
**Fire detection and alarm systems —
Part 31:
Resettable line-type heat detectors**

*Systèmes de détection et d'alarme incendie —
Partie 31: Détecteurs de chaleur en ligne resettable*

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Foreword

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

A list of all parts in the ISO 7240 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Resettable line-type heat detectors (RLTHD) have been incorporated into fire alarm systems for a considerable number of years. These detectors are typically used in areas where point-type heat detectors are presented with challenging environmental characteristics and also where access to the detectors can significantly influence the fire alarm system design.

This document gives common requirements for the construction and robustness of line-type heat detectors, as well as for their performance under climatic, mechanical and electrical interference conditions which are likely to occur in the service environment

This document defines the minimum system functionality for RLTHD products. RLTHD are based upon many unique operating principles. It is the intention of this document to define common operating characteristics for each type of RLTHD in conjunction with existing ISO 7240 detector International Standards, so that resettable line-type heat detectors have a response behaviour comparable to that of point-type heat detectors.

Generally, there are three functional principles employed by RLTHD: non-integrating systems, integrating systems and ror-only detectors; separate subclasses have been created for each of these systems.

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Fire detection and alarm systems —

Part 31: Resettable line-type heat detectors

1 Scope

This document applies to resettable line-type heat detectors consisting of a sensing element distributed either continuously or discretely at close intervals along its length and connected to a sensor control unit, either directly or through an interface module, intended for use in fire detection and fire alarm systems installed in and around buildings and other civil engineering works. Examples of such technology are an optical fibre, a pneumatic tube, or an electrical sensor cable.

This document specifies the requirements and performance criteria, the corresponding test methods, and provides for the assessment.

This document also covers resettable line-type heat detectors intended for use in the local protection of plants and equipment.

This document does not cover non-resettable line-type heat detectors that can only respond once and are based on fixed temperature electrical cables.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 7240-1, *Fire detection and alarm systems — Part 1: General and definitions*

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

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

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

IEC 62599-2, *Alarm systems — Part 2: Electromagnetic compatibility — Immunity requirements for components of fire and security alarm systems*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 environmental group

group used to designate the level of severity, applied during environmental tests

Note 1 to entry: The level should reflect service environment to which the components of specimens under test are subjected.

3.2 functional unit

part of a *line-type heat detector* (3.5) in addition to the *sensor control unit* (3.12) and the *sensing element* (3.11) which is essential for the function of the line-type heat detector

EXAMPLE Terminating device, filter, switch.

3.3 integrating line-type heat detector

detector for which the response to temperature is summed in a certain way (not necessarily linearly), along a length of the *sensing element* (3.11)

Note 1 to entry: For such detectors, the output to the *sensor control unit* (3.12) is a function of the temperature distribution along the length of the sensing element.

EXAMPLE Pneumatic systems.

3.4 linear heat detector

linear line-type heat detector

detector which responds to heat applied to any point along the length of the *sensing element* (3.11)

3.5 line-type heat detector

LTHD

detector which responds to heat sensed in the vicinity of a continuous line

Note 1 to entry: A line-type heat detector may consist of a *sensor control unit* (3.12), a *sensing element* (3.11) and *functional units* (3.2).

3.6 multipoint heat detector

multipoint line-type heat detector

detector that contains multiple discrete temperature sensors which are separated by a distance of no more than 10 m, embedded within the *sensing element* (3.11)

3.7 non-integrating RLTHD non-integrating line-type heat detector

detectors for which the output signal is dependent on local temperature effects but not on the integration of the whole temperature distribution along the *sensing element* (3.11)

EXAMPLE Fibre optics systems.

3.8 ror-only detector

line-type heat detector (3.5) which responds to a temperature rise but does not have a fixed operating temperature

3.9 resettable line-type heat detectors RLTHD

line-type heat detector (3.5) which is able to return to its quiescent condition after a response

3.10 room protection application

application in which the *sensing element* (3.11) is installed at a distance from the potential fire hazard close to the ceiling or roof of the area to be protected

EXAMPLE Car parks (open or closed), road/rail/metro tunnels, floor/ceiling voids, elevator shafts, cold stores, warehouses, heritage buildings, aircrafts hangars, spray shops, chemical storehouses, ammunition depots, refineries, silos, etc.

3.11 sensing element

heat sensing part of the *line-type heat detector* (3.5)

EXAMPLE A fibre optic cable, a pneumatic tube or an electrical cable

Note 1 to entry: A sensing element may consist of different segments separated for example by *functional units* (3.2) or splices.

3.12 sensor control unit

unit that supervises the *sensing element* (3.11) and communicates to the control and indicating equipment

Note 1 to entry: The unit can be remote or an integral part of the control and indicating equipment as defined by ISO 7240-2.

4 Requirements

4.1 General

4.1.1 Conformance

In order to conform to this document, the detector shall meet the requirements of [Clause 4](#), which shall be verified by inspection and engineering assessment, and when tested in accordance with the tests described in [Clause 5](#), the detector shall meet the requirements of the tests.

4.1.2 Heat response classes

4.1.2.1 Heat response for Class A integrating and non-integrating RLTHD

For Class A application the heat response of RLTHD is classified as indicated in [Table 1](#).

NOTE Test fires TF6S, TF6 and TF6F are specified in [Annex B](#).

Table 1 — Heat response for Class A

Heat response class		Typical application temperature	Maximum application temperature	Minimum static response temperature	Maximum static response temperature	TF6S		TF6		TF6F	
						Response time		Response time		Response time	
Non-integrating RLTHD	Integrating RLTHD	°C	°C	°C	°C	Lower value	Upper value	Lower value	Upper value	Lower value	Upper value
A1N	A1I	25	50	54	65	50	400	30	210	20	130

Table 1 (continued)

Heat response class		Typical application temperature	Maximum application temperature	Minimum static response temperature	Maximum static response temperature	TF6S		TF6		TF6F	
						Response time		Response time		Response time	
Non-integrating RLTHD	Integrating RLTHD	°C	°C	°C	°C	Lower value	Upper value	Lower value	Upper value	Lower value	Upper value
						s	s	s	s	s	s
A2N	A2I	25	50	54	70	120	600	60	300	40	180

4.1.2.2 Heat response for higher application temperatures RLTHD

For higher temperature applications the heat response of the RLTHD is classified as indicated in [Table 2](#).

Table 2 — Heat response for higher application temperatures of integrating and non-integrating RLTHD

Heat response class		Typical application temperature °C	Maximum application temperature °C	Minimum static response temperature °C	Maximum static response temperature °C
Non-integrating RLTHD	Integrating RLTHD				
BN	BI	40	65	69	85
CN	CI	55	80	84	100
DN	DI	70	95	99	115
EN	EI	85	110	114	130
FN	FI	100	125	129	145
GN	GI	115	140	144	160

4.1.2.3 Heat response for ror-only RLTHD

For ror-only RLTHD the heat response is classified as indicated in [Table 3](#).

Table 3 — Heat response for ror-only RLTHD

Heat response class		Typical application temperature °C	Maximum application temperature °C	TF6		TF6F	
				Response time		Response time	
Non-integrating RLTHD	Integrating RLTHD			Lower value	Upper value	Lower value	Upper value
				s	s	s	s
A1NR	A1IR	25	50	30	210	20	130
A2NR	A2IR	25	50	60	300	40	180

NOTE Test fires TF6 and TF6F are specified in [Annex B](#).

4.1.2.4 Response classes from typical higher application temperature for ror-only detectors

For higher temperature application ror-only RLTHD the heat response is classified as indicated in [Table 4](#).

Table 4 — Heat response, for integrating ror-only RLTHD

Heat response class for ror-only RLTHD	Typical application temperature °C	Maximum application temperature °C
BIR	40	65
CIR	55	80
DIR	70	95
EIR	85	110
FIR	100	125
GIR	115	140

4.1.2.5 Environmental groups

Different environmental groups are necessary to reflect the different service environment of the components of a line-type heat detector.

The sensing element shall meet the requirements of environmental groups II or III. The sensor control unit and the functional unit shall meet the requirements of environmental groups I, II or III.

Environmental group I covers equipment likely to be installed indoors in commercial/industrial premises but for which the avoidance of extreme environmental conditions can be taken into account in the selection of the mounting site.

Environmental group II covers equipment likely to be installed indoors in commercial/industrial premises in all general areas.

Environmental group III covers equipment which is intended to be installed outdoors and in harsh environments such as tunnels.

4.2 Individual alarm indication

Each sensor control unit shall be provided with an integral red visual indicator, by which the alarm condition of the sensing element can be identified, until the alarm condition is reset. Where other conditions of the sensor control unit can be visually indicated, they shall be clearly distinguishable from the alarm indication except when the sensor control unit is switched into a service mode. The visual indicator shall be visible from a distance of 6 m in the direct line of sight perpendicular to the surface, in an ambient light intensity of up to 500 lux.

If more than one sensing element is connected to the sensor control unit, there shall be a separate alarm indication for each sensing element.

To confirm this, the detector shall be assessed in accordance with [5.2](#).

4.3 Signalling

The line-type heat detector shall signal the alarm and fault status to the control and indicating equipment.

If more than one sensing element is connected to a sensor control unit, there shall be separate alarm and fault signals for each sensing element.

To confirm this, the detector shall be assessed in accordance with [5.3](#).

4.4 Repeatability

The ratio of response times of the RLTHD shall be within the limits, even after a number of alarm conditions, as specified in [5.4](#).

4.5 Reproducibility

The ratio of response times of several specimens of the RLTHD shall be within the limits as specified in [5.5](#).

4.6 Connection of ancillary devices

Where the RLTHD provides for connections to ancillary devices (e.g. remote indicators, RS 485 interface), open or short-circuit failures of these connections shall not prevent the correct operation of the RLTHD.

Where such connections are present, the detector shall be assessed in accordance with [5.6](#).

4.7 Manufacturer's adjustments

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

To confirm this, the detector shall be assessed in accordance with [5.7](#).

4.8 Software

4.8.1 General

For RLTHD, which rely on software control to fulfil the requirements of this document, the requirements of [5.8](#) shall be met.

4.8.2 Software design

In order to ensure the reliability of the RLTHD, the following requirements for software design shall 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.

4.8.3 The storage of programs and data

The program necessary for conformance with this document 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 a special tool or code and shall not be possible during normal operation of the RLTHD.

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.

To confirm this, the detector shall be assessed in accordance with [5.8](#).

