PAS 820:2012

Laboratory-identifiable forensic codes – Classification of performance when exposed to artificial weathering

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Publishing and copyright information

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Foreword

This Publicly Available Specification (PAS) was sponsored by SmartWater Technology Limited. Its development was facilitated by BSI Standards Limited and published under licence from The British Standards Institution. It came into effect on 31 August 2012.

Acknowledgement is given to the following organizations that were involved in the development of this PAS as members of the steering group:

- ACPO Secured by Design
- Applied DNA Sciences
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- British Security Industry Association (BSIA)
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- Paint Research Association (PRA)
- Product & Image Security Foundation Ltd
- RISCAuthority
- SmartWater Technology Limited

Acknowledgement is also given to the members of a wider review panel who were consulted in the development of this PAS.

This PAS is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

Information about this document

Assessed capability. Users of this PAS are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body.

Test laboratory accreditation. Users of this PAS are advised to consider the desirability of selecting test laboratories that are accredited to BS EN ISO/IEC 17025 by a national or international accreditation body.

Product certification. Users of this PAS are advised to consider the desirability of independent third-party certification of product conformance to this PAS. Users seeking assistance in identifying appropriate assessment bodies or schemes may ask BSI to forward their enquiries to the relevant association.

Use of this document

It has been assumed in the preparation of this PAS that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentation conventions

The provisions of this PAS are presented in roman type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a PAS does not in itself confer immunity from legal obligations.

0 Introduction

0.1 Laboratory-identifiable forensic codes and forensic marking products

A forensic code is a uniquely identifiable organic or inorganic code that can be verified by laboratory analysis. A product that incorporates a forensic code in a ready-to-use format is known as a forensic marking product. Forensic marking products can also include adhesives, polymers, dyes and/or covert markers such as fluorescent markers or microdots.

Forensic marking products can be used to link an item to an owner, manufacturer or location, or a suspect to a stolen item or a scene of a crime, amongst other applications. They can be used to protect, for example, critical infrastructure components (such as cabling), lead roofing, property, banknotes, safety critical parts, electronic components and premises.

For some forensic codes, a presumptive identification (i.e. one which is derived from circumstances which necessarily or usually attend a fact) may be made using a high-specification reader (e.g. electronic scanner); however, for all forensic marking products, laboratory analysis is required to verify the identity of the forensic code.

A high-specification reader may be portable, whereas laboratory analysis uses fixed equipment. A high-specification reader is not a simple, readily obtainable reader, such as a microscope. It is a custom-made product, specifically designed and used to identify the forensic code.

The presence of a forensic code might also be detected by other means, e.g. using microdots, or other overt or covert markers.

0.2 Aim of PAS 820

The aim of the PAS is to provide a credible and repeatable test method to assess the functional life of a forensic code within a forensic marking product under accelerated weathering conditions simulating internal or external environments.

This PAS is intended for use by manufacturers of forensic codes and/or forensic marking products.

The classification scheme is to help end users identify the conditions under which the forensic code has been tested and compare tested products against their needs.

0.3 Functional test life of forensic codes

The functional test life of the forensic codes can be measured in years and it is often not viable to undertake testing in real time. However, it is necessary to determine the likely effects of filtered or unfiltered ultraviolet (UV) light and exposure to moisture on the performance of the forensic codes. Artificial weathering tests use specific test procedures, allowing exposure to be conducted under controlled conditions, accelerating the natural degradation of materials.

The results of artificial weathering cannot be directly compared with those found in actual-use conditions, which are highly variable and depend upon the geographic location, exposure to direct sunlight, amount of rainfall, levels of humidity, extremes of temperature, presence of pollutants in the atmosphere and other environmental stresses.

1 Scope

This PAS describes a method for assessing the performance of the forensic code as used in a forensic marking product over time and through exposure to artificial weathering simulating both internal and external environments.

