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Communication cables — Specifications for test methods

Part 4-17: Test methods for UV resistance evaluation of the sheath of electrical and optical fibre cable

National foreword

This British Standard is the UK implementation of EN 50289-4-17:2015. It supersedes BS EN 50289-4-17:2011 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/46, Cables, wires and waveguides, radio frequency connectors and accessories for communication and signalling.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Câbles de communication - Spécifications des méthodes d'essais - Partie 4-17: Méthodes d'essai pour évaluer la résistance aux UV des gaines des câbles électriques et des câbles à fibre optique

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European foreword

This document (EN 50289-4-17:2015) has been prepared by CLC/TC 46X “Communication cables”.

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2016-08-31
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2018-08-31

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This document supersedes EN 50289-4-17:2011.

EN 50289-4-17:2015 includes the following significant technical changes with respect to EN 50289-4-17:2011:

Annex A has been downgraded as “informative”.

Annexes B and C have been deleted and a new Annex B has been introduced that is no longer requirements but only a guideline to the interpretation and use.

Introduction

UV hazard assessment for synthetic compounds is possible using a number of UV sources. For the purposes of this European Standard, three alternative methods are given.

1) Method A uses a xenon arc source to simulate the UV effect on cable sheath. The effect is measured by the variation of mechanical characteristics and/or change in colour after exposure.

2) Method B uses a fluorescent lamp to simulate the UV effect on cable sheath. Two different lamps may be used; type I (called UV-A lamps) and type II (called UV-B lamps). The effect is measured as for method A, by the variation of mechanical characteristics and/or change in colour after exposure.

3) Method C uses mercury vapour lamp to simulate the UV effect on cable sheath. As for methods A and B, the effect is determined by the variation of mechanical characteristics and/or change in colour after exposure. This test has been typically used for telecommunication cables.

For outdoor cable application only, the test specimens are periodically subjected to water attack, for methods A and B. A recent modification of method C now allows for a water immersion cycle.

For method C, the round robin tests made without water (see Annex B) indicate the method may be applicable to outdoor environments.

Other sources and determination methods are capable of detecting and analysing the UV hazard for a cable sheath. Examples of such methods are metal halide lamps or sunshine carbon arc lamps, in combination with proper filters in order to cut off most radiation having wavelengths lower than 290 nm. Contracting parties may agree to use such other methods, but such methods cannot claim conformity to this European Standard. If used, it is recommended that such methods have at least equivalent sensitivity and detection levels as those in this European Standard.

Informative Annex B gives guidelines for the use and interpretation of results.

NOTE It is important to recall the introduction to EN ISO 4892-1:2000, which says, "*The relative durability of materials in actual-use exposures can be very different depending on the location of the exposure because of differences in UV radiation, time of wetness, temperature, pollutants and other factors. Therefore, even if results from a specific accelerated laboratory test are found to be useful for comparing the relative durability of materials exposed in a particular outdoor location or in particular actual-use conditions, it cannot be assumed that they will be useful for determining the relative durability of materials exposed in a different outdoor location or in different actual-use conditions.*"

1 Scope

This European Standard describes three methods to determine the UV resistance of sheath materials for electric and for optical fibre cables. These tests apply for outdoor and indoor cable applications according to the product standard. The samples of sheath are taken from the finished cables.

Although this test method European Standard is written principally for communication cables, it may be used for energy cables if called up by the relevant product standard.

Where a sheath is of cross-linked (thermosetting) material, it should be recalled that the preparation of moulded plaques should be made before crosslinking.

Methods differ by the nature of the UV source.

Due to the excessive time to failure, the methods described are inappropriate to products where UV resistance is conferred by ≥ 2,0 % carbon black meeting the dispersion requirements defined in EN 50290-2-24.

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.

