INTERNATIONAL STANDARD

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Fire detection and alarm systems —

Part 5: **Point-type heat detectors**

Systèmes de détection et d'alarme d'incendie —

Partie 5: Détecteurs de chaleur de type ponctuel

Reference number
ISO 7240-5:2012(E)

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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 7240-5 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

This second edition cancels and replaces the first edition (ISO 7240-5:2003), which has been technically revised. It also incorporates ISO 7240-5:2003/Cor1:2005.

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 Report]

— *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*

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— *Part 19: Design, installation, commissioning and service of sound systems for emergency purposes*
— *Part 20: Aspirating smoke detectors*
— *Part 21: Routing equipment*
— *Part 22: Smoke-detection equipment for ducts*
— *Part 24: Sound-system loudspeakers*
— *Part 25: Components using radio transmission paths*
— *Part 27: Point-type fire detectors using a scattered-light, transmitted-light or ionization smoke sensor, an electrochemical-cell carbon-monoxide sensor and a heat sensor*
— *Part 28: Fire protection control equipment*

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Introduction

This part of ISO 7240 is based on a draft prepared by European Standards Technical Committee CEN/TC72 “*Fire detection and fire alarm systems*”.

A fire detection and alarm system is required to function satisfactorily, not only in the event of a fire, but also during and after exposure to conditions likely to be met in practice, such as corrosion, vibration, direct impact, indirect shock and electromagnetic interference. Some tests specified are intended to assess the performance of the heat detectors under such conditions.

The performance of heat detectors is assessed from the results obtained in specific tests. This part of ISO 7240 is not intended to place any other restrictions on the design and construction of such heat detectors.

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Fire detection and alarm systems —

Part 5:
Point-type heat detectors

1 Scope

This part of ISO 7240 specifies requirements, test methods and performance criteria for point-type heat detectors for use in fire detection and fire alarm systems for buildings (see ISO 7240-1).

For other types of heat detector, or for detectors intended for use in other environments, this part of ISO 7240 should only be used for guidance. This part of ISO 7240 is not applicable to heat detectors with special characteristics and developed for specific risks.

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 209, *Aluminium and aluminium alloys — Chemical composition*

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

EN 50130-4, *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*

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

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

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

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

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

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

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

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

3 Terms and definitions

For the purposes of this document, the following definitions and those given in ISO 7240-1 apply:

3.1
typical application temperature
temperature that an installed detector may be expected to experience for long periods of time in the absence of a fire condition

NOTE This temperature is deemed to be 29 °C below the minimum static response temperature, according to the class marked on the detector, as specified in Table 1.

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3.2
maximum application temperature
maximum temperature that an installed detector may be expected to experience, even for short periods of time, in the absence of a fire condition

NOTE This temperature is deemed to be 4 °C below the minimum static response temperature, according to the class marked on the detector, as specified in Table 1.

3.3
static response temperature
temperature at which the detector would produce an alarm signal if subjected to a vanishingly small rate of rise of temperature

NOTE Rates of rise of temperature of approximately 0,2 K min^{-1} are normally found to be suitable for measuring this, however, lower rates may be required in some instances (see 5.3).

4 General requirements

4.1 Compliance

In order to comply with this part of ISO 7240, the detector shall meet the requirements of this clause, which shall be verified by visual inspection or engineering assessment, shall be tested as specified in Clause 5, and if applicable Clause 6, and shall meet the requirements of the tests in accordance with its marked class(es).

4.2 Classification

Detectors shall conform to one or more of the following Classes: A1, A2, B, C, D, E, F or G, according to the requirements of the tests specified in Clause 5 (see Table 1).

Table 1 — Detector classification temperatures

Detector Class	Typical application temperature °C	Maximum application temperature °C	Minimum static response temperature °C	Maximum static response temperature °C
A1	25	50	54	65
A2	25	50	54	70
B	40	65	69	85
C	55	80	84	100
D	70	95	99	115
E	85	110	114	130
F	100	125	129	145
G	115	140	144	160

Manufacturers may optionally give additional information concerning the type of response exhibited by the detector, by adding the suffix S or R to the above classes. Detectors, which are marked with the letter S or R as a suffix to the class marking, shall be tested in accordance with the applicable test specified in Clause 6, and shall meet the requirements of that test, in addition to the tests of Clause 5.

NOTE Detectors with a suffix S to their class, do not respond below the minimum static response temperature applicable to their classification (see Table 1), even at high rates of rise of air temperature. Detectors with a suffix R to their class, incorporate a rate-of-rise characteristic, which meets the response time requirements (see Table 4) for high rates of rise of air temperature even when starting at air temperatures substantially below the typical application temperature.

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4.3 Position of heat sensitive elements

Each detector shall be constructed such that at least part of its heat sensitive element(s), except elements with auxiliary functions (e.g. characteristic correctors), shall be ≥ 15 mm from the mounting surface of the detector.

4.4 Individual alarm indication

Class A1, A2, B, C or D detectors shall be provided with an integral red visual indicator, by which the individual detector which released an alarm, may be identified, until the alarm condition is reset. Where other conditions of the detector may be visually indicated, they shall be clearly distinguishable from the alarm indication, except when the detector is switched into a service mode.

For detachable detectors, the indicator may be integral with the base or the detector head.

The visual indicator shall be visible from a distance of 6 m at an angle of up to 5° from the axis of the detector in any direction, in ambient light intensity up to 500 lx.

Class E, F or G detectors shall be provided with either an integral red indicator, or with another means for locally indicating the alarm status of the detector.

NOTE The alarm condition is reset manually at the control and indicating equipment (See ISO 7240-2).

The visual indicator shall be visible from a distance of 6 m in an ambient light intensity up to 500 lx at an angle of up to:

a) 5° from the axis of the detector in any direction, and

b) 45° from the axis of the detector in at least one direction.

4.5 Connection of ancillary devices

Where the detector provides for connections to ancillary devices (e.g. remote indicators, control relays), open- or short-circuit failures of these connections shall not prevent the correct operation of the detector.

4.6 Monitoring of detachable detectors

For detachable detectors, a means shall be provided for a remote monitoring system (e.g. the control and indicating equipment) to detect the removal of the head from the base, in order to give a fault signal.

4.7 Manufacturer’s adjustments

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

4.8 On-site adjustment of response behaviour

If there is provision for on-site adjustment of the response behaviour of the detector, then:

a) for each setting at which the manufacturer claims compliance with this part of ISO 7240, he shall declare a corresponding class, and for each such setting, the detector shall comply with the requirements of this part of ISO 740 for the corresponding class, and access to the adjustment means shall only be possible by the use of a code or special tool or by removing the detector from its base or mounting;

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

These adjustments may be carried out at the detector or at the control and indicating equipment.

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4.9 Marking

Each detector shall be clearly marked with the following information:

a) reference to this part of ISO 7240, i.e. ISO 7240-5:2012;

b) class(es) of the detector (e.g. A1, A1R, A1S, A2, B etc.). If the detector has provision for on-site adjustment of the class (see 4.8), then the marking of the class may be replaced by the symbol P;

c) name or trademark of the manufacturer or supplier;

d) model designation (type or number);

e) wiring terminal designations;

f) some 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 detector.

For detachable detectors, the detector head shall be marked with a), b), c), d) and f), and the base shall be marked with, at least d), i.e. its own model designation, and e).

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

The marking shall be visible during installation of the detector and shall be accessible during maintenance.

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

4.10 Data

Detectors shall either be supplied with sufficient technical, installation and maintenance data to enable their correct installation and operation or, if all of this data is not supplied with each detector, reference to the appropriate data sheet(s) shall be given on, or with each detector.

To enable correct operation of the detectors, this data should describe the requirements for the correct processing of the signals from the detector. This may be in the form of a full technical specification of these signals, a reference to the appropriate signalling protocol or a reference to suitable types of control and indicating equipment etc.

For detectors with provision for on-site adjustment of their class, this data shall identify the applicable classes and shall describe the method of programming (e.g. by selecting a switch position on the detector or a setting from a menu in the control and indicating equipment).

NOTE Additional information may be required by organizations certifying that detectors conform to the requirements of this part of ISO 7240.