4.9 Sensing element fault

The RLTHD shall generate fault conditions as specified in [5.9](#).

4.10 On-site adjustment of response behaviour

The effective response behaviour of a RLTHD is dependent upon both the sensitivity settings of the sensor control unit and the heat sensing element. Many types of RLTHD therefore have facilities to adjust the sensitivity of the RLTHD to suit the application.

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 conformance with this document, the detector shall conform with the requirements of this document, and access to the adjustment means shall only be possible by the use of a code or special tool;
- b) any setting(s) at which the manufacturer does not claim conformance with this document 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 conform to this document.

NOTE These adjustments can be carried out at the sensor control unit or at the control and indicating equipment.

To confirm this, the detector shall be assessed in accordance with [5.10](#).

4.11 Maximum ambient temperature test (sensing element)

The RLTHD shall function correctly even if the sensing element is exposed to high ambient temperatures as specified in [5.11](#).

4.12 Variation in supply parameters

The RLTHD shall function correctly within the specified range(s) of the supply parameters as specified in [5.12](#).

4.13 Low voltage fault

The RLTHD shall signal a fault condition when its input power supply falls below the minimum voltage specified by the manufacturer as specified in [5.13](#).

4.14 Fire sensitivity for Class A and ror-only RLTHD

Heat response Class A1N, A1I, A2N and A2I RLTHD shall have an adequate sensitivity to the heat release of a real test fire as required for general application in fire detection systems as specified in [4.1.2.1](#) and tested as specified in [5.14](#).

A ror-only RLTHD shall have, depending on its classification, an adequate sensitivity to the heat release of a real test fire as required for general application in fire detection systems as specified in [4.1.2.3](#) and tested as specified in [5.14](#).

4.15 Static response temperature test

The RLTHD shall have, depending on its classification, an adequate sensitivity to a slow rate of rise of temperature as specified in [4.1.2.2](#) and tested as specified in [5.15](#).

The RLTHD shall also be capable of alarming when temperature rise is very slow and generating the alarm within a temperature range specified for its class.

4.16 Response times from typical application temperature for ror-only RLTHD

Ror-only detectors shall have, depending on their classification, an adequate response time starting from typical application temperature specified in [4.1.2.4](#) and as tested in [5.16](#).

4.17 Dry heat (operational) sensor control unit

The sensor control unit of the RLTHD shall function correctly at high ambient temperatures as specified in [5.17](#).

4.18 Dry heat (endurance) for sensor control unit and sensing element

The sensor control unit and the sensing element of the RLTHD shall be capable of withstanding long-term exposure to high temperature as specified in [5.18](#).

4.19 Cold (operational) for sensing element

The RLTHD shall function correctly even if the sensing element is exposed to low ambient temperatures as specified in [5.19](#).

4.20 Cold (operational) for sensor control unit

The sensor control unit of the RLTHD shall function correctly at low ambient temperatures as specified in [5.20](#).

4.21 Damp heat, steady-state (endurance) for sensor control unit and sensing element

The RLTHD shall be capable of withstanding long-term exposure to a high level of continuous humidity as specified in [5.21](#).

4.22 Damp heat, cyclic (operational) for sensing element

The RLTHD shall function correctly even if the sensing element is exposed to a high level of humidity as specified in [5.22](#).

4.23 Damp heat, cyclic (operational) for sensor control unit

The sensor control unit of the RLTHD shall function correctly at a high level of humidity as specified in [5.23](#).

4.24 Damp heat, steady-state (operational) for sensor control unit

The sensor control unit of the RLTHD shall function correctly at a high level of humidity as specified in [5.24](#).

4.25 Damp heat, cyclic (endurance) for sensor control unit and sensing element

The RLTHD shall be capable of withstanding the effect of cyclic humidity levels as specified in [5.25](#).

4.26 Shock (operational) for sensor control unit

The sensor control unit of the RLTHD shall operate correctly when submitted to mechanical shocks as specified in [5.26](#).

4.27 Impact (operational) for sensor control unit

The sensor control unit of the RLTHD shall operate correctly when submitted to mechanical impacts as specified in [5.27](#).

4.28 Impact (operational) for sensing element

The RLTHD shall function correctly even if the sensing element is submitted to mechanical impacts as specified in [5.28](#).

4.29 Vibration, sinusoidal (operational) for sensor control unit

The sensor control unit of the RLTHD shall operate correctly when submitted to sinusoidal vibration as specified in [5.29](#).

4.30 Vibration, sinusoidal (operational) for sensing element

The RLTHD shall function correctly even if the sensing element is submitted to sinusoidal vibration as specified in [5.30](#).

4.31 Vibration, sinusoidal (endurance) for sensor control unit

The sensor control unit of the RLTHD shall be capable of withstanding the effect of sinusoidal vibration as specified in [5.31](#).

4.32 Vibration, sinusoidal (endurance) for sensing element

The sensing element of the RLTHD shall be capable of withstanding the effect of sinusoidal vibration as specified in [5.32](#).

4.33 Sulfur dioxide (SO₂) corrosion (endurance) for sensing element

The sensing element of the RLTHD shall be capable of withstanding exposure to an SO₂ corrosive atmosphere as specified in [5.33](#).

4.34 Sulfur dioxide (SO₂) corrosion (endurance) for sensor control unit

The sensor control unit of the RLTHD shall be capable of withstanding exposure to an SO₂ corrosive atmosphere as specified in [5.34](#).

4.35 Electromagnetic immunity

The RLTHD shall operate correctly when submitted to electromagnetic interference as specified in [5.35](#).

5 Test methods

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:

- a) temperature: (15 to 35) °C;

- b) relative humidity: (25 to 75) %;
- c) 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 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

Unless otherwise stated, 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

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

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 Procedure for measurement of response time

5.1.5.1 General

The purpose of this procedure is to establish any deviation in system response time following the environmental tests.

The specimen shall be connected to suitable supply and monitoring equipment in accordance with [5.1.2](#)

The response time of the RLTHD shall be measured using the heat tunnel described in [Annex F](#).

The orientation of the sensing element in the heat tunnel shall be chosen arbitrarily and shall be the same for each measurement.

Before the measurement, stabilize the temperature of the air stream and the section of sensing element to be heated at a typical application temperature according to [4.1.2](#) unless otherwise specified. The measurement is then made by increasing the air temperature in the tunnel, linearly with respect to time and at the rate of rise specified in the applicable test procedure, until the supply and monitoring equipment indicates an alarm.

During the measurement, the airflow in the tunnel shall be maintained at a constant mass flow, equivalent to $(0,8 \pm 0,1)$ m/s at 25 °C. The air temperature shall be controlled to within ± 2 K of the nominal temperature required at any time during the test.

The response time, t , shall be measured from the moment the temperature starts increasing to the indication of an alarm from the supply and monitoring equipment.

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

NOTE 2 It is important to take care not to subject detectors to a damaging thermal shock when transferring them to and from a stabilized or alarm temperature.

5.1.5.2 Linear and ror-only heat detectors

For measurement of the response time of linear heat detectors, the length of sensing element, L_1 , which shall be connected to the sensor control unit shall be chosen to be the worst case for the technology employed. This shall be agreed between the manufacturer and the testing laboratory.

NOTE 1 The effect on the temperature measurement of noise and losses in the sensing element is taken into account.

A section of $(10 \pm 0,1)$ m (L_{test}) of sensing element shall be wrapped around a test frame as described in [Annex C](#) and [Annex D](#) and heated in the heat tunnel. This section shall be kept the same for all relevant tests to allow the comparison of the response time before, during and after the environmental tests.

The remaining section of the sensing element ($L_1 - L_{\text{test}}$) not exposed to the intended test temperature shall remain at ambient temperature (23 ± 5) °C during the measurement unless otherwise stated in the individual tests.

NOTE 2 To facilitate the test procedure, it can be necessary to introduce easily detachable connections between different sections of the sensing element. The losses introduced by these connections are taken into account when determining L_1 .

NOTE 3 The manufacturer can specify a minimum length of sensing element that needs to be connected before and/or after the section of the sensing element being heated (L_{test}).

NOTE 4 To reduce the validation time for integrating line-type heat detectors, the system setting used in the test in [5.1.5](#) could be more sensitive than the system settings used in the performance tests (see [5.14](#) and [5.15](#)).

NOTE 5 For ror-only RLTHD the manufacturer can choose an alternative ror to the 3 Kmin^{-1} agreed between the manufacturer and the testing laboratory. This value shall replace 3 Kmin^{-1} in [subclauses 5.4, 5.5, 5.12, 5.17, 5.18, 5.19, 5.20, 5.21, 5.22, 5.23, 5.24, 5.25, 5.26, 5.27, 5.28, 5.29, 5.30, 5.31, 5.32, 5.33, 5.34](#) and [5.35](#). The description of the value in this subclause remains $t(3)_{\text{min}}$ and $t(3)_{\text{max}}$.

5.1.5.3 Multipoint heat detectors

For measurement of the response time of multipoint heat detectors, the length of sensing element, L_1 which shall be connected to the sensor control unit, shall be chosen to be the worst case for the technology employed. This shall be agreed between the manufacturer and the testing laboratory.

When testing the response time of multipoint detectors, one single sensor of the multipoint detector shall be placed in the centre of the tunnel measuring section (in accordance with [Annex E](#)). All other sensors shall be outside the heat tunnel and shall remain at ambient temperature (23 ± 5) °C during the measurement unless otherwise stated in the individual tests.

NOTE The manufacturer can specify a minimum length of sensing element that needs to be connected before and/or after the section of the sensing element being heated.

5.1.6 Provision for tests

Three specimens of sensor control unit, at least three specimens of sensing element and, if applicable, at least three specimens of each functional unit shall be provided to conduct the tests in [5.1.7](#). The exact

number and length of sensing elements shall be agreed between the manufacturer and the testing laboratory.

NOTE 1 If there are different types of sensor control units, sensing elements and/or functional units (e.g. with different environment groups), at least three specimens can be provided for each type.

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

NOTE 2 This implies that the mean response time of the three specimens as found in the reproducibility test can also represent the production mean. The limits specified in the reproducibility test can also be applicable to the manufacturer's production.

5.1.7 Test schedule

The specimens shall be tested according to the following test schedule (see Table 5).

