

# Five Reasons PV Modules Fail Product Certification Testing the First Time



## Introduction

Safety testing laboratories test products to ensure that they are compliant with prescribed, applicable standards. Testing and product certification are generally seen as the final hurdle before releasing a product to market.

When a product does not meet all of the requirements of the standard, the manufacturer must make appropriate corrections and repeat the testing process before receiving certification for market access. The time consumed by correcting problematic issues and retesting can have a profound impact on manufacturers, the most common being:

- Delays in getting to market
- Cost overruns
- Loss of market share
- Reduced profitability
- Lowered brand ranking

In the testing of PV modules, a large proportion of products do not receive certification based on their first testing cycle. This document addresses five of the most common reasons PV modules do not pass certification, and explains some of the reasons why they occur. PV module manufacturers can use this information to detect and avoid errors in the design and manufacturing stages, thereby saving considerable time, cost and frustration.

**Note:** All clause and sub-clause numbering used in this document refers to ANSI/UL 1703-2004 unless otherwise indicated.

## The most common problems

1. Inappropriate / incomplete installation instructions
2. Models provided for testing do not accurately represent the entire production model scheme being Listed (largest module must be submitted for test)
3. Testing requested without prior construction evaluation being performed
4. Complete bill of materials with ratings and certification information not provided prior to start of the project
5. Lack of Backsheet Panel RTI Rating

### #1: Inappropriate Installation Instructions

The most common source of problems for PV module certification is the documentation that accompanies the product. In over 85% of the modules Intertek has evaluated, installations instructions are incomplete or contain errors that must be corrected prior to testing for the product to be tested and receive certification.

Lack of clear instructions hampers the ability of the evaluating engineer to determine how the module is intended to be installed. Installation documentation is particularly important because numerous sections in UL 1703 are related to assessing the product after it has been installed according to its intended manner (as specified in the instructions). Missing or incomplete documentation makes it difficult and sometime impossible to evaluate a module. In many cases manufacturers try to use a single installation instruction manual to cover many different modules. This often results in instructions which are vague or contain irrelevant information.

Due to the fact that the instructions are usually the last step in the design process, manufacturers often submit modules without proper instructions. This drastically increases the time to complete the evaluation process. Even after this issue is presented to the manufacturer, it often takes several revisions to write instructions

which properly describe how to connect, secure, and electrically ground the modules.

When a testing laboratory receives a product for testing, the installation instructions are considered part of the equipment and must be delivered with the equipment for evaluation. In some cases, up to one-third of the conformity assessment time is spent reading and checking the installation instructions.

The following are common errors that have been identified in the review of installation instructions and can cause delays in product certification.

- Lack of explanation of symbols used on the equipment or diagrams.
- Instructions worded in a way that they do not adequately address intended use.
- The instructions are over-simplified, or vague.
- The instructions do not adequately cover user maintenance. Instructions should be written with an understanding of the technical and skill level of the intended reader.
- The instructions are adapted from another module and do not properly match the module being tested.
- Accessories are not itemized and explained in the manual.
- The language of the manual is unclear for the intended use.
- The name and address, telephone and fax number of the manufacturer is not clear (sometimes not even listed).
- Installation instructions provide inadequate details on how the grounding of the module is to be accomplished.
- Installation instructions are unclear regarding how the module should be secured to the mounting rack and to the building structure.



## **#2: Models provided for testing do not accurately represent the entire model scheme being listed**

Another source of delay in testing is the result of the proper model scheme not being defined clearly during the process setup. This is often the result of an incorrect assumption that testing any one of the many models that are built with the same materials will assure the approval of the entire model scheme. Such an assumption is not usually correct because the biggest (highest watt density) modules are usually the ones needed for testing due to the failure rate of higher size modules during temperature cycling and loading tests. Additionally, the requirements are always to test the higher power modules.

In some cases, a manufacturer will add bigger and higher power modules than those available at the beginning of the test process, mainly because the added modules were not available before the evaluation and testing began. This problem can be avoided by having a clear definition of the scope of equipment to be included in the evaluation at the beginning of the quote stage. If a manufacturer makes changes to the scope of equipment covered by an evaluation after the testing has begun, it usually results in significant delays and often requires that certain portions of the evaluation and testing be repeated.

