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Edition 2.0 2022-06
COMMENTED VERSION

INTERNATIONAL STANDARD

colour inside

Photovoltaic (PV) modules – Transportation testing – Part 1: Transportation and shipping of module package units

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PHOTOVOLTAIC (PV) MODULES – TRANSPORTATION TESTING –

Part 1: Transportation and shipping of module package units

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This commented version (CMV) of the official standard IEC 62759-1:2022 edition 2.0 allows the user to identify the changes made to the previous IEC 62759-1:2015 edition 1.0. Furthermore, comments from IEC TC 82 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 62759-1 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems. It is an International Standard.

This second edition cancels and replaces the first edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Cancellation of tests and references to relevant standards for CPV.
b) Deletion of different classes for PV modules.
c) Deletion of requirement for minimum 10 modules per shipping unit.
d) Implementation of stabilization as intermediate measurement.
e) Addition of pass/fail criteria.
f) Change of requirements for retesting.
g) Change of number of cycles in dynamic mechanical load test. See also clause 6.4.2.1.

The text of this International Standard is based on the following documents:

Draft	Report on voting
82/2029/FDIS	82/2052/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

A list of all parts in the IEC 62759 series, published under the general title *Photovoltaic (PV) modules – Transportation testing*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

PHOTOVOLTAIC (PV) MODULES – TRANSPORTATION TESTING –

Part 1: Transportation and shipping of module package units

1 Scope ~~and object~~

Photovoltaic (PV) modules are electrical devices intended for continuous outdoor exposure during their lifetime. Existing type approval standards do not consider mechanical stresses that may occur during transportation to the PV installation destination.

This part of IEC 62759 describes methods for the simulation of transportation of complete package units of modules and combined subsequent environmental impacts~~, it does however not include pass/fail criteria~~. 1

~~This standard is designed so that its test sequence can co-ordinate with those of IEC 61215 or IEC 61646, so that a single set of samples may be used to perform both the transportation simulation and performance evaluation of a photovoltaic module design. This standard applies to flat plate photovoltaic modules, but may also be used as a basis for testing of CPV modules and assemblies.~~ 2

A list of design modifications which require a retest is provided in Annex B.

This document applies to flat plate photovoltaic modules.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-27:2008, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

~~IEC 60068-2-64, *Environmental testing – Part 2-64: Tests – Test Fh: Vibration, broadband random and guidance*~~

IEC TS 60904-13, *Photovoltaic devices – Part 13: Electroluminescence of photovoltaic modules*

~~IEC 61215:2005, *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*~~

IEC 61215-1:2021, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements*

IEC 61215-2:2021, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

~~IEC 61646:2008, *Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval*~~

IEC 61730-2:~~2004~~2022, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

IEC TS 61836, *Solar photovoltaic (PV) energy systems – Terms, definitions and symbols*

~~IEC 62108:2007, *Concentrator photovoltaic (CPV) modules and assemblies – Design qualification and type approval*~~

IEC TS 62782:2016, ~~*Dynamic mechanical load testing for*~~ *Photovoltaic (PV) modules – Cyclic (dynamic) mechanical load testing* ~~(to be published)~~

~~ISO 13355, *Packaging – Complete, filled transport packages and unit loads – Vertical random vibration test*~~

ASTM D880-92~~:2008~~, *Standard Test Method for Impact Testing for Shipping Containers and Systems*

~~ASTM D4169:2008, *Standard Practice for Performance Testing of Shipping Containers and Systems*~~

ASTM D4169-16, *Standard Practice for Performance Testing of Shipping Containers and Systems*

ASTM D4728:2006, *Standard Test Method for Random Vibration Testing of Shipping Containers*

ASTM D5277-92~~:1992~~, *Test method for performing programmed horizontal impact using an inclined impact tester*

ISTA 3E:~~2009~~2017, *Unitized Loads of Same Product*

~~MIL-STD-810G, *Test Method Standard for Environmental Engineering Considerations and Laboratory Tests*~~

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836~~:1999~~ and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
bandwidth
difference in Hz between the upper and lower limits of a frequency band

Note 1 to entry: For the purposes of the described test method, the bandwidth may be considered equivalent to the frequency resolution of a spectrum analysis.

3.2
overall g_{RMS}
square root of the integral of power spectral density over the total frequency range

Note 1 to entry: It describes the severity or harshness of the testing grade.

3.3
root mean square
RMS
square root of the mean square value

Note 1 to entry: In the exclusive case of a sine wave, the RMS value is 0,707 times peak value.

