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Plastics — Methods of exposure to laboratory light sources —

Part 2: Xenon-arc lamps

Plastiques — Méthodes d'exposition à des sources lumineuses de laboratoire —

Partie 2: Lampes à arc au xénon

Reference number
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BLUESTAR

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4892-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 6, *Ageing, chemical and environmental resistance*.

This third edition cancels and replaces the second edition (ISO 4892-2:2006), which has been technically revised. It also cancels and replaces the Amendment ISO 4892-2:2006/Amd.1:2009.

ISO 4892 consists of the following parts, under the general title *Plastics — Methods of exposure to laboratory light sources*:

— *Part 1: General guidance*

— *Part 2: Xenon-arc lamps*

— *Part 3: Fluorescent UV lamps*

— *Part 4: Open-flame carbon-arc lamps*

Plastics — Methods of exposure to laboratory light sources —

Part 2:
Xenon-arc lamps

1 Scope

This part of ISO 4892 specifies methods for exposing specimens to xenon-arc light in the presence of moisture to reproduce the weathering effects (temperature, humidity and/or wetting) that occur when materials are exposed in actual end-use environments to daylight or to daylight filtered through window glass.

Specimen preparation and evaluation of the results are covered in other International Standards for specific materials.

General guidance is given in ISO 4892-1.

NOTE Xenon-arc exposures of paints and varnishes are described in ISO 11341.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4582, *Plastics — Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or laboratory light sources*

ISO 4892-1, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

ISO 9370, *Plastics — Instrumental determination of radiant exposure in weathering tests — General guidance and basic test method*

3 Principle

3.1 A xenon arc, fitted with filters, is used to simulate the relative spectral irradiance of daylight in the ultraviolet (UV) and visible regions of the spectrum.

3.2 Specimens are exposed to various levels of light, heat, relative humidity and water (see 3.4) under controlled environmental conditions.

3.3 The exposure conditions are varied by selection of

a) the light filter(s);

b) the irradiance level;

c) the temperature during exposure to light;

d) the relative humidity in the chamber during light and dark exposures, when exposure conditions requiring control of humidity are used;

e) the way the test specimens are wetted (see 3.4);

f) the water temperature and wetting cycle;

g) the relative lengths of the light and dark periods.

3.4 Wetting is produced by spraying the test specimens with demineralized/deionized water, by immersion in water or by condensation of water vapour onto the surfaces of the specimens.

3.5 The procedure includes measurements of the UV irradiance and UV radiant exposure in the plane of the specimens.

3.6 It is recommended that a similar material of known performance (a control) be exposed simultaneously with the test specimens to provide a standard for comparative purposes.

3.7 Intercomparison of results obtained from specimens exposed in different apparatus should not be made unless an appropriate statistical relationship has been established between the apparatuses for the particular material exposed.

4 Apparatus

4.1 Laboratory light source

4.1.1 General

The light source shall comprise one or more quartz-jacketed xenon-arc lamps which emit radiation from below 270 nm in the ultraviolet through the visible spectrum and into the infrared. In order to simulate daylight, filters shall be used to remove short-wavelength UV radiation (method A, see Table 1). Filters to minimize irradiance at wavelengths shorter than 310 nm shall be used to simulate daylight through window glass (method B, see Table 2). In addition, filters to remove infrared radiation may be used to prevent unrealistic heating of the test specimens, which can cause thermal degradation not experienced during outdoor exposures.

NOTE Solar spectral irradiance for a number of different atmospheric conditions is described in CIE Publication No. 85. The benchmark daylight used in this part of ISO 4892 is that defined in Table 4 in CIE No. 85:1989.

4.1.2 Spectral irradiance of xenon-arc lamps with daylight filters

Filters are used to filter xenon-arc emissions in order to simulate daylight (CIE Publication No. 85:1989, Table 4). The minimum and maximum levels of the relative spectral irradiance in the UV wavelength range are given in Table 1 (see also Annex A).

