
**Safety colours and safety signs —
Classification, performance and
durability of safety signs**

*Couleurs de sécurité et signaux de sécurité — Classification,
performance et durabilité des signaux de sécurité*

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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.

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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 17398 was prepared by Technical Committee ISO/TC 145, *Graphical symbols*, Subcommittee SC 2, *Safety identification, signs, shapes, symbols and colours*.

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Introduction

This International Standard has been prepared to provide manufacturers/suppliers and purchasers with the means for agreeing and specifying performance parameters for safety signs. The performance parameters agreed for each safety sign shall be maintained throughout that product's expected service life.

This International Standard requires manufacturers/suppliers to classify products and provide comprehensive product descriptions. Both manufacturer/supplier and purchaser have the possibility to specify product requirements in terms of performance levels, and where appropriate, the expected service environment.

Consistent use of this International Standard will assist in improving knowledge of the requirements set out below and further understanding of the performance of various types of safety signs in everyday use.

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Safety colours and safety signs — Classification, performance and durability of safety signs

1 Scope

This International Standard specifies requirements for a performance-related classification system for safety signs according to expected service environment, principal materials, photometric properties, means of illumination, fixing methods and surface. Performance criteria and test methods are specified in this International Standard so that properties related to durability and expected service life can be characterized and specified at the time of the product's delivery to the purchaser.

This International Standard does not cover electrical power supplies, their components or electrically powered elements. It also does not cover properties of illuminating components, but the photometric properties for the particular types of safety signs are covered.

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-X12, *Textiles — Tests for colour fastness — Part X12: Colour fastness to rubbing*

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

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 2409, *Paints and varnishes — Cross-cut test*

ISO 2813, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°*

ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs in workplaces and public areas*

ISO 4046-4:2002, *Paper, board, pulps and related terms — Vocabulary — Part 4: Paper and board grades and converted products*

ISO 4589-2:1996, *Plastics — Determination of burning behaviour by oxygen index — Part 2: Ambient-temperature test*

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

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

ISO 7784-3, *Paints and varnishes — Determination of resistance to abrasion — Part 3: Reciprocating test panel method*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 16069, *Graphical symbols — Safety signs — Safety way guidance system (SWGS)*

ISO 17724, *Graphical symbols — Vocabulary*

IEC 60068-2-75, *Environmental testing — Part 2: Tests — Test Eh: Hammer tests*

IEC 60092-101, *Electrical installations in ships — Part 101: Definitions and general requirements*

IEC 60695-2-10, *Fire hazard testing — Part 2-10: Glowing/hot-wire based test methods — Glow-wire apparatus and common test procedure*

IEC 60695-2-11, *Fire hazard testing — Part 2-11: Glowing/hot-wire based test methods — Glow-wire flammability test method for end-products*

CIE 15.2, *Colorimetry*

CIE 69, *Methods of characterizing illuminance meters and luminance meters — Performance, characteristics and specifications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17724 and the following apply.

3.1

expected service life

period of time, indicated by the manufacturer/supplier, for which a safety sign is expected to retain its classified and described properties

3.2

ordinary safety sign

safety sign which is neither retroreflective nor phosphorescent

3.3

phosphorescent safety sign

safety sign that uses phosphors as pigmentation and emits light for periods of time after an activating energy source has been removed

3.4

pressure-sensitive adhesive

adhesive applied to create a bond between two surfaces by a simple application of pressure

3.5

retroreflective safety sign

safety sign designed using materials which reflect visible radiation in a direction close to the opposite of the direction from which it came

4 Classification and detailed product description requirements

4.1 Classification of safety signs

Safety signs shall be classified according to Table 1.

NOTE Examples of classifications used for designation of safety signs are given in Clause 8.