4.11 Requirements for software controlled detectors

4.11.1 General

For detectors which rely 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:

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

   1) 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 detector;

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

b) description of those areas of memory used for each purpose (e.g. the program, site-specific data and running data);

c) 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 (CASE-tools, compilers etc).

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

4.11.3 Software design

In order to ensure the reliability of the detector, the following requirements for software design apply:

a) The software shall have a modular structure;

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

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

4.11.4 Storage of programs 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 be possible only by the use of some special tool or code and shall not be possible during normal operation of the detector.

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

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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, as specified in IEC 60068-1, as follows:

— temperature: (15 to 35) °C;

— relative humidity: (25 to 75) %;

— air pressure: (86 to 106) kPa.

If variations in these parameters have a significant effect on a measurement, then such variations should be kept to a minimum during a series of measurements carried out as part of one test on one specimen.

5.1.2 Operating conditions for tests

If a test method requires a specimen to be operational, then the specimen shall be connected to suitable supply and monitoring equipment with characteristics as required by the manufacturer’s data. Unless otherwise specified in the test method, the supply parameters applied to the specimen shall be set within the manufacturer’s specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value, or the mean of the specified range. If a test procedure requires a specimen to be monitored to detect any alarm or fault signals, then connections shall be made to any necessary ancillary devices, e.g. through wiring to an end-of-line device for conventional detectors, to allow a fault signal to be recognized.

The details of the supply and monitoring equipment and the alarm criteria used should be given in the test report.

5.1.3 Mounting arrangements

The specimen shall be mounted by its normal means of attachment in accordance with the manufacturer’s instructions. 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

5.1.4.1 Unless otherwise stated, the tolerances for the environmental test parameters shall be as given in the basic reference standards for the test, e.g. the relevant part of IEC 60068.

5.1.4.2 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 Measurement of response time

The specimen for which the response time is to be measured shall be mounted in a heat tunnel, as specified in 5.1.3 and Annex A. It shall be connected to suitable supply and monitoring equipment in accordance with 5.1.2. The orientation of the specimen, relative to the direction of airflow, shall be that which gave the maximum response time in the directional dependence test of 5.2, unless otherwise specified.

Before the measurement, the temperature of the air stream and the specimen shall be stabilized to the temperature specified in the applicable test procedure. The measurement is then made by increasing the air temperature in the heat tunnel, linearly with respect to time, at the rate of rise specified in the applicable test procedure, until the supply and monitoring equipment indicates an alarm or until the upper limit of response time for the test is exceeded. During the measurement, the air flow shall be maintained at a constant mass flow, equivalent to (0,8 ± 0,1) m/s at 25 °C, and the air temperature shall be controlled to within ± 2 K of the nominal

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temperature required at any time during the test (see Annex A). The response time is the time interval between the start of the temperature increase and the indication of an alarm from the supply and monitoring equipment.

Linear extrapolation of the stabilized and the increasing temperature against time lines may be used to establish the effective start time of the temperature increase.

Care should be taken not to subject detectors to a damaging thermal shock when transferring them to and from a stabilization or alarm temperature.

NOTE Details and information concerning the design of the heat tunnel are given in Annexes A and B.

5.1.6 Provision for tests

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

— For resettable detectors: 15 detectors;

— For non-resettable detectors: 62 detectors;

— For non-resettable suffix S detectors: 63 detectors;

— For non.resettable suffix R detectors: 68 detectors;

— The data required in 4.10.

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

5.1.7 Test schedule

Resettable specimens shall be arbitrarily numbered 1 to 15 by the testing organization and tested according to the test schedule in Table 2.

For detectors with provision for on-site adjustment of their class:

a) tests in accordance with 5.3, 5.4, 5.5, 5.6, 5.8, 6.1 and 6.2 shall be applied for each applicable class;

b) the test in accordance with 5.10 shall be applied for the class with the highest temperature rating;

c) all other tests shall be applied for at least one class.

Non-resettable specimens shall be arbitrarily numbered 1 to 62, 1 to 63, or 1 to 68 according to class, by the testing organization and tested according to the test schedule in Table 3.

Table 2 — Test schedule for resettable detectors

Test	Sub clause	Specimen number(s)							
		Rate of rise of air temperature (K min^{-1})							
		≤ 0,2	1	3	5	10	20	30	Plunge
Directional dependence	5.2					1			
Static response temperature	5.3	1, 2							
Response times from typical application temperature	5.4		1, 2	1, 2	1, 2	1, 2	1, 2	1, 2	
Response times from 25 °C	5.5			1			1		
Response times from high ambient temperature	5.6			1			1		
Variation in supply parameters	5.7			1, 2			1, 2		
Reproducibility (response times before environmental tests)	5.8			3 to 15			3 to 15		

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Table 2 *(continued)*

Test	Sub clause	Specimen number(s) Rate of rise of air temperature (K min^{-1})							
		≤ 0,2	1	3	5	10	20	30	Plunge
Cold (operational)	5.9			3			3		
Dry heat (endurance)	5.10			4			4		
Damp heat, cyclic (operational)	5.11			5			5		
Damp heat, steady-state (endurance)	5.12			6			6		
Sulfur dioxide SO_2 corrosion (endurance)	5.13			7			7		
Shock (operational)	5.14			8			8		
Impact (operational)	5.15			9			9		
Vibration, sinusoidal (operational)	5.16			10			10		
Vibration, sinusoidal (endurance)	5.17			10			10		
Electrostatic discharge (operational)	5.18			11[a]			11[a]		
Radiated electromagnetic fields (operational)	5.18			12[a]			12[a]		
Conducted disturbances induced by electromagnetic fields (operational)	5.18			13[a]			13[a]		
Fast transient burst (operational)	5.18			14[a]			14[a]		
Slow high-energy voltage surge (operational)	5.18			15[a]			15[a]		
Additional test for suffix S detectors	6.1								1
Additional test for suffix R detectors	6.2					1, 2	1, 2	1, 2	

[a] In the interest of test economy, it is permitted to use the same specimen for more than one EMC test. In that case, intermediate functional test(s) on the specimen(s) used for more than one test can be substituted by a simple check that the specimen is still capable of raising an alarm, and the full functional test conducted at the end of the sequence of tests. However, it should be noted that in the event of a failure, it may not be possible to identify which test exposure caused the failure.

Table 3 — Test schedule for non-resettable detectors

Test	Sub clause	Specimen number(s) Rate of rise of air temperature (K min^{-1})							
		≤ 0,2	1	3	5	10	20	30	Plunge
Directional dependence	5.2					1 to 8			
Static response temperature	5.3	9, 10							
Response times from typical application temperature	5.4		11, 12	13, 14	15, 16	17, 18	19, 20	21, 22	
Response times from 25 °C	5.5			23			24		
Response times from high ambient temperature	5.6			25			26		
Variation in supply parameters	5.7			27, 28			29, 30		
Reproducibility (response times before environmental tests)	5.8			31, 32			33, 34		
Cold (operational)	5.9			35			36		
Dry heat (endurance)	5.10			37			38		
Damp heat, cyclic (operational)	5.11			39			40		
Damp heat, steady-state (endurance)	5.12			41			42		

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Table 3 *(continued)*

Test	Sub clause	Specimen number(s)							
		Rate of rise of air temperature (K min^{-1})							
		≤ 0,2	1	3	5	10	20	30	Plunge
Sulfur dioxide SO_2 corrosion (endurance)	5.13			43			44		
Shock (operational)	5.14			45			46		
Impact (operational)	5.15			47			48		
Vibration, sinusoidal (operational)	5.16			49			50		
Vibration, sinusoidal (endurance)	5.17			51			52		
Electrostatic discharge (operational)	5.18			53[a]			54[a]		
Radiated electromagnetic fields (operational)	5.18			55[a]			56[a]		
Conducted disturbances induced by electromagnetic fields (operational)	5.18			57[a]			58[a]		
Fast transient burst (operational)	5.18			59[a]			60[a]		
Slow high-energy voltage surge (operational)	5.18			61[a]			62[a]		
Additional test for suffix S detectors	6.1								63
Additional test for suffix R detectors	6.2					63, 64	65, 66	67, 68	

[a] In the interest of test economy, it is permitted to use the same specimen for more than one EMC test. In that case, intermediate functional test(s) on the specimen(s) used for more than one test can be deleted, and the full functional test conducted at the end of the sequence of tests. However, it should be noted that in the event of a failure, it may not be possible to identify which test exposure caused the failure.

