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INTERNATIONAL STANDARD

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Environmental testing –
Part 2-5: Tests – Test Sa: Simulated solar radiation at ground level and guidance for solar radiation testing

Essais d'environnement –
Partie 2-5: Essais – Essai Sa: Rayonnement solaire simulé au niveau du sol et guide pour les essais de rayonnement solaire

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International Standard IEC 60068-2-5 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This second edition cancels and replaces the first edition of IEC 60068-2-5, published in 1975, and IEC 60068-2-9, published in 1975, and constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

This second edition of IEC 60068-2-5 will make the reading much easier, partly because it includes guidance for solar radiation testing, previously published in a separate publication, IEC 60068-2-9, and partly because it now allows the use of all lamps specified in CIE 85 and published in 1985 by the International commission on Illumination.

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The text of this standard is based on the following documents:

FDIS	Report on voting
104/500/FDIS	104/515/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 60068 series, under the general title *Environmental testing,* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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The contents of the corrigendum of December 2010 have been included in this copy.

INTRODUCTION

This part of IEC 60068 describes methods of simulation designed to examine the effect of solar radiation on equipment and components at the surface of the earth. The main characteristics of the environment to be simulated are the spectral energy distribution of the sun, as observed at the earth's surface, and the intensity of received energy, in combination with controlled temperature conditions. However, it may be necessary to consider a combination of solar radiation with other environments, e.g. temperature, humidity, air velocity, etc.

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ENVIRONMENTAL TESTING –

Part 2-5: Tests – Test Sa: Simulated solar radiation at ground level and guidance for solar radiation testing

1 Scope and object

This part of IEC 60068 provides guidance for testing equipment or components under solar radiation conditions.

The purpose of testing is to investigate to what extent the equipment or components are affected by solar radiation.

The method of combined tests detects electrical, mechanical or other physical variations.

2 Normative references

The following referenced documents are indispensable for the application 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 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

CIE 20:1972, *Recommendation for the integrated irradiance and the spectral distribution of simulated solar radiation for testing purposes*

CIE 85:1985, *Solar spectral irradiance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60068-1, as well as the following, apply.

3.1
air mass
path length that light from a celestial object takes through the earth's atmosphere relative to the length where air mass = 1

NOTE The air mass is 1/sin (gamma), where gamma is the elevation angle of the sun.

3.2
black standard temperature
BST
characteristic value of the specimen surface temperature

NOTE Black standard temperature as measured by a black standard thermometer (see ISO 4892-1).

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3.3
black panel temperature
characteristic value of the specimen surface temperature

NOTE Black panel temperature as measured by a black panel thermometer (see ISO 4892-1).

3.4
solar constant
rate at which solar energy, at all wavelengths, is received per unit area at the top level of earth's atmosphere

NOTE The value of the solar constant is E_0 = 1 367 W/m^2.

3.5
optical depth
measure of how much light is absorbed in travelling through a medium

NOTE A completely transparent medium has an optical depth of zero.

4 General remarks

4.1 Overview

The effect of radiation on the specimen will depend on the level of irradiance, the spectral distribution, the location, the time of day and the sensitivity of the material of the specimen.

4.2 Irradiance

The irradiance by the sun on a plane perpendicular to the incident radiation outside the earth's atmosphere at the mean earth-sun distance is known as the solar constant E_0.

The irradiance at the surface of the earth is influenced by the solar constant and the attenuation and scattering of radiation in the atmosphere. For test purposes, CIE 85 gives a value of 1 090 W/m^2 for the global radiation at the surface of the earth from sun at zenith; value based on a solar constant E_0 = 1 367 W/m^2 .

4.3 Spectral distribution

The standard spectral distribution of the global radiation specified for this test, in accordance with the recommendations of the CIE 85, is given in Figure 1 and in Table 1.

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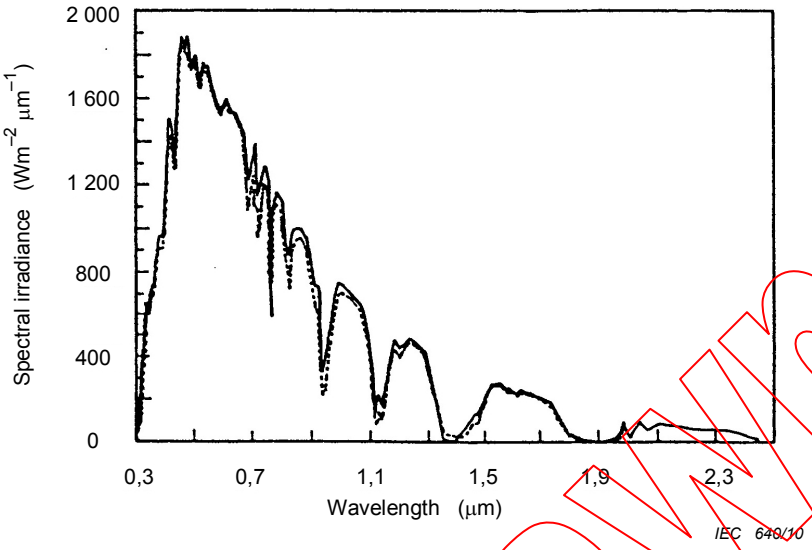

NOTE Optical depth of aerosol extinction 0,1 (solid line) and 0,27 (dashes), respectively.

