

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

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

**Essais d'environnement –**  
**Partie 2-5: Essais – Essai S: Rayonnement solaire simulé au niveau du sol et recommandations pour les essais de rayonnement solaire et le vieillissement aux intempéries**



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## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	7
3 Terms and definitions .....	7
4 General remarks.....	8
4.1 Overview.....	8
4.2 Irradiance of solar radiation .....	8
4.3 Spectral irradiance of solar radiation.....	8
4.4 Radiation source.....	9
5 Test method Sa: thermal effect test .....	9
5.1 Conditioning.....	9
5.1.1 General .....	9
5.1.2 Temperature .....	9
5.1.3 Humidity .....	9
5.1.4 Ozone and other contamination gases .....	10
5.1.5 Surface contamination .....	10
5.1.6 Mounting of test specimen(s).....	10
5.1.7 Test facility.....	10
5.1.8 Test apparatus .....	10
5.2 Initial measurements.....	11
5.3 Testing .....	11
5.3.1 General .....	11
5.3.2 Procedure Sa 1 – 24 h cycle, 8 h irradiation and 16 h darkness, repeated as required .....	11
5.3.3 Procedure Sa 2 – 24 h cycle, 20 h irradiation and 4 h darkness, repeated as required .....	11
5.3.4 Procedure Sa 3 – Continuous irradiation as required .....	11
5.4 Final measurements.....	13
6 Test method Sb: Weathering test with or without wetting .....	13
6.1 Test apparatus.....	13
6.1.1 Laboratory radiation source .....	13
6.1.2 Test chamber.....	14
6.1.3 Temperature .....	14
6.1.4 Humidity .....	15
6.1.5 Spray cycle.....	15
6.1.6 Mounting of test specimen(s).....	15
6.1.7 Ozone and other contaminating gases .....	15
6.1.8 Surface contamination .....	15
6.2 Initial measurements.....	15
6.3 Testing .....	15
6.3.1 General .....	15
6.3.2 Test duration .....	16
6.3.3 Test procedure .....	16
6.3.4 Ancillary environmental conditions .....	16
6.4 Final measurements.....	16

7	Information to be given in the relevant specification.....	17
8	Information to be given in the test report.....	17
	Annex A (informative) Standard solar spectral irradiance.....	18
	Annex B (informative) Radiation source.....	20
	B.1 General.....	20
	B.2 Filters.....	20
	B.3 Uniformity of irradiance.....	20
	Annex C (informative) Typical apparatus for weathering.....	21
	Annex D (informative) Instrumentation.....	23
	D.1 General.....	23
	D.2 Measurement of irradiance.....	23
	D.3 Measurement of spectral irradiance.....	23
	D.4 Measurement of temperature.....	23
	D.5 Difference between insulated black panel and uninsulated black panel thermometer.....	23
	Bibliography.....	24
	Figure 1 – Global solar spectral irradiance at sea level.....	8
	Figure 2 – Test procedures Sa 1, Sa 2 and Sa 3.....	13
	Figure C.1 – Example of test apparatus.....	21
	Figure C.2 – Example of test apparatus with flat array.....	22
	Table 1 – Spectral irradiance.....	9
	Table 2 – Minimum and maximum levels of the relative spectral irradiance.....	10
	Table 3 – Relative spectral irradiance of xenon-arc lamp(s) with daylight filters.....	14
	Table 4 – Relative spectral irradiance for xenon-arc lamp(s) with window glass filters.....	14
	Table 5 – Exposure cycles.....	16
	Table A.1 – Comparison of basic atmospheric conditions used for the solar spectrum defined in ASTM G 177 and that defined in CIE 85:1989, Table 4.....	19
	Table A.2 – Irradiance comparison for the ASTM G 177 solar spectrum and the CIE 85:1989, Table 4, solar spectrum.....	19

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## ENVIRONMENTAL TESTING –

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

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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 bilingual version (2018-10) corresponds to the monolingual English version, published in 2018-04.