EN 16472:2014, *Plastics — Method for artificial accelerated photoageing using medium pressure mercury vapour lamps*

EN 60811-202, *Electric and optical fibre cables — Test methods for non-metallic materials — Part 202: General tests - Measurement of thickness of non-metallic sheath (IEC 60811-202)*

EN 60811-501, *Electric and optical fibre cables — Test methods for non-metallic materials — Part 501: Mechanical tests — Tests for determining the mechanical properties of insulating and sheathing compounds (IEC 60811-501)*

EN ISO 4892-1:2000, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance (ISO 4892-1:1999)*

EN ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps (ISO 4892-2:2013)*

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

3 Terms and definitions

For the purposes of this document, the following term and definition applies.

3.1
median value
when several test results have been obtained and ordered in an increasing (or decreasing) succession, middle value if the number of available value is odd, and mean of the two middle values if the number is even

[SOURCE: EN 60811-100:2012, 3.1)

4 Test methods

4.1 Test methods for outdoor application

4.1.1 Method A: xenon arc source

4.1.1.1 General

According to EN ISO 4892-1:2000, 5.1.6.1, the xenon arc lamp, when appropriately filtered, produces radiations with a spectral power distribution that is a good simulation of average daylight throughout the UV and visible region.

The exposure apparatus is typically constituted by a rotating specimen holder drum, which rotates around the light source, as per EN ISO 4892-1:2000, Figure B.1.

Apparatus having a fixed specimen holder is also permitted. In this case, it is important that air can circulate around the sample to allow a homogeneous repartition of temperature.

4.1.1.2 Apparatus

The testing apparatus is equipped with the following lamps and filters and is set with the parameters prescribed below:

– a ray source consisting of a xenon arc lamp ("long arc" type) equipped with borosilicate filters so that the typical irradiance should be 43 W/m^2 ± 15 % with a spectrum between 300 nm and 400 nm;

– a means to provide automatic control of temperature, humidity and cycles;

– a generator of deionised water with a conductivity not greater than 5 µS/cm (the pH should be recorded); the water shall leave no observable stains or deposits and should therefore contain less than 1 ppm of solids; the rate of flow should be sufficient to guarantee that all the test specimens can be washed;

– a means to control the irradiance to produce (43,0 ± 0,2) W/m^2 at 340 nm (if the apparatus is not equipped with irradiance control, follow the device manufacturer's recommendations to produce this irradiance).

More details are given in EN ISO 4892-2:2013.

4.1.1.3 Sample and test specimen preparation

A sample, at least 600 mm long, of the finished cable or of the outer sheath removed from the finished cable. It shall be used to prepare 12 test specimens. Test specimens shall be prepared according to EN 60811-202.

In case, for geometrical reasons, it is not possible to use the above samples (finished cable or outer sheath), test specimens shall be cut from finished cable, a moulded plaque prepared from pieces of the cable sheath or a moulded plaque produced from granules of the same material and colour of the cable sheath. The thickness of the test pieces shall be (1,0 ± 0,1) mm.

4.1.1.4 Procedure

Six test specimens shall be suspended vertically so that the external surface is uniformly exposed to the action of the actinic rays. During the test, the temperature indicated by the black-panel or the black-standard thermometer shall remain in the range (60 ± 3) °C and the relative humidity shall remain in the range (50 ± 5) % (only in the dry period in the case of a test for outdoor application). The rotating drum carrying the test specimens shall turn at a speed of (1 ± 0,1) r/min. If a flat specimen plane is used, the minimum irradiance in any point of the specimen exposure area shall be at least 90 % of maximum irradiance.

Test specimens are cycled through periods of UV exposure, followed by periods of no radiation during which temperature changes occur.

The periods of each cycle, total time of 120 min, are the following:

– 102 min of dry UV exposure at a temperature of (60 ± 3) °C [1)], followed by

– 18 min of deionised water exposure, without radiation, at a temperature of (50 ± 5) °C.

The overall duration of the test shall be as defined in the relevant product standard. In the absence of such a definition, guidance is given in Annex B.

After the exposure, the exposed test specimens shall be removed from the equipment and conditioned at ambient temperature for at least 16 h.

The six other test specimens shall be kept at ambient temperature and protected from any light source during the UV treatment; they shall be tested at the same time as the exposed test specimens.