Table 1 — Classification of safety signs

Class. order	Specification	Classification			Subclause reference
1	Service environment ^a	I = Interior	E = Exterior	S = Special	4.2.2, 5.3, 5.4, 7.3, 7.4
2	Principal material: — R = Rigid — F = Flexible	P = Plastic	M = Metal	O = Other	4.2.3, 5.4, 7.4
3	Photometric property ^b	P = Phosphorescent	R = Retroreflective	O = Ordinary	4.2.3.3, 5.3, 5.5, 5.6, 7.3, 7.11
4	Illumination method	E = External	T = Internal (transilluminated)	B = Both external and internal	4.2.4, 5.2, 7.11
5	Fixing method	M = Mechanical	P = Pressure-sensitive adhesive	A = Alternative	4.2.5, 5.7, 7.12
6	Surface	H = High gloss	I = Intermediate gloss	L = Low gloss	5.1.5
^a Service environment classifications are defined as follows. — Interior I: to be used normally in an environment where ambient temperatures are in the range 10 °C to 30 °C, and subject to limited degrading conditions resulting, for example, from impact, abrasion, short periods of temperature variations outside the above range, UV exposure or aggressive atmospheres. It is to be expected that the safety signs will be cleaned regularly with non-aggressive cleaning products. — Exterior E: to be used normally in climatic conditions that include seasonal and daily temperature and humidity variations, as well as exposure to sunlight, wind and humidity. Climatic conditions may be specified more precisely, for example "Northern Hemisphere", "Tropical", and may be complemented with a description of designed resistance to specific atmospheres. — Special S: to be used normally in service environments other than those denoted by classifications I or E or are conditions denoted by I or E that are specifically described to emphasize the special performance attributes of the product. ^b Phosphorescent, retroreflective and ordinary are types of safety signs as defined in Clause 3.					

4.2 Product description

4.2.1 General

Safety signs shall be provided with a product description to complement the classification according to Table 1.

4.2.2 Service environment

The product description shall describe in detail the service conditions in which the safety sign is to be used, particularly where a special service environment is classified according to Table 1.

4.2.3 Principal materials and construction

4.2.3.1 Description of principal materials and construction

The product description shall describe in detail the exact nature of the principal material of manufacture, to include the construction of any material, including multi-layered material, that is of a composite nature. The description shall include the method used to create layers and adhesion between layers.

A description of the surface characteristics and any specific protection afforded to the material shall be given. If the safety sign is classified as phosphorescent (P) or retroreflective (R), the product description shall include the type of construction of the photometric layer and protection provided to this layer (if any).

The uniformity of the photometric layer across the surface shall be described as well as any areas on the safety sign, such as edges, that do not give the photometric properties.

4.2.3.2 Physical properties of the principal materials and the safety sign

The product description shall describe in detail other physical properties of the safety sign construction material selected from the following list, where applicable, and shall reference the test methods used to determine the physical properties:

- thickness;
- dimensions;
- density;
- tensile strength/elongation at break/modulus;
- tear strength for flexible materials;
- delamination strength for layered composites.

After testing in accordance with 7.10, the product description shall indicate the sub-classification of the principal material of manufacture of the safety sign as either rigid (R) or flexible (F). A material shall be classified as rigid when a 50 mm wide strip of material with one end held firmly to a flat surface produces, under its own weight at a temperature of $23\text{ °C} \pm 2\text{ °C}$, an angle of declination $\leq 5^\circ$ over a 200 mm length and $\leq 15^\circ$ over a 300 mm length. A material shall be classified as flexible when a 50 mm wide strip of material with one end held firmly to a flat surface produces, under its own weight at a temperature of $23\text{ °C} \pm 2\text{ °C}$, an angle of declination $> 5^\circ$ over a 200 mm length and $> 15^\circ$ over a 300 mm length.

4.2.3.3 Photometric and surface properties

A description of the appearance of the printed surface of the safety sign at the time of delivery shall be provided.

A description shall be provided of the reproduction method used to incorporate the graphical elements, symbols, safety colours and contrast colours and shall state whether the reproduction of each element is surface or sub-surface.

The product description shall include the colorimetric and photometric properties, tested and verified as being in accordance with ISO 3864-1.

For phosphorescent safety signs, the product description shall include the colour of the phosphorescence. This shall be determined by the spectral emission and its relationship to standard colour definitions during the first 5 min of the phosphorescence period after excitation with the test light source in accordance with 7.11.5.2 a), using the test method specified in CIE 15.2.

The product description shall include the results of testing in accordance with 7.3, together with details of the test conditions (where they differ from those specified in 7.3).

For safety signs classified as phosphorescent (P) in accordance with 4.1, the product description shall include the luminance decay sub-classification (see 5.5), which shall be given in conjunction with the main photometric property classification as either PA, PB, PC or PD.

The photometric properties of safety signs classified as retroreflective shall be sub-classified according to properties at the time of delivery as R1 or R2 as specified in ISO 3864-1.

4.2.4 Illumination method

For safety signs intended to be internally illuminated, the product description shall include any particular service conditions of temperature to which the safety sign may be subjected, resulting from the light sources and any particular requirements of the illumination source, which might affect the colorimetric and photometric properties of the safety sign.