Figure 1 – Global solar spectral irradiance at the earth´s surface for relative air mass 1

Table 1 – Spectral energy distribution

Spectral region	Ultra-violet B*	Ultra-violet A	Visible	Infra-red	Total radiation
Bandwidth	300 nm to 320 nm	320 nm to 400 nm	400 nm to 800 nm	800 nm to 2 450 nm	300 nm to 2 450 nm
Irradiance	4,06 W/m^2	70,5 W/m^2	604,2 W/m^2	411,2 W/m^2	1 090 W/m^2
Approximate proportion of total radiation	0,4 %	6,4 %	55,4 %	37,8 %	100 %
* Radiation shorter than 300 nm reaching the earth's surface is insignificant.					

If the source of radiation used for the test does not meet the standard spectral distribution given in Table 1, the exact spectral absorption data of the material and the exact spectral irradiance of the alternative radiation source in the range from 300 nm to about 3 000 nm and for the solid angle of 2π sr above the specimen surface shall be known or measured.

5 Conditioning

5.1 General

During the entire test, the irradiation, the temperature within the chamber, the humidity and any other specified environmental conditions shall be maintained at the levels appropriate to the particular test procedure specified in the relevant specification. The relevant specification shall state which preconditioning requirements are to be applied.

5.2 Temperature

The temperature within the chamber during irradiation and darkness periods shall be controlled in accordance with the procedure (A, B or C) specified. During irradiation, the

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temperature within the chamber shall rise or fall by 1 K/min and be maintained at one of the preferred values given in IEC 60068-2-1, IEC 60068-2-2 or the relevant specification.

NOTE Additionally, a black standard thermometer or a black panel thermometer can be used to measure the maximum surface temperature. By ventilation, this temperature can be influenced.

5.3 Humidity

Different humidity conditions, particularly condensation, can markedly affect photochemical degradation of materials, paints, plastics, etc. If required, the values of IEC 60068-2-78 shall be preferred.

The relevant specification shall state the humidity and whether it is to be maintained during

a) the irradiation periods only;

b) the periods of darkness only;

c) the whole test duration.

5.4 Ozone and other contaminating gases

Ozone, generated by short wavelength ultra-violet of test sources, will normally be excluded from the test chamber by the radiation filter(s) used to correct the spectral energy distribution. As ozone and other contaminating gases can significantly affect the degradation processes of certain materials, it is important to exclude these gases from the test chamber, unless otherwise required by the relevant specification.

5.5 Surface contamination

Dust and other surface contamination may significantly change the absorption characteristics of irradiated surfaces. Unless otherwise required, specimens should be tested in a clean condition. However, if effects of surface contamination are to be assessed, the relevant specification should include the necessary information on preparation of surfaces, etc.

5.6 Mounting of specimen

The specimen to be tested shall be placed either on raised support, on a turntable or a specified substrate of known thermal conductivity and thermal capacity within the chamber as stated in the relevant specification, and so spaced from other specimens as to avoid shielding from the source of radiation or re-radiated heat. Temperature sensors should be attached to specimen as required.

5.7 Test facility

It shall be ensured that the optical parts of the test facility, lamps, reflectors and filters, etc. are clean.

The level of irradiation over the specified measurement plane shall be measured immediately prior to each test.

Any ancillary environmental conditions, e.g. ambient temperature, humidity and other parameters if specified, should be monitored continuously throughout the test.

5.8 Test apparatus

The chamber in which the tests are to be carried out shall be provided with means for obtaining, over the prescribed irradiation measurement plane, an irradiance of 1 090 W/m^2 ± 10 % with the spectral distribution given in Table 1. The value of 1 090 W/m^2 shall include any radiation reflected from the test chamber and received by the specimen under test. It should not include long-wave infra-red radiation emitted by the test chamber.

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Means shall also be provided whereby the specified conditions of temperature, air flow and humidity can be maintained within the chamber.

The temperature within the chamber shall be measured (with adequate shielding from radiated heat) at a point or points in a horizontal plane 0 mm to 50 mm below the prescribed irradiation measurement plane, at half the distance between the specimen under test and the wall of the chamber, or at 1 m from the specimen, whichever is the lesser.