4.1.2 Method B: fluorescent UV lamp

4.1.2.1 General

According to EN ISO 4892-3:2013, 4.1.1, there are different types of fluorescent UV lamps that may be used as laboratory light sources:

– type I lamps (commonly called UV-A lamps), with the preferred option of the UV-A 340 lamp, having a spectral radiation that peaks at 340 nm;

– type II lamps (commonly called UV-B lamps), having a spectral radiation that peaks near the 313 nm mercury line; these type II fluorescent UV lamps emit significant amount of radiation below 300 nm, the nominal cut off wavelength for solar radiation, which may result in ageing processes not completely equal to those occurring outdoors. The method using UV-B lamps is however frequently used by agreement between the parties.

The exposure apparatus is typically constituted by a device where specimens are positioned in a flat plane in front of an array of light sources, as per EN ISO 4892-1:2000, Figure B.2.

4.1.2.2 Apparatus

The testing apparatus is equipped as follows:

– a ray source consisting of type I or type II fluorescent UV lamps, having a typical irradiance peak of at least 0,68 W/m^2 at 340 nm for the UV-A 340 lamp, and at 313 nm for the UV-B 313 lamp;

– an exposure chamber constructed from inert material, such as to provide uniform irradiance, with a means for controlling temperature and cycles and a means for providing the formation of water condensate on the exposed face of the specimens;

– a means to control the specified value of irradiance or, if the apparatus is not equipped with irradiance control, follow the device manufacturer’s recommendations on the procedure necessary to maintain the required irradiance.

4.1.2.3 Sample and test specimen preparation

See 4.1.1.3.

1) Temperature indicated by the black-panel or the black-standard thermometer.

4.1.2.4 Procedure

Six test specimens shall be mounted so that the exposed face is uniformly exposed to the action of the actinic rays.

Depending on the apparatus, lamp replacement, lamp rotation and test specimens, re-arrangement may be required to obtain uniform exposure of all specimens to UV radiation and temperature. In such a case, follow the manufacturer’s recommendations for lamp replacement / rotation or for the re-arrangement of the test specimens.

Test specimens are cycled through periods of UV exposure, followed by periods of no radiation during which temperature changes occur and condensation forms on the specimens.

The periods of each cycle, total time of 720 min, are the following:

– 600 min of dry UV exposure at a temperature of (60 ± 3) °C [2)], followed by

– 120 min of condensation exposure, without radiation, at a temperature of (50 ± 3) °C [2)].

For coloured compounds, a black-standard temperature of (60 ± 3) °C shall be used.

The overall duration of the test shall be as defined in the relevant product standard. In the absence of such a definition, guidance is given in Annex B.

After the exposure, the exposed test specimens shall be removed from the equipment and conditioned at ambient temperature for at least 16 h.

The six other test specimens shall be kept at ambient temperature and protected from direct sunlight during the UV treatment; they shall be tested at the same time as the exposed test specimens.

4.1.3 Method C: mercury vapour lamp

4.1.3.1 General

EN 16472:2014 specifies a method for carrying out artificial accelerated photoageing of test specimens by exposing them to medium pressure filtered mercury vapour lamp as light source, under controlled temperature conditions. An example of a test chamber is shown in Annex A.

4.1.3.2 Apparatus

The apparatus shall consist of a test chamber as described in EN 16472.

The UV irradiance, between 300 nm to 400 nm, is typically controlled in the range (90 ± 10) W/m^2 by mean of an additional radiometer, according to ISO 9370.

The drum carrying the test specimens shall rotate at a minimal speed of 0,5 r/min.

4.1.3.3 Sample and test specimen preparation

Twelve test specimens shall be cut from a moulded plaque of the same material of the cable sheath to be tested. The material used for the test specimens shall have the same composition as the relevant cable sheath, and be of the same colour.

Test specimens shall be prepared according to EN 60811-202; the thickness shall be (1,0 ± 0,1) mm.

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2) Temperature indicated by the black-panel or the black-standard thermometer.

