SRI LANKA STANDARD 1256 : PART 28 : SECTION 2 : 2016

ISO 16474-2 : 2013

UDC 667.6

METHOD OF TEST FOR
PAINTS AND VARNISHES
PART 28 : EXPOSURE TO LABORATORY LIGHT SOURCES
SECTION 2 : XENON ARC LAMPS

SRI LANKA STANDARDS INSTITUTION

Sri Lanka Standard
METHOD OF TEST FOR PAINTS AND VARNISHES
PART 28: EXPOSURE TO LABORATORY LIGHT SOURCES
SECTION 2 : XENON ARC LAMPS

SLS 1256 : Part 28 : Section 2 : 2016
ISO 16474-2 : 2013
(Superseding SLS 1256 : Part 28 : 2009)

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Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This standard does not purport to include all the necessary provisions of a contract.

Sri Lanka Standard
METHOD OF TEST FOR PAINTS AND VARNISHES
PART 28: EXPOSURE TO LABORATORY LIGHT SOURCES
SECTION 2: XENON ARC LAMPS

NATIONAL FOREWORD

This Sri Lanka Standard was approved by the Sectoral Committee on Chemical and Polymer Technology and authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2016-10-27.

This Standard supersedes SLS 1256: Part 28: 2009 Artificial weathering and exposure to artificial radiation- Exposure to filtered xenon arc radiation which was an adoption of ISO 11341: 2004. The text of ISO 11341: 2004 has been technically revised and replaced by ISO 16474-1 and ISO 16474-2. This Standard series of SLS 1256 : Part 28 is published to adopt ISO 16474: 2013 part 1 to part 4: Paints and varnishes – Methods of exposure to laboratory light sources which consists of four sub sections:

SLS 1256: Part 28: Section 1- General guidance
SLS 1256: Part 28: Section 2- Xenon arc lamps
SLS 1256: Part 28: Section 3- Fluorescent UV lamps
SLS 1256: Part 28: Section 4- Open flame carbon arc lamps

The text of the International Standard ISO 16474-2 : 2013 Paints and varnishes – Methods of exposure to laboratory light sources- Part 2: Xenon arc lamps has been accepted for adoption as SLS 1256 : Part 28 : Section 2 : 2016.

This Sri Lanka standard is identical ISO 16474-2 : 2013 Paints and varnishes – Methods of exposure to laboratory light sources- Part 2: Xenon arc lamps published by the International Organization for Standardization (ISO).

TERMINOLOGY AND CONVENTIONS

The text of the International Standard has been accepted as suitable for publication, without deviation, as a Sri Lanka Standard. However, certain terminology and conventions are not identical with those used in Sri Lanka Standards. Attention is therefore drawn to the following:

a) Wherever the words “International Standard” appear referring to a particular Standards they should be interpreted as “Sri Lanka Standard”.

b) The comma has been used throughout as a decimal marker. In Sri Lanka Standards it is the current practice to use the full point at the base as the decimal marker.

c) Wherever page numbers are quoted, they are ISO page numbers.

Cross References

International Standard	Corresponding Sri Lanka Standard
ISO 4618, Paints and varnishes – Terms and definitions	No corresponding Sri Lanka Standard
ISO 9370, Plastics — Instrumental determination of radiant exposure in weathering tests — General guidance and basic test method	No corresponding Sri Lanka Standard
ISO 16474-1, Paints and varnishes — Methods of exposure to laboratory light sources — Part 1: General guidance	No corresponding Sri Lanka Standard

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SLS 1256-28-2:2016

INTERNATIONAL STANDARD

ISO 16474-2

First edition
2013-11-15

Paints and varnishes — Methods of exposure to laboratory light sources —

Part 2: Xenon-arc lamps

Peintures et vernis — Méthodes d'exposition à des sources lumineuses de laboratoire —

Partie 2: Lampes à arc au xénon

Reference number
ISO 16474-2:2013(E)

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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.

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

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

This first edition of ISO 16474-2, together with ISO 16474-1, cancels and replaces ISO 11341:2004 which has been technically revised.

ISO 16474 consists of the following parts, under the general title *Paints and varnishes — 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*

Introduction

Coatings of paints, varnishes and similar materials (subsequently referred to simply as coatings) are exposed to laboratory light sources, in order to simulate in the laboratory the ageing processes which occur during natural weathering or during exposure tests under glass cover.

Paints and varnishes — Methods of exposure to laboratory light sources —

Part 2:
Xenon-arc lamps

1 Scope

This part of ISO 16474 specifies methods for exposing specimens to xenon-arc light in the presence of moisture to reproduce the weathering effects that occur when materials are exposed in actual end-use environments to daylight or to daylight filtered through window glass.