3.4
random vibration
oscillation whose instantaneous amplitude is not prescribed for any given instant in time

Note 1 to entry: The instantaneous amplitudes of a random vibration are prescribed by a probability distribution function, the integral of which, over a given amplitude range, will give the probable percentage of time that the amplitude will fall within that range.

Note 2 to entry: Random vibration contains no periodic or quasi-periodic components.

3.5
packaging
material and technology used to protect goods from transportation stresses and separate individual units from each other

3.6
power spectral density
PSD
expression of random vibration in terms of mean square acceleration per unit of frequency~~. The units are g^2/Hz (g^2/cycles/s).~~

Note 1 to entry: Power spectral density is the limit of the mean square amplitude in a given rectangular waveband divided by the bandwidth, as the bandwidth approaches zero.

Note 2 to entry: The units are $(m/s^2)^2$/Hz, it is equal to m^2/s^3. The coherent non-SI unit is g^2/Hz.

~~**3.7**~~
~~**grade A PV modules**~~
~~100 % functional modules without any visual or functional defects~~

~~**3.8**~~
~~**grade B or lower PV modules**~~
~~grade B or lower modules may have visual or functional defects. The modules should be equivalent to grade A modules regarding their mass, size and mechanical behavior.~~

4 Sampling

As test samples for the basic transportation and shock test methods, a shipping unit of PV modules, shall be taken at random from a production batch or batches. When the test samples are prototypes of a new design and not from production, this fact shall be noted in the test report. The shipping unit shall contain the usual~~ amount~~ number of PV modules.~~ This test procedure is however designed for shipping units containing at least 10 modules. For further testing (path A and B for PV modules) at least six grade A modules are needed from the shipping unit.~~ 3

Further three~~ grade A~~ PV modules are to be taken from a separate shipping unit not undergoing any transportation simulation.

~~Grade B or lower modules can be used to fill up the shipping system (uniform distribution) of samples, completing it to a regular shipping unit. Each individual substitute shall cover the same mass, size and bending stiffness as the modules to be tested in the subsequent environmental impact tests.~~

~~The shipping unit shall contain at least 25 % grade A modules. If the shipping unit contains less than 24 modules at least six grade A modules shall be provided.~~

~~In case of horizontal shipping the bottom and the top of the shipping unit shall be made up with grade A modules and in case of vertical shipping the outer modules of the shipping unit shall be made up with grade A modules.~~

Use the regular shipment packaging materials with the modules, as marketed and designed by the manufacturer.

The modules shall have been manufactured from specified materials and components in accordance with the relevant drawings and process sheets and shall have been subjected to the manufacturer's normal inspection, quality control and production acceptance procedures.

The modules shall be complete in every detail, including a type label and shall be accompanied by the manufacturer's handling, mounting, shipping/packaging and installation instructions, including the information of the maximum permissible system voltage.

The test specimen of shipping unit shall be packed in accordance with the standard procedures used to ship modules to customers.

~~NOTE For CPV modules the sample numbers may vary, as shipping units may be much larger.~~

5 Handling

The test samples shall be handled with suitable care prior to the application of the tests described in this document. It ~~shall~~ should be ensured that the test samples are not exposed to additional mechanical impacts in form of shocks, rough handling, dropping, etc.

For the transportation from the manufacturer to the test laboratory special care should be taken to avoid any kind of damage. A special packaging concept, e.g. an additional packaging, special transportation method, etc., may be considered for this particular shipping route (manufacturer – test site). Testing shall be carried out without additional packaging.

6 Testing procedures

6.1 General

Performance measurements, visual inspection, insulation and wet leakage current testing shall be performed in accordance with ~~IEC 61215:2005 respectively IEC 61646:2008, 10.2, 10.3 and 10.15~~ IEC 61215-2:2021, MQT 01, MQT 02, and in accordance with IEC 61730-2:2022, MST 16 and MST 17 as ~~relative~~ reference initial and control measurements. ~~Electroluminescence or thermal images can be used to support the evaluation of the samples initial and intermediate status (e. g. micro cracks, defects, etc.).~~

~~The initial and visual inspection in accordance with IEC 61215:2005, 10.1 or IEC 61646:2008, 10.1 for PV modules and IEC 62108:2007, 10.1 for CPV modules shall also be part of the assessment.~~

Electroluminescence images according to IEC TS 60904-13 may be used to detect cracks which are not visible at initial and intermediate status (no pass/fail criteria are specified).

