



Association of Public Insurance Companies (APIB)
Association des établissements cantonaux d'assurance incendie

HAIL IMPACT PROTECTION REGISTER HSR

APIB Test Specification No. 25

Photovoltaic Modules

01.11.2016 / 25-16en
Version 1.03

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25 Photovoltaic modules

25.1 General information

The test specifications for the "Photovoltaic modules" component category includes additional, component specific provisions for the standard test, which are not governed by the general test specifications. The test specification applies to all PV modules covered in the scope of standard IEC 61215 Terrestrial photovoltaic (PV) modules:

Group I	IEC 61215-1-1: Crystalline silicon photovoltaic (PV) modules
Group II	IEC 61215-1-2: Thin-film Cadmium Telluride (CdTe) based photovoltaic (PV) modules IEC 61215-1-3: Thin-film amorphous(a-Si) and microcrystalline ($\mu\text{c-Si}$) silicon based photovoltaic (PV) modules IEC 61215-1-4: Thin-film Cu (In, GA)(S, Se) based photovoltaic (PV) modules
Group III	IEC 61215-1-5: Flexible photovoltaic modules.

The application of test results and their transferability to other module types is determined according to the provisions in *IEC Retesting Guidelines IEC 62915 TS*. This APIB test specification is, to the extent possible, based on current standards for photovoltaic modules. It will be adjusted or withdrawn as soon as appropriate international standards are available.

25.2 Test specimen

The test specimen consists of an entire PV-module mounted according to the supplier's instructions.

For Group I and Group II modules that are produced in various sizes, the following directives apply: (*IEC 62915 TS, 4.1.12 und 4.2.15*):

In the case of modules having transparent cover plates made of tempered glass, the test can be performed on a representative module;

In the case of modules having other types of transparent cover plates, the test must be performed on a module having a size that is at least 80% of the maximum module size.

For Group III flexible terrestrial photovoltaic modules sold in integral combination with another material element (e.g., waterproofing membrane, polymeric plate, metal sheet), the test specimen consists of a commercially available module having an adequate size so that all relevant impact target zones can be tested. The test specimen must include support components (e.g., concrete slab, thermal insulation board, etc.), and be specified, mounted, and tested as installed in practice.

25.3 Test set-up

The entire test assembly (i.e., PV module and support components) must be stiff enough such that only negligible torsion or bending of the entire assembly can occur during impact.

25.4 Specimen storage prior to testing (conditioning)

If a proposed impact target zone is made of a material other than glass or metal, the test specimen must be stored (conditioned) in the testing environment for at least 3 days before testing. If all proposed impact target zones consist of glass or metal, no special storage (conditioning) is required

25.5 Specimen treatment before testing

For an impact target zones made of polymers, the surface is cooled with ice chips for 3 minutes before ice balls are fired. Otherwise, no pre-treatment is required.

25.6 Target area and angle of impact

The PV-modules must be impacted at the target locations according to Table 1 or Figures 1 and 2. The standard IEC 61215-2 forms the basis for the testing.

Shot No.	Location
1	A corner of the module cover plate, not more than 50 mm from the frame
2	An edge of the module, not more than 12 mm from the frame
3, 4	Above edges of cells, near electrical connections
5, 6	Above electrical connections near cells joints and bus bars
7, 8	On the module cover plate, not more than 12 mm from one of the points at which the module is fixed to the supporting structure
9, 10	On the module cover plate, at points farthest from the points selected above
11 and ff.	Any points which may prove especially vulnerable to hail impact

Table 1 Impact locations for PV-modules, graphically displayed in Figures 1 and 2

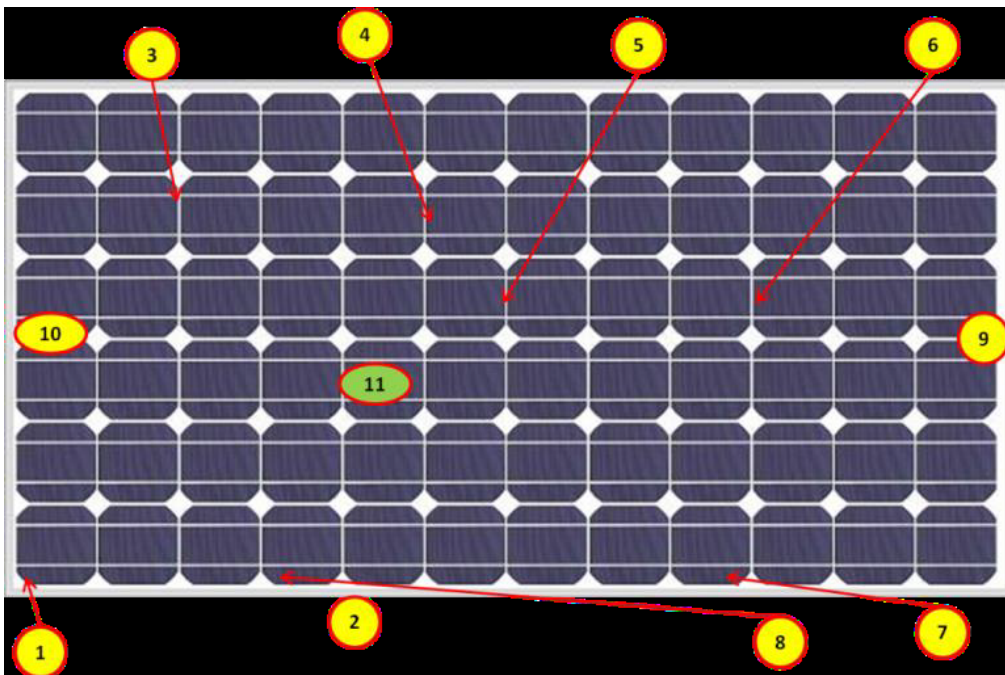


Figure 1 View of impact locations for modules of Groups I and III (if crystalline cells are installed) (See list in Table 1.)

