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Fire detection and alarm systems —

Part 20:
Aspirating smoke detectors

Systèmes de détection et d'alarme d'incendie —

Partie 20: Détecteurs de fumée par aspiration

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

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

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

ISO 7240-20 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 3, *Fire detection and alarm systems*.

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

— *Part 1: General and definitions*

— *Part 2: Control and indicating equipment*

— *Part 3: Audible alarm devices*

— *Part 4: Power supply equipment*

— *Part 5: Point-type heat detectors*

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

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

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

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

— *Part 10: Point-type flame detectors*

— *Part 11: Manual call points*

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

— *Part 13: Compatibility assessment of system components*

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

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

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

— *Part 17: Short-circuit isolators*

— *Part 18: Input/output devices*

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

— *Part 20: Aspirating smoke detectors*

— *Part 21: Routing equipment*

— *Part 22: Smoke-detection equipment for ducts*

— *Part 24: Sound-system loudspeakers*

— *Part 25: Components using radio transmission paths*

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

— *Part 28: Fire protection control equipment*

A part 23, dealing with visual alarm devices, is under preparation.

Introduction

This part of ISO 7240 is based on a European Standard EN 54-20:2006, prepared by the European Committee for Standardization CEN/TC 72 "*Fire detection and fire alarm systems*". It has been reviewed and revised by ISO/TC 21/SC 3/WG 21.

Aspirating smoke detectors differ from point-type smoke detectors (see ISO 7240-7) in that air is drawn into the smoke-sensing chamber, rather than relying on convection.

This part of ISO 7240 is not intended to place any other restriction on the design and construction of such detectors.

Fire detection and alarm systems —

Part 20: **Aspirating smoke detectors**

WARNING — Certain types of detectors contain radioactive materials. National requirements for radiation protection differ from country to country and they are not, therefore, specified in this part of ISO 7240.

1 Scope

This part of ISO 7240 specifies the requirements, test methods and performance criteria for aspirating smoke detectors for use in fire detection and alarm systems installed in buildings.

Aspirating smoke detectors developed for the protection of specific risks that incorporate special characteristics (including additional features or enhanced functionality for which this part of ISO 7240 does not define a test or assessment method) are also covered by this part of ISO 7240. The performance requirements for any special characteristics are beyond the scope of this part of ISO 7240.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 7240-4, *Fire detection and alarm systems — Part 4: Power supply equipment*

ISO 7240-7:2003, *Fire detection and fire alarm systems — Part 7: Point-type smoke detectors using scattered light, transmitted light or ionization*

EN 50130-4:1995 + Amendment 1:1998 + Amendment 2:2003, *Alarm systems — Part 4: Electromagnetic compatibility — Product family standard: Immunity requirements for components of fire, intruder and social alarm systems*

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 61386-1:2008, *Conduit systems for cable management — Part 1: General requirements*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1
aspirating smoke detector
smoke detector, in which air and aerosols are drawn through a sampling device and carried to one or more smoke-sensing elements by an integral aspirator (e.g. fan or pump)

NOTE Each smoke sensing element may contain more than one sensor exposed to the same smoke sample.

3.1.2
response threshold value
measure of the aerosol concentration in the proximity of the smoke sensing element at the moment that the specimen generates an alarm signal, when it is tested as described in 5.1.5

3.1.3
sampling device
component or series of components or a dedicated device (e.g. a pipe network, dedicated duct, probe or hood) which forms part of the a.s.d. and transfers samples of air to the smoke sensing element(s)

NOTE The sampling device may be supplied separately.

3.1.4
sampling point
any point at which an air sample is drawn into the sampling device

3.1.5
transport time
time for aerosols to transfer from a sampling point to the smoke sensing element

3.2 Abbreviated terms

For the purposes of this document, the following abbreviations apply.

a.s.d. aspirating smoke detector

c.i.e. control and indicating equipment

c.p.c. condensation particle counter

EMC electromagnetic compatibility

MIC measuring ionization chamber

r.t.v. response threshold value

4 Requirements

4.1 Compliance

To comply with this part of ISO 7240, 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, shall meet the requirements of the tests.