This third edition cancels and replaces the second edition of published in 2010. This edition constitutes a technical revision.

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

- a) the title of this document has been modified;
- b) the current thermal effect test method, specified as "Test method Sa" has been retained and the weathering test method specified as "Test method Sb" has been added.

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

CDV	Report on voting
104/735/CDV	104/789/RVC

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

The French version of this standard has not been voted upon.

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

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

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

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## 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 irradiance of solar radiation, as observed at the earth's surface, and the intensity of received energy, in combination with controlled temperature conditions. However, the combination of solar radiation with other environments, for example temperature, humidity, water spray (to simulate wetting) and air velocity, should be considered. Two different methods are described, one aiming at the thermal effects, a second aiming at the weathering effects.

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## ENVIRONMENTAL TESTING –

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

#### 1 Scope

This part of IEC 60068-2 specifies the methods for testing equipment or components under simulated solar radiation conditions.

This document is applicable to the equipment and components at the surface of the earth.

The purpose of testing is to investigate to what extent the equipment or components are affected by simulated solar radiation in the presence of moisture to reproduce the weathering effects (temperature, humidity and/or wetting) that occur when they are exposed in actual end-use environments to daylight or to daylight filtered through window glass. This document specifies two test methods, test method Sa: thermal effect test, and test method Sb: weathering test.

#### 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 60068-1, *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*

#### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60068-1 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

##### **black standard temperature**

insulated black panel temperature

characteristic value of the test specimen's(s') surface temperature measured by an insulated black panel thermometer, consisting of a black painted stainless steel panel and a resistance temperature sensor embedded in insulating material (white PVDF, polyvinylidene difluoride) attached

Note 1 to entry: More details are described in ISO 4892-1.

Note 2 to entry: It is designed to approximate the maximum surface temperature of any material with thermal insulating properties and for control in weathering test apparatus.

### 3.2

#### black panel temperature

uninsulated black panel temperature

characteristic value of the test specimen's(s') surface temperature measured by an uninsulated black panel thermometer, consisting of a black painted stainless steel panel and a resistance temperature sensor attached

Note 1 to entry: More details are described in ISO 4892-1.

Note 2 to entry: It is designed to approximate the maximum surface temperature of any material and for control in weathering test apparatus.

## 4 General remarks

### 4.1 Overview

The effect of solar radiation on the test specimen(s) will depend on the level of irradiance, the spectral irradiance, the location, the time of day and the sensitivity of the material of the test specimen(s).

### 4.2 Irradiance of solar radiation

The irradiance at sea level is influenced by the solar constant and the attenuation and scattering of solar radiation in the atmosphere. For test purposes, CIE 85:1989, Table 4 gives a value of 1 090 W/m<sup>2</sup> for the global solar radiation at the surface of the earth from the sun at zenith; this value is based on a solar constant  $E_0 = 1\,367\text{ W/m}^2$ .

### 4.3 Spectral irradiance of solar radiation

The standard spectral irradiance of the global solar radiation specified for this test, in accordance with the recommendations of CIE 85:1989, Table 4 (see Annex A), is given in Figure 1 and in Table 1.

