 13.3 The licensee may not identify as certified any product that has been produced under a suspended license applicable to that product.
- 13.4 A license may also be suspended after mutual agreement between the manufacturer and the certification body for reasons of existence of a finite period of nonproduction or inactivity, or for other reasons.
- 13.5 An official suspension of a licensee shall be confirmed by the certification body in a registered letter to the manufacturer (or by other equivalent means).

- 13.6 The certification body shall indicate under what conditions the suspension will be removed, such as, for example, corrective action taken in accordance with Section 15 of this document.
- 13.7 At the end of the suspension period, the certification body will ascertain if the conditions for reinstating the license have been fulfilled and shall notify the manufacture either that the license has been reinstated or that the license has been withdrawn (see Section 14).

**14. Withdrawal or cancellation of a license**

- 14.1 The applicable tenets of this Section shall be included in the licensing agreement.
- 14.2 Apart from the temporary suspension of a license, a license may be withdrawn or canceled in the following circumstances:
- (a) If the surveillance shows that the noncompliance is of a serious nature
  - (b) If the licensee fails to comply with the due settlement of his financial obligations
  - (c) If there is any other contravention of the licensing agreement
  - (d) If inadequate measures are taken by the licensee in the case of suspension.
- 14.3 In the circumstances described in Section 14.2, the certification body shall have the right to withdraw or cancel the license by informing the licensee by registered letter (or by equivalent means). The specification of time limit shall be contained in the licensing agreement (see Article 10 of the specimen licensing agreement in Appendix 5 of this document).
- 14.4 The licensee may give notice of appeal. The certification body shall consider all appeals, but shall reserve the right to reject, after due consideration, the appeal by licensee, thereby letting the withdrawal or cancellation stand.
- 14.5 The certification body shall ensure that documented appeals procedures are adopted for use in the photovoltaic certification program.
- 14.6 The procedures adopted by the certification body for withdrawal or cancellation of a license shall include procedures for considering and acting appropriately on the consequences in relation to products certified under the license, whether the mark of conformity shall be removed from all products in stock, and if practical, whether the mark shall be removed from products already sold, or whether a clearance of the stock of marked products should be allowed within a short period of time, and if other actions are required.
- 14.6.1 In any case, the manufacturer shall be required to notify the purchasers of decertified product that the license has been canceled.

- 14.7 The license may be cancelled for any of the following reasons:
- (a) If the licensee does not wish to continue the license
  - (b) If the rules are changed and the licensee either will not or cannot ensure compliance with the new requirements (see Section 16)
  - (c) If the product is no longer manufactured or the licensee ceases to operate
  - (d) Noncompliance with other provisions of the licensing agreement.
- 14.8 The certification body shall have the right to publish all revocations of licenses to use the certification program's certificates and marks of conformity. However, regardless of whether the certification body established such a policy, the publication of revocations of license shall apply to all withdrawals and cancellations.
- 15. Corrective action**
- 15.1 In cases of misuse of a certificate or a mark of conformity, corrective action shall be taken to safeguard their use.
- 15.2 Procedures for corrective action shall be established and documented by the certification body. Such procedures shall conform, as a minimum, to the requirements of ISO/IEC Guide 27.
- 16. Implementation of modifications to Document PV-3**
- 16.1 There are a number of circumstances that can force changes in the testing procedures and other product requirements that impact the manufacturers. These include
- (a) Improvements in test methods of such significance as to require revisions of Document PV-3
  - (b) The necessity for adding test methods to Document PV-3
  - (c) Changes required by federal, state, or local mandates, laws, or regulations.
- 16.2 The certification body shall establish procedures for revising Document PV-3.
- 16.3 The effective date of modification to a standard must be published by the certification body, and all licensees listed under the photovoltaic certification program shall be notified to provide adequate time for resubmittal of their applications.
- 16.4 Factors that shall be considered when choosing an effective date include, but are not necessarily limited to, the following:
- (a) The urgency of complying with revised health, safety, or environmental requirements

- (b) The length of time and financial costs for retooling and manufacturing a product to meet revised requirements
- (c) The extent of stock on hand and whether it can be reworked to meet the revised requirements
- (d) Avoidance of unintentional commercial advantage given to a particular manufacturer or design
- (e) Operational problems of the certification body.

**17. Liability**

- 17.1 Where questions of product liability are at issue, they must be dealt with on the basis of the relevant law.
- 17.2 The certification body shall take all possible steps to secure affordable *officers' and directors' insurance*.

**18. Disputes**

- 18.1 Disputes between the certification body and licensees or potential licensees shall be handled in the same manner as appeals.
- 18.2 The certification body's appeals procedures shall include procedures for the resolution of disputes arising from matters other than license revocation actions.

**19. Fees**

- 19.1 The certification body shall establish a fee structure for the licensing process that provides adequate revenue for the operation of the photovoltaic module certification program.
- 19.2 The certification body shall establish assessment fees that include reimbursement of expenses associated with:
  - (a) The inspection, assessment, and accreditation of the certification program's test laboratories
  - (b) The inspection, assessment, and approval of the manufacturer's production facilities, organizational capabilities, and quality system as a condition of acceptance as a participant in the certification program (notwithstanding the additional requirements for testing and the consequences derived therefrom).



**PV-2 Appendix 1**

**An approach to the review by a certification body of its own internal quality system**  
(reproduced from Appendix 1 of ISO/IEC Guide 56)

# An approach to the review by a certification body of its own internal quality system

## Appendix 1

### 0 Introduction

**0.1** One of the most essential elements for the operation of an international certification system or for mutual recognition of national certification systems is confidence in the competence of the certification bodies participating in the system or engaged in mutual recognition.

**0.2** Confidence can be built through a progressively expanding set of acceptance arrangements, bilateral or multilateral, in the process of a step-by-step approach to an international certification system, as described in ISO/IEC Guide 42.

**0.3** The aim of the procedure recommended in this Guide is to facilitate and accelerate the initiation of such a process, by providing certification bodies with a means of maintaining and improving their competence.<sup>1)</sup>

**0.4** It is recognized that confidence in the conformity certification system operated by a certification body will be based both

- on the organizational structure and documented procedures of the certification body, and
- on the manner in which the procedures are applied and how the organizational structure serves to enhance the effectiveness of the certification body's operation.

**0.5** Confidence should be based on identical fundamental elements and criteria to be met by certification bodies, which necessitates the appropriate organization and administrative structure, surveillance facilities and testing facilities (if included), and legal and fees structure — the performance of all functions being specified by the certification system.

**0.6** The following factors contribute to increased confidence among certification bodies participating in an international certification system, or involved in mutual certification arrangements:

- 1) use of equivalent standards;

- 2) use of procedures which provide for appropriate organizational and administrative structure, comparable testing equipment and methods, comparable surveillance procedures, comparable legal protection and other features which assure that none of the participants is at undue risk in accepting other participants' work.

**0.7** Agreements between parties operating certification systems in different countries will generally include provisions covering a number of items not dealt with in this Guide, including such items as exchanges of personnel, comparison of surveillance, testing and inspection techniques, the legal system to be utilized in case of dispute, etc.

### 1 Scope

This Guide provides a framework for use by a certification body in assessing itself, its procedures, and its operations. The framework incorporates requirements and recommendations to be found in all relevant ISO/IEC reference documents. Using this framework, a certification body should be able to compile a documentary record of its internal quality system review procedure. It will also be possible to use this documentary record for subsequent distribution to all parties concerned.

Certification bodies may include other specific elements and criteria depending on specific needs.

### 2 References

ISO/ITC booklet, *Certification — Principles and practice*

ISO/IEC Guide 2, *General terms and their definitions concerning standardization and related activities*

ISO/IEC Guide 7, *Requirements for standards suitable for product certification*

<sup>1)</sup> Most of the points addressed in this Guide are covered in more detail in other ISO/IEC guides (see clause 2). The purpose of this Guide is only to facilitate the approach to the first steps recommended, for example, in ISO/IEC Guide 42. In no way is it implied, however, that a certification body that has used this Guide to review its internal quality procedures will automatically be recognized by other certification bodies. Agreements between certifying bodies (reciprocity) require some form of assessment of each other's arrangements regarding procedures, experience, organizational structure, legal framework, rules, auditing, testing, etc. A system of assessment involving examination teams may be required for a valid implementation of mutual recognition, as is the case, for example, in the IEC Quality assessment system for electronic components (IECQ).

ISO/IEC Guide 16, *Code of principles on third-party certification systems and related standards*

ISO/IEC Guide 23, *Methods of indicating conformity with standards for third-party certification systems*

ISO/IEC Guide 25, *General requirements for the technical competence of testing laboratories*

ISO Guide 27, *Guidelines for corrective action to be taken by a certification body in the event of misuse of its mark of conformity*

ISO/IEC Guide 28, *General rules for a model third-party certification system for products*

ISO/IEC Guide 38, *General requirements for the acceptance of testing laboratories*

ISO/IEC Guide 39, *General requirements for the acceptance of inspection bodies*

ISO/IEC Guide 40, *General requirements for the acceptance of certification bodies*

ISO/IEC Guide 42, *Guidelines for a step-by-step approach to an international certification system*

ISO/IEC Guide 44, *General rules for ISO or IEC international third-party certification schemes for products*

ISO/IEC Guide 54, *Testing laboratory accreditation systems — General recommendations for the acceptance of accreditation bodies*

### 3 Definitions

The relevant definitions in ISO/IEC Guide 2:1986, or any later edition, are applicable.

### 4 Credibility

Of prime importance to any certification scheme, whether intended for internal, bilateral or multilateral use, will be its credibility and therefore acceptability. This aspect must be kept foremost during any self-assessment programme, and becomes critical to any international scheme.

### 5 Elements to be addressed

The elements to be addressed in a comprehensive internal quality system review procedure are the following:

- documentation (clause 6);
- testing laboratories (clause 7);
- inspection services (clause 8);
- certification staff (clause 9);
- checklist for assessment (clause 10).

### 6 Documentation

6.1 Before self-assessment can commence, the system under operation should be fully documented.

6.2 The elements to be documented are covered in the ISO/ITC booklet, *Certification — Principles and practice*, in which eight typical systems are identified (systems 1 to 8).

6.3 The main types of documentation are outlined in Chapter 5 of the ISO/ITC booklet, *Certification — Principles and practice*.

6.4 In addition to the operational documentation the certification body should have a manual to cover

- a) legal identification of the certification body;
- b) the administrative structure of the certification body;
- c) terms of reference of the governing board;
- d) organizational chart which depicts responsibilities and reporting structure;
- e) list of names, qualifications and experience of each member of the staff engaged in the actual certification process, including details regarding availability of staff in places other than headquarters;
- f) information on any certification training received by the staff, including training in the principles and practice of quality assurance;
- g) staff instructions;
- h) documentation and change control;
- i) records, including system used for their maintenance, and blank copies of report forms used;
- j) procedures covering the control of marks of conformity and actions to be taken in cases of misuse;
- k) procedure for investigating complaints received and taking any necessary corrective action;
- l) procedures and staff instructions to ensure confidentiality;
- m) publications;
- n) appeals (see ISO/ITC booklet, *Certification — Principles and practice*, Chapter 5.11).

The general requirements pertaining to these elements are given in ISO/IEC Guide 40.

### 7 Testing laboratories

7.1 The testing laboratory may be an integral part of the certification body or it may be a separate entity.

7.2 It is not intended that this Guide cover the work of testing laboratories.

3. It is of critical importance that the testing work performed for certification purposes be done by a competent testing laboratory.

7.4 Testing work performed for certification purposes is to be done by a testing laboratory that meets the criteria specified in ISO/IEC Guides 25 and 38 and additional specific criteria appropriate for the type of product involved.

7.5 The certification body should have a system of laboratory selection based on these points.

7.6 A laboratory suitably accredited for the purpose should be capable of satisfying the above requirements.

## 8 Inspection services

8.1 The inspection body may be an integral part of the certification body or it may be a separate entity.

8.2 Inspection work performed for certification purposes is to be done by an inspection body that meets the criteria of ISO/IEC Guide 39 and additional specific criteria appropriate for the type of product involved.

## 9 Certification staff

1. Staff should be competent for the functions they undertake and should have the necessary education, training, technical knowledge and experience.

9.2 Information on the academic or other qualifications and experience of each member of the staff should be maintained by the certification body. Records of training and experience should be kept up-to-date.

9.3 Staff should have available to them clear documented instructions pertaining to their duties and responsibilities. These instructions should be maintained up-to-date.

9.4 When work is sub-contracted to an outside body, the certification body is responsible for the sub-contracted work and should ensure that the party performing the work meets the requirements for a testing laboratory referred to in 7.4, and the requirements for an inspection body referred to in 8.2.

9.5 In small organizations, one person may fulfil more than one function.

## 10 Checklist for assessment

NOTE — The following checklist for assessing a certification body's operation of third-party certification systems is based on ISO/IEC Guides 7, 23, 25, 27, 28, 38, 39 and 40.

### 10.1 Standards

Standards upon which the system is based, covering products, processes and services, shall be suitable for use as a basis for certification.

## 10.2 Procedures

Procedures by which the system is operated include provision for

- a) competent and responsible management and appropriately trained staff;
- b) participation on a non-discriminatory basis;
- c) both initial and continuing validation activities;
- d) selection and retention of qualified testing and inspection services;
- e) dispute resolution through an impartial appeals mechanism;
- f) notification to licensees of changes in standards and procedures;
- g) confidentiality of proprietary information;
- h) maintenance of records;
- i) safeguarding use of mark, including legal support;
- j) revocation of authorization to use mark;
- k) monitoring procedures regarding periodic inspections, etc;
- l) training programme on certification for the benefit of industries and staff engaged in certification work.

## 10.3 Requirements for licensing

Requirements for licensing include (see clause 6 of ISO/IEC Guide 28)

- a) supplier's quality management system and documentation (only for Systems 5 and 6 described in the ISO/IEC booklet, *Certification — Principles and practice*);
- b) technically appropriate resources for testing and inspection;
- c) complaint records system;
- d) provisions against non-conforming products to which the mark is applied;
- e) provision for notification of product changes;
- f) practices relating to the use of the certification body name or mark of conformity.

## 10.4 Indication of conformity

Conformity is indicated by a certificate or mark which

- a) reflects the registered mark of the certification body;
- b) includes information on product, standards, supplier and other parties, where applicable (see ISO/IEC Guide 23);

- c) presents clearly the extent of the certification, where applicable.

## 10.5 Documentation

Documentation required by the system includes

- a) availability of a published programme directory listing products, processes and services which may be certified, standards, licensees, and other parties;
- b) file of legally binding agreements with licensees;
- c) availability of statement covering operating procedures;
- d) availability of annual review or report.

## 10.6 Fee structure and financial aspects

The certification body should have well laid out guidelines from the financial point of view for granting licences and for operating the certification system (see clause 19 of ISO/IEC Guide 28).

NOTE — When complete, the checklist will be accompanied by a document which will key each item to relevant sections of the ISO/IEC reference documents.

## 11 Appeal

The certification body should provide for an independent line of appeal available to its licensees.

**PV-2 Appendix 2**

**Checklist for assessing the capabilities and quality system of  
manufacturers and producers**

## Appendix 2

### Checklist for inspection and assessing the capabilities and quality system of manufacturers and producers<sup>2</sup>

- 1. Management responsibility**
  - 1.1 Is a quality policy defined, documented, understood, implemented, and maintained?
  - 1.2 Are the responsibilities and authorities for all personnel specifying, achieving, and monitoring quality defined?
  - 1.3 Are in-house verification resources defined, trained, and funded?
  - 1.4 Has a staff person been designated to implement and maintain the quality system?
  
- 2. Quality system**
  - 2.1 Has a quality manual been prepared? Is it used by all pertinent employees?
  - 2.2 Have quality procedures been prepared and implemented?
  - 2.3 Do the management and staff understand the requirements for certification?
  
- 3. Contract review**
  - 3.1 Are incoming contracts and purchase orders reviewed to determine if the requirements are adequately defined, whether they agree with the bid, and whether they can be implemented?
  - 3.2 Are adequate records of such contract reviews maintained?
  