NOTE 1 *Forensic codes in forensic marking systems can be used, for example, in the identification of the legitimate ownership of an item; for confirmation that an item is genuine (anti-counterfeiting) and to link a suspect with the scene of a crime.*

It also specifies requirements for manufacture, record keeping, labelling of the forensic code and the uniqueness of the forensic code.

It is applicable to forensic codes that require laboratory analysis to verify their unique code.

It also specifies a classification system based on performance under artificial weathering conditions, which comprises the following classification codes:

a) Grade A (external);
b) Grade A (internal);
c) Grade B (external);
d) Grade B (internal);
e) Grade C (external);
f) Grade C (internal).

NOTE 2 *Grade A represents the longest functional test life and Grade C the shortest.*

This PAS does not cover:

1) forensic codes, or forensic marking products, where the forensic code cannot be verified using laboratory analysis;
2) the performance of the forensic code within a forensic marking product in resisting removal from a surface, whether deliberate or accidental;

   NOTE 1 *This does not include the effects of artificial weathering.*

   NOTE 2 *This property is determined by the composition of the forensic marking product and the surface to which it is applied.*
3) the performance of covert and overt markers that might be components of forensic marking products;
4) the requirements for other components of a forensic marking product (e.g. polymers, adhesives, dyes, solvents, greases, fluorescent or phosphorescent pigments, anti-fungicides);
5) requirements for forensic marking products, i.e. the product in/on which the forensic code is used;
6) forensic codes intended to have a functional test life of less than 6 months.

NOTE 3 *Testing a forensic code in isolation is not usually possible. Testing is undertaken on a forensic code within a representative forensic marking product. The results might not be applicable for the same forensic code as used in different forensic marking products.*

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and 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.

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

3 Terms and definitions

For the purposes of this PAS, the following terms and definitions apply.

3.1 artificial weathering

exposure to cyclic laboratory conditions involving changes in temperature, relative humidity and radiant energy, with or without direct water spray, in an attempt to produce changes in the material similar to those observed after long-term, continuous, indoor or outdoor exposure

NOTE *The laboratory exposure conditions are usually intensified beyond those encountered in actual indoor or outdoor exposure in an attempt to achieve an accelerated effect. This term does not cover exposure to special conditions, such as ozone, salt spray, industrial gases, etc.*

[SOURCE: BS EN ISO 472, adapted]

3.2 laboratory-identifiable forensic code (forensic code)

uniquely identifiable organic or inorganic code that can be verified by laboratory analysis

NOTE 1 *A presumptive identification (i.e. one which is derived from circumstances which necessarily or usually attend a fact) may be made using a high-specification reader (e.g. electronic scanner) [see Note 2 and Note 3], however laboratory analysis is required to verify the forensic code. It is this laboratory analysis which falls under the scope of this PAS.*

NOTE 2 *A high-specification reader may be portable, whereas laboratory analysis uses fixed equipment.*

NOTE 3 *A high-specification reader is not a simple, readily obtainable reader, such as a microscope. It is a custom-made product, specifically designed and used to identify the forensic code.*

NOTE 4 *The presence of a forensic code might also be detected by other means, e.g. using microdots, or other overt or covert markers. Microdots or other overt or covert markers, and the techniques used to identify them, are not covered by this PAS.*

3.3 forensic marking product

product, which incorporates a forensic code, and is in a format ready for use

3.4 covert marker

marker that is not visible with normal or corrected vision under normal lighting conditions but can be seen using widely available or simple equipment

NOTE 1 *Examples of covert markers include fluorescent or phosphorescent colours, microdots and coloured particles.*

NOTE 2 *Examples of widely available or simple equipment that can be used to view a covert marker include handheld microscopes or UV or infra red lighting.*

3.5 functional test life

nominal period of time, starting from application of the representative forensic marking product, during which the forensic code can be identified and verified using laboratory analysis

3.6 manufacturer

organization that creates forensic codes and/or forensic marking products

3.7 internal use

use of a forensic marking product in an indoor environment, such as a home or office, where it is not subject to unfiltered UV radiation or exposed to moisture

3.8 external use

use of a forensic marking product in an outdoor or aggressive industrial environment, where it is subject to unfiltered UV radiation and might be exposed to moisture

3.9 overt marker

marker that can be read with normal or corrected vision under normal lighting conditions

3.10 unique identifier

non-repeating identifier that cannot be copied

4 Product requirements

4.1 Uniqueness

4.1.1 Each forensic code shall be unique and shall be able to be differentiated from all other forensic codes by laboratory analysis.

