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Plastics — Methods of exposure to laboratory light sources —

Part 4:
Open-flame carbon-arc lamps

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

Partie 4: Lampes à arc au carbone

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 6, *Ageing, chemical and environmental resistance*.

This third edition cancels and replaces the second edition (ISO 4892-4:2004), of which it constitutes a minor revision. It also incorporates Technical Corrigendum ISO 4892-4:2004/Corr.1:2005.

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 4:
Open-flame carbon-arc lamps

1 Scope

This part of ISO 4892 specifies methods for exposing specimens to open-flame carbon-arc lamps in the presence of moisture to reproduce the weathering effects that occur when materials are exposed in actual end-use environments in daylight or daylight filtered through window glass.

The specimens are exposed to filtered open-flame carbon-arc light under controlled environmental conditions (temperature, moisture). Various filters are described.

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

General guidance is given in ISO 4892-1.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to 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 4892-1:1999, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

3 Principle

3.1 Specimens of the materials to be tested are exposed to glass-filtered open-flame carbon-arc light, to heat and to moisture continuously or in repetitive cycles.

3.2 The exposure conditions may be varied by selection of:

a) the light filter;

b) the type of exposure to moisture/humidity;

c) the length of exposure to light and moisture/humidity;

d) the temperature of the exposure;

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

The effect of moisture is usually produced by controlling the humidity of the air or by spraying the test specimens with demineralized/deionized water or by condensation of water vapour on to the surfaces of the specimens.

3.3 The procedure may include measurements of the irradiance and radiant exposure at the surface of the specimens.

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

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

4 Apparatus

4.1 Laboratory light source

4.1.1 General

Open-flame carbon-arc light sources typically use three or four pairs of carbon rods, which contain a mixture of rare-earth metal salts and have a surface coating of a metal, such as copper. An electric current is passed between the carbon rods, which burn, giving off ultraviolet, visible and infrared radiation. The pairs of carbon rods are burned in sequence, with one pair burning at any one time. Use the carbon rods recommended by the manufacturer of the apparatus. The radiation reaching the specimens passes through glass filters. Three types of glass filter are used in practice. Tables 1 and 2 show the typical relative spectral irradiance for open-flame carbon-arc lamps with daylight and window-glass filters, respectively. When extended-UV filters are used, the relative spectral irradiance shall meet the requirements of Table 3.

4.1.2 Spectral irradiance of open-flame carbon-arc lamps with daylight filters (type 1)

Table 1 shows typical relative spectral irradiance in the UV wavelength range of an open-flame carbon-arc lamp with daylight filters in order to simulate daylight (see CIE Publication No. 85:1989, Table 4).

Table 1 — Typical relative spectral irradiance for open-flame carbon-arc lamps with daylight filters (type 1)[a][b]

Spectral passband [λ = wavelength in nanometres (nm)]	Typical distribution for open-flame carbon-arc lamp with daylight filters[c] %	CIE No. 85:1989, Table 4[d][e] %
$\lambda < 290$	0,05	
$290 \leq \lambda \leq 320$	2,9	5,4
$320 < \lambda \leq 360$	20,5	38,2
$360 < \lambda \leq 400$	76,6	56,4

[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 the relative spectral irradiance for a specific daylight filter or set of filters for an open-flame carbon-arc lamp, the relative spectral irradiance shall be measured from 250 nm to 400 nm. Typically, this is done in 2 nm increments. The total irradiance in each passband is then summed and divided by the total irradiance between 290 nm and 400 nm.

[b] This table gives typical data for an open-flame carbon-arc lamp with borosilicate-glass daylight filters. At the time of publication of this part of ISO 4892, not enough data are available to develop a specification for the open-flame carbon-arc lamp with a daylight filter.

[c] For any individual relative spectral irradiance, the calculated percentages for the passbands in this table will sum to 100 %.

[d] The data from Table 4 of 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 provided for comparison purposes only.

[e] For the solar spectrum represented by Table 4 of CIE No. 85:1989, the UV irradiance (290 nm to 400 nm) is 11 % and the visible irradiance (400 nm to 800 nm) is 89 %, expressed as a percentage of the total irradiance from 290 nm to 800 nm.

