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Fire detection and alarm systems —

Part 23:
Visual alarm devices

Systèmes de détection et d'alarme d'incendie —

Partie 23: Dispositifs d'alarme visuels

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 7240-23 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

ISO 7240 consists of the following parts, under the general title *Fire detection and alarm systems*:

— *Part 1: General and definitions*

— *Part 2: Control and indicating equipment*

— *Part 3: Audible alarm devices*

— *Part 4: Power supply equipment*

— *Part 5: Point-type heat detectors*

— *Part 6: Carbon monoxide fire detectors using electro-chemical cells*

— *Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization*

— *Part 8: Carbon monoxide fire detectors using an electro-chemical cell in combination with a heat sensor*

— *Part 9: Test fires for fire detectors* [Technical Specification]

— *Part 10: Point-type flame detectors*

— *Part 11: Manual call points*

— *Part 12: Line type smoke detectors using a transmitted optical beam*

— *Part 13: Compatibility assessment of system components*

— *Part 14: Guidelines for drafting codes of practice for design, installation and use of fire detection and fire alarm systems in and around buildings* [Technical Report]

— *Part 15: Point type fire detectors using scattered light, transmitted light or ionization sensors in combination with a heat sensor*

— *Part 16: Sound system control and indicating equipment*

— *Part 17: Short-circuit isolators*

— *Part 18: Input/output devices*

— *Part 19: Design, installation, commissioning and service of sound systems for emergency purposes*

— *Part 21: Routing equipment*

— *Part 22: Smoke detection equipment for ducts*

— *Part 23: Visual alarm devices*

— *Part 24: Sound-system loudspeakers*

— *Part 25: Components using radio transmission paths*

— *Part 27: Point-type fire detectors using scattered-light, transmitted-light or ionization smoke sensor, an electrochemical cell carbon-monoxide sensor and a heat sensor*

— *Part 28: Fire protection control equipment*

Introduction

The purpose of a visual fire alarm device is to warn person(s) within, or in the vicinity of, a building of the occurrence of a fire emergency in order to enable such person(s) to take appropriate measures.

This part of ISO 7240 allows manufacturers to specify visual alarm devices in terms of the range at which the required illumination is met. Three classes of device are defined, one for ceiling mounted devices, one for wall mounted devices and an open class. The maximum range of the visual alarm device is tested by measuring the light output in a part of the hemisphere surrounding it to determine its light distribution. As the light output of some visual alarm devices can change over time due, for example, to the effect of self-heating, a specific test checks that the variation of light output over time is within acceptable limits.

This part of ISO 7240 gives common requirements for the construction and robustness of visual alarm devices as well as for their performance under climatic, mechanical and electrical interference conditions which are likely to occur in the service environment. Visual alarm devices can be classified in one of three application environment types.

Fire detection and alarm systems —

Part 23: Visual alarm devices

1 Scope

This part of ISO 7240 specifies the requirements, test methods and performance criteria for visual alarm devices in a fixed installation intended to signal a visual warning of a fire between a fire detection and alarm system and occupants in and around buildings.

This part of ISO 7240 specifies visual alarm devices for three types of application environment.

It is only applicable to pulsing or flashing visual alarm devices, for example xenon beacons or rotating beacons. It is not applicable to devices giving continuous light output.

This part of ISO 7240 is not intended to cover visual indicators, for example, on detectors or on the control and indicating equipment.

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 2813:1994, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20 degrees, 60 degrees and 85 degrees*

ISO 7240-1, *Fire detection and alarm systems — Part 1: General and definitions*

ISO/CIE 23539:2005, *Photometry — The CIE system of physical photometry*

IEC 60068-1:1988, *Environmental testing — Part 1: General and guidance*

IEC 60068-2-1:2007, *Environmental testing — Part 2-1: Tests — Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing — Part 2-2: Tests — Test B — Dry heat*

IEC 60068-2-6:2007, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27:2008, E*nvironmental testing — Part 2-27: Tests — Test Ea and guidance: Shock*

IEC 60068-2-30:2005, *Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-42:2003, *Environmental testing — Part 2-42: Tests — Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60068-2-75:1997, *Environmental testing — Part 2-75: Tests — Test Eh: Hammer tests*

IEC 60068-2-78:2001, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*

IEC 60529:2001, *Degrees of protection provided by enclosures (IP Code)*

IEC 60695-11-10:2003, *Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods*

IEC 60695-11-20:2003, *Fire hazard testing — Part 11-20: Test flames — 500 W flame test methods*

EN 50130-4:2011, *Alarm systems — Part 4: Electromagnetic compatibility — Product family standard: immunity requirements for components of fire, intruder, hold up, CCTV, access control and social alarm systems*

UL 94, *Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances testing*

3 Terms, definitions and abbreviations

For the purposes of this document, the terms, definitions and abbreviations given in ISO 7240-1 and the following apply.

3.1 Terms and definitions

3.1.1
coverage volume
volume within which the required illumination is achieved

3.1.2
class C visual alarm device
device intended for mounting on ceilings

3.1.3
class O visual alarm device
device where the mounting is specified by the manufacturer

3.1.4
class W visual alarm device
device intended for mounting on walls

3.1.5
normal axis
axis normal to the mounting plane which passes through the reference point

3.1.6
mode (of operation)
one of a possible number of pre-defined light outputs selected by means specified by the manufacturer

3.1.7
reference point
optical centre within or on the surface of the visual alarm device specified by the manufacturer

3.1.8
required illumination
illumination of 0,4 lm/m^2 on a surface perpendicular to the direction of the light emitted from the device

3.1.9
type A visual alarm device
device primarily intended for conditioned indoor applications

Note 1 to entry: In certain climates, a Type A visual alarm device may be suitable for some unconditioned indoor areas such as an enclosed attached garage or some protected outdoor areas such as under an awning.

3.1.10
type B visual alarm device
device primarily intended for unconditioned indoor or outdoor applications

Note 1 to entry: A Type B visual alarm device may be more suitable than a Type A visual alarm device for some conditioned indoor areas where high temperature and/or humidity are present.

3.1.11
type C visual alarm device
device primarily intended for harsh environment applications

Note 1 to entry: Type C visual alarm devices are specifically intended for use in extreme climates and areas were harsh environment exists, e.g. mining, including open-cast mining.

3.1.12
visual alarm device
v.a.d
device which generates a flashing light to signal to the occupants of a building that a fire condition exists

3.2 Abbreviations

a.c. alternating current

d.c. direct current

r.m.s. root mean square

v.a.d. visual alarm device

4 Requirements

4.1 Compliance

In order to comply with this part of ISO 7240, the v.a.d. shall meet the requirements of Clause 4, which shall be verified by visual inspection or engineering assessment, shall be tested as described in Clause 5 and shall meet the requirements of the tests.

4.2 Device class

4.2.1 The v.a.d shall meet the requirement for coverage volume of at least one of the following three classes:

a) '**C**', ceiling mounted devices;

b) '**W**', wall mounted devices;

c) '**O**', open class devices.

4.2.2 Class C devices shall be further specified as **C-x-y** (see 4.10 2 d) 1)), where:

— **x** is the maximum height, in metres, between 2,5 m and 10 m at which the device may be mounted, and

— **y** is the diameter, in metres, of the coverage cylindrical volume when the device is mounted at the ceiling height.

EXAMPLE **C-3-12** refers to a ceiling mounted device, with a maximum mounting height of 3 m, providing a cylindrical volume of 12 m diameter.

NOTE If a **C-3-12** is located at the centre of square, it corresponds to a square coverage range (8.49 × 8.49) m contained within a circle of 12 m diameter.

4.2.3 Class W devices shall be further specified as **W-x-y** (see 4.10 2 d) 2)), where:

— **x** is the maximum height of the devices on the wall, in metres, with a minimum value of 2,4 m, and

— **y** is the width of a square room, in metres, covered by the device.

EXAMPLE **W-2.4-6** refers to a wall mounted device, with a maximum mounting height of 2,4 m, providing a coverage volume of (2,4 × 6 × 6) m.

4.2.4 For class **O** devices the coverage volume in which the required illumination is achieved shall be specified (see 4.10 2 d) 3)).

4.3 Minimum and maximum effective light intensity

When tested in accordance with 5.4, the v.a.d. shall produce an effective light intensity of at least 1 cd for 70 % of all measurement points and shall not exceed 500 cd for any measurement points.

4.4 Light colour

The v.a.d. shall emit a white or red flashing light.

4.5 Light pattern and frequency of flashing

The flash rate of the v.a.d. shall be between 0,5 Hz and 2 Hz measured between the 10 % of peak values of consecutive leading edges of the pulses (P_{10L}).

NOTE The frequency of flashing may vary in different countries. Reference needs to be made to local regulations. Some countries have adopted the ISO 8201 temporal pattern.

The maximum on-time, measured between the 10 % of peak values of the leading edge (P_{10L}) and trailing edge (P_{10T}) of the pulse shall not exceed 0,2 s.

If the light emitted consists of groups of several pulses and if the time between the P_{10T} of one pulse and the P_{10L} of the next pulse is less than 0,04 s then the pulses shall be considered as a single event.

Any set of multiple pulses shall not exceed 0,2 s between the P_{10L} of the first peak to the P_{10T} of the last peak.

A set of pulses where the minimum value does not drop below 10 % of the peak value is considered as a single pulse and shall not exceed 0,2 s between P_{10L} and P_{10T}.

4.6 Durability

The v.a.d. shall be rated for at least 100 h operation. No limitation on duty factor or maximum on-time shall prevent the device from operating the 1 h 'on' 1 h 'off' cycle required by the test procedure described in 5.5.

NOTE This requirement does not apply to the capacity of batteries which may be used within a v.a.d as a means of local storage of operating power. The capacity and charging requirements of such batteries need to meet the requirements of the system.

4.7 Construction

4.7.1 Provision for external conductors

The v.a.d. shall provide space within its enclosure for entry and termination of external conductors. Entry holes for conductors or cables shall be provided or the location where such holes are to be made shall be indicated by providing a template or some other suitable means.

Terminals for connecting external conductors to the v.a.d. shall be designed so that the conductors are clamped between metal surfaces without being damaged.