For phosphorescent safety signs, manufacturers/suppliers shall provide a description concerning the luminance decay performance. The minimum information made available shall be the photopic luminance decay properties resulting from the different illumination levels and light sources as determined in accordance with 7.11.5.2. Where required by agreement between the manufacturer/supplier and the purchaser, or for the optional performance description requirements of 4.2.6 or for the purpose of characterizing safety signs and safety way-guidance components for use as described in ISO 16069, the product description shall include the times taken for the luminance to decrease to 3 mcd/m² and to 2 mcd/m² when tested under the excitation conditions given in 7.11.5.1 and 7.11.5.2 respectively.

4.2.5 Fixing method

The product description shall describe the recommended fixing method or methods for the safety sign.

When a safety sign is supplied with pressure-sensitive adhesive (P) as an integral part of the delivered product, the adhesive shall be described using the following performance classifications. One or more or a combination of classifications shall be given as appropriate.

- P = Permanent: an adhesive designed to remain in a specific location to which it has been applied for the full duration of its service life.
- R = Removable: removable pressure-sensitive adhesive that allows a sign to be easily removed within its specified lifetime without significantly impairing the surfaces to which it is applied.
- M = Re-positionable: re-positionable pressure-sensitive adhesive that can be applied to a surface, removed and reapplied at least twice without detrimental effects.
- S = Special: adhesive that is designed to be applied to rough, non-polar surfaces or low surface energy substrates.
- L = Low temperature: adhesive that can be applied at temperatures down to 4 °C.
- V = Very low temperature: adhesive that can be applied at temperatures below 4 °C.

The temperature limits may be specified if required.

For safety signs classified as using pressure-sensitive adhesive (P) as a fixing method in accordance with 4.1, the product description shall include the adhesive strength sub-classification (see 5.7).

Manufacturers/suppliers shall provide a description of the correct storage of safety signs prior to fixing and any service and maintenance requirements.

4.2.6 Optional performance description

Where the safety sign conforms to one or more of the optional performance requirements specified in Clause 6, a description of the performance shall be given in the product description.

5 Performance requirements

5.1 All safety signs

5.1.1 Flame resistance

When tested in accordance with one of the test methods given in 7.7, safety signs manufactured from materials other than metal, glass or ceramic shall achieve any one of the following performance requirements, appropriate to the test chosen:

- have an oxygen index no less than 26 (see 7.7.2);
- pass the glow-wire test at 850 °C (see 7.7.3);
- be classified as non-flammable (see 7.7.4).

5.1.2 Resistance to humidity

After testing in accordance with 7.2, a visual inspection of the safety sign with the naked eye as compared against an untested, new control specimen, shall detect no significant indications of indentation, separation, splitting, chalking, swelling, peeling, blistering, flaking, large scratches or cracking of the material and/or its graphical components.

5.1.3 Wipe resistance

After testing in accordance with 7.16, a visual inspection of the safety sign with the naked eye as compared against an untested, new control specimen shall detect no significant indications of indentation, separation, splitting, chalking, swelling, peeling, blistering, flaking, large scratches or cracking of the material and/or its graphical components.

5.1.4 Surface print adhesion

When tested in accordance with 7.8, no significant print area shall be transferred to the adhesive tape.

5.1.5 Gloss

When measured at 60° geometry in accordance with ISO 2813, the surface of the safety colour of the safety sign shall be classified according to one of the following three classes:

- H (high gloss): > 75 units;
- I (intermediate gloss): between 50 units and 75 units;
- L (low gloss): < 50 units.

5.2 Internally illuminated safety signs

After testing in accordance with 7.13 at either the temperatures given in Table 8 or the highest operating temperature described in the product description, a visual inspection of the safety sign with the naked eye as compared against an untested, new control specimen shall detect no significant indications of indentation, separation, splitting, chalking, swelling, peeling, blistering, flaking, large scratches or cracking of the material and/or its graphical components.

5.3 Weather resistance of safety signs classified for exterior use

After testing in accordance with no less than one of the test methods given in 7.3, with the duration of the test either as required in 7.3 or as agreed between the manufacturer/supplier and the purchaser, the photometric properties of the safety sign shall remain within the limits of the photometric and colorimetric ranges given in ISO 3864-1 and the relevant sub-classifications given in this standard (see 5.5). A visual inspection of the safety sign with the naked eye as compared against an untested, new control specimen shall detect no significant indications of indentation, separation, splitting, chalking, swelling, peeling, blistering, flaking, large scratches or cracking of the material and/or its graphical components.

5.4 Salt spray and corrosion resistance of metal safety signs classified for exterior use

After testing in accordance with 7.4 for 100 h, a visual inspection of the safety sign with the naked eye as compared against an untested, new control specimen shall detect no significant indications of corrosion, separation, splitting, chalking, swelling, peeling, blistering, flaking, large scratches or cracking of the material and/or its graphical components.