4.2 Classification

The manufacturer shall clearly state, in accordance with the data presented in 4.13, to which class or classes the aspirating smoke detector is designed. To demonstrate compliance with a specific class, the aspirating smoke detector shall be subjected to the appropriate fire sensitivity test as defined in 5.15.

NOTE Due to the differences and many variations in the design of sampling devices, aspirating smoke detectors are generally intended for use in many varied and often rather specialized applications. Therefore, it might not be practical to conduct type tests that define acceptance criteria for all of these applications. However, in recognition of the diversity of application, three classes are defined to enable system designers and installers to select the most appropriate sensitivity.

Table 1 identifies the classes of detector and the corresponding fire tests used for the classification.

Table 1 — Classification of aspirating smoke detectors

Class	Description	Example application(s)	Test fires
A	Aspirating smoke detector providing very high sensitivity	Very early detection: the detection of very dilute smoke, for example entering air conditioning ducts, to detect the extremely dilute concentrations of smoke that can emanate from equipment in an environmentally controlled area such as a clean room	TF2A, TF3A, TF4 and TF5A
B	Aspirating smoke detector providing enhanced sensitivity	Early detection: for example, special fire detection within or close to particularly valuable, vulnerable or critical items such as computer or electronic equipment cabinets	TF2B, TF3B, TF4 and TF5B
C	Aspirating smoke detector providing normal sensitivity	Standard detection: general fire detection in normal rooms or spaces, giving, for example, at least an equivalent level of detection as a point- or beam-type smoke detection system	TF2, TF3, TF4 and TF5

4.3 Individual visual alarm indication

Each aspirating smoke detector shall be provided with integral red visual indicator(s), visible from outside the aspirating smoke detector, by which the individual smoke-sensing element(s) (see 3.1.1) that released an alarm can be identified until the alarm condition is reset. Where other conditions of the detector can be visually indicated, they shall be clearly distinguishable from the alarm indication.

4.4 Connection of ancillary devices

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

4.5 Manufacturer's adjustments

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

4.6 On-site adjustment of response behaviour

NOTE 1 The effective response behaviour of an aspirating smoke detector is dependent upon both the sensitivity settings of the smoke sensing element and the design of the sampling device. Many types of aspirating smoke detectors, therefore, have facilities to adjust the smoke-sensing element sensitivity to suit the application and sampling device, etc.

If there is provision for field-adjustment of the sensitivity of the smoke sensing element, then

a) access to the means of adjustment shall be limited by the requirement for the use of tools or a special code;

b) it shall be possible to determine what sensitivity settings have been selected and to relate these to documentation that describes the sensitivity settings required for different sampling devices and applications;

NOTE 2 These adjustments may be made at the detector or at the c.i.e.

NOTE 3 Changing sensitivity settings may affect the classification of the installed a.s.d. – see 4.2.

c) if it is possible to configure the detector (including the sampling device and the sensitivity settings) in such a way that the detector does not comply with this part of ISO 7240, it shall be clearly marked on the detector or in the associated data that, if such configurations are used, the detector does not comply with this part of ISO 7240.

4.7 Response to slowly developing fires

The provision of “drift compensation” (e.g. to compensate for sensor drift due to the build-up of dirt in the detector) and/or the provision of algorithms to match a detector to its environment shall not lead to a significant reduction in the sensitivity of the detector to slowly developing fires.

Because it is not practical to carry out tests with very slow increases in smoke density, an assessment of the response of the detector to slow increases in smoke density shall be made by analysis of the circuit/software, and/or physical tests and simulations.