4.1.3 Spectral irradiance of open-flame carbon-arc lamps with window-glass filters (type 2)

Table 2 shows typical relative spectral irradiance in the UV wavelength range of an open-flame carbon-arc lamp with window-glass filters.

Table 2 — Typical relative spectral irradiance for open-flame carbon-arc lamps with window-glass filters (type 2)[a,b]

Spectral passband [λ = wavelength in nanometres (nm)]	Typical distribution for open-flame carbon-arc lamp with window-glass filters[c] %	CIE No. 85:1989, Table 4, plus effect of window glass[d,e] %
$\lambda < 300$	0,0	
$300 \le \lambda \le 320$	0,3	≤1
$320 < \lambda \le 360$	18,7	33,1
$360 < \lambda \le 400$	81,0	66,0

a This table gives the typical irradiance in the given passband, expressed as a percentage of the total irradiance between 290 nm and 400 nm. To determine the irradiance in each passband for an open-flame carbon-arc lamp with a specific set of window-glass filters, the relative spectral irradiance shall be measured from 250 nm to 400 nm. Typically, this is done in 2 nm increments. The total irradiance in each passband is then summed and divided by the total irradiance between 290 nm and 400 nm.

b This table gives typical data for an open-flame carbon-arc lamp with window-glass filters. At the time of publication of this part of ISO 4892, there is not enough data available to develop a specification for the relative spectral irradiance.

c For any individual relative spectral irradiance, the calculated percentages for the passbands in this table will sum to 100 %. Contact the manufacturer of the carbon-arc apparatus for the relative spectral irradiance data for the particular carbon arcs and window-glass filters used.

d The data from Table 4 of CIE No. 85:1989 plus the effect of window glass was determined by multiplying the data from Table 4 of CIE No. 85:1989 by the upper and lower transmission ranges typical for window glass used in the USA and Europe. These data are provided for comparison purposes only.

e For the CIE No. 85:1989 Table 4 plus window glass data, the UV irradiance between 300 nm and 400 nm ranges from 7,7 % to 10,6 % and the visible radiation ranges from 89,4 % to 92,3 %, expressed as a percentage of the total irradiance between 300 nm and 800 nm.

4.1.4 Spectral irradiance of open-flame carbon-arc lamps with extended-UV filters (type 3)

Table 3 shows relative spectral irradiance in the UV wavelength range for an open-flame carbon-arc lamp with extended-UV filters. There are several suitable type 3 filters available on the market.

Table 3 — Relative spectral irradiance for open-flame carbon-arc lamps with extended-UV filters (type 3)[a][b]

Spectral passband [λ = wavelength in nanometres (nm)]	Minimum[c] %	Maximum[c] %	CIE No. 85:1989, Table 4[d][e] %
$\lambda < 290$		4,9	
$290 \le \lambda \le 320$	2,3	6,7	5,4
$320 < \lambda \le 360$	16,4	24,3	38,2
$360 < \lambda \le 400$	68,1	80,1	56,4

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

[b] The minimum and maximum limits in this table are based on 24 relative spectral irradiance measurements with open-flame carbon-arc lamps with filters from different production lots and of various ages, used in accordance with the recommendations of the manufacturer. The minimum and maximum limits are at least three sigma from the mean for all the measurements. Open-flame carbon-arc lamps emit significant amounts of short-wavelength UV radiation between 250 nm and 280 nm. The intensity of this short-wavelength UV radiation varies with the age and initial transmission properties of the extended-UV filters used, as well as the composition of the carbon rods. The composition of the carbon rods may vary between production lots and between manufacturers.