Table 5 — Test schedule

Test ^d	Sub-clause	Specimen Number ^a		
		Sensor control units	Sensing elements	Functional units
Individual alarm indication	5.2	One specimen, chosen arbitrarily	—	—
Signalling	5.3	One specimen, chosen arbitrarily	—	—
Repeatability	5.4	One specimen, chosen arbitrarily	One specimen, chosen arbitrarily	One specimen (of each type), chosen arbitrarily
Reproducibility ^c	5.5	1 to 3	1 to 3 ^b	1 to 3 ^b
Connection of ancillary devices	5.6	One specimen, chosen arbitrarily	—	—
Manufacturer's adjustments	5.7	One specimen, chosen arbitrarily	—	—
Requirements for software-controlled detectors	5.8	One specimen, chosen arbitrarily	—	—
Sensing element fault	5.9	2	2	2

^a The schedule shows the specimen numbers recommended for each test. Other arrangements can be used by agreement between the various parties (e.g. approval body, testing laboratory, manufacturer, etc.) in order to improve the efficiency or cost of testing, or to reduce the number of specimens damaged by the testing. However, the reproducibility of the sensitivity of at least three specimens shall be measured in the reproducibility test. If fewer specimens are to be used for the rest of the tests then the possible damaging effects of subjecting a specimen to a number of tests, especially endurance tests, have to be considered.

^b Assigned arbitrarily to the sensor control units. If more than 2 sensing elements may be connected to the sensor control unit (single ended or loop configuration) and/or there are sensing elements for different environment groups, then the number of tests shall be agreed between the manufacturer and the testing laboratory.

^c For the reproducibility test, only combinations of sensor control units with functional units and sensing elements that are used in 5.4 to 5.16 shall be used.

^d The test order remains open to allow optimization of the test program to minimize test time and cost.

^e Subclause 5.15 does not apply to ror-only RLTHD.

Table 5 (continued)

Test ^d	Sub-clause	Specimen Number ^a		
		Sensor control units	Sensing elements	Functional units
On-site adjustment of response behaviour	5.10	One specimen, chosen arbitrarily	—	—
Maximum ambient temperature test (sensing element)	5.11	2	3	3
Variation in supply parameters	5.12	1	1	1
Low voltage fault	5.13	2	2	2
Fire sensitivity for Class A and ror-only RLTHD	5.14	1	1	1
Static response temperature test ^e	5.15	1	2	2
Response times from typical application temperature for ror-only RLTHD	5.16			
Dry heat (operational) sensor control unit	5.17	1	2	2
Dry heat (endurance) sensor control unit and sensing element	5.18	2	3	3
Cold (operational) sensing element	5.19	2	3	3
Cold (operational) for sensor control unit	5.20	2	3	3
Damp heat, steady-state (endurance) for sensor control unit and sensing element	5.21	3	2	2
Damp heat, cyclic (operational) for sensing element	5.22	2	3	3
Damp heat, cyclic (operational) for sensor control unit	5.23	2	3	3
Damp heat, steady-state (operational) for sensor control unit	5.24	2	3	3
Damp heat, cyclic (endurance) for sensor control unit and sensing element	5.25	2	3	3
Shock (operational) for sensor control unit	5.26	2	2	2
Impact (operational) for sensor control unit	5.27	2	2	2
Impact (operational) for sensing element	5.28	2	2	2
Vibration, sinusoidal (operational) for sensor control unit	5.29	2	2	2
Vibration, sinusoidal (operational) for sensing element	5.30	2	2	2
Vibration, sinusoidal (endurance) for sensor control unit	5.31	2	2	2
Vibration, sinusoidal (endurance) for sensing element	5.32	2	2	2
Sulfur dioxide (SO ₂) corrosion (endurance) for sensing element	5.33	2	3	3

^a The schedule shows the specimen numbers recommended for each test. Other arrangements can be used by agreement between the various parties (e.g. approval body, testing laboratory, manufacturer, etc.) in order to improve the efficiency or cost of testing, or to reduce the number of specimens damaged by the testing. However, the reproducibility of the sensitivity of at least three specimens shall be measured in the reproducibility test. If fewer specimens are to be used for the rest of the tests then the possible damaging effects of subjecting a specimen to a number of tests, especially endurance tests, have to be considered.

^b Assigned arbitrarily to the sensor control units. If more than 2 sensing elements may be connected to the sensor control unit (single ended or loop configuration) and/or there are sensing elements for different environment groups, then the number of tests shall be agreed between the manufacturer and the testing laboratory.

^c For the reproducibility test, only combinations of sensor control units with functional units and sensing elements that are used in [5.4](#) to [5.16](#) shall be used.

^d The test order remains open to allow optimization of the test program to minimize test time and cost.

^e [Subclause 5.15](#) does not apply to ror-only RLTHD.

Table 5 (continued)

Test ^d	Sub-clause	Specimen Number ^a		
		Sensor control units	Sensing elements	Functional units
Sulfur dioxide (SO ₂) corrosion (endurance) for sensor control unit	5.34	3	3	3
Electromagnetic compatibility (EMC), immunity tests (operational)	5.35	2	2	2
<p>^a The schedule shows the specimen numbers recommended for each test. Other arrangements can be used by agreement between the various parties (e.g. approval body, testing laboratory, manufacturer, etc.) in order to improve the efficiency or cost of testing, or to reduce the number of specimens damaged by the testing. However, the reproducibility of the sensitivity of at least three specimens shall be measured in the reproducibility test. If fewer specimens are to be used for the rest of the tests then the possible damaging effects of subjecting a specimen to a number of tests, especially endurance tests, have to be considered.</p> <p>^b Assigned arbitrarily to the sensor control units. If more than 2 sensing elements may be connected to the sensor control unit (single ended or loop configuration) and/or there are sensing elements for different environment groups, then the number of tests shall be agreed between the manufacturer and the testing laboratory.</p> <p>^c For the reproducibility test, only combinations of sensor control units with functional units and sensing elements that are used in 5.4 to 5.16 shall be used.</p> <p>^d The test order remains open to allow optimization of the test program to minimize test time and cost.</p> <p>^e Subclause 5.15 does not apply to ror-only RLTHD.</p>				

5.2 Individual alarm indication

The visual indicator shall be visually inspected to confirm it meets the requirements of [4.2](#).

5.3 Signalling

An engineering assessment shall be carried out for the correct signalling of the alarm and fault signal(s). The following test methods shall apply to generate the alarm or fault status:

- a) sensing element faults (see [5.9](#));
- b) low voltage (see [5.13](#));
- c) procedure for measuring response time (see [5.1.5](#)).

NOTE if there is more than one sensing element, the assessment is carried out for every sensing element.

5.4 Repeatability

5.4.1 Object of the test

To show that the RLTHD is stable with respect to its sensitivity, even after a number of alarm conditions.

5.4.2 Test procedure

The response time of the specimen to be tested shall be measured as described in [5.1.5](#), three times each at rates of rise of temperature of 3 Kmin⁻¹ and 20 Kmin⁻¹.

A recovery period as specified by the manufacturer shall be allowed between consecutive tests.

At the 3 Kmin⁻¹ rate, the maximum response time shall be designated $t(3)_{max}$ and the minimum response time $t(3)_{min}$.

At the 20 Kmin⁻¹ rate, the maximum response time shall be designated $t(20)_{max}$ and the minimum response time $t(20)_{min}$.

5.4.3 Requirements

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

The ratio of the response times $t(20)_{\max}:t(20)_{\min}$ shall be not greater than 1,6.

5.5 Reproducibility

5.5.1 Object of the test

To show that the sensitivity of the detector does not vary unduly from specimen to specimen and to establish response time data for comparison with the response times measured after the environmental tests.

5.5.2 Test procedure

The response time of the specimen to be tested shall be measured as described in [5.1.5](#) at rates of rise of temperature of 3 Kmin⁻¹ and 20 Kmin⁻¹.

A recovery period as specified by the manufacturer shall be allowed between consecutive tests.

At the 3 Kmin⁻¹ rate, the maximum response time shall be designated $t(3)_{\max}$ and the minimum response time $t(3)_{\min}$.

At the 20 Kmin⁻¹ rate, the maximum response time shall be designated $t(20)_{\max}$ and the minimum response time $t(20)_{\min}$.

5.5.3 Requirements

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

The ratio of the response times $t(20)_{\max}:t(20)_{\min}$ shall be not greater than 1,6.

5.6 Connection of ancillary devices

Open- and short-circuit shall be applied at the connections for ancillary devices.

An engineering assessment shall be carried out for the correct operation of the detector as specified in [4.6](#).

5.7 Manufacturer's adjustments

A visual inspection of a specimen shall be conducted to verify that the detector meets the requirements for manufacturer adjustments as specified in [4.7](#).

5.8 Requirements for software-controlled detectors

For detectors that rely on software for their operation, a visual inspection of documentation provided by the manufacturer shall be conducted to verify that the device conforms to the requirements specified in [4.8](#).

5.9 Sensing element fault

5.9.1 Object of the test

To ensure that faults on the sensing element which may prevent the proper function of the RLTHD are monitored and signalled.

5.9.2 Sensing element operational continuity

A fault condition corresponding to an interruption of the sensing element(s) in operation shall be generated while the RLTHD is monitored.

If a sensing element consists of more than one conductor/optical fibre/tube, each of them shall also be interrupted individually.

5.9.3 Requirements

The fault condition shall be detected and signalled within 300 s.

No alarm signal shall be triggered.

5.10 On-site adjustment of response behaviour

A visual inspection shall be conducted to verify that the detector meets the requirements for on-site adjustment of response behaviour as specified in [4.10](#).

5.11 Maximum ambient temperature test (sensing element)

5.11.1 Object of the test

To demonstrate the ability of the RLTHD to function correctly even if the sensing element is exposed to high ambient temperature appropriate to the anticipated service temperature.

5.11.2 Mounting of the sensing element

The maximum length of sensing element shall be mounted in a heat chamber in a way that allows it to be heated up such that the temperature difference between any two points at the surface of the sensing element is not more than 5 K. A suitable test arrangement shall be agreed between the testing laboratory and the manufacturer and shall be supplied by the manufacturer.

5.11.3 Test procedure

The sensor control unit is in operation and remains at normal ambient conditions (23 ± 5) °C.

Starting from the typical application temperature the temperature inside the heat chamber shall be increased with a rate of rise of temperature of $\leq 0,1 \text{ Kmin}^{-1}$ up to the maximum application temperature (see [4.1.2](#)). This temperature level shall be maintained for 16 h.

