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Rubber and plastics hoses — Methods of exposure to laboratory light sources — Determination of changes in colour, appearance and other physical properties

Tuyaux en caoutchouc et en plastique — Méthodes d'exposition à des sources lumineuses de laboratoire — Détermination du changement de coloration, d'aspect et d'autres propriétés physiques

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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 30013 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 1, *Hoses (rubber and plastics)*.

It cancels and replaces ISO 8580:1987 and ISO 11758:1995, which have been combined and technically revised. It also cancels and replaces the Technical Corrigendum ISO 11758:1995/Cor.1:1998.

Rubber and plastics hoses — Methods of exposure to laboratory light sources — Determination of changes in colour, appearance and other physical properties

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This International Standard specifies methods for the exposure of rubber and plastics hoses to three types of laboratory light source (xenon-arc, fluorescent UV and open-flame carbon-arc lamps).

These methods are designed to simulate the exposure of hoses used in an outdoor environment (exposure to xenon-arc lamps by method A, exposure to fluorescent UV lamps by method A and exposure to open-flame carbon-arc lamps with type 1 filters) or in an indoor environment (exposure to xenon-arc lamps by method B, exposure to fluorescent UV lamps by method B and exposure to open-flame carbon-arc lamps with type 2 filters).

Four types of test piece (two strained and two unstrained upon exposure) are specified. Results from the three light sources and the different sets of exposure conditions specified are not comparable.

2 Normative references

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

ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

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 4665, *Rubber, vulcanized or thermoplastic — Resistance to weathering*

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

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

ISO 4892-3:2006, *Plastics — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps*

1) To be published (revision of ISO 4892-2:2006).

ISO 4892-4:2004, *Plastics — Methods of exposure to laboratory light sources — Part 4: Open-flame carbon-arc lamps*

ISO 7326:2006, *Rubber and plastics hoses — Assessment of ozone resistance under static conditions*

ISO 7724-3[2)], *Paints and varnishes — Colorimetry — Part 3: Calculation of colour differences*

ISO 8330, *Rubber and plastics hoses and hose assemblies — Vocabulary*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4665, ISO 4892-1 and ISO 8330 apply.

4 Principle

Test pieces are exposed to artificial laboratory light sources, and the resulting changes in colour, appearance and selected physical properties are determined for a simulated outdoor or indoor environment.

5 Test pieces

5.1 Types of test piece

5.1.1 General

Four types of test piece are detailed in Table 1. The type used shall be as specified in the product standard.

Results obtained with the various types of test piece are not comparable, even for the same property.

Table 1 — Types of test piece

	Type 1	Type 2	Type 3	Type 4
Bore size, mm	≤25	>25	>25	Any size
Test piece	Sample of hose	Strip cut longitudinally from hose	Strip cut longitudinally from hose cover or hose	Sample of hose
Test piece size,[a] mm	$L = \pi(r_b + d/2) + 2d$	$L = 150$, $W = 25$	$L = 100$, $W = 25$	$L \approx 150$
Test piece mounting method	Mandrel (see Figure 1)	Holder (see Figure 2)	Holder (see Figure 3)	Holder (see Figure 4)
Test piece condition during exposure	Strained	Strained	Not strained	Not strained
Elongation	Bent for minimum bend radius	Required elongation of hose cover	Not elongated	Not elongated
NOTE Types 1 and 2 are tested under strain, types 3 and 4 are tested without strain.				
[a] W = width, L = length, r_b = minimum bend radius, d = hose outside diameter.				

2) Users should note that ISO 7724-3 will be withdrawn at some time in the future. It will be replaced by ISO 11664-4.

5.1.2 Type 1

The test piece shall consist of a sample of hose. The length shall be calculated from the equation

$$L = \pi\left(r_b + \frac{d}{2}\right) + 2d$$

where

L is the length, in mm, of the test piece;

r_b is the minimum bend radius, in mm, of the hose under test;

d is the outside diameter, in mm, of the hose under test.

Mount the test piece in a test piece holder as shown in Figure 1. The radius r_b shall be equal to the specified minimum bend radius for the hose under test or, if this is not specified, six times the inside diameter.

5.1.3 Type 2

The test piece shall consist of a strip cut longitudinally from a hose. The strip shall be 150 mm in length and 25 mm in width.