Where such algorithms are used, the detector shall be deemed to meet the requirements of 4.7 if the documentation and assessment shows

a) how and why a sensor drifts;

b) how the compensation technique modifies the detector response to compensate for the drift;

c) that suitable limits to the compensation are in place to prevent the algorithms/means from being applied outside the known limitations of the sensor and to ensure ongoing compliance with the provisions of this part of ISO 7240;

d) for any rate of increase in smoke density, R, that is greater than $A/4$ per hour (where A is the initial uncompensated r.t.v. of the a.s.d.), the time for the detector to give an alarm does not exceed $1,6 \times A/R$ by more than 100 s;

e) that the range of compensation is limited such that, throughout this range, the compensation does not cause the r.t.v. of the detector to exceed its initial value by a factor greater than 1,6.

NOTE Further information about the assessment of requirements d) and e) is given in Annex J.

4.8 Mechanical strength of the pipework

Sampling pipes and fittings shall have adequate mechanical strength and temperature resistance.

Pipes shall either be classified in accordance with IEC 61386-1:2008 to at least class 1131 (for the significance of the digits, see Table 2) or shall be tested in accordance with 5.16.

Table 2 — Mechanical requirements of sampling pipe

Property	Class	Severity
Resistance to compression	1	125 N
Resistance to impact	1	0,5 kg, 100 mm height to fall
Temperature range	31	−15 °C to +60 °C

Where the supplier of the a.s.d. does not supply pipes for the sampling device, the product documentation shall specify that the requirements of this subclause shall be met.

4.9 Hardware components and additional sensing elements in the sampling device

Components, including optional components (box, filter, sensor, valve, etc.), in the sampling device shall be described in the documentation. The a.s.d., including the hardware components listed (i.e. the worst-case combination in accordance with the manufacturer's documentation), shall meet the requirements of this part of ISO 7240.

If the component incorporates a sensing element that participates in the signal output of the a.s.d. (e.g. for localization information), then the performance of the a.s.d., including these sensing elements, shall meet the requirements of this part of ISO 7240.

4.10 Airflow monitoring

4.10.1 The airflow through the aspirating smoke detector shall be monitored to detect leakage or obstruction of the sampling device or sampling point(s).

4.10.2 A fault signal shall be given when the airflow is outside the operational limits as specified by the manufacturer's data.

A fault signal shall be given for the following:

a) when any leakage or obstruction results in an increase or decrease in the volumetric airflow of 20 % and greater through an aspirating smoke detector; or

b) when, for aspirating smoke detectors that incorporate technology that provides for constant (or nearly constant) volumetric flow rate, which is largely independent of the sampling device (e.g. incorporates speed control of the fan or uses a positive displacement pump), there is a loss of 50 % or more of sampling points.

In either case, the fault signal shall be released within not more than 300 s of the fault occurring.

NOTE This time is independent of any delay times between signalling the fault and its indication at the c.i.e. and compensates for spurious, short-term flow variations that would otherwise result in an unwanted fault signal.

4.10.3 Where an a.s.d. has a facility to memorize the “normal” flow rate (present when the detector is installed or serviced) and, thereafter, monitor for deviations from this normal flow, the action of setting the memorized “normal” flow shall be a voluntary action at access level 3 (see ISO 7240-2).

4.10.4 Power cycling of the a.s.d. (turning it off and on) shall not result in a change to the memorized “normal” flow rate.

4.11 Power supply

The power for the aspirating detector shall be supplied by power supply equipment in accordance with ISO 7240-4. This power supply equipment may be common to the c.i.e.

4.12 Marking

Each detector shall be clearly marked with the following information:

a) number of this part of ISO 7240, e.g. “This product conforms to ISO 7240-20”;

b) name or trademark of the manufacturer or supplier;

c) model designation (type or number);

d) wiring terminal designations;

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

Where the sensitivity class (see 4.2) is marked on the detector, additional information shall be provided to clearly indicate the means by which the classification of any used configuration can be determined.

This additional information may be a cross-reference to a separate document or may be a summary of the worst-case configuration tested under each class.

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

The markings shall be visible during installation and shall be accessible during maintenance.

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

4.13 Data

Either an aspirating smoke detector shall be supplied with sufficient technical, installation and maintenance data to enable its correct installation, sensitivity setting and operation or, if all of these data are not supplied with each a.s.d., reference to the appropriate data sheet(s) shall be given on, or with, each aspirating smoke detector.