In case, for geometrical reasons, it is not possible to use the above samples (finished cable or outer sheath), test specimens shall be cut from finished cable, a moulded plaque prepared from pieces of the cable sheath or a moulded plaque produced from granules of the same material and colour of the cable sheath. The thickness of the test pieces shall be (1,0 ± 0,1) mm.

4.1.3.4 Procedure

Six test specimens shall be suspended vertically so that the surface is exposed to the action of the UV lamp. During the test, the temperature of the temperature sensor shall remain in the range (60 ± 2) °C.

The overall duration of the test shall be as defined in the relevant product standard.. In the absence of such a definition, guidance is given in Annex B.

After the exposure, the exposed test specimens shall be removed from the equipment and conditioned at ambient temperature for at least 16 h.

The six other test specimens shall be kept at ambient temperature and protected from direct sunlight during the UV treatment; they shall be tested at the same time as the exposed test specimens.

If an immersion cycle is used, the kind of aqueous solution, the frequency, temperature and duration of the immersion shall be reported.

If dark periods are introduced in the cycle, their frequency, temperature and duration shall be reported.

Cycles shall be agreed upon by the interested parties.

4.2 Test methods for indoor application

4.2.1 Method A: xenon arc source

4.2.1.1 General

See 4.1.1.1.

4.2.1.2 Apparatus

The testing apparatus is equipped with the following lamps and filters and is set with the parameters prescribed below:

- a ray source consisting of a xenon arc lamp (“long arc” type) equipped with borosilicate filters[1]) so that the typical irradiance should be (43,0 ± 0,2) W/m^2 at 340 nm;
- a means to provide automatic control of temperature and cycles;
- a means to control the irradiance to produce (43,0 ± 0,2) W/m^2 at 340 nm (if the apparatus is not equipped with irradiance control, follow the device manufacturer's recommendations to produce this irradiance).

4.2.1.3 Sample and test specimen preparation

See 4.1.1.3.

4.2.1.4 Procedure

Six test specimens shall be suspended vertically so that the external surface is uniformly exposed to the action of the actinic rays. During the test, the temperature indicated by the black-panel or the black-standard thermometer shall remain in the range (60 ± 3) °C.

The rotating drum carrying the test specimens shall turn at a speed of (1 ± 0,1) r/min. If a flat specimen plane is used, the minimum irradiance in any point of the specimen exposure area shall be at least 90 % of maximum irradiance.

Test specimens are cycled through periods of UV exposure, followed by periods of no radiation during which no temperature changes occur.

The periods of each cycle, total time of 120 min, are the following:

– 102 min of dry UV exposure at a black-standard temperature of (60 ± 3) °C, followed by

– 18 min without radiation, at a black-standard temperature of (60 ± 3) °C.

The overall duration of the test shall be as defined in the relevant product standard. In the absence of such a definition, guidance is given in Annex B.

After the exposure, the exposed test specimens shall be removed from the equipment and conditioned at ambient temperature for at least 16 h.

The six other test specimens shall be kept at ambient temperature and protected from direct sunlight during the UV treatment; they shall be tested at the same time as the exposed test specimens.

4.2.2 Method B: fluorescent UV lamp

See 4.1.2.

4.2.3 Method C: mercury vapour lamp

See 4.1.3.

An additional standard window glass filter (3 mm of thickness) shall be placed between the exposed test specimen and the source (not too close to the test specimen exposed surface to prevent any abnormal heating).

5 Measurements

5.1 Loss in mechanical properties

5.1.1 General

After the appropriate procedure of Clause 4, the mechanical properties of the exposed and the unexposed test pieces shall be measured in accordance with EN 60811-501. The performance requirements for a particular type or class of cable should preferably be given in the relevant cable standard. In the absence of specific requirements, either of the following options may be applied.

5.1.2 Defined test duration

After exposure for the specified duration, the variation of tensile strength and elongation at break shall be less than ± 30 % compared to a reference sample tested at the same time.