- 4. Design control**
  - 4.1 Do design projects receive adequate planning?
  - 4.2 Are design input parameters adequately defined?
  - 4.3 Are design output parameters, including crucial product characteristics, adequately defined and documented?
  - 4.4 Is the design output verified to determine if the input requirements are met?
  - 4.5 Are design changes appropriately reviewed, controlled, and documented?
  
- 5. Document control**
  - 5.1 Is the generation of all quality and production-related documents controlled?
  - 5.2 Is the distribution of such documents controlled?
  - 5.3 Are changes to documents controlled?
  - 5.4 Are obsolete documents promptly removed from all points of issue and use?
  
- 6. Purchasing**
  - 6.1 Are potential subcontractors and subsuppliers evaluated for their ability to provide the stated requirements?
  - 6.2 Are the requirements clearly defined in contract documents and data?
  - 6.3 Is the effectiveness of the subcontractor's quality assurance system assessed?

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<sup>2</sup> Adapted from a summary of ANSI/ASQC Q91 requirements authored by Dennis Arter, Columbia Quality Inc., Pasco, WA

**7. Product identification and traceability**

- 7.1 Is the product identified by item and batch, or lot, during all stages of production, delivery, and installation?
- 7.2 Is the product uniquely identified in relation to any required traceability to specifications or standards?

**8. Process control**

- 8.1 Are production processes defined, planned, and documented?
- 8.2 Is production performed under controlled conditions that include (a) documented work instructions, (b) in-process controls, (c) approval of processes and equipment, and, (d) establishment of criteria for workmanship?
- 8.3 Are processes that cannot be verified after production monitored and controlled throughout the processes?
- 8.4 Are production records adequately prepared and maintained?

**9. Inspection and testing**

- 9.1 Is incoming material inspected, tested, or otherwise verified before use?
- 9.2 Is in-process inspection and verification (where required) performed and documented?
- 9.3 Is final inspection and testing performed prior to release of the finished product?
- 9.4 Are the results of inspection and testing adequately documented and maintained?

**10. Inspection, measuring, and test equipment**

- 10.1 Are all items of equipment and instruments controlled, calibrated, and maintained?
- 10.2 Are the required measurements identified and documented?
- 10.3 Are the required instruments and test equipment adequately identified?
- 10.4 Is their calibration and maintenance status affixed to the items and contained in an adequate *calibration and maintenance file*?
- 10.5 Are periodic independent in-test parameters performed?
- 10.6 Are between-calibration verification checks performed?
- 10.7 Is the validity of measurements assessed when out-of-calibration conditions are found?
- 10.8 Are the environmental conditions properly maintained and monitored in metrology laboratories?
- 10.9 Are the measurement uncertainties of test equipment and instruments known and documented?
- 10.10 Whenever software is used as a part of the in-process or final testing procedures, is it periodically and adequately checked?

**11. Inspection and test status**

- 11.1 Is the status of inspections and tests maintained for production items as they progress through various processing stages?
- 11.2 Are records maintained to indicate the person who released conforming product at all pertinent stages?

**12. Control of nonconforming product**

- 12.1 Are the measures to control nonconforming product adequate to prevent inadvertent use or installation?
- 12.2 Is nonconforming product adequately segregated?
- 12.2 Are there documented policies and procedures for the review and disposition of nonconforming product?



- 13. Corrective action**
- 13.1 Are there documented procedures for identifying the causes of nonconforming product?
- 13.2 Are there documented procedures for assuring that corrective actions are taken for nonconforming product?
- 13.3 Are records of nonconforming product, of the causes, and of the corrective actions taken, adequately maintained?
  
- 14. Handling, storage, packaging, and delivery**
- 14.1 Are procedures for handling, storage, packaging, and delivery developed, documented and maintained?
- 14.2 Are handling controls adequate to prevent damage and deterioration?
- 14.3 Is product in stock periodically checked? Is the storage secure?
- 14.4 Are delivery controls used to maintain the integrity of the product between the factory and the delivery point?
  
- 15. Quality records**
- 15.1 Are the quality records adequately identified, collected, indexed, filed, stored, maintained and eventually disposed of?
  
- 16. Internal quality audits**
- 16.1 Are procedures of performing internal quality audits documented?
- 16.2 Are audits planned and performed?
- 16.3 Are the results of internal audits communicated to top management?
- 16.4 Are procedures for corrective action documented? Are deficiencies found corrected?
- 16.5 Are records of deficiencies and corrective actions maintained?
  
- 17. Training**
- 17.1 Are training needs identified and documented? Is training provided?
- 17.2 Is cross-training provided?
- 17.3 Are records of training maintained?
  
- 18. Servicing**
- 18.1 Are written procedures available for servicing activities? Are they used?
- 18.2 Does the service provided meet the relevant specifications and requirements?

## **PV-2 Appendix 3**

**Specimen for initial questionnaire for factory assessment**  
(reproduced from Appendix 1 of Annex B from ISO/IEC Guide 28)

## Appendix 1 to annex B

### Specimen<sup>1)</sup> for initial questionnaire for factory assessment

Annex to application .....

This questionnaire should be filled in and returned together with the application form. It is intended to provide preliminary information relative to the applicant and his capability to control the quality and continuing conformance of his products to the requirements of relevant specifications.

This document will be used by the certification body's inspection staff during preliminary visits to the factory or factories involved as a part of the initial inspection.

Supplements may be included where it is necessary to expand any statements.

A separate document should be completed for each factory involved, or variations between factories clearly indicated.

The statements should relate to the facilities available as the date of completion of this form.

The information given in this document will be treated in the strictest confidence.

Information on the following subjects will furthermore facilitate the treatment of the application.

Date sample is available for evaluation :

Will this be production or prototype sample?

If prototype, when is production scheduled?

Has product been tested to the standard? (if so please attach report) :

Urgency of application.

#### INDEX

Section 1 — Factory organization

Section 2 — Materials, components and services

Section 3 — Manufacture

Section 4 — Quality control and testing

Section 5 — Records and documentation

Section 6 — Application of indications of conformity

## Section 1 — Factory organization

### 1.1 Procedures/paperwork

Please give following information on basic system

1.1.1 Do you produce against orders or for stock?

1.1.2 Do you issue a Works Order or equivalent?

<sup>1)</sup> This specimen was selected from a current national practice; no attempt was made to harmonize the wording with the main part of this Guide. The specimen can be adapted in accordance with the actual situation for a given scheme.

## ISO/IEC GUIDE 28-1982 (E)

- 1.1.3 If so does this identify a batch as a separate entity?
- 1.1.4 Do products and/or containers carry Works Order identification in manufacture?
- 1.1.5 If not how does system allow for products to be isolated in case of doubtful quality?
- 1.1.6 Please give any other relevant information on basic system

### 1.2 Quality control/inspection staff

Please give following information on factory QC staff organization :

- 1.2.1 Head of Quality Assurance
- 1.2.2 Reporting to?
- 1.2.3 Is there a separate QC/Inspection Dept?
- 1.2.4 If so indicate
  - 1.2.4.1 Chief Inspector if different from 1.2.1
  - 1.2.4.2 If staff are aware of the tests in the relevant standard(s)
- 1.2.5 Are storeman/production operators responsible for inspection and test on
  - 1.2.5.1 Materials?
  - 1.2.5.2 In process operations?
  - 1.2.5.3 Final product?
- 1.2.6 If so are they monitored by QC staff?
- 1.2.7 Are Quality Audit checks carried out and by whom?
- 1.2.8 Please give any other information on QC staff organization

## Section 2 – Materials, components and services

### 2.1 Purchase specifications/materials quality assurance

Please detail main materials purchased, specification used and major suppliers involved.

Please also give quality assurance methods adopted on receipt of materials, components, or services, indicating action taken on rejects.

## Section 3 – Manufacture

### 3.1 System

Please detail various steps in manufacture – a production schedule and/or supplement in chart form showing stages may be advantageous.

### 3.2 Maintenance system plant and equipment

What maintenance system is in operation?

## Section 4 — Quality control and testing

### 4.1 System

Please detail Quality Control system, including sampling system followed, with particular reference to the tests in the relevant standard. A QC schedule or supplement cross-referenced to chart required in 3.1 is advantageous.

Please attach any QC manual or instructions on Quality Control issued to staff.

### 4.2 Test equipment/instruments, gauges and tools

Please detail test equipment used, makers' names and references, and indicate system and frequency of checking and if certificates are available.

## Section 5 — Records and documentation

### 5.1 General

5.1.1 Please indicate form of master specification, i.e. drawings, product/parts schedule, reference sample, etc. Also indicate other general records available.

5.1.2 Please indicate system used to amend design/specification.

### 5.2 Compliance — Specification

5.2.1 Please indicate level of defectives found in past six months. If tests in accordance with the relevant standard(s) have already been carried out, attach copies of summary of test results if available.

5.2.2 Please indicate the level of claims/complaints made under warranty and/or otherwise and give also as a percentage of total output.

5.2.3 Have independent tests been made on products against the standard? By whom? Please attach copies if available.

## Section 6 — Application of indications of conformity

### 6.1 Mark of conformity

Please attach an illustration if available and indicate method, e.g. special label, embossing, etc., which will be used to show mark of conformity. Please indicate at which stage of manufacture the mark of conformity will be applied.

### 6.2 Certificate of conformity

Please attach an illustration of the proposed format and indicate at which stage of manufacture or shipment the certificate is issued. A specimen certificate is reproduced in appendix 2 by way of an example.

**PV-2 Appendix 4**

**Application for conformity certification by use of certificates or mark of conformity**  
(reproduced from Annex B of ISO/IEC Guide 28)

## Annex B

Specimen of form for  
APPLICATION for CONFORMITY CERTIFICATION  
BY USE OF CERTIFICATES OR MARK OF CONFORMITY

To be sent to ..... (Certification body)

Address :

Information regarding the applicant :

The applicant's name and address of registered office :	Phone and telex numbers :
Name and title of person responsible for the quality management system :	Manufacturing place of the product :
Business address :	
Phone and telex numbers :	

Designation of product for which conformity certification is requested :

Description of products : (see first two columns of specimen licence — appendix 1 to annex C)	Relevant standard(s) Number : Title : Date of issue :	Relevant Specific Rules Number : Title : Date of issue :
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Statement : \*            We herewith declare that we will settle the costs related to this application.

Statement : \*            We herewith declare to be willing, on a positive result of the initial testing and inspection, to conclude within a specified time an agreement related to the certification of the products mentioned above.

Date of application .....

Name and title of person authorized to sign on behalf of the applicant :

.....  
(In block letters)

Signature .....

\* (Examples)

**PV-2 Appendix 5**

**Specimen of a licensing agreement for the use of a certificate or mark of conformity**  
(reproduced from Annex C of ISO/IEC Guide 28)



## Annex C

### Specimen of a licensing agreement for the use of a certificate or mark of conformity

The ..... Certification Body, having its registered offices at ....., hereinafter referred to as the certification body and represented in this matter by ..... (name), ..... (title) ....., hereby grants to ....., having its registered offices at ....., hereinafter referred to as the licensee, licence to certify the products covered by the appended licence, as approved by the certification body for such products specified in the first column of the valid licence which are controlled by the licensee in accordance with the standards referred to in the second column and the Specific Rules referred to in the third column of the valid licence and on the conditions of the following general agreement.

#### Article 1 : Regulations for certification and inspection

The stipulations of the *General Rules for the certification system* (in question) apply to this agreement as well as the standard(s) and the Specific Rules, specified in the attached licence.

#### Article 2 : Rights and obligations

**2.1** The licensee agrees that the certified products manufactured and supplied by him as specified in the licence based on and attached to this agreement will comply with the requirements stated in the standards and General and Specific Rules specified in the licence. Accordingly, the certification body authorizes the licensee to certify the products covered by the licence, as stated in the Specific Rules of the scheme.

**2.2** The licensee agrees that the persons representing the certification body will have unobstructed access without prior notification to the premises of the factory covered by the licence during the normal working hours of the factory involved.

**2.3** The licensee agrees that the products for which the licence is granted will be produced to the same specifications as the sample that the certification body found by the initial testing to be in compliance with the standard.

#### Article 3 : Surveillance

**3.1** The certification body carries out a continuing surveillance on the licensee's compliance with his obligations, in accordance with the conditions stated in the *General Rules for the certification system* and the Specific Rules for the scheme as specified in the licence.

**3.2** This surveillance is carried out by the certification body employees or by employees of agencies on behalf of the certification body.

#### Article 4 : Information on modifications in production

The licensee shall inform the certification body of any intended modification in the product, the manufacturing process or the quality management system.

#### Article 5 : Complaints

The licensee shall upon request of the certification body keep records and report to the certification body any complaints regarding those aspects of the products covered by the licence.

#### Article 6 : Publicity

**6.1** The licensee has the right to publish that he has been authorized to certify the products to which the licence applies.

**6.2** Among other methods the certification body gives publicity to the authorization of certifying compliance with a standard in the public journal ..... and to cancellation of this agreement with the licensee, as appropriate.

**Article 7 : Confidentiality**

The certification body is responsible for seeing that confidentiality is maintained by its employees concerning all confidential information with which they become acquainted as a result of their contacts with the licensee.

**Article 8 : Payment**

8.1 The licensee shall pay to the certification body all expenses in relation to the surveillance, including test, inspection and administration costs.

**Article 9 : Agreement period**

This agreement comes into force on ..., and remains in force until ... unless withdrawn for justified reasons or cancelled by either party upon due notice given to the other party.

**Article 10 : Withdrawal/cancellation of licence**

If withdrawal/cancellation of the licence comes into question, the necessary time of notice prior to the withdrawal/cancellation will differ due to the situation that causes it.

Depending on the reason for the withdrawal/cancellation the following schedule of notice will be followed :

**Situation requiring the dispatch of notice that can lead to withdrawal/cancellation**

**Days of notice prior to withdrawal/cancellation**

Manufacturer's wish to cancel :

to be specified by the certification body

The certification body determines that the product is hazardous :

none

Violation of an existing standard, for other reasons than safety :

max. 60 days

Non-payment of charges to certification body :

max. 30 days

Failure to meet other provisions of the licensing agreement :

max. 60 days

Mandatory compliance with new requirements in relation to revision of a standard :

Negotiable

Advice of cancellation shall be sent by registered letter (or equivalent means) to the other party, stating the reasons and the date of termination of the agreement.

**Article 11 : Modification of product requirements**

11.1 If the requirements applying to the products covered by this agreement are modified, the certification body shall immediately inform the licensee by registered letter (or equivalent means), stating at what date the modified requirements will become effective, and advising him of any need for a supplementary examination of the products which are subject to this agreement.

11.2 Within a specified period of time after receipt of the advice described in paragraph 11.1, the licensee shall inform the certification body by registered letter (or equivalent means) whether he is prepared to accept the modifications. If the licensee gives confirmation within the specified period of his acceptance of the modification and provided the result of any supplementary examination is favourable, a supplementary licence will be issued or other modifications of the certification body's records.

11.3 If the licensee advises the certification body that he is not prepared to accept the modification within the time specified in accordance with 11.2 or if he allows the terms for acceptance to lapse, or if the result of any supplementary examination is not favourable, the licence covering the particular product shall cease to be valid on the date on which the modified specifications become effective to the certification body, unless otherwise decided by the certification body.

**Article 12 : Liability**

[To be specified in connection with the relevant legal systems.]

**Article 13 : Appeal/dispute**

All disputes that may arise in connection with this agreement are to be settled in accordance with the appeal procedures of the certification body.

\_\_\_\_\_

Issued in duplicate and signed by authorized representatives of the certification body and the applicant.

For the certification body :

For the applicant :

Date .....

Date .....

.....  
(Signature) (title)

.....  
(Signature) (title)

SPECIMEN

**PV-2 Appendix 6**

**Specimen of form for a license for the use of the certificates or mark of conformity**  
(reproduced from Appendix 1 of Annex C from ISO/IEC Guide 28)

**Appendix 1 to annex C**

**Specimen of form for a licence for the use of the certificates or mark of conformity**

[An illustration of the certificate or mark of conformity is to be attached to this form or may be inserted here]

Licence No. .... to Agreement No. ....

Issued by ..... (certification body)

To ..... (licensee)

Products for which the licence is granted	Cat. no., type or other descriptive identifiers	Standard(s)	Specific rules

Date of issue .....