This performance requirement also applies to safety signs classified for use in special service environments (S) but only where those special service environments include exterior environments (E).

5.5 Phosphorescent safety signs

When measured in accordance with 7.11, the minimum luminance of safety signs classified as phosphorescent (P) in accordance with 4.1 shall conform to one of the four sub-classifications given in Table 2. The phosphorescent classification and subclassification shall both be maintained after testing in accordance with 7.3.

Table 2 — Luminance decay characteristics of phosphorescent safety signs

Sub-classification	Minimum luminance mcd/m ²			
	At decay time 2 min	At decay time 10 min	At decay time 30 min	At decay time 60 min
A	108	23	7	3
B	210	50	15	7
C	690	140	45	20
D	1 100	260	85	35

5.6 Retroreflective safety signs

Safety signs classified as retroreflective (R) in accordance with 4.1 shall be sub-classified according to their photometric properties as either R1 or R2 in accordance with ISO 3864-1. The retroreflective classification and subclassification shall both be maintained after testing in accordance with 7.3.

5.7 Adhesive strength of safety signs fixed using pressure-sensitive adhesive

When tested in accordance with 7.12, the adhesive properties of safety signs classified as using pressure-sensitive adhesive (P) as a fixing method in accordance with 4.1 shall conform to one of the sub-classifications given in Table 3, according to whether the principal material of manufacture is flexible or rigid. Where the shear strength of rigid materials is tested in accordance with 7.12.4, the results shall be categorized as follows:

- If there is bond failure in any of the three test specimens with the 10 N weight attached, the shear strength shall be categorized as "O".

- b) If there is no bond failure in any of the three test specimens with the 10 N weight attached, the shear strength shall be categorized as "N".
- c) If there is bond failure in any of the three test specimens with the 50 N weight attached, the shear strength shall be categorized as "N".
- d) If there is no bond failure in any of the three test specimens with the 50 N weight attached, the shear strength shall be categorized as "H".

Table 3 — Classification of peel and shear strength

Peel strength of flexible materials N per 25 mm width	Shear strength of rigid materials N per 25 mm × 25 mm
$T \geq 25$	$O \leq 10$
$U \geq 18$	$N > 10$
$V \geq 13$	$H = 50$
$W \geq 10$	—
$X \geq 7$	—
$Y \geq 4$	—
$Z \geq 1$	—

6 Optional performance requirements for safety signs

6.1 General

The performance requirements specified in 6.2 to 6.7 shall apply where appropriate according to the service environment.

6.2 Shrinkage/dimensional stability

When tested in accordance with 7.14, the shrinkage of the safety sign shall be no greater than 5 %.

6.3 Resistance to test liquids

After testing in accordance with 7.15, a visual inspection of the safety sign with the naked eye as compared against an untested, new control specimen shall detect no significant indications of indentation, separation, splitting, chalking, swelling, peeling, blistering, flaking, large scratches or cracking of the material and/or its graphical components.

6.4 Impact resistance

When tested in accordance with 7.5 with an impact energy either of 0,5 N·m or as agreed between the manufacturer/supplier and the purchaser from the list given in 7.5, under test conditions agreed between the manufacturer/supplier and the purchaser, the safety sign shall show only slight indentation and no other damage to the surface or to the graphical elements.

6.5 Abrasion resistance

When tested in accordance with 7.9 using 600 double strokes, a visual inspection of the safety sign with the naked eye as compared against an untested, new control specimen, shall detect no significant indications of indentation, separation, splitting, chalking, swelling, peeling, blistering, flaking, large scratches or cracking of the material and/or its graphical components.

6.6 Water resistance

When tested in accordance with 7.6, a visual inspection of the safety sign with the naked eye as compared against an untested, new control specimen, shall detect no significant indications of indentation, separation, splitting, chalking, swelling, peeling, blistering, flaking, large scratches or cracking of the material and/or its graphical components.

6.7 Resistance to climatic conditions for externally illuminated or internally and externally illuminated safety signs

When tested in accordance with 7.13, under one or more of the standard conditions given in Table 8, a visual inspection of the safety sign with the naked eye as compared against an untested, new control specimen shall detect no significant indications of indentation, separation, splitting, chalking, swelling, peeling, blistering, flaking, large scratches or cracking of the material and/or its graphical components. Additionally, for safety signs classified as phosphorescent (P) or retroreflective (R) in accordance with 4.1, the photometric properties shall be shown to remain as classified in 4.1 after testing.

