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**Environmental and endurance test
methods for crystalline solar PV
modules**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS C 8917:1989** is replaced with **JIS C 8917:1998**.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

The provisions of **IEC 61215** except those specified in this Standard are specified in the following standards.

JIS C 8916 *Temperature coefficient measuring methods of output voltage and output current for crystalline solar cells and modules*

JIS C 8918 *Crystalline solar PV modules*

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Environmental and endurance test methods for crystalline solar PV modules

Introduction In the application of a standard, the normative references to the standard shall be simultaneously referred to. It is often necessary to compare with similar standards, if any.

This Japanese Industrial Standard has been prepared based on the corresponding portions of IEC 61215 *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*, published in 1993 and IEC 61701 *Salt mist corrosion testing of PV modules*, published in 1995, without any modification in technical contents, but specification items (heat resistance test, waterproof test) which are not stated in the corresponding International Standard are added.

In the said International Standard, Measurement of operating cell temperature, Performance at NOCT, Performance at low irradiance, NOCT and UV test (for UV test, items only) are specified. As for these items, appropriateness of these tests is now under investigation, and inclusion of these items into this Standard will be considered after the results of present investigation.

1 Scope This Japanese Industrial Standard specifies environmental and endurance test methods for evaluation of endurance of terrestrial non-condensing type crystalline solar cell modules for use in a solar photovoltaic energy system installed on the ground (hereafter referred to as “modules”) under various environmental conditions to which they are exposed during use, storage and transportation.

Remarks: Normative references cited in this Standard are given below.

- JIS A 4111 *Solar water heater for dwellings*
- JIS B 7753 *Light-exposure and light-and-water-exposure apparatus (Open-flame sunshine carbon-arc type)*
- JIS C 0021 *Basic environmental testing procedures Part 2: Tests, Test B: Dry heat*
- JIS C 0022 *Basic environmental testing procedures Part 2: Tests, Test Ca: Damp heat, steady state*
- JIS C 0024 *Basic environmental testing procedures Part 2: Tests – Test Kb: salt mist, cyclic (Sodium chloride solution)*
- JIS C 0920 *Tests to prove protection against ingress of water and degrees of protection against ingress of solid objects for electrical equipment*
- JIS C 8912 *Solar simulators for crystalline solar cells and modules*
- JIS C 8914 *Measuring method of output power for crystalline solar PV modules*
- JIS C 8918 *Crystalline solar PV modules*
- JIS D 0205 *Test method of weatherability for automotive parts*
- JIS R 3212 *Test method of safety glazing materials for road vehicles*

2 Definitions For the purpose of this Standard in addition to the definitions in **JIS C 8918**, the following principal definitions apply.

- (1) **specimen** A module which is used for test.
- (2) **standard atmospheric conditions** Allowable range of atmospheric conditions of the test place for carrying out all the tests and measurements.
- (3) **black panel** A metal plate coated with black matt paint to absorb majority of incident light.

Remarks: This is used to simulate the temperature rise of module with a thermometer attached.

- (4) **mini-module** A small sized module to facilitate testing having similar construction to that of modules actually used. Its performances shall have correlation with that of modules actually used.
- (5) **hot spot** The part of a module where the temperature rises locally when the sunlight is locally screened, or when a fault or deterioration of characteristics occurs in a part of solar cells comprising the module.

3 Tests

3.1 Standard conditions The standard conditions shall be a temperature of 15 °C to 35 °C, a relative humidity of 45 % to 75 % and an air pressure of 86 kPa to 106 kPa.

3.2 Classification of tests The tests are classified into environmental test, endurance test and other test, and further classified into the detail tests accompanied with the symbols as given below.

(1) Environmental tests

Thermal cycling test A-1

Damp heat cyclic test A-2

Robustness of termination test A-3

Salt mist corrosion test A-4

Irradiation test A-5

Hot spot test A-6

Wind resistance test A-7

Hail resistance test A-8

Waterproof test A-9

Twist test A-10

(2) Endurance tests

Dry heat (Hot storage) test B-1

Damp heat steady state test B-2

(3) **Other test**

Sequence test D-1

3.3 Test methods The methods for the tests shown in 3.2 shall be as specified in Annexes 1 to 11. However, the methods for hot spot test A-6 and sequence test D-1 are subject to agreement between the parties concerned with the acceptance.