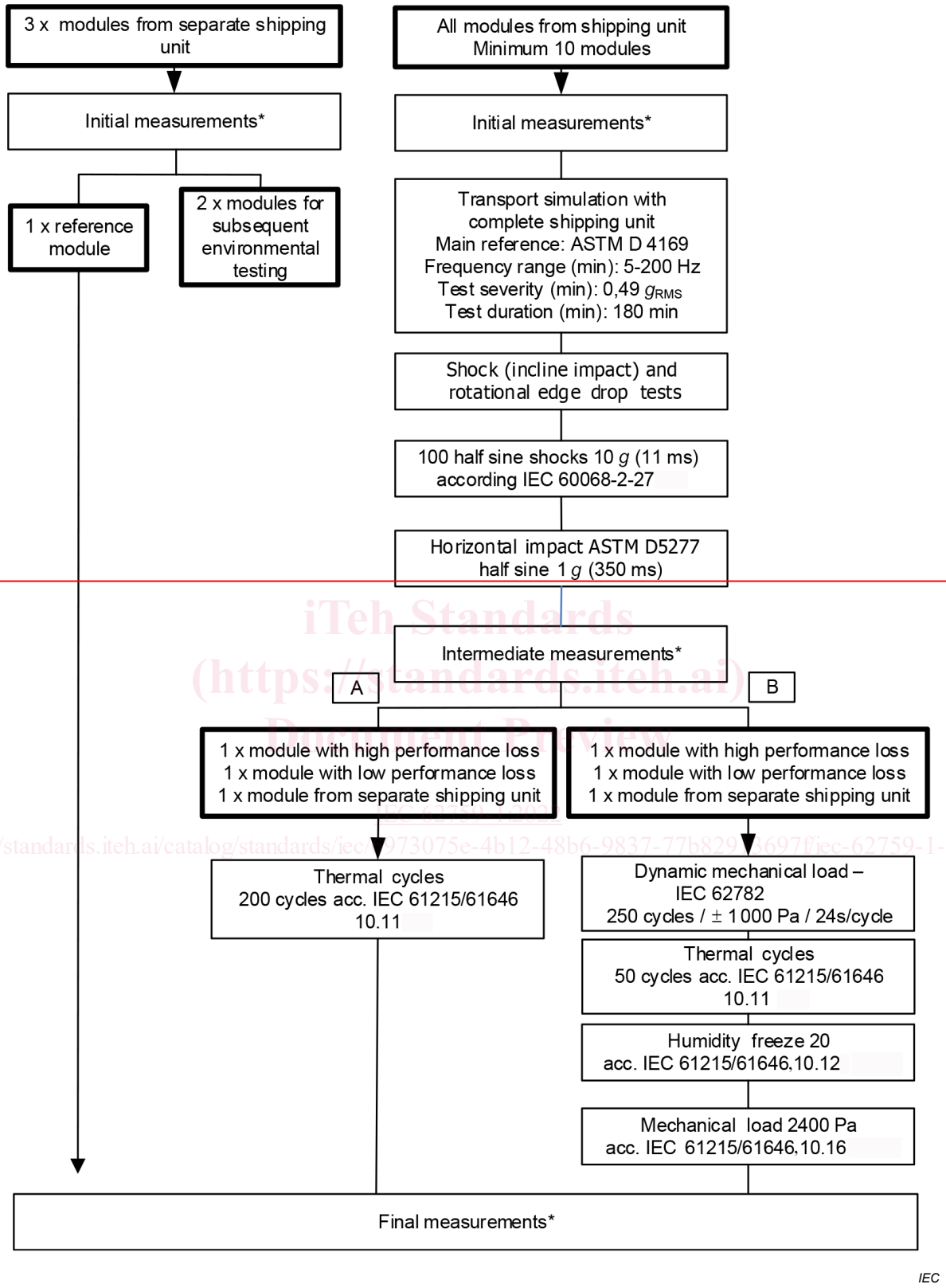
The actual transportation test is shown in Figure 1 ~~for PV modules; Figure 2 shows a possible test sequence for CPV modules~~. The sequences of combined transportation stress testing and the possible effects of these impacts on the PV modules shall detect early failures in regards to future life time stresses.