Immediately after the exposure period the sensing element shall be stimulated by a means, agreed between manufacturer and testing laboratory, to trigger an alarm signal.

5.11.4 Requirements

No alarm or fault signal shall be given during the initial temperature increase and the 16 h stabilization period.

The RLTHD shall give an alarm signal by stimulation after the exposure period.

5.12 Variation in supply parameters

5.12.1 Object of the test

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

5.12.2 Test procedure

The response time of the specimen to be tested shall be measured as described in [5.1.5](#) at a rate of rise of temperature of 3 Kmin⁻¹ and at the upper and lower limits of the supply parameter (e.g. voltage) range(s) specified by the manufacturer.

A recovery period as specified by the manufacturer shall be allowed between consecutive tests.

The maximum response time shall be designated $t(3)_{\max}$ and the minimum response time $t(3)_{\min}$.

NOTE For conventional RLTHD the supply parameter is the dc voltage applied to the sensor control unit. For other types of detector, signal levels and timing need to be considered. If necessary, the manufacturer can be requested to provide suitable supply equipment to allow the supply parameters to be changed as required.

5.12.3 Requirements

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.13 Low voltage fault

5.13.1 Object of the test

To show that the sensor control unit is able to signal a fault condition when its input power supply falls below the minimum voltage specified by the manufacturer (see [5.3](#)).

5.13.2 Test procedure

The specimen shall be mounted as described in [5.1.3](#) and shall be connected to supply and monitoring equipment as described in [5.1.2](#). The sensor control unit shall be operated at its maximum loading and at the lower voltage specified by the manufacturer (as tested in [5.3](#)).

The supply voltage to the sensor control unit shall then be lowered by 15 %.

NOTE Maximum loading can include optional cards, power consuming sensor cables, etc.

5.13.3 Requirements

The sensor control unit shall signal a fault condition within 100 s following the voltage being lowered.

5.14 Fire sensitivity for Class A and ror-only RLTHD

5.14.1 Object of the test

To show that the RLTHD (for room protection application) has, depending on its classification, an adequate sensitivity to the heat release of a real test fire as required for general application in fire detection systems.

5.14.2 Principle

A part of the sensing element of the RLTHD is mounted in accordance with [Annex A](#) and is exposed to three defined test fires in accordance with [Annex B](#). That part of the sensing element not installed in the fire test room shall remain in stable environmental conditions, as specified in [5.14.5](#).

5.14.3 Fire test room

The fire sensitivity tests shall be conducted in a rectangular room with a flat horizontal ceiling, and the following dimensions:

— length: 9 m to 11 m;

- width: 6 m to 8 m;
- height: 3,8 m to 4,2 m.

The fire test room shall be equipped with a temperature probe arranged as indicated in [Annex A](#).

5.14.4 Test fires

The sensing element of the specimen shall be subjected to the test fires TF6F, TF6 and TF6S. The TF6S test fire is not required for ror-only detectors.

The type, quantity and arrangement of the fuel and the method of ignition are described in [Annex B](#) along with the end of test condition and the required profile curve limits.

In order to be a valid test fire, the development of the fire shall be such that the test validity criteria in [Annex B](#) are fulfilled. It is permissible, and can be necessary, to adjust the quantity, condition and arrangement of the fuel to obtain valid test fires.

5.14.5 Mounting of the specimens

A length of $(10 \pm 0,2)$ m of the sensing element of the specimen shall be mounted on the fire test room ceiling in the designated area (in accordance with [Annex A](#)) in such a manner that the sensing element has at least a horizontal distance of 2 m from the centre of the test fire. The specimen shall be mounted 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.

Sensing elements of multipoint RLTHD shall be installed so that at least 1 sensor is arranged within the fire test room. This sensor shall be located on the 3 m radius (Position D). If there is more than 1 sensor in the test room then one sensor shall be located on the 3 m radius (Position D).

The part of the sensing element in the fire test room shall have a spacing from the ceiling of (3 ± 2) cm.

That part of the sensing element not installed in the fire test room and the sensor control unit shall remain at an air temperature of $T = (23 \pm 5)$ °C, and the air movement negligible.

The length of the sensing element under test (10 m) plus the length of the sensing element not installed in the fire test room shall be the maximum length of the sensing element in accordance with manufacturer's specification.

The position of the part of the sensing element under test shall be chosen such that it represents the least sensitive response behaviour of the RLTHD. A typical example of a test setup is shown in [Figure A.2](#).

The RLTHD shall be connected to its supply and monitoring equipment, as described in [5.1.2](#), and shall be allowed to stabilize in its quiescent condition before the start of the test fire.

NOTE Detectors which dynamically modify their sensitivity in response to varying ambient conditions, sometimes require special reset procedures and/or stabilization times. The manufacturer's guidance can be sought in such cases to ensure that the state of the detectors at the start of each test is representative of their normal quiescent state.

5.14.6 Initial conditions

Before each test fire the room shall be ventilated with clean air until it is free from fire products and so that the conditions listed below can be obtained.

The ventilation system shall then be switched off and all doors, windows and other openings shall be closed. The air in the room shall then be allowed to stabilize and the following conditions shall be obtained before the test is started:

- air temperature: (23 ± 5) °C;

— air movement: negligible.

5.14.7 Recording of the fire parameters and response times

During each test fire the temperature, T , (in °C, measuring defined in [Annex B](#) on the 3 m circle) shall be recorded continuously or at least once per second.

The alarm signal given by the RLTHD shall be taken as the indication that a specimen has responded to the test fire.

The time of response of each specimen shall be recorded along with the test fire temperature T at the moment of response.

5.14.8 Requirements

The RLTHD shall generate an alarm signal, in its assigned response class, according to the response time in [Table 6](#).

Table 6 — Response times for Class A and ror-only RLTHD

Heat response classes	Response times					
	TF6S		TF6		TF6F	
	Lower value s	Upper value s	Lower value s	Upper value s	Lower value s	Upper value s
A1N, A1I	50	400	30	210	20	130
A2N, A2I	120	600	60	300	40	180
A1NR, A1IR	No test	No test	30	210	20	130
A2NR, A2IR	No test	No test	60	300	40	180

5.15 Static response temperature test

5.15.1 Object of the test

To show that the RLTHD has, depending on its classification, an adequate sensitivity to a slow rate of rise of temperature.

NOTE Not applicable for ror-only detectors.

5.15.2 Test procedure for non-integrating linear and multipoint RLTHD

5.15.2.1 Principle

A part of the sensing element of the RLTHD is mounted in a heat tunnel in accordance with [Annex C](#) and [Annex E](#) and is exposed to a static temperature test.

5.15.2.2 Test procedure for non-integrating linear RLTHD

5.15.2.2.1 Mounting of the sensing element

For measurement of the sensitivity of the non-integrating linear RLTHD, the length of sensing element, L_1 , that shall be connected to the sensor control unit shall be chosen to be the worst case for the technology employed. This shall be agreed between the manufacturer and the testing laboratory.

NOTE 1 The worst case can be determined taking into account the effect on the temperature measurement of noise and losses in the sensing element.

A section of $(10 \pm 0,1)$ m (L_{test}) of the sensing element shall be wrapped around a test frame as described in [Annex C](#) and heated in the heat tunnel.

The position of the part of the sensing element under test shall be chosen such that it represents the least sensitive response behaviour of the RLTHD. A typical example of a test setup is shown in [Figure C.1](#).

NOTE 2 To facilitate the test procedure, it could be necessary to introduce easily detachable connections between different sections of the sensing element. The losses introduced by these connections can be taken into account when determining L_1 .

NOTE 3 The manufacturer can specify a minimum length of sensing element that needs to be connected before and after the section of the sensing element being heated (L_{test}).

5.15.2.2.2 Initial conditions

Before the measurement, the temperature of the air stream and the section of sensing element at the typical ambient temperature for the appropriate response class as specified in [4.1.2](#) shall be stabilized.

For non-integrating linear RLTHD, the remaining section of the sensing element ($L_1 - L_{\text{test}}$) not exposed to the intended test temperature shall be stabilized at an ambient temperature of (23 ± 5) °C during the measurement.

The sensor control unit shall be operated at an ambient temperature of (23 ± 5) °C during the measurement.

5.15.2.2.3 Measurement of response temperature

The measurement shall then be done by increasing the air temperature in the tunnel from the initial condition at a rate of rise of 1 Kmin^{-1} until the applicable maximum application temperature is reached as specified in [4.1.2](#) according to the appropriate class. Thereafter the test shall be continued at a maximum rate of rise of air temperature of $0,2 \text{ Kmin}^{-1}$ until the sensor control unit annunciates an alarm.

During the measurement, the airflow in the tunnel shall be maintained at a constant mass flow, equivalent to $(0,8 \pm 0,1)$ m/s at 25 °C. The air temperature shall be controlled to within ± 2 K of the nominal temperature required at any time during the test.

The measured temperature at the moment the sensor control unit indicates an alarm shall be recorded.

5.15.2.3 Test procedure for multipoint RLTHD

5.15.2.3.1 Mounting of the sensing element

For measurement of the sensitivity of the multipoint RLTHD, the length of sensing element, L_1 , that is to be connected to the sensor control unit shall be chosen to be the worst case for the technology employed. This shall be agreed between the manufacturer and the testing laboratory.

NOTE The worst case can be determined by taking into account the effect on the temperature measurement of noise and losses in the sensing element.

When testing the response temperature of multipoint detectors, one single sensor within a 10 m section of the sensing element, L_{test} , shall be placed in the tunnel measuring section as described in [Annex E](#).

The position of the part of the sensing element under test (L_{test}) shall be chosen such that it represents the least sensitive response behaviour of the RLTHD. A typical example of a test setup is shown in [Figure E.1](#).

5.15.2.3.2 Initial conditions

Before the measurement, the temperature of the air stream and the section of sensing element, L_{test} , at the typical ambient temperature for the appropriate response class as specified in 4.1.2 shall be stabilized.

The remaining section of the sensing element ($L_1 - L_{\text{test}}$) not exposed to the intended test temperature shall be stabilized at an ambient temperature of (23 ± 5) °C during the measurement.

The sensor control unit shall be operated at an ambient temperature of (23 ± 5) °C during the measurement.

5.15.2.3.3 Measurement of response temperature

The measurement shall then be done by increasing the air temperature in the tunnel from the initial condition at a rate of rise of 1 Kmin^{-1} until the applicable maximum application temperature is reached as specified in 4.1.2 according to the appropriate class. Thereafter the test shall be continued at a maximum rate of rise of air temperature of $0,2 \text{ Kmin}^{-1}$ until the sensor control unit annunciates an alarm.