5.2 Directional dependence

5.2.1 Object of test

To confirm that the response time of the detector is not unduly dependent on the direction of airflow around the detector.

5.2.2 Test procedure

The specimen(s) shall be tested as specified in 5.1.5 at a rate of rise of air temperature of 10 K min^{-1}. Eight such tests shall be made, with the specimen rotated about a vertical axis by 45° between successive tests so that tests are made with eight different orientations. Before each test, the specimen shall be stabilized to the typical application temperature specified in Table 1, according to the class marked on the specimen. The response time at the eight orientations shall be recorded. The orientations at which the maximum and minimum response times were measured shall be noted.

5.2.3 Requirements

Class A1 detectors shall respond between 1 min 0 s and 4 min 20 s at all eight orientations.

Classes A2, B, C, D, E, F and G detectors shall respond between 2 min 0 s and 5 min 30 s at all eight orientations.

5.3 Static response temperature

5.3.1 Object of test

To confirm the ability of a detector to respond correctly to a slow rate of rise of air temperature.

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5.3.2 Test procedure

The specimens shall be tested as specified in 5.1.5, at a rate of rise of air temperature of 1 K min^{-1}, until the applicable maximum application temperature is reached, as specified in Table 1, according to the class marked on the specimen. Thereafter, the test shall be continued at a maximum rate of rise of air temperature of 0,2 K min^{-1}. One specimen shall be tested at the orientation which gave the maximum response time, and the other at the orientation which gave the minimum response time in the test in 5.2. Before each test, the specimen shall be stabilized to the typical application temperature specified in Table 1, according to the class marked on the specimen. The temperature at which the specimens respond shall be recorded.

5.3.3 Requirements

The response temperatures of the detectors tested shall lie between the minimum and maximum static response temperatures shown in Table 1, according to the class of the detector.

5.4 Response times from typical application temperature

5.4.1 Object of test

To confirm the ability of the detector stabilized at its typical application temperature to respond correctly over a range of rates of rise of air temperature.

5.4.2 Test procedure

The specimens shall be tested as specified in 5.1.5 at rates of rise of air temperature of 1, 3, 5, 10, 20 and 30 K min^{-1}. One specimen shall be tested at the orientation which gave the maximum response time, and the other at the orientation which gave the minimum response time in the test in 5.2. Before each test, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen. The response time for each rate of rise of air temperature shall be recorded for each specimen.

5.4.3 Requirements

The response times of the detectors shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

Table 4 — Response time limits

Rate of rise of air temperature	Class A1 detectors				Class A2, B, C, D, E, F and G detectors			
	Lower limit of response time		Upper limit of response time		Lower limit of response time		Upper limit of response time	
K min^{-1}	min	s	min	s	min	s	min	s
1	29	00	40	20	29	00	46	00
3	7	13	13	40	7	13	16	00
5	4	09	8	20	4	09	10	00
10	1	00	4	20	2	00	5	30
20		30	2	20	1	00	3	13
30		20	1	40		40	2	25

NOTE Information concerning the derivation of the limits given in Table 4 is given in Annex C.

5.5 Response times from 25 °C

NOTE This test is not applicable to Class A1 or A2 detectors

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5.5.1 Object of test

To confirm that detectors in a class with a typical application temperature above 25 °C (see Table 1) do not exhibit an abnormally fast response to normal increases in temperature. Therefore, this test is not applicable to Class A1 or A2 detectors.

5.5.2 Test procedure

The specimen(s) shall be tested as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1}. The specimen shall be tested at the orientation which gave the minimum response time in the test in 5.2. Before each test, the specimen shall be stabilized to 25 °C. The response times of the specimen shall be recorded.

5.5.3 Requirements

The response time at 3 K min^{-1} shall exceed 7 min 13 s, and the response time at 20 K min^{-1} shall exceed 1 min 0 s.

5.6 Response times from high ambient temperature (dry heat operational)

5.6.1 Object of test

To demonstrate the ability of the detector to function correctly at high ambient temperatures appropriate to the anticipated service temperatures.

5.6.2 Test procedure

The specimens shall be tested as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1}. The specimen shall be tested at the orientation which gave the maximum response time in the test in 5.2. Before each test, the specimen shall be stabilized for 2 h at the maximum application temperature specified in Table 1 according to the class marked on the specimen. The rate of rise of air temperature up to the stabilization temperature shall be ≤ 1 K min^{-1}. The response times of the specimen shall be recorded.

5.6.3 Requirements

No alarm or fault signals shall be given during the period that the temperature is increasing to the stabilization temperature or during the stabilization period.

Detectors shall respond according to their class, between the lower and upper response time limits specified in Table 5.

Table 5 — Response time limits from maximum application temperature

Detector class	Lower limit of response time at air temperature rise of:				Upper limit of response time at air temperature rise of:			
	3 K min^{-1}		20 K min^{-1}		3 K min^{-1}		20 K min^{-1}	
	min	s	min	s	min	s	min	s
A1	1	20	0	12	13	40	2	20
All others	1	20	0	12	16	00	3	13

5.7 Variation in supply parameters

5.7.1 Object of test

To show that, within the specified range(s) of the supply parameters (e.g. voltage), the response time of the detector is not unduly dependent on these parameters.

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5.7.2 Test procedure

The specimen(s) shall be tested as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time in the test in 5.2, at the upper and lower limits of the supply parameters (e.g. voltage) range specified by the manufacturer. Before each test, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen. The response times for both rates of rise of air temperature at each supply parameter limit shall be recorded.

NOTE For collective (conventional) detectors, the supply parameter is the dc voltage applied to the detector. For other types of detector (e.g. analogue addressable), signal levels and timing may need to be considered. If necessary, the manufacturer may be requested to provide suitable supply equipment to allow the supply parameters to be changed as required.

5.7.3 Requirements

The response times of the detectors shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.8 Reproducibility

5.8.1 Object of test

To show that the response times of the specimens are within the required limits, and, for resettable detectors, to establish response time base data for comparison with the response times measured after the environmental tests.

5.8.2 Test procedure

The response time of the specimens shall be measured as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time as determined by the test in 5.2. Before each measurement, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen.

5.8.3 Requirements

The response times of the detectors shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.9 Cold (operational)

5.9.1 Object of test

To demonstrate the ability of the detector to function correctly at low ambient temperatures appropriate to the anticipated service temperature.

5.9.2 Test procedure

5.9.2.1 Reference

The test apparatus and procedure shall be as specified in IEC 60068-2-1, Test Ab, and 5.9.2.2 to 5.9.2.4.

5.9.2.2 State of the specimen(s) during conditioning

The specimen(s) shall be mounted as specified in 5.1.3 and shall be connected to supply and monitoring equipment as specified in 5.1.2.

5.9.2.3 Conditioning

The following conditioning shall be applied:

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temperature: (–10 ± 3) °C;

duration: 16 h.

NOTE Test Ab specifies rates of change of temperature of ≤ 1 K min^{-1} for the transitions to and from the conditioning temperature.

5.9.2.4 Measurements during conditioning

The specimens shall be monitored during the conditioning period to detect any alarm or fault signals.

5.9.2.5 Final measurements

The response time of the specimen(s) shall be measured as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time in the test in 5.2. Before each measurement, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen.

5.9.3 Requirements

No alarm or fault signals shall be given during the transition to the conditioning temperature or during the period at the conditioning temperature.

For resettable detectors, the response time at 3 K min^{-1} shall not be less than 7 min 13 s and any change in the response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 2 min 40 s.

For resettable detectors, the response time at 20 K min^{-1} shall not be less than 30 s for Class A1 detectors, 1 min 0 s for all other classes, and any change in response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 30 s.

For non-resettable detectors, the response times shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.10 Dry heat (endurance)

5.10.1 Object of test

To demonstrate the ability of the detector to withstand a high ambient temperature appropriate to its class. This test is not applicable to Class A1, A2 and B detectors.