5.1.3 Defined loss in property

Samples should be periodically removed from the test chamber and tested for their tensile strength and elongation at break. The results should be plotted with time as the x-axis. By interpolation, the time at which the sample has lost 50 % of their initial tensile strength or elongation may be estimated. Normally it is found that the loss of elongation is the parameter most sensitive to UV degradation. This approach requires far more samples to be exposed (e.g. 6 samples per exposure time). To minimize equipment loading it may be found helpful to use some other technique (such as oxidative induction time (EN ISO 11357-6)) to monitor the depletion in stabilizer.

5.2 Change in appearance

In the absence of a specific requirement in the product standard or specification, any change of appearance (specifically cracking or other textural change) should be recorded and added to the test report.

5.3 Change in colour

In the absence of a specific requirement in the product standard or specification, any change of colour should be recorded and added to the test report.

For further study.

6 Evaluation of results

Calculate the tensile strength and the elongation at break, according to the definition given in EN 60811-501.

The values found for the exposed test specimens shall be calculated, as a variation compared to the unexposed test specimens and according to the following formulae:

$$V_\mathrm{T} = \frac{T_\mathrm{E} - T_\mathrm{U}}{T_\mathrm{U}} 100 \quad (1)$$

$$V_\mathrm{E} = \frac{E_\mathrm{E} - E_\mathrm{U}}{E_\mathrm{U}} 100 \quad (2)$$

where

V_T is the variation of the tensile strength in percent;

T_E is the tensile strength of aged test specimen;

T_U is the tensile strength of untreated test specimen;

V_E is the variation of the elongation at break in percent;

E_E is the elongation at break of aged test specimen in percent;

E_U is the elongation at break of untreated test specimen in percent.

The value and the variation between the median value obtained of the test specimens exposed and the median value of the values obtained for the unexposed test specimens (see EN 60811-501), expressed as a percentage of the latter, shall not exceed the percentage specified in the standard for the material in the relevant standard for the type of cable.

7 Test report

The test report shall include:

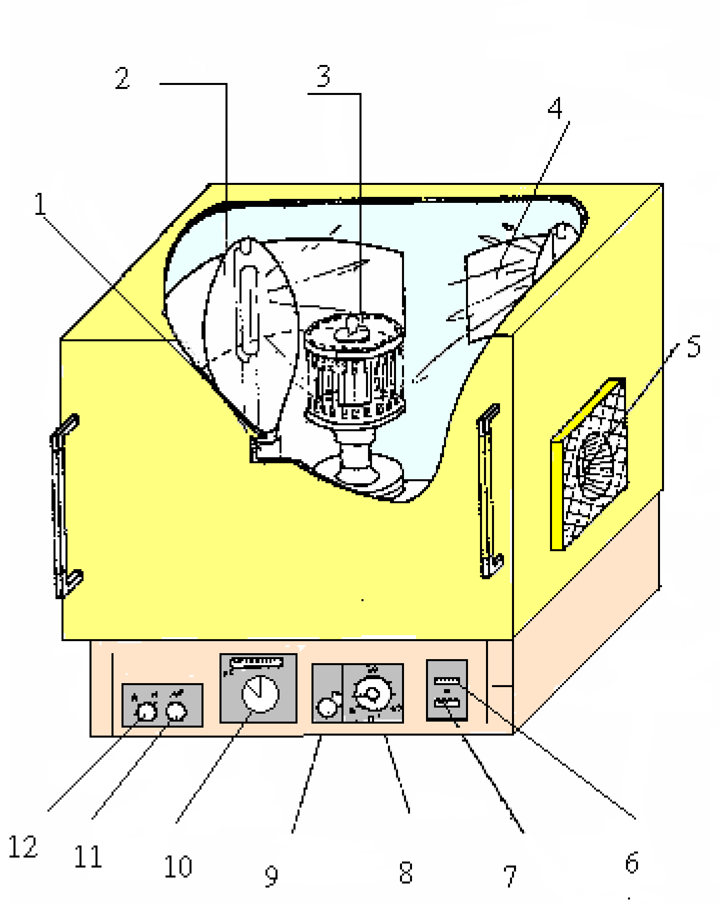
- type and model of exposure device;
- method, light source and wattage;
- type and age of filters;
- spectral irradiance at sample location, W/m^2;