During the measurement, the airflow in the tunnel shall be maintained at a constant mass flow, equivalent to $(0,8 \pm 0,1) \text{ m/s}$ at 25 °C. The air temperature shall be controlled to within $\pm 2 \text{ K}$ of the nominal temperature required at any time during the test (in accordance with Annex E).

The measured temperature at the moment the sensor control unit indicates an alarm shall be recorded.

5.15.3 Test procedure for integrating linear RLTHD

5.15.3.1 Principle

The maximum length of the sensing element of the integrating linear RLTHD as specified by the manufacturer is exposed to the heat.

5.15.3.2 Mounting of the sensing element

The sensing element shall be mounted in a heat chamber in a way that allows the sensing element to be heated homogeneously. A suitable test arrangement shall be agreed between the testing laboratory and the manufacturer and shall be supplied by the manufacturer.

5.15.3.3 Initial conditions

Before the measurement, the temperature in the heat chamber at the typical ambient temperature for the appropriate response class as specified in 4.1.2 shall be stabilized.

The sensor control unit shall be operated at an ambient temperature of (23 ± 5) °C during the measurement.

5.15.3.4 Measurement of response temperature

The measurement shall then be done by increasing the air temperature in the heat chamber from the initial condition at a rate of rise of $\leq 0,5 \text{ Kmin}^{-1}$ until the applicable maximum application temperature is reached as specified in 4.1.2 according to the appropriate class. Thereafter the test shall be continued at a maximum rate of rise of air temperature of $0,2 \text{ Kmin}^{-1}$ until the sensor control unit announce an alarm.

The air temperature shall be controlled to within $\pm 2 \text{ K}$ of the nominal temperature required at any time during the test.

The measured temperature at the moment the sensor control unit indicates an alarm shall be recorded.

5.15.4 Requirements

The detector tested shall respond between the minimum and maximum static response temperatures shown in [4.1.2](#), according to the class of the detector.

5.16 Response times from typical application temperature for ror-only RLTHD

5.16.1 Object of the test

To show that the ror-only RLTHD has, depending on its classification, an adequate sensitivity to selected rate of rise of temperature.

5.16.2 Test procedure

The specimens shall be tested as described in [5.1.5](#) at rates of rise of air temperature of 20 Kmin⁻¹ and 30 Kmin⁻¹. Before each test the specimen shall be stabilized to the typical application temperature specified in [Table 4](#) 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.

5.16.3 Requirements

The response times of the detectors shall lie between the lower and upper response time limits specified in [Table 7](#).

Table 7 — Response time limits

Rate of rise of air temperature	Lower limit of response time		Upper limit of response time	
	min	s	min	s
20	0	30	2	20
30	0	20	1	40

5.17 Dry heat (operational) test for sensor control unit

5.17.1 Object of the test

To demonstrate the ability of the sensor control unit to function correctly at high ambient temperatures appropriate to the anticipated service environment.

5.17.2 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-2, Test Bb or Bd, and as indicated below.

5.17.3 State of the specimen during conditioning

The specimen shall be mounted as described in [5.1.3](#) and shall be connected to supply and monitoring equipment as described in [5.1.2](#).

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in [5.1.5](#).

The sensing element shall be maintained at normal atmospheric conditions (see [5.1.1](#)).

5.17.4 Conditioning

The conditioning shall be applied to the sensor control unit in accordance with the applicable environmental group shown in [Table 8](#).

Table 8 — Conditions for dry heat (operational) test for sensor control unit

Environmental group	Temperature °C	Duration h
I	40 ± 2	16
II	55 ± 2	16
III	70 ± 2	16

NOTE If a sensor control unit is specified for more than one environmental group, the test need only be carried out for the most severe group.

5.17.5 Measurements during conditioning

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

During the last hour of the conditioning, stimulate an alarm condition by means agreed with the manufacturer.

5.17.6 Final measurements

After the conditioning and a recovery period of at least 1 h, the functional test as described in [5.1.5](#) shall be conducted at a rate of rise of 3 Kmin⁻¹ and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.17.7 Requirements

No alarm or fault signal shall be given during the period in which the temperature is increasing to the stabilization temperature or during the stabilized period.

An alarm shall be generated when stimulated according to [5.17.5](#).

An alarm shall be generated during the functional test in [5.17.6](#).

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.18 Dry heat (endurance) for sensor control unit and sensing element

5.18.1 Object of the test

To demonstrate, if applicable, the ability of the RLTHD sensor control unit and sensing element to withstand long-term ageing effects.

5.18.2 Principle

The test consists of exposure of the sensor control unit and the sensing element specimens to the high temperature, for a long period to accelerate ageing effects.

The test shall be conducted consecutively for the sensor control unit and the sensing element. However, in case the temperature conditioning for the sensor control unit and the sensing element is the same, testing may be conducted simultaneously.

5.18.3 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-2.

5.18.4 State of the specimen during conditioning

The sensor control unit and the sensing element specimens shall not be supplied with power during conditioning and tests for non heat-dissipating specimens shall apply (Test Bb).

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5.

The length of sensing element to be exposed to the heat shall be the 10 m section, L_{test} , which is to be used for the response test (see 5.1.5.).

NOTE The section of the sensing element to be exposed to the dry heat can be disconnected from the remainder of the sample and its open ends can be sealed in accordance with the manufacturer's instructions if necessary.

5.18.5 Conditioning

Conditioning shall be applied to the specimen as indicated in Table 9 and Table 10.

Table 9 — Conditions for dry heat (endurance) test for sensing elements

Environmental group	Class	Temperature °C	Duration days
II	A1I, A2I, BI, A1N, A2N, BN, A1IR, A2IR, BIR, A1NR and A2NR	No test	
	class CI, CN and CIR	80 ± 2	21
	class DI, DN and DIR	95 ± 2	
	class EI, EN and EIR	110 ± 2	
	class FI, FN and FIR	125 ± 2	
	class GI, GN and GIR	140 ± 2	
III	A1I, A2I, BI, A1N, A2N, BN, A1IR, A2IR, BIR, A1NR and A2NR	70 ± 2	21
	class CI, CN and CIR	80 ± 2	21
	class DI, DN and DIR	95 ± 2	
	class EI, EN and EIR	110 ± 2	
	class FI, FN and FIR	125 ± 2	
	class GI, GN and GIR	140 ± 2	

Table 10 — Conditions for dry heat (endurance) test for sensor control unit

Environmental group	Class	Temperature °C	Duration days
I and II	all	No test	
III	all	70 ± 2	21

5.18.6 Final measurements

After the conditioning and a recovery period of at least 1 h, the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin⁻¹ and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.18.7 Requirements

No alarm or fault signal shall be given after powering the sensing element at the end of the conditioning and recovery periods.

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.19 Cold (operational) for sensing element

5.19.1 Object of the test

To demonstrate the ability of the RLTHD to function correctly even if the sensing element is exposed to low ambient temperatures appropriate to the anticipated service environment.

5.19.2 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-1, Test Ab.

5.19.3 State of the specimen during conditioning

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

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5.

The sensor control unit shall be maintained at normal ambient conditions defined in 5.1.1.

5.19.4 Conditioning

Conditioning shall be applied to the specimen as indicated in Table 11.

Table 11 — Conditions for cold (operational) test for sensing element

Environmental group	Temperature ^a °C	Duration h
II	-10 ± 3	16
III	-25 ± 3	16
^a In countries with very cold outside temperatures test condition of (-40 ± 3) °C should be used.		

NOTE If the sensor control unit and the sensing element belong to the same environmental group the test can be performed concurrently with 5.20.

5.19.5 Measurements during conditioning

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

5.19.6 Final measurements

After the conditioning and a recovery period of at least 1 h, the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin⁻¹ and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.19.7 Requirements

No alarm or fault signal shall be given during the period that the temperature is decreasing to the stabilization temperature or during the stabilized period.

The ratio of the response times $t(3)_{max}:t(3)_{min}$ shall be not greater than 1,3.

5.20 Cold (operational) for sensor control unit

5.20.1 Object of the test

To demonstrate the ability of the RLTHD sensor control unit to function correctly at low ambient temperatures appropriate to the anticipated service environment.

5.20.2 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-1.

The tests with gradual changes in temperature shall be used. Test Ad shall be used for heat-dissipating specimens (as defined in IEC 60068-2-1) and Test Ab for non heat-dissipating specimens.

5.20.3 State of the specimen during conditioning

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

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5.

The sensing element shall be maintained at normal ambient conditions defined in 5.1.1.

5.20.4 Conditioning

Conditioning shall be applied to the specimen as indicated in Table 12.

Table 12 — Conditions for cold (operational) test for sensor control unit

Environmental group	Temperature °C	Duration h
I	-5 ± 3	16
II	-10 ± 3	16
III	-25 ± 3	16

NOTE If the sensor control unit and the sensing element belongs to the same environmental group the test can be performed concurrently with 5.19.

5.20.5 Measurements during conditioning

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

During the last hour of the conditioning, simulate an alarm condition by means agreed with the manufacturer.

5.20.6 Final measurements

After the conditioning and a recovery period of at least 1 h, the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin⁻¹ and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.20.7 Requirements

No alarm or fault signal shall be given during the period that the temperature is decreasing to the stabilization temperature or during the stabilized period.

An alarm shall be generated during the functional test in [5.20.5](#).

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.21 Damp heat, steady-state (endurance) for sensor control unit and sensing element

5.21.1 Object of the test

To demonstrate the ability of the RLTHD (sensor control unit and sensing element) 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, etc.).

5.21.2 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-78, Test Cab.

5.21.3 State of the specimen during conditioning

The specimen shall be mounted as described in [5.1.3](#) but shall not be supplied with power during the conditioning.

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in [5.1.5](#)

5.21.4 Conditioning

Conditioning shall be applied to the specimen as indicated in [Table 13](#).

Table 13 — Conditions for damp heat, steady-state (endurance) test

Environmental group	Temperature °C	Relative humidity %	Duration days
I, II and III	40 ± 2	93 ± 3	21

5.21.5 Final measurements

After the conditioning and a recovery period of at least 1 h at standard laboratory conditions, the functional test as described in [5.1.5](#) shall be conducted at a rate of rise of 3 Kmin⁻¹ and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.21.6 Requirements

No alarm or fault signal shall be given after powering the RLTHD at the end of the conditioning and recovery periods.