Table 1 — Relative spectral irradiance of xenon-arc lamps with daylight filters[a][b] (method A)

Spectral passband (λ = wavelength in nm)	Minimum[c] %	CIE No. 85:1989, Table 4[d][e] %	Maximum[c] %
$\lambda < 290$			0,15
$290 \leq \lambda \leq 320$	2,6	5,4	7,9
$320 < \lambda \leq 360$	28,2	38,2	39,8
$360 < \lambda \leq 400$	54,2	56,4	67,5

[a] This table gives the irradiance in the given passband, expressed as a percentage of the total irradiance between 290 nm and 400 nm. To determine whether a specific filter or set of filters for a xenon-arc lamp meets the requirements of this table, the spectral irradiance must be measured from 250 nm to 400 nm. The total irradiance in each wavelength passband is then summed and divided by the total irradiance from 290 nm to 400 nm. Typically, this is done in 2 nm increments.

[b] The minimum and maximum limits in this table are based on more than 100 spectral irradiance measurements with water- and air-cooled xenon-arc lamps with daylight filters from different production lots and of various ages,[3] used in accordance with the recommendations of the manufacturer. As more spectral irradiance data become available, minor changes in the limits are possible. The minimum and maximum limits are at least three sigma from the mean for all the measurements.

[c] The minimum and maximum columns will not necessarily sum to 100 % because they represent the minima and maxima for the measurement data used. For any individual spectral irradiance, the percentages calculated for the passbands in this table will sum to 100 %. For any individual xenon-arc lamp with daylight filters, the calculated percentage in each passband shall fall within the minimum and maximum limits given. Exposure results can be expected to differ if obtained using xenon-arc apparatus in which the spectral irradiances differ by as much as that allowed by the tolerances. Contact the manufacturer of the xenon-arc apparatus for specific spectral irradiance data for the xenon-arc lamp and filters used.

[d] The data from Table 4 in CIE Publication No. 85:1989 is the global solar irradiance on a horizontal surface for an air mass of 1,0, an ozone column of 0,34 cm at STP, 1,42 cm of precipitable water vapour and a spectral optical depth of aerosol extinction of 0,1 at 500 nm. These data are target values for xenon-arc lamps with daylight filters.

[e] For the solar spectrum represented by Table 4 in CIE No. 85:1989, the UV irradiance (between 290 nm and 400 nm) is 11 % and the visible irradiance (between 400 nm and 800 nm) is 89 %, expressed as a percentage of the total irradiance between 290 nm and 800 nm. The percentage of the UV irradiance and that of the visible irradiance incident on specimens exposed in xenon-arc apparatus might vary due to the number of specimens being exposed and their reflectance properties.

4.1.3 Spectral irradiance of xenon-arc lamps with window glass filters

Filters are used to filter the xenon-arc lamp emissions in order to simulate daylight which has passed through window glass. The minimum and maximum levels of the relative spectral irradiance in the UV region are given in Table 2 (see also Annex A).

Table 2 — Relative spectral irradiance for xenon-arc lamps with window glass filters[a][b] (method B)

Spectral passband (λ = wavelength in nm)	Minimum[c] %	CIE No. 85:1989, Table 4, plus effect of window glass[d][e] %	Maximum[c] %
$\lambda < 300$			0,29
$300 \leq \lambda \leq 320$	0,1	≤ 1	2,8
$320 < \lambda \leq 360$	23,8	33,1	35,5

Table 2 *(continued)*

Spectral passband (λ = wavelength in nm)	**Minimum**[c] %	**CIE No. 85:1989, Table 4, plus effect of window glass**[de] %	**Maximum**[c] %
360 < λ ≤400	62,4	66,0	76,2

[a] This table gives the irradiance in the given passband, expressed as a percentage of the total irradiance between 290 nm and 400 nm. To determine whether a specific filter or set of filters for a xenon-arc lamp meets the requirements of this table, the spectral irradiance must be measured from 250 nm to 400 nm. The total irradiance in each passband is then summed and divided by the total irradiance between 290 nm and 400 nm. Typically, this is done in 2 nm increments.