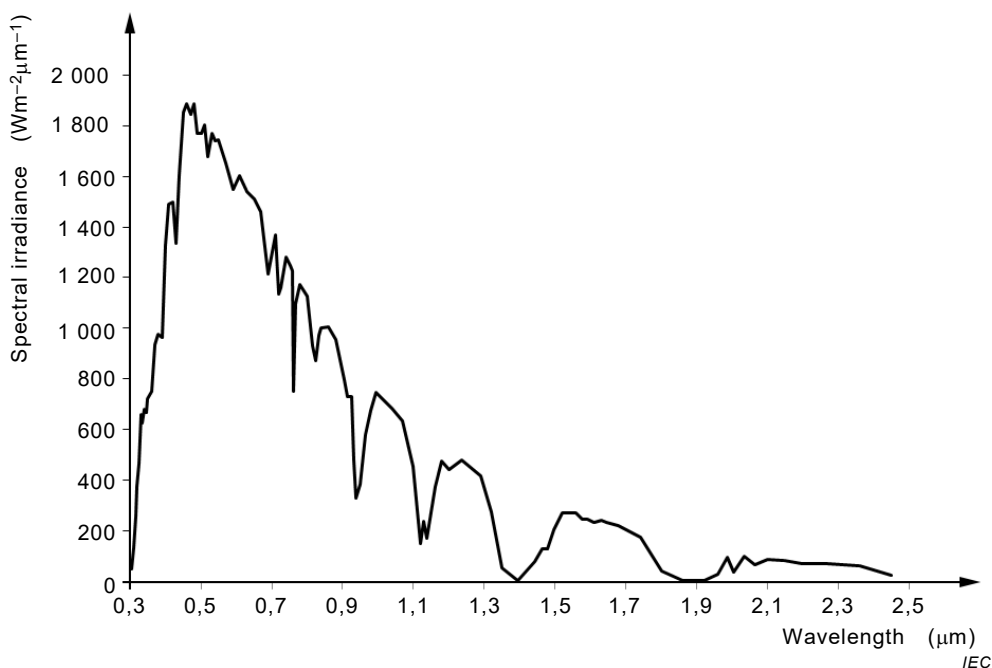


Figure 1 – Global solar spectral irradiance at sea level

**Table 1 – Spectral irradiance**

Spectral region	Ultra-violet B <sup>a</sup>	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 <sup>2</sup>	70,5 W/m <sup>2</sup>	604,2 W/m <sup>2</sup>	411,2 W/m <sup>2</sup>	1 090 W/m <sup>2</sup>
Proportion of total radiation	0,4 %	6,4 %	55,4 %	37,8 %	100 %

NOTE This table is a condensed version of CIE 85:1989, Table 4.

<sup>a</sup> Radiation shorter than 300 nm reaching the earth's surface is insignificant

#### 4.4 Radiation source

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  $2\pi$  sr above the specimen surface shall be known or measured.

Detail of a radiation source is described in Annex B.

### 5 Test method Sa: thermal effect test

#### 5.1 Conditioning

##### 5.1.1 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.

Detail of instrumentation is described in Annex D.

##### 5.1.2 Temperature

The temperature within the chamber during irradiation and darkness periods shall be controlled in accordance with the procedure (Sa 1, Sa 2 or Sa 3) specified.

NOTE Additionally, an insulated black panel thermometer or an uninsulated black panel thermometer can be used to measure the maximum surface temperature. This temperature can be influenced by ventilation.

##### 5.1.3 Humidity

Different humidity conditions, particularly condensation, can markedly affect photochemical degradation of materials, paints, plastics, etc. If applicable, the values given in IEC 60068-2-78 should be used.

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

- the irradiation periods only;
- the periods of darkness only;
- the whole test duration.

**5.1.4 Ozone and other contamination gases**

Ozone, generated by short wavelength ultra-violet 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.

**5.1.5 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.

**5.1.6 Mounting of test specimen(s)**

The specimen(s) 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 specimen(s) as to avoid shielding from the source of radiation or re-radiated heat. Temperature sensors should be attached to specimen(s) as required.

**5.1.7 Test facility**

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

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

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Any ancillary environmental conditions, for example ambient temperature, humidity and other parameters if specified, should be monitored continuously during the test.

**5.1.8 Test apparatus**

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

**Table 2 – Minimum and maximum levels of the relative spectral irradiance**

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
Proportion of total radiation (%)	0,4	6,4	55,4	37,8	100,0
Minimum level (%)	0,3	4,2	43,8	33,7	–
Maximum level (%)	0,7	7,4	57,0	50,5	–

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 specified 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.