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.22 Damp heat, cyclic (operational) for sensing element

5.22.1 Object of the test

To demonstrate the ability of the RLTHD to function correctly even if the sensing element is exposed to high relative humidity which can occur for short periods in the anticipated service environment.

5.22.2 Principle

The lower severity (with an upper temperature of 40 °C) is intended for areas where light condensation can infrequently occur for short periods (e.g. during the warming up of storage areas with limited or no temperature control).

The higher severity (with an upper temperature of 55 °C) is intended for areas where heavy and/or frequent condensation can occur (e.g. outdoors or in wet rooms, etc.)

5.22.3 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-30, using the Variant 2 test cycle and controlled recovery conditions.

NOTE The test consists of exposing the specimen to cyclic temperature variations between 25 °C and the appropriate upper temperature (40 °C or 55 °C). The relative humidity is maintained at (93 ± 3) % during the high temperature phase and above 95 % during the low temperature and temperature changing phases. The rates of increase of temperature are such that condensation can occur on the surface of the specimen.

5.22.4 State of the specimen during conditioning

The specimen shall be mounted as described in [5.1.3](#) and shall be connected to the supply and monitoring equipment as described in [5.1.2](#).

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in [5.1.5](#).

The sensor control unit shall be maintained at normal ambient conditions defined in [5.1.1](#).

5.22.5 Conditioning

Conditioning shall be applied to the specimen as indicated in [Table 14](#).

Table 14 — Conditions for damp heat, cyclic (operational) test for sensing element

Environmental group	Lower temperature °C	Upper temperature °C	Relative humidity %		Number of cycles
			At lower temperature	At upper temperature	
II	25 ± 2	40 ± 2	≥ 95	93 ± 3	2
III	25 ± 2	55 ± 2	≥ 95	93 ± 3	2

NOTE 1 If the sensor control unit and the sensing element belong to the same environmental group the test can be performed concurrently with [5.23](#).

NOTE 2 For RLTHD class A1 and A2 system under environmental group III the minimum static response temperature is 54 °C so it can be possible that the system triggers an alarm if it works at the lower end of the tolerance. Therefore, the minimum static response temperature needs to be greater than 55 °C plus the tolerance of 2 °C.

5.22.6 Measurements during conditioning

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

5.22.7 Final measurements

After the conditioning and a recovery period of at least 1 h, the functional test as described in [5.1.5](#) shall be conducted at a rate of rise of 3 Kmin^{-1} and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated $t(3)_{\text{max}}$ and the lesser shall be designated $t(3)_{\text{min}}$.

5.22.8 Requirements

No alarm or fault signal shall be given during the conditioning and the following recovering period.

The ratio of the response times $t(3)_{\text{max}}:t(3)_{\text{min}}$ shall be not greater than 1,3.

5.23 Damp heat, cyclic (operational) for sensor control unit

5.23.1 Object of the test

To demonstrate the ability of the RLTHD sensor control unit to function correctly at high relative humidity which can occur for short periods during the anticipated service environment.

5.23.2 Principle

The lower severity (with an upper temperature of $40 \text{ }^\circ\text{C}$) is intended for areas where light condensation can infrequently occur for short periods (e.g. during the warming up of storage areas with limited or no temperature control).

The higher severity (with an upper temperature of $55 \text{ }^\circ\text{C}$) is intended for areas where heavy and/or frequent condensation can occur (e.g. outdoors or in wet rooms etc.)

5.23.3 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-30 using the Variant 2 test cycle and controlled recovery conditions.

NOTE The test consists of exposing the specimen to cyclic temperature variations between $25 \text{ }^\circ\text{C}$ and the appropriate upper temperature ($40 \text{ }^\circ\text{C}$ or $55 \text{ }^\circ\text{C}$). The relative humidity is maintained at $(93 \pm 3) \%$ during the high temperature phase and above 95% during the low temperature and temperature changing phases. The rates of increase of temperature are such that condensation ought to occur on the surface of the specimen.

5.23.4 State of the specimen during conditioning

The specimen shall be mounted as described in [5.1.3](#) and shall be connected to the supply and monitoring equipment as described in [5.1.2](#).

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in [5.1.5](#).

The sensing element shall be maintained at normal ambient conditions defined in [5.1.1](#).

5.23.5 Conditioning

Conditioning shall be applied to the specimen as indicated in [Table 15](#).

Table 15 — Conditions for damp heat, cyclic (operational) test for sensor control unit

Environmental group	Lower temperature °C	Upper temperature °C	Relative humidity %		Number of cycles
			At lower temperature	At upper temperature	
I	No test				
II	25 ± 2	40 ± 2	≥ 95	93 ± 3	2
III	25 ± 2	55 ± 2	≥ 95	93 ± 3	2

NOTE 1 If the sensor control unit and the sensing element belong to the same environmental group the test can be performed concurrently with [5.22](#).

NOTE 2 If the sensor control unit is classified in environmental group I then the damp heat, steady-state (operational) test for sensor control units is conducted instead.

5.23.6 Measurements during conditioning

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

During the last hour of the conditioning, simulate an alarm condition by means agreed with the manufacturer.

5.23.7 Final measurements

After the conditioning and a recovery period of at least 1 h, the functional test as described in [5.1.5](#) shall be conducted at a rate of rise of 3 Kmin⁻¹ and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.23.8 Requirements

No alarm or fault signal shall be given during the conditioning and the following recovering period.

An alarm shall be generated during the last hour of conditioning in [5.23.6](#) and functional test in [5.23.7](#).

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.24 Damp heat, steady-state (operational) for sensor control unit

5.24.1 Object of the test

To demonstrate the ability of the sensor control unit to function correctly at high relative humidity (without condensation) which can occur for short periods in the service environment.

5.24.2 Principle

The test consists of exposing the specimen to a constant temperature and a constant high relative humidity, in such a manner that condensation does not occur on the specimen.

The period of exposure is chosen to allow surface effects due to adsorption to be identified.

5.24.3 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-78, Test Cab.

5.24.4 State of the specimen during conditioning

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

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5.

The sensing element shall be maintained at normal ambient conditions defined in 5.1.1.

5.24.5 Conditioning

Conditioning shall be applied to the specimen as indicated in Table 16.

Table 16 — Conditions for damp heat, steady-state (operational) test for sensor control unit

Environmental group	Temperature °C	Relative humidity %	Duration days
I	40 ± 2	93 ± 3	4
II, III	No test		

NOTE If the sensor control unit is classified in environmental group II or III then the damp heat, cyclic (operational) test for sensor control units is conducted instead.

5.24.6 Measurements during conditioning

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

During the last hour of the conditioning, simulate an alarm condition by means agreed with the manufacturer.

5.24.7 Final measurements

After the conditioning and a recovery period of at least 1 h, the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin⁻¹ and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.24.8 Requirements

No alarm or fault signal shall be given during the conditioning and the following recovering period.

An alarm shall be generated during the conditioning in 5.24.6 and the functional test in 5.24.7.

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.25 Damp heat, cyclic (endurance) for sensor control unit and sensing element

5.25.1 Object of the test

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

5.25.2 Principle

The conditioning to this test is applicable to the sensing element and/or sensor control unit of environmental group III.

5.25.3 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-30 using the Variant 2 test cycle and controlled recovery conditions.

NOTE The test consists of exposing the specimen to cyclic temperature variations between 25 °C and 55 °C. The relative humidity is maintained at $(93 \pm 3) \%$ during the high temperature phase and above 95 % during the low temperature and temperature changing phases. The rates of increase of temperature are such that condensation ought to occur on the surface of the specimen.

5.25.4 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3 but shall not be supplied with power during the conditioning.

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5.

The part of the RLTHD which is not exposed to conditioning shall be maintained at normal ambient conditions defined in 5.1.1.

5.25.5 Conditioning

Conditioning shall be applied to the specimen as indicated in Table 17.

Table 17 — Damp heat, cyclic (endurance)

Environmental group	Lower temperature °C	Upper temperature °C	Relative humidity %		Number of cycles
			At lower temperature	At upper temperature	
I and II	No test				
III	25 ± 2	55 ± 2	≥ 95	93 ± 3	6

5.25.6 Final measurements

After the conditioning and a recovery period of at least 1 h at standard laboratory conditions, the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin^{-1} and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated $t(3)_{\text{max}}$ and the lesser shall be designated $t(3)_{\text{min}}$.

5.25.7 Requirements

No alarm or fault signal shall be given after powering the RLTHD at the end of the conditioning and recovery periods.

The ratio of the response times $t(3)_{\text{max}}:t(3)_{\text{min}}$ shall be not greater than 1,3.

5.26 Shock (operational) for sensor control unit

5.26.1 Object of the test

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

5.26.2 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-27, Test Ea, except that the conditioning shall be as described in the following subclauses.

5.26.3 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3 to a rigid fixture and shall be connected to its supply and monitoring equipment as described in 5.1.2.

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5.

5.26.4 Conditioning

For specimens with a mass $\leq 4,75$ kg, conditioning shall be applied to the specimen as indicated in Table 18. For specimens with a mass $> 4,75$ kg no test shall be applied.

Table 18 — Shock (operational) test for sensor control unit

Environmental group	Pulse type	Pulse duration ms	Maximum acceleration related to the specimen mass M (kg) ms^{-2}	Number of shock directions	Number of pulses per direction
I	No test				
II and III	Half sine	6	$1\,000 - (200 \times M)$	6 (i.e. 2 per axis)	3

5.26.5 Measurements during conditioning

The specimen shall be monitored during the conditioning period and for a further 2 min to detect any change.

5.26.6 Final measurements

After the conditioning and the further 2 min, the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin^{-1} and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\text{max}}$ and the lesser shall be designated $t(3)_{\text{min}}$.

5.26.7 Requirements

No alarm or fault signal shall be given during conditioning and the further 2 min.

The ratio of the response times $t(3)_{\text{max}}:t(3)_{\text{min}}$ shall be not greater than 1,3.

5.27 Impact (operational) for sensor control unit

5.27.1 Object of the test

To demonstrate the immunity of the RLTHD sensor control unit to mechanical impacts upon its surface, which it can potentially sustain in the normal service environment, and which it can reasonably be expected to withstand.

5.27.2 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-75, for Test Ehb.