5.10.2 Test procedure

5.10.2.1 Reference

The test apparatus and procedure shall be as specified in IEC 60068-2-2 Test Ba or Bb, and 5.10.2.2 to 5.10.2.4.

5.10.2.2 State of the specimen during conditioning

The specimen(s) shall not be supplied with power during conditioning.

5.10.2.3 Conditioning

The applicable conditioning temperature specified in Table 6 shall be applied for 21 d.

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Table 6 — Dry heat (endurance) conditioning temperatures

Detector class	Conditioning temperature °C
C	80 ± 2
D	95 ± 2
E	110 ± 2
F	125 ± 2
G	140 ± 2

5.10.2.4 Final measurements

The response time of the specimen(s) shall be measured as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time in the test in 5.2. Before each measurement, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen.

5.10.3 Requirements

No fault signal, attributable to the endurance conditioning, shall be given on reconnection of the specimen.

For resettable detectors, the response time at 3 K min^{-1} shall not be less than 7 min 13 s and any change in the response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 2 min 40 s.

For resettable detectors, the response time at 20 K min^{-1} shall not be less than 1 min 0 s and any change in response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 30 s.

For non-resettable detectors, the response times shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.11 Damp heat, cyclic (operational)

5.11.1 Object of test

To demonstrate the ability of the detector to function correctly in an environment with high relative humidity (with condensation), which may occur for short periods in the anticipated service environment.

5.11.2 Test procedure

5.11.2.1 Reference

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

5.11.2.2 State of the specimen during conditioning

The specimen(s) shall be mounted as specified in 5.1.3 and shall be connected to supply and monitoring equipment as specified in 5.1.2.

5.11.2.3 Conditioning

The following severity of conditioning (IEC 60068-2-30, Severity 1) shall be applied:

Lower temperature: (25 ± 3) °C;

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Upper temperature: (40 ± 2) °C;

Relative Humidity:

i) at lower temperature: ≥ 95 %;

ii) at upper temperature: (93 ± 3) %;

Number of cycles: 2.

5.11.2.4 Measurements during conditioning

The specimen(s) shall be monitored during the conditioning period to detect any alarm or fault signals.

5.11.2.5 Final measurements

After the recovery period, the response time of the specimen(s) shall be measured as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time in the test in 5.2. Before each measurement, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen.

5.11.3 Requirements

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

For resettable detectors, the response time at 3 K min^{-1} shall not be less than 7 min 13 s and any change in the response time compared with the time obtained in the equivalent test 5.8 shall not exceed 2 min 40 s.

For resettable detectors, the response time at 20 K min^{-1} shall not be less than 30 s for Class A1 detectors, 1 min 0 s for all other classes, and any change in response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 30 s.

For non-resettable detectors, the response times shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.12 Damp heat, steady-state (endurance)

5.12.1 Object of test

To demonstrate the ability of the detector to withstand the long-term effects of humidity in the service environment (e.g. changes in electrical properties of materials, chemical reactions involving moisture, galvanic corrosion).

5.12.2 Test procedure

5.12.2.1 Reference

The test apparatus and procedure shall be as specified in IEC 60068-2-78, Test Cab, and in 5.14.2.2 to 5.14.2.4.

5.12.2.2 State of the specimen(s) during conditioning

The specimen(s) shall be mounted as specified in 5.1.3. It shall not be supplied with power during the conditioning.

5.12.2.3 Conditioning

The following conditioning shall be applied:

temperature: (40 ± 2) °C;

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relative humidity: (93 ± 3) %;

duration: 21 d.

5.12.2.4 Final measurements

After a recovery period of at least 1 h in standard laboratory conditions, the response time of the specimen(s) shall be measured as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time in the test in 5.2. Before each measurement, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen.

5.12.3 Requirements

No fault signal, attributable to the endurance conditioning, shall be given on reconnection of the specimen.

For resettable detectors, the response time at 3 K min^{-1} shall not be less than 7 min 13 s and any change in the response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 2 min 40 s.

For resettable detectors, the response time at 20 K min^{-1} shall not be less than 30 s for Class A1 detectors, 1 min 0 s for all other classes, and any change in response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 30 s.

For non-resettable detectors, the response times shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.13 Sulfur dioxide (SO_2) corrosion (endurance)

5.13.1 Object of test

To demonstrate the ability of the detector to withstand the corrosive effects of sulfur dioxide as an atmospheric pollutant.

5.13.2 Test procedure

5.13.2.1 Reference

The test apparatus and procedure shall be as specified in IEC 60068-2-42 Test Kc, and in 5.13.2.2 to 5.13.2.4.

5.13.2.2 State of the specimen during conditioning

The specimen(s) shall be mounted as specified in 5.1.3. It shall not be supplied with power during the conditioning. Untinned copper wires, of the appropriate diameter connected to sufficient terminals, shall be used to allow the final measurement to be made, without making further connections to the specimen.

5.13.2.3 Conditioning

The following conditioning shall be applied:

temperature: (25 ± 2) °C;

relative humidity: (93 ± 3) %;

SO_2 concentration: (25 ± 5) μl/l;

duration: 21 d.

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5.13.2.4 Final measurements

Immediately after the conditioning, the specimen shall be subjected to a drying period of 16 h at (40 ± 2)°C, ≤ 50 % RH, followed by a recovery period of at least 1 h at the standard laboratory conditions. After this, the response time of the specimen(s) shall be measured as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time in the test in 5.2. Before each measurement, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen.

5.13.3 Requirements

No fault signal, attributable to the endurance conditioning, shall be given on reconnection of the specimen.

For resettable detectors, the response time at 3 K min^{-1} shall not be less than 7 min 13 s and any change in the response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 2 min 40 s.

For resettable detectors, the response time at 20 K min^{-1} shall not be less than 30 s for Class A1 detectors, 1 min 0 s for all other classes, and any change in response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 30 s.

For non-resettable detectors, the response times shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.14 Shock (operational)

5.14.1 Object of test

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

5.14.2 Test procedure

5.14.2.1 Reference

The test apparatus and procedure shall be as specified in IEC 60068-2-27, Test Ea, and in 5.14.2.2 to 5.14.2.5.

5.14.2.2 State of the specimen during conditioning

The specimen(s) shall be mounted as specified in 5.1.3 to a rigid fixture, and shall be connected to its supply and monitoring equipment as specified in 5.1.2.

5.14.2.3 Conditioning

For specimens with a mass ≤ 4,75 kg, the following conditioning shall be applied:

shock pulse type:	half sine;
pulse duration:	6 ms;
peak acceleration:	10 × (100 − 20M) ms^{-2} (where M is the mass of the specimen in kg);
number of directions:	6;
pulses per direction:	3.

No test is applied to specimens with a mass > 4,75 kg.

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5.14.2.4 Measurements during conditioning

The specimen shall be monitored during the conditioning period and for a further 2 min to detect any alarm or fault signals.

5.14.2.5 Final measurements

The response time of the specimen(s) shall be measured as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time in the test in 5.2. Before each measurement, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen.

5.14.3 Requirements

No alarm or fault signals shall be given during the conditioning period or the additional 2 min.

For resettable detectors, the response time at 3 K min^{-1} shall not be less than 7 min 13 s and any change in the response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 2 min 40 s.

For resettable detectors, the response time at 20 K min^{-1} shall not be less than 30 s for Class A1 detectors, 1 min 0 s for all other classes, and any change in response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 30 s.

For non-resettable detectors, the response times shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.15 Impact (operational)

5.15.1 Object of test

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

5.15.2 Test procedure

5.15.2.1 Apparatus

The test apparatus shall consist of a swinging hammer incorporating a rectangular-section aluminium alloy head (aluminium alloy Al Cu_4 Mg complying with ISO 209, solution- and precipitation-treated condition) with the plane impact face chamfered to an angle of 60° to the horizontal, when in the striking position (i.e. when the hammer shaft is vertical). The hammer head shall be (50 ± 2,5) mm high, (76 ± 3,8) mm wide and (80 ± 4) mm long at mid height, as shown in Figure D1. A suitable apparatus is specified in Annex D.