## 5.2 Initial measurements

The specimen(s) shall be submitted to the visual, dimensional and functional checks specified by the relevant specification.

## 5.3 Testing

### 5.3.1 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 Sa 1, the temperature within the chamber shall start to rise 2 h before the irradiation period starts.

During the darkness period in procedures Sa 1 and Sa 2, the temperature within the chamber shall fall with average rate of 1 K/min and be maintained at +25 °C, unless otherwise specified.

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  $\pm 2$  K of that shown for the appropriate procedure.

The level of irradiance shall be  $1\,090 (1 \pm 10\%) \text{ W/m}^2$  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 Sa 1 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 Sa 3) could 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 test procedures outlined in 5.3.2, 5.3.3 and 5.3.4 (see Figure 2).

### 5.3.2 Procedure Sa 1 – 24 h cycle, 8 h irradiation and 16 h darkness, repeated as required

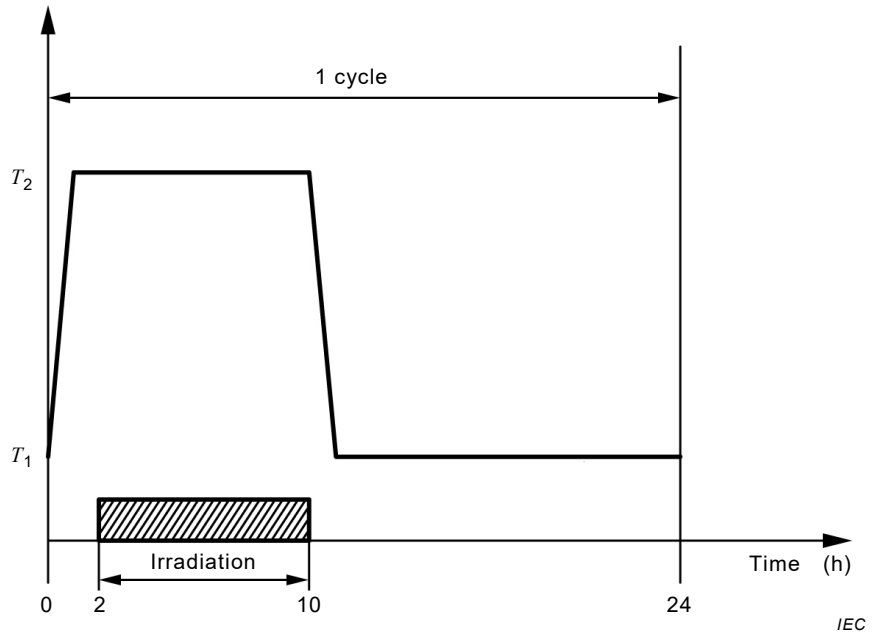
This gives a total irradiation of  $8,72 \text{ kWh/m}^2$  per diurnal cycle, which approximates to the most severe natural conditions. Procedure Sa 1 is specified where the principal interest is in thermal effects.