[b] The minimum and maximum limits in this table are based on more than 30 spectral irradiance measurements with water- and air-cooled xenon-arc lamps with window glass filters from different production lots and of various ages,[3] used in accordance with the recommendations of the manufacturer. As more spectral irradiance data become available, minor changes in the limits are possible. The minimum and maximum limits are at least three sigma from the mean for all the measurements.

[c] The minimum and maximum columns will not necessarily sum to 100 % because they represent the minima and maxima for the data used. For any individual spectral irradiance, the percentages calculated for the passbands in this table will sum to 100 %. For any individual xenon-arc lamp with window glass filters, the calculated percentage in each passband shall fall within the minimum and maximum limits given. Exposure results can be expected to differ if obtained using xenon-arc apparatus in which the spectral irradiances differ by as much as that allowed by the tolerances. Contact the manufacturer of the xenon-arc apparatus for specific spectral irradiance data for the xenon-arc lamp and filters used.

[d] The data from Table 4 in CIE No. 85:1989 plus the effect of window glass was determined by multiplying the CIE No. 85:1989, Table 4, data by the spectral transmittance of 3-mm-thick window glass (see ISO 11341). These data are target values for xenon-arc lamps with window glass filters.

[e] For the CIE No. 85:1989 plus window glass data, the UV irradiance between 300 nm and 400 nm is typically about 9 % and the visible irradiance (between 400 nm and 800 nm) is typically about 91 %, expressed as a percentage of the total irradiance between 300 nm and 800 nm. The percentage of the UV irradiance and that of the visible irradiance incident on specimens exposed in xenon-arc apparatus might vary due to the number of specimens being exposed and their reflectance properties.

4.1.4 Irradiance uniformity

The irradiance at any position in the area used for specimen exposure shall be at least 80 % of the maximum irradiance. Requirements for periodic repositioning of specimens when this requirement is not met are described in ISO 4892-1.

NOTE For some materials of high reflectivity, high sensitivity to irradiance and temperature, periodic repositioning of specimens is recommended to ensure uniformity of exposures, even when the irradiance uniformity in the exposure area is within the limits so that repositioning is not required.

4.2 Test chamber

The design of the test chamber may vary, but it shall be constructed from inert material. In addition to the controlled irradiance, the test chamber shall provide for control of temperature. For exposures that require control of humidity, the test chamber shall include humidity-control facilities that meet the requirements of ISO 4892-1. When required by the exposure used, the apparatus shall also include facilities for the provision of water spray or the formation of condensate on the surface of the test specimens, or for the immersion of the specimens in water. Water used for water spray shall meet the requirements of ISO 4892-1.

The light source(s) shall be located, with respect to the specimens, such that the irradiance at the specimen surface complies with 6.1.

NOTE If the lamp system (one or more lamps) is centrally positioned in the chamber, the effect of any eccentricity of the lamp(s) on the uniformity of exposure can be reduced by using a rotating frame carrying the specimens or by repositioning or rotating the lamps.

Should any ozone be generated from operation of the lamp(s), the lamp(s) shall be isolated from the test specimens and operating personnel. If the ozone is in an air stream, it shall be vented directly to the outside of the building.

4.3 Radiometer

When a radiometer is used, it shall comply with the requirements outlined in ISO 4892-1 and ISO 9370.

4.4 Black-standard/black-panel thermometer

The black-standard or black-panel thermometer used shall comply with the requirements for these devices given in ISO 4892-1.

The preferred maximum surface temperature device is the black-standard thermometer. The relevant cycles are described in Table 3 and Table B.1.