5.15.2.2 State of the specimen during conditioning

The specimen(s) shall be mounted rigidly to the apparatus by its normal mounting means and it shall be positioned so that it is struck by the upper half of the impact face when the hammer is in the vertical position (i.e. when the hammerhead is moving horizontally). The azimuthal direction and position of impact, relative to the specimen, shall be chosen as that most likely to impair the normal functioning of the specimen. The specimen(s) shall be connected to its supply and monitoring equipment as specified in 5.1.2.

5.15.2.3 Conditioning

The following conditioning shall be applied:

impact energy: (1,9 ± 0,1) J;

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hammer velocity: (1,5 ± 0,13) m/s;

number of impacts: 1.

5.15.2.4 Measurements during conditioning

The specimen shall be monitored during the conditioning period and for a further 2 min to detect any alarm or fault signals.

5.15.2.5 Final measurements

The response time of the specimen(s) shall be measured as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time in the test in 5.2. Before each measurement, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen.

5.15.3 Requirements

No alarm or fault signals shall be given during the conditioning period or the additional 2 min.

For resettable detectors, the response time at 3 K min^{-1} shall not be less than 7 min 13 s and any change in the response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 2 min 40 s.

For resettable detectors, the response time at 20 K min^{-1} shall not be less than 30 s for Class A1 detectors, 1 min 0 s for all other classes, and any change in response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 30 s.

For non-resettable detectors, the response times shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.16 Vibration, sinusoidal (operational)

5.16.1 Object of test

To demonstrate the immunity of the detector to vibration at levels considered appropriate to the normal service environment.

5.16.2 Test procedure

5.16.2.1 Reference

The test apparatus and procedure shall be as specified in IEC 60068-2-6 Test Fc, and 5.16.2.2 to 5.16.2.5.

5.16.2.2 State of the specimen during conditioning

The specimen(s) shall be mounted on a rigid fixture as specified in 5.1.3 so that one of the three axes is perpendicular to its normal mounting plane. It shall be connected it to its supply and monitoring equipment as specified in 5.1.2. Vibration shall be applied in each of three mutually perpendicular axes, in turn.

5.16.2.3 Conditioning

The following conditioning shall be applied:

Frequency range: (10 to 150) Hz;

Acceleration amplitude: 5 m s^{-2} (≈0,5 g_n);

Number of axes: 3;

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Sweep rate: 1 octave/min^{-1};

Number of sweep cycles: 1/axis.

The vibration operational and endurance tests may 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 Measurements during conditioning

The specimen shall be monitored during the conditioning period to detect any alarm or fault signals.

5.16.2.5 Final measurements

The final measurements specified in 5.17.2.4 are normally made after the vibration endurance test and it is only necessary to make them here if the operational test is conducted in isolation.

5.16.3 Requirements

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

For resettable detectors the response time at 3 K min^{-1} shall not be less than 7 min 13 s and any change in the response time compared with the time obtained in the equivalent test 5.8 shall not exceed 2 min 40 s.

For resettable detectors, the response time at 20 K min^{-1} shall not be less than 30 s for Class A1 detectors, 1 min 0 s for all other classes, and any change in response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 30 s.

For non-resettable detectors, the response times shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.17 Vibration, sinusoidal (endurance)

5.17.1 Object of test

To demonstrate the ability of the detector to withstand the long-term effects of vibration at levels appropriate to the service environment.

5.17.2 Test procedure

5.17.2.1 Reference

The test apparatus and procedure shall be as specified in IEC 60068-2-6 Test Fc, and 5.17.2.2 to 5.17.2.4.

5.17.2.2 State of the specimen during conditioning

The specimen(s) shall be mounted on a rigid fixture as specified in 5.1.3 so that one of the three axes is perpendicular to its normal mounting axis. It shall not be supplied with power during the conditioning. Vibration shall be applied in each of three mutually perpendicular axes, in turn.

5.17.2.3 Conditioning

The following conditioning shall be applied:

Frequency range: (10 to 150) Hz;

Acceleration amplitude: 10 m s-2 (≈1,0 g_n);

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Number of axes: 3;

Sweep rate: 1 octave/min^{-1};

Number of sweep cycles: 20 /axis.

NOTE The vibration operational and endurance tests may 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.

5.17.2.4 Final measurements

The response time of the specimen(s) shall be measured as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time in the test in 5.2. Before each measurement, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen.

5.17.3 Requirements

No fault signal, attributable to the endurance conditioning, shall be given on reconnection of the specimen.

For resettable detectors, the response time at 3 K min^{-1} shall not be less than 7 min 13 s and any change in the response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 2 min 40 s.

For resettable detectors, the response time at 20 K min^{-1} shall not be less than 30 s for Class A1 detectors, 1 min 0 s for all other classes, and any change in response time compared with the time obtained in the equivalent test in 5.8 shall not exceed 30 s.

For non-resettable detectors, the response times shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

5.18 Electromagnetic compatibility (EMC) immunity tests (operational)

5.18.1 Test procedure

5.18.1.1 Reference

The following EMC immunity tests shall be carried out as specified in EN 50130-4:

a) electrostatic discharge;

b) radiated electromagnetic fields;

c) conducted disturbances induced by electromagnetic fields;

d) fast transient bursts;

e) slow high-energy voltage surges.

5.18.1.2 Final measurements

After the conditioning, the response time of the specimen(s) shall be measured as specified in 5.1.5 at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} in the orientation which gave the maximum response time in the test in 5.2. Before each measurement, the specimen shall be stabilized to the typical application temperature specified in Table 1 according to the class marked on the specimen.

5.18.2 Requirements

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

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During the functional test after conditioning:

- For resettable detectors, the response time at 3 K min^{-1} shall not be less than 7 min 13 s and any change in the response time compared with the time obtained in the equivalent test of 5.8 shall not exceed 2 min 40 s;
- For resettable detectors, the response time at 20 K min^{-1} shall not be less than 30 s for Class A1 detectors, 1 min 0 s for all other classes, and any change in response time compared with the time obtained in the equivalent test of 5.8 shall not exceed 30 s;
- For non-resettable detectors, the response times shall lie between the upper and lower response time limits specified in Table 4 for the appropriate detector class.

6 Additional tests for detectors with class suffixes

6.1 Test for suffix S detectors

6.1.1 Object of test

To confirm that a suffix S detector does not respond below the minimum static response temperature applicable to the class of the detector. This test is only applicable to suffix S detectors.

NOTE Suffix S detectors may be particularly suitable for use in applications, such as boiler rooms and kitchens, where high rates of temperature rise may be sustained for long periods.

6.1.2 Test procedure

6.1.2.1 Plunge test

The specimen shall be mounted as specified in 5.1.3 and shall be connected to supply and monitoring equipment as specified in 5.1.2.

The specimen shall be stabilized to the conditioning temperature specified in Table 7 according to the class marked on the specimen. At the end of the conditioning period, the specimen shall be transferred, in a period not exceeding 10 sec, into an airflow of 0,8 m/s (mass equivalent at 25 °C) maintained at the temperature specified in Table 7. The specimen shall be tested in the orientation which gave the minimum response time as determined by the test in 5.2. The specimen shall be exposed to the airflow for at least 10 min. Any response from the specimen during this time or during the transfer period shall be noted.

Table 7 — Conditioning and airflow temperatures

Detector class	Conditioning temperature °C	Airflow temperature °C
A1S	5 ± 2	50 ± 2
A2S	5 ± 2	50 ± 2
BS	20 ± 2	65 ± 2
CS	35 ± 2	80 ± 2
DS	50 ± 2	95 ± 2
ES	65 ± 2	110 ± 2
FS	80 ± 2	125 ± 2
GS	95 ± 2	140 ± 2

6.1.2.2 Review of response time data

The response times of the specimens tested in 5.2, 5.4, 5.7 and 5.8 shall be reviewed.

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6.1.3 Requirements

The specimen subjected to the plunge test, when tested in accordance with 6.1.2.1, shall not produce an alarm or fault signal during the transfer period or during the 10 min exposure to the airflow.

The response times of the specimens tested in 5.2, 5.4, 5.7 and 5.8 shall exceed the lower limits of response time for each applicable rate of temperature rise specified in Table 8.