Signed for Certification Body .....  
(signature) (title)

**Annex C**

**PV-3. Testing Requirements for a Certification and Labeling Program for  
Photovoltaic Modules**

## DOCUMENT PV-3, Rev d

### Testing Requirements for a Certification and Labeling Program for Photovoltaic Modules

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## FOREWORD

This document sets forth the testing and reporting requirements for qualification testing and *baseline performance value* measurements of photovoltaic (PV) modules that may be used in support of a PV module certification and labeling program. The test methods and procedures chosen for this purpose have all been promulgated through consensus standards development procedures in relevant committees of the Institute of Electrical and Electronics Engineers (IEEE), the American Society for Testing and Materials (ASTM), or the International Electrotechnical Commission (IEC).

The requirements presented are taken largely from IEEE 1262 and ASTM E 1036 (see Sections 3.14 and 3.5). To the extent that other specific ASTM test methods are referenced in certain IEEE 1262 test procedures adopted in these requirements, the so-referenced ASTM standards are hereby incorporated as mandatory test requirements for the purposes of this document.

The test methods and procedures presented represent the minimum testing requirements for any product certification and labeling programs that may be developed for photovoltaic modules. Additionally, these test procedures and the concomitant equipment and facilities requirements represent the minimum test capabilities against which laboratories should be evaluated for testing in support of any module certification and labeling programs.

This document is one of a series of three documents that together are intended to address the totality of the criteria and requirements for a PV module testing, certification, and labeling program. The other two documents in this series are:

- PV-1 Criteria for a Model Quality System for Laboratories Engaged in Testing Photovoltaic Modules
- PV-2 Model for a Third-Party Certification and Labeling Program for Photovoltaic Modules



## **1. Introduction**

### **1.1 Purpose**

- 1.1.1 The purpose of this document is to delineate the testing requirements for a photovoltaic module certification and labeling program.
- 1.1.2 These testing requirements represent the minimum requirements against which photovoltaic modules shall be evaluated in terms of (a) their quantitative response to electrical performance-based tests and (b) their qualitative response to environmental and mechanical tests.
- 1.1.3 These test procedures represent the minimum capabilities against which laboratories shall be assessed and accredited in accordance with Document PV-1 for testing in support of a photovoltaic module certification and labeling program.

### **1.2 Scope**

- 1.2.1 The testing requirements set forth in this document shall be used for the evaluation of terrestrial flat-plate photovoltaic modules intended for power-generating applications. These requirements are not intended for use in the testing and evaluation of photovoltaic solar-concentrator modules.
- 1.2.2 This document sets forth the minimum requirements with which photovoltaic modules shall comply to demonstrate their ability to meet the overall performance requirements of the certification program.
- 1.2.3 These requirements also represent the minimum standards with which laboratories selected by manufacturers shall comply and operate to demonstrate their competence to test photovoltaic modules<sup>1</sup>.
- 1.2.4 Guidelines for equipment and apparatus required are included in Appendix 1 of this document. Guidelines for the management of the testing laboratory are discussed in Appendix 2.
- 1.2.5 The actual electrical performance and lifetime expectancy of modules tested, certified, and labeled under the provisions of this document will depend on their design, the environment in which they are deployed, and other conditions under which they are operated. Lifetime expectancy is not within the scope of this document.

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<sup>1</sup> Laboratories accredited in accordance with Document PV-1 are required to demonstrate their compliance to the general criteria of Document PV-1 in terms of their quality system and to the specific criteria required by Document PV-1 and set forth in this Document (PV-3).

## 2. Definitions

- 2.1 Terms defined in this section are relevant to photovoltaic module testing. Terms defined in Documents PV-1 and PV-2 are incorporated by reference.
- 2.1.1 *Air mass (AM)*: The ratio of the mass of atmosphere in the actual observer-sun path to the mass that would exist if the observer was at sea level, at standard barometric pressure, and the sun was directly overhead. Note—(sometimes called air mass ratio.) Air mass varies with the zenith angle of the sun and the local barometric pressure, which changes with altitude. For sun zenith angle,  $Z$ , of  $62^\circ$  or less and local atmospheric pressure,  $P$ , where  $P_0$  is standard atmospheric pressure,  $AM = \sec Z(P/P_0)$ . [ASTM E 772]
- 2.1.2 *AM 1.5 standard reference spectrum*: The solar spectral irradiance distribution (diffuse and direct) incident at sea level on a sun-facing  $37^\circ$  tilted surface. The atmospheric conditions for AM 1.5 are: precipitable water vapor, 14.2 mm; total ozone, 3.4 mm; turbidity (base e,  $\lambda = 0.5$  mm), 0.27. [ASTM E 892, Table 2]
- 2.1.3 *Baseline Performance Value*: Initial values of  $I_{SC}$ ,  $V_{OC}$ ,  $P_{MP}$ ,  $V_{MP}$ ,  $I_{MP}$  measured by the accredited laboratory and corrected to Standard Test Conditions, used to validate the manufacturer's performance measurements provided with the qualification modules per IEEE 1262.
- 2.1.4 *Blocking diode*: A diode used to restrict or block reverse current from flowing backward through a module. [UL 1703]
- 2.1.5 *Bypass diode*: A diode connected across one or more solar cells in a photovoltaic module such that the diode will conduct if the cell(s) become reverse biased. [UL 1703]
- 2.1.6 *Current at maximum power ( $I_{MP}$ )*: The current at which maximum power is available from a module (for the purpose of this document, the "rated" current at maximum power will be defined as  $I_{MP}$  at STC). [UL 1703]
- 2.1.7 *Interconnect*: A conductor within a module or other means of connection which provides an electrical interconnection between the solar cells. [UL 1703]
- 2.1.8 *I-V data*: The relationship between current and voltage of a photovoltaic device in the power-producing quadrant, as a set of ordered pairs of current and voltage readings in a table, or as a curve plotted in a suitable coordinate system (i.e., Cartesian). (ASTM E 1036)
- 2.1.9 *Maximum power ( $P_{MP}$ )*: The point on the current-voltage (I-V) curve of a module under illumination, where the product of current and voltage is maximum. For the purpose of this document, "rated" power is defined as  $P_{MP}$  at STC. [UL 1703]
- 2.1.10 *PV module (flat-plate)*: The smallest environmentally protected, essentially planar assembly of solar cells and ancillary parts, such as interconnections, terminals, [and

protective devices such as bypass diodes] intended to generate dc power under unconcentrated sunlight. The structural (load carrying ) member of a module can either be the top layer (superstrate), or the back layer (substrate). [UL 1703]

- 2.1.11 *Qualification test (PV)*: A procedure applied to a selected set of PV modules involving the application of defined electrical, mechanical, or thermal stress in a prescribed manner and amount. Test results are subject to a list of defined requirements.
- 2.1.12 *Standard Reporting Conditions (SRC)*: A fixed set of conditions (including meteorological) to which the electrical performance data of a photovoltaic module are translated from the set of actual test conditions. [ASTM E 1036]
- 2.1.13 *Standard Test Conditions (STC)*: Conditions under which a module is typically tested in a laboratory: (1) Irradiance intensity of  $1000 \text{ W/m}^2$ , (2) AM1.5 solar reference spectrum [see Section 2.1.2], and (3) a cell (module) temperature of  $25 \pm 2^\circ\text{C}$ . [IEC 1215]
- 2.1.14 *Test sequence*: A set of one or more qualification tests applied in a specified order to a selected group of PV modules.
- 2.1.15 *Voltage at maximum power ( $V_{MP}$ )*: The voltage at which maximum power is available from a module. (For the purpose of this document, the “rated” voltage at maximum power will be defined as  $V_{MP}$  at STC). [UL 1703]

### 3. References

- 3.1 ANSI/IEEE 928-1986:  
“Recommended Criteria for Terrestrial Photovoltaic Power Systems.”
- 3.2 ASTM E 772:  
“Standard Terminology Relating to Solar Energy Conversion.”
- 3.3 ASTM E 892:  
“Standard Tables for Terrestrial Solar Spectral Irradiance at Air Mass 1.5 for a  $37^\circ$  Tilted Surface”, Table 2.
- 3.4 ASTM E 927:  
“Standard Specification for Solar Simulation for Terrestrial PV Testing.”
- 3.5 ASTM E 1036:  
“Standard Test Methods for Electrical Performance of Nonconcentrator Terrestrial Photovoltaic Modules and Arrays Using Reference Cells.”
- 3.6 ASTM E 973:  
“Standard Test Method for Determination of the Spectral Mismatch Parameter Between a Photovoltaic Device and a Photovoltaic Reference Cell.”

- 3.7 ASTM E 1038:  
“Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls.”
- 3.8 ASTM E 1171:  
“Standard Test Method for Photovoltaic Modules in Cyclic Temperature and Humidity Environments.”
- 3.9 ASTM E 1362:  
“Standard Test Method for Calibration of Nonconcentrator Photovoltaic Secondary Reference Cells.”
- 3.10 ASTM E 1462:  
“Standard Test Methods for Insulation Integrity and Ground Path Continuity of Photovoltaic Modules.”
- 3.11 IEC TC 82 (Secretariat) 120:  
“Thin-Film Silicon Terrestrial Photovoltaic (PV) Modules—Design Qualification and Type Approval” (draft international standard).
- 3.12 IEC 68-1:  
“Basic Environmental Test Procedures”, 1988.
- 3.13 IEC 1215:  
“Crystalline Silicon Terrestrial Photovoltaic (PV) Modules—Design Qualification and Type Approval.”
- 3.14 IEEE 1262:  
“Recommended Practice for Qualification of Photovoltaic (PV) Modules” (draft PAR).<sup>2</sup>
- 3.15 JPL 5101:  
Jet Propulsion Laboratory, JPL 5101-161, Pasadena, CA, 1981, “Block V Solar Cell Module Design and Test Specification for Intermediate Load Applications.”
- 3.16 SERI IQT:  
Solar Energy Research Institute (SERI), Golden, CO, TR-213-3624, 1990, “Interim Qualification Tests and Procedures for Terrestrial Photovoltaic Thin-Film Flat-Plate Modules.”
- 3.17 UL 1703:  
Underwriters Laboratories Inc., UL Standard 1703, Second Edition, May 7, 1993, “Standard for Safety, Flat-Plate PV Modules and Panels.”
- 4. General test plan and sequence of testing**
- 4.1 Conduct module qualification tests in accordance with IEEE 1262, Figure 4-1—Qualification Test Program

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<sup>2</sup> Contact Laxmi Mrig, NREL, 1617 Cole Boulevard, Golden, CO 80401-3393

## 5. Module qualification and performance tests<sup>3</sup>

### 5.1 General test and inspection procedures

- 5.1.1 The sequence of testing and inspection procedures listed are in the same order as described in the sequence of tests presented in Figure 4.1 of IEEE 1262. No significance should be attached to the order in which the test methods are presented in the following sections with respect to the importance of their suitability to photovoltaic modules for their intended applications.
- 5.1.2 When modifications to the IEEE 1262 test and inspection procedures are not required for the purposes of this document, these unmodified portions of the standard shall be complied with in full as if they were repeated herein in their entirety.
- 5.1.3 When modifications to the referenced test and inspection procedures adopted from IEEE 1262 are required for the purposes of this document (as defined in Section 6.2), all unmodified subparagraphs of the referenced sections of such standards shall be complied with in full as if they were repeated herein in their entirety.

### 5.2 Modifications to specific tests defined by IEEE 1262

- 5.2.1 IEEE 1262: Where referred to as *Baseline measurements*, replace paragraph 5.2, *Electrical-Performance Test*, with PV-3 Section 5.2.1.1, *Baseline Performance Value Test*, and replace all other references to paragraph 5.2 with PV-3 Section 5.2.1.2, *Electrical-Performance Test*:

#### 5.2.1.1 Baseline performance value test

**PURPOSE:** The purpose of this test is to verify that the manufacturer's measured I-V curve data (i.e.,  $I_{SC}$ ,  $V_{OC}$ ,  $P_{MP}$ ,  $V_{MP}$ ,  $I_{MP}$ ) are within  $\pm 5\%$  of the testing laboratory's measurements for each of the nine modules required by IEEE 1262.

**PROCEDURE:** Clean the module's optical surface prior to the electrical performance measurements. Measure the I-V curve for each module in accordance with ASTM E 1036. Translate the performance data to the following standard reporting conditions: 25°C module temperature, 1000 W/m<sup>2</sup> total irradiance, and ASTM E 892 (Table 2) global spectral irradiance (i.e., Standard Test Conditions, STC). From the corrected data, determine and record  $I_{SC}$ ,  $V_{OC}$ ,  $P_{MP}$ ,  $V_{MP}$ , and  $I_{MP}$ . The light source may be natural sunlight or a solar simulator. The light source must meet the requirements of a Class A solar simulator as specified by ASTM E 927. Spectral mismatch error corrections shall be made to the measured data per ASTM E 973). Because the results of

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<sup>3</sup> Because IEEE 1262 is a draft document and not yet a published standard, the section numbers referenced here and elsewhere in Document PV-3 are subject to change. Document PV-3 may need to be updated in the future to reflect any such changes.

these qualifications tests depend on the electrical performance measurements to determine the magnitude of any degradation of module output power, use the same measurement system (including the light source and reference cell) for I-V curve measurements throughout the test sequences.

Reference cells used for these tests shall have the same optical and electrical properties as the modules under test. Such reference cells shall have been calibrated by a minimum of two qualified laboratories<sup>4</sup> per ASTM E 1362 using the ASTM E 892 (Table 2) global reference spectrum. The calibration constants shall agree within  $\pm 2.0\%$  of the average value. If these reference cells are used at cell temperatures outside the temperature range of 23° to 27°C, the temperature coefficient of the calibration constant shall have also been measured by the two qualified laboratories, and the values shall agree within  $\pm 5\%$  of the average value. The average value of the calibration constant and temperature coefficient measured by the qualified laboratories shall be considered the true value.

**REQUIREMENT:** Values of factory measured power must be within  $\pm 5\%$  of the testing laboratory's values of measured power for all nine modules tested.

#### 5.2.1.2 Electrical-performance test

**PURPOSE:** The purpose of this test is to characterize the electrical performance of test modules and to determine each module's peak output power.

**PROCEDURE:** Clean the module's optical surface prior to the electrical performance measurements. Determine the module's maximum power point in accordance with ASTM E 1036. Correct the performance data to the following standard reporting conditions: 25°C module temperature, 1000 W/m<sup>2</sup> total irradiance, and ASTM E 892 (Table 2) global spectral irradiance (i.e., Standard Test Conditions, STC). The light source may be natural sunlight or solar simulator. The light source must meet the requirements of a Class A solar simulator as specified by ASTM E 927. Spectral mismatch error corrections shall be made to the measured data per ASTM E 973). Because these qualification tests depend on the electrical performance measurements to determine the magnitude of any degradation of module output power, use the same measurement system (including the light source and reference cell) for I-V curve measurements throughout the test sequences.

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<sup>4</sup> The requirements of a "qualified" laboratory shall be determined by the certification body.

**REQUIREMENT:** Initial test data recorded in 5.2.1.1 shall be used as the established baseline electrical output power that will serve as the comparison value for determination of the effects of qualification testing on electrical performance.

For intermediate and final performance tests, the maximum power measured for each module tested shall not be less than 90% of the initial baseline power measured by the testing laboratory. Exception: Amorphous silicon modules must meet the manufacturer's minimum rated power output, following the UV and Outdoor Exposure tests.

## **6. Reporting**

- 6.1 Test results shall cover all of the test requirements and shall be made available only to the certification body and the manufacturer.
- 6.2 The testing laboratory's values for the following parameters shall be reported for the purpose of establishing a baseline performance value for:  $I_{SC}$ ,  $V_{OC}$ ,  $P_{MP}$ ,  $V_{MP}$ , and  $I_{MP}$  for each module tested. These values shall be compared with the corresponding factory module data. Factory data for all nine modules shall be within five percent ( $\pm 5\%$ ) of the testing laboratory's values.<sup>5</sup>
- 6.3 When a module cannot be subjected to some aspect of a test required by Document PV-3, the circumstances shall be documented and reported. As an example, consider the case in which the module is too rigid to perform the twist test. The Test Report then must clearly state this omission and explain the reason and any subsequent implications and ramifications. It will be up to the certification body to resolve such issues with the manufacturer, which may require the manufacturer to state the ramifications in the installation manual.