The manufacturer shall declare in these data the classification of each sampling device configuration and associated sensitivity settings. If the number of configurations is undetermined, the manufacturer shall provide the necessary means to determine the classification of any configuration used.

These data shall also be available on the commercial datasheets to enable the correct design of an installation prior to delivery of the hardware.

These data shall be referred to in the test report and shall be used to describe and determine the worst-case configuration(s) that are used in the fire tests (see 5.15) and the transport time for the sampling point(s) in the fire test room.

The transport time should not include any processing time and is specifically limited to the time required to transport aerosols from the sampling point (in the fire test room) to the sensing element.

The method used for determining the classification shall be clearly stated. This is likely to take into account the following parameters:

a) sizes and number of sampling points (maximum and minimum) and any limitations on their position along the sampling device;

b) sensitivity settings for the detector and how this parameter should be adjusted;

c) details of permitted sampling device arrangement (e.g. single pipe, branch, “H”-configurations);

d) maximum length of the sampling device (e.g. the maximum pipe length and branch length);

e) aspirator setting (if adjustable).

4.14 Additional requirements for software controlled detectors

4.14.1 General

For detectors that rely on software control to fulfil the requirements of this part of ISO 7240, the requirements of 4.14.2, 4.14.3 and 4.14.4 shall be met.

4.14.2 Software documentation

4.14.2.1 The manufacturer shall submit documentation to the testing authority that gives an overview of the software design. This documentation shall be in sufficient detail to allow inspection of the design for compliance with this part of ISO 7240 and shall include at least the following:

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

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

   2) the manner in which the modules interact,

   3) the overall hierarchy of the program,

   4) the manner in which the software interacts with the hardware of the detector,

   5) the manner in which the modules are called, including any interrupt processing;

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

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

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

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

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

   1) the name of the module,

   2) a description of the tasks performed,

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

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

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

This detailed design documentation may be reviewed at the manufacturer's premises.

4.14.3 Software design

To ensure the reliability of the detector, the following requirements for software design shall apply.

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

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

4.14.4 The storage of programs and data

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

Site-specific data shall be held in memory that can retain 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.

5 Tests

5.1 General

5.1.1 Atmospheric conditions for tests

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

— temperature: (15 to 35) °C;

— relative humidity: (25 to 75) %;

— air pressure: (86 to 106) kPa.

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

5.1.2 Operating conditions for tests

If a test method requires that a specimen be operational, then the specimen shall be connected to suitable supply and monitoring equipment with characteristics as required by the manufacturer's data. Unless otherwise specified in the test method, the supply parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value or the mean of the specified range.

Where an a.s.d. has multiple sensitivity settings, the sensitivity of the specimen during all tests in Table 3 (with the exception of the fire sensitivity test in 5.15) shall be set at the highest sensitivity setting used during the fire sensitivity test(s).

NOTE It is not intended that the environmental tests be conducted at all possible sensitivity settings, only at the highest used during the fire sensitivity test. This is particularly relevant where multiple classes and/or multiple configurations are submitted.

To allow a check of the flow monitoring function as required before, during and/or after environmental tests, the sampling device may be simulated by a simpler sampling device [e.g. stub pipe with appropriate orifice(s)] to provide a typical airflow through the detector.

During the dry heat, damp heat and cold tests, a sufficient length of pipe shall be installed in the chamber to allow the temperature of the test aerosol entering the specimen to stabilize at the test temperature.

The details of the supply and monitoring equipment and the alarm criteria used shall be given in the test report; see Clause 6.

5.1.3 Mounting arrangements

When necessary, 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 as the most unfavourable shall be chosen for each test.

5.1.4 Tolerances

Unless otherwise specified, the tolerances for the environmental test parameters shall be as given in the basic reference standards for the test (i.e. the relevant parts of IEC 60068-2).