4.7.2 Materials

The v.a.d. shall be constructed of material(s) capable of withstanding the tests specified in 5.2 to 5.19. In addition, the material(s) of plastic enclosures shall meet the following flammability requirements:

a) IEC 60695-11-10, Class V-2 or HB75 for devices operating from a voltage source less than or equal to 30 V r.m.s. or 42,4 V d.c. and consuming less than 15 W of power;

b) IEC 60695-11-20, Class 5VB for devices operating from a voltage source greater than 30 V r.m.s. or 42,4 V d.c. and/or consuming more than 15 W of power.

NOTE Verification of conformance to 4.7.2 a) and 4.7.2 b) can be carried out by examination of a Certificate of Conformity or equivalent (see Annex D).

4.7.3 Ingress protection

The degree of protection provided by the enclosure of the v.a.d shall meet the following requirements:

a) for a Type A v.a.d.: Code IP21C of IEC 60529:2001;

b) for a Type B v.a.d.: Code IP33C of IEC 60529:2001;

c) For a Type C v.a.d.: Code IP53C of IEC 60529:2001.

4.7.4 Access

Means shall be provided to limit access for removal of parts or the whole device, e.g. special tool, codes, hidden screws, seals.

4.8 Manufacturer's adjustments

It shall not be possible to change the manufacturer's settings except by special means (e.g. the use of a special code or tool) or by breaking removing a seal.

4.9 On-site adjustment of mode or behaviour

If there is provision for on-site adjustment of the behaviour of the v.a.d.:

a) for each setting at which compliance with this part of ISO 7240 is claimed, the v.a.d. shall comply with the requirements of this part of ISO 7240 and access to the adjustment means shall only be possible by the use of a code or special tool or by removing the v.a.d. from its base or mounting, and

b) any setting(s) at which compliance with this part of ISO 7240 is not claimed, shall only be accessible by the use of a code or special tool and it shall be clearly marked on the v.a.d. or in the associated data that when these setting(s) are used, the v.a.d. does not comply with this part of ISO 7240.

NOTE These adjustments may be carried out at the v.a.d. or at the control and indicating equipment.

4.10 Marking and data

4.10.1 Marking

Each v.a.d. shall be clearly marked with the following information:

a) number of this International Standard (i.e. ISO 7240-23:2012);

b) environment Type [i.e. Type A, Type B or Type C (see definitions in Clause 3)];

c) device class (see 4.2);

d) name or trademark of the manufacturer or supplier;

e) manufacturer or supplier model designation (type or number of the v.a.d.);

f) terminal designations;

g) a mark(s) or code(s) (e.g. serial number or batch code), by which the manufacturer can identify, at least, the date or batch and place of manufacture and the version number(s) of any software contained within the device.

For a detachable v.a.d., the detachable part shall be marked with a), b), c), d), e) and g), and the base shall be marked with, at least e) (i.e. its own model designation) and f).

Where any marking on the device uses symbols or abbreviations not in common use then these shall be explained in the data supplied with the device.

The marking need not be discernible when the device is installed and ready for use but shall be visible during installation and shall be accessible during maintenance.

The markings shall not be placed on screws or other easily removable parts of the device.

4.10.2 Data

The information required in 4.10.1, together with the following, shall be supplied with the device, or shall be given in a data sheet or technical manual identified on, or with each device:

a) rated supply voltages or voltage ranges (a.c. or d.c.);

b) power and current consumption;

c) supply frequency ranges, where relevant;

d) the coverage characteristics:

   1) for class C devices, the information shall clearly show or state:

      i) the maximum allowable height of the device above the floor level, given in metres, i.e. parameter **x** in the class specification as described in 4.2.2,

      ii) the cylindrical volume with its central axis extending vertically downwards from the device,

      iii) the diameter of the above cylindrical volume, given in metres, i.e. parameter **y** in the specification of the class as described in 4.2.2;

   2) for class W devices, the information shall clearly show or state:

      i) the device correct orientation,

      ii) features of the device used to align the device to the orientation given in 4.10.2 d 2) i),

      iii) the maximum allowable mounted height of the device, given in metres, i.e parameter **x** in the specification of the class as described in 4.2.3,

      iv) the cuboid volume with its vertical side equal to the height at which the device is mounted and with the device in the centre of one top edge,

      v) the length of the other two sides of the cuboid, given in metres, i.e. parameter **y** in the specification of the class as described in 4.2.3;

   3) for class O devices, the information shall clearly show or state:

      i) the recommended mounting position of the device,

      ii) any specific requirement for mounting the device in a particular orientation, and how this orientation can be identified on the device,

iii) any restrictions on the minimum and maximum allowable mounted height,

iv) the volumetric shape, its dimensions and how it is related to the device;

e) the light pattern and frequency of flashing;

f) IP Code to IEC 60529:2001;

g) any other information necessary to allow correct installation, operation and maintenance of the device.

4.11 Additional requirements for software controlled visual alarm devices

4.11.1 General

For a v.a.d. which relies on software control in order to fulfil the requirements of this part of ISO 7240, the requirements of 4.11.2, 4.11.3 and 4.11.4 shall be met.

4.11.2 Software documentation

4.11.2.1 The manufacturer shall submit documentation which gives an overview of the software design. This documentation shall be in sufficient detail for the design to be inspected for compliance with this part of ISO 7240 and shall include at least the following:

a) a functional description of the main program flow (e.g. as a flow diagram or structogram) including:

1) a brief description of the modules and the functions that they perform,

2) the way in which the modules interact,

3) the overall hierarchy of the program,

4) the way in which the software interacts with the hardware of the v.a.d.,

5) the way in which the modules are called, including any interrupt processing.

b) a description of which areas of memory are used for the various purposes (e.g. the program, site specific data and running data);

c) a designation, by which the software and its version can be uniquely identified.

4.11.2.2 The manufacturer shall prepare and maintain detailed design documentation. This shall be available for inspection in a manner that respects the manufacturers' rights for confidentiality. It shall comprise at least the following:

a) an overview of the whole system configuration, including all software and hardware components;

b) a description of each module of the program, containing at least:

1) the name of the module,

2) a description of the tasks performed,

3) a description of the interfaces, including the type of data transfer, the valid data range and the checking for valid data;

c) full source code listings, as hard copy or in machine-readable form (e.g. ASCII-code), including all global and local variables, constants and labels used, and sufficient comment for the program flow to be recognized;

d) details of any software tools used in the design and implementation phase (e.g. CASE-tools, compilers).

NOTE This detailed design documentation may be reviewed at the manufacturers' premises.

4.11.3 Software design

In order to ensure the reliability of the v.a.d., the following requirements for the software design shall apply:

a) the design of the interfaces for manually and automatically generated data shall not permit invalid data to cause error in the program operation;

b) the software shall be designed to avoid the occurrence of deadlock of the program flow.

4.11.4 Storage of programme and data

The program necessary to comply with this part of ISO 7240 and any preset data, such as manufacturer's settings, shall be held in non-volatile memory. Writing to areas of memory containing this program and data shall only be possible by the use of some special tool or code and shall not be possible during normal operation of the v.a.d.

Site-specific data shall be held in memory which will retain data for at least two weeks without external power to the v.a.d, unless provision is made for the automatic renewal of such data, following loss of power, within 1 h of power being restored.

4.12 Synchronization — Optional function

Where v.a.d. have a provision for synchronising signals with that of at least one other v.a.d. the maximum difference between v.a.d. shall be less than 0,05 s.

NOTE 1 Light flashing at rates of 3 Hz or more may cause seizure in people with photosensitive epilepsy. To prevent this, the pulse-rate of v.a.d.s placed in the same open space may need to be synchronized.

NOTE 2 This synchronization can be achieved by internal circuitry, the addition of a trigger wire connected between devices or by other means defined by the manufacturer.

When power interruption is used for synchronisation purposes, this shall not adversely affect the visual warning signal.

5 Tests

5.1 General

5.1.1 Atmospheric conditions for tests

Unless otherwise stated in a test procedure, the testing shall be carried out after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing described in IEC 60068-1, as follows:

— temperature: 15 °C to 35 °C;

— relative humidity: 25 % to 75 %;

— air pressure: 86 kPa to 106 kPa.

The temperature and humidity shall be substantially constant for each test where these standard atmospheric conditions are applied.

5.1.2 Operating conditions for tests

If a test method requires a specimen to be giving the visual alarm signal, then the specimen shall be connected to suitable power supply equipment as specified in the data provided by the manufacturer. Where, in order to be giving the visual alarm signal, a v.a.d. also requires the application of a control signal or signals, this shall be provided in accordance with the manufacturer's specification.

If a test method requires a specimen to be in the quiescent state, then the specimen shall not be supplied with power unless it is a v.a.d. of the types which have electronic circuits for analysing control signals and triggering the visual alarm signal, in which case the specimen shall be connected to suitable power supply and control equipment as specified in the data provided by the manufacturer and the control signals shall be arranged so that the specimen is in a non-signalling state.

Unless otherwise specified in the test procedure, the supply parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain constant throughout the tests. The value chosen for each parameter shall be the nominal value, or the mean of the specified range.

If different light levels for operation under different conditions are declared (see 4.10.2), then, unless otherwise specified by the test procedure, the tests shall be conducted under one selected mode of operation only. Selection of the mode of operation shall be made with the aim to use that which consumes the most power. This shall normally be the brightest mode and/or the mode with the highest frequency of flashing.

NOTE All modes of operation and all voltage ranges are tested in 5.4.

5.1.3 Mounting arrangements

Unless otherwise specified, the specimen shall be mounted by its normal means of attachment in accordance with the manufacturer's instructions on a flat rigid backing board. If these instructions describe more than one method of mounting then the method considered to be most unfavourable shall be chosen for each test.

5.1.4 Tolerances

The tolerances for the environmental test parameters shall be given in the basic reference standards for the test (e.g. the relevant part of IEC 60068).

If a specific tolerance or deviation limit is not specified in a requirement or test procedure, then a deviation limit of ± 5 % shall be applied.

5.1.5 Provision for tests

The following shall be provided for testing compliance with this part of ISO 7240:

a) eight specimens of Type A or 10 specimens of Type B or Type C with any mounting, bases, boxes or accessories etc.;

b) any equipment, such as a control and indicating equipment, as may be necessary for the correct operation of the v.a.d. in accordance with the manufacturer's specification;

c) the data required in 4.10.2.