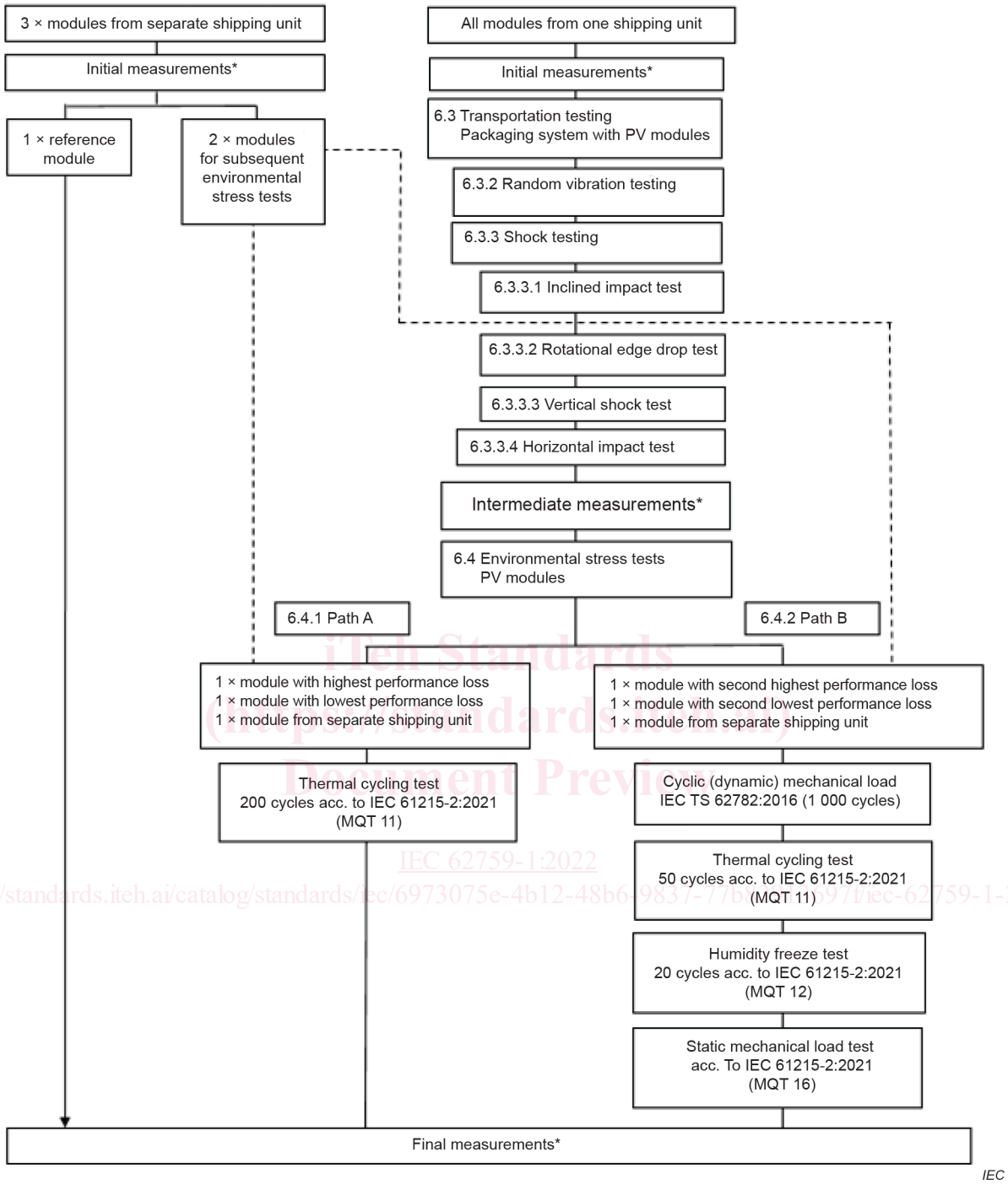
~~If a manufacturer wishes to combine the testing to this standard with type approval testing, sequence A of Figure 1 can also be used in conjunction with IEC 61215 respectively IEC 61646 testing. Combined testing will increase the risk of failure in type approval testing, as the transportation testing will pose additional stress to the samples.~~ **4**

~~Sequence B of Figure 1 could be extended with the UV preconditioning test and then also be coordinated with IEC 61215 respectively IEC 61646.~~

~~The proposed test sequence in Figure 2 for CPV modules can also be adjusted to coordinate with IEC 62108. The sequence shall be adjusted depending on whether receivers or modules are tested. For receivers, instead of the pre-thermal cycling and humidity freeze test, the thermal cycling test according to IEC 62108:2007, 10.8 may be performed.~~