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

5.1.5 Measurement of response threshold value

5.1.5.1 General

There are a number of different a.s.d. operating principles, which have different ranges of sensitivity. Accordingly, various methods can be used to measure the r.t.v. The object of any method chosen shall be to determine a measure of the aerosol concentration that, when passing through the detector, just causes the release of an alarm. This can generally be achieved by introducing smoke or an aerosol into the sampled air stream so that the detector is subjected to a slowly increasing concentration, and recording the concentration at the moment when an alarm is released. The r.t.v. is used only as a relative measurement; therefore, various parameters to measure the aerosol concentration may be used, providing that the chosen parameter is essentially proportional to the particle-number concentration (i.e. a linear relationship) for the particular test aerosol. Further information is provided in Annex A.

5.1.5.2 Typical r.t.v. measurement procedure

Connect the specimen to measuring apparatus as recommended in Annex A. Control the airflow through the detector at a typical rate within the manufacturer's specification.

Connect the specimen to the supply and monitoring equipment in accordance with 5.1.2 and allow it to stabilize for at least 15 min unless otherwise specified by the manufacturer.

Before commencing each measurement, purge the measuring apparatus and specimen sufficiently to ensure that the result is not affected by the previous measurements.

Increase the aerosol concentration at an appropriate rate, depending upon the sensitivity of the specimen. The rate of increase in aerosol density shall be similar for all measurements on a particular a.s.d. type. It is recommended that the alarm signal be released at between 2 min and 10 min after the start of the test.

NOTE Preliminary testing can be necessary to determine the appropriate rate for a particular detector type.

The r.t.v. N shall be taken as the aerosol concentration at the moment when the specimen releases an alarm signal. The particular measuring unit for the aerosol concentration depends on the measuring apparatus used.

5.1.6 Test of the airflow monitoring facility

In accordance with the requirements in 4.10, the airflow monitoring facility shall be tested as follows.

a) Where the volumetric flow is not maintained at a constant, verify the increase and decrease in flow as follows.

   1) Determine the normal volumetric airflow, F_n, expressed in litres per minute, from the sampling configuration used for the fire tests using suitable instrumentation.

   2) For testing the airflow monitoring, set the test flow rate, F_t, at the specimen to $F_n \pm 10$ %. If the specimen has a memorized normal flow, enter F_t into the memory in accordance with the normal operating instructions. This shall be done only once at the start of each environmental test and shall not be done during or after conditioning.

   3) For decreased flow, decrease the volumetric airflow from F_t by 20 % (F_t – 20 %).

   4) For increased flow, increase the volumetric airflow from F_t by 20 % (F_t + 20 %).

   An example of a possible practical arrangement to achieve this test is given in Annex K.

b) Where the tests of a) cannot be applied (e.g. where the volumetric flow is maintained at a constant), verify the flow monitoring facility by the loss of a maximum of 50 % of the sampling points by disabling the furthest sampling points from the sensing element on the worst-case sampling device used in the fire sensitivity test(s). Test for loss of the points separately as follows.

   1) Disable (i.e. close or block off) a total of 50 % of the sampling points furthest from the sensing element.

   2) Break the sampling device such that the same points are disabled by the breakage.

5.1.7 Provision for tests

Eight specimen a.s.d. shall be provided to conduct the tests in the test schedule (see 5.1.8), together with sufficient sampling pipes and fittings to set up the various sampling device configuration required by the tests.

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

This implies that the mean r.t.v. of the eight specimens, found in the reproducibility test, should also represent the production mean, and that the limits specified in the reproducibility test should also be applicable to the manufacturer's production.

5.1.8 Test schedule

The specimens shall be tested according to the test schedule in Table 3. The specimens shall be numbered arbitrarily, with the exception of specimen No. 8.