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<sup>5</sup> Paragraph 6.2 of Document PV-3 was added after the final draft of Document PV-3 was reviewed by the criteria development committee.

## **PV-3 Appendix 1**

### **Equipment and Apparatus Required for PV Module Testing and Certification**



**Figure A1-1. Equipment and Apparatus Required for PV Module Testing and Certification**

Item No.	Requirement for Apparatus Per IEEE 1262:	Equipment Required	Requirements Defined By:	Notes
A.1	5.1 Visual Inspection	Camera	IEEE 1262: § 5.1	Documentation of visual defects
A.2	5.2.1 and 5.2.2 Electrical Performance Tests	Source of irradiance I-V curve tracer Reference cell, DMMs, Temperature sensors	IEEE 1262: § 5.2 ASTM E 1036 ASTM E 892, ASTM E 927 PV-3: ¶ 5.2.1.1 and 5.2.1.2	Multijunction subcells require a Class A solar simulator per ASTM E 927
A.3	5.3 Ground Continuity Tests 5.4 Electrical Isolation (Dry Hi-Pot) Tests 5.6 Wet Hi-Pot Tests	Variable dc power supply Ground path continuity tester Ohmmeter Metallic contacts Test stand Immersion tray (wet hi-pot)	IEEE 1262: § 5.3, 5.4, 5.6 ASTM E 1462: § 6	
A.4	5.5 Wet Insulation Resistance Tests	Megger or equivalent	IEEE 1262: § 5.5	
A.5	5.7 Thermal Cycle Tests 5.8 Humidity Freeze Cycle Test	Chamber(s) Temperature measuring and recording device Test base	IEEE 1262: § 5.7 and 5.8 ASTM E 1171	
A.6	5.9 Robustness of Terminations	Torque wrench Tensile strength gauge	IEEE 1262: § 5.9 UL 1703: Sec. 28	
A.7	5.10 Twist Test	Test fixture Continuity tester	IEEE 1262: § 5.10	
A.8	5.11.1 Static Mechanical Load Test	Rigid test structure Continuity tester 2400 Pa uniform static load	IEEE 1262: § 5.11.1	
A.9	5.11.2 Dynamic Mechanical Load Test	Rigid test structure Continuity tester 1440 Pa uniform dynamic load	IEEE 1262: § 5.11.2 UL 1703: § 39	
A.10	5.12 Surface-Cut Susceptibility Test	Cut test tool (e.g. UL 1703, Fig. 23.1)	IEEE 1262, ¶ 5.5 UL 1703: § 24	
A.11	5.13 Damp Heat Test	Chamber(s)	IEEE 1262: § 5.13	

**Figure A1-1. Equipment and Apparatus Required for PV Module Testing and Certification (continued)**

<b>Item No.</b>	<b>Requirement for Apparatus Per IEEE 1262:</b>	<b>Equipment Required</b>	<b>Requirements Defined By:</b>	<b>Notes</b>
A.12	5.14 Hail-Impact Test	Ice-ball launcher and velocity measuring instrument	IEEE 1262: § 5.5 ASTM E 1038	
A.13	5.15 Bypass-Diode Thermal Test 5.15.1 Nonintrusive 5.15.2 Intrusive	Oven Temperature measuring instrument Constant current power supply Sample and hold voltmeter IR heat lamps	IEEE 1262: § 5.15	
A.14	5.16.1 Non-intrusive Hot Spot Endurance Test	Source of irradiance I-V curve tracer Temperature detector ammeter irradiance monitor	IEEE 1262: § 5.16	
A.15	5.16.2 Intrusive Hot Spot Endurance Test (Requires special test module)	Constant current/voltage power supply Source of irradiance (w/o IR) I-V curve tracer Temperature detector Voltmeter, ammeter Irradiance monitor IR heat lamps	IEEE 1262: § 5.16	
A.16	5.17 Ultraviolet Conditioning Test	Source of UV or sunlight UV radiometer Oven or module heater	IEEE 1262: § 5.17	
A.17	5.18 Outdoor Exposure Test	Solar irradiance monitor	IEEE 1262: § 5.18	
A.18	5.19 Annealing Procedure	Oven or module heater	IEEE 1262: § 5.19	

## PV-3 Appendix 2

### Laboratory Organization and Personnel

#### A2.1 Introduction

This section will provide guidelines to the organization, structure, and functional requirements for personnel needed to effectively manage and operate a PV qualification laboratory.

Economics will dictate the staff needs to be kept small, yet large enough to perform all tasks required by Documents PV-1 and PV-3. Because of the technical nature of the testing, combined with stringent requirements for documentation and conformance to standards, the staff will need to be multidisciplinary with extensive cross-training.

#### A2.2 Organization

A simplified organization chart for operation of a certification laboratory is shown in Figure A2-1. The number of people needed to fill each functional box will depend on the level of PV testing and other related businesses operated by the laboratory. During the formative stages, a total of two or three carefully selected staff members should be adequate to perform all tasks. During this period, certain functions, such as periodic equipment maintenance and certain of the facility requirements, will likely be contracted. The initial staff, being limited to a few individuals, will have to be highly trained, multidisciplined, and quite versatile.

#### A2.3 Functional Requirements

The functions needed to operate the laboratory depicted in Figure A2-1 are:

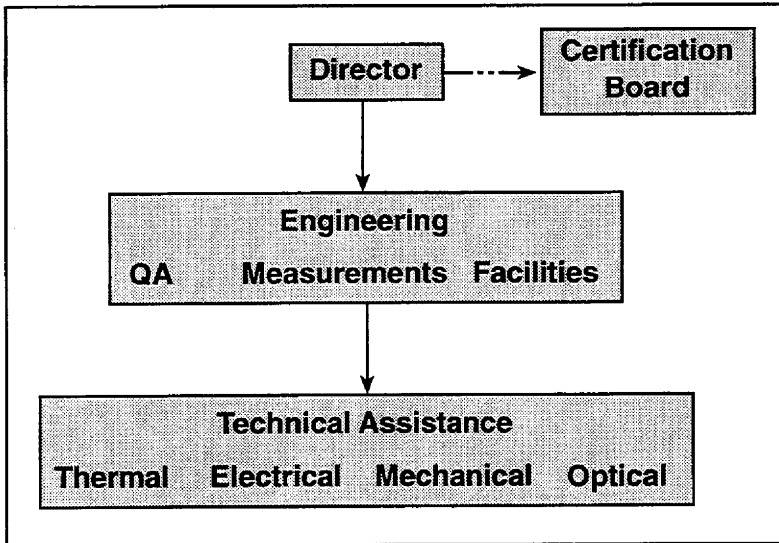
##### Director:

- Provides technical expertise, marketing, and leadership for the laboratory
- Provides customer interface
- Provides interface to the certification body
- Maintains contacts and information flow with government, industry, and organizations relevant to the laboratories' business
- Is responsible for the overall laboratory operation; sets and maintains laboratory policy
- Reviews all records and reports
- Sets and keeps budgets
- Plans the laboratory needs for personnel and equipment
- Reviews performance of the laboratory and its personnel.

##### Quality Assurance:

- Conducts and records all calibration functions
- Writes, maintains, and controls the quality manual
- Reviews all reports, and periodically checks data
- Conducts training
- Acquires, keeps, and maintains all physical standards and certificates
- Helps select and qualify laboratories for outside testing if such testing is required
- Establishes and maintains relationships with vendors

**Figure A2-1. Laboratory Organization**



- Provides interface and communications with engineering
- Conducts annual audit
- Is responsible for Plant Safety Program.

**Measurements Engineering:**

- Is responsible for all product testing
- Plans flow, logistics, and personnel requirements
- Prepares all technical reports
- Arranges and conducts special tests, i.e., round-robin
- Supervises outside testing and checks results
- Plans for and is responsible for equipment calibration
- Interfaces with quality assurance
- Provides technical training
- Establishes standards and reviews performance of laboratory personnel
- Provides interface and reacts to communications from quality assurance.

**Equipment/Facilities Engineering:**

- Maintains all equipment
- Provides for equipment installation or movement
- Provides periodic preventative and required maintenance
- Provides repair and service
- Keeps traceable records
- Maintains building/facility, including HVAC, support equipment/supplies, and cleaning function.

Laboratory Technician (Electrical, Thermal, Mechanical, Optical):

- Conducts assigned tests
- Monitors equipment and testing function
- Records and maintains data log
- Calibrates assigned equipment.

#### **A2.4 Operational Guidelines**

The total number of people on staff will depend on the level of testing and on other business the laboratory may conduct. Considering the cost-sensitive nature of the PV industry, and in the formative stages when the laboratory is gaining an experience base and credibility, it would be prudent to keep testing costs low. Operation of the laboratory during this stage should be characterized by a minimum staff of two or three people, with emphasis on automated, computerized equipment base. For economy and efficiency, a selected number of tests may be sent to qualified outside laboratories.

To obtain and maintain accreditation, the following guidelines are offered regarding organization, personnel and laboratory function:

- Maintain lines of responsibility and authority, especially in reporting to and interacting with the certification body.
- Maintain and provide good record keeping, especially on calibration, data log books, and certification and training of personnel.
- Follow and assure all safety regulations.
- Provide evidence of training and cross-training of technicians and equipment operators. Require that at least two people be trained for each major test or procedure.
- When subcontracting testing, ensure the qualification and competence of the subcontracting laboratory. Document these.
- Set a goal to initially subcontract no more than 50% of the tests in Figure A1-1, and after 3 years of operation, no more than 20%.
- Keep good records of customer communications, especially complaints and complaint resolution.
- Keep the quality assurance manual current and ensure that the stated quality system is in force.

## **Annex D**

### **The Criteria Development Process**

## **The Criteria Development Process**

### **1. Introduction**

Three drafts of each of the three documents (PV-1, PV-2 and PV-3) were sent to the 30 criteria development committee members for comment. Members often raised questions as they reviewed a draft document and submitted those questions with their comments on the document. Those questions, with answers, were included in a cover letter that accompanied the next draft document sent to members.

Two meetings of the committee were held at convenient times in conjunction with other PV standards meetings. Rather than spend time going through the documents line by line, these meetings were used to present tutorials on certification/accreditation and discuss unresolved issues concerning the documents.

The first committee meeting was held on March 16, 1994, in conjunction with an IEEE Standards Coordinating Committee 21 standards meeting in Tempe, Arizona. Seventeen committee members attended. Minutes of the first meeting are included here (without attachments).

The first hour of the 5-hour meeting was devoted to a tutorial by Gene Zerlaut on standard practices for "laboratory accreditation and product certification and labeling." During the next 3 hours, broad issues related to the photovoltaic module certification/laboratory accreditation criteria development program were discussed. Issues such as these were discussed "What does the PV industry need at this time?" "How does this program (and Documents PV-1, PV-2, and PV-3) fit those needs?" "What are the costs associated with certification/accreditation?" "Is the proposed program too complicated?" Details of Documents PV-1, PV-2 or PV-3 were not covered in this meeting. The last hour was devoted to developing the approach to Document PV-3.

One month prior to the meeting, committee members were asked to submit three questions, rank ordered, that they would like to have answered at the meeting. Seventeen questions were received and answered by a panel during the meeting. A summary of these questions and answers is included as Section 2 of this Annex.

A subcommittee of six members developed a conceptual definition of Document PV-3. This committee developed a variety of questions which were discussed at the second committee meeting. A summary of these questions and answers is included as Section 6 of this Annex.

The second committee meeting was held on June 30, 1994, as part of the annual NREL Standards and Codes Forum in Golden, Colorado. Eighteen of the 30 committee members, and eight nonmembers attended. The minutes of this meeting are included here (without attachments). The meeting was structured in a similar manner to the first meeting, with tutorials, question and answer period, and discussions regarding Document PV-3.

## 2. Questions and answers prior to the first committee meeting:

The following questions were submitted by committee members prior to the first committee meeting, March 16, 1994. Questions are organized by subject. The questions with numbered headings are questions received from different committee members that were answered collectively. These answers have the numbered headings.

### Subject: Costs associated with certification

- Q1:** What is the anticipated cost to the manufacturer for product certification?
- Q2:** What will such a program cost the industry and how does that compare to other industries?
- Q3:** What are the expected operating costs for an accredited laboratory, based on known standard tests and related equipment, liability insurance for product certification programs, staffing required to meet present industry or research activities, and fees associated with inspections and other requirements for maintaining accreditation?
- Q4:** What is the current cost by ISPRA [ESTI] to perform CEC 503 and what does/would it cost to provide certification and labeling for 503?
- A1:** It is premature to attempt to project costs of a PV Certification Program until a dialog has taken place between the manufacturers, NREL and DOE. The costs would first depend on the following major elements:
- Tests selected for certification (e.g., reliability, durability and electrical performance).
  - Relationship between certification body and test laboratory: e.g., same organization, two organizations, use of existing certification body, etc.
- A2:** More specific elements that will determine costs include the following:
- Test laboratory fees (set by test laboratory, or laboratories). It is pointed out that the laboratory accreditation fees would be amortized into the test costs, as would the cost of test instruments and equipment.
  - Manufacturer's costs, in addition to test laboratory fees, would depend on the type of certification body. Nonetheless, the application fee would logically include the costs of initial factory inspection and random selection (which ought to be done at the same time). Any costs for factory surveillance between re-testing requirements, if required by the certification body, would be an additional assessment.
  - Licensing fees, which are usually based on *sold units*. For example, units can be delivered watts, square feet (or meters), panels, etc.
- A3:** Laboratory accreditation costs are in the neighborhood of \$4000 to \$5000 every two years. This includes typical 3 to 4 day, one-assessor assessments at approximately \$650 per man-day, plus travel and living expenses, and about \$1500 to \$1800 application fees ... depending on the size of the laboratory.



**Subject: Structure of the certification program**

**Q:** Who Certifies the Certification Laboratory?

**A:** The Certification Laboratory may be accredited by one of the following processes:

- The Certification Body may choose to establish a laboratory accreditation program in accordance with document PV-1, and accredit the laboratory itself by selecting, or hiring, assessors to perform the audits required, or
- The Certification Body may establish a basic accreditation plan in accordance with document PV-1 and request that laboratories wishing to participate seek A2LA accreditation to PV-1, or
- The Certification Body may request NVLAP to establish a LAP, notice it in the Federal Register, and thereby end up with NVLAP accreditation (most expensive to labs of the three procedures), or
- If a Laboratory chooses to establish its own Certification Program around documents PV-2 and PV-3, it will have to obtain ANSI approval of its certification program and obtain A2LA accreditation on its own.

**Q:** Should we be certifying products or processes? (Aren't the process certifications already handled by ISO, etc.?)

**A:** The purpose of the Certification Program embodied in PV-2 is the certification of products. While this also entails ensuring that the manufacturer's quality system, e.g., its manufacturing processes, meet the standards, or criteria, enumerated in PV-2 (e.g., ¶ 6.2), the Certification Body may (and, we believe, ought to) accept registration to ISO 9001 in lieu of the inspection/assessment provisions of ¶ 6.2

However, registration to ISO 9001 is a much more laborious, time-consuming, and costly (fees-wise) process than would be the approval of the participant's quality system by the PV Certification Program.

**Q:** How will the proposed organizations listed in PV-1, PV-2 and PV-3 align with the existing industry structure and who will be ultimately responsible for governing these organizations? (e.g., what organization would provide the approval and oversight for the "Certification Body" described in PV-2A section 5?)

**A:** To the question of who will provide approval and oversight of the Certification Body, the answer is the Certification Body's Board of Directors, or Governing Board. See response to next question.

In reality, the PV Certification Program may be mandated, or otherwise required, by the purchasers of PV modules and systems. The industry ought not to want this mandate to come from government, or from any segment of society that might dictate the provisions, requirements and costs.