7 Test methods

7.1 Test specimens and control specimens

7.1.1 General

New test specimens shall be prepared for each of the tests given in 7.2 to 7.16. New control specimens shall also be prepared for any test that involves a visual inspection. The test specimen/control specimen shall be the safety sign wherever possible, except where the physical limitations of the test equipment do not allow for testing of an entire sign or when the graphical content of the safety sign has no effect on the results of the test.

7.1.2 Number of test specimens/control specimens

The number of test specimens and control specimens prepared for each test shall be as required for confidence of reproducibility of the test results. Where the test results include a quantified property or where there is any doubt in the reproducibility of the test results, the number of test specimens/control specimens prepared for each test shall be a minimum of three or as required by the test method itself.

It is possible to reduce the total number of test specimens/control specimens required to perform the total test programme chosen by carrying out non-destructive tests first, followed by the destructive tests.

7.1.3 Conditioning of test specimens

Test specimens and control specimens shall be conditioned at a temperature of $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ with a relative humidity of $50\% \pm 15\%$ for 24 h as specified in ISO 291, prior to testing.

7.2 Resistance to humidity test

Test specimens shall be subjected to a water condensation climate at a temperature of $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ with a relative humidity of $98\% \pm 2\%$ for 48 h, then visually inspected.

7.3 Weather resistance test

7.3.1 General

Test specimens shall be tested according to one or more of the test methods given in 7.3.2 to 7.3.4, with the test conditions, including the duration of the test, either as given in the relevant test or as agreed between the manufacturer/supplier and the purchaser. After testing, each test specimen shall be visually inspected.

7.3.2 Open flame carbon lamp type accelerated weathering test

The open flame carbon lamp type accelerated weathering test shall be performed in accordance with ISO 4892-4, with the test conditions as given in Table 4, or as agreed between the manufacturer/supplier and the purchaser.

Table 4 — Conditions for open flame carbon lamp type accelerated weathering test

Test conditions	
Number of open flame carbon arc lights	One light (Type 1 light filter used)
Source voltage	Single-phase current 180 V to 230 V
Average discharge voltage and current	50 V ($\pm 2\%$), 60 A ($\pm 2\%$)
Relative humidity	(50 $\pm$ 5) %
Temperature on the black panel thermometer	(63 $\pm$ 3) °C
Duration of water spray	18 min during 120 min light
Water pressure of supply source	78 kPa to 127 kPa
Aperture of nozzle	1 mm approximately
Irradiance on the surface of test specimen	(255 $\pm$ 45) W/m ² for 300 nm to 700 nm
Duration of test	100 h

7.3.3 Dew cycle type accelerated weathering test

The dew cycle type accelerated weathering test shall be performed in accordance with ISO 4892-4, with the test conditions as given in Table 5, or as agreed between the manufacturer/supplier and the purchaser.

Table 5 — Conditions for dew cycle type accelerated weathering test

Test conditions	
Number of open flame carbon arc lights	One light (no light filters used)
Source voltage	Single-phase current 180 V to 230 V
Light on/off cycle	60 min/60 min
Conditions during light on period	
Average discharge voltage and current	50 V ($\pm 2\%$), 60 A ($\pm 2\%$)
Temperature on the black panel thermometer	(63 $\pm$ 3) °C
Relative humidity	(50 $\pm$ 5) %
Conditions during light off period	
Air temperature	30 °C
Relative humidity	98 % or more
Temperature of cooling water to the back	7 °C approximately
Surface of a test specimen	
Testing duration (total light on and off) periods	20 h
Water spray to the surface of a test specimen	Not available
Irradiance on the surface of a test specimen	(285 $\pm$ 50) W/m ² for 300 nm to 700 nm

7.3.4 Artificial weathering resistance test

The test shall be performed in accordance with ISO 4892-2, with the test conditions as given in either Table 6 or Table 7, or as agreed between the manufacturer/supplier and the purchaser.