4.1.2 A forensic code shall not be reused for different customers.

4.1.3 The number of forensic codes that can be manufactured shall be documented.

NOTE *The number of forensic codes may be made available upon request.*

4.2 Functional test life and environment

The functional test life of a forensic code within a representative forensic marking product, in the environment (internal or external) in which it is intended for use, shall be tested in accordance with Annex A.

NOTE 1 *The functional test life is dependent on the forensic code and the forensic marking product having been kept in appropriate storage conditions (as defined by the manufacturer) prior to use.*

NOTE 2 *The functional test life is also dependent on the forensic code and the forensic marking product having been applied before any "use by" or expiry date given by the manufacturer.*

NOTE 3 *The functional test life is dependent on the forensic code and the forensic marking product being used in accordance with the manufacturer's guidelines.*

5 Classification

Following artificial weathering, the forensic code, as tested in a representative forensic marking product, shall be classified in accordance with Table 1.

NOTE The classification system of the forensic code, as tested in a representative forensic marking product, is based on the functional test life and the environment (internal or external) in which it is intended for use.

6 Manufacturing requirements

6.1 The manufacturer shall have a defined and documented structure and a quality management system.

6.2 The forensic code manufacturer's quality system shall be such that conformance to the PAS of the forensic code, as tested in a representative forensic marking product, can be demonstrated.

NOTE Assessed capability. *Users of this PAS are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body.*

6.3 Controls shall be in place to ensure that a specific forensic code is not reused for different customers (see **4.1.2**).

6.4 Controls shall be in place during the manufacturing process to ensure that no cross-contamination of the forensic codes can occur. This shall be verified by quality control of the forensic codes.

6.5 Records of the manufacture and dispatch of each forensic code shall be retained.

Table 1 – Classification of forensic codes

Classification	Nominal functional test life	Environment
Grade A – External	≥5 years	External
Grade A – Internal	≥5 years	Internal
Grade B – External	≥2 years	External
Grade B – Internal	≥2 years	Internal
Grade C – External	≥6 months	External
Grade C – Internal	≥6 months	Internal

7 Documentation

7.1 Manufacturer's instructions for identifying the forensic code by laboratory analysis

The manufacturer's instructions for identifying the forensic code by laboratory analysis shall be documented.

***NOTE** These manufacturer's instructions might contain commercially sensitive information.*

7.2 Labelling of the forensic code

Each forensic code shall be labelled with, or accompanied by, the following information:

a) the number and date of this PAS, i.e. PAS 820:2012[1)];

b) classification of the forensic code, as tested in a representative forensic marking product, according to functional test life and environment (see Clause **5**) including any criteria that could affect this (e.g. storage conditions prior to use, contaminants to be avoided and compatibility with other components of the forensic marking product);

c) supplier or manufacturer's name and/or trademark;

d) unique identifier relating to the forensic code;

e) safety data sheet (SDS);

f) either the date of manufacture and shelf life or the expiry date;

g) storage and usage information, including details of the recommended concentration of the forensic code to be used in the forensic marking product;

h) where authorized, the conformity mark of a third party certification body.