The specimens submitted shall be deemed representative of the manufacturer's normal production with regard to their construction and settings.

The details of the power supply equipment used and/or the equipment used for generating the control signal(s) should be given in the test report.

5.1.6 Test schedule

The specimens shall be tested and inspected according to the schedule given in Table 1.

All the specimens shall be first submitted to the reproducibility test described in 5.2. On completion of the reproducibility test, the specimen with the least bright light level shall be numbered 1 and the rest arbitrarily numbered from 2 to 8 for Type A or 2 to 10 for Type B or for Type C.

Unless otherwise required by the test procedure, the mode of operation selected for conducting the reproducibility test shall be used for the other tests.

Table 1 — Test schedule

Test [c]	Subclause	Specimen No(s) [a, b, c]	
		Type A	Type B/C
Reproducibility	5.2	All	All
Variation of effective luminous intensity	5.3	1	1
Operational performance	5.4	1	1
Durability	5.5	2	2
Dry heat (operational)	5.6	3	3
Dry heat (endurance)	5.7	—	9
Cold (operational)	5.8	3	3
Damp heat, cyclic (operational)	5.9	3	3
Damp heat, steady state (endurance)	5.10	3	3
Damp heat, cyclic (endurance)	5.11	—	10
Sulphur dioxide (SO_2) corrosion (endurance)	5.12	4	4
Shock (operational)	5.13	5	5
Impact (operational)	5.14	6	6
Vibration sinusoidal (operational)	5.15	7	7
Vibration sinusoidal (endurance)	5.16	7	7
EMC, Electrostatic discharge (operational)	5.17 [b]	8	8
EMC, Radiated electromagnetic fields (operational)	5.17 [b]	8	8
EMC, Conducted disturbances induced by electromagnetic fields (operational)	5.17 [b]	8	8
EMC, Voltage transients fast transient bursts (operational)	5.17 [b]	8	8
EMC, Voltage transients slow high energy voltage surge (operational)	5.17 [b]	8	8
Enclosure protection	5.18	1, 2	1, 2
Flash synchronisation testing (optional function)	5.19	1, 2	1, 2

[a] Where a specimen is intended to be used for more than one test and its light output level differs from that measured during the reproducibility test by more than a factor of 2 after one of the tests, a new specimen shall be used for the next test on the schedule for that specimen. The light output level shall be first measured as specified in 5.2.

[b] The EMC tests specified in 5.17 are not required for a v.a.d. which do not rely on active electronic components for their operation.

[c] The tests on an individual specimen may be carried out in any order except that the reproducibility test (5.2) shall be performed first on all specimens and the tests on specimens 1 and 2 shall be carried out in the order listed (i.e. 5.18 last).

5.2 Reproducibility

5.2.1 Object of the test

To show that the light output of the v.a.d. does not vary unduly from specimen to specimen and to establish light output data for comparison with the light output measured during and/or after the environmental tests.

5.2.2 Test procedure

Measure the light output levels of all the specimens as described in Annex B.

Record the measurement for each specimen and designate the light output level of the brightest and the least bright specimen Q_{max} and Q_{min} , respectively.

5.2.3 Test requirements

The ratio of the light output levels Q_{max} : Q_{min} shall not exceed 2.

5.3 Variation of effective luminous intensity

5.3.1 Object of the test

To show that the effective luminous intensity of the v.a.d. does not unduly vary over time.

5.3.2 Test procedure

Mount the specimen as shown in Figure A.2, view C, with an α rotation of 90°. Log the signal received by the light sensor and power the v.a.d. until the stabilization time specified is achieved or for 30 min, whichever is shorter. Determine the effective luminous intensity $I_{eff(av)}$ as described in A.7 after 1 min, 10 min, 20 min and 30 min.

Designate the maximum $I_{eff(av)}$ and the minimum $I_{eff(av)}$, P_{max} and P_{min} respectively.

5.3.3 Test requirements

The ratio of the luminous intensity P_{max} : P_{min} shall be less than 1,33.

5.4 Operational performance

5.4.1 Object of the test

To check that the effective luminous intensity declared can be achieved at the worst case of the specified supply parameters (e.g. voltage) and is not unduly dependent on these parameters.

5.4.2 Test procedure

Measure the effective luminous intensity of the specimen as described in Annex A with the supply parameters set at the minimum of the specified range(s) [see 4.10.2 a) and c)].

If different effective luminous intensities and different flashing frequencies and/or patterns for different modes of operation are declared [see 4.10.2 e)], then the effective luminous intensity of the specimen shall be measured under each mode.

After all the measurements have been made, select the position which produced the highest effective luminous intensity and repeat the measurement for that position with the supply parameters set at the maximum of the specified range(s) [see 4.10.2 a) and c)].

5.4.3 Test requirements

a) the effective luminous intensity obtained by calculation in A.7 shall be greater than 1 cd for 70 % of all the measurement points, and

b) the effective luminous intensity obtained by calculation in A.7 shall not exceed 500 cd, at any measurement point, and

c) the calculated coverage distance at each of the specified angles shall not be less than that required by the class of the v.a.d. declared [see 4.10.2 d)].

5.5 Durability

5.5.1 Object of the test

To show that the light level of the v.a.d. does not change significantly after prolonged operation.

5.5.2 Test procedure

5.5.2.1 Conditioning

Submit the specimen to the following durability cycle 100 times:

— operational condition for 1 h at the maximum of the supply voltage declared [see 4.10.2 a)]; followed by

— non-operational condition for 1 h.

5.5.2.2 Final measurements

Within 1 h of the final period of operation:

a) for v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output of the specimen as described in Annex B.

5.5.3 Test requirements

a) all light sources shall be functioning when checked during final measurements [see 5.5.2.2 a)]; and

b) the light output level measured after 100 durability cycles shall not change by more than 1,5 from that measured, for the same specimen, under the same operating condition, in the reproducibility test (see 5.2).

5.6 Dry heat (operational)

5.6.1 Object of the test

To demonstrate the ability of the v.a.d. to function correctly at high ambient temperatures, which may occur for short periods in the service environment.

5.6.2 Test procedure

5.6.2.1 Reference

Use the test apparatus and perform the procedure specified in IEC 60068-2-2, Test Bb, for non-heat dissipating specimens or Test Bd for heat dissipating specimens, except that the test shall be conducted as specified in Annex B and 5.6.2.2 to 5.6.2.6.

5.6.2.2 Pre-conditioning test

Mount the specimen in the light chamber as specified in Annex B.

Where modifications to the light chamber are necessary in order to heat the chamber, conduct a pre-conditioning measurement of the light output as described in Annex B before the start of conditioning. In this case, the result of this pre-conditioning test shall be used in place of the result obtained during the reproducibility test.

5.6.2.3 State of specimen during conditioning

Maintain the specimen in the quiescent state during the conditioning period except during the last hour when it shall be giving the visual alarm signal (see 5.1.2).

5.6.2.4 Conditioning

Increase the air temperature in the light output test chamber to the test temperature at a rate not exceeding 1° K/min. Apply the following test conditions:

Temperature: (55 ± 2) °C for Type A or (70 ± 2) °C for Type B and Type C;

Duration: 16 h.

5.6.2.5 Measurements during conditioning

Monitor those devices requiring power during the quiescent state (see 5.1.2) for false alarms and fault signals during the conditioning period.

Measure the air temperature of the light test chamber at the location of the v.a.d. and record the measurement.

Measure the light output level as described in Annex B after the first minute of the specimen giving the visual alarm signal.

5.6.2.6 Final measurements

After the recovery period specified in IEC 60068-2-2:

a) for v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.6.2.6 b), or that measured in the reproducibility test if used, Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.6.3 Test requirements

a) No false alarm or fault signals shall be given during the conditioning; and

b) All light sources shall be functioning when checked during final measurements [see 5.6.2.6 a)]; and

c) The ratio of the light output levels $Q_{max} : Q_{min}$ shall not exceed 1,5.

NOTE If the v.a.d. is combined with a heat detector which could operate at (55 ± 2) °C, then the response of the heat detector can be disabled or ignored during the test.

5.7 Dry heat (endurance)

5.7.1 Object of the test

To demonstrate the ability of Type B v.a.d. and Type C v.a.d. to withstand long term ageing effects.

5.7.2 Test procedure

5.7.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-2, Test Bb for non-heat dissipating specimens or Test Bd for heat dissipating specimens, and in 5.7.2.2 to 5.7.2.4.

5.7.2.2 State of the specimen during conditioning

Do not supply the specimen with power during the conditioning.

5.7.2.3 Conditioning

Apply the following test conditioning to the selected Type B or Type C specimen:

— Temperature: (70 ± 2) °C;

— Duration: 21 d.

5.7.2.4 Final measurements

After the recovery period specified in IEC 60068-2-2:

a) for a v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.7.2.4 b), or that measured in the reproducibility test (see 5.2) Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.7.3 Test requirements

a) No false alarm or fault signal attributable to the endurance conditioning shall be given on reconnection of the specimen; and

b) All light sources shall be functioning when checked during final measurements [see 5.7.2.4 a)]; and

c) The ratio of the light output levels $Q_{max} : Q_{min}$ shall not exceed 1,5.

5.8 Cold (operational)

5.8.1 Object of the test

To demonstrate the ability of the v.a.d. to function correctly at low ambient temperatures appropriate to the anticipated service environment.

5.8.2 Test procedure

5.8.2.1 Reference

Use the test apparatus and perform the procedure in IEC 60068-2-1, Test Ab, for non-dissipating specimens, or Test Ad for heat dissipating specimens, except conduct the test in a reverberation chamber as specified in Annex B and in 5.8.2.2 to 5.8.2.6.

5.8.2.2 Pre-conditioning test

Mount the specimen in the light test chamber as specified in Annex B.

Where modifications to the light chamber are necessary in order to cool the chamber, conduct a pre-conditioning measurement of the light output as described in Annex B before the start of conditioning. In this case, this result of this pre-conditioning test shall be used in place of the result obtained during the reproducibility test.

5.8.2.3 State of specimen during conditioning

Maintain the specimen in the quiescent state during the conditioning period except during the last hour when it shall be giving the visual alarm signal (see 5.1.2).