Table 6 — Conditions for xenon-arc sources artificial weathering resistance test

Test conditions	
Type of light source	Xenon-arc
Light on/off cycle	Continuous on
Temperature on the black panel thermometer	$(65 \pm 3) ^\circ\text{C}$
Relative humidity	$(50 \pm 5) \%$
Duration of water spray	$(18 \pm 0,5)$ min spray $(102 \pm 0,5)$ min dry
Irradiance on the surface of a test specimen	550 W/m^2 for 300 nm to 800 nm or 60 W/m^2 for 300 nm to 400 nm
Duration of test	1 000 h

Table 7 — Conditions for xenon-arc sources artificial weathering resistance test

Test conditions	
Type of light source	Xenon-arc
Light on/off cycle	Continuous on
Temperature on the black panel thermometer	$(65 \pm 3) ^\circ\text{C}$
Relative humidity	$(50 \pm 5) \%$
Duration of water spray	$(18 \pm 0,5)$ min spray $(102 \pm 0,5)$ min dry
Irradiance on the surface of a test specimen	180 W/m^2 for 300 nm to 400 nm
Duration of test	340 h

7.4 Salt spray/corrosion resistance test

The salt spray/corrosion resistance test shall be conducted in accordance with ISO 9227, for a duration of 100 h. After testing, each test specimen shall be visually inspected.

7.5 Impact resistance test

The impact resistance test shall be conducted in accordance with IEC 60068-2-75, under the following conditions.

- Three specimens installed in simulated normal use following manufacturer/supplier instructions, shall be tested with the spring hammer test apparatus specified in IEC 60068-2-75 with a minimum impact energy of 0,5 N·m.

The spring hammer test apparatus is illustrated in Annex A.

Other impact energy values may be agreed between the manufacturer/supplier and the purchaser from the following list of values: 0,5 N·m; 0,7 N·m; 1 N·m; 2 N·m; 5 N·m; 10 N·m; 20 N·m; 50 N·m.

- Each sign shall be tested with five impacts, one in the centre, two in opposite locations close to the border and two in an intermediate location. Examples of impact locations are given in Figure 1.

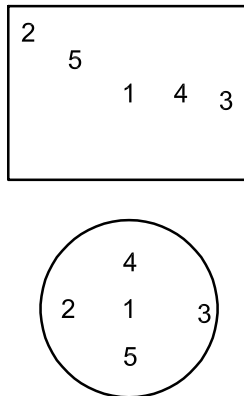


Figure 1 — Examples of impact positions

7.6 Water resistance test

Test specimens shall be immersed in distilled water at $(20 \pm 5) ^\circ\text{C}$ for 24 h, removed, and allowed to stand at room temperature for 1 h, then visually inspected.

7.7 Flame resistance test

7.7.1 General

One of the tests given in 7.7.2 to 7.7.4 shall be performed.

7.7.2 Flame resistance test for synthetic resin substrates of safety signs

A flame resistance test for synthetic resin substrates of safety signs shall be carried out in accordance with ISO 4589-2:1996, Clause 10, Procedure C, to obtain flame-resistance indexes.

7.7.3 Glow-wire test

The front faces of three safety signs shall be subjected to a glow-wire test in accordance with IEC 60695-2-11, at a test temperature of $850 ^\circ\text{C}$. Each sign shall be tested twice on the same face, but care shall be taken that any deterioration caused by previous tests does not affect the result of the second test made. The test equipment to be used shall be as described in IEC 60695-2-10.

Any flame or glowing of the specimen shall extinguish within 30 s of withdrawing the glow-wire, and any burning or molten drop shall not ignite a single layer of capacitor tissue paper as defined in ISO 4046-4:2002, 4.29, spread out horizontally (200 ± 5) mm below the specimen.

7.7.4 Flame retardance test

A flame retardance test shall be carried out in accordance with IEC 60092-101.

7.8 Surface print adhesion

The surface print adhesion shall be tested according to the methodology described in ISO 2409 but without the requirement for cutting the surface layer. The adhesive tape used shall have a peel strength of (7 ± 2) N per 25 mm width.

7.9 Abrasion resistance test

An abrasion resistance test shall be carried out in accordance with ISO 7784-3, using 600 double strokes, then visually inspected.

7.10 Rigidity test

A test specimen 50 mm wide and a minimum of 300 mm in length, shall be held firmly by one end to a flat surface and subjected to its own weight at a temperature of $(23 \pm 2) ^\circ\text{C}$. The resulting angle of declination shall be measured immediately at both 200 mm and 300 mm along the length of the test specimen and recorded.

7.11 Measurement of photopic luminance of phosphorescent safety signs

7.11.1 Test specimens

Three specimens shall be tested. Each test specimen shall have an area of phosphorescent material at least 35 mm in diameter, sufficient for the proper operation of the luminance meter used.

The test specimens shall be final products complete with UV protection where applicable and specified. The graphical symbols shall be sufficiently large to provide the minimum test diameter or a test specimen shall be from a production batch without printing of the graphical symbols but with any UV protection applied.

7.11.2 Conditioning

All test specimens shall be pre-conditioned by being placed in a completely dark enclosure for at least 48 h. The specimens shall not be removed from the dark enclosure until immediately prior to the tests.