***NOTE 1** This information can be provided in any suitable format (e.g. barcode, written text, pictograms).*

***NOTE 2** This information pertains to the forensic code as used in a forensic marking product in accordance with the manufacturer's guidelines. Different information may be required by a forensic marking product in which the forensic code is used.*

8 Claims of conformity

Claims of conformity of a forensic code, as tested in the representative forensic marking product, to PAS 820 shall include:

a) the number and date of this PAS, i.e. PAS 820:2012[1)];

b) supplier or manufacturer's name and/or trademark;

c) unique identifier relating to the forensic code;

d) classification of the forensic code, as tested in the representative forensic marking product, according to functional test life and environment (see Clause **5**);

e) substrate on which it was tested;

f) (name of) the representative forensic marking product in which it was tested;

g) compatibility with other forensic marking product components;

h) contaminants to be avoided;

i) storage conditions;

j) usage information, including details of the recommended concentration of the forensic code to be used in the forensic marking product;

k) where authorized, the conformity mark of a third-party certification body.

[1)] Marking PAS 820:2012 on or in relation to a product (forensic code) represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the PAS. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

Annex A (normative)
Test method to determine the functional test life of a forensic code when exposed to artificial weathering

NOTE This test method is based on the method given in BS EN ISO 4892-3.

A.1 Principle

Forensic codes contained within a representative forensic marking product are exposed to a combination of ultraviolet (UV) light, heat and, for external use, moisture, under controlled laboratory conditions.

Following exposure, the test specimen is tested to demonstrate whether the forensic code can be identified by laboratory analysis.

Where the forensic code can be identified, then it may be classified (see Clause **5**). Where the forensic code cannot be identified, then no classification can be made on the forensic code without repeating the test using a shorter exposure time.

A.2 Apparatus

A.2.1 Laboratory light source

Fluorescent UV lamps are fluorescent lamps in which radiant emission in the UV region of the spectrum, i.e. below 400 nm, makes up at least 80% of the total light output.

a) Type 1A (UVA-340) fluorescent lamp: These lamps have a radiant emission below 300 nm of less than 2% of the total light output, have an emission peak at 343 nm, and are more commonly identified as UVA-340 for simulation of daylight from 300 nm to 340 nm.

   NOTE The relative UV spectral irradiance for these lamps is given in BS EN ISO 4892-3:2006, Table 1, column A.1.

b) Type 1A combination: A combination of fluorescent UVA lamps may be used. When combinations of lamps with different spectral emissions are used, provision shall be made to ensure the uniformity of the spectral irradiance at the surface of the specimens.

   NOTE The relative UV spectral irradiance for these lamps is given in BS EN ISO 4892-3:2006, Table 1, column A.2.

c) Type 1B (UVA-351) fluorescent UV lamp: These lamps have a radiant emission below 300 nm of less than 2% of the total light output, have a peak emission at 353 nm, and are more commonly identified as UVA-351 for simulation of the UV portion of daylight behind window glass.

   NOTE The relative UV spectral irradiance for these lamps is given in BS EN ISO 4892-3:2006, Table 2.

A.2.2 Test chamber

A.2.2.1 General
The design of the exposure chamber can vary, but it shall be constructed from inert material and provide uniform irradiance in conformance with BS EN ISO 4892-1, with means for controlling the temperature. For Option 1 and Option 2 (see Table A.1), provision shall be made for spraying water onto the exposed faces of the test specimens in the exposure chamber. For Option 2 (see Table A.1), provision shall be made for controlling the relative humidity in the exposure chamber.

A.2.2.2 Radiometer
The radiometer shall conform to the requirements given in BS EN ISO 4892-1. Where an automatic irradiance control system is not used, follow the apparatus manufacturer's instructions on the procedure necessary to maintain the irradiance specified in Table A.1.

A.2.2.3 Black-standard/black-panel thermometer
The black-standard or black-panel thermometer used shall conform to the requirements given in BS EN ISO 4892-1.

A.2.2.4 Relative humidity control equipment
The locations of the sensors used to measure the humidity shall conform to the requirements given in BS EN ISO 4892-1. The equipment shall be able to maintain the humidity at the value specified in Table A.1 to within ±10% relative humidity.

A.2.2.5 Spray system
For Option 1 and Option 2 (see Table A.1), the test chamber shall be equipped with a means of directing intermittent water spray onto the front of the test

specimens, under specified conditions. The spray shall be uniformly distributed over the test specimens. The spray system shall be made from corrosion resistant materials that do not contaminate the water employed.