Hot spot test A-6 and sequence test D-1 are shown in Informative references 1 to 3.

To make the measurement conditions as same as possible at the beginning and end of testing a module, the same solar simulator shall be used. It is desired that the irradiance and the spectrum remain without change during a test duration.

The solar simulator of grade B specified in **JIS C 8912** and upward shall be used.

Annex 1 (normative) Thermal cycling test A-1

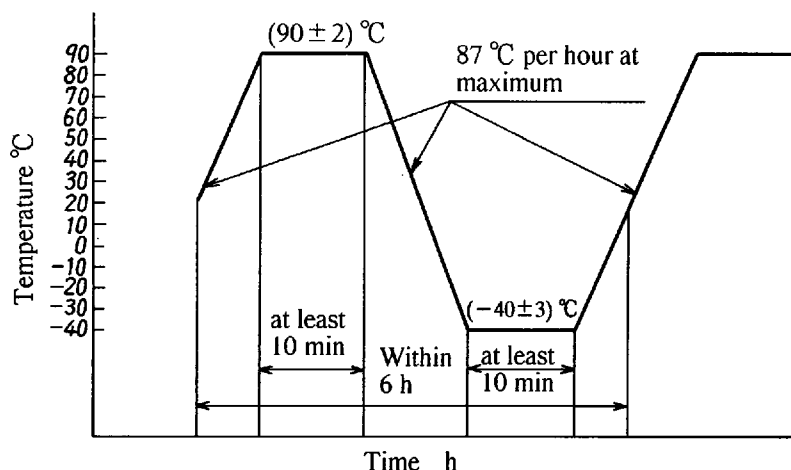
1 Purpose The purpose of this test is to determine the ability of the module to withstand repeated rapid change of temperature.

2 Equipment The test chamber for this test shall be capable of controlling the chamber temperature so that the module is maintained at specified temperatures, and the temperature can be continuously varied from a high temperature to a low temperature or vice versa at variable rate. The test chamber shall be so constructed that whole of the specimen is heated or cooled almost uniformly.

3 Preparation and mounting The terminations of the module, being opened, shall be covered with an insulating tape of p.v.c. or the like to prevent corrosion, and the specimen shall be mounted on a position in the test chamber where it will not disturb the ventilation of chamber. A mini-module which has the same characteristics as those of the module to be tested may be used as the specimen.

4 Test procedures The test procedures shall be as follows:

- (1) Prior to the test of specimen, measure the electrical performances specified in 6.1 of JIS C 8918, and visually examine the appearance.
- (2) Put the specimen into the chamber, maintain the specimen for 10 minutes or more in the chamber at a high temperature of $90^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and a low temperature of $-40^{\circ}\text{C} \pm 3^{\circ}\text{C}$ as shown in Annex 1 Fig. 1, and change the temperature from the high temperature to the low temperature and vice versa at a rate of 87°C per hour at the maximum. Count these operations as one cycle and carry out one cycle within 6 h. Unless otherwise specified, subject the specimen to 200 cycles continuously.
- (3) After completion of the last cycle, allow the specimen to stand under the standard atmospheric conditions for 4 h to 16 h, then measure the electrical performances specified in (1) and visually examine the appearance.
- (4) Monitor the module temperature continuously during the test by attaching a temperature sensor to a part of the specimen.



Annex 1 Fig. 1 Conditions for repeated change of temperature test

5 Items to be specified in detail specifications The following items shall be specified in detail specifications:

- (1) Initial measurement items (if necessary) [see 4 (1)]
- (2) Final measurement items (if necessary) [see 4 (3)]

Annex 2 (normative) Damp heat cyclic test A-2

1 Purpose The purpose of this test is to examine the deterioration of a module when the module is used and stored being subjected to temperature change at high relative humidity, in a short period.