Mount the test piece in a test piece holder as shown in Figure 2, in such a way that the convex side will be exposed to the light during the exposure.

For details of the mounting of the test piece, see method 2 in ISO 7326:2006.

5.1.4 Type 3

The test piece shall normally consist of a strip of hose cover, cut longitudinally from the hose.

The strip shall be 100 mm in length and 25 mm in width.

If a hose cover test piece cannot easily be cut from the hose, the test piece shall consist of a strip cut longitudinally from the complete hose with its cover in place. The strip shall be 100 mm in length and 25 mm in width.

Mount the test piece in a test piece holder as shown in Figure 3, in such a way that the convex side will be exposed to the light during the exposure.

5.1.5 Type 4

The test piece shall consist of a sample of hose approximately 150 mm in length. If possible, test pieces shall be cut from different sections of the hose (e.g. from each end and from the middle).

Mount each test piece in a test piece holder as shown in Figure 4, ensuring that it is not subject to any stress but curves naturally in such a way that the convex side will be exposed to the light during the exposure.

5.2 Conditioning

Prior to testing, condition the test pieces, mounted as described in 7.2, under the applicable standard conditions as specified in ISO 23529 or ISO 291, as appropriate, in darkness or subdued light.

5.3 Number of test pieces

At least three test pieces shall be exposed to laboratory light sources, and at least one piece shall be kept in darkness as a control in order to permit the evaluation of the change in colour, appearance and physical properties. The total number of test pieces will therefore be at least four.

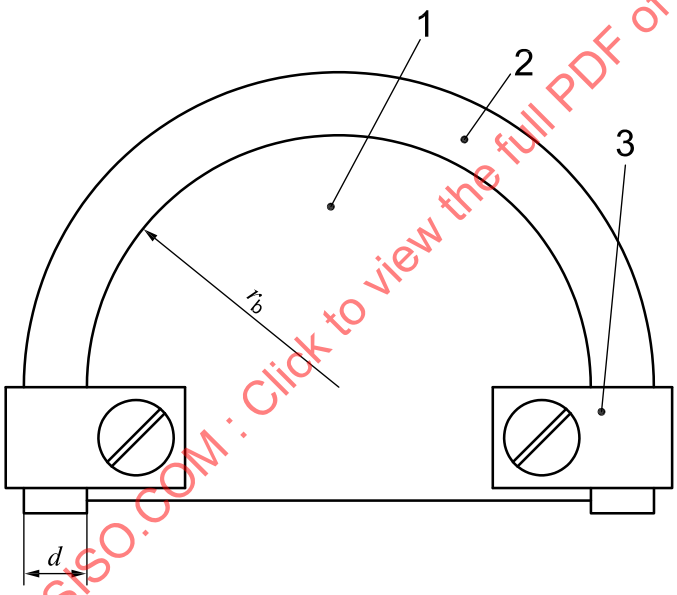
5.4 Test piece holders

The test piece holders may be used in each type of test piece. The holder shall be constructed with inert materials that do not affect the results, e.g. aluminium or stainless steel. They are also designed to support the back of the test piece. Brass, steel and copper shall not be used near to the test piece.

5.5 Radiation direction and radiation surface

Test pieces shall be attached to the appropriate holder shown in Figure 1 to Figure 4. Place the holder with the test piece in the exposure area using holder or mounting hardware appropriate to the type and model of exposure device being used (see Figure 6).

The direction of the radiation and the surface of the test piece which is irradiated are shown in Figure 5.