4.5 Wetting and humidity-control equipment

4.5.1 General

Specimens may be exposed to moisture in the form of water spray or condensation, or by immersion. Specific exposure conditions using water spray are described in Table 3 (see also Table B.1) and Table 4 (see also Table B.2). If condensation, immersion or other methods are used to expose the specimens to moisture, details of the procedures and exposure conditions used shall be included in the exposure report.

Table 3 and Table 4 also describe exposure conditions in which the relative humidity is controlled. Table B.1 and Table B.2 describe exposure conditions in which humidity control is not required.

NOTE The relative humidity of the air can have a significant influence on the photodegradation of polymers.

4.5.2 Relative-humidity control equipment

For exposures where relative-humidity control is required, the location of the sensors used to measure the humidity shall be as specified in ISO 4892-1.

4.5.3 Spray system

The test chamber may be equipped with a means of directing an intermittent water spray onto the fronts or backs of the test specimens under specified conditions. The spray shall be uniformly distributed over the specimens. The spray system shall be made from corrosion-resistant materials that do not contaminate the water employed.

The water sprayed onto the specimen surfaces shall have a conductivity below 5 µS/cm, contain less than 1 µg/g dissolved solids and leave no observable stains or deposits on the specimens. Care shall be taken to keep silica levels below 0,2 µg/g. A combination of deionization and reverse osmosis can be used to produce water of the desired quality.

4.6 Specimen holders

Specimen holders may be in the form of an open frame, leaving the backs of the specimens exposed, or they may provide the specimens with a solid backing. They shall be made from inert materials that will not affect the results of the exposure, for example non-oxidizing alloys of aluminium or stainless steel. Brass, steel or copper shall not be used in the vicinity of the test specimens. The backing used might affect the results, as might any space between the backing and the test specimen, particularly with transparent specimens, and shall be agreed on between the interested parties.

4.7 Apparatus to assess changes in properties

If an International Standard relating to the determination of the properties chosen for monitoring the changes in properties exists (see, in particular, ISO 4582), the apparatus specified by the International Standard concerned shall be used.

5 Test specimens

Make reference to ISO 4892-1.

6 Exposure conditions

6.1 Radiation

Unless otherwise specified, control the irradiance at the levels indicated in Table 3 (see also Table B.1) and Table 4 (see also Table B.2). Other irradiance levels may be used when agreed on by the interested parties. The irradiance, and the pass band in which it was measured, shall be included in the exposure report.

6.2 Temperature

6.2.1 Black-standard and black-panel temperature

For referee purposes, Table 3 and Table B.1 specify black-standard temperatures. For normal work, black-panel thermometers may be used in place of black-standard thermometers (see Table 4 and Table B.2).

The black-panel temperatures specified in Table 4 and the black-standard temperatures specified in Table 3 are those most commonly used, but have no relationship to each other. Therefore, test results obtained with the two tables might not be comparable.

NOTE 1 If a black-panel thermometer is used, the temperature indicated will be 3 °C to 12 °C lower than that indicated by a black-standard thermometer under typical exposure conditions.

If a black-panel thermometer is used, then the panel material, the type of temperature sensor and the way in which the sensor is mounted on the panel shall be included in the exposure report.

NOTE 2 If higher temperatures are used as specified in Table 3 and Table 4 for special exposures, the tendency for specimens to undergo thermal degradation will increase and this might affect the results of such exposures.

Other temperatures may be used when agreed on by the interested parties, but shall be stated in the exposure report.

If water spray is used, the temperature requirements apply to the end of the dry period. If the thermometer does not reach a steady state during the dry period after the short water-spray part of the cycle, check whether the specified temperature is reached during a longer dry period, and consider using this longer dry period.

NOTE 3 During the water-spray part of the cycle, the black-standard or black-panel temperature will be close to that of the water used.

NOTE 4 The additional measurement of a white-standard/white-panel temperature with a white-standard/white-panel thermometer in accordance with ISO 4892-1 gives important information on the range of surface temperatures of differently coloured test specimens.