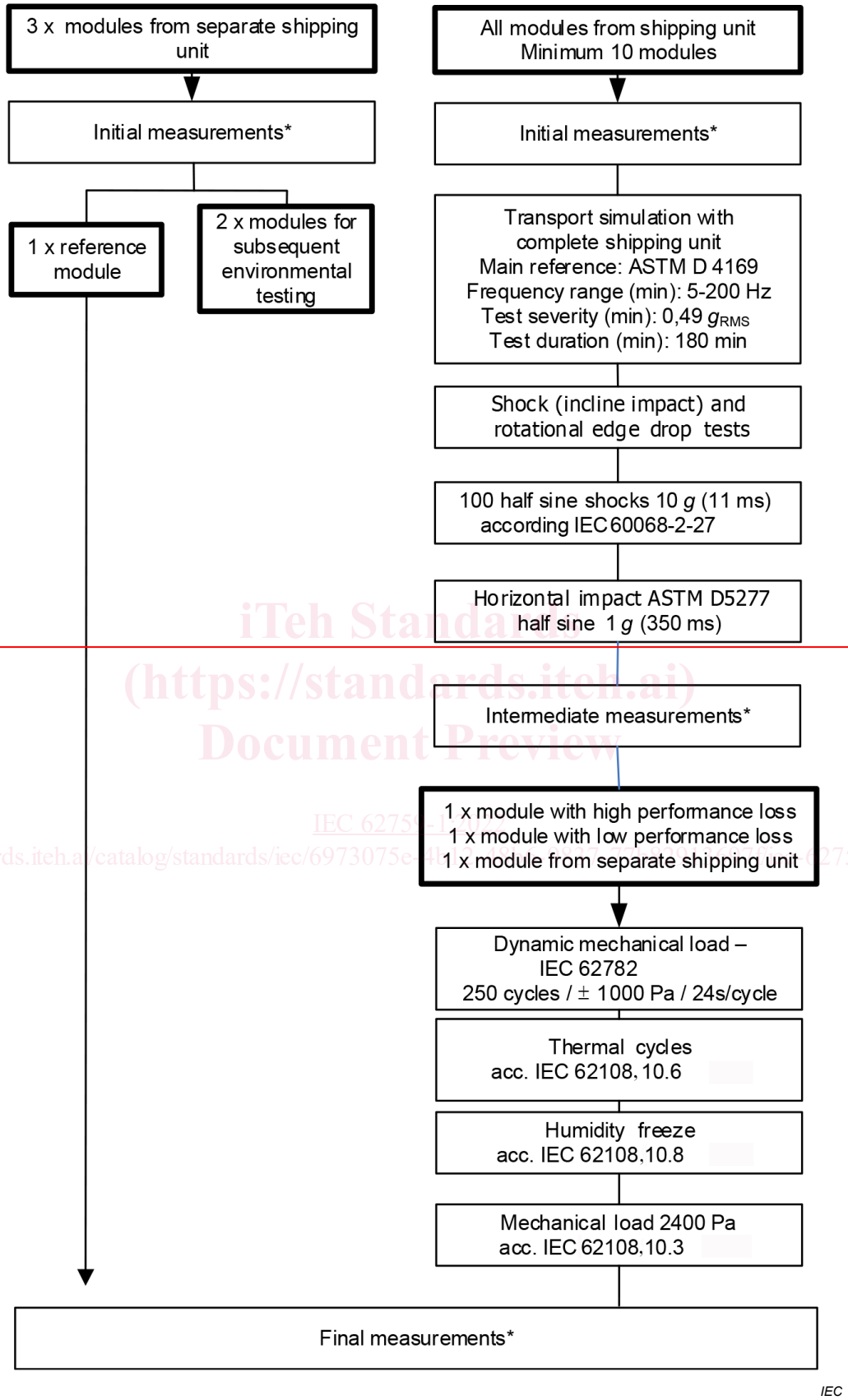
Separate modules, that have not undergone any transportation testing, are also subjected to the stress tests in sequences A and B.~~ Failures induced by the transportation simulation and potentially worsen defects due to the environmental stress tests shall be identified in comparison to the modules tested without any transportation pre-damages.~~ These modules shall be used to identify if defects are caused by transportation test and subsequent environmental test, or by environmental test only.





* See 6.2 for details on measurements.

Figure 1 – Test sequences for PV modules 5



* See 6.2 for details on measurements.

Figure 2 – Test sequences for CPV modules