Water sprayed on test specimen surfaces shall have a conductivity value below 5 µS/cm, contain less than 1 ppm of dissolved solids and leave no observable stains or deposits on the specimens. Silica levels shall be kept below 0.2 ppm.

NOTE *A combination of deionization and reverse osmosis can be used to produce water of the specified quality.*

A.2.3 Specimen holders

Specimen holders shall be made from inert materials that do not affect the results of the exposure.

A.2.4 Laboratory equipment to identify the forensic code

The laboratory equipment shall be capable of identifying the forensic code within the forensic marking product.

NOTE *The laboratory equipment used to identify the forensic code within the forensic marking product depends on the type of forensic code, i.e. its composition.*

A.3 Sample preparation

A.3.1 Test sample

A.3.1.1 The test sample shall comprise a forensic code within a representative forensic marking product.

NOTE *Other materials that might be used in the forensic marking product include polymers, adhesives, dyes, solvents, greases, fluorescent or phosphorescent pigments and anti-fungicides.*

A.3.1.2 The concentration of the forensic code within the forensic marking product shall be in accordance with the manufacturer's guidelines for use. Where dilution of the forensic code is required, it shall be diluted according to the manufacturer's guidelines.

A.3.1.3 Overt or covert markers that could be used to identify the forensic code shall not be present in the test sample.

NOTE *Overt or covert markers that cannot be used to identify the forensic code being tested can be present in the test sample, in order to create a representative forensic marking product.*

A.3.1.4 A minimum of five test samples (i.e. five different forensic codes) shall be provided for a test. Each test sample shall be given a unique anonymized identifier. One of the test samples shall be selected at random from the five anonymized test samples. The remaining test samples shall not be used.

A.3.1.5 Where the test is repeated, then a further five test samples (i.e. another five different forensic codes) shall be provided for testing.

A.3.2 Conditioning

A.3.2.1 The test sample shall be applied to a declared substrate, in accordance with the manufacturer's application guidelines to create a test specimen. The area of application shall be no more than 5 cm by 5 cm in size.

NOTE *The substrate should be of an inert material to avoid affecting the results of the test. An example of a suitable substrate is a ceramic tile.*

A.3.2.2 The test specimen shall be conditioned at room temperature (18 °C to 22 °C) with a relative humidity of 45% to 55% for either the period prescribed by the manufacturer or for a minimum of 24 hours, whichever is the greater. The conditioning shall not take place in direct sunlight, unless this is specifically required for the individual forensic marking product.

A.4 Mounting the test specimens

A.4.1 Attach the test specimen to the specimen holder (**A.2.3**) in the test chamber (**A.2.2**) in such a manner that the test specimen is not subject to any applied stress. Identify each test specimen by suitable indelible marking, avoiding areas to be used for subsequent testing.

NOTE *As a check, a plan of the test specimen positions may be made.*

A.4.2 Fill all spaces in the exposure area in order to ensure uniform exposure conditions. Use blank panels if necessary.

A.5 Exposure

A.5.1 Before placing the test specimens in the test chamber (**A.2.2**), programme the exposure conditions (cycle duration, water spray, lamp type, irradiance, black-standard temperature, relative humidity) to operate continuously throughout the test duration:

a) for external use, in accordance with either Option 1 or Option 2 as specified in Table A.1; or

b) for internal use, in accordance with Option 3 as specified in Table A.1.

A.5.2 Interruptions to service the apparatus and to inspect test specimens shall be minimized.

A.5.3 Expose the test specimens and the irradiance-measuring device for the specified period of exposure in accordance with Table A.1.

NOTE 1 *Repositioning of the test specimens during exposure is desirable and may be necessary to ensure uniformity of all exposure stresses.*

NOTE 2 *For guidance on exposure to laboratory light sources, see BS EN ISO 4892-1.*

A.6 Measurement of radiant exposure

A.6.1 Mount the radiometer so that it indicates the irradiance at the exposed surface of the test specimen.