**Q:** Whom do you expect to be the certification body to operate the certification program?

**A:** It is too early in the processes of discourse on the subject of a PV Certification Program to mandate the operating group that ought to be selected and empowered, or formed, to manage the PV Certification Program. However, it would logically be either [1] a creation of an industry association (i.e., an existing industry trade association), [2] a new organization created by a group of *interested manufacturers*, or [3] a laboratory (who is desirous of being both the testing laboratory and the product certifier).

For reasons to be discussed, it may very well be that option [2] is the most attractive.

**Q:** If there are several accredited laboratories in the USA, will they be required to be uniformly equipped, or will accreditation be permitted for varying ranges of services?

**A:** It will be the prerogative of the Certification Body to determine whether it will accept a laboratory testing regimen for certification purposes that *requires* more than one laboratory. In a large sense, this will be

determined by the laboratories who consider themselves candidates for accreditation to test PV modules for the certification program.

**Q:** Could the *Photovoltaic Module Certification/ Laboratory Accreditation Criteria Development* program use existing ISO/IEEE/UL structure of documentation, auditors and certification labs?

**A:**

- ISO documents on conformity assessment and certification programs are embodied in PV-1 and PV-2 already. These are Guides 25, 38, 39, 54, and 55 in PV-1 and Guides 27, 28, 40, and 56 for PV-2.
- Neither ISO nor IEEE have auditors or certification laboratories.
- While UL operates one of the nation's largest product certification programs, it is our understanding that they are largely confined to issues of safety, and not performance and reliability/durability issues related to performance.

**Q:** Why are PV-1 and PV-2 documents so general, rather than being specific to PV modules, and how will they be useful considering that the ISO/IEC Guide 25, Guide 28 and associated Guides (22, 28, series 9000 documents already exist?

**A:** Laboratory accreditation is based on two sets of criteria. One relates to the lab's specific quality system (i.e., its structure, policies, documentation, records, internal controls, accountability, etc.), and the other relates to the lab's capabilities to perform the specific tests required by the Certification Body for certification. Document PV-1 relates to the first and is largely independent of the specific testing arena of interest. Document PV-3 will cover the tests required, etc. The job of the assessor, or assessors, is to determine compliance with document PV-1 from both the general criteria and specific test capabilities.

**Subject: Need for PV module certification**

**Q:** We would support the development of a system that separates the manufacturer's system certification from the module certification process. Presently the manufacturer's system certification can be accomplished through the internationally recognized requirements of ISO 9001. This structure is in place and frees the certification body to proceed with module qualification/ certification, its specialty.

**A:** Registration to ISO 9001 would most likely satisfy the requirements for factory inspection, but whether it does or not will be up to the Certification Body. However, to require ISO 9001 registration in lieu of factory inspection of the manufacturer's quality system will cost the manufacturer much more than to require development of a simpler quality system to meet PV certification. This statement assumes that the manufacturer is not *a priori* registered to ISO 9001.

**Q:** What does the US industry need in terms of Laboratories capable of PV module qualification and certification?

**A:** Initially, one laboratory with a few people and the requisite test facilities can handle the US PV industry.

**Q:** What are the metrics by which this program will be judged?

**A:** While *metrics* is the science of *writing in meter, or rhythm*, I assume the question to be "how will the success of the program be measured?" In my opinion, the most important criteria are:

- Will it lead to improved product within, for example, 5 years of operation?
- Will it lead to consumer and buyer confidence?
- Will it lead to increased markets?
- Will it be affordable to most PV manufacturers?

**Q:** What are the pitfalls of such a program or, in other words, how can it hurt the industry?

**A:** The main pitfalls are:

- A technically rigid test program could limit innovation.
- A too costly program might preclude entry or survival of marginal but innovative manufacturers.

**Q:** What is the expected capacity or number of testing laboratories in the USA, based on world markets and the possibility of specializing in testing for unique environments, etc.?

**A:** The American Association for Laboratory Accreditation currently has some 350 laboratories accredited in the US, of which a significant proportion are independent testing laboratories. If the business develops and laboratory testing for a PV certification program is not marginal, you can count on laboratories entering the PV test arena.

**Q:** Is the PV industry supporting the PV module certification and laboratory accreditation program development, and will it support PV module certification on a voluntary basis, at no cost or by fee payment?

**A:** Industry must answer this question.

**Subject: Module performance ratings**

**C:** We support the idea of an independent and accredited third party laboratory that can both qualify and certify that a module meets certain criteria. However, we strongly suggest that the issue of manufacturer's power measurement verification be addressed in order to make this laboratory certification truly useful to us.

**C:** Another important aspect of module certification would be the generation of standard power rating requirements. With these a user would be able to compare different modules with the same, or different, technologies both in the short term and in the longer time frame associated with the expected module life. Associated with this is to question how modules are presently rated and provide clear user oriented guidelines for module performance rating. (For instance,  $P_{max}$  @ 850 W/m<sup>2</sup>, 50°C along with the associated intensity and temperature coefficients.)

**3. Questions and answers prior to the second committee meeting:**

Questions and comments were received from committee members during the 4 weeks prior to the June 20, 1994, meeting.

**Q:** PV does have products certified to safety standards by UL and FM. PV-3 must be consistent with these.

**A:** Neither PV-3, nor the certification program in general, address safety issues. PV-3 is essentially consistent with IEEE PAR 1262 and IEC 1215.

**Q:** ISPRA [ESTI] already issues certificates of conformance to specified test or test sequence, historically CEC sequences, but now the corresponding IEC documents. PV-3 must allow US manufacturers to be certified to IEC-1215 or it will be of limited value to an industry that ships a majority of products overseas.

**A:** IEEE 1262 and IEC 1215 are nearly identical. Hopefully they will remain equivalent. If there is a consensus, we have the option of referencing IEC 1215 instead of IEEE 1262. Also, if the US module

certification program is structured and marketed properly, the international specifiers and buyers will embrace our certification program just as they did the JPL Block IV and V programs.

**Q:** PV-1 and PV-2 are very general documents. Can we somehow keep PV-3 this way by using/referring to other consensus standards like IEEE, IEC, ASTM, etc.?

**A:** Yes. PV-3 will reference IEEE 1262 (which is nearly identical to IEC 1215). However, PV-3 is a very specific document with no room for interpretation or deviation.

**Q:** Modules used in different places for different applications are liable to require different qualification tests, for example marine applications. Can we have certifications and marks for many different product tests?

**A:** Possibly a few, but not many. Costs will be too high to certify low volume products. This certification program should begin with a single mark/label and let other mark/labels evolve after the program is established. Just as the JPL Block IV and V programs covered 95% of all PV applications, one mark/label can easily cover 90% of all PV non-consumer power applications.

**Q:** In my opinion the biggest and most costly issue for the certification laboratories will be performance testing. I don't think that you can solve it in PV-3. Maybe however, PV-3 can provide a road map on how to solve it in the future.

**A:** The additional cost to measure module performance for rating purposes will be small relative to qualification testing, if the performance test is specified at STC. Performance tests are already required by IEEE 1262 and IEC 1215 (but not for ratings). The challenge for certification will be to accurately measure absolute values of module performance to establish a rating. It is time to resolve the issue of module performance at STC.

**Q:** I think that something beyond STC should be on the sticker [label] for two reasons. First, a PVUSA Test Condition (PTC) rating (for example) would be something that users might see if not regularly, at least periodically: I rarely ever see 50 Watts from a 50 Watt STC rated module. Second, if users start comparing systems at PTC, manufacturers will start competing at and designing for PTC. Module designs — everything from doping to encapsulation to frames — will be optimized for performance at PTC instead of STC. I think if cell designers were comparing world record efficiencies and  $J_{sc}$  and  $V_{oc}$  at PTC rather than STC, the resulting modules would perform better in the field.

**A:** There are good arguments to use PTC or NOCT instead of STC for the module performance rating. However, this certification program is not the place to try to reach consensus on this approach. We are much closer to consensus on STC measurements than PTC or NOCT for laboratory measurements. Having all modules that are rated at 50 Watts at STC actually measure 50 Watts at STC by an independent laboratory would be a real achievement in itself.

**Q:** Concerning the definition of STC and NOCT: how do you handle a concentrator module?

**A:** It was agreed at the March 16 committee meeting that concentrators would not be included in the current scope of work. There is no commercial market for concentrator modules at this time and we need to focus our time and energy where the market and need are.

**Q:** Can only the performance rating of PV modules be certified instead of complete qualification testing? If so, how many modules will be required for only performance rating?

**A:** The program is currently defined such that the label includes a performance rating and qualification test. There was general consensus regarding this approach at the March 16 meeting and with the subcommittee

after 3/16. Most industrial/commercial/utility buyers today require some qualification test. Performance rating testing can be added to the qualification testing for a minimal increase in cost.

**Q:** Will the performance testing include the energy rating, in addition to power rating?

**A:** Since there are no standards which define energy ratings for PV modules and there is no industry consensus on how to specify the energy rating, it would be premature to include an energy rating at this time. However, when a consensus energy rating is developed, it may be appropriate to add it to the certification program. An energy rating is what is needed, but now is not the time...

**Q:** Could there be a provision initially to accept some specific tests by manufacturers, if they meet certain well established criteria?

**A:** Possibly. This would be determined by the certification body and is beyond the scope of this program. Performance rating testing is one test that would likely be limited to an accredited laboratory.

#### 4. **Responses to PV-1a**

These responses to comments from committee members regarding Document PV-1a (first draft, dated February 10, 1993), were distributed via memo on February 2, 1994. The final draft of Document PV-1 is contained in Annex A.

Para.      Q: Question   C: Comment   A: Answer   R: Response

1.3      **Q: Is this true?** [i.e., 1.3 Laboratories meeting the requirements of this standard comply, within the context of their testing activities, with the requirements of ASTM Standard E 548 and ISO Guide 25, and with the relevant requirements of the ISO 9000 series of quality standards.]

**A:** Yes. Since PV-1 meets all of the requirements of both ISO Guide 25 (and ASTM E 548), this is a true statement. Additionally, the portion of the statement dealing with the relevant requirements of ISO 9000 standards is taken from Guide 25.

**Q: Do we expect labs to be ISO 9002 certified?**

**A:** That is up to the lab. There are no US regulations or specifications that we know of requiring laboratories to become *registered* to ISO 9001 or ISO 9002.

**Q: Why base PV-1 on ISO Guide 25?**

**A:** ISO Guide 25 is the only model now used in the US by laboratory accreditation bodies when they either up-grade their program, or form a new program. It is universally accepted. ASTM E 548 is based on Guide 25 and being modified to be exactly harmonious.

**Q: Will a correlation matrix between Guide 25 and ISO 9000 be provided?**

**A:** We can furnish such a matrix, but in light of above answer, such a matrix is neither useful nor desirable in PV-1.

2.3      **C: Use of the document should be for external auditing as well as internal.**

**R:** It is. However, the exact use of PV-1 as a guide for auditing should be covered in the operational procedures of the certification body that is structured to conform to Document PV-2. In satisfying the requirements for internal audits, the laboratory may choose to perform them using their own resources, or may contract them out. An external, third-party audit is required to gain accreditation and is usually performed every two to three years.

2.5 **Q: What is meant by *supplies* in the last line?**

**A:** Materials and consumable items used in testing (not instruments or test equipment).

3.0 **Q: Most of the references are not referred to in the body of PV-1. Does this mean they are required in their entirety?**

**A:** It is common practice to list consensus-developed conformity assessment standards as references as the first section after the introduction or scope when preparing specific conformity assessment documents, or criteria. When a specific requirements of one of the referenced documents is mandatory, unambiguous language is contained in the body of documents such as PV-1. However, laboratories seeking accreditation, certification bodies doing the accrediting, and assessors performing audits, would all be wise to become familiar with these documents.

**Q: You have used language that is identical to language in ISO Guide 25. Ought you to place such language in quotes, or use footnotes?**

**A:** No, it is not necessary and would be cumbersome. The ISO Guides and ISO Standards are not copyrighted, and it is intended that they will be used in this manner. For example, ASTM E 548 uses language essentially identical to Guide 25, and ANSI/ASQC 92, as a example, is, as a document, essentially identical in language to ISO 9002.

**Q: Why are there no dates of issue, or latest issue, attached to the designations of the referenced documents.**

**A:** In most standards and conformity documents, it is understood that the latest issue will apply unless a specific date is attached to a reference, e.g., ASTM G 1146-1956. If desired, such a statement can be inserted.

**Q: Why are there no IEEE references?**

**A:** To the best of our knowledge, IEEE has not issued conformity assessment documents, or standards.

**Q: Is ASTM E 1322 directly relevant?**

**A:** Yes. For several reasons. First, if an accrediting organization is formed for the purpose of the PV certification program, they must have some guide for selecting, or selecting and training assessors. Second, the assessor chosen to evaluate the laboratory to be accredited ought to be familiar with this document. The comparable ISO document is in revision, but should be available next year.

4.3 **C: Add: The calibration records shall be written, as well as other forms (e.g., computer data storage).**

**R:** This requirement should not be in the definition. Place in either section 11 or 12 after discussion with author of remark.

- 4.8 & **Q: What is the meaning of the term “physical standard?”**
- 4.9 **A:** We have used the term *physical* to distinguish the standard from a standard *document*, or *test* standard. By convention, a *reference standard* is usually an instrument, or device, whereas a *reference material* is not ... it might be a reference mirror used in the measurement of the reflectance of concentrating devices.
- 4.10 **C: Perhaps the term *standard reference cell* in this context is a bad example?**
- R:** Yes it is, but we have left it in for purposes of discussion in our March meeting.
- 5.2 **Q: How is the term *shall not invalidate the results or adversely affect the required uncertainty level* quantified?**
- A:** This requirement is the “rule,” as it were. When an assessor makes an observation, and a value judgment, i.e., qualitatively, that the laboratory’s calibration laboratory, optical measurements laboratory, or other, is filthy, a deficiency is noted (which must be addressed by the laboratory). This becomes a quantitative assessment if the auditor also observes that there are inconsistencies in recorded information that might be attributable to the *filthy laboratory*. Criterion 5.2, then, is the *law* cited by the assessor in issuing the deficiency.
- 5.6 **C: Document known safety hazards such as high voltage tests, flash tubes.**
- R:** This should not be done in a quality conformance document lest a laboratory relies on our list and we become liable for omissions.
- 6.2.2 **Q: Add *political* to the list of prohibited activities.**
- A:** Every citizen has the right to run for office and this right cannot be contravened by the language of documents imposed on a laboratory. Certain political behavior might be prohibited, such as contributions to an office seeker, or holder, who might take a position that affects the laboratory. Discuss further in March meeting, if important to author.
- Q: Should gifts from clients be allowed at all?**
- A:** Most organizations permit gifts under a certain value ... such as pencils, mechanical pencils, low-cost pens, rulers, baseball-type caps, etc. Monitoring this level of gifts when excluding all gifts is burdensome.
- 6.2.5 **Q: What is the objective of the last sentence dealing with the ratio of supervisory to non-supervisory personnel?**
- A:** It is a requirement of ISO Guide 25, and has cogent reasons. When an auditor finds several problems related to [1] technicians not understanding the test being audited, [2] corrections to data not being witnessed, [3] data sheets or logs not properly signed or dated, to name only a few, the question of inadequate supervision becomes increasingly obvious. The next question is: is the problem due to an incompetent supervisor, or is it due to a supervisor having too many technicians to manage?
- 6.2.6 & **Q: Can the Technical and Quality Managers be the same person?**
- 6.2.7 **A:** While it is, of course, preferable that they are not the same person, it is often necessary that both functions be handled by the same person in small laboratories (certainly in labs of less than five persons, for example).