5.27.3 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3 to a rigid structure, as required by IEC 60068-2-75, and shall be connected to its supply and monitoring equipment as described in 5.1.2.

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5.

5.27.4 Conditioning

Impacts shall be applied to all accessible surfaces of the specimen. For all such surfaces three blows shall be applied to any point(s) considered likely to cause damage to or impair the operation of the specimen.

Care should be taken to ensure that the results from a series of three blows do not influence subsequent series. In case of doubt, the defect shall be disregarded and a further three blows shall be applied to the same position on a new specimen.

Conditioning shall be applied to the specimen as indicated in Table 19.

Table 19 — Impact (operational) test for sensor control unit

Environmental group	Impact energy J	Number of impacts per point
I, II and III	0,5 ± 0,04	3

5.27.5 Measurements during conditioning

The specimen shall be monitored during the conditioning period and for a further 2 min to detect any change.

5.27.6 Final measurements

After the conditioning and the further 2 min, the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin⁻¹ and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{max}$ and the lesser shall be designated $t(3)_{min}$.

5.27.7 Requirements

No alarm or fault signal shall be given during conditioning and the further 2 min.

The ratio of the response times $t(3)_{max} : t(3)_{min}$ shall be not greater than 1,3.

5.28 Impact (operational) for sensing element

5.28.1 Object of the test

To demonstrate the ability of the RLTHD to function correctly even if the sensing element is exposed to mechanical impacts upon its surface, which it can potentially sustain in the normal service environment, and which it can reasonably be expected to withstand.

5.28.2 Test apparatus

The test apparatus shall be as shown in [Annex I](#).

5.28.3 State of the specimen(s) during conditioning

The specimen shall be mounted as described in [5.1.3](#) and shall be connected to its supply and monitoring equipment as described in [5.1.2](#).

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in [5.1.5](#).

5.28.4 Conditioning

A section of the sensing element shall be placed on the base of the apparatus described in [Annex I](#) either under a round-edged intermediate piece or, at a right angle, under the chisel-edged intermediate piece. The section of the sensing element shall be chosen as that most likely to impair the normal functioning of the specimen.

The first part of the conditioning is to be conducted using the round edged intermediate piece with the sensing element placed beneath it. Allow the hammer to fall from a height of (200 ± 10) mm.

After a period of at least 2 min the second part of the conditioning is to be applied to a different position of the sensing element, using the chisel edged intermediate piece with the sensing element placed in a right angle beneath it. Allow the hammer to fall from a height of (200 ± 10) mm.

Conditioning shall be applied to the specimen as indicated in the [Table 20](#).

Table 20 — Impact (operational) test for sensing element

Environmental group	Intermediate piece	Fall height mm	Hammer weight g	Number of impacts
II and III	Round-edged	200 ± 10	500 ± 10	1
II and III	Chisel-edged	200 ± 10	500 ± 10	1

5.28.5 Measurements during conditioning

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

5.28.6 Final measurements

After the conditioning and the further 2 min, the functional test as described in [5.1.5](#) shall be conducted at a rate of rise of 3 Kmin^{-1} and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.28.7 Requirements

No alarm or fault signal shall be given during conditioning and the further 2 min.

Although there can be visible distortion to the sheath of the sensing element where it was impacted, there shall be no visible cracking or cutting of the sheath.

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.29 Vibration, sinusoidal (operational) for sensor control unit

5.29.1 Object of the test

To demonstrate the immunity of the RLTHD sensor control unit to vibration at levels considered appropriate to the normal service environment.

5.29.2 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-6.

5.29.3 State of the specimen during conditioning

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

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5.

5.29.4 Conditioning

Conditioning shall be applied to the specimen as indicated in Table 21.

Table 21 — Vibration, sinusoidal (operational) test for sensor control unit

Environmental group	Frequency range Hz	Acceleration amplitude ms^{-2} {gn}	Number of axes	Sweep rate octaves $\times \text{min}^{-1}$	Number of sweep cycles per axis
I	10 to 150	1,0 { $\approx 0,1$ }	3	1	1
II and III	10 to 150	5,0 { $\approx 0,5$ }	3	1	1

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. Only one final measurement needs to be made.

5.29.5 Measurements during conditioning

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

5.29.6 Final measurements

After the conditioning, the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin^{-1} and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.29.7 Requirements

No alarm or fault signal shall be given during conditioning.

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.30 Vibration, sinusoidal (operational) for sensing element

5.30.1 Object of the test

To demonstrate the ability of the RLTHD to function correctly even if the sensing element is exposed to vibration at levels considered appropriate to the normal service environment.

5.30.2 Reference

The test apparatus and the procedure shall be as described in IEC 60068-2-6 and in accordance with [5.30](#).

5.30.3 State of the specimen during conditioning

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in [5.1.5](#).

A section of approximately 2 m of the sensing element shall be mounted on the test apparatus as described in [Annex H](#) and shall be connected to its supply and monitoring equipment as described in [5.1.2](#). The vibration shall be applied in the vertical axis.

For multipoint sensing elements a sensor shall be within the 2 m section under test located centrally between two of the three mounting brackets.

5.30.4 Conditioning

Conditioning shall be applied to the specimen as indicated in [Table 22](#).

Table 22 — Vibration, sinusoidal, (operational) for sensing element

Environmental group	Frequency range Hz	Acceleration amplitude ms^{-2} {gn}	Number of axes	Sweep rate octaves \times min^{-1}	Number of sweep cycles per axis
II and III	10 to 150	5,0 { $\approx 0,5$ }	1	1	1

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. Only one final measurement needs to be made.

5.30.5 Measurements during conditioning

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

5.30.6 Final measurements

After the conditioning, the functional test as described in [5.1.5](#) shall be conducted at a rate of rise of 3 Kmin^{-1} and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.30.7 Requirements

No alarm or fault signal shall be given during conditioning.

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.31 Vibration, sinusoidal (endurance) for sensor control unit

5.31.1 Object of the test

To demonstrate the ability of the RLTHD sensor control unit to withstand the long-term effects of vibration at levels appropriate to the service environment.

5.31.2 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-6.

5.31.3 State of the specimen during conditioning

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

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5.

5.31.4 Conditioning

Conditioning shall be applied to the specimen as indicated in Table 23.

Table 23 — Vibration, sinusoidal (endurance) for sensor control unit

Environmental group	Frequency range Hz	Acceleration amplitude ms^{-2} {gn}	Number of axes	Sweep rate octaves $\times \text{min}^{-1}$	Number of sweep cycles per axis
I	10 to 150	5,0 { $\approx 0,5$ }	3	1	20
II and III	10 to 150	10,0 { $\approx 1,0$ }	3	1	20

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. Only one final measurement needs to be made.

5.31.5 Final measurements

After the conditioning, the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin^{-1} and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.31.6 Requirements

No alarm or fault signal shall be given after powering the RLTHD at the end of the conditioning.

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.32 Vibration, sinusoidal (endurance) for sensing element

5.32.1 Object of the test

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

5.32.2 Reference

The test apparatus and the procedure shall be as described in IEC 60068-2-6 and as described in the following subclauses.

5.32.3 State of the specimen during conditioning

A section of approximately 2 m of sensing element shall be mounted on the test apparatus as described in [Annex H](#) and shall not be supplied with power during the conditioning. The vibration shall be applied in the vertical axis.

For multipoint sensing elements, a sensor shall be within the 2 m section under test located centrally between two of the three mounting brackets.

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in [5.1.5](#).

5.32.4 Conditioning

Conditioning shall be applied to the specimen as indicated in the [Table 24](#).

Table 24 — Vibration, sinusoidal (endurance) for sensing element

Environmental group	Frequency range Hz	Acceleration amplitude ms^{-2} {gn}	Number of axes	Sweep rate octaves \times min^{-1}	Number of sweep cycles per axis
II and III	10 to 150	10,0 { $\approx 1,0$ }	1	1	20

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. Only one final measurement needs to be made.

5.32.5 Final measurements

After the conditioning, the functional test as described in [5.1.5](#) shall be conducted at a rate of rise of 3 Kmin^{-1} and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated $t(3)_{\text{max}}$ and the lesser shall be designated $t(3)_{\text{min}}$.

5.32.6 Requirements

No alarm or fault signal shall be given after powering the RLTHD at the end of the conditioning.

The ratio of the response times $t(3)_{\text{max}}:t(3)_{\text{min}}$ shall be not greater than 1,3.

5.33 Sulfur dioxide (SO₂) corrosion (endurance) for sensing element

5.33.1 Object of the test

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

5.33.2 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-42, Test Kc, except that the conditioning shall be as described in the following subclauses.

5.33.3 State of the specimen during conditioning

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5, except that the length of the sensing element to be exposed shall be the 10 m section, L_{test} , which is to be used for the response test (see 5.1.5). In order to conduct the test, the section of the sensing element to be exposed to the corrosive atmosphere shall be disconnected from the remainder of the sample and its open ends shall be sealed in accordance with the manufacturer's instructions.

5.33.4 Conditioning

Conditioning shall be applied to the specimen as indicated in Table 25.

Table 25 — Sulfur dioxide (SO₂) corrosion (endurance) test for sensing element

Environmental group	Sulfur dioxide content μl/l	Temperature °C	Relative humidity %	Duration days
II and III	25 ± 5	25 ± 2	93 ± 3	21

NOTE If the sensor control unit and the sensing element belong to the same environmental group, the test can be performed concurrently with 5.34.

5.33.5 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 the recovery period, the section L_{test} shall be reconnected to the remainder of the sensing element and the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin⁻¹ and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\text{max}}$ and the lesser shall be designated $t(3)_{\text{min}}$.

5.33.6 Requirements

No alarm or fault signal shall be given after powering the RLTHD at the end of the conditioning and recovery periods.

The ratio of the response times $t(3)_{\text{max}}:t(3)_{\text{min}}$ shall be not greater than 1,3.

5.34 Sulfur dioxide (SO₂) corrosion (endurance) for sensor control unit

5.34.1 Object of the test

To demonstrate the ability of the RLTHD sensor control unit to withstand the corrosive effects of sulfur dioxide as an atmospheric pollutant.

5.34.2 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-42, Test Kc, except that the conditioning shall be as described in the following subclauses.

5.34.3 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3. It shall not be supplied with power during the conditioning.

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in 5.1.5.

5.34.4 Conditioning

Conditioning shall be applied to the specimen as indicated in Table 26.