A.6.2 Express the exposure interval in terms of the incident radiant energy per unit area of the exposure plane in joules per square metre ($J \cdot m^{-2}$) in the wavelength band from 290 nm to 400 nm or joules per square metre per nanometre [$J \cdot m^{-2} \cdot nm^{-1}$] for the wavelength selected (e.g. 340 nm).

A.7 Identification of forensic code after exposure

Following the exposure test, identify the unique forensic code of the test specimen by laboratory analysis in accordance with the manufacturer's instructions (see **7.1**).

NOTE *The laboratory performing the analysis should have no indication of which of the five supplied forensic codes has been used for the artificial weathering tests.*

A.8 Results

Compare the forensic code identified in **A.7** with the test sample as identified through the unique anonymized identifier to assess whether the forensic code's records are the same.

A.9 Classification

If the forensic code can be identified (see **A.7**) following the exposure test (see **A.5**) and can be confirmed as being the same as the test sample (see **A.8**), classify the forensic code as tested in the forensic marking product in accordance with Clause **5**.

NOTE *If the forensic code cannot be detected and identified, a new sample of a different forensic code may be tested to a shorter functional test life.*

A.10 Test report

A.10.1 General

The test report shall contain the following information:

a) test sample description:
   1) the classification to which the sample was tested (see Clause **5**);
   2) a description of the test sample(s) and their origin (see **A.3.1**);
   3) conditioning time and temperature (see **A.3.2**);
   4) the type of substrate which was used (see **A.3.2.1**);

b) description of the artificial weathering test conducted, including:
   1) the exposure option selected for testing (see Table A.1);
   2) a description of the exposure device and light source, including:
      i) the type of device and light source (see **A.2.1**);
      ii) the irradiance at the specimen surface (including the bandpass in which the radiation was measured) (see **A.6**);
   3) the type of black-panel temperature sensor used, and the position of the sensor if it was not located in the test specimen exposure area (see **A.2.2.3**);
   4) for Option 2, the type of instrument used to measure the humidity (see **A.2.2.4**);
   5) a description of the exposure cycle used, including the following information for each light and dark period:
      i) the mean and the tolerance limits for the temperature recorded by the black-panel temperature sensor used (see **A.2.2.3**);
      ii) for Option 2 the mean and the tolerance limits for the relative humidity of the air passing over the test specimens (see **A.2.2.4**);
      iii) for Option 1 and Option 2 (see Table A.1), the duration of the water spray;
      iv) the length of each light and dark period (see Table A.1);
   6) a description of the method used to mount the specimens in the exposure frame (see **A.4**);
   7) the procedure for test specimen repositioning, if repositioned (see Note 1 to **A.5.3**);
   8) a description of the radiometer used for measuring the light dosage, if used (see **A.2.2.2**);

9) the test duration (time in days) (see Table A.1);

c) test results:

1) the test report following the laboratory analysis for the detection and identification of the forensic code shall contain;

i) the unique anonymized identifier of the test sample provided for analysis (see **A.3.1.4**);

ii) a description of the laboratory equipment used to identify the forensic code (see **A.2.4**);

iii) reference to the test procedure used for the identification of the forensic code (as given in **7.1**);

iv) whether or not a forensic code was detected (see **A.7**);

v) whether or not the forensic code (if any) was identified (see **A.7**);

vi) the date of the test;

d) whether the forensic code has been correctly identified (see **A.8**);

e) the classification achieved (if any) (see **A.9**).

A.10.2 Summary report

A summary report shall also be available, containing:

a) the date of the test;

b) test sample description:

1) a description of the test sample(s) and their origin (see **A.3.1**);

2) conditioning time and temperature (see **A.3.2**);

3) the type of substrate which was used (see **A.3.2.1**);

c) duration and total radiant exposure of the artificial weathering (see **A.5.3, A.6**);

d) whether or not the forensic code was correctly identified after the artificial weathering (see **A.8**);

e) the classification achieved (if any) (see **A.9**).