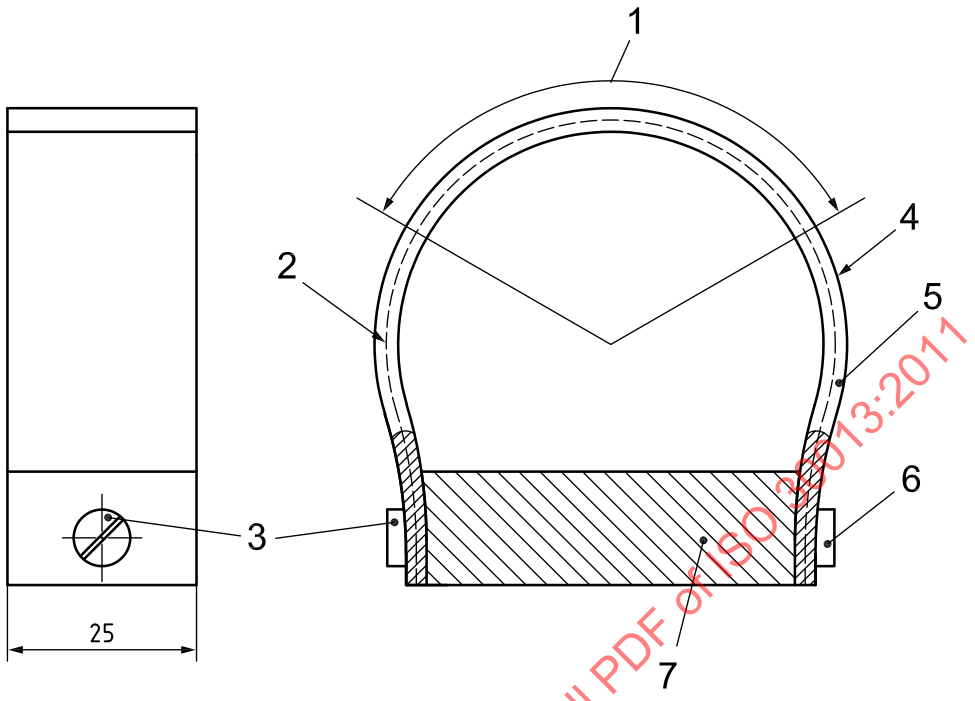
Key

d hose outside diameter
r_b bend radius

1 mandrel
2 test piece
3 retaining clamp

Figure 1 — Arrangement for mounting a type 1 test piece on a mandrel

Dimensions in millimetres

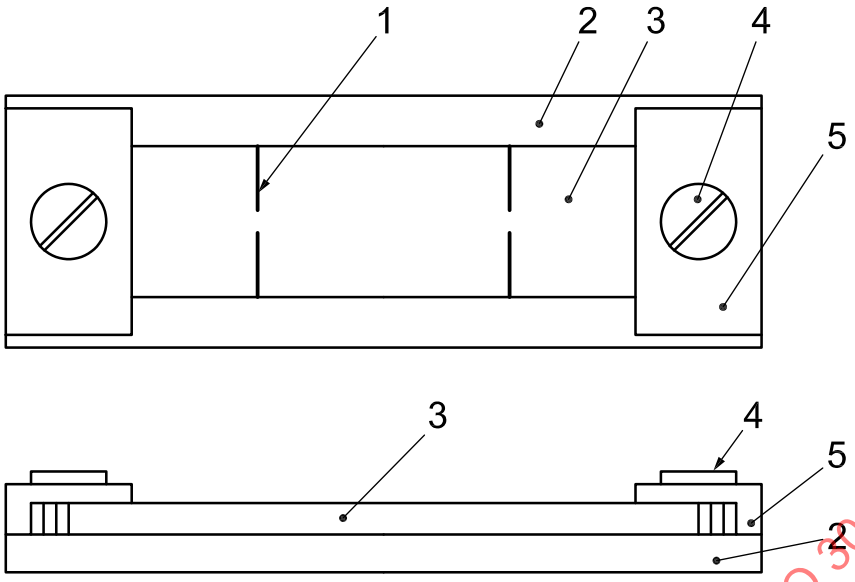


Key

1 measurement distance (20 mm)
2 hose reinforcement
3 retaining bolt
4 outside surface of hose
5 test piece
6 grip
7 holder, made of stainless steel or aluminium

NOTE End-to-end length of test piece is 150 mm.