- 7.4 **Q: In the second sentence, who makes the decision as to “found competent?”**  
**A:** The person’s supervisor within the framework of the procedures in ¶ 2.6.
- 8.0 **C: Two reviewers expressed concern about certain redundancies in this section.**  
**R:** Most of the language in this section is taken either from Guide 25 or from the requirements of one of the major accreditation programs. Although this section will most likely be discussed in some detail in the March meeting, it may be helpful to note that in several of the cases, the first mention of an issue is the “rule,” and the second is the “guidance.”
- 8.1 **C: Add: “and for reviewing by any relevant qualified outside personnel.”**  
**R:** This was not added since review of a laboratory’s Quality Manual is a requirement of all accreditation programs of which we are aware. Can be discussed further in the March meeting.
- 8.3 **Q: What about electronic on-line access of documents?**  
**A:** If the only form of the Quality Manual is an on-line computer version, the laboratory’s quality system is difficult, if not impossible, to assess (even if all the computer-related safeguards for data traceability and “chain of evidence” are in compliance). Therefore, on-line, read-only manuals are not acceptable if printed manuals are not also distributed.
- Q: Is it really necessary that copies of the manual shall be numbered and a log maintained?**  
**A:** This is not required in the current version of ISO Guide 25, but is required by several organizations who accredit laboratories. The reason is that failure to maintain a log of control copies (i.e., recipients) becomes an impediment to up-dating, and to ensuring that all personnel have the current version of all parts of the Manual.
- 8.4.2 **C: Bureaucratic, the personnel should sign a log that they are up to date with any revisions - part of their on-going training.**  
**R:** It is not enough that personnel sign training and “reading” logs ... which is fine in itself. Personnel are known to sign such logs to avoid reading revisions and documentation. Discuss further in March meeting if desired.
- 8.5.3 **C: Delete last sentence.**  
**R:** The requirement to identify the interrelation of all personnel who manage, perform or verify work affecting the quality of tests is contained in the language of all programs with which we are familiar. We have simplified the requirement by requiring a separate but simple organizational chart to depict these relationships. Can be discussed further.
- 8.5.4.d **C: Delete 8.5.4.d in its entirety.**  
**R:** Discuss at March meeting whether this master list is in the Quality Manual or if it may be maintained elsewhere.
- 8.5.8 **Q: Isn’t this getting into the operation a little far?**  
**A:** This criterion is taken from ISO Guide 25, and is necessitated by the fact that some laboratories undertake work they ought not, bringing the reputation of both the laboratory and accrediting body into question if it is not addressed.



- 9.1 **C: Insert *and* in place of *or* in the phrase “conduct objective internal or contracted audits” in the second line.**
- R:** This would unfairly force the laboratory to contract for audits not associated with the 3rd party audits that might be performed by a customer (which are done at the expense of the customer) or the accrediting body (which are done at the expense of the laboratory).
- 9.1.4 **Q: What about 3rd party audits?**
- A:** A laboratory that implements a Guide 25-based quality system would have two principle objectives: First, to ensure that its services are of the highest possible quality; and, second, to be prepared for 3rd party audits (from the body under which its accreditation is obtained, or from important customers).
- Q: Would ISO 9000 certification count as a 3rd party audit?**
- A:** Not usually. Certain customers or an organization requiring that a laboratory become registered to one of the ISO 9000 standards might find it acceptable. One can be *certified* privately to ISO 9000, but is officially *registered*. Generally, ISO 9000 registration would be acceptable to lab accreditation bodies in terms of meeting the requirements for internal audits ... depending on who the registrar was.
- C: Subpara. (c) is essentially the same as (a) and (b) above.**
- R:** (a) and (b) require that the lab has a planned schedule for the audits and that they shall be documented, respectively. ¶ 9.1.4.c requires that they be carried out.
- 9.3 **Q: Who determines the timetable (second sentence)?**
- A:** The Quality Assurance Manager on the basis of the policy on audits contained in the Quality Manual.
- 10.3 **Q: All equipment should have a defined calibration period; recalibration period. This should be recorded.**
- A:** Covered in ¶ 10.4.
- C: The requirement for affixing labels on equipment to indicate maintenance status is not realistic. Should be sufficient to record this information in the record required in Section 10.5.8.**
- R:** While ISO Guide 25 only requires that calibration labels be affixed to each item of test equipment to indicate the status (i.e., last calibration date, next calibration date, and who?), we believe that it is important that the same information be required on a maintenance label. Laboratories also have the option of using a single label that has both the calibration and maintenance status on the one label. **The maintenance label is an aid to the lab in preventing missed maintenance schedules, i.e., it is observable to the technician, his supervisor, management, and customers.**
- 10.4 **Q: Don't we say this in ¶ 10.3?**
- A:** No. ¶ 10.3 covers maintenance. ¶ 10.4 covers calibration.
- 11.1 **Q: Who makes the decision that the *absence of instructions jeopardizes* the quality of test results?**
- A:** If it is not caught in an internal audit, it will be caught in the initial or periodic 3rd party assessment of the laboratory as a condition of accreditation. If during the assessment, the test operator cannot readily locate the operating instructions, the lab is cited for a deficiency.

- 11.6 **Q: How will calculations be stored?**  
**A:** Covered in Section 14. Records.
- 12.2.1 **Q: What about traceability to NIST for solar radiation measurements?**  
**A:** NIST does not maintain a primary reference instrument for certifying traceability of solar radiation measuring instruments. Only the WRR can be cited for primary traceability. However, this can be done through NOAA, NREL, Eppley, DSET, and several other organizations who participate in the IPCs. Until NIST places an absolute instrument in a WMO International Pyrheliometric Comparison (IPC), traceability to NIST is not possible.
- 12.9 **C: This paragraph is only a re-wording of 12.4.**  
**R:** ¶ 12.4 covers *traceability* of the calibration of instruments and equipment. The requirement is for traceability to NIST, or another country's national standards body . ¶ 12.9 is specific to reference materials, which may be purchased from NIST, for example a *standard of specular reflectance*, e.g., a mirror.
- 12.14 **Q: Why reagents?**  
**A:** Reagents used in test laboratories who routinely perform chemical tests must, of course, have a program to ensure that all reagents, whether purchased or made up by the laboratory, are fresh. In non-analytical laboratories that employ methods such as salt spray/salt fog environmental or certain corrosion resistant tests, the tests are usually performed by non-chemical technicians. "Old", sometimes discolored, reagents are often found in environmental test laboratories who employ only one or two tests requiring reagents. Should no such tests be required by Document PV-2 for the PV module certification program, this paragraph will be dropped from Document PV-1.
- 13.1.1 **Q: Sampling will be defined here (referring to Document PV-2) and not in Document PV-3?**  
**A:** Yes, to the extent that it is defined in Document PV-2. However, exact procedures must await the development of operating procedures for management of the certification body. Such procedures would be based on the criteria presented in Document PV-2.
- 13.3 **Q: Is this only a visual inspection (first sentence)?**  
**A:** Yes. However, it might be desirable under certain circumstances to take a photograph or perform a simple measurement to augment the visual statement.
- 14.2 **Q: What is the basis for a seven year retention requirement?**  
**A:** The lab accreditation envisioned is in support of a product certification program. Product liability laws in most states are unfathomable to the layman and vary from one state to another. Seven years is believed to adequately cover most contingencies.
- 17.3 **Q: What type records?**  
**A:** Records of acceptance tests, inspections, etc. should be maintained for each supplier. Records of telephone interviews, or site visits (if performed) are relevant. If the supplier is a manufacturer of instrumentation or test equipment, records should include maintenance histories on equipment (when available from third parties in an absence of internal information),.
- 14.2.1 **C: Add as third bullet statement: in the case of multiple samples received, a unique identifier shall identify each sample to provide correlation between the data recorded and the sample tested.**  
**R:** We believe this is covered adequately in the first bullet.

## 5. Responses to PV-2a

The following are responses to comments from committee members regarding the first draft of Document PV-2. These responses were distributed via correspondence dated February 15, 1994. The final draft of Document PV-3 is contained in Annex B.

Para.      Q: Question C: Comment A: Answer R: Response

- Gen      **C: Two comments questioned the general, non-specific, nature of PV-2, suggesting that detailed rules of procedures and structure be presented in this document.**
- R:** PV-2 is the guide containing the criteria for the development of the rules of procedure and organizational structure of the Certification Body. We have been constrained by our client to only develop the criteria in this phase of the program. While a *pro forma* set of rules and organizational procedures, and by-laws, can be developed *a priori* of the actual formation, or incorporation, of a Certification Body, the actual rules and by-laws must be drafted at the behest of, and approved by, the *sitting* board of directors of such an organization. Hence, it is too early in the process to draft detailed rules and organizational structure.
- C:** Everything is very general. I guess this is all right, since it allows a manufacturer to establish his own QA system and then just prove to the auditor that he follows the system he says he does.
- R:** The manufacturer is not *allowed* to develop his own QA ... he is **required** to do so. The auditor must then find *objective evidence* that the manufacturer has an adequate quality system (but at a level of inquiry that is determined by the Certification Body).
- Q: If the certification body operates its own testing laboratory, how is self-certification accomplished, or is this not a problem if the certification body follows the quality system requirements?**
- A:** If the certification body operates its own testing laboratory, or as is more often the case, if the laboratory operates its own certification program, it must get ANSI accreditation of its certification program. This, in turn, triggers the necessity for the laboratory to seek accreditation from A2LA, NVLAP, BSI, NATA, or another body. Worthy of further discussion.
- Q: What about an independent review body for the program so developed ... some sort of independent approval?**
- A:** On whose authority? And to whom would they report? Actually, the Criteria Development Committee is that Review Body, in our opinion.
- 2.2      **C: Add to end of ¶ 2.2 the following: “It is the responsibility of the Third Party Certification Body to notify the appropriate standards agency that it plans to serve as a conformance monitor, and to grant certification and labeling approval if such conformance is demonstrated.”**
- R:** We do not believe the Certification Body has a duty to notify standards organizations that it is using their standards for certification purposes.

**Q: Will PV-3 recognize these (referring to *new* and *additional* standards)?**

**A:** While that is up to the Technical Committee of the Certification Body formed to manage and operate the certification and labeling program, that is certainly the intent of the language contained in PV-3. Discussion of unambiguous language to this effect is in order.

2.3 **Q: This paragraph implies that Document PV-3 will dictate a factory quality management system. Is this the intent?**

**A:** The requirement is two-fold: [1] testing to PV-3, and [2] assessment of the factory's quality system. It is not the intent to dictate what quality system the manufacturer installs, only that the factory have a quality system. Nonetheless, the elements of a minimum quality system must be specified by the Certification Body. To this end, a skeletal version of ISO 9001 is provided in Appendix 2 of PV-3 and represents a checklist for both the manufacturer and the Certification Body's auditor, or quality assessor.

**Q: This paragraph also implies that there will be initial tests, and then on-going testing of factory and open-market samples. Is this the intent?**

**A:** Yes, in principle. It is envisioned that the Certification Body would provide for testing samples procured from the open market in the event of challenge of procedures, or problems in complying with the program's sampling procedures.

**Q: Shouldn't configuration control be required to assess design changes?**

**A:** Yes. However, it is premature at this stage to define the nature of the configuration control that the Certification Body might implement. This can be discussed further.

2.4 **Q: Shouldn't Footnote 2 apply to PV-1 rather than here?**

**A:** No, both ¶ 2.3 and Footnote 2 are requirements being placed on the Certification not the Accreditation Body (which should indeed adhere to PV-1 (or ISO Guide 25)). But, in the author's judgment, compliance by the Certification Body with the requirements of ISO 9002 would be entirely satisfactory.

**C: ISO is more *product* oriented and thus doesn't have the higher intent of *quality*.**

**R:** Not really true. The ISO 9000 series is intended for *products* and *services*. The degree to which these quality standards improve quality depends first on the organizations interpretation, and second on the intent of the Registration Body they select for their assessment. All of the elements are present.

2.5 **C: I suggest that a laboratory be accredited. If more than one laboratory is required, then they should be accredited for specific measurements.**

**R:** Agreed. But one cannot dictate what tests any one lab can be accredited to perform. Further, the issue of a single versus multiple laboratories for certification programs is one that was visited most vigorously in the solar thermal arena. G. Zerlaut has a thorough discussion of this issue in his chapter on solar standards being published by MIT Press. Worthy of further discussion.

3. **Q: Referring to the titles of ISO 9001 and ISO 9002, the question is: Do both of these standards refer to *production and installation*?**

**A:** Yes. These are progressive standards, with ISO 9001 having the greater requirements in the hierarchy.

4.2.1 **C: Add: "controlled by the producer, the buyer, or the test agency?"**

**R:** This would not be appropriate if the industry were to accept the fact that both ISO Guide 28 and ANSI Z34.1 permit testing agencies, or laboratories, to also be certification bodies.

- 4.2.3 **C, Q: This allows an organization (i.e., a Certification Body) to accredit its own *certification laboratory*. Is this desirable?**
- A:** Who else would do it other than either of the two national-in-scope programs, or one set up for this purpose only. The latter doesn't really make sense for photovoltaics at the current size of the industry. If it is not contracted or delegated to A2LA or NVLAP, it ought to be the Certification Body who manages the laboratory accreditation program.
- 4.2.3 Note: **Q: There are lots of implications to this (referring to a laboratory also implementing its own product certification program).**
- A:** While it may not be wholly desirable, it certainly is permissible and is not uncommon. Indeed, it is permitted by the primary standards governing product certification programs ... ANSI Z34.1 and ISO Guide 28, to be precise.
- 5.1(4) **C: "An organization of manufacturers" is dangerous, and "an organization of testing laboratories" is potentially dangerous.**
- R:** Why? SRCC is an organization of manufacturers of solar hot water heaters with public sector organizations represented on the Board of Directors. Also, that is what a "trade association" is, and generally, public sector organizations and professional/technical societies do not get involved in such activities. That leaves manufacturers and government!
- 5.2.5.1 **C: Could lead to COI (conflict of interest) if the certification body operates its own laboratory(ies).**
- R:** Not on the merits of the concept. While we do not advocate that the laboratory and certification body be one and the same, it is permissible as stated before, and the safeguards are ANSI accreditation of its Certification Program and outside accreditation of its laboratory.
- 5.2.5.3 **C: Define the frequency.**
- 5.2.5.4 **R:** This will be the prerogative of the Certification Body.
- 6.1.1 **C: A copy of the quality plan should be got early, reviewed and used in developing initial checklist specific to the manufacture.**
- R:** Agree. But, again, this is the purview of the Certification Body. However, the requirement can be noted in here in the criteria of the model. Discuss further.
- 6.1.3 **C: The assessment should not be done by a single individual.**
- R:** Why not, if the manufacturer is a small or medium-sized company, and does not require an elaborate, complicated quality management system. For such organizations, one assessor can handle the audit of their quality system. Furthermore, manufacturers (and laboratories) pay the fees for quality audits in support of certification and labeling programs, and two assessors when one will suffice is an unnecessary burden on the manufacturer. Only logistical reasons should dictate how many auditors are used; there are no COI or legal implications unless the Certification Body selects the wrong assessor for the job.
- 6.1.4.4 **C: Needs to cover PV-1 requirements.**
- R:** PV-1 applies only to laboratories and is wholly appropriate as a model for the quality system for manufacturers.
- 6.1.7 & **Q: What are the time periods specified in 6.1.7 and 6.1.8?**
- 6.1.8 **A:** These should be the purview of the Certification Body and covered in their rules and procedures.

- 6.2.5.2, 3 **C: These quality requirements should also include the following: changes to materials or suppliers, changes to components, etc.**
- R:** Agree that these requirements are a necessary element of good manufacturing quality systems, but it is not the intent to force full ISO 9001 compliance on manufacturers within the scope of PV-2. The level of detail required by the Certification Body in terms of participant manufacturers is in reality their purview.
- 7.1.1 **Q: Why should the certification body have to go to the expense of sending someone to the manufacturer's facility every time they want to conduct a qualification test?**
- A:** Because [1] all other manufacturers in the program, [2] any insurers of the directors of the Certification Body, and [3] the purchasers of the certified product, all require assurance that the manufacturer had no opportunity to influence the test results by inappropriate, or *illegal*, manipulation of the sample from which the test specimens were selected, i.e., that there was no opportunity to *stack the deck*.
- 7.1.2 **Q: How is the lot size quantified, or will this be done in PV-3?**
- A:** This requirement will be part of the rules and operating procedures adopted by the Certification Body to govern itself. It would not be a part of PV-2, nor a task of this phase of the program.
- 7.1.4 **C: Certification should be on production-products only, and not on prototype models?**
- R:** We tend to agree, but as a practical matter, some programs permit testing of final-stage prototypes in anticipation of entering the market. ANSI Z34.1 and ISO Guide 28, recognizing that such might occur, have provided for this eventuality.
- 7.3.1 **Q: Should the periodic re-testing time frame be fixed in this document?**
- A:** This is the purview of the Certification Body, who must take into account the health of the industry ... weighting this against the cost to the manufacturers.
- 8.3 **Q: Where will the rules for the certification program (referenced here and in other places, e.g., 6.1.3, 6.1.9, 7.3.1, etc.) be documented?**
- A:** Ultimately, they will be documented in the Rules and Operational Procedures of the Certification Body. However, in the event that a second phase of the current effort is undertaken, *pro forma* documentation relating to rules and procedures for operation of a Certification Body, and for structuring the actual photovoltaics certification and labeling program may be required.
- 9.4 **Q: Who decides what constitutes an affect?**
- A:** The licensing agreement between the manufacturer and the Certification Body should contain language protecting the Certification Body from abuse. The *pro forma* agreement presented as Appendix 5 to PV-2 presents in ¶ 2.3 of Article 2 a binding agreement relating to this question, and in ¶ 3.1 of Article 3 provides for the right to conduct surveillance visits. The latter ought to be designed by the Certification Body in such a manner that non-conformance in this respect is caught.
- 9.6 **Q: What is a complaint? Do you mean a return because of failed performance?**
- A:** Yes, that is implied.