## **#3: Testing requests without the initial construction evaluation being performed**

Since temperature testing test takes several weeks to complete, it is not uncommon for manufacturers to request starting this test as soon as possible. However, temperature testing without first performing the construction evaluation on the module can lead to having to repeat the test. This is because assumptions must be made as part of the test setup which cannot be confirmed without the construction evaluation. Key areas are identified during the construction evaluation which will lead to proper sample preparation and ensure that the right samples are chosen with the right components.

## **#4: Not providing a complete bill of materials with ratings and certification information prior to start of the project**

Not providing a complete bill of materials is another common issue causing delays in PV modules testing. Because of tight timelines and time to market demands manufacturers occasionally provide bills of materials that are missing certification ratings. This leads to tests being performed without checking to make sure that the ratings of the modules' different materials are within the ratings of the tests being performed. Without the proper bill of materials it is not possible to determine the rating of the sample. If any of the materials do not have ratings, it is not possible to allow modules with those alternate components to be included in the listing.

## **#5: Lack of Backsheet panel RTI rating**

The requirement in UL 1703 clause 7.3 states:

*7.3 A polymeric substrate or superstrate shall have a thermal index, both electrical and mechanical, as determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, not less than 90°C (194°F). In addition, the thermal index shall not be less than 20°C (36°F) above the measured operating temperature of the material. All other polymeric materials shall have a thermal index (electrical and mechanical) 20°C above the measured operating temperature. The measured operating temperature is the temperature measured during the open-circuit mode for Temperature Test, Section 19, or the temperature during the short-circuit mode, whichever is greater.*

About 95% of substrates in the market today do not have the minimum RTI value as required by clause 7.3.

The practice has been to use the RTI of the outer layer. If the outer layer is a spray-on thin coating it will not be considered for the RTI requirement. If the middle layer of the substrate has an RTI of less than 90 it will not be acceptable. If we try to establish an RTI of 90 for such a laminate, this middle layer will likely fail and the laminate will destabilize.

The inner layer mentioned is often the same as the encapsulant for the cells in the module. Since Encapsulants do not need to meet the RTI requirement in clause 7.3, the engineering rationale has been that this layer of the laminate does not need to have an RTI of 90.

As an interim arrangement until the manufacturers of substrates obtain recognition and RTI ratings, Intertek has agreed that if a laminate is recognized for the application (substrate in PV module), then it can be used without specifically identifying the RTI of the laminate, provided that:

- Documentation that the material is recognized for the application is provided, and
- Documentation, from the substrate vendor, of the RTI values of individual layers in the laminate is provided.

## How to avoid these failures

What are the root causes behind these common problems? In some cases design engineers don't have copies of the standard(s) they need to meet. In other cases they "design to the specification" given to them by marketing, or the edition or revision of the standard they followed is out of date. Pressure to cut costs and shorten time to market also have effects, resulting in the selection of components that require additional evaluation by the certification body to determine suitability.

One way to avoid these problems is to conduct a full and detailed risk analysis of the intended use of the module based on the modes of installation. Start the risk analysis before starting the design. Continue the risk assessment throughout the design process to make sure your design is addressing the identified risks and is compliant with the standard. Designing your device using a risk-based model usually means that the device will be compliant.

The following are additional simple steps that ensure fast and smooth certification:

1. Seek assistance from qualified sources early in the design cycle. For example, work with your test lab for a design review based on documentation and drawings. This will identify potential problems early in the cycle and you will be able to use the information for future products.
2. Qualify the components you intend to use. Don't take the supplier's word for it – secure proof that the component is “approved for the application.”
3. Ensure that the wiring you use is the correct type and rating for the circuit application.
4. Make current copies of the standards available to the designers and extract the tables that apply to your product (this saves a lot of time flipping backwards and forwards).
5. Using the tables you extracted from the standards, clearly define the required elements for compliance in the design specification. This may sound simple, but very few do this. Those who do can save themselves thousands of dollars in rework.
6. Produce an illustration detailing the different components in the module. This will save you time and money when doing conformity assessment testing.

## For more information

If you'd like to connect with an expert to answer your technical questions, or obtain a quote for a new testing project, contact Intertek at [icenter@intertek.com](mailto:icenter@intertek.com) or 1-800-967-5352.