5.8.2.4 Conditioning

Reduce the air temperature in the light output test chamber to the required test temperature at a rate not exceeding 1° K/min. Apply the following test conditioning:

— Temperature: (–10 ± 3) °C for Type A and (–25 ± 3) °C for Type B and Type C;

— Duration: 16 h.

5.8.2.5 Measurements during conditioning

Monitor devices requiring power during the quiescent state (see 5.1.2) for false operation and fault signals.

Measure the air temperature of the light output test chamber at the location of the specimen and log the result.

Measure the light output level as described in Annex B after the first minute of the specimen giving the visual alarm signal (see 5.8.2.3).

5.8.2.6 Final measurements

After the recovery period specified in IEC 60068-2-1:

a) for a v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.8.2.6 b), or that measured in the reproducibility test, if used, Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.8.3 Test requirements

a) No false alarm or fault signals shall be given during the conditioning.

b) All light sources shall be functioning when checked during final measurements [see 5.8.2.6 a)].

c) The ratio of the light output levels Qmax : Qmin shall not exceed 1,5.

5.9 Damp heat, cyclic (operational)

5.9.1 Object of the test

To demonstrate the immunity of the v.a.d. to an environment with high relative humidity, where condensation on the device may occur.

5.9.2 Test procedure

5.9.2.1 Reference

Use the test apparatus and perform the procedures as specified in IEC 60068-2-30 using the Variant 1 test cycle and controlled recovery conditions and in 5.9.2.2 to 5.9.2.5.

5.9.2.2 State of the specimen during conditioning

Maintain the specimen in the quiescent state during the conditioning period except during the last 30 min of the high temperature phase of the last cycle when it shall be giving the visual alarm signal (see 5.1.2).

5.9.2.3 Conditioning

Apply the following conditioning for Type A, Type B and Type C specimens:

— lower temperature: (25 ± 3) °C at > 95 %;

— relative humidity (lower temperature): ≥ 95 %;

— upper temperature: (40 ± 2) °C for Type A or (55 ± 2) °C for Type B and Type C;

— relative humidity (upper temperature): (93 ± 3) %;

— number of cycles: 2.

5.9.2.4 Measurements during conditioning

Except during the final 30 min of conditioning, monitor those devices requiring power during the quiescent state (see 5.1.2) for false operation and fault signals during the conditioning period.

During the final hour of the high temperature phase in the last cycle, check the specimen for visual operation.

5.9.2.5 Final measurements

After the recovery period specified in IEC 60068-2-30:

a) for a v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.9.2.5 b), or that measured in the reproducibility test (see 5.2), Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.9.3 Test requirements

a) Except during the final 30 min of conditioning, no false operation or fault signals shall be given (see 5.9.2.4).

b) All light sources shall be functioning when checked during final measurements [see 5.9.2.5 a)].

c) The ratio of the light output levels $Q_{max} : Q_{min}$ shall not exceed 1,5.

5.10 Damp heat, steady-state (endurance)

5.10.1 Object of the test

To demonstrate the ability of the v.a.d. to withstand the long term effects of humidity in the service environment (e.g. changes in electrical properties due to absorption, chemical reactions involving moisture, galvanic corrosion).

5.10.2 Test procedure

5.10.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-78, Test Cab and in 5.10.2.2 to 5.10.2.4.

5.10.2.2 State of the specimen during conditioning

The specimen shall not be supplied with power during the conditioning.

5.10.2.3 Conditioning

Apply the following conditioning for Type A, Type B and Type C specimens:

— temperature: (40 ± 2) °C;

— relative humidity: (93 ± 3) %;

— duration: 21 d.

5.10.2.4 Final measurements

After the recovery period specified in IEC 60068-2-78, Test Cab:

a) for v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B

Designate the light output measured in 5.10.2.4 b), or that measured in the reproducibility test (see 5.2), Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.10.3 Test requirements

a) No false alarm or fault signal attributable to the endurance conditioning shall be given on reconnection of the specimen;

b) All light sources shall be functioning when checked during final measurements [see 5.10.2.4 a)]; and

c) The ratio of the light output levels Qmax : Qmin shall not exceed 1,5.

5.11 Damp heat, cyclic (endurance)

5.11.1 Object of the test

To demonstrate the ability of Type B v.a.d. and Type C v.a.d. to withstand the longer term effects of high humidity and condensation.

5.11.2 Test procedure

5.11.2.1 Reference

Use the test apparatus and perform the procedure specified in IEC 60068-2-30, using the Variant 1 test cycle and controlled recovery conditions, and in 5.11.2.2 to 5.11.2.4.

5.11.2.2 State of the specimen during conditioning

Do not supply the specimen with power during the conditioning.

5.11.2.3 Conditioning

Apply the following conditioning to Type B and Type C specimens:

— lower temperature: (25 ± 3) °C;

— relative humidity (lower temperature): ≥ 95 %;

— upper temperature: (55 ± 2) °C;

— relative humidity (upper temperature): (93 ± 3) %;

— number of cycles: 6.

5.11.2.4 Final measurements

After the recovery period specified in IEC 60068-2-30:

a) for a v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.11.2.4 b), or that measured in the reproducibility test (see 5.2), Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.11.3 Test requirements

a) No false alarm or fault signal attributable to the endurance conditioning shall be given on reconnection of the specimen;

b) All light sources shall be functioning when checked during final measurements [see 5.11.2.4 a)]; and

c) The ratio of the light output levels Qmax : Qmin shall not exceed 1,5.

5.12 Sulfur dioxide (SO_2) corrosion (endurance)

5.12.1 Object of the test

To demonstrate the ability of the v.a.d. to withstand the corrosive effect of sulfur dioxide as an atmospheric pollutant.

5.12.2 Test procedure

5.12.2.1 Reference

Use the test apparatus and procedure as generally specified in IEC 60068-2-42, Test Kc, except for the relative humidity of the test atmosphere, which shall be maintained at (93 ± 3) % instead of (75 ± 5) %, and in 5.12.2.2 to 5.12.2.4.

5.12.2.2 State of the specimen during conditioning

Do not supply the specimen with power during the conditioning, but equip it with untinned copper wires of the appropriate diameter, connected to a sufficient number of terminals to allow the final measurement to be made without making further connections to the specimen.

5.12.2.3 Conditioning

Apply the following test conditioning to Type A, Type B and Type C specimens:

— temperature: (25 ± 2) °C;

— relative humidity: (93 ± 3) %;

— SO_2 concentration: (25 ± 5) µl/l;

— duration: 21 d.

5.12.2.4 Final measurements

Immediately after the conditioning, subject the specimen to a drying period of 16 h at (40 ± 2) °C, and < 50 % RH, followed by a recovery period of 1 h to 2 h at the standard atmospheric conditions. After the recovery period:

a) for a v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B after the specified recovery period.

Designate the light output measured in 5.12.2.4 b), or that measured in the reproducibility test (see 5.2), Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.12.3 Test requirements

a) No false alarm or fault signal attributable to the endurance conditioning shall be given on reconnection of the specimen;

b) All light sources are functioning when checked during final measurements [see 5.12.2.4 a)] and;

c) The ratio of the light output levels Qmax : Qmin shall not exceed 1,5.

5.13 Shock (operational)

5.13.1 Object of the test

To demonstrate the immunity of the v.a.d. to mechanical shocks, which are likely to occur, albeit infrequently, in the anticipated service environment.

5.13.2 Test procedure

5.13.2.1 Reference

Use the test apparatus and perform the procedure generally as specified in IEC 60068-2-27, Test Ea and in 5.13.2.2 to 5.13.2.5.

5.13.2.2 State of the specimen during conditioning

The specimen shall be mounted on a rigid fixture and maintained in the quiescent state during the conditioning period (see 5.1.2).

5.13.2.3 Conditioning

For Type A, Type B and Type C specimens with a mass ≤ 4,75 kg, apply the following conditioning:

— shock pulse type: half sine;

— pulse duration: 6 ms;

— peak acceleration: $10 \times (100 - 20M)$ m/s^2 (where M is the mass of the specimen in kilograms);

— number of directions: 6;

— pulses per direction: 3.

Do not test specimens with a mass > 4,75 kg.

5.13.2.4 Measurements during conditioning

Monitor the specimen for false operation and fault signals during the conditioning period and a further 2 min after the end of the conditioning period.

5.13.2.5 Final measurements

At the end of the conditioning period and the further 2 min:

a) for a v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.13.2.5 b), or that measured in the reproducibility test (see 5.2), Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.13.3 Test requirements

a) No false operation or fault signals shall be given during the conditioning period, and a further 2 min after the end of the conditioning period (see 5.13.2.4).

b) All light sources shall be functioning when checked during final measurements [see 5.13.2.5 a)].

c) The ratio of the light output levels $Q_{max} : Q_{min}$ shall not exceed 1,5.

5.14 Impact (operational)

5.14.1 Object of the test

To demonstrate the immunity of the v.a.d. to mechanical impacts upon its surface, which it may sustain in the normal service environment, and which it can reasonably be expected to withstand.

5.14.2 Test procedure

5.14.2.1 Reference

Use the test apparatus and procedure described in IEC 60068-2-75, Test Eh for Test Ehb and in 5.14.2.2 to 5.14.2.5.

5.14.2.2 State of the specimen during conditioning

Maintain the specimen in the quiescent state during the conditioning period (see 5.1.2).

5.14.2.3 Conditioning

Apply an impact to each accessible surface of the specimen at any point(s) considered likely to cause damage or to impair the operation of the specimen.

Apply the following test conditioning to Type A, Type B and Type C specimens:

— impact energy: (0,5 ± 0,04) J;

— number of impacts: 3.

5.14.2.4 Measurement during conditioning

Monitor the specimen for false operation and fault signals during the conditioning period and a further 2 min after the end of the conditioning period.

5.14.2.5 Final measurements

At the end of the conditioning period and the further 2 min:

a) for a v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.14.2.5 b), or that measured in the reproducibility test (see 5.2), Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.14.3 Test requirements

a) No false operation or fault signals shall be given during the conditioning period and a further 2 min after the conditioning period (see 5.14.2.4).

b) All light sources shall be functioning when checked during final measurements [see 5.14.2.5 a)].

c) The ratio of the light output levels $Q_{max} : Q_{min}$ shall not exceed 1,5.

5.15 Vibration, sinusoidal (operational)

5.15.1 Object of the test

To demonstrate the immunity of the v.a.d. to vibration at levels considered appropriate to the normal service environment.