- C:** I don't think a Certification Laboratory should get involved with customer complaints, since these may have nothing at all to do with product quality or reliability. They should want to know when licensed products fail prematurely.
- R:** An Accredited Laboratory doesn't get involved with complaints regarding certified product *except to the extent that failed product triggers a review of the chain of evidence relating to the quality of the tests themselves*. On the other hand, a Certification Body must have the right of knowledge of any complaint that may affect it. Put another way, in the eyes of the purchaser, and his counsel and the courts in case of adjudication of the complaint, the Certification Body is the most visible party to the entire process of certification after the manufacturer himself ... making it mandatory that the Certification Body have access to all complaints relating to performance of the product ... not just to ultimate failure!
- 10.2.2 **Q:** This clause appears to be inconsistent with the language of 10.3.4. Is that true?
- A:** No. If the Certification Body so wishes, the language of a certificate of conformity can indicate specific areas of conformity in the body of the document that are not inclusive of all of the requirements, and the purchaser who relies on the conformity statement will not be misled. This is not the case for a *Mark*, where there is no such distinction and the purchaser may, and most likely will, rely on the mark to represent conformity to all of the certification program's requirements.
- 10.2.3.d **C:** add "or to the appropriate non-PV-3 standard (see ¶ 2.2).
- R:** This would only be appropriate if test methods were adopted and if the Technical Committee did not revise PV-3 to accommodate additional tests. If they did not, then this comment is germane. Should be discussed further.
- Q:** Does the information required by sub-paragraphs d) and e) need to be in the certificate's language?
- A:** Not if the Certification Body's Certification Committee decides that this language is not required. However, this language is contained in the *conformity standards* referenced by ANSI Z34.1.
- 10.3.3 **Q:** How?
- A:** The Certification Body should incorporate language in its licensing agreement to this effect.
- 14.6 **C:** The phrase, "whether the mark shall be removed from products already sold" sounds impossible and unnecessary.
- R:** This phraseology is from the documentation proscribed by ANSI Z34.1 You are arguably correct. However, the manufacturers will have the opportunity to discuss this issue at various stages in the program development ... with the ultimate decision resting with the Board of Directors of the Certification Body formed to manage and operate the certification and labeling program. Discuss further.
- 14.2(2) **Q:** To whom
- A:** The Certification Body. In the absence of outside financial support (e.g., government seed money, foundation support, trade association support, etc.), licensing fees are the only sustaining revenues that can be counted on.

- C: Add to 14.2 subpara. (4) “has released certified products contrary to 9.5**
- R:** This is covered in 14.2.(3) in PV-2 and in Articles 3 and 11 of the *pro forma* licensing agreement (Appendix 5 to PV-2).
- 15 **C: This section does not say very much (implying that it says too little).**
- R:** Agreed. However, the section refers specifically to ISO Guide 27, which is a detailed, 4<sup>1/2</sup>-page document. Suggest discussion during March meeting with the view that we either 1) incorporate the most important of the relevant language into PV-2 for the next draft, or 2) permit the Certification Committee of the Certification Body to develop detailed complaint procedures as part of the Body’s rules and operational procedures.
- 16 **C: Sections 16.1 and 16.2 should be part of PV-3.**
- R:** Not in our opinion. The criteria for establishing the requirements of a product certification program, of which revisions to the required testing methodologies are a vital part, should be in PV-2. PV-3 should be confined only to the tests themselves, and whatever requirements are placed on instrumentation and personnel qualifications (as required by the contract from NREL).
- 16.3 **Q: Why? The conformance would just be to the earlier issue. Need only to be revoked if a violation of 16.3 would result.**
- A:** When the testing requirements are changed for urgent and cogent reasons, existing licenses cannot be maintained for re-test requirements or manufacturers entering a new model into the system will be unfairly penalized, the purchaser might be harmed, and the FTC fairness rules (i.e., the *rule of reason*) might be violated. Further discussion is invited.
- 16.4 **C: Subparas. (1) and (4) are very, very dangerous, and (5) should be deleted.**
- R:** These are all deemed reasonable and are provided for in the criteria of ISO Guide 28, ANSI Z34.1, and other documentation. Further discussion is invited.
- 17 **C: Paragraphs 17.1 and 17.2 are very weak requirements.**
- R:** Agreed. However, it is anticipated that the Certification Body will retain competent counsel for review of their rules of procedures (and by-laws), and for drafting certain articles of their operational rules such as those on product liability. We are not attorneys and cannot draft this section ... any more than can the author’s of ANSI Z34.1 and ISO Guide 28.
18. **C: Paragraphs 18.1 and 18.2 are, like 17.1 and 17.2, very weak.**
- R:** Also agreed. However, in this case, we are waiting for copies of draft ISO documentation that we understand is in an advanced stage of development. If received in time, we will *flesh out* this section. Otherwise, we will do so from other perspectives.



## 6. Results of PV-3 subcommittee questionnaire

Compiled here are the responses to a questionnaire (dated March 28, 1994) concerning possible performance testing and labeling aspects of PV-3. Each subsection corresponds to one question of the questionnaire.

The subcommittee consisted of the following members:

Don Aldrich, Siemens Solar Industries  
Jerry Anderson, Sunset Technology  
Mark Genard, Texas Instruments  
Steve Hogan, Spire Corporation  
Carl Osterwald, NREL  
Chuck Whitaker, ENDECON  
John Wohlgemuth, Solarex Corporation

### 6.1 Which test method do you recommend be included in PV-3?

**R:** Method 1 [STC]. Comments:

- a. It is only reasonable to expect that the industry representatives would never be able to reach consensus on a different test method.
- b. It is indeed standardized and widely recognized.
- c. This is easy to do in the factory.
- d. There are too many field related factors to adequately predict outside performance from any one measurement, so it is of limited usefulness, as a performance predictor, to an average user anyway.

**R:** Method 1 [STC]

**R:** Method 1 [STC]. Comments:

50°C/Global is allowed by module test standard, this would be a "user defined" reference condition. However, using 50°C module temperature would be new. STC is easiest, but what happens when 50W STC certified module is measured by user at 40W outdoors? They might jump to conclusion that certification is bogus (see 3).

**R:** Method 3 [NOCT]. Comments:

I'm not too uncomfortable rating a module at STC and providing translations to other conditions like NOCT rather than trying to measure an NOCT rating. However, I think the lab will need to measure NOCT which is the hard part: the only difference in tests 2 and 3 is the irradiance level (800 vs. 1000) and the module temperature (47 or so vs. 50). I can't imagine that test 3 is really any harder than test 2 if you have to measure NOCT in any case.

**R:** IEC 1215 and CEC 503 contains the requirements for "Characterization", by measuring NOCT, temperature coefficients, performance at NOCT and performance at low light intensity. I think it will be perfectly appropriate for the IEEE to prepare a "Guide to Characterization of the Performance of PV Modules" after the Qualification Document is complete.

The initial performance measurement required is at STC. An IV curve along with  $V_{oc}$ ,  $I_{sc}$ ,  $V_{max}$  and  $P_{max}$  should be perfectly adequate. Each module must be measured before the qualification test begins and again after each of the stress tests. If we can work on getting this right everything else will fall into place later.

The real hard work will be establishing agreement among the PV community that an independent laboratory has the capability to certify PV module performance. If you believe Keith Emery at NREL, module measurements from laboratory to laboratory are no better than  $\pm 5\%$ . Our experience is confirming this level of uncertainty. Right now, using the same reference cell, we are about 4% different from JQA. To make matters worse ISPRA [ESTI] agrees with us and NREL agrees with JQA. Keith says don't worry, we are all within 5%. Is the PV community willing to accept PV performance measurements at  $\pm 5\%$  on each module?

I don't see how a certification laboratory can put a "Performance Mark" on modules without measuring each module. Wouldn't it be better to certify the measuring system technique? That is to say that the laboratory certifies that the procedure, calibration, reference cells, etc., are calibrated and handled correctly and that random cross checking by the laboratory results in agreement within the accuracy of the measurement. I think this later approach would be favored by the PV community.

**R:** #1. #3 should also be available to do; it's value for both thermal and electrical information is significant. It could perhaps have an optional or recommended (?) tng [can't make out this word].

**R:** 1 and 2 from figure 1 options. Comments: Full I-V curve with raw data and corrected data would be very useful.

## 6.2 What parameters should be reported?

**R:** [This company] recommends that the measurement reporting requirements of ASTM 1036 be adopted. (Just about everything you could ever need is covered there.)

**R:**  $I_{sc}$ ,  $V_{oc}$ , FF,  $P_{max}$ ,  $I_{max}$ ,  $V_{max}$ , and a graphical IV curve. Most simulator software provides all this on a single page.

**R:**  $V_{oc}$ ,  $I_{sc}$ ,  $P_{max}$ ,  $V_{max}$ ,  $I_{max}$  and test conditions

**R:** There are two issues: first, how well does one module perform versus another? These issues can be (partly) addressed by STC/NOCT ratings. Secondly, you need design/safety information: what are the operating current and voltage at the rated output; what's the maximum V, I, and P that his module can produce; what's the maximum system voltage that this module can be used in; what are the translation parameters; and what are the ranges of all of these values. We probably need to define the conditions for maximum current and voltage such as  $1200 \text{ W/m}^2$  and NOCT + 25°C for max current,  $500 \text{ W/m}^2$  and 0°C module temp for max voltage.

I have submitted a proposal to NREL to work on a module energy rating methodology which you will obviously need to be involved with. We are developing some concepts which will be presented in a strawman in the next few months (assuming we get a contract, of course). We are looking at defining 4 or 5 climatic

regions, generating some standard weather data for each region, enhancing the P926 performance model, calculating module production based on the weather data and measured module parameters (to be defined) and extrapolating an annual energy production possibly normalized to module rating. The required module parameters would need to have well-defined measurement procedures (ASTM) and would reasonably be part of the certification process. Nothing is concrete yet, but I thought this info might be useful.

- R: An IV curve along with  $V_{oc}$ ,  $I_{sc}$ ,  $V_{max}$  and  $P_{max}$  should be perfectly adequate.
- R: In general the parameters defined on the ASTM standard [i.e., 1036] , pretty extensive list for report versus label.
- R: Same as question 1. (1 and 2 from figure 1 options. Comments: Full I-V curve with raw data and corrected data would be very useful.)

### 6.3 What parameters should be placed on the label?

- R: [This company] recommends that, at a minimum, the label should be consistent with UL 1703 requirements. (Ultimately, it is more important to have manufacturers-to-manufacturer consistency than the actual content.)
- R:  $I_{sc}$ ,  $V_{oc}$ ,  $P_{max}$  are required by UL (at STC). A tolerance band should also be given which should also be given which covers the module family.
- R: Standard explanation of difference in performance at non STC conditions (brief).
- R: STC/NOCT rating(s), nominal and maximum V and I, max system voltage: Optional: translation information/ energy rating.
- R: [see #1 and #2]
- R:  $V_{oc}$ ,  $I_{sc}$ ,  $P_{max}$  ,  $V_{max}$ , STC conditions, uncertainty or range of measurement, indoor/outdoor.
- R:  $V_{mp}$ ,  $I_{mp}$ ,  $P_{max}$  ,  $V_{oc}$ , and  $I_{sc}$ . Also recommend asking the users what is needed!

### 6.4 Should a two-part or two labels be offered?

- R: [This company] strongly urges that the qualification and performance certifications be linked both in terms of acceptance criteria as well as physically on the same label (i.e., it should be impossible to get one certification without the other.)
- R: One label
- R: NO

- R:** Two labels?: Yes, if the optional information is to be included.
- R:** I'm not sure why? Two-part versus two labels preferred. Labeling should take advantage of auto label printers by not being too extensive in reported data.
- R:** Do not understand the question.

## 6.5 Other comments?

- R:** The goal of the performance measurement should be to gauge the power producing characteristics of a stabilized module. To this end a sufficient sample of modules should be outdoor exposed for an approximate time before performance measurements are made. The module rating should then be determined from the resulting performance distribution. Future performance audits should focus on how closely a manufacturer stays to the target value, not just if they are within specifications.
- R:** Comments on labeling: Production modules usually are shipped with a manual which contains warnings, qualification information, installation instructions, performance parameters, alpha & beta coefficients, etc. The certification committee should consider manual requirements (UL does).
- R:** If NOCT is adopted (or considered), modify NOCT so that measurement is at zero wind speed and open frame mounting to ease measurement.
- R:** Sorry that I was unable to attend the last meeting and have a better idea on the issues of the above.
- R:** How will we deal with typical degradation over time? This is a customer concern.

A rating system would be more meaningful than having an independent lab or company certifying power output. What the industry needs is a system for rating energy output (kWh), not just instantaneous power. Customers are buying energy. Power is useful in the lab, but not to customers. What can ASU do to further this? This questionnaire should go more users, not primarily manufacturers. It might be useful to solicit input from the UPVG, which has 80 plus representatives.

## 7. Responses to PV-3a

The following are responses to comments from committee members about the first draft of Document PV-3.

This summary was sent to committee members on September 15, 1994. The final draft of Document PV-3 is contained in Annex C.

- C:** This certification program will be of limited value if it is limited to Certification to IEEE PAR 1262. US PV manufacturers are interested in having their modules certified to all international PV standards. If a US lab can't certify our product to international standards (like IEC 1215) we have to get this certification

done elsewhere. Today we have to go to ISPRA [ESTI]. I thought the whole purpose of this exercise was to provide a laboratory in the US that the PV industry could use.

- R:**
- a) IEEE 1262 was selected for this strawman because the US PV industry, as a whole, supports this document and the majority of Committee members support this selection. We will send this issue to the Committee at the end of this month for a vote. The final selection of a qual test document, however, will be made by the Certification Body.
  - b) If IEEE 1262 is used for the Certification Program, it places the US in a bargaining position with other countries and organizations, including the CEC and ISPRA [ESTI]. Assuming that the Certification program is well accepted in the US, US buyers will specify that PV modules must be “Certified” (per PV-3) in their purchasing documents. Foreign manufactures will have incentive to become “Certified”. It should be relatively easy to reach a reciprocity agreement with ISPRA [ESTI], for example, which would make 1262 and 1215/CEC 503 interchangeable for crystalline modules. This would eliminate the potential requirement for a manufacturer to test to both 1262 and 1215. To have an effective Certification Program, the Certification Body will have to actively market the program and deal with issues such as reciprocity.
  - c) One could argue that we should simply use 1215 in PV-3. The argument not to use IEC 1215 should be the same argument that we have used to develop 1262 instead of accepting 1215.
  - d) The purpose of this exercise is to assist the PV industry in establishing the framework (i.e., criteria) for a PV Module Certification Program. Such a Certification Program will increase customer confidence (worldwide) in the certified modules, increase PV sales and reduce the number of different qual tests required.
- C:** PV-3 must allow for certification to a variety of consensus standards including IEEE PAR 1262, IEC 1215, UL 1703 and new ones as they are approved. I also see no reason why you couldn’t certify modules to specific environmental specifications, for example, a set of marine module tests.
- R:**
- a) As discussed above, the Certification Program could conceivably combine 1262 and 1215 into a single Label (see Response b).
  - b) UL 1703 is a safety Label. It is beyond the scope of this project to negotiate with UL to pre-approve portions of the 1703 tests that are common to the 1262/1215 tests.
  - c) The Certification Program could provide different labels for different test programs. Our goal at this time is to define a “main stream” certification program and not get bogged down in details and variations to the main theme. The Certification Body can readily change and expand the program to meet market needs.
  - d) Remember that the Certification Program will be defined and managed by the Certification Body. The Certification Body will be made up of people like you from industry. The Certification Body can change any or all parts of the strawman documents that the Committee has developed thus far.
- C:** Making performance measurements using ASTM 1036 requires the use of a spectrally matched reference cell. This may actually be impossible for many technologies, where stable spectrally matched reference cells are not available. Therefore, you make spectra corrections in the measurements using appropriate ASTM or IEC procedures. The present wording is too restrictive.