Table A.1 – Exposure duration and cycles

Option	Environment – Exposure conditions							Functional test life		Classification tested for
	Test criterion	Cycle duration	Water spray	Lamp type	Irradiance	Black-standard temperature	Relative humidity	Test criterion	Test duration	
1 [1)]	External	5 h	No	Type 1A (UVA-340)	0.84 $W \cdot m^{-2} \cdot nm^{-1}$ at 340 nm	(50 ±3) °C	Not controlled	≥5 years	198.0 days	**Grade A – External**
								≥2 years	79.0 days	**Grade B – External**
		1 h	Yes	(No lamp)	Light off	(25 ±3) °C	Not controlled	≥6 months	19.8 days	**Grade C – External**
2 [1)]	External	5 h	No	Type 1A lamp combination	45 $W \cdot m^{-2}$ (290 nm to 400 nm)	(50 ±3) °C	<15%	≥5 years	165.0 days	**Grade A – External**
								≥2 years	66.0 days	**Grade B – External**
		1 h	Yes	Type 1A lamp combination	45 $W \cdot m^{-2}$ (290 nm to 400 nm)	(25 ±3) °C	Not controlled	≥6 months	16.5 days	**Grade C – External**

Table A.1 – Exposure duration and cycles *(continued)*

Option	Environment – Exposure conditions							Functional test life		Classification tested for
	Test criterion	Cycle duration	Water spray	Lamp type	Irradiance	Black-standard temperature	Relative humidity	Test criterion	Test duration	
3	Internal	24 h	No	Type 1B (UVA-351)	0.76 $W \cdot m^{-2} \cdot nm^{-1}$ at 340 nm	(50 ±3) °C	Not controlled	≥5 years	132.0 days	**Grade A – Internal**
								≥2 years	52.8 days	**Grade B – Internal**
								≥6 months	13.2 days	**Grade C – Internal**

NOTE 1 *A method for simulating external natural weathering conditions in moderate European climates by accelerated weathering is given in the EOTA Technical Report TR010 [1].*

A moderate climatic zone was defined by EOTA TR010 as having annual solar radiant exposure on a horizontal surface of less than, or equal to, 5 $GJ \cdot m^{-2}$ and an average temperature in the warmest month of the year of less than 22 °C. The annual solar radiant exposure on a horizontal surface in the UK is taken as 3.2 $GJ \cdot m^{-2}$. Therefore, for the purpose of calculating the duration of the test, an annual radiant exposure of 3.2 $GJ \cdot m^{-2}$ is used.

The durations for external exposure are in accordance with the calculation method for the determination of the radiation and exposure time to be used for artificial weathering listed in Appendix C of EOTA Technical Report TR010.

For comparison with laboratory light sources, only UV radiation (i.e. wavelengths between 300 nm and 400 nm) is used. This constitutes around 6% of the total radiant exposure, or 192 $MJ \cdot m^{-2}$. To correct for seasonal variations in the amount of radiation, a further factor of 67% is applied, bringing the exposure to 129 $MJ \cdot m^{-2}$ per year, or 643 $MJ \cdot m^{-2}$ for an equivalent of 5 years' exposure.

NOTE 2 *The durations for internal exposure take into account the differences in irradiance of the lamps and the filtering effect of glass on sunlight.*

[1)] Option 1 and Option 2 provide two equivalent exposure conditions for simulating external environments. This is to allow for the use of different laboratory equipment, whilst retaining the same overall exposure.

Bibliography

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS EN ISO 472, *Plastics – Vocabulary*

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

BS EN ISO 9000 series, *Quality management systems*

Other publications

[1] EUROPEAN ORGANISATION FOR TECHNICAL APPROVALS. EOTA Technical Report: TR010. *Exposure procedure for artificial weathering*. EOTA: Brussels, 2004.

Further reading

BS ISO/IEC 27001, (BS 7799-2), *Information technology – Security techniques – Information security management systems – Requirements*

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