5.15.2 Test procedure

5.15.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and in 5.15.2.2 to 5.15.2.5.

5.15.2.2 State of the specimen during conditioning

The specimen shall be mounted on a rigid structure. Apply the vibration in each of three mutually perpendicular axes, in turn. Mount the specimen so that one of the three axes is perpendicular to its normal mounting plane.

Apply the conditioning to the specimen in both the quiescent state and when giving the visual alarm signal (see 5.1.2).

5.15.2.3 Conditioning

Apply the following test conditioning to Type A, Type B and Type C specimens:

— frequency range: (10 to 150) Hz;

— acceleration amplitude: 5 m/s^2 (approximately 0,5 g_n);

— number of axes: 3;

— sweep rate: 1 octave/min;

— number of sweep cycles: 2 /axis.

NOTE The vibration (operational) and vibration (endurance) tests can be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis. It is only necessary to make one final measurement.

5.15.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period for:

a) any false operation or fault signals when in the quiescent state; and

b) any interruption of light output when flashing.

5.15.2.5 Final measurements

At the end of the conditioning period:

a) for a v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.15.2.5 b), or that measured in the reproducibility test (see 5.2), Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.15.3 Test requirements

a) No false operation or fault signals and no interruption of light output shall be given during the conditioning period (see 5.15.2.4).

b) All light sources shall be functioning when checked during final measurements [see 5.15.2.5 a)].

c) The ratio of the light output levels Q_{max} : Q_{min} shall not exceed 1,5.

5.16 Vibration, sinusoidal (endurance)

5.16.1 Object of the test

To demonstrate the ability of the v.a.d. to withstand the long term effects of vibration at levels appropriate to the service environment.

5.16.2 Test procedure

5.16.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc, and in 5.16.2.2 to 5.16.2.4.

5.16.2.2 State of the specimen during conditioning

Mount the specimen on a rigid fixture and apply the vibration in each of three mutually perpendicular axes, in turn. Mount the specimen so that one of the three axes is perpendicular to its normal mounting plane.

The specimen shall not be supplied with power during the conditioning.

5.16.2.3 Conditioning

Apply the following test conditioning to Type A, Type B and Type C specimens:

— frequency range: (10 to 150) Hz;

— acceleration amplitude: 10 m/s^2 (approximately 1,0 g_n);

— number of axes: 3;

— sweep rate: 1 octave/min;

— number of sweep cycles: 20 /axis.

NOTE The vibration operational and endurance tests can be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis. It is only necessary to make one final measurement.

5.16.2.4 Final measurements

At the end of the conditioning period:

a) for a v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.16.2.4 b), or that measured in the reproducibility test (see 5.2), Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.16.3 Test requirements

a) All light sources shall be functioning when checked during final measurements [see 5.16.2.4 a)].

b) The ratio of the light output levels $Q_{max} : Q_{min}$ shall not exceed 1,5.

5.17 Electromagnetic compatibility (EMC), immunity (operational)

5.17.1 Object of the tests

To demonstrate the immunity of the v.a.d. to electromagnetic interference.

5.17.2 Test procedures

5.17.2.1 Reference

Conduct the following EMC, immunity tests as specified in EN 50130-4:

a) electrostatic discharge;

b) radiated electromagnetic fields;

c) conducted disturbances induced by electromagnetic fields;

d) fast transient burst;

e) slow high energy voltage surge.

5.17.2.2 State of the specimen during conditioning

a) For tests a), d) and e) in 5.17.2.1, apply the conditioning to the specimen in the quiescent state.

b) For tests b) and c) in 5.17.2.1, apply the conditioning to the specimen in both the quiescent state and when flashing.

5.17.2.3 Conditioning

Apply the tests conditions specified in EN 50130-4.

5.17.2.4 Measurements during conditioning

During the conditioning period, monitor the specimen for:

a) any false operation or fault signals when in the quiescent state; and

b) any interruption of light output when flashing.

5.17.2.5 Final measurements

After the conditioning period:

a) for a v.a.d. using multiple light sources, verify the functioning of each light source;

b) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.17.2.5 b), or that measured in the reproducibility test (see 5.2), Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.17.3 Test requirements

For these tests the criteria for compliance specified in EN 50130-4 and the following shall apply:

a) no false operation or fault signals and, when giving the visual alarm signal, no interruption of light output shall be detected during the conditioning period (see 5.17.2.4); and

b) all light sources shall be functioning when checked during final measurements [see 5.17.2.5 a)]; and

c) the ratio of the light output levels $Q_{max} : Q_{min}$ shall not exceed 1,5.

5.18 Enclosure protection

5.18.1 Object of the tests

To demonstrate that the degree of protection provided by the enclosure of the v.a.d., with regard to the ingress of solid foreign objects and the harmful effects due to the ingress of water, meets the requirements of 4.7.3.

5.18.2 Enclosure of the v.a.d

For the purpose of this test, the enclosure of the v.a.d. shall be taken as comprising any parts of the outer physical envelope of the device which prevent or restrict access of solid foreign objects to the light source, electronic assembly(ies) and wiring terminals.

NOTE Ingress of liquid inside the enclosure may be possible, but should not adversely affect the operation of the device.

5.18.3 Test procedures

5.18.3.1 Reference

Use the test apparatus and perform the procedures as specified in IEC 60529 and 5.18.3.2 to 5.18.3.5. The following tests shall be conducted:

a) protection against solid foreign objects indicated by the first characteristic numeral;

b) protection against access to hazardous parts indicated by the additional letter;

c) protection against water indicated by the second characteristic numeral.

5.18.3.2 State of the specimen during conditioning

Maintain the specimen in the following state:

a) unpowered during the test for protection against solid foreign objects;

b) unpowered during the test for protection against access to hazardous parts;

c) powered and giving the visual alarm signal during the test for protection against water.

Mount the specimen as specified in IEC 60529 and include all wiring termination boxes which form part of the v.a.d. when installed in accordance to the installation instructions.

5.18.3.3 Conditioning

Apply the test conditions specified in IEC 60529 as follows:

a) Type A specimens: IP21C;

b) Type B specimens: IP33C;

c) Type C specimens: IP53C.

5.18.3.4 Measurements during conditioning

During the conditioning for the test for protection against water, monitor the specimen to check that the v.a.d. continues to give the visual alarm signal, in the selected mode of operation, without interruptions.

5.18.3.5 Final measurements

At the end of the conditioning period for the test for protection against water:

a) examine the specimen for ingress of water inside the enclosure;

b) for a v.a.d. using multiple light sources, verify the functioning of each light source; and

c) measure the light output level of the specimen as described in Annex B.

Designate the light output measured in 5.18.3.5 c), or that measured in the reproducibility test (see 5.2) Q_{max} and Q_{min} for the maximum and minimum light outputs respectively.

5.18.4 Test requirements

a) The specimen shall comply with the acceptance conditions for the test for protection against solid foreign objects of IEC 60529:2001, 13.3;

b) The specimen shall comply with the acceptance conditions for the test against protection against access to hazardous parts of IEC 60529:2001, 15.3,

c) After the conditioning period for the test for protection against water (see 5.18.3.5):

   1) all light sources shall be functioning when checked during final measurements [see 5.18.3.5 b)]; and

   2) the ratio of the light output levels $Q_{max} : Q_{min}$ shall not exceed 1,5, and

   3) no water shall have penetrated the enclosure or, if water has penetrated the enclosure, the device shall incorporate adequate provision for drainage.

5.19 Flash synchronisation testing (optional function)

5.19.1 Object of the test

To demonstrate the ability of a v.a.d. to remain synchronised with at least one other v.a.d. over a 30 min period after power has been applied to the devices.

5.19.2 Test procedure

Place two specimens in adjacent areas that have the same ambient temperature but are separated such that there is no light interaction between each specimen;

Connect each specimen to be tested to suitable power supply equipment (see 5.1.2);

Place identical light sensors at suitable identical distances in front of each specimen under test and connect the light sensors to a dual channel measuring instrument (see Figure 1); and:

a) apply power to the two specimens and if required, apply the control equipment trigger signal;

b) at power on, measure the time between the start of the flashes produced by the two specimens and record the differences between the signals;

c) thereafter and every 5 min, measure the time between the signal given by the two specimens until the specimens have been operating for 30 min;

NOTE If the supply to the devices is interrupted at any point during the 30 min test period, then the test sequence shall be repeated over a new period of 30 min.

Conduct the measurements in 5.19.2 a) to 5.19.2 c) at the minimum and maximum supply parameters declared by the manufacturer.(see 4.10.2 a).

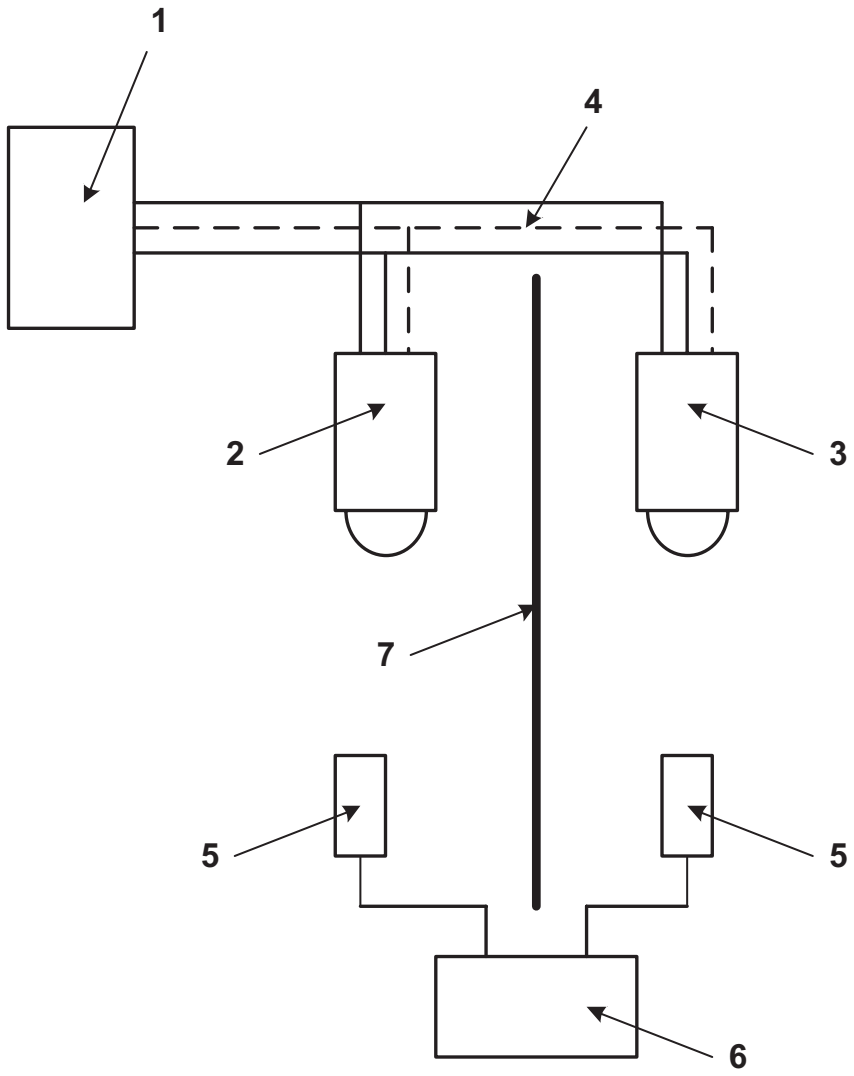
5.19.3 Measurements during conditioning

Measure the time differences between the signals from the two specimens at a representative point in the sequence every 5 min (i.e. six measurements during the conditioning period).