The specimens are exposed to filtered xenon-arc light under controlled conditions (temperature, humidity and/or wetting). Various types of xenon-arc lamps and various filter combinations may be used to meet all the requirements for testing different materials.

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

General guidance is given in ISO 16474-1.

NOTE Xenon-arc exposures for plastics are described in ISO 4892-2.

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 4618, *Paints and varnishes — Terms and definitions*

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

ISO 16474-1, *Paints and varnishes — Methods of exposure to laboratory light sources — Part 1: General guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 and the following apply.

3.1
radiant exposure
H
amount of radiant energy to which a test panel has been exposed

Note 1 to entry: Radiant exposure is given by the equation $H = \int E \cdot \mathrm{d}t$.

where

H is the radiant exposure, in joules per square metre;

E is the irradiance, in watts per square metre;

t is the exposure time, in seconds.

Note 2 to entry: If the irradiance E is constant throughout the whole exposure time, the radiant exposure H is given simply by the product of E and t.

4 Principle

4.1 A xenon arc, fitted with suitable filters and properly maintained, is used to simulate the spectral power distribution of daylight in the ultraviolet (UV) and visible regions of the spectrum.

4.2 Specimens are exposed to various levels of irradiance (radiant exposure), heat, relative humidity and water (see 4.4) under controlled environmental conditions.

4.3 The exposure conditions may be varied by selection of

a) the light filter(s);

b) the irradiance level;

c) the temperature during light exposure;

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

e) the type of wetting (see 4.4);

f) the water temperature and wetting cycle;

g) the timing of the light/dark cycle.

4.4 Wetting is usually 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.

4.5 The procedure shall include measurements of the irradiance and radiant exposure in the plane of the specimens.

4.6 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.

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

5 Apparatus

5.1 Laboratory light source

5.1.1 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 No. 85. The benchmark daylight used in this part of ISO 16474 is that defined in CIE No. 85:1989, Table 4.

5.1.2 Spectral irradiance of xenon-arc lamps with daylight filters

Filters are used to filter xenon-arc emissions in order to simulate daylight (CIE No. 85:1989, Table 4[2]). 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 filter [a,b] (method A)

Spectral passband	Minimum[c]	CIE No. 85:1989, Table 4 [d,e]	Maximum[c]
(λ = wavelength in nm)	%	%	%
$\lambda < 290$			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 has to 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 290 nm to 400 nm.

[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, 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 CIE Publication No. 85:1989, Table 4 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 in CIE No. 85:1989, Table 4, 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 can vary due to the number of specimens being exposed and their reflectance properties.

5.1.3 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	Minimum[c]	CIE No. 85:1989, Table 4 plus effect of window glass[d,e]	Maximum[c]
(λ = wavelength in nm)	%	%	%
$\lambda < 300$			0,29
$300 \leq \lambda \leq 320$	0,1	≤ 1	2,8
$320 < \lambda \leq 360$	23,8	33,1	35,5
$360 < \lambda \leq 400$	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 has to 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] 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, 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 CIE No. 85:1989, Table 4 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 Table A.1). 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 can vary due to the number of specimens being exposed and their reflectance properties.

5.1.4 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 16474-1.

For some materials of high reflectivity, or/and 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.

5.2 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 16474-1. 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 16474-1.

The light source(s) shall be located, with respect to the specimens, such that the irradiance at the specimen surface complies with 5.1.

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.

5.3 Radiometer

The radiometer used shall comply with the requirements outlined in ISO 16474-1 and ISO 9370.

5.4 Black-standard/black-panel thermometer

The black-standard or black-panel thermometer used shall comply with the requirements for these devices given in ISO 16474-1.

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

5.5 Wetting and humidity-control equipment

5.5.1 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 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 coatings.

5.5.2 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 16474-1.

5.5.3 Spray system

The test chamber shall 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 content 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 may be used to produce water of the desired quality.

5.6 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.

5.7 Apparatus to assess changes in properties

The apparatus required by the International Standards relating to the determination of the properties chosen for monitoring shall be used.

6 Test specimens

Refer to ISO 16474-1.

7 Exposure conditions

7.1 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.

7.2 Temperature

7.2.1 Black-standard/black-panel temperature

For referee purposes, Table 3 and Table B.1 specifies black-standard temperatures. For normal work, black-panel thermometers may be used in place of black-standard thermometers. However, allowance will have to be made for the fact that the two types of thermometer indicate different temperatures, due to their different thermal conductivities (see ISO 16474-1).

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 and report if the specified temperature is reached during a longer dry period without water spray.

NOTE 3 During the water spray part of the cycle, the black-standard or black panel temperature is close to the water temperature.