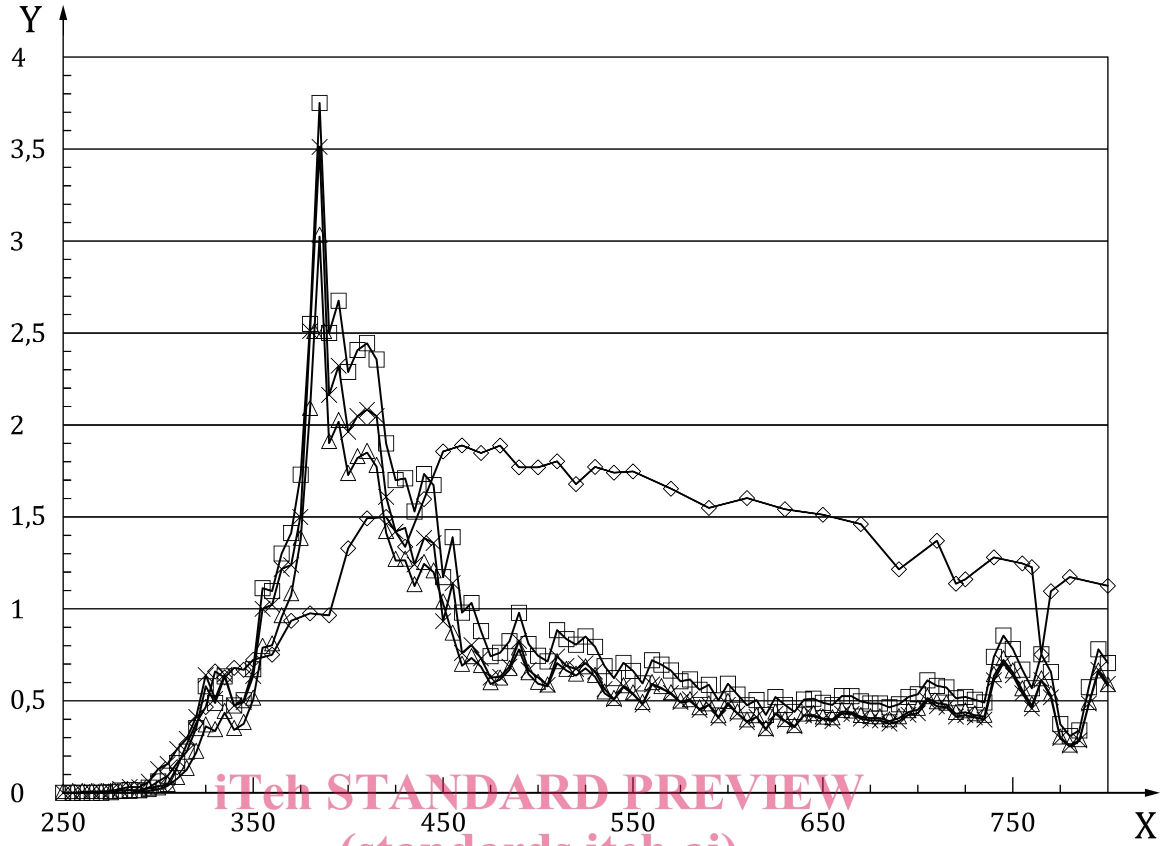
[c] The minimum and maximum columns will not necessarily sum to 100 % because they represent the minima and maxima for the measurement data used. For any individual relative spectral irradiance, the percentages calculated for the passbands in this table will sum to 100 %. For any individual open-flame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

[d] The data from Table 4 of 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 provided for comparison purposes only.

[e] For the solar spectrum represented by Table 4 of CIE No. 85:1989, the UV irradiance (290 nm to 400 nm) is 11 % and the visible irradiance (400 nm to 800 nm) is 89 %, expressed as a percentage of the total irradiance between 290 nm and 800 nm.

4.1.5 Typical spectral irradiance:

Figure 1 shows the typical spectral irradiance from 250 nm to 800 nm for open-flame carbon-arc lamps with type 1, type 2, and type 3 filters compared to CIE 85:1989 Table 4 daylight. Figure 2 shows the typical spectral irradiance from 250 nm to 320 nm for open-flame carbon-arc lamps with type 1, type 2, and type 3 filters, compared to CIE 85:1989 Table 4 daylight. Figure 2 is a better illustration of the short-wavelength cut-on differences between the three filter types.



Key

X wavelength (nm)

Y irradiance (W/m² per nm)

Figure 1 — Typical spectral irradiance for open-flame carbon-arc lamps with type 1 filters (square symbols), type 2 filters (triangular symbols) and type 3 filters (crosses) compared to spectral irradiance of CIE 85:1989 Table 4 daylight (diamond-shaped symbols)