Designate the maximum measured time difference Δt_{MAX}.

5.19.4 Test requirements

At each power supply voltage setting, the maximum time difference, Δt_{MAX}, shall be less than 0,05 s.



Key

1 power supply/control equipment
2 v.a.d. under test No. 1
3 v.a.d. under test No. 2
4 trigger wire (if required)
5 light sensors (x 2)
6 dual channel signal measurement/recording instrument
7 light screen

Figure 1 — Test arrangement for measuring synchronization

6 Test report

The test report shall contain as a minimum the following information:

a) identification of the device tested;

b) reference to this International Standard, i.e. ISO 7240-23:2013;

c) device class;

d) results of the test: the individual response and the minimum, maximum and arithmetic mean values where appropriate;

e) environmental Type (i.e. Type A, Type B or Type C);

f) conditioning period and the conditioning atmosphere;

g) temperature and the relative humidity in the test room throughout the test;

h) details of the supply and monitoring equipment and the alarm criteria;

i) details of any deviation from this part of ISO 7240 or from the International Standards to which reference is made;

j) details of any operations regarded as optional.

Annex A
(normative)

Method for measuring the light distribution from a visual alarm device

A.1 General

Annex A specifies the test method that is referred to in 5.3.2 and 5.4.2.

A.2 Test apparatus

A.2.1 The test apparatus shall comprise two turntables that allow the angle between the specimen and the light sensor to be adjusted to within ± 0,5 degree while maintaining the relative alignment of the optical axes between them.

NOTE Calibration of the test apparatus at regular intervals are needed to ensure that the specified angles (Tables A.2 to A.4) are within the required tolerance.

A.2.2 Rotations about the reference point of the v.a.d. shall be referred to as α rotations (see Figure A.1) and rotations about the normal axis of the v.a.d. as β rotations (see Figure A.2). Figure A.1 shows the positions of the turntables for two different rotations.

A.2.3 For each α rotation, a number of measurements shall be taken by producing regular angular β rotations (see Figure A.2 for examples of β rotations). This results in an even distribution of equally spaced measurements taken over the entire hemispherical area surrounding the v.a.d.

NOTE The number of measurements taken for any v.a.d. increases with its range so as to determine whether the incident light intensity is relatively uniform over the hemisphere at the maximum range.

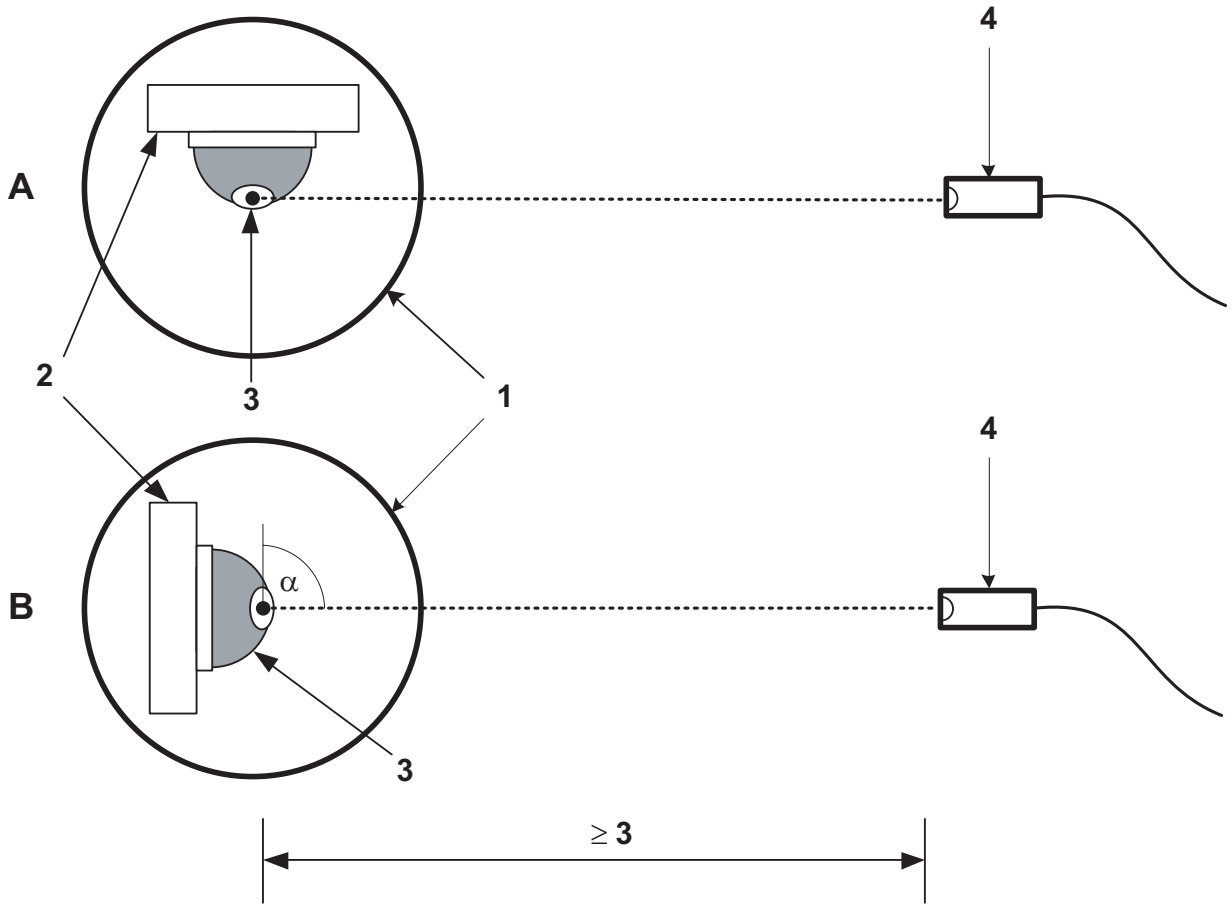
A.3 Instrumentation

A light sensor with an accuracy of ± 5 % shall be used to provide an output proportional to the luminous intensity received. The instrument shall be capable of measuring the effective candela, within the specified accuracy, for the pulse length produced by the unit under test. The transition time of the measuring instrument shall be less than 10 % of the measured pulse. The spectral sensitivity of the sensor shall be adjusted to comply with the CIE standard spectral luminous efficiency function for photopic vision as defined by ISO/CIE 23539:2005.

A.4 Test room

A light output measurement chamber or test room, sufficiently sealed so that external light does not affect the measurements, shall be used. It is not a requirement that the room is completely dark, however, the ambient light shall not be greater than 0,2 lux. Measures shall be taken to minimize reflections.