NOTE 4 The additional measurement of a white-standard/white-panel temperature with a white-standard/white-panel thermometer according to ISO 16474-1 gives important information on the range of surface temperatures of differently coloured test specimens.

7.2.2 Chamber air temperature

Exposures may 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).

7.3 Relative humidity of chamber air

Exposures may 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**	**Chamber temperature**	**Relative humidity**
		Broadband	**Narrowband**			
		(300 nm to 400 nm)	(340 nm)			
		W/m^2	$W/(m^2 \cdot nm)$	°C	°C	%
1	102 min dry	60 ± 2	0,51 ± 0,02	65 ± 3	38 ± 3	50 ± 10 [c]
	18 min water spray	60 ± 2	0,51 ± 0,02	—	—	—
Method B — Exposures using window glass filters						
Cycle No.	**Exposure period**	**Irradiance** [b]		**Black-standard temperature**	**Chamber temperature**	**Relative humidity**
		Broadband	**Narrowband**			
		(300 nm to 400 nm)	(420 nm)			
		W/m^2	$W/(m^2 \cdot nm)$	°C	°C	%
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 set point value is allowed to be set between the plus/minus amount from the value specified.

NOTE 2 For uncontrolled chamber temperature and humidity it could be helpful to report the measured numbers in the test 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/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.

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

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**	**Chamber temperature**	**Relative humidity**
		Broadband	**Narrowband**			
		(300 nm to 400 nm)	(340 nm)			
		W/m^2	W/(m^2·nm)	°C	°C	%
4	102 min dry	60 ± 2	0,51 ± 0,02	63 ± 3	38 ± 3	50 ± 10 [b]
	18 min water spray	60 ± 2	0,51 ± 0,02	—	—	—
Method B — Exposures using window glass filters						
Cycle No.	**Exposure period**	**Irradiance** [a]		**Black-panel temperature**	**Chamber temperature**	**Relative humidity**
		Broadband	**Narrowband**			
		(300 nm to 400 nm)	(420 nm)			
		W/m^2	W/(m^2·nm)	°C	°C	%
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 set point value is allowed to be set between the plus/minus amount from the value specified.

NOTE 2 For uncontrolled chamber temperature and humidity it could be helpful to report the measured numbers in the test 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/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.

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

NOTE 1 High-irradiance testing has been shown to be useful for several materials, e.g. automotive interior materials. When using high-irradiance testing, the linearity of the property change with the irradiance has to be checked carefully. Results obtained at different irradiance levels can only be compared if the other test parameters (black-standard or black panel temperature, chamber air temperature, relative humidity) are similar.

NOTE 2 The conversion factors used above to calculate the narrow-band (340 nm or 420 nm) irradiance from the broad-band (300 nm to 400 nm) irradiance are mean values for a variety of filter systems. Details of such conversion factors will normally be provided by the manufacturer.

NOTE 3 Ageing of the xenon-arc lamps and filters causes the relative spectral energy distribution to change during operation and the irradiance to decrease. Renewal of the lamps and filters will help keep the spectral energy distribution and the irradiance constant. The irradiance may also be kept constant by adjustment of the apparatus. Follow the manufacturer's instructions.

7.4 Spray cycle

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

7.5 Cycles with dark periods

The conditions in Table 3 and Table B.1 (see Table 4 and Table B.2 as well) 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.

7.6 Sets of exposure conditions

Table 3 (see also Table B.1) and Table 4 (see also Table B.2) list 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 (additional cycles see Table B.1) specifies three exposure cycles where the insulated black-standard temperatures have to be controlled. In Table 4 (additional cycles see Table B.2) black-panel temperatures are given.

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

Black-standard thermometers may also be used in place of the black-panel thermometers to meet the temperature requirements in Table 4 and in Table B.2. However, in this case the actual temperature difference between the different types of thermometers has to be determined and the measured respective temperature is used as the equivalent set point temperature to compensate for the differences in the thermal conductivity between the two thermometer types (see ISO 16474-1).

8 Procedure

8.1 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.

8.2 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.

8.3 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 16474-1.

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.

8.4 Duration of test

Test until

a) either the surfaces of the test panels have been subjected to an agreed radiant exposure;

b) or an agreed or specified ageing criterion is satisfied.

In the latter case, remove and examine the test panels at various stages during the test period and determine the end point by plotting an ageing curve.

No single test duration or test programme can be specified which would be suitable for all types of coating. The total number of tests and the number of stages in each test shall be chosen as a function of the requirements of the individual tests and shall be agreed between the interested parties for each particular case. If not otherwise agreed, take two test panels for each assessment.

Testing of the test panels shall be carried out without interruption except for cleaning or exchanging the xenon-arc lamps or the filter system or, when testing in stages, removal of the test panels.