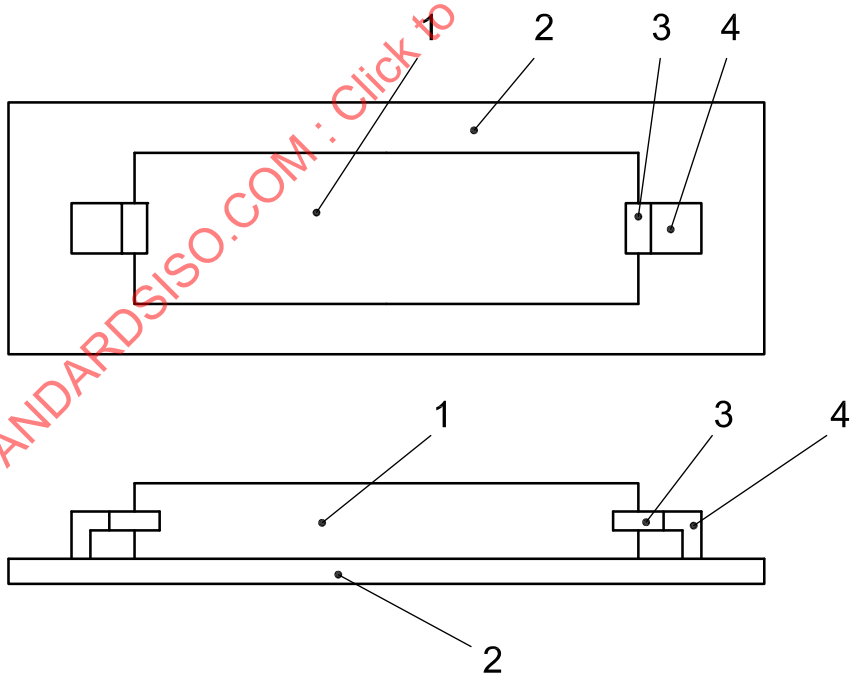
Figure 2 — Holder for type 2 test piece



Key

1 mark for extension measurement
2 holder, made of stainless steel or aluminium
3 test piece
4 retaining bolt
5 clamp

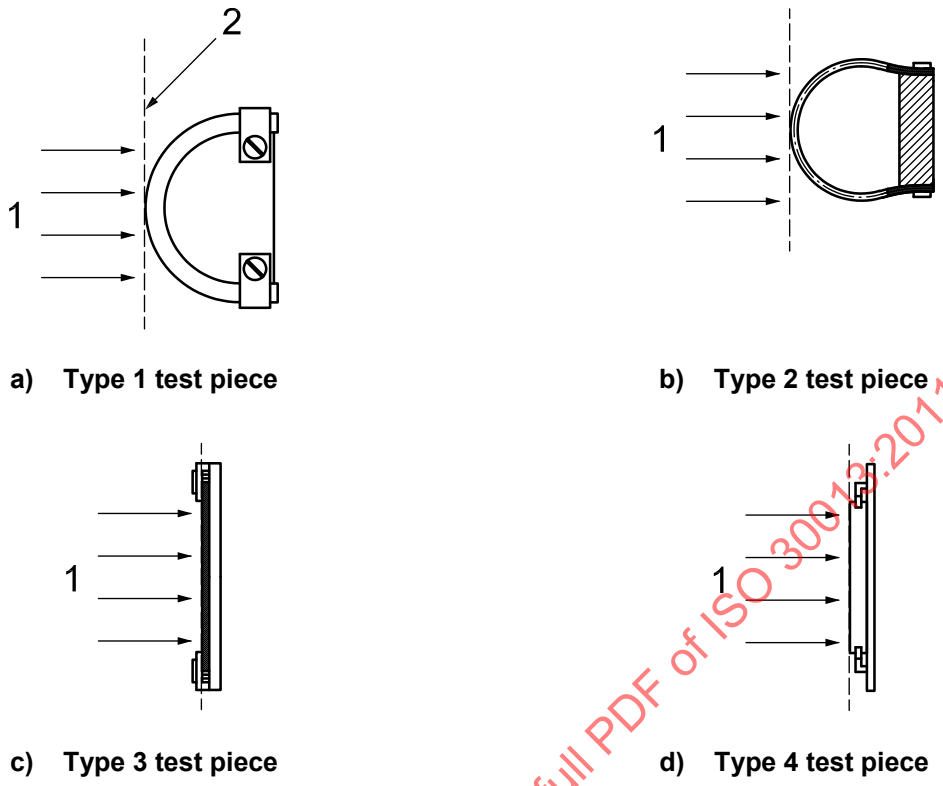
Figure 3 — Holder for type 3 test piece



Key

1 test piece
2 holder, made of stainless steel or aluminium
3 clip
4 clamp

Figure 4 — Holder for type 4 test piece



a) Type 1 test piece

b) Type 2 test piece

c) Type 3 test piece

d) Type 4 test piece

Key

1 light source

2 exposed surface closest to light source

Figure 5 — Radiation direction and exposed surface closest to the light source

6 Light sources and exposure cycles

6.1 General

The test piece shall be exposed to the light source (see 6.2, 6.3 and 6.4) specified in the product standard, using the method and cycle No. specified in the product standard.