6.2.2 Chamber air temperature

Exposures can be run either with the chamber air temperature controlled at a specified level (see Table 3 and Table 4) or allowing the air temperature to find its own level (see Table B.1 and Table B.2).

NOTE The possible specimen surface temperature has as its lower limit the temperature of the air surrounding the specimens (i.e. the chamber temperature) and as its upper limit the black-standard temperature specified. It is assumed that the actual specimen temperature lies somewhere between these two limits.

6.3 Relative humidity of chamber air

Exposures can be conducted either with the relative humidity controlled at a specified level (see Table 3 and Table 4) or allowing the relative humidity to find its own level (see Table B.1 and Table B.2).

Table 3 — Exposure cycles with temperature control by black-standard thermometer (BST)[a]

Method A — Exposures using daylight filters (artificial weathering)						
Cycle No.	**Exposure period**	**Irradiance[b]**		**Black-standard temperature** °C	**Chamber temperature** °C	**Relative humidity** %
		Broadband (300 nm to 400 nm) W/m²	**Narrowband (340 nm)** W/(m²·nm)			
1	102 min dry 18 min water spray	60 ± 2 60 ± 2	0,51 ± 0,02 0,51 ± 0,02	65 ± 3 —	38 ± 3 —	50 ± 10[c] —
Method B — Exposures using window glass filters						
Cycle No.	**Exposure period**	**Irradiance**		**Black-standard temperature** °C	**Chamber temperature** °C	**Relative humidity** %
		Broadband (300 nm to 400 nm) W/m²	**Narrowband (420 nm)** W/(m²·nm)			
2	Continuously dry	50 ± 2	1,10 ± 0,02	65 ± 3	38 ± 3	50 ± 10[c]
3	Continuously dry	50 ± 2	1,10 ± 0,02	100 ± 3	65 ± 3	20 ± 10

NOTE 1 The ± tolerances given for irradiance, black-standard temperature and relative humidity are the allowable fluctuations of the parameter concerned about the given value under equilibrium conditions. This does not mean that the value may vary by plus/minus the amount indicated from the given value.

NOTE 2 For exposures in which the chamber temperature and humidity are not controlled (see Table B.1), it could be useful to report the measured values of both in the exposure report.

[a] This table gives the conditions for exposures conducted with daylight filters (method A) and with window glass filters (method B) using a black-standard thermometer, whereas in Table 4 temperature control is by means of a black-panel thermometer.

[b] The irradiance values given are those that have historically been used. In apparatus capable of producing higher irradiances, the actual irradiance might be significantly higher than the stated values, e.g. up to 180 W/m² (300 nm to 400 nm) for xenon-arc lamps with daylight filters or 162 W/m² (300 nm to 400 nm) for xenon-arc lamps with window glass filters.

[c] For materials sensitive to humidity, the use of (65 ± 10) % RH is recommended.

6.4 Spray cycle

The spray cycle used shall be as agreed between the interested parties, but should preferably be that in Table 3 (or Table B.1) for method A and Table 4 (see also Table B.2) method A.

6.5 Cycles with dark periods

The conditions in Table 3 and Table B.1 (see also Table 4 and Table B.2) are valid for continuous presence of radiant energy from the source. More complex cycles may be used. These could include dark periods that might involve high humidity and/or the formation of condensate on the surfaces of the specimens.

Such programmes shall be given, with full details of the conditions, in the exposure report.