Table 8 — Lower limit of response for class suffix S detectors

Rate of rise of air temperature	Lower limit of response time	
K min^{-1}	min	s
3	9	40
5	5	48
10	2	54
20	1	27
30		58

NOTE These lower limits of response time correspond to a minimum rise of temperature of 29 °C above the stabilization temperature.

6.2 Test for suffix R detectors

6.2.1 Object of test

To confirm that a suffix R detector maintains the response requirements of its class for high rates of rise of temperature starting from an initial temperature below the typical application temperature applicable to the class marked on the detector. This test is only applicable to suffix R detectors.

NOTE Suffix R detectors may be particularly suitable for use in unheated buildings where the ambient temperature may vary considerably and high rates of temperature rise are not sustained for long periods.

6.2.2 Test procedure

The specimen(s) shall be tested as specified in 5.1.5 at rates of rise of air temperature of 10 K min^{-1}, 20 K min^{-1}, and 30 K min^{-1}. One specimen shall be tested with the orientation which gave the minimum response time and the other at the orientation which gave the maximum response time in the test in 5.2. Before each test, the air stream and the specimen shall be stabilized to the temperature specified in Table 9 according to the class marked on the specimen. The response times of the specimens shall be recorded.

Table 9 — Initial conditioning temperature for suffix R detectors

Detector class	Initial conditioning temperature °C
A1R	5 ± 2
A2R	5 ± 2
BR	20 ± 2
CR	35 ± 2
DR	50 ± 2
ER	65 ± 2
FR	80 ± 2
GR	95 ± 2

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6.2.3 Requirements

The response times of the detectors shall lie between the lower and upper response time limits specified in Table 4 for the appropriate detector class.

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Annex A
(normative)

Heat tunnel for response time and response temperature measurements

The following specifies those properties of the heat tunnel which are of primary importance for making repeatable and reproducible measurements of response time and static response temperature of heat detectors. However, since it is not practical to specify and measure all parameters which may influence the measurements, the background information in Annex B should be carefully considered and taken into account when a heat tunnel is designed and used to make measurements in accordance with this part of ISO 7240.

The heat tunnel shall meet the following requirements for each class of heat detector it is used to test:

— The heat tunnel shall have a horizontal working section containing a working volume. The working volume is a defined part of the working section, where the air temperature and air flow conditions are within ± 2 K and ± 0,1 m/s of the nominal test conditions, respectively. Conformance of this requirement shall be regularly verified under both static and rate-of-rise conditions, by measurements at an adequate number of points distributed within and on the imaginary boundaries of the working volume. The working volume shall be large enough to fully enclose the detector(s) to be tested, the required amount of mounting board and the temperature measuring sensor.

— The detector to be tested shall be mounted in its normal operating position on the underside of a flat board aligned with the airflow in the working volume. The board shall be (5 ± 1) mm thick and of such dimensions that the edge(s) of the board are at least 20 mm from any part of the detector. The edge(s) of the board shall have a semi-circular form and the air flow between the board and the tunnel ceiling shall not be unduly obstructed. The material from which the board is made shall have a thermal conductivity not greater than 0,52 W m^{-1} K^{-1}.

— If more than one detector is to be mounted in the working volume and tested simultaneously, then previous tests shall have been conducted which confirm that response time measurements made simultaneously on more than one detector are in close agreement with measurements made by testing detectors individually. In the event of a dispute, the value obtained by individual testing shall be accepted.

— Means shall be provided for creating a stream of air through the working volume at the constant temperatures and rates of rise of air temperature specified for the classes of detector to be tested. This air stream shall be essentially laminar and maintained at a constant mass flow, equivalent to (0,8 ± 0,1) m/s at 25 °C.

— The temperature sensor shall be positioned at least 50 mm upstream of the detector and at least 25 mm below the lower surface of the mounting board. The air temperature shall be controlled to within ± 2 K of the nominal temperature required at any time during the test.

— The air temperature measuring system shall have an overall time constant of not greater than 2 sec, when measured in air with a mass flow equivalent to (0,8 ± 0,1) m/s at 25 °C.

— Means shall be provided for measuring the response time of the detector under test to an accuracy of ± 1 sec.

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Annex B
(informative)

Information concerning the construction of the heat tunnel

Heat detectors respond when the signal(s) from one or more sensors fulfil certain criteria. The temperature of the sensor(s) is related to the air temperature surrounding the detector but the relation is usually complex and dependent on several factors, such as orientation, mounting, air velocity, turbulence, rate of rise of air temperature etc. Response times and response temperature and their stability are the main parameters considered when the fire detection performance of heat detectors is evaluated by testing in accordance with this part of ISO 7240.

Many different heat tunnel designs are suitable for the tests specified in this part of ISO 7240, but the following points should be considered when designing and characterizing a heat tunnel.

There are two basic types of heat tunnel; recirculating and non-recirculating. All else being equal, a non-recirculating tunnel requires a higher power heater than a recirculating tunnel, particularly for the higher rates of rise of air temperature. More care is generally needed to ensure that the high power heater and control system of a non-recirculating tunnel are sufficiently responsive to the changes in heat demand necessary to attain the required temperature versus time conditions in the working section. On the other hand, maintaining a constant mass flow with increasing temperature is generally more difficult in a recirculating tunnel.

The temperature control system shall be able to maintain the temperature within ± 2 K of the “ideal ramp” for all of the specified rates of rise of air temperature. Such performance can be achieved in different ways, e.g.:

— by proportional heating control, where more heating elements are used when generating higher rates of rise. Improved temperature control may be achieved by powering some of the heating elements continuously, while controlling others. With this control system, the distance between the tunnel heater and the detector under test should not be so large that the intrinsic delay in the temperature control feedback loop becomes excessive at an air flow of 0,8 m/s.

— by rate controlled feed forward heating control, assisted by proportional/integral (PI) feedback. This control system will permit greater distance between the tunnel heater and the detector under test.

It is important that the specified temperature profiles are obtained with the required accuracy within the working section.

For a non-recirculating tunnel, the anemometer used for air flow control and monitoring may be placed in a section of the tunnel upstream of the heater where it will be subject to a substantially constant temperature, thereby eliminating any need to temperature compensate its output. A constant velocity, indicated by an anemometer so positioned, should correlate with a constant mass flow through the working volume. However, to maintain a constant mass flow at normal atmospheric pressure in a recirculating tunnel, it is necessary to increase the air velocity as the air temperature is increased. Careful consideration should, therefore, be given to ensuring that an appropriate correction is for the temperature coefficient of the anemometer monitoring the air flow. It should not be assumed that an automatically temperature compensated anemometer will compensate sufficiently quickly at high rates of rise of air temperature.

The airflow created by a fan in the tunnel will be turbulent, and needs to pass through an air straightener to create a nearly laminar and uniform air flow in the working volume (see Figures B.1 and B.2). This may be facilitated by using a filter, honeycomb or both, in line with, and upstream of the working section of the tunnel. Care should be taken to ensure that the airflow from the heater is mixed to a uniform temperature, before entering the flow straightener.

It is not possible to design a tunnel where uniform temperature and flow conditions prevail in all parts of the working section. Deviations will exist, especially close to the walls of the tunnel, where a boundary layer of slower and cooler air will normally be observed. The depth of this boundary layer and the temperature gradient across it can be reduced by constructing or lining the walls of the tunnel with a low thermal conductivity material.