6.2 Xenon-arc lamps

6.2.1 Apparatus

The apparatus used shall be in accordance with Clause 4 of ISO 4892-2:—.

6.2.2 Exposure conditions (exposure cycles)

6.2.2.1 General

The exposure conditions (exposure cycles) available are listed in Table 2 for the case when a black-standard thermometer (BST) is used and Table 3 for the case when a black-panel thermometer (BPT) is used. The cycle used shall be as stated in the product standard. If no exposure cycle is stated, use cycle 1 or 2 with a BST and cycle 5 or 6 with a BPT (i.e. method A).

If other exposure cycles are required, refer to Tables 3, 4, B.1 and B.2 in ISO 4892-2:—.

If more complex cycles, such as a combination of cycles 1 and 3, are required, full details of the conditions used shall be given in the test report.

Table 2 — Xenon-arc lamp exposure cycles with temperature control by black-standard thermometer

Method A: Exposures using daylight filters (artificial weathering)						
Cycle No.	**Exposure cycle**	**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)			
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 —
2	102 min dry 18 min water spray	60 ± 2 60 ± 2	0,51 ± 0,02 0,51 ± 0,02	65 ± 3 —	Not controlled —	50 ± 10 —
Method B: Exposures using window-glass filters						
Cycle No.	**Exposure cycle**	**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)			
3	Continuously dry	50 ± 2	1,10 ± 0,02	65 ± 3	38 ± 3	50 ± 10
4	Continuously dry	50 ± 2	1,10 ± 0,02	65 ± 3	Not controlled	50 ± 10

NOTE The plus/minus 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 instrument setting can vary by plus/minus the value given in this table.

[a] The irradiance values given are those that have historically been used. In apparatus capable of producing higher irradiances, the actual irradiance can 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 3 — Xenon-arc lamp exposure cycles with temperature control by black-panel thermometer

Method A — Exposures using daylight filters (artificial weathering)						
Cycle No.	Exposure cycle	Irradiance[a]		Black-panel temperature °C	Chamber temperature °C	Relative humidity %
		Broadband (300 nm to 400 nm) W/m^2	Narrowband (340 nm) W/(m^2·nm)			
5	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 —
6	102 min dry 18 min water spray	60 ± 2 60 ± 2	0,51 ± 0,02 0,51 ± 0,02	63 ± 3 —	Not controlled —	50 ± 10 —
Method B — Exposures using window-glass filters						
Cycle No.	Exposure cycle	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)			
7	Continuously dry	50 ± 2	1,10 ± 0,02	63 ± 3	38 ± 3	50 ± 10
8	Continuously dry	50 ± 2	1,10 ± 0,02	63 ± 3	Not controlled	50 ± 10

NOTE The plus/minus 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 instrument setting can vary by plus/minus the value given in this table.

[a] The irradiance values given are those that have historically been used. In apparatus capable of producing higher irradiances, the actual irradiance can 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.

6.2.2.2 Irradiation

Unless otherwise specified, control the irradiance at the levels indicated in Table 2 or Table 3. Other irradiance levels may be used if agreed upon by the interested parties. The irradiance, and the passband in which it was measured, shall be included in the test report.

6.2.2.3 Temperature

6.2.2.3.1 Black-standard/black-panel temperature

The black-standard temperatures specified in Table 2 are intended for referee purposes. For normal work, black-panel thermometers may be used in place of black-standard thermometers (see Table 3). However, allowance will have to be made for the fact that the two types of thermometer indicate different temperatures, due to the different design and to interchange with the surrounding atmosphere (see ISO 4892-1).

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 test report.

NOTE 2 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 pieces.

6.2.2.3.2 Chamber air temperature

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

6.2.2.4 Relative humidity of chamber air

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

6.2.2.5 Spray cycle

The exposure chamber shall be equipped with a means of directing water spray onto the exposed surfaces of the test pieces under specified conditions.

The spray cycle shall be as specified for method A in Table 2 or Table 3.

6.2.2.6 Cycles with dark periods

The conditions in Table 2 and Table 3 are valid for the continuous presence of radiant energy from the source. More complex cycles may be used if specified in the product standard. These could include dark periods involving high humidity and/or the formation of condensate on the surfaces of the test pieces.