Table 4 — Exposure cycles with temperature control by black-panel thermometer (BPT)

Method A — Exposures using daylight filters (artificial weathering)						
Cycle No.	Exposure period	Irradiance[a]		Black-panel temperature °C	Chamber temperature °C	Relative humidity %
		Broadband (300 nm to 400 nm) W/m²	Narrowband (340 nm) W/(m²·nm)			
4	102 min dry 18 min water spray	60 ± 2 60 ± 2	0,51 ± 0,02 0,51 ± 0,02	63 ± 3 —	38 ± 3 —	50 ± 10[b] —
Method B — Exposures using window glass filters						
Cycle No.	Exposure period	Irradiance[a]		Black-panel temperature °C	Chamber temperature °C	Relative humidity %
		Broadband (300 nm to 400 nm) W/m²	Narrowband (420 nm) W/(m²·nm)			
5	Continuously dry	50 ± 2	1,10 ± 0,02	63 ± 3	38 ± 3	50 ± 10[b]
6	Continuously dry	50 ± 2	1,10 ± 0,02	89 ± 3	65 ± 3	20 ± 10

NOTE 1 The ± tolerances given for irradiance, black-panel temperature and relative humidity are the allowable fluctuations of the parameter concerned about the given value under equilibrium conditions. This does not mean that the value may vary by plus/minus the amount indicated from the given value.

NOTE 2 For exposures in which the chamber temperature and humidity are not controlled (see Table B.2), it could be useful to report the measured values of both in the exposure report.

[a] The irradiance values given are those that have historically been used. In apparatus capable of producing higher irradiances, the actual irradiance might be significantly higher than the stated values, e.g. up to 180 W/m² (300 nm to 400 nm) for xenon-arc lamps with daylight filters or 162 W/m² (300 nm to 400 nm) for xenon-arc lamps with window glass filters.

[b] For materials sensitive to humidity, the use of (65 ± 10) % RH is recommended.

6.6 Sets of exposure conditions

Table 3 (see also Table B.1) and Table 4 (see also Table B.2) lists various sets of conditions for exposures conducted with daylight filters (method A) and those conducted with window glass filters (method B).

If no other exposure conditions are specified, use cycle No. 1 (BST control) or cycle No. 4 (BPT control).

Table 3 specifies three exposure cycles in which the black-standard temperatures are controlled (for additional cycles, see Table B.1). In Table 4 (for additional cycles see Table B.2), black-panel temperatures are given.

The black-panel temperatures specified in Table 4 and Table B.2 and the black-standard temperatures specified in Table 3 and Table B.1 are the ones most commonly used, but have no relationship to each other. The exposure results might therefore not be comparable.

Black-standard thermometers may also be used instead of black-panel thermometers to ensure that the temperature requirements in Table 4 and Table B.2 are met. However, in this case the actual temperature difference between the different types of thermometer shall be determined and the temperature measured by each shall be used as the equivalent set point temperature to compensate for the differences in the thermal conductivity between the two thermometer types.

7 Procedure

7.1 General

It is recommended that at least three test specimens of each material evaluated be exposed in each run to allow statistical evaluation of the results.

7.2 Mounting the test specimens

Attach the specimens to the specimen holders in the equipment in such a manner that the specimens are not subject to any applied stress. Identify each test specimen by suitable indelible marking, avoiding areas to be used for subsequent testing. As a check, a plan of the test-specimen positions may be made.

If desired, in the case of specimens used to determine change in colour and appearance, a portion of each test specimen may be shielded by an opaque cover throughout the exposure. This gives an unexposed area adjacent to the exposed area for comparison. This is useful for checking the progress of the exposure, but the data reported shall always be based on a comparison with file specimens stored in the dark.

7.3 Exposure

Before placing the specimens in the test chamber, be sure that the apparatus is operating under the desired conditions (see Clause 6). Programme the apparatus with the selected conditions to operate continuously for the required number of cycles at the selected exposure conditions. Maintain these conditions throughout the exposure, keeping any interruptions to service the apparatus and to inspect the specimens to a minimum.

Expose the test specimens and, if used, the irradiance-measuring instrument for the specified period. Repositioning of the specimens during exposure is desirable and might be necessary. Follow the guidance in ISO 4892-1.

If it is necessary to remove a test specimen for periodic inspection, take care not to touch the exposed surface or alter it in any way. After inspection, return the specimen to its holder or to its place in the test chamber with its exposed surface oriented in the same direction as before.