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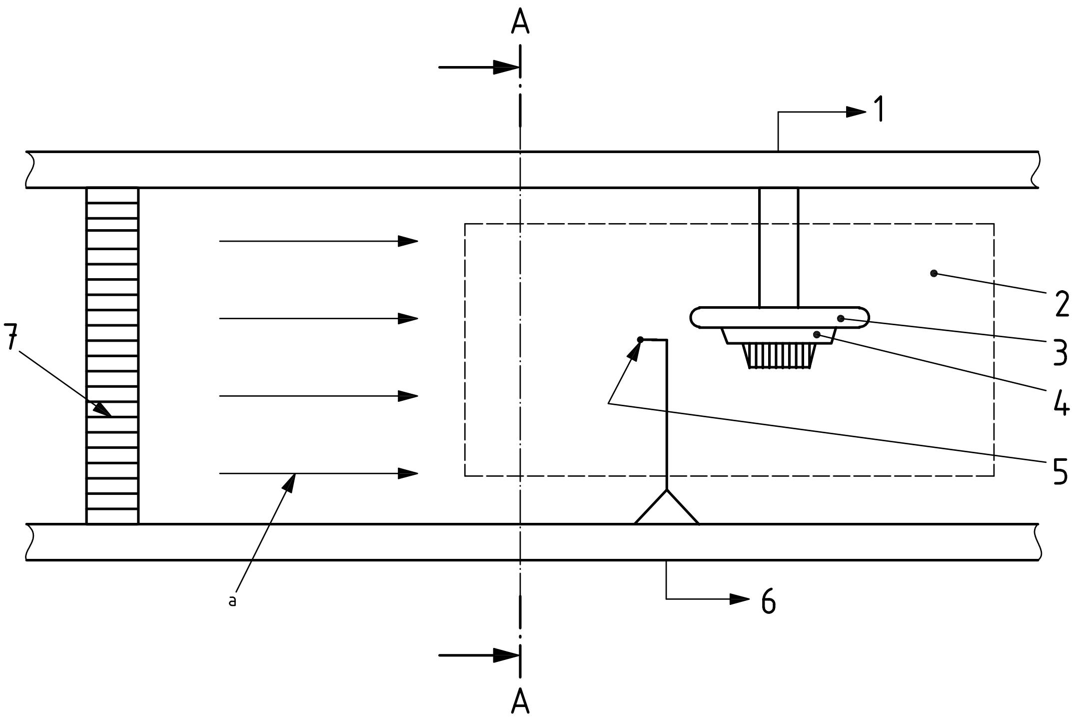
Special attention must be given to the temperature measuring system in the tunnel. The required overall time constant of not greater than 2 sec in air, means that the temperature sensor must have a very small thermal mass. In practice, only the fastest thermocouples and similar small sensors will be adequate for the measuring system. The effect of heat loss from the sensor via its leads can normally be minimised by exposing several centimetres of the lead to the air flow.



Key

1 to supply and monitoring equipment
2 working volume
3 mounting board
4 detector(s) under test
5 temperature sensor
6 to control and measuring equipment
7 flow straightener
a Air flow

Figure B.1 — Example of working section of heat tunnel

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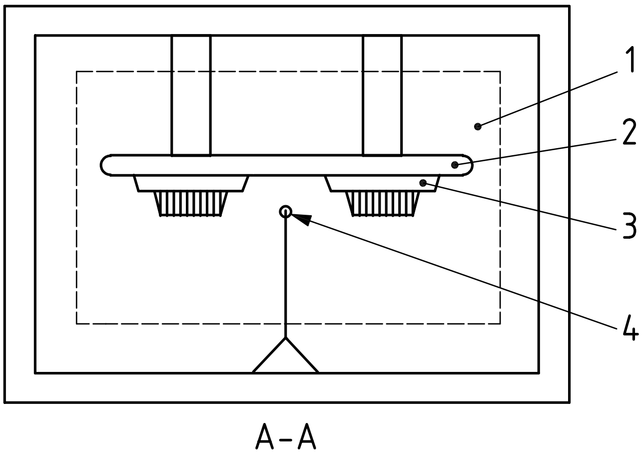

Key

1 working volume

2 mounting board

3 detector(s) under test

4 temperature sensor

Figure B.2 — Example of mounting arrangement for simultaneously testing two detectors

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Annex C
(informative)

Derivation of upper and lower limits of response times

NOTE These equations were originally used to derive the limits specified in ISO 3116:2007. Appendix G to ISO 3116:2007 detailed the equations, the original thermal constants used and the minimum size of fires that can be detected by detectors with performances equivalent to the then specified upper response time limits, when mounted at a distance of 4,6 m (15 feet) horizontally from the fire on ceilings of various heights.

Upper limits. Upper limits of response times are derived from the theoretical response times of idealised detectors containing only a static element (fixed temperature detector). Assuming no heat losses from the sensing element, the response time of such a detector under constant conditions of air mass flow and rate of rise in air temperature depends on two design properties. The first is the "time constant" τ of the sensing element as expressed by the equation:

$$\tau = \frac{C}{HA}$$

where

C is the thermal capacity of the heat sensitive element;

H is the coefficient of convective heat transfer to the element;

A is the surface area of the element.

The second property is the temperature at which the detector will give an alarm when subjected to an infinitely slow rate of rise of air temperature, its fixed temperature setting, which is normally set by an adjustment of a gap between contacts, electrical resistance, etc.

A decrease in either of these properties will result in a decrease in the response time of the detector at any given rate of rise of air temperature. Hence, a detector having a high response time (low sensitivity) will have a high temperature setting or a long time constant or both, while a detector having a low response time (high sensitivity) will have lower values of either or both.

Assuming no heat losses, the temperature rise θ of the heat sensitive element at any time t, when subject to a constant mass flow with linearly increasing temperature α, is given by the equation:

$$\tau \frac{d\theta}{dt} + \theta = \alpha t$$

The solution of this equation is:

$$\theta = \alpha \left(t - \tau \left(1 - e^{-\frac{t}{\tau}} \right) \right)$$

If θ_o is the operating temperature rise of the sensitive element (the difference between the alarm and the stabilization temperatures) then the response time is given by the root of the above equation with θ set to θ_o. The two sets of upper response time limits given in Table 4 were calculated using the values shown in Table C.1.

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Table C.1 — Thermal constants used to derive upper limits in Table 4

Detector class	Thermal time constants for upper limits	
	θ_0 K	τ s
A1	40	20
All others	45	60

The time constants shown in Table C.1 are referenced to an airflow of 0,8 m/s and should not be confused with the "response time index" (I_{rt} in m^{-1} s^{-1}) commonly used in other heat detector standards. I_{rt} referenced to 1 m/s is related to the time constant τ_u at an airflow u by the following equation:

$$I_{rt} = \tau_u \sqrt{u}$$

A time constant referenced to 1 m/s has the same numerical value as the I_{rt} referenced to 1 m/s.

Lower limits. The purpose of imposing lower limits on the response times of detectors is to minimise the incidence of false alarms due to changes in air temperature which occur under non-fire conditions.

An analysis of the performance of rate of rise detectors made by many manufacturers has shown that, with the exception of detectors that have a performance equivalent to Class A1, they alarm at substantially the same temperature at rates of rise of between 1 K min^{-1} and 30 K min^{-1}. In the light of this finding and the wide range of application conditions in which these detectors may be installed, the minimum increase in temperature necessary to cause an alarm for detectors other than Class A1 has been set at 20 K for rates of rise of 10 K min^{-1} and above, starting from an initial temperature at or below the typical application temperature. For Class A1 detectors, the minimum rise in temperature to cause an alarm has been set at 10 K for rates of rise of 10 K min^{-1} and above because it is envisaged that Class A1 detectors will be installed in environments that are not subject to large, rapid changes in temperature.

The lower limits of response times specified in Table 4 for rates of rise up to 5 K min^{-1} for Class A1 and up to 30 K min^{-1} for other classes were derived from the calculated performance of a rate of rise detector consisting of two heat sensitive elements, one with a zero time constant and the other with a time constant of 34 min, and having a 19,51 K initial temperature "setting" between the elements. These values were selected because they produce a smooth curve yielding an operating temperature rise of 29 K for 1 K min^{-1} and 20 K for 10 K min^{-1} and above. For this detector, assuming no heat losses, the response time t is given by the following equation:

$$t = \tau \ln\left(1 - \frac{\theta}{\alpha\tau}\right)$$

where

τ is the time constant of the second element;

θ is the temperature setting between the elements;

α is the rate of rise of air temperature.

Change after environmental tests. For a single measurement, the response time of a detector can be measured to a high degree of accuracy, but the response temperature is usually subject to a proportionately greater uncertainty because the temperature is changing with time, and may deviate from the required temperature at any instant by 2 K. For this reason, response time measurements have been specified in this part of ISO 7240 for tests in which the detector is subject to rates of rise of 1 K min^{-1} and above.