Table 3 — Test schedule

Test	Subclause	Specimen No.[a]
Repeatability	5.2	1
Reproducibility	5.3	1 to 8[b]
Variation in supply parameters	5.4	1
Dry heat (operational)	5.5	1
Cold (operational)	5.6	1
Damp heat, steady state (operational)	5.7	1
Damp heat, steady state (endurance)	5.8	2
SO_2 corrosion (endurance)	5.9	3
Shock (operational)	5.10	4
Impact (operational)	5.11	4
Vibration, sinusoidal (operational)	5.12	5
Vibration, sinusoidal (endurance)	5.13	5
Electromagnetic compatibility (EMC) immunity tests	5.14	6 and 7
Fire sensitivity	5.15	8

[a] The schedule shows the specimen numbers recommended for each test. Other arrangements may be used 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 eight smoke-sensitive parts shall be measured in the reproducibility test. If fewer specimens are being used for the rest of the tests, then it is necessary to consider the possible damaging effects of subjecting a specimen to a number of tests, especially endurance tests.

[b] The least sensitive specimen shall be designated specimen No. 8 and used in the fire sensitivity tests.

5.2 Repeatability

5.2.1 Object

The object of this test is to show that the detector has stable behaviour with respect to its sensitivity, even after a number of alarm conditions.

5.2.2 Test procedure

Measure the r.t.v. of the specimen six times in accordance with 5.1.5.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.2.3 Requirements

The ratio $N_{max} : N_{min}$ shall not be greater than 1,6.

5.3 Reproducibility

5.3.1 Object

The object of this test is to show that the sensitivity of the detector does not vary unduly from specimen to specimen.

5.3.2 Test procedure

Test the function of the airflow monitoring facility on each specimen, in accordance with 5.1.6.

Measure the r.t.v. of each of the test specimens in accordance with 5.1.5.

Calculate the mean r.t.v., $\overline{N}$.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.3.3 Requirements

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio $N_{max} : \overline{N}$ shall not be greater than 1,33.

The ratio $\overline{N} : N_{min}$ shall not be greater than 1,5.

5.4 Variation in supply parameters

5.4.1 Object

The object of this test is to show that within the specified range(s) of the supply parameters (e.g. voltage), the sensitivity of the specimen is not unduly dependent on these parameters.

This may be demonstrated by testing in accordance with 5.4.2.1 or by consideration of the electronic design of a.s.d. and appropriate testing in accordance with 5.4.3.

5.4.2 Standard test procedure

5.4.2.1 Test procedure

Measure the r.t.v. of the specimen in accordance with 5.1.5.

Test the airflow monitoring facility in accordance with 5.1.6 under the nominal and extremes of the specified supply conditions (e.g. nominal, maximum and minimum supply voltage).

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.4.2.2 Requirements

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio $N_{max} : N_{min}$ shall not be greater than 1,6.

5.4.3 Alternative test procedure

Where it can be shown by design examination that the sensitivity of the detector and speed of the airflow are independent of the supply voltage, then appropriate measurements (e.g. of internal voltages and flow rate) may be used to determine whether the specimen fulfills this requirement.

The appropriate measurements should be chosen by discussion between the testing laboratory and the manufacture.

5.5 Dry heat (operational)

5.5.1 Object

The object of this test is to demonstrate the ability of the specimen to function correctly at high ambient temperature that can occur for short periods in the service environment.

5.5.2 Test procedure

5.5.2.1 Reference

Use the test apparatus and conduct the procedure in accordance with IEC 60068-2-2, Test Bb, and with 5.5.2.2 to 5.5.2.6.

5.5.2.2 Initial measurements

Before conditioning, with the temperature stabilizing pipes installed in accordance with 5.1.2, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5.

5.5.2.3 State of the specimen during conditioning

Mount the specimen in accordance with 5.1.3 and connect it to its supply and monitoring equipment in accordance with 5.1.2.

5.5.2.4 Conditioning

Apply the following conditioning:

— temperature: (55 ± 2) °C, starting at an initial air temperature of (23 ± 5) °C;

— duration: 16 h.

5.5.2.5 Measurements during conditioning

Monitor the specimen during the transition to the conditioning temperature and during the conditioning period to detect any alarm or fault signals.