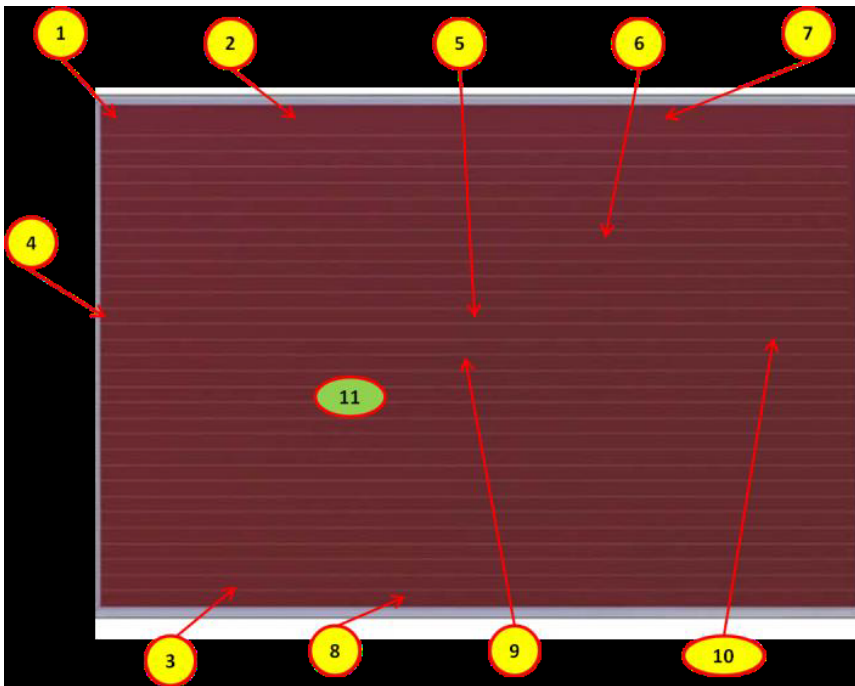


Figure 2 View of impact locations for modules of Groups II and III (if thin film technology is applied),(See list given inTable 1.)

The list of impact locations (Table 1) is a minimum requirement and therefore not exhaustive. In addition, the following directive applies: If there are any other obvious critical target areas which have an effect on appearance, performance, durability or safety (e.g. framing, mounting or fastening components, exposed elements, electrical connectors, encapsulations, etc.), such locations must be tested as well (refer to Part A). Each additional critical target area must be tested separately.

In the case of frameless modules, mounting or fasteneing components must be tested. The additional critical target areas that were impacted must be marked and identified along with photographs in the test report. The report must also confirm that no other critical target areas were identified.

25.7 Invalid shots

Invalid shots with ice balls having an impact energy outside the tolerance range have to be listened in the test records. Shots with an energy below the class limit are invalid and must be repeated. Shots with an excessive energy are valid, if the test specimen is undamaged. If the test specimen is damaged, the test must be repeated using a new test specimen.

25.8 Component function

The photovoltaic module specimen is assessed for mechanical performance and appearance.

25.9 Damage criterion

Mechanical performance function: Any kind of damage of the PV-module which may reduce

- lifetime (e.g., leakage, water penetration,),
- performance (e.g., cell fractures , damage to conductors,.....)
- product safety (e.g., loose parts,.....).

A listing can be found in Section 8 of the current standard IEC 61215-1.

Appearance function: Permanent optical changes caused by the ice ball impact.

25.10 Measuring methods

Mechanical performance function: For the mechanical performance function, the following assessments must be performed:

- Visual assessment (MQT 01) according to chapter 4.1 of standard IEC 61215-2.
- Test for current leakage when wet (MQT 15) according chapter 4.1 of standard IEC 61215-

Appearance function: The appearance of the PV-module is visually checked under all light conditions and at all possible angles at a distance of 5 m from the test specimen.

25.11 Test report

The test report must contain all information as required in accordance with test specification no. 00b, General Part B, Chapter 0.1 as well as all technical information as required for a test report in accordance with IEC 61215. If a PV-module has been tested by an accredited testing institute in accordance with IEC 61215, and if this test report is fully available, the technical information can be referenced to this test report. The appropriate IEC 61215 test report will be part of the VKF test report. It must be submitted together with the VKF test report.

In addition, the thickness of any materials that would be in practice exposed to the weather, in particular the transparent cover plate, must be measured by adequate means. The data must be included in the test report.

The scope of the test report and the procedure for any modifications of the product are defined by IEC Retesting Guidelines (IEC 62915 TS).

25.12 Existing standards and regulations (not exhaustive)

- IEC 61215-1: Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1: Test requirements
- IEC 61215-1-1: Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
- IEC 61215-1-2: Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-2: Special requirements for testing of cadmium telluride (CdTe) photovoltaic (PV) modules
- IEC 61215-1-3: Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-3: Special requirements for testing of amorphous silicon (a-Si) and microcrystalline silicon ($\mu\text{-Si}$) photovoltaic (PV) modules
- IEC 61215-1-4: Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-4: Special requirements for testing of copper indium gallium selenide (CIGS) and copper indium selenide (CIS) photovoltaic (PV) modules
- IEC 61215-1-5: Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1-5: Special requirements for testing of flexible (non-glass superstrate) photovoltaic (PV) modules
- IEC 61215-2: Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 2: Test procedures
- IEC 62915 TS: Photovoltaic (PV) modules - Retesting for type approval, design and safety qualification