2 Equipment The test chamber for this test shall satisfy the following requirements:

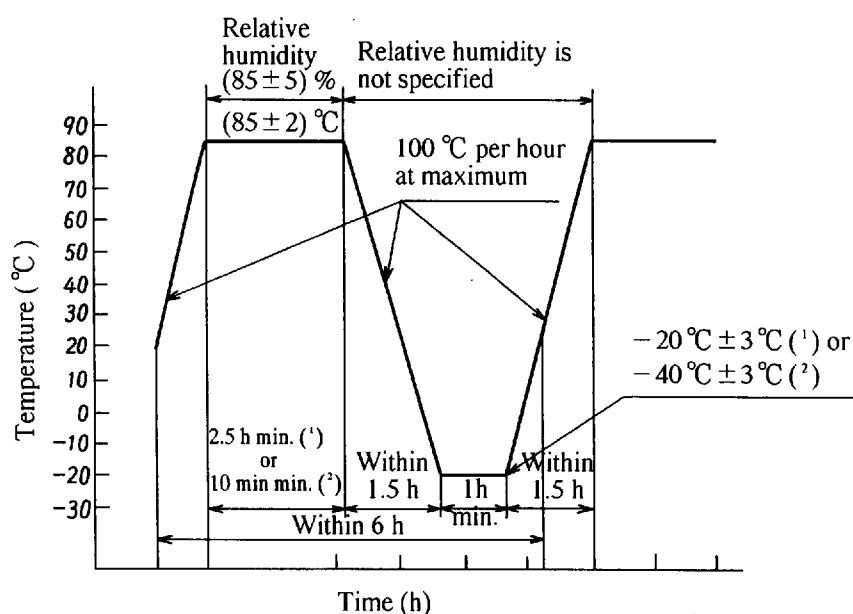
- (1) The chamber shall be capable of adjusting the temperature and relative humidity in the chamber as illustrated in Annex 2 Fig. 1.
- (2) The water condensed on the inner wall and ceiling of test chamber shall not fall on the specimen or in the vicinity of specimen.

3 Preparation and mounting The specimen shall be so installed that its light receiving surface is vertical and it does not disturb the air flow in the test chamber remarkably.

The terminations of the module, being opened, shall be covered with insulating tape of p.v.c. or the like to prevent corrosion. The mini-module which has the same characteristics as those of the module to be tested may be used as the specimen.

4 Test procedures The test procedures shall be as follows:

- (1) Prior to the test of specimen, measure the electrical performances specified in 6.1 of JIS C 8918, and visually examine the appearance.
- (2) Count the operations shown in Annex 2 Fig. 1 as one cycle. Carry out the test of one cycle within 6 h. Employ -20°C or -40°C as the low temperature. Subject the specimen to 10 cycles continuously.
- (3) After completion of the last cycle, allow the specimen to stand under the standard atmospheric conditions for 4 h to 16 h, then measure the electrical performances specified in 6.1 of JIS C 8918 and visually examine the appearance.



Annex 2 Fig. 1 Conditions for damp heat cyclic test

- Notes (1) When $-20\text{ °C} \pm 3\text{ °C}$ is employed as the low temperature, the duration of temperature $85\text{ °C} \pm 2\text{ °C}$ and relative humidity $85\% \pm 5\%$ at high temperature side shall be 2.5 h or more.
- (2) When $-40\text{ °C} \pm 3\text{ °C}$ is employed as the low temperature, the duration of temperature $85\text{ °C} \pm 2\text{ °C}$ and relative humidity $85\% \pm 5\%$ at high temperature side shall be 10 min or more.

5 Items to be specified in detail specifications The following items shall be specified in detail specifications:

- (1) Initial measurement items (if necessary) [see 4 (1)]
- (2) Final measurement items (if necessary) [see 4 (3)]
- (3) Test temperature at low [see 4 (2)]

Annex 3 (normative) Robustness of termination test A-3

1 Purpose The purpose of this test is to examine whether or not the terminations of a module have enough strength against external forces applied to them during mounting, wiring and use of the module.

2 Equipment The equipment shall not cause any scratch, strain or other damage which affects the test results on the specimen during the test.

3 Test

3.1 Initial measurement Measure the electrical and mechanical performances specified in 6.1 and 6.2 of JIS C 8918 and visually examine the appearance.

3.2 Test method A (applicable to lead wire system)

3.2.1 Tensile strength Fix the body of specimen, gradually apply the tensile force specified in Annex 3 Table 1 (without shock) in the axial direction of the coming out lead and maintain the state for $10 \text{ s} \pm 1 \text{ s}$.