- irradiation, kJ/m^2;
- elapsed exposure time, h;
- light, dark, water, or humidity programme employed (not applicable for indoor test);
- type of thermometer (black-panel or black standard) to indicate the temperature;
- operating temperature;
- operating relative humidity (if any);
- type of water spray (if any);
- conductivity (or pH) of water used for specimens spray (if any, not applicable for a test for indoor application);
- type of spray nozzle (if any, not applicable for a test for indoor application);
- test pieces relocation procedure;
- type of specimens – pieces of cable, mouldings from pieces of cable or mouldings from granules;
- variation of tensile strength, in percent;
- results of the visual inspection (possible cracks or their absence);
- variation of elongation at break, in percent;
- determination of colour (if specified)

Annex A
(informative)

Example of UV test apparatus with mercury vapour lamp source

An example of the test chamber is shown below.

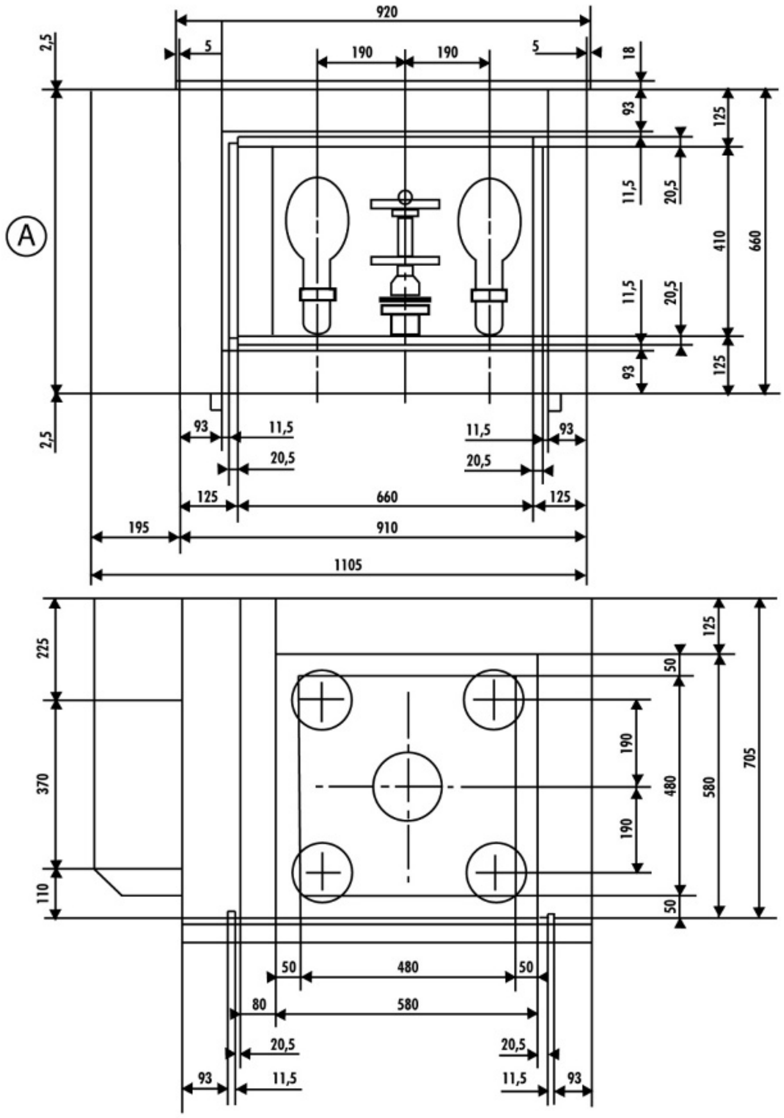


Key

1	checking device	7	hour indicator checking device
2	UV lamp	8	timing device
3	test specimens holder	9	selection for timing
4	light reflecting device	10	temperature regulation device
5	fan	11	feed
6	general hour indicator	12	interrupter

Figure A.1 — Vapour mercury test apparatus

Dimensions in millimetres (precision ± 2 mm)



Key

A standard height of the case 655

Figure A.2 — Vapour mercury test apparatus — Details of construction

Annex B
(informative)

Guidelines to the interpretation and use

This European Standard describes methodologies to perform artificial accelerated UV ageing. The three test methods described in this European Standards have each different advantages and disadvantages. It is a matter for the product standard and/or the user to choose which of the three methods is applicable in each case. Some guidance on this is given below.