Some heat detectors, particularly fixed temperature detectors with a very short thermal time constant, may produce a spread of response times from repeated measurements which reflect the temperature control limitations of the tests apparatus rather than changes in the detector. This is because the response time of the detector may be more closely related to the temperature of the air flow than to the time it is subjected to a rate of rise of temperature. Conversely, the response time of other detectors may be more dependant on the initial stabilization temperature than the instantaneous temperature at the moment of response. These possibilities

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were considered in determining the maximum change in response time between measurements made before and after the environmental tests.

The maximum allowable change at 3 K min^{-1} of 2 m 40 s equates to an 8 K change in response temperature, 4 K attributable the measuring apparatus and 4 K to the detector. Similarly, the maximum allowable change of 30 s at 20 K min^{-1} also equates to 8 K plus a further 2 K attributable to twice the rounded up, allowable uncertainty of 1 s in the measurement of response time.

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Annex D
(informative)

Apparatus for impact test

D.1 The apparatus (see Figure D.1) consists essentially of a swinging hammer comprising a rectangular section head (striker), with a chamfered impact face, mounted on a tubular steel shaft. The hammer is fixed into a steel boss, which runs on ball bearings on a fixed steel shaft mounted in a rigid steel frame, so that the hammer can rotate freely about the axis of the fixed shaft. The design of the rigid frame is such as to allow complete rotation of the hammer assembly when the specimen is not present.

D.2 The striker, with overall dimensions of 76 mm (width), 50 mm (height) and 94 mm (length) is manufactured from aluminium alloy Al Cu_4 Si Mg , as specified in ISO 209, which has been solution- and precipitation- treated. It has a plane-impact face chamfered at (60 ± 1)° to the long axis of the head. The tubular steel shaft has an outside diameter of (25 ± 0,1) mm with a wall thickness of (1,6 ± 0,1) mm.

D.3 The striker is mounted on the shaft so that its long axis is at a radial distance of 305 mm from the axis of rotation of the assembly, the two axes being mutually perpendicular. The central boss is 102 mm in outside diameter and 200 mm long, and is mounted coaxially on the fixed steel pivot shaft, which is approximately 25 mm in diameter; however, the precise diameter of the shaft depends on the bearings used.

D.4 Diametrically opposite the hammer shaft are two steel counter-balance arms, each 20 mm in outside diameter and 185 mm long. These arms are screwed into the boss so that the length of 150 mm protrudes. A steel counter-balance weight is mounted on the arms so that its position can be adjusted to balance the weight of the striker and arms, as in Figure D.1. On the end of the central boss is mounted a 150 mm-diameter aluminium alloy pulley, 12 mm wide, and around this an inextensible cable is wound, one end being fixed to the pulley. The other end of the cable supports the operating weight.

D.5 The rigid frame also supports the mounting board on which the specimen is mounted by its normal fixings. The mounting board is adjustable vertically so that the upper half of the impact face of the hammer shall strike the specimen when the hammer is moving horizontally, as shown in Figure D.1.

D.6 To operate the apparatus, the position of the specimen and the mounting board is first adjusted as shown in Figure D.1 and the mounting board is then secured rigidly to the frame. The hammer assembly is then balanced carefully by adjustment of the counter-balance weight with the operating weight removed. The hammer arm is then drawn back to the horizontal position ready for release and the operating weight is reinstated. On release of the assembly, the operating weight shall spin the hammer and arm through an angle of $3\pi/2$ rad to strike the specimen. The mass, in kilograms, of the operating weight to produce the required impact energy of 1,9 J equals:

$$\frac{0{,}388}{3\pi r}\ \text{kg}$$

where r is the effective radius of the pulley in metres. This equals approximately 0,55 kg for a pulley radius of 75 mm.

D.7 As this part of ISO 7240 requires a hammer velocity at impact of (1,5 ± 0,13) m/s the mass of the hammer head shall need to be reduced by drilling the back face sufficiently to obtain this velocity. It is estimated that a head of mass of about 0,79 kg will be required to obtain the specified velocity, but this shall be determined by trial and error.

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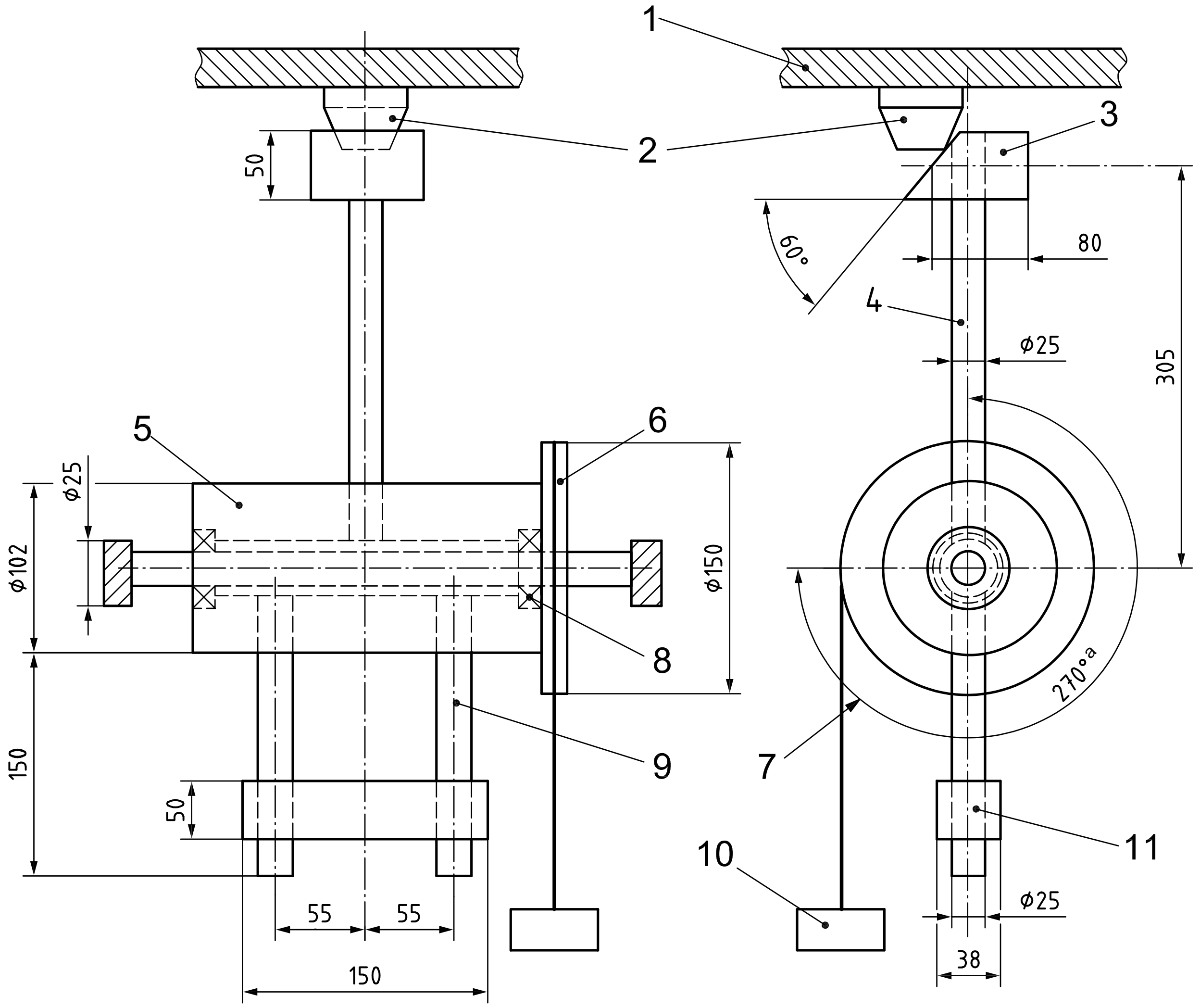
Dimensions in millimetres



Key

1 mounting board
2 detector
3 striker
4 striker shaft
5 boss
6 pulley
7 270° angle of movement
8 ball bearings
9 counter-balance arms
10 operating weight
11 counter-balance weight

NOTE The dimensions shown are for guidance, apart from those relating to the hammer head.

Figure D.1 — Apparatus for impact test

Bibliography

[1] ISO 3116: 2007, *Magnesium and magnesium alloys — Wrought magnesium alloys*

[2] ISO 7240-2, *Fire detection and alarm systems — Part 2: Control and indicating equipment*

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