Dimensions in metres

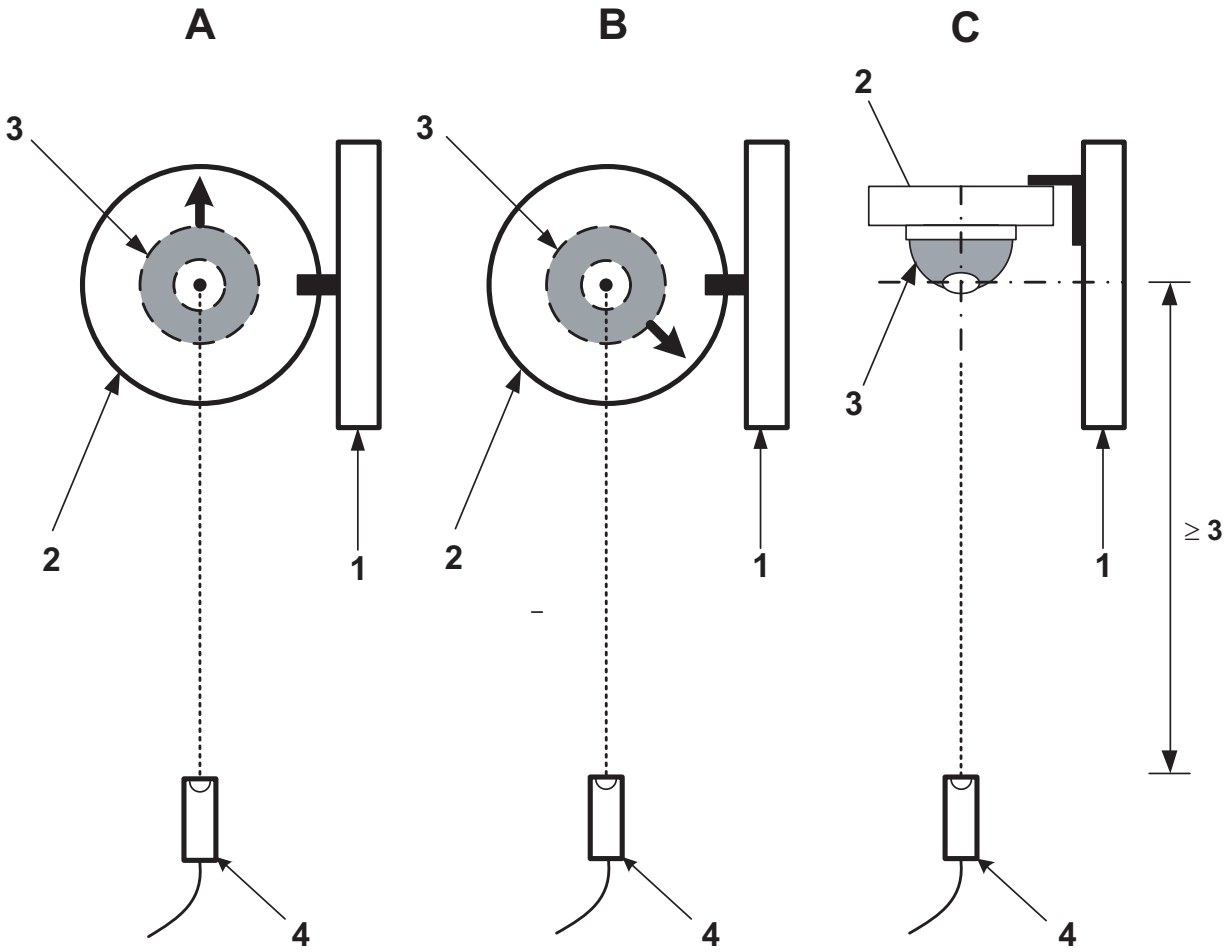


Key

1	turntable for producing α rotations	A	α rotation of 0° about the reference point
2	turntable for producing β rotations	B	α rotation of 90° about the reference point
3	v.a.d		
4	light sensor		

Figure A.1 — Side view indicating α rotations of 0° and 90°

Dimensions in metres



Key

1	turntable for producing α rotations	A	α rotation of 0°, β rotation of 0
2	turntable for producing β rotations	B	α rotation of 0°, β rotation of 135°
3	v.a.d	C	α rotation of 90°
4	light sensor		
5	bracket connecting turnTables A and B		

NOTE The arrowhead shows orientation of v.a.d.

Figure A.2 — Top view indicating β rotations of 0° and 135° and α rotation of 90°

A.5 Arrangement for measuring the effective luminous intensity

A.5.1 The distance between the reference point of the specimen under test and the light sensor shall be at least 3 m. All rotations shall take place about the reference point of the specimen.

NOTE 1 The measuring distance chosen depends on the sensitivity and the dynamic range of the sensor and the distance at which the v.a.d. can be considered a point source. The optimum distance can be determined by the testing laboratory.

NOTE 2 The zero degree position for β rotations can be determined by the testing laboratory and should be recorded.

A.5.2 The number of measurements taken for any v.a.d. shall be determined by the maximum range at which the manufacturer claims to meet the required illumination on all surfaces perpendicular to the direction of the light emitted from the device. The required measurements are summarized in Table A.1 and the specified measurements for each range are shown in Tables A.2, A.3 and A.4.

A.5.3 Measurements shall be made of the average effective luminous intensity in accordance with A.7 and the coverage distance shall be calculated as in A.8 for each measurement point.

Table A.1 — Summary of measurements for different ranges

Manufacturers maximum range m	**α plane spacing** degree (°)	**Total No. of α planes**	**Total number of measurement points**	
			C devices (hemisphere) (see 4.2.2)	**W devices** (half-hemisphere) (see 4.2.3)
< 10	15	7	107	60
10-17	10	10	227	123
> 17	5	19	871	454

Table A.2 — Measurements for a v.a.d. with range < 10 m

Plane No.	**α value for plane** degree (°)	**Value of each β rotation** [a] degree (°)	**Total number of β measurements for α layer**	
			C devices (hemisphere) (see 4.2.2)	**W devices** (half-hemisphere) (see 4.2.3)
1	0	15	24	13
2	15	15	24	13
3	30	16,36	22	12
4	45	20	18	10
5	60	30	12	7
6	75	60	6	4
7	90	N/A	1	1
		Total	**107**	**60**

[a] The value of each β rotation angle (column 3) is calculated so that, after the corresponding number of measurement points have been made, the v.a.d. rotates 360°degree for C devices or 180° for W devices.

Table A.3 — Measurements for a v.a.d. with range 10 m - 17 m

Plane No.	α value for plane degree (°)	Value of each β rotation [a] degree (°)	Total number of β measurements for α layer	
			C devices (hemisphere) (see 4.2.2)	W devices (half-hemisphere) (see 4.2.3)
1	0	10	36	19
2	10	10	36	19
3	20	10,59	34	18
4	30	11,25	32	17
5	40	12,86	28	15
6	50	15	24	13
7	60	20	18	10
8	70	30	12	7
9	80	60	6	4
10	90	N/A	1	1
		Total	**227**	**123**

[a] The value of each β rotation angle (column 3) is calculated so that, after the corresponding number of measurement points have been made, the v.a.d. rotates 360° for C devices or 180° for W devices.

Table A.4 — Measurements for a v.a.d. with range > 17 m

Plane No.	α value for plane degree (°)	Value of each β rotation [a] degree (°)	Total number of β measurements for α layer	
			C devices (hemisphere) (see 4.2.2)	W devices (half-hemisphere) (see 4.2.3)
1	0	5	72	37
2	5	5	72	37
3	10	5	72	37
4	15	5,14	70	36
5	20	5,29	68	35
6	25	5,45	66	34
7	30	5,81	62	32
8	35	6	60	31
9	40	6,43	56	29
10	45	6,92	52	27
11	50	7,83	46	24
12	55	8,57	42	22
13	60	10	36	19
14	65	12	30	16
15	70	13,85	26	14
16	75	18	20	11
17	80	25,71	14	8

[a] The value of each β rotation angle (column 3) is calculated so that, after the corresponding number of measurement points have been made, the v.a.d. rotates 360° for C devices or 180° for W devices.

Table A.4 *(continued)*

Plane No.	α value for plane degree (°)	Value of each β rotation [a] degree (°)	Total number of β measurements for α layer	
			C devices (hemisphere) (see 4.2.2)	**W devices** (half-hemisphere) (see 4.2.3)
18	85	60	6	4
19	90	N/A	1	1
		Total	**871**	**454**

[a] The value of each β rotation angle (column 3) is calculated so that, after the corresponding number of measurement points have been made, the v.a.d. rotates 360° for C devices or 180° for W devices.

A.6 Test procedure

Mount the specimen to be tested on the test apparatus as described in A.2 and place the apparatus and specimen in a light output measuring chamber or test room as described in A.4.

Following the arrangements described in A.5, measure the effective luminous intensity in a hemisphere, so as to determine its light distribution.

Allow the v.a.d. to stabilize for a period of 1 min or as specified by the manufacturer before the start of the test and ensure the v.a.d. is not switched off before the end of the test.

A.7 Calculation of I_{eff} (av)

The effective luminous intensity (I_{eff}), expressed in candela (cd), shall be calculated for each pulse measured using the following Blondel-Rey formula:

$$I_{eff} = \frac{\int_{t_1}^{t_2} I(t)dt}{a+(t_2-t_1)}$$

where:

$I(t)$ is the instantaneous value in candela (cd);

a = 0,2 s;

$t_2 - t_1$ is the light pulse duration as measured between the 10 % of peak amplitude for the leading and trailing edges of the pulse.

For each measurement point the average value, I_{eff}(av), of 10 measured light pulses shall be calculated.

A.8 Calculation of coverage distance

Calculate the distance d, in metres, for each point at which the illumination reduces to 0,4 lm/m^2 using the following formula:

$$d = \sqrt{\frac{I_{\text{eff}}(\text{av})}{0{,}4}}$$

where:

$I_{eff}(av)$ is the average effective luminous intensity in candela (lm/sr) as calculated in A.7;

0,4 is the luminance in lm/m^2 (lux).

Annex B
(normative)

Comparative light output level measurement for visual alarm devices

B.1 General

Annex B specifies the test methods that are referred to in 5.2.2, 5.5.2, 5.6.2, 5.7.2, 5.8.2, 5.9.2, 5.10.2, 5.11.2, 5.12.2, 5.13.2, 5.14.2, 5.15.2, 5.16.2, 5.17.2 and 5.18.3.

The purpose for measuring the light output level is so that comparative assessments can be made of the performance of the v.a.d. before, during and following the environmental conditioning specified in this part of ISO 7240.

NOTE The v.a.d. light output level is measured by recording the level of illumination it produces inside an integrating test chamber.

B.2 Light test chamber

An integrating light test chamber shall be used for the measurements. As the measurements are for comparative purposes, it is not necessary that the size of the chamber is precisely specified. The dimensions of the test chamber shall, however, remain constant throughout the test programme. Annex C gives further information for the construction of a possible light test chamber.

The test chamber shall include a screen the size and position of which shall be designed so that no direct illumination is received by the light sensor. The size and positioning of this screen, in relation to the size of the test chamber, shall be such as to allow sufficient reflected light to reach the sensor.

The test chamber shall be sufficiently sealed so that external light does not affect the measurements. It is not a requirement that the chamber should be completely dark – a small amount of light (e.g. 0,2 lux) may be allowed, however, the background light shall be consistent for all measurements. The inside surfaces of the chamber including the screen shall be coated with a matt reflecting material that is capable of withstanding temperature in the range –25 °C to +70 °C.

Provisions shall be made to heat or cool the air within the chamber during hot and cold tests. Means shall be provided for measuring the interior air temperature in the test chamber.

The same test chamber and the same mounting conditions shall be used for all tests and shall be carried out on all the specimens.

B.3 Calibration of the light test chamber

An initial check of the overall reflectance of the light test chamber shall be made as described below.

A stable light source incorporating a vacuum filament lamp of concentrating type and with no backward light is positioned at the location of the v.a.d. in the light test chamber. Readings of the light output shall be taken using the light sensor. Before commencing this test one screen size and position should be found so that, when viewed from the location of the light sensor all luminous parts of the light source being measured are just screened. The light source shall be allowed to stabilize for a period of 5 min. Readings shall be taken in four orientations with the light source rotated 90° every time.

No reading shall deviate by more than ± 5 % from the average of all the readings.