NOTE This requirement is in addition to the conditioning requirements given in 7.1.

7.11.3 Ambient conditions

The ambient temperature during preconditioning of test specimens, excitation and luminance testing shall be $(23 \pm 2) ^\circ\text{C}$. The relative humidity shall be $(50 \pm 10) \%$. All luminance testing shall be performed in a room/chamber whose ambient light level is at least one order of magnitude lower than the lowest luminance measurement to be made.

7.11.4 Illuminance and luminance instrumentation

7.11.4.1 Illuminance instrumentation

A cosine photopic $V(\lambda)$ corrected illuminance meter shall be provided, calibrated to measure illuminance in lux (lx), with the following features:

- spectral error: $f_1' \leq 5 \%$ (with f_1' as defined in CIE 69);
- UV response: $u \leq 0,5 \%$ (with u as defined in CIE 69);
- resolution: 1,0 lx;
- linearity error: $f_3 \leq 0,5 \%$ (with f_3 as defined in CIE 69);
- measuring range: ≥ 10 lx to 10 klx;
- light entry diameter of the photometer-head: ≤ 1 cm.

7.11.4.2 Luminance instrumentation

A luminance meter shall be provided, calibrated to measure photopic luminance. The luminance meter shall be either a telephotometer, or a contact luminance meter, depending on whether the telephotometer method (see 7.11.6.2) or the contact method (see 7.11.6.3) is used, and shall have the following minimum features:

- spectral error: $f_1' \leq 5\%$ (with f_1' as defined in CIE 69);
- UV response: $u \leq 0,5\%$ (with u as defined in CIE 69);
- resolution: at least $0,01 \text{ mcd/m}^2$;
- linearity error: $f_3 \leq 0,5\%$ (with f_3 as defined in CIE 69);
- signal-to-noise-ratio: at least 10:1 for all measurements;
- measuring range: $\geq 10^{-5} \text{ cd/m}^2$ to 10 cd/m^2 ;
- display: $\geq 3,5$ digits, range min $\geq 0,001 \times 10^{-2}$, max $\leq 1,999 \times 10$.

7.11.5 Excitation light conditions

7.11.5.1 Excitation light conditions for classification purposes

Excitation of the phosphorescent test specimens shall be by a non-diffusing, unfiltered, continuous short xenon-arc source of light of 500 W or less, providing a mean illuminance of 1 000 lx on the surface of the test specimen. The illuminance shall be measured using the illuminance meter specified in 7.11.4.1. Shields in front of the lamp that would provide protection, such as heat-protection, shall not be used. No filter shall be placed in front of the light source. The excitation duration shall be 5 min. The test specimen body temperature shall not exceed 25°C , 1 min after excitation. No ambient or stray light shall be present during excitation.

Test patches for measurement of illuminance shall be positioned in the centre of the illuminated area of the test specimen and at each of the four points 90° on the outer rim of the surface of the test specimen. The mean illuminance on the five test patches shall be 1 000 lx. The maximum illuminance divided by the minimum illuminance of the test patches shall be less than 1,1.

7.11.5.2 Excitation light conditions for product description purposes

Excitation of the phosphorescent test specimens shall be carried out according to the following list.

- a) 200 lx using a standard light source D_{65} for 20 min;
- b) 50 lx using a cool white fluorescent lamp of colour temperature 4 300 K for 15 min;
- c) 25 lx using a warm white fluorescent lamp of colour temperature 3 000 K for 15 min.

The test specimen body temperature shall not exceed 25°C , 1 min after excitation. No ambient or stray light shall be present during excitation. The illuminance shall be measured using the illuminance meter specified in 7.11.4.1.

Test patches for measurement of illuminance shall be positioned in the centre of the illuminated area of the test specimen and at each of the four points 90° on the outer rim of the surface of the test specimen. The mean illuminance on the five test patches shall be as described in a), b) and c) above. The maximum illuminance divided by the minimum illuminance of the test patches shall be less than 1,1.

Supplier and purchaser may agree other conditions of illumination level and type of light source as well as the excitation time according to the specific requirements of service, in addition to a), b) and c) above. At lower excitation illuminances, the time necessary to reach maximum performance will increase.

7.11.6 Luminance measurements

7.11.6.1 General

The luminance measurements shall be carried out using the luminance meter specified in 7.11.4.2, using either the telephotometer method given in 7.11.6.2 or the contact method given in 7.11.6.3.