If such a cycle is used, full details, including the conditions, shall be given in the test report.

6.2.2.7 Length of exposure

The length of the exposure shall be as specified in the product standard or as agreed between the interested parties.

6.3 Fluorescent UV lamps

6.3.1 Apparatus

The apparatus used shall be in accordance with Clause 4 of ISO 4892-3:2006.

6.3.2 Exposure conditions (exposure cycles)

6.3.2.1 General

Various sets of exposure conditions are listed in Table 4 as exposure cycles for artificial weathering (method A), for daylight behind window glass (method B) and for type 2 (UVB-313) lamps (method C). The set of conditions used shall be as stated in the product standard.

If other exposure cycles are required, refer to Table 4 in ISO 4892-3:2006.

Table 4 — Exposure cycles for fluorescent UV lamps

Cycle No.	Exposure cycle	Lamp type	Irradiance[a] W/(m^2·nm)	Black-standard temperature °C	Relative humidity
Method A: Artificial weathering					
1	8 h dry 4 h condensation	Type 1A (UVA-340)	0,76 at 340 nm Lamp off	60 ± 3 50 ± 3	Not controlled Not controlled
Method B: Daylight behind window glass					
2	24 h dry (no moisture)	Type 1B (UVB-351)	0,76 at 340 nm	50 ± 3	Not controlled
Method C: Type 2 UVB-313 lamps					
3	8 h dry 4 h condensation	Type 2 (UVB-313)	0,48 at 310 nm Lamp off	70 ± 3 50 ± 3	Not controlled Not controlled

NOTE The ±3 °C variation shown for the black-standard temperature is the allowable fluctuation of the indicated black-standard temperature around the temperature set under equilibrium conditions. It does not mean that the temperature set can vary by ±3 °C from the given value.

[a] Higher-irradiance tests may be conducted if agreed upon by the interested parties. When high-irradiance conditions are used, lamp life may be significantly shortened.

6.3.2.2 Irradiation

Unless otherwise specified, control the UV irradiance at the levels indicated in Table 4. Other irradiance levels may be used if agreed upon by the interested parties. The irradiance, and the passband in which it was measured, shall be included in the test report.

6.3.2.3 Temperature

Fluorescent UV lamps emit relatively little visible and infrared radiation compared to solar radiation, xenon-arc sources and carbon-arc sources. Unlike the case with solar radiation, in fluorescent-UV apparatus heating of the test piece surface is primarily by convection of heated air across the test piece. Therefore, the difference between the temperature of a black-panel thermometer, a black-standard thermometer, the test piece surface and the air in the exposure chamber is typically <2 °C. Additional measurement of the white-standard temperature or white-panel temperature as recommended in ISO 4892-1 is not necessary.

The black-standard temperatures specified in Table 4 are intended for referee purposes. For normal work, black-panel thermometers may be used in place of black-standard thermometers.

NOTE The surface temperature of the test pieces is a crucial exposure parameter. Generally, degradation processes progress faster with increasing temperature. The test piece temperature permissible for accelerated exposure depends on the material under test and on the ageing criterion under consideration.

Other temperatures may be selected if agreed upon by the interested parties, but shall be stated in the test report.

If condensation periods are used, the temperature requirements apply to the equilibrium conditions during the condensation period. If water spray periods are used, the temperature requirements apply to the end of the dry period. If the temperature does not attain equilibrium during a cycle, in the case of a spray cycle the specified temperature shall first be established without water spray and, in the case of a dry cycle, the maximum temperature attained during the cycle shall be reported.

6.3.2.4 Relative humidity of chamber air

Exposures can be conducted either with the relative humidity controlled at a specified level or allowing the relative humidity to find its own level.

6.3.2.5 Condensation and spray cycles

The exposure chamber shall be equipped with a means of producing intermittent condensation on, or directing intermittent water spray onto, the exposed surfaces of the test pieces under specified conditions.

The condensation and/or spray cycle shall be as stated in the product standard, but the one given in Table 4 is the preferred cycle.

6.3.2.6 Cycles with dark periods

More complex cycles may be used. These could include dark periods involving high humidity and/or the formation of condensate on the surfaces of the test pieces.