7.4 Measurement of radiant exposure

If used, mount and calibrate the radiometer so that it measures the irradiance at the exposed surface of the test specimen.

When radiant exposures are used, express the exposure interval in terms of incident radiant energy per unit area of the exposure plane, in joules per square metre (J/m^2), in the wavelength band from 300 nm to 400 nm, or in joules per square metre per nanometre [$J/(m^2 \cdot nm)$] at the wavelength selected (e.g. 340 nm).

7.5 Determination of changes in properties after exposure

These shall be determined as specified in ISO 4582 in as far as possible. Other properties may be used if agreed upon by all interested parties.

8 Exposure report

Make reference to ISO 4892-1.

Annex A
(informative)

Filtered xenon-arc radiation — Relative spectral irradiance

A.1 General

CIE Publication No. 85:1989 provides data on spectral solar irradiance for typical atmospheric conditions, and this data can be used as a basis for comparing laboratory light sources with daylight. The data used for filtered xenon-arc radiation are given in Table 4 in CIE No. 85:1989. However, CIE No. 85:1989 has a number of disadvantages: The global solar spectral energy distribution which it gives does not start until 305 nm, the increments are rather approximate and the calculation code is no longer available. Therefore, efforts have been under way for several years to revise CIE No. 85. The revision is based on more recent measurements and an improved calculation model (SMARTS2[4]). CIE No. 85:1989, Table 4, may continue to be employed when recalculated using the SMARTS2 model.[5]

A.2 Spectral irradiance specification (UV region)

A.2.1 Xenon-arc lamps with daylight filters

The data given in CIE No. 85:1989, Table 4, for the UV region (≤ 400 nm) represent the irradiance benchmark for xenon-arc lamps with daylight filters. Table 1 gives the CIE No. 85:1989, Table 4, benchmark data.

A.2.2 Xenon-arc lamps with window glass filters

The benchmark spectral data for xenon-arc lamps with window glass filters given in Table 2 were determined by modifying the data in the UV region given in CIE No. 85:1989, Table 4, to allow for the transmission of typical window glass. The window glass transmittance used was based on the transmittance of a specific 3-mm-thick window glass as given in Table B.2 of ISO 11341:2004. The CIE No. 85:1989, Table 4, irradiance was multiplied by the appropriate transmittance of the window glass to determine the irradiance in each passband.

NOTE Note that Table 2 allows very different spectral distributions, even spectral distributions overlapping with those in Table 1. To achieve a spectral distribution meeting the minimum and maximum limits for window glass, a spectral transmittance for window glass of between 0,1 and 0,2 at 320 nm and a minimum of 0,8 at 380 nm is preferred.

A.2.3 Specification limits

The spectral irradiance specifications given in Tables 1 and 2 are based on spectral irradiance data provided by 3M, Atlas Material Testing Technology, Q-Lab Corporation, and Suga Test Instruments. The irradiance in each passband was totalled and then expressed as a percentage of the total irradiance between 290 nm and 400 nm. The specification limits given in Tables 1 and 2 are based on plus and minus 3 standard deviations from the mean of the data available. Assuming that the measurements are representative of the xenon-arc apparatus population, this range encompasses 99 % of this population.

Annex B
(normative)

Additional exposure cycles

Table B.1 — Additional exposure cycles with temperature control by black-standard thermometer (BST)