7.11.6.2 Telephotometer method

The distance between the luminance meter and the measured test specimen, and also the aperture of the luminance meter, shall be chosen in such a way that the area of the test specimen to be evaluated shall be sufficient for the luminance meter to give a luminance reading at low luminance levels.

Where possible, an area of the test specimen at least 30 mm in diameter should be evaluated.

7.11.6.3 Contact method

The measurement head of the luminance meter shall be placed on the surface of the test specimen. The influence of ambient light shall be avoided by covering the test specimen's surface outside/around the luminance measurement head with a light protecting material. The area of the test specimen to be evaluated shall be sufficient for the luminance meter to give a luminance reading at low luminance levels.

Where possible, an area of the test specimen at least 30 mm in diameter should be evaluated.

The luminance shall be determined by measuring illuminance and converting to luminance, according to the following equation:

$$\bar{L} = E/\Omega_p$$

where

$\bar{L}$ is the average luminance, expressed in cd/m^2 , of the test specimen measured;

E is the illuminance, expressed in lux (lx), of the place determined on the light incidence area of the photometer head used;

Ω_p is the projected solid angle, expressed in steradians (sr), which the tested surface of the measuring object takes viewed from the middle of the light incidence area of the photometer head.

The projected solid angle Ω_p follows the equation:

$$\Omega_p = \pi [1 + (r/R)^2]^{-1} \Omega_0$$

where

Ω_0 is the unit solid angle, $\Omega_0 = 1 \text{ sr}$;

r the distance, expressed in millimetres (mm), between the light incidence area of the photometer head and the measuring object;

R the radius, expressed in millimetres (mm), of the plane of the tested surface of the measuring object.

7.11.6.4 Luminance recordings

7.11.6.4.1 General

The luminance meter shall be zeroed prior to start of measurement, then checked immediately after the final measurement. A measurement shall be rejected if the zero has drifted by more than 5 % of the measured value.

7.11.6.4.2 Luminance recordings for classification purposes

The luminance shall be measured at least every 2 min after the excitation light is removed. In all cases, the measurements shall include the time period up to 60 min after the excitation light is removed and shall include measurements (which shall be recorded in mcd/m^2) at $2 \text{ min} \pm 10 \text{ s}$, $10 \text{ min} \pm 10 \text{ s}$, $30 \text{ min} \pm 10 \text{ s}$ and $60 \text{ min} \pm 10 \text{ s}$ for each of the three test specimens.

For the purposes of classification of the safety sign, the luminance performance shall be based on the mean values of the three test specimens.

7.11.6.4.3 Luminance recordings for product description purposes

The luminance shall be measured at least every 2 min after the excitation light is removed. In all cases, the measurements shall include the time period up to 60 min after the excitation light is removed and shall include measurements (which shall be recorded in mcd/m^2) at $2 \text{ min} \pm 10 \text{ s}$, $10 \text{ min} \pm 10 \text{ s}$, $30 \text{ min} \pm 10 \text{ s}$ and $60 \text{ min} \pm 10 \text{ s}$ for each of the three test specimens.

Where required by agreement between the manufacturer/supplier and the purchaser, or for the product description requirements of 4.2.4 or 4.2.6, or for the purpose of characterizing safety signs and safety way-guidance components for use as described in ISO 16069, the luminance measurement tests shall be continued and the time taken for the luminance to decrease to 3 mcd/m^2 (when tested under the light conditions given in 7.11.5.1) and 2 mcd/m^2 (when tested under the excitation light conditions given in 7.11.5.2) shall be measured for each of the three test specimens and recorded as a mean for all three test specimens.

7.12 Testing of adhesive properties of pressure-sensitive adhesive signs

7.12.1 General

The adhesive properties of safety signs classified as using pressure-sensitive adhesive (P) as a fixing method in accordance with 4.1 shall be determined in accordance with one of the test methods given in 7.12, according to whether the principal material of manufacture is flexible or rigid.

7.12.2 Preparation of test specimens

7.12.2.1 General

At least three test specimens shall be prepared for the peel strength test in 7.12.3 and at least six test specimens shall be prepared for the shear strength test in 7.12.4. Each test specimen shall be prepared in accordance with 7.12.2.3, and mounted on a test panel prepared in accordance with 7.12.2.2.

7.12.2.2 Test panels

Test panels shall be made from either of the following materials:

- a) float glass, measuring $200 \text{ mm} \times 50 \text{ mm}$;
- b) stainless steel (e.g. X5CrNi18), ground smooth to a roughness degree of $R_z 100$, measuring $200 \text{ mm} \times 50 \text{ mm} \times 2 \text{ mm}$.