If such a cycle is used, full details, including the conditions, shall be given in the test report.

6.3.2.7 Length of exposure

The length of the exposure shall be as specified in the product standard or as agreed between the interested parties.

6.4 Open-flame carbon-arc lamps

6.4.1 Apparatus

The apparatus used shall be in accordance with Clause 4 of ISO 4892-4:2004.

6.4.2 Exposure conditions (exposure cycles)

The exposure conditions available are listed in Table 5. The conditions used shall be as stated in the product standard.

6.4.2.1 Temperature

6.4.2.1.1 Black-standard/black-panel temperature

For referee purposes, it is recommended that black-standard temperatures be used. However, black-panel temperatures are widely used for open-flame carbon-arc lamp apparatus. In the case of the black-panel temperature, 63 °C ± 3 °C is typically used. If a black-panel thermometer is used, then the type of thermometer, the way in which it is mounted on the test piece holder and the temperature of operation selected shall be stated in the test report. If water spray is used, the temperature requirement applies to the end of the dry period.

6.4.2.1.2 Chamber air temperature

If required, the chamber air temperature may also be controlled. If so, use 40 °C ± 3 °C unless otherwise specified.

Table 5 — Exposure cycles for open-flame carbon-arc lamps

Filter type	Cycle No.	Exposure cycle	Black-panel temperature °C	Chamber temperature °C	Relative humidity %
Type 1 (daylight filters)	1	102 min ± 0,5 min dry 18 min ± 0,5 min water spray	63 ± 3 —	40 ± 3 —	50 ± 5 —
	2	48 min ± 0,5 min dry 12 min ± 0,5 min water spray	63 ± 3 —	40 ± 3 —	50 ± 5 —
Type 2 (window-glass filters)	3	Continuously dry	63 ± 3	40 ± 3	50 ± 5
Type 3 (extended-UV filters)	4	102 min ± 0,5 min dry 18 min ± 0,5 min water spray	63 ± 3 —	40 ± 3 —	50 ± 5 —
	5	48 min ± 0,5 min dry 12 min ± 0,5 min water spray	63 ± 3 —	40 ± 3 —	50 ± 5 —

6.4.2.2 Relative humidity of air

Unless otherwise specified, the relative humidity shall be (50 ± 5) %.

NOTE The relative humidity of the air as measured in the exposure chamber is not necessarily equivalent to the moisture content of the air very close to the test piece surface owing to the differences in temperature of test pieces of different colours and thicknesses.

6.4.2.3 Spray cycle

The exposure chamber shall be equipped with a means of directing an intermittent water spray onto the exposed surfaces of the test pieces under specified conditions.

The water spray cycle used shall be as agreed between the interested parties, but the following are the preferred cycles:

a) water spray cycle 1:

— length of water-spraying period: 18 min ± 0,5 min,

— dry interval between spraying periods: 102 min ± 0,5 min;

b) water spray cycle 2:

— length of water-spraying period: 12 min ± 0,5 min,

— dry interval between spraying periods: 48 min ± 0,5 min.

6.4.2.4 Cycles with dark periods

The conditions in Table 5 are valid for the continuous presence of radiant energy from the source. More complex cycles may be used. These could include dark periods involving high humidity and/or the formation of condensate on the surfaces of the test pieces at elevated temperatures.

If such a cycle is used, full details, including the conditions, shall be given in the test report.

6.4.2.5 Length of exposure

The length of the exposure shall be as specified in the product standard or as agreed between the interested parties.

7 Procedure

7.1 General

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

7.2 Mounting the test pieces

Mount the test pieces on a type of holder appropriate to the shape of the test pieces. Identify each test piece, or the holder on which it is mounted, by suitable indelible marking. Do not place any markings on an area of the test piece that will be used for testing after the exposure. Place these holders in the exposure chamber on mountings appropriate to the type of exposure device being used.

In exposure devices with fluorescent UV lamps, the way in which the test pieces are mounted depends on the type of test piece. In such cases, use an exposure device with the correct mountings as shown in Figure 6.

Fill all the spaces in the exposure area in order to ensure uniform exposure conditions. Use blank panels, if necessary.

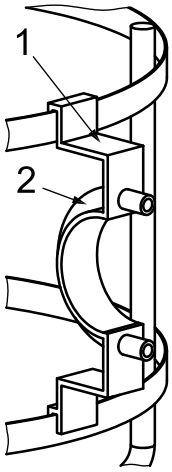
It can by useful to make a sketch indicating the location of each test piece in the exposure chamber.

7.3 Exposure

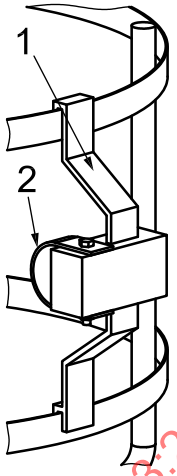
Before placing the test pieces in the exposure chamber, check that the apparatus is operating under the desired conditions (see Clause 6). Programme the apparatus to operate continuously for the required number of cycles at the selected exposure conditions. Maintain these conditions throughout the exposure,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

Expose the test pieces, and, if used, a radiometer to measure the irradiance, for the specified period. Repositioning of the test pieces during exposure is desirable and might be necessary. Follow the guidance given in ISO 4892-1.

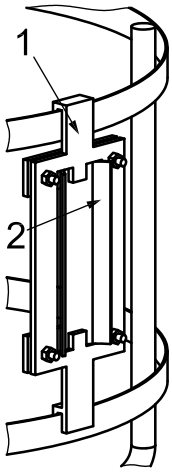
If it is necessary to remove a test piece for periodic inspection, take care not to touch the exposed surface or alter it in any way. After inspection, return the test piece to its holder or to its place in the exposure chamber with its exposed surface oriented in the same direction as before.



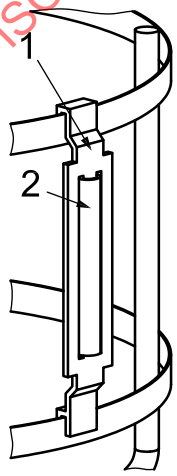
a) For type 1 test specimens



b) For type 2 test specimens



c) For type 3 test specimens



d) For type 4 test specimens

Key

1 clamp
2 test piece

Figure 6 — Examples of clamps for attaching mandrels/test piece holders to the exposure frame

7.4 Measurement of radiant exposure

If a radiometer is used, mount it so that it measures the irradiance at the exposed surfaces of the test pieces.

When radiant exposures are used, express the exposure interval in terms of incident radiant energy per unit area in 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 Removal and inspection of test pieces

Take a mandrel or test piece holder out of the chamber after a given length of exposure to inspect the test piece to see if the test piece shows any abnormality. Without removing the test piece from its holder, examine the surface of the test piece under ×2 magnification for cracking and other changes in appearance. Then remove the test piece from the holder and determine the change in colour and changes in physical properties.

Changes in colour can be determined from measurements made before and after exposure or from a comparison of the exposed test pieces with file specimens of the same material that have been kept in the dark. An unexposed area can also be placed adjacent to an exposed area for comparison purposes, and this is useful for checking the progress of the exposure, but the results reported shall always be based on a comparison with file specimens stored in the dark.

8 Expression of results

8.1 Cracking and appearance

The presence of any cracking shall be noted, together with its extent and the cracking pattern. The appearance shall be described in terms of the features specified in the product standard (see also Annex A).

8.2 Changes in colour

Measure the colour with a colorimeter either before and after exposure or by comparing unexposed file specimens with the exposed test pieces.

When a hose is made from a thermoplastic resin, measure the change in colour in accordance with ISO 4582 and ISO 105-A02.

When the hose material is rubber, measure the change in colour in accordance with ISO 7724-3 and ISO 105-A02.

8.3 Changes in physical properties

Determine changes in physical properties by determining the value of each property for unexposed test pieces and exposed test pieces, following the procedure specified in ISO 4582.

9 Test report

The test report shall include the following information:

a) Test piece description:

   1) a full description of the test pieces and their origin;

   2) compound details, cure time and temperature, where appropriate;

   3) a complete description of the method used for the preparation of the test pieces.

NOTE If exposure tests are conducted by a contracting agency, test pieces are usually identified by code-number. In such cases, it is the responsibility of the originating laboratory to provide the complete test piece description when reporting the results of the exposure.

b) A description of the exposure, including:

   1) a description of the exposure device and light source, including:

      i) the type of device and light source,

      ii) a description of the filters used,

      iii) if required, the irradiance at the test piece surface (including the passband in which the radiation was measured),