6 Initial measurement

The specimen shall be submitted to the visual, dimensional and functional checks prescribed by the relevant specification.

7 Testing

7.1 General

During exposure, the temperature within the chamber shall rise or fall by 1 K/min and be maintained at one of the preferred values given in IEC 60068-2-1 or IEC 60068-2-2 or the relevant specification.

In procedure A, the temperature within the chamber shall start to rise 2 h before the irradiation period starts.

During the darkness period in procedures A and B, the temperature within the chamber shall fall approximately with 1 K/min and be maintained at +25 °C. If the required temperature is lower than 25 °C, the temperature shall be maintained at the required temperature.

The requirements for irradiation, temperature and time relationships are given in Figure 2. Throughout the specified test duration, the temperature within the chamber shall be maintained within ±2 °C of that shown for the appropriate procedure.

The level of irradiance should be 1 090 W/m^2 ± 10 % or specified in the relevant specification. Acceleration of the test by increasing the irradiation above this level is not recommended. The total daily irradiation approximating the most severe natural conditions is simulated by procedure A with a duration of exposure to the standard irradiation conditions of 8 h per day. Thus, exposure for periods in excess of 8 h will effect acceleration over natural conditions. However, continuous exposure of 24 h per day, procedure C, might mask any degradation effects of cyclic thermal stressing, and this procedure is therefore not generally recommended in this instance.

The specimen shall be exposed, for the duration called for in the relevant specification, to one of the following test procedures (see Figure 2).

7.2 Procedure A – 24 h cycle, 8 h irradiation and 16 h darkness, repeated as required

This gives a total irradiation of 8,96 kWh/m^2 per diurnal cycle, which approximates to the most severe natural conditions. Procedure A should be specified where the principal interest is in thermal effects.

7.3 Procedure B – 24 h cycle, 20 h irradiation and 4 h darkness, repeated as required

This gives a total irradiation of 22,4 kWh/m^2 per diurnal cycle and is applicable where the principal interest is in degradation effects.

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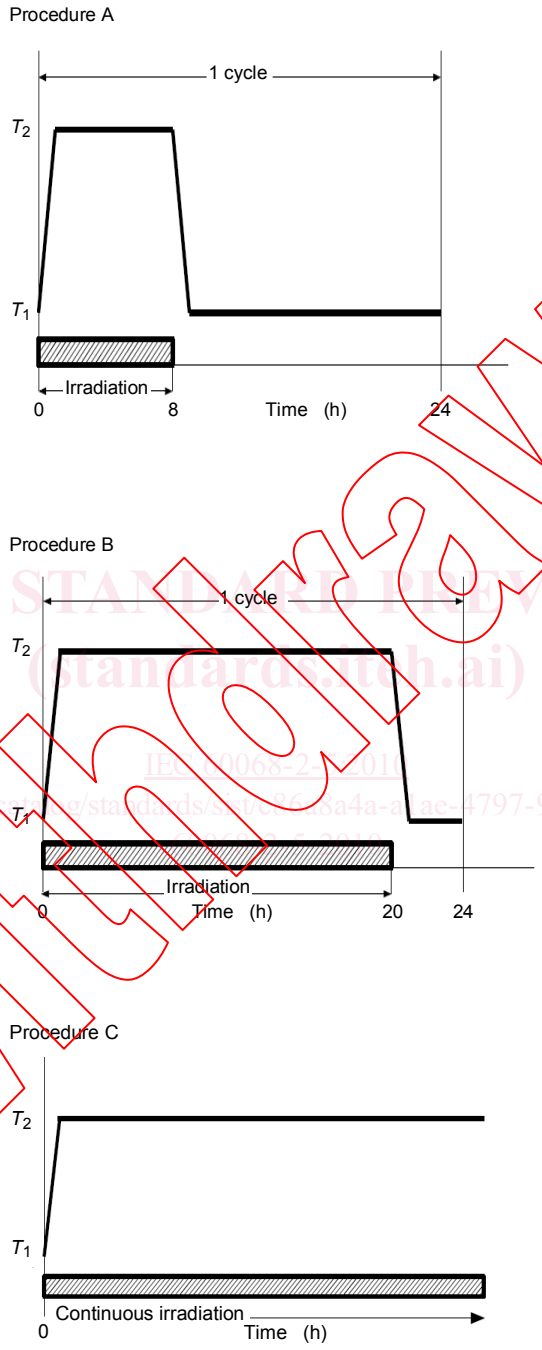
7.4 Procedure C – Continuous irradiation as required

A simplified test, applicable where cyclic thermal stressing is unimportant and photochemical effects only are to be assessed. Also for the assessment of heating effects on specimens with low thermal capacity.



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Key

T_1 lower temperature (25 °C if not otherwise specified)

T_2 upper temperature (40 °C if not otherwise specified)

Figure 2 – Test procedures A, B and C