Method A — Exposures using daylight filters (artificial weathering)						
Cycle No.	**Exposure period**	**Irradiance**[a]		**Black-standard temperature** °C	**Chamber temperature** °C	**Relative humidity** %
		Broadband (300 nm to 400 nm) W/m^2	**Narrowband (340 nm)** W/(m^2·nm)			
B1	102 min dry 18 min water spray	60 ± 2 60 ± 2	0,51 ± 0,02 0,51 ± 0,02	65 ± 3 —	Not controlled —	Not controlled —
Method B — Exposures using window glass filters						
Cycle No.	**Exposure period**	**Irradiance**[a]		**Black-standard temperature** °C	**Chamber temperature** °C	**Relative humidity** %
		Broadband (300 nm to 400 nm) W/m^2	**Narrowband (420 nm)** W/(m^2·nm)			
B2	Continuously dry	50 ± 2	1,10 ± 0,02	65 ± 3	Not controlled	Not controlled
B3	Continuously dry	50 ± 2	1,10 ± 0,02	100 ± 3	Not controlled	Not controlled

NOTE 1 The ± tolerances given for irradiance, black-standard temperature and relative humidity are the allowable fluctuations of the parameter concerned about the given value under equilibrium conditions. This does not mean that the value may vary by plus/minus the amount indicated from the given value.

NOTE 2 For exposures in which the chamber temperature and humidity are not controlled, it could be useful to report the measured values of both in the exposure report.

NOTE 3 Types of exposure apparatus that do not control chamber temperature but do control the humidity shall be set to a relative humidity of (50 ± 10) %.

[a] The irradiance values given are those that have historically been used. In apparatus capable of producing higher irradiances, the actual irradiance might be significantly higher than the stated values, e.g. up to 180 W/m^2 (300 nm to 400 nm) for xenon-arc lamps with daylight filters or 162 W/m^2 (300 nm to 400 nm) for xenon-arc lamps with window glass filters.

Table B.2 — Additional exposure cycles with temperature control by black-panel thermometer (BPT)

Method A — Exposures using daylight filters (artificial weathering)						
Cycle No.	**Exposure period**	**Irradiance**[a]		**Black-panel temperature** °C	**Chamber temperature** °C	**Relative humidity** %
		Broadband (300 nm to 400 nm) W/m^2	**Narrowband (340 nm)** /(m^2·nm)			
B4	102 min dry 18 min water spray	60 ± 2 60 ± 2	0,51 ± 0,02 0,51 ± 0,02	63 ± 3 —	Not controlled —	Not controlled —
B5	102 min dry 18 min water spray	60 ± 2 60 ± 2	0,51 ± 0,02 0,51 ± 0,02	83 ± 3 —	Not controlled —	Not controlled —
B6	102 min dry 18 min water spray	60 ± 2 60 ± 2	0,51 ± 0,02 0,51 ± 0,02	89 ± 3 —	Not controlled —	20 ± 10 —
Method B — Exposures using window glass filters						
Cycle No.	**Exposure period**	**Irradiance**[a]		**Black-panel temperature** °C	**Chamber temperature** °C	**Relative humidity** %
		Broadband (300 nm to 400 nm) W/m^2	**Narrowband (420 nm)** W/(m^2·nm)			
B7	Continuously dry	50 ± 2	1,10 ± 0,02	63 ± 3	Not controlled	Not controlled
B8	Continuously dry	50 ± 2	1,10 ± 0,02	89 ± 3	Not controlled	Not controlled

NOTE 1 The ± tolerances given for irradiance, black-panel temperature and relative humidity are the allowable fluctuations of the parameter concerned about the given value under equilibrium conditions. This does not mean that the value may vary by plus/minus the amount indicated from the given value.

NOTE 2 For exposures in which the chamber temperature and humidity are not controlled, it could be useful to report the measured values of both in the exposure report.

NOTE 3 Types of exposure apparatus that do not control chamber temperature but do control the humidity shall be set to a relative humidity of (50 ± 10) %.

[a] The irradiance values given are those that have historically been used. In apparatus capable of producing higher irradiances, the actual irradiance might be significantly higher than the stated values, e.g. up to 180 W/m^2 (300 nm to 400 nm) for xenon-arc lamps with daylight filters or 162 W/m^2 (300 nm to 400 nm) for xenon-arc lamps with window glass filters.

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