### 5.3.3 Procedure Sa 2 – 24 h cycle, 20 h irradiation and 4 h darkness, repeated as required

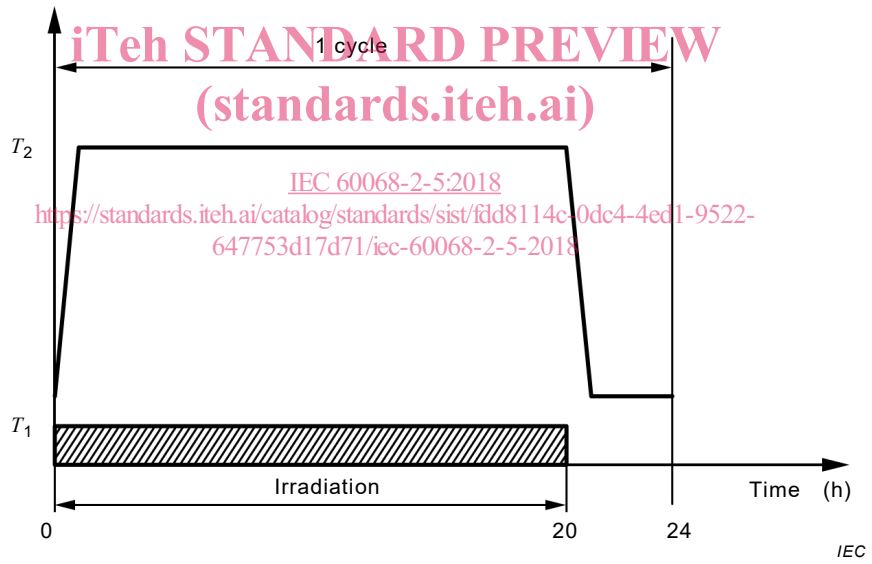
This gives a total irradiation of  $21,8 \text{ kWh/m}^2$  per diurnal cycle and is applicable where the principal interest is in degradation effects.

### 5.3.4 Procedure Sa 3 – Continuous irradiation as required

Procedure Sa3 is a simplified test, applicable where cyclic thermal stressing is unimportant and photochemical effects only are to be assessed. This procedure is also applicable for the assessment of heating effects on specimens with low thermal capacity.

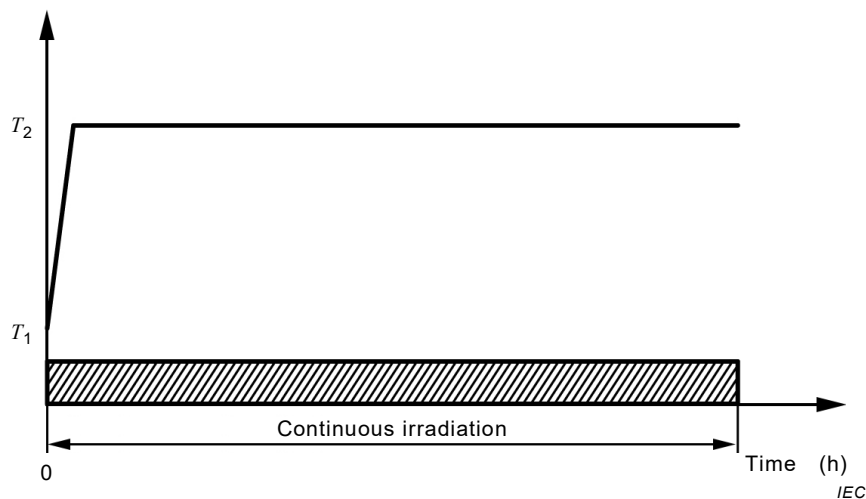


a) Procedure Sa 1



b) Procedure Sa 2

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c) Procedure Sa 3

**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 Sa 1, Sa 2 and Sa 3****5.4 Final measurements**

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

**6 Test method Sb: Weathering test with or without wetting**

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**6.1 Test apparatus****6.1.1 Laboratory radiation source****6.1.1.1 Xenon arc lamp**

The radiation source shall comprise one or more quartz-jacketed xenon-arc lamps that emit radiation from below 270 nm in the ultraviolet through the visible spectrum and into the infrared. In order to simulate solar radiation, filters shall be used to remove short-wavelength UV radiation (Table 3). For tests intended to simulate solar radiation through window glass, filters to minimize irradiance at wavelengths shorter than 310 nm shall be used (Table 4). In addition, filters to remove infrared radiation may be used to prevent unrealistic heating of the test specimen(s), which can cause thermal degradation not experienced during outdoor exposures.

**6.1.1.2 Spectral irradiance of xenon-arc lamp(s) with daylight filters**

Filters are used to filter xenon-arc emissions in order to simulate solar radiation (CIE 85:1989, Table 4). The minimum and maximum levels of the relative spectral irradiance in the UV wavelength range are given in Table 3.