- R:** a) It may be necessary to begin this program with certification limited to crystalline silicon modules. It seems prudent to define accurate performance test specifications for crystalline products first, and then determine how to perform accurate performance tests on amorphous silicon.
- b) Most of the major PV module purchases for power applications today are for crystalline modules, not thin film modules. There is an immediate need for certified crystalline modules. We should deal with the most pressing needs first; the Certification Body can phase in other technologies as the market dictates.
- C:** Using reference cells calibrated by “qualified laboratories” is much too broad. The absolute first requirement must be the use of a consensus standard for calibration of the reference cells. Once you have consensus on the methods of calibration it will be much easier to agree on who can do the calibration in a qualified manner.
- R:** Agreed. See PV-3b.
- C:** I’m not sure where measurement agreement within 3% came from. According to Keith Emery, 5% would be a better number to start with. This is especially true if you allow measurements to be made under varying conditions before translation to STC. We really should have Keith do a detailed error analysis on this before accepting an arbitrary number.
- R:** The 3% was proposed as a strawman number. It has been changed to 5% in PV-3b.
- C:** I can’t stress enough the need for this document to cover international IEC standards as well as IEEE and ASTM standards. We are an international industry selling a majority of our products outside the US against strong non-US competitors. We need a US laboratory that can certify our products to IEC and IEEE standards.
- R:** Agreed.
- C:** The document does not address how to determine the electrical performance of amorphous silicon modules, considering their light-induced degradation and seasonal variation of power output. This is not covered in IEEE PAR 1262 either. Since the scope of PV-3 covers all flat-plate modules, it should address determining performance parameters ( $V_{OC}$ ,  $I_{SC}$ ,  $P_{MP}$ ,  $V_{MP}$ ,  $I_{MP}$ ) of amorphous silicon modules also, whether they are before, after or at certain exposure levels of irradiance.
- R:** a) The intent of the Certification Program was to include all flat-plate modules. Thin-film modules are included in IEEE PAR 1262. The requirements of PV-3b, 5.2, however, may preclude amorphous modules from passing.
- b) There is currently no consensus (or suggested approach) on how to accommodate testing amorphous modules “whether they are before, after or at certain exposure levels of irradiance”.
- c) It may be necessary to provide a different set of test conditions and a different label for certain technologies (e.g., amorphous silicon). In the meantime, developing a Certification Program for crystalline modules seems to be appropriate.
- C:** Paragraph 5.2.1.2 Electrical Performance Test is mostly a repetition of paragraph 5.2.1.1 Baseline Performance Value Test, except for the Purpose. The difference between the application and contents of paragraphs 5.2.1.1 and 5.2.1.2 are not clear.
- R:** Agreed. These paragraphs have been revised in PV-3b. Paragraph 5.2.1.1 is intended to verify the manufacturer’s performance rating (within 5% now), while paragraph 5.2.1.1 defines module pass/fail

criteria (10% power loss) after each major stress test in the battery of tests. Paragraph 5.2.1.1 focuses on absolute value of the power measurement (e.g., is it really a 50 watt module); paragraph 5.2.1.1 is more concerned about power loss relative to the baseline measurement (did the module lose more than 10% power during a test).

## 8. Responses to PV-3b

The following comments received in response to Document PV-3b (the second draft) were not incorporated into the third draft of Document PV-3 for the reasons provided in the response. All other comments were included in Revision c.

- C:** I feel the document [PV-3 Rev b] needs more details on the facilities and equipment required for PV module certification, including the description of specifications for the equipment. The requirements or references presented in the table are not sufficient.
- R:** a) It is inappropriate to define or specify a specific pieces of test equipment. Instead, the equipment used must meet the requirements of the specified test (IEEE, ASTM, IEC, etc.). This is also the currently accepted practice of IEEE, ASTM and IEC.
- b) It will be up to the accreditation body and its assessors to determine if the laboratory can meet the requirements of the certification program, including the tests specified in PV-3.
- C:** Add “Solar Simulator with electronic load” to *Equipment Required for Electrical Performance Test*, Appendix A, EQUIPMENT AND APPARATUS REQUIRED FOR PV MODULE CERTIFICATION.
- R:** The referenced specification (i.e., ASTM E 1036) permits either natural light or simulated light per paragraph 4.5—“The tests shall be performed using either natural or simulated sunlight. Solar simulation requirements are specified in Specification ASTM E 927”.

As in Response #1, the laboratory should not be constrained to a specific type of equipment (or manufacturer or model), unless called for by the test specification. Also, simulator requirements for thin-film devices are still being defined.

- C:** How shall a laboratory demonstrate long term measurements capability?
- R:** Laboratory quality assurance requirements are defined by PV-1: Criteria for a Model Quality System or Laboratories Engaged in Testing Photovoltaic Modules. Further, the Certification Program will require periodic audits of an accredited laboratory to maintain its accreditation.
- C:** (Re: 6.0 REPORTING)  
Define statistics; average within 5%? or each module data within 5%?
- R:** The intent was that the factory measurements for all nine modules must be within plus or minus 5% of the laboratory measurement. If not, then this discrepancy would have to resolved with the Certification Body before proceeding with the license to use the label. This conditions could require a re-audit of the manufacturer’s performance testing equipment and procedures to identify the source of error. The accredited laboratory will be required to validate their measurement accuracy on a periodic basis and such a discrepancy could trigger an unscheduled check.

- C:** ...[does] anyone really use ASTM E 1362 to calibrate reference cells? I don't believe that NREL or Sandia use that method.
- R:** NREL can and does calibrate reference cells per ASTM E 1362. However, they do not generally measure temperature coefficient unless requested to do so (temperature coefficient data increases the level of effort by a factor of four!). SNL, on the other hand, calibrates reference cells per ASTM E 1362 and routinely provides temperature coefficient data.

Recent data from six reference cells calibrated by NREL and SNL show that the calibration constants agree within  $\pm 1.6\%$  from the average value for a given reference cell.

**9. Minutes of the first committee meeting**  
(3/16/94, without attachments)

## OVERVIEW

The first meeting of the Criteria Development Committee was held on March 16 at the Howard Johnson Hotel, 225 East Apache Boulevard, Tempe, Arizona. The meeting was attended by 17 of the 29 committee members (see Attachment 1; shaded areas indicate members who attended.)

## OBJECTIVE OF MEETING

The objective of this meeting was to discuss broad issues related to the program *Photovoltaic Module Certification/Laboratory Accreditation Criteria Development*. The objective was not to review details of PV-1, PV-2 or PV-3.

A second objective of the meeting was to provide a tutorial on standard practices related to product certification and laboratory accreditation programs.

## APPROACH

On February 15, all committee members received a memo via facsimile defining the objective of the March 16 meeting. This notice also included a request to submit three questions, rank-ordered, that the member would like discussed at the meeting.

Members who submitted questions were:

- John Wohlgemuth, Solarex
- Steve Chalmers, Consultant
- Mark Genard, TI
- Moneer Azzam, Mobil Solar Energy Corp.
- Gobind Atmaram, FSEC
- Paul Taylor, Advanced Photovoltaic Systems
- Don Aldrich, Siemens Solar

A panel was present at the meeting to answer the above questions, plus questions from the floor during the meeting. The panel consisted of Gene Zerlaut, Byard Wood, Robert D'Aiello, and Carl Osterwald, with Bob Hammond as the facilitator.



## **AGENDA: March 16, 1994**

11:00–12:00	Tutorial
12:00–1:00	Lunch
1:00–5:00	Introductions (Panel, Team and Committee Members) Questions and Answers Discussion of the concept and approach to PV-3 Summary and Conclusions

## **TUTORIAL**

Carl Osterwald discussed the purpose and objective of the program. Bob Hammond followed with a brief description and status of the program, and then introduced Gene Zerlaut. Gene made a formal presentation with “overheads”, which are included herein as Attachment 2.

## **INTRODUCTION**

The panel members were introduced (Gene Zerlaut, Byard Wood, Robert D’Aiello and Carl Osterwald), followed by other members of the ASU team (Chuck Backus and Robert Sears), followed by committee members. In addition to the 17 members present (see Attachment 1), Dan Moesher (TI), Dick Addis (Consultant) and Meiji Takabayashi (USSC) were present.

A brief overview of the program was provided by Bob Hammond and copies of the following documents were distributed:

- PV-1b (since revised to PV-1c<sup>1</sup>; Attachment 3)
- PV-2b (since revised to PV-2c<sup>1</sup>; Attachment 4)
- *Rationale for the structure and format of Documents PV-1 and PV-2* (Attachment 5)
- partial drafts of Section 1 and 2 of the Final Report (Attachments 6).

Overhead transparencies of committee questions and prepared answers (Attachment 7) were used as a lead-in to topics of interest. Questions fell into three categories:

1. Costs associated with certification
2. The need for PV module certification
3. Structure of the certification program
4. Module performance ratings

During the discussions, information was requested on the *ISO 9000 Compendium*. Bob Hammond agreed to send a copy of the Table of Contents and ordering information (Attachment 8) to committee members.

The topic of module performance ratings was mentioned but detailed discussions were included in the following topic (PV-3).

## **DISCUSSION AND APPROACH TO PV-3**

Robert D’Aiello lead the discussion with two areas of focus: qualification test specifications and module performance testing.

John Wohlgemuth of Solarex expressed a desire that the PV-3 specification for qualification testing cover both the IEEE SCC 21 PAR 1262 and the IEC 1215 specification. There was general support of this approach from the committee members.

Dr. D'Aiello reviewed the issues regarding performance testing (Attachment 9). There was much debate but little agreement from the committee of how to structure the performance specification. There was agreement, however, that some sort of certified performance testing should be done.

## **SUMMARY AND CONCLUSIONS**

The meeting was successful and many positive comments were received from participants after the meeting. Gene Zerlaut's tutorial was well received and many compliments were received regarding Gene's tutorial and participation in the program. Committee members were very supportive of the program in general, with PV manufacturers in particular voicing strong support for an accreditation/certification program.

The overall conclusion from the meeting was that this program is on course and that we should continue on the current path.

**10. Minutes of the second committee meeting**  
(6/30/94, without attachments)

**OVERVIEW**

The second meeting of the Criteria Development Committee was held on June 30 at the Denver West Marriott Hotel, 1717 Denver West Boulevard, Golden, Colorado. The meeting was attended by 18 of the 30 Committee Members and eight non-members, for a total of 26 participants (see Attachment 1).

**OBJECTIVES OF THE MEETING**

The objectives of this meeting were to provide additional information (tutorials) on standard practices regarding product certification and accreditation programs, define the remaining steps required to establish a PV module certification program, discuss the philosophy behind the development of *PV-3 Testing Requirements For A Certification And Labeling Program* and provide Committee Members with an opportunity to ask questions concerning the certification/accreditation criteria program.

**APPROACH**

On June 3, all committee members received a memo via facsimile defining the agenda for the June 30 meeting. This notice also included a request to submit three questions, rank-ordered, that the member would like discussed at the meeting.

**AGENDA: JUNE 30, 1994**

8:00–11:00	TUTORIALS BY GENE ZERLAUT Review of March 16 tutorial Structure and function of a Certification Body Discussion of ANSI Accreditation of Certification Programs
11:00–12:00	QUESTIONS AND ANSWERS, FACILITATED BY BOB HAMMOND
12:00–1:00	LUNCH
1:00–3:00+	PV-3 BY BOB D'AIELLO Background, philosophy, first draft of PV-3 SUMMARY AND CONCLUSIONS

**TUTORIAL**

Gene Zerlaut provided a three-part tutorial starting with an overview of laboratory accreditation and product certification (Part 1). This material was a refresher for those who attended the March 16 meeting and a useful introduction for those who did not attend the March 16 meeting. A copy of Gene's overheads are included in Attachment 2.

Part 2 detailed the structure and function of the Certification Body (Attachment 3).

Part 3 described the American National Standards Institute, including purpose, goals and initial accreditation process (Attachment 4).

## QUESTIONS AND ANSWERS

Questions and comments received from Committee Members during the four weeks prior to the June 30 meeting were collected and answered via overhead slides (Attachment 5).

Members who submitted questions or comments prior to the meeting were: Gobind Atmaram, FSEC, Chuck Whitaker, ENDECON and John Wohlgemuth, Solarex. A panel was present to answer the above questions, plus questions from the floor during the meeting. The panel consisted of Bob D'Aiello, Bob Hammond, Carl Osterwald, and Gene Zerlaut.

### PV-3 TESTING REQUIREMENTS FOR A CERTIFICATION AND LABELING PROGRAM FOR PHOTOVOLTAIC (PV) MODULES

Bob D'Aiello described the three basic program documents, PV-1, PV-2 and PV-3 to put these documents in context and then devoted the remainder of the two hours to PV-3. Bob covered three main topics (Attachment 6):

- The specific test sequence which the laboratory must conduct
- Performance testing requirements
- Test procedures

Time did not permit Bob to cover the consolidated results of the PV-3 subcommittee correspondence which formed the basis for performance testing. Material which was prepared but not covered at the meeting is included in Attachment 7 for reference.

Copies of the first draft of PV-3 were distributed (Attachment 8). Committee Members were advised not to provide written response to this draft, since a revised draft (PV-3b) would be sent out about the end of July (with a request for written response).

Copies of "*Equipment And Apparatus Required For PV Module Certification*" were distributed (Attachment 9), but time did not permit discussion of this document. It will be included with PV-3b for comments.

Dick DeBlasio (NREL) suggested that it was inappropriate to call the proposed performance test a "performance rating" since this could be confused with an energy rating. There was general consensus to define the performance test as a "baseline performance measurement".

Moneer Azzam, Mobil Solar Energy Corporation, expressed a strong desire for a baseline performance measurement test which would allow the manufacturer to mark the module with the factory measured power  $P_{MP}$  (and  $I_{SC}$ ,  $V_{OC}$ ,  $V_{MP}$ ,  $I_{MP}$ ) and not to constrain the manufacturer to an "average power rating". There was general consensus to a two part solution: 1) have the certification body audit and "certify" the manufacturer's module power measurement program and 2) have the accredited laboratory verify the factory I-V curve data for the nine modules provided for qualification testing.

## SUMMARY AND CONCLUSIONS

Except for the performance measurement, PV-3 was, in general, acceptable to the Committee. It is expected that performance measurements will also be acceptable when proposed changes are incorporated in draft PV-3b.

Dick DeBlasio asked the question "where do we go from here?" There was little response from participants to this question. The ASU team volunteered to draft options for consideration.



# REPORT DOCUMENTATION PAGE

Form Approved  
OMB NO. 0704-0188

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6. AUTHOR(S)  C. R. Osterwald, <i>National Renewable Energy Laboratory</i> R. L. Hammond, B. D. Wood, C. E. Backus, R. L. Sears, <i>Arizona State University</i> G. A. Zerlaut, <i>SC-International Inc.</i> R. V. D'Aiello, <i>RD Associates</i>				
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13. ABSTRACT ( <i>Maximum 200 words</i> )  This document provides an overview of the structure and function of typical product certification/laboratory accreditation programs. The overview is followed by a model program that could serve as the basis for a photovoltaic (PV) module certification/laboratory accreditation program. The model covers quality assurance procedures for the testing laboratory and manufacturer, third-party certification and labeling, and testing requirements (performance and reliability).				
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