During the last hour of the conditioning period, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5. For these measurements, install a sufficient length of pipe in the chamber to allow the temperature of the test aerosol to stabilize at the test temperature before entering the detector in accordance with 5.1.2.

NOTE It can also be necessary to have a length of pipe external to the chamber to transport the test aerosol from its source (e.g. a standard smoke tunnel). In this case, the reference detector referred to in Figure A.4 is likely to be needed.

5.5.2.6 Final measurements

After a recovery period of at least 1 h at laboratory conditions, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.5.3 Requirements

No alarm or fault signals shall be given during the period that the temperature is increasing to the conditioning temperature or during the conditioning period, except as required by the tests in the last hour.

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio $N_{max} : N_{min}$ shall not be greater than 1,6.

5.6 Cold (operational)

5.6.1 Object

The object of this test is to demonstrate the ability of the specimen to function correctly at low ambient temperatures appropriate to the anticipated service environment.

5.6.2 Test procedure

5.6.2.1 Reference

Use the test apparatus and conduct the procedure in accordance with IEC 60068-2-1, Test Ab and with 5.6.2.2 to 5.6.2.6.

5.6.2.2 Initial measurements

Before conditioning, with the temperature stabilizing pipes installed in accordance with 5.1.2, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5.

5.6.2.3 State of the specimen during conditioning

Mount the specimen in accordance with 5.1.3 and connect it to its supply and monitoring equipment in accordance with 5.1.2.

5.6.2.4 Conditioning

Apply the following conditioning:

— temperature: (–10 ± 3) °C;

— duration: 16 h.

If the detector cannot operate at a temperature below 0 °C, then

a) the cold test shall be conducted at (+ 5 ± 3) °C;

b) the detector shall give a fault warning if the temperature falls below 0 °C; this shall be tested by reducing the temperature to (– 5 ± 3) °C;

c) the manufacturer's information shall state that the detector cannot operate below 0 °C.

5.6.2.5 Measurements during conditioning

Monitor the specimen during transition to the conditioning temperature and during the conditioning period to detect any alarm or fault signals.

During the last hour of the conditioning period, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5. For these measurements, install a sufficient length of pipe in the chamber to allow the temperature of the test aerosol to stabilize at the test temperature before entering the detector in accordance with 5.1.2.

5.6.2.6 Final measurements

After a recovery period of at least 1 h at laboratory conditions, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.6.3 Requirements

No alarm or fault signals shall be given during the period in which the temperature is decreasing to the conditioning temperature or during the conditioning period, except as required by the tests in the last hour.

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio $N_{max} : N_{min}$ shall not be greater than 1,6.

5.7 Damp heat, steady state (operational)

5.7.1 Object

The object of this test is to demonstrate the ability of the detector to function correctly at high relative humidity (without condensation), which can occur for short periods in the anticipated service environment.

5.7.2 Test procedure

5.7.2.1 Reference

Use the test apparatus and conduct the procedure in accordance with IEC 60068-2-78, Test Cab and with 5.7.2.2 to 5.7.2.6.

5.7.2.2 Initial measurements

Before conditioning, with the temperature stabilizing pipes installed in accordance with 5.1.2, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5.

5.7.2.3 State of the specimen during conditioning

Mount the specimen in accordance with 5.1.3 and connect it to its supply and monitoring equipment in accordance with 5.1.2.

5.7.2.4 Conditioning

Apply the following conditioning:

— temperature: (40 ± 2) °C;

— relative humidity (93 ± 3) %;

— duration: 4 days.

5.7.2.5 Measurements during conditioning

Monitor the specimen during the transition to the conditioning temperature and during the conditioning period to detect any alarm or fault signals.

During the last hour of the conditioning period, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5. For these measurements, install a sufficient length of pipe in the chamber to allow the temperature of the test aerosol to stabilize at the test temperature before entering the detector in accordance with 5.1.2.

NOTE For practical reasons, it is accepted that the test aerosol is not at the same relative humidity as the conditioning environment.