Annex 3 Table 1 Tensile force

Nominal sectional area ⁽¹⁾ mm ²	Nominal diameter of wire mm (when cross section is circular)	Tensile force ⁽²⁾ ⁽³⁾ N
Up to and including 0.05	Up to and including 0.25	1
Over 0.05 up to and including 0.1	Over 0.25 up to and including 0.35	2.5
Over 0.1 up to and including 0.2	Over 0.35 up to and including 0.5	5
Over 0.2 up to and including 0.5	Over 0.5 up to and including 0.8	10
Over 0.5 up to and including 1.2	Over 0.8 up to and including 1.25	20
Over 1.2	Over 1.25	40

Notes ⁽¹⁾ In the case of stranded wires, this means the total sum of nominal sectional areas of the component wires.

⁽²⁾ In the case of insulated wires, the insulating coating of the portion to which the tensile force is applied shall be removed.

⁽³⁾ In the case of stranded wires, the part to which the tensile force is applied shall be made one body mechanically (by soldering or knotting.).

3.2.2 Bending strength (applicable to pliable terminations only) Support the specimen so that the normal coming out axis of wire termination becomes vertical, suspend a weight of a mass which can exert the bending force specified in Annex 3 Table 2 from the end of the termination. Incline the module body, taking a time of 2 s or more, toward an angle of

approximately 90 degrees, return it to its initial position and then allow it to stand for 2 s to 3 s. Consecutively incline the module to the same angle in the opposite direction over the same period, return it and rest it. Count these operations as two bends. Subject each termination to five bends along the cell surface and then to five bends in a direction approximately 90 degrees to the cell surface.

Remarks: In the case of strip terminations, the wider surface shall be bent.

Annex 3 Table 2 Bending force

Section modules (¹) mm³	Nominal wire diameter mm (when cross section is circular)	Bending force N
Up to and including 0.001 5	Up to and including 0.25	0.5
Over 0.001 5 up to and including 0.004 2	Over 0.25 up to and including 0.35	1.25
Over 0.004 2 up to and including 0.012	Over 0.35 up to and including 0.5	2.5
Over 0.012 up to and including 0.05	Over 0.5 up to and including 0.8	5
Over 0.05 up to and including 0.19	Over 0.8 up to and including 1.25	10
Over 0.19	Over 1.25	20

Note (¹) For circular cross section, calculate the section modules from the following equation:

$$Z = \frac{\pi d^3}{32}$$

where, d : diameter of lead wire (mm)

Z : section modules (mm³)

For plate terminals, calculate the section modules from the following equation:

$$Z = \frac{ba^3}{6}$$

where, a : thickness of plate perpendicular to the bending axis (mm)

b : dimension of other side of the rectangular section (mm)

3.2.3 Final measurement Measure the electrical and mechanical performances specified in 6.1 and 6.2 of JIS C 8918, and then visually examine the appearance.

3.3 Test method B (applicable to screw clamp system)

3.3.1 Tensile strength and bending strength Tests for tensile strength and bending strength shall be as follows:

- (1) Follow 3.2.1 if the termination is exposed.
- (2) If the termination is accommodated in a protective box, use the following method:

Connect the cable of the type and size recommended by the module manufacturer to the termination in the protective box. Draw the cable through the hole with packing,

clamp it and then carefully attach the cover of protective box. After such a preparation, subject the specimen to the tests of 3.2.1 and 3.2.2.

3.3.2 Twisting strength (applicable to all screw terminations) Fix the specimen body, and apply the torque specified in Annex 3 Table 3 to the nut normally mated with the threaded termination for 10 ± 1 s.

During this test, insert a washer or metal plate with a hole having ordinary clearance to the screw between the head of screw and the face to be tightened.

Annex 3 Table 3 Torque

Nominal diameter of screw mm	2.6	3	3.5	4	5	6
Torque N•m	0.2	0.25	0.4	0.6	1	1.25

3.3.3 Final measurement Measure the electrical and mechanical performances specified in 6.1 and 6.2 of JIS C 8918, and then visually examine the appearance.

4 Items to be specified in detail specifications The following items shall be specified in detail specifications :

- (1) Initial measurement items (if necessary) (see 3.1)
- (2) Test conditions for tensile strength (if necessary) (see 3.2.1 and 3.3.1)
- (3) Test conditions for bending strength (see 3.2.2)
- (4) Test conditions for twisting strength (see 3.3.2)
- (5) Final measurement items (if necessary) (see 3.3.3)