If panels are evaluated for changes in gloss or colour, the panels shall be removed from the weathering instrument at the end of the dry period.

8.5 Measurement of radiant exposure

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

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 [$J/(m^2 \times nm)$] at the wavelength selected (e.g. 340 nm).

8.6 Determination of changes in properties after exposure

These shall be determined as specified in ISO 16474-1.

9 Test report

Refer to ISO 16474-1.

Annex A
(informative)

Filtered xenon-arc radiation — Spectral power distribution

A.1 General

CIE Publication No. 85:1989 provides data on spectral solar irradiance for typical atmospheric conditions and this data may be used as a basis for comparing laboratory light sources with daylight. The data used for filtered xenon-arc radiation are given in CIE No. 85:1989, Table 4 (see also ISO 16474-1).

A.2 Spectral irradiance specification (UV region)

A.2.1 Xenon-arc lamps with daylight filters

The data given in CIE Publication 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 Publication 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 3-mm-thick window glass as given in Table A.1. The CIE Publication No. 85:1989, Table 4, irradiance was multiplied by the appropriate transmittance of the window glass to determine the irradiance in each passband.

Table A.1 — Transmittance through 3-mm-thick window glass[a]

Range	Wavelength, λ nm	Transmittance
UV-C	$\lambda < 280$	0
UV-B	$280 \leq \lambda \leq 320$[b]	0,10
UV-A	$320 < \lambda \leq 360$	0,65
UV-A	$360 < \lambda \leq 400$	0,88
VIS[b]	$400 < \lambda \leq 440$	0,88
	$440 < \lambda \leq 480$	0,90
	$480 < \lambda \leq 520$	0,90
	$520 < \lambda \leq 560$	0,90
	$560 < \lambda \leq 600$	0,90
	$600 < \lambda \leq 640$	0,88
	$640 < \lambda \leq 680$	0,86
	$680 < \lambda \leq 720$	0,84
	$720 < \lambda \leq 760$	0,82
	$760 < \lambda \leq 800$	0,80
Sum	280 to 3 000	0,85

[a] Source: Zentralabteilung Forschung der VEGLA — Vereinigte Glaswerke GmbH, Aachen, Germany, 1983.

[b] Radiation below 300 nm does not reach the surface of the Earth; at wavelengths above 3 000 nm, radiation levels are negligible.

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-Panel Lab Products, and Suga Test Instruments. The irradiance in each pass band 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)

Cycle No.	Exposure period	Irradiance [a]		Black-standard temperature	Chamber temperature	Relative humidity
Method A — Exposures using daylight filters (artificial weathering)						
		Broadband	Narrowband			
		(300 nm to 400 nm)	(340 nm)			
		W/m^2	$W/(m^2 \cdot nm)$	°C	°C	%
B1	102 min dry	60 ± 2	0,51 ± 0,02	65 ± 3	Not controlled	Not controlled
	18 min water spray	60 ± 2	0,51 ± 0,02	—	—	—
Method B — Exposures using window glass filters						
Cycle No.	Exposure period	Irradiance [a]		Black-standard temperature	Chamber temperature	Relative humidity
		Broadband	Narrowband			
		(300 nm to 400 nm)	(420 nm)			
		W/m^2	$W/(m^2 \cdot nm)$	°C	°C	%
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 set point value is allowed to be set between the plus/minus amount from the value specified.

NOTE 2 For uncontrolled chamber temperature and humidity, it could be helpful to report the measured numbers in the test 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/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**	**Chamber temperature**	**Relative humidity**
		Broadband	**Narrowband**			
		(300 nm to 400 nm)	(340 nm)			
		W/m²	W/(m²·nm)	°C	°C	%
B4	102 min dry	60 ± 2	0,51 ± 0,02	63 ± 3	Not controlled	Not controlled
	18 min water spray	60 ± 2	0,51 ± 0,02	—	—	—
Method B — Exposures using window glass filters						
Cycle No.	**Exposure period**	**Irradiance [a]**		**Black-panel temperature**	**Chamber temperature**	**Relative humidity**
		Broadband	**Narrowband**			
		(300 nm to 400 nm)	(420 nm)			
		W/m²	W/(m² · nm)	°C	°C	%
B5	Continuously dry	50 ± 2	1,10 ± 0,02	63 ± 3	Not controlled	Not controlled
B6	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 set point value is allowed to be set between the plus/minus amount from the value specified.

NOTE 2 For uncontrolled chamber temperature and humidity, it could be helpful to report the measured numbers in the test 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.

Bibliography

[1] ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

[2] CIE No. 85:1989, *Solar spectral irradiance*

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