5.7.2.6 Final measurements

After a recovery period of at least 1 h at laboratory conditions, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.7.3 Requirements

No alarm or fault signals shall be given during the period that the temperature is increasing to the conditioning temperature or during the conditioning period, except as required by the tests in the last hour.

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio $N_{max} : N_{min}$ shall not be greater than 1,6.

5.8 Damp heat, steady state (endurance)

5.8.1 Object

The object of this test is to demonstrate the ability of the specimen to withstand the long-term effects of humidity in the service environment (e.g. changes in electrical properties of materials, chemical reactions involving moisture, galvanic corrosion).

5.8.2 Test procedure

5.8.2.1 Reference

Use the test apparatus and conduct the procedure in accordance with IEC 60068-2-78, Test Cab, and with 5.8.2.2 to 5.8.2.5.

5.8.2.2 Initial measurements

Before conditioning, measure the r.t.v. in accordance with 5.1.5.

5.8.2.3 State of the specimen during conditioning

Mount the specimen in accordance with 5.1.3 but do not supply it with power during the conditioning.

The sampling ports shall be open during the test.

5.8.2.4 Conditioning

Apply the following conditioning:

— temperature: (40 ± 2) °C;

— relative humidity: (93 ± 3) %;

— duration: 21 days.

5.8.2.5 Final measurements

After a recovery period of at least 1 h at laboratory conditions, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.8.3 Requirements

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio N_{max} : N_{min} shall not be greater than 1,6.

5.9 Sulfur dioxide (SO_2) corrosion (endurance)

5.9.1 Object

The object of this test is to demonstrate the ability of the detector to withstand the corrosive effects of sulfur dioxide as an atmospheric pollutant.

5.9.2 Test procedure

5.9.2.1 Reference

Use the test apparatus and procedure in accordance with IEC 60068-2-42, Test Kc, but carry out the conditioning in accordance with 5.9.2.4.

5.9.2.2 Initial measurements

Before conditioning, measure the r.t.v. in accordance with 5.1.5.

5.9.2.3 State of the specimen during conditioning

Mount the specimen in accordance with 5.1.3. Do not supply it with power during the conditioning, but equip it with untinned copper wires, of the appropriate diameter, connected to sufficient terminals, to allow making the final measurement without making further connections to the specimen.

The sampling ports shall be open during the test.

5.9.2.4 Conditioning

Apply the following conditioning:

— temperature: (25 ± 2) °C;

— relative humidity: (93 ± 3) % (no condensation);

— SO_2 concentration: (25 ± 5) µl/l;

— duration: 21 days.

5.9.2.5 Final measurements

Immediately after the conditioning, subject the specimen to a drying period of 16 h at (40 ± 2) °C, ⩽ 50 % RH, followed by a recovery period of at least 1 h at laboratory conditions. After this recovery period, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.9.3 Requirements

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio $N_{max} : N_{min}$ shall not be greater than 1,6.

5.10 Shock (operational)

5.10.1 Object

The object of this test is to demonstrate the immunity of the detector to mechanical shocks that are likely to occur, albeit infrequently, in the anticipated service environment.

5.10.2 Test procedure

5.10.2.1 Reference

Use the test apparatus and procedure in accordance with IEC 60068-2-27, Test Ea, but carry out the conditioning in accordance with 5.10.2.4.

5.10.2.2 Initial measurements

Before conditioning, measure the r.t.v. in accordance with 5.1.5.

5.10.2.3 State of the specimen during conditioning

Mount the specimen in accordance with 5.1.3 to a rigid fixture, and connect it to its supply and monitoring equipment in accordance with 5.1.2.

5.10.2.4 Conditioning

For specimens with a mass ⩽ 4,75 kg, apply the following conditioning:

— shock pulse type: half sine;

— pulse duration: 6 ms;

— peak acceleration: 10 (100 − 20M) m/s^2, where M is the specimen's mass, expressed in kilograms;

— number of directions: 6;

— pulses per direction: 3.

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

5.10.2.5 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.10.2.6 Final measurements

After the conditioning, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.10.3 Requirements

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

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio $N_{max} : N