– 'Artificial' means that the light is artificially produced with equivalence to a greater or lesser extent to the natural light spectrum. For the consideration of oxidative degradation, it is important that the lamp wavelength be above 295 nm to 300 nm, which corresponds to the lowest wavelength of natural light. Exposure below these wavelengths could lead to a poor correlation with outdoor weathering.

– 'Accelerated' means that the degradation is faster in comparison to natural exposure. As the specimen undergoes photo-oxidation, acceleration is due to the severe light exposure (high irradiance) and also to the increase of the temperature (often around 60 °C) in the test cell. Thus, simple irradiance comparisons could lead to erroneous data because of the temperature factor.

– The acceleration factor (used for lifetime prediction) which could be calculated to quantify the acceleration produced between artificial and natural ageing depends in several parameters:

  • the compound (i.e. the polymer type, the formulation - amount and type of additives, anti-oxidant etc.);

  • the test device (i.e. type of lamp, the irradiance, the temperature, the type of cycle etc.);

  • the climatic conditions at the outdoor destination.

  Thus, generalities and empirical factors that are not confirmed by experiments could lead to erroneous lifetime estimation. To aid the interpretation of data, the use of standardised test conditions is strongly recommended.

– Due to the excessive time to failure, the methods described are inappropriate to products where UV resistance is conferred by ≥ 2,0 % carbon black meeting the dispersion requirements [3)] defined in EN 50290-2-24. Such products should be deemed to satisfy MICE C1, C2 and C3 (see Table B.1).

In 2005-2007, a round robin comparing the methods specified in this European Standard was completed [16]. One of the targets of the work is to see if there is any correlation between the methods. The approach taken is to attempt to define by inspection, limits which would give the same pass/fail result for each method.

– For unstabilized LLDPE, the Xenon (wet) exposure was < 504 h, the Xenon (dry) exposure 720 h to 1 500 h, the UVA < 720 h, the UVB 504 h to 720 h and the Hg lamp < 350 h. The results suggest that the Xenon (wet), the UVA and UVB give deterioration in the same order of magnitude. The Xenon (dry) is less severe and the Hg Lamp is significantly more severe. For UV stabilized LLDPE, none of the methods caused a significant deterioration.

– For EPR, the Xenon (dry) and Hg lamp need the same order of exposure duration and for the QUVB just 10 % of the Xenon duration. The consistency of results across the three test methods is remarkable.

3) In some jurisdictions, the carbon black dispersion is specified by an absorption coefficient greater than 400 per millimetre (e.g. Telcordia, GR-20)

– For TPU/C, the Hg Lamp needs 50 % of the Xenon duration, the QUVA is similar to the Xenon and the QUVB again just 2 % of the Xenon duration.

It is clear that the sensitivity is polymer dependent.

ISO/IEC_JTC1_SC25 has defined performance level for a number of mechanical, ingress, climatic and electromagnetic (MICE) parameters including UV ageing [8], [9]. These parameters are to be applied to cables. Three classes are identified (1-3), where class 3 represents the most demanding requirement. In MICE Table 9 summarizing details of environmental class, the following values relating to weathering/UV resistance of materials are defined.