B.4 Mounting arrangements

Mount the v.a.d. to be tested rigidly by its normal means (see 5.1.3). Rigidly mount the light sensor and screen to ensure consistency of test results.

B.5 Measurement of effective average illumination

Apply power to the v.a.d. during the test such that the v.a.d. emits an alarm signal for at least 1 min, unless otherwise specified in this part of ISO 7240, before any measurements of the light output are made.

The light sensor shall be as described in A.3.

Calculate the effective illumination, E_{eff}, expressed in lm/m^2, for each pulse measured using the following Blondel-Rey formula:

$$E_{eff} = \frac{\int_{t_1}^{t_2} E(t)dt}{a+(t_2-t_1)}$$

where:

$E(t)$ is the instantaneous value in lm/m^2;

a = 0,2 s;

$t_2 - t_1$ is the light pulse duration as measured between the 10 % of peak amplitude for the leading and trailing edges of the pulse.

For each measurement point calculate the average value, E_{eff} (av), using 10 measured light pulses.

NOTE For tests conducted at high or low temperatures, it may be necessary to adjust the light output measured in order to compensate for variations in the sensitivity of the light sensor at the test temperature.

Annex C
(informative)

Construction of the light test chamber and associated equipment for comparative measurements

C.1 Light test chamber

Annex C gives further information on the construction of the light test chamber specified in B.2.

The test chamber should be a cuboid shape with the internal edges chamfered which experience has shown to give satisfactory results. An example of a suitable light test chamber is shown in Figure C.1.

The length of the cuboid should be at least three times the maximum distance from the mounting surface to the front face of the v.a.d. to be accommodated. The width and height of the cuboid should be equal to 0,6 of its length and should be at least three times the largest dimension of the v.a.d. luminous surface.

EXAMPLE A light test chamber measuring (600 × 360 × 360) mm will be adequate for testing devices measuring up to 200 mm between mounting base and front face.

The light screen between the light measuring sensor and the v.a.d. under test should have a diameter K, in metres (m) such that:

$$\frac{W}{6} + 3S \leq K \leq \frac{W}{3}$$

where:

W is the width of the test chamber expressed in metres (m);

S is the diameter of the receiving area of the light sensor expressed in metres (m).

It is recommended that the projection of the chamfer onto the internal surfaces of the cuboid should be 1/12 of its width, W (see Figure C.2).

It should be easy to mount and remove the test specimen without soiling the interior of the test chamber.

Supports inside the test chamber should present as little obstruction as is necessary to provide adequate strength for holding the device being tested, the light sensor and the screen in the specified positions. All exposed components inside the chamber except the device under test should be matt white.

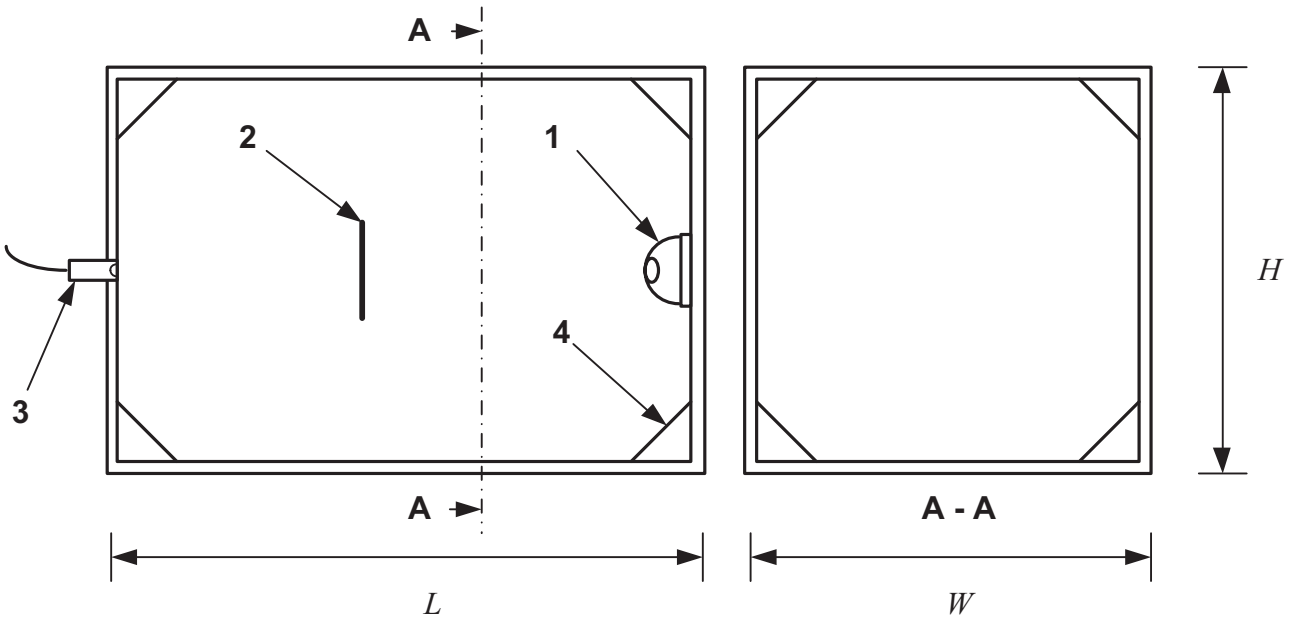
C.2 Surface finishes

All internal surfaces should preferably be matt white, substantially non-selective, (non-fluorescent when exposed to ultraviolet radiation) and with high reflectance, e.g. over 0,85.

It is important that the reflecting surfaces should not be impaired by the method of cleaning. It is recommended that the finish is renewed regularly in accordance with checks made with a gloss meter (see ISO 2813). The average reflectance of each of the six surfaces should not be allowed to fall by more than 10 % from its original value, and the average reflectance of any one surface should be within 5 % of that of any other surface.

At regular intervals during service, the reflecting surfaces should be renewed and, following this, the response of the photocell should be checked as described above. From time to time, the value of light

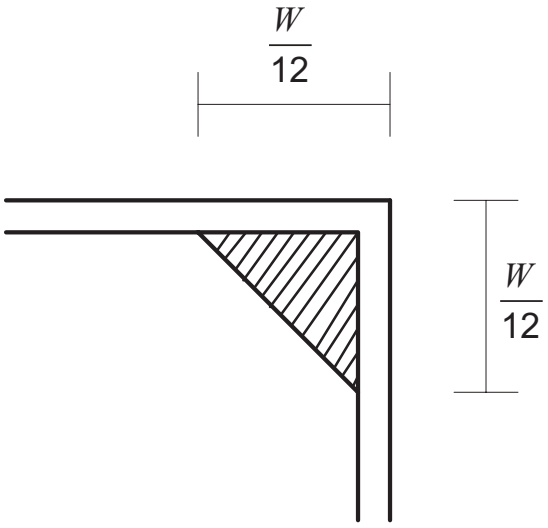
output obtained using this test should be compared with previously obtained values. The changes over time should not exceed ±5 %.



Key

1	v.a.d. under test	*L*	length of test chamber
2	screen	*W*	width of test chamber
3	light sensor	*H*	height of test chamber
4	chamfered edges		

Figure C.1 — Example of light test chamber for comparative measurements



Key

W width of test chamber

Figure C.2 — Details of internal chamfer for the light test chamber

Annex D
(informative)

Comparison of flammability test requirements

D.1 Introduction

This annex is intended to give information on the test requirements for the flammability of plastics (see 4.7.2) given in some relevant standards. In particular, it gives a comparison of flammability ratings between UL 94 and relevant IEC international standards.

D.2 Relevant standards

The following standards are covered in this annex:

— IEC 60695-11-10;

— IEC 60695-11-20:1999/A1:2003;

— UL 94, Edition 5:1996.

The test apparatus, conditioning applied, number of specimens, size of the specimens and procedure for the horizontal and vertical tests are very similar between UL 94 and IEC 60695-11-10. The number of specimens specified in UL 94 is less than that specified in IEC 60695-11-10.

A.1 Vertical burning tests

For the vertical burning test, the categories given in Table D.1 can be regarded as being similar.

Table D.1 — Equivalence of flammability categories between IEC 60695-11-10 and UL 94

EN 60695-11-10	**UL 94 categories**
V-0	V-0
V-1	V-1
V-2	V-2

A.2 Horizontal burning tests

A.2.1 IEC 60695-11-10 and UL 94

The classification for the horizontal burning tests differs between IEC 60695-11-10 and UL 94 making a direct comparison difficult. To assist in such a comparison, the performance criteria for each standard are given in Tables D.2 and D.3.

Table D.2 — Horizontal flammability classification in IEC 6095-11, 10

HB	HB40	HB75
The test specimens do not visibly burn with a flame after the ignition source is removed.	The test specimens do not visibly burn with a flame after the ignition source is removed.	If the flame front passes the 100 mm mark, the test specimens do not have a linear burning rate exceeding 75 mm/min,
If the test specimens continue to burn with a flame after removal of the ignition source, the flame is less than 100 mm.	If the test specimens continue to burn with a flame after removal of the ignition source, the flame is less than 100 mm.	
If the flame front exceeds 100 mm, the linear burning rate of the specimens is less than 40 mm/min for a thickness of 3,0 mm to 13,0 mm or less than 75 mm/min for a thickness of less than 3,0 mm.	If the flame front exceeds 100 mm, the linear burning rate of the specimens is less than 40 mm/min.	
If the linear burning rate does not exceed 40 mm/min for tests with 3,0 mm ± 0,2 mm thickness, the specimen is automatically accepted down to a 1,5 mm minimum thickness		

Table D.3 — Horizontal flammability classification in UL 94

HB
-for specimens having a thickness of 3,0 mm to 13,0 mm, the burning rate shall not exceed 40 mm/min over a 75 mm span, or -for specimens having a thickness less than 3,0 mm, the burning rate shall not exceed 75 mm/min over a 75 mm span, or -the specimens cease to burn before the flame exceeds 100 mm.

A.2.2 IEC 60695-11-20 and UL 94

For the horizontal burning test, the categories given in Table D.4 can be regarded as being similar.

Table D.4 — Equivalence of flammability categories between IEC 60695-11-20 and UL 94

IEC 60695-11-20	**UL 94**
5VA	94-5VA
5VB	94-5VB

Bibliography

[1] ISO 8201, *Acoustics — Audible emergency evacuation signal*

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