Table 26 — Sulfur dioxide (SO₂) corrosion (endurance) test for sensor control unit

Environmental group	Sulfur dioxide content μl/l	Temperature °C	Relative humidity %	Duration days
I	No test			
II and III	25 ± 5	25 ± 2	93 ± 3	21

NOTE If the sensor control unit and the sensing element belongs to the same environmental group the test can be done concurrently with 5.33.

5.34.5 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 the recovery period, the functional test as described in 5.1.5 shall be conducted at a rate of rise of 3 Kmin⁻¹ and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.34.6 Requirements

No alarm or fault signal shall be given after powering the RLTHD at the end of the conditioning and recovery periods.

The ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

5.35 Electromagnetic compatibility (EMC), immunity tests (operational)

5.35.1 General

The following EMC immunity tests as specified in IEC 62599-2 shall be carried out:

- a) electrostatic discharge;
- b) radiated electromagnetic fields;
- c) conducted disturbances induced by electromagnetic fields;
- d) fast transient bursts;
- e) slow high energy voltage surges.

5.35.2 State of the specimen during conditioning

The length of sensing element used in the test shall correspond to the most unfavourable operating condition of the RLTHD technology under test. The configuration shall be the same as chosen in [5.1.5](#).

5.35.3 Final measurements

After the conditioning, the functional test as described in [5.1.5](#) shall be conducted at a rate of rise of 3 Kmin^{-1} and the response time recorded.

The greater response time value measured in this test and that measured for the same specimen in the reproducibility test shall be designated $t(3)_{\max}$ and the lesser shall be designated $t(3)_{\min}$.

5.35.4 Requirements

For these tests the criteria for conformance specified in IEC 62599-2 and the following shall apply:

- a) no alarm or fault signal shall be given during conditioning;
- b) the ratio of the response times $t(3)_{\max}:t(3)_{\min}$ shall be not greater than 1,3.

6 Test report

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

- a) identification of the RLTHD tested and the version number(s) of any software contained within the sensor control unit;
- b) a reference to this document, i.e. ISO 7240-31:2022;
- c) the results of the test: the individual response threshold values and the minimum, maximum, and arithmetic mean values where appropriate;
- d) the conditioning period and the conditioning atmosphere;
- e) the temperature and the relative humidity in the test room throughout the test;
- f) details of the supply and monitoring equipment and the alarm criteria;
- g) details of any deviation from this document or from the International Standards to which reference is made, and details of any operations regarded as optional.
- h) any unusual features observed;
- i) the date of the test.

7 Marking

7.1 General

The marking of resettable line-type heat detectors shall be visible during installation and shall be accessible during maintenance.

The marking shall not be placed on easily removable parts like screws.

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.

NOTE Where regulatory marking provisions require information on some or all items listed in this clause, the requirements of this clause concerning those common items are deemed to be met.

7.2 Marking of sensor control unit

The sensor control unit shall be clearly marked with the following information:

- a) the number and date of this document (i.e. ISO 7240-31:2022);
- b) the heat response class(es) of the RLTHD (e.g. A1N, A2N, BN, CN or A1I – GI or A1IR, A2IR).
- c) a clear statement “Rate-of-Rise only” (only for A1IR, A2IR, BIR ... GIR);
- d) the environmental group (I, II or III);
- e) the name or trademark of the manufacturer or supplier;
- f) the model designation (type or number);
- g) the wiring terminal designations;
- h) 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 sensor control unit.

7.3 Marking of sensing element

Each sensing element (batch) shall be marked with the following information:

- a) the name or trademark of the manufacturer or supplier;
- b) the model designation (type or number);
- c) the environment group (II or III);
- d) 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 sensing element, if applicable.
- e) a marking of sensor location and orientation (if applicable, e.g. for multipoint heat detector);

If it is not possible to mark directly on the sensing element, then the marking shall be affixed to the coil or other packaging used to protect the sensing element during transport and the use of at least one label securely fixed to the sensing element once installed is permitted.

7.4 Marking of functional units

Each functional unit shall be marked with the following information:

- a) the number and date of this document (i.e. ISO 7240-31:2022);

- b) the name or trademark of the manufacturer or supplier;
- c) the model designation (type or number);
- d) the environment group (I, II or III);
- e) the wiring terminal designations (if applicable);
- f) 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 functional unit.

8 Data

8.1 Hardware documentation

To ensure correct operation of resettable line-type heat detectors, manufacturers should make available, in addition to the marking information listed in [Clause 7](#), the following data.

- RLTHD should either be supplied with sufficient technical, installation and maintenance data to enable their correct installation and operation or, if all of these data are not supplied with each detector, reference to the appropriate data sheet should be given with each RLTHD.
- To understand correct operation of the detectors, additional data should be available that describe the 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 sensor control unit and/or control and indicating equipment, etc.
- For integrating and ror-only RLTHD, the manufacturer should declare the relation between the maximum application temperature and the corresponding sensing element length for each class for which conformance is claimed.

8.2 Software documentation

8.2.1 The manufacturer shall submit documentation that gives an overview of the software design. This documentation shall be in sufficient detail for the design to be inspected for conformance with this document and shall include at least the following:

- a) a functional description of the main program flow (e.g. as a flow diagram or schema) including the following:
 - 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 detector,
 - 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, sites specific data, and running data);
- c) a designation, by which the software and its version can be uniquely identified.

8.2.2 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 a hard copy or in machine-readable form (e.g. ASCII-code), including the 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 can be reviewed at the manufacturers' premises.

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Annex A (normative)

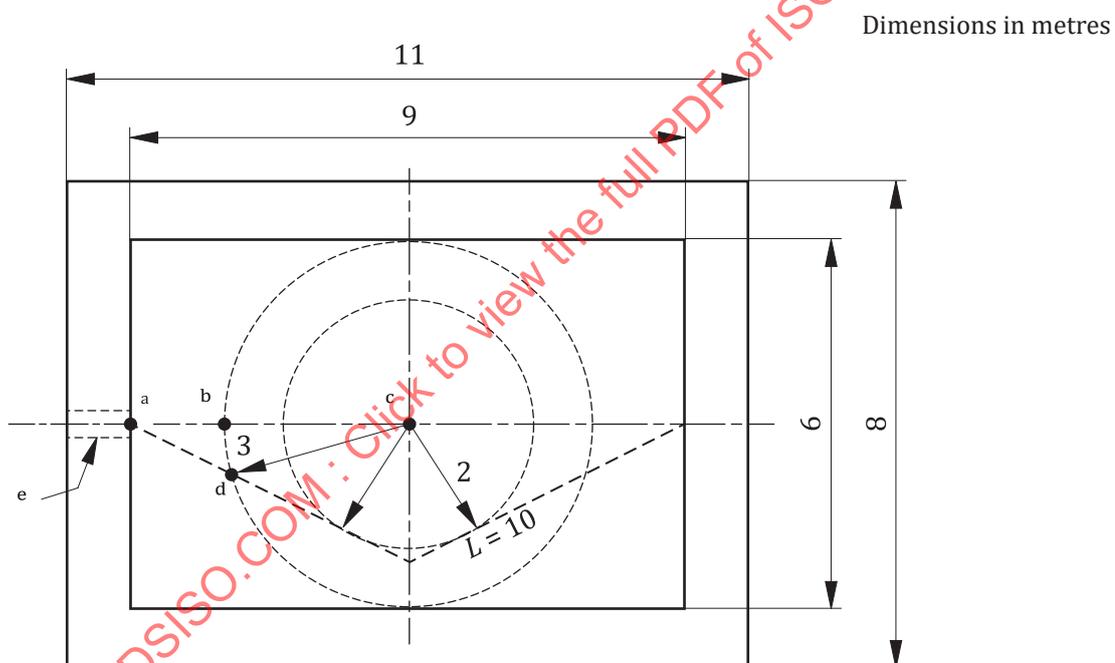
Arrangement of the sensing element in the fire test room

A.1 General

This annex specifies the arrangement of the sensing element for the fire tests (see 5.14).

A.2 Fire test room arrangement

A part of sensing element shall be mounted as shown in [Figure A.1](#) in a fire test room as described in ISO 7240-7.



Key

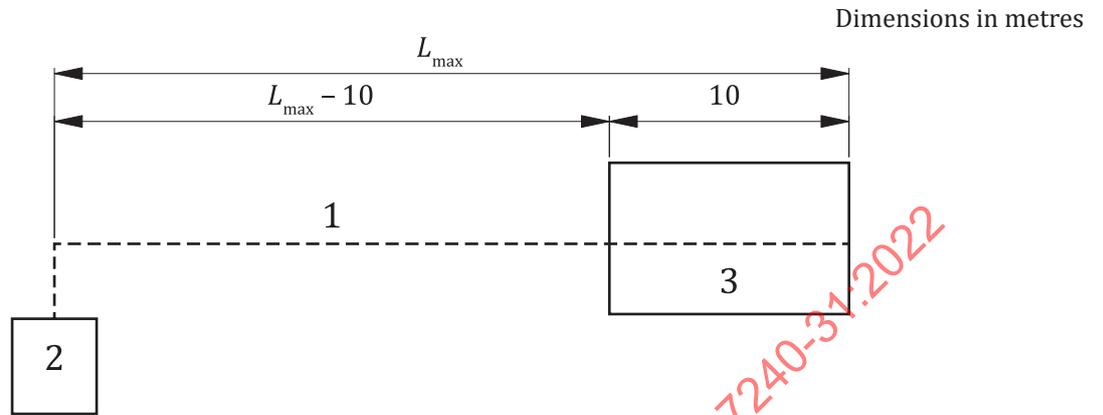
- a starting point of the sensing element
- b location of the temperature probe (distance from ceiling (50 ± 10) mm)
- c location of the test fire (centre of the floor)
- d in case of a multipoint sensing element: location of one sensor
- e thermal insulation in case of a fire test room exceeding the minimum dimensions

NOTE The inner rectangle shows the arrangement of sensing element in the smallest permissible size of the fire test room. The outer rectangle shows the arrangement of sensing element in the largest permissible size of the fire test room.

Figure A.1 — Arrangement of the sensing element in the fire test room

A.3 Sensing element outside the fire test room

The remaining part of the sensing element shall be arranged in a stable environment at $(23 \pm 5) \text{ }^\circ\text{C}$ as shown in [Figure A.2](#).



Key

- 1 sensing element
- 2 sensor control unit
- 3 fire test room as in [Figure A.1](#)

Figure A.2 — Arrangement of sensing element outside the fire test room

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