Table B.1 — Excerpt from MICE table

	C1	C2	C3
Solar radiation (wavelength ffs)	700 W/m^2	1 120 W/m^2	1 120 W/m^2
UV exposure	500 h	3 000 h	6 000 h

The value for irradiance of 1 120 W/m^2 corresponds to full spectrum (Table B.1). The value 700 W/m^2 is not specifically mentioned in EN 60068-2-5 but it presumably corresponds to the UV and visible spectrum. In a report 10 concerning the development of a blank detail specification in support of ISO/IEC 24702, the source of solar radiation levels is described as follows: "*The three climatic environments of the MICE concept use two limits (700 W/m^2 or 1 120 W/m^2). These values are taken from IEC 60068-2-5 which defines a power spectrum across a wavelength range. Solar radiation may influence both mechanical and cosmetic (colour change) properties. We look forward to receiving your input for pass/fail criteria.*"

Some measurement units and conversion factors are shown in Table B.2. The unit Langley is sometimes used to measure radiant exposure when subjecting materials to natural weathering, and corresponds to 1 calorie per square centimetre of irradiated surface. As the term implies all wavelengths of the solar spectrum, it cannot be directly related to artificial light sources.

Table B.2 — Measurement units and conversion [a]

1 kilo-Langley (1 kLy)	41,84 MJ/m^2
Xenon Lamp: E = 0,35 W/m^2 nm (λ = 340 nm); E = 30 W/m^2 (λ = 300 nm to 385 nm)	
1 h WOM (30 W/m^2 × 3 600 s)	0,108 MJ/m^2
1 year WOM	946 MJ/m^2
1 year Basel (global λ = 295 nm to 3 000 nm)	4 200 MJ/m^2 = 100 kLy
1 year Florida (global λ = 295 nm to 3 000 nm)	6 000 MJ/m^2 = 144 kLy
1 year Basel (UV irradiation λ = 295 nm to 385 nm)	165 MJ/m^2
1 year Florida (UV irradiation λ = 295 nm to 385 nm)	285 MJ/m^2
[a] See [1], [2] and [11].	

EXAMPLE 1 Assuming that the UV part of the spectrum is the most important part of light for degradation of a polymeric material, the relation between natural weathering in Florida and laboratory weathering in a Weather-Ometer (WOM) can be estimated. The UV radiant exposure per year in Florida is 285 MJ/m^2. The same level is obtained after approximately 3,7 months in WOM (2 640 h or 110 days). The radiant exposure in Florida is comparable to the level in south of Spain. As seen in previous section, most cable standards specify significantly shorter exposure times than 3 months (EN ISO 4892-1, 720 h (30 days) equivalent 3 months Florida).

EXAMPLE 2 The criteria for MICE, level 3, are 1 120 W/m^2 of irradiance (280 nm to 3 000 nm) for a period of 6 000 h. The resulting radiant exposure is 24 200 MJ/m^2, corresponding to approximately 6 years exposure in Basel - or 4 years in Florida.

Conclusions:

1) The xenon arc lamp corresponds most closely to natural light but gives the least acceleration.

2) In general, two wet methods (Xenon and UVA) gave approximately the same deterioration in mechanical properties when tested according to the EN ISO 4892-1 specified test duration.

3) The fluorescent UVB lamp corresponds to the shorter wavelength (i.e. more damaging) part of the spectrum. For some materials, the UVB lamp gave equivalent results after much shorter exposure times.

4) Due to the absence of longer wavelengths, both UVA and UVB lamps have poor correlation to natural sunlight, which may make this equipment inappropriate for the assessment of colour fading.

5) The Hg lamp has a discontinuous light spectrum with a poor correlation to natural sunlight. However, this does not exclude a good correlation with ageing performance under natural sunlight. The Hg lamp requirement of 1 000 h (NF C32-062-2) appears excessive compared to Xenon criteria.

6) The MICE standards specify a limited UV performance requirement. Most commercial products on the market will satisfy MICE 3 requirements (6 years in central Europe). The utility for an intermediate MICE 2 performance level needs to be confirmed. The MICE 2 and 3 requirements should encompass total weathering, e.g. including water spray.

7) MICE 1 corresponds to the U/V degradation encountered in an office (indoor) environment. Further work is needed to better understand this requirement.

8) Industry needs to confirm the level of UV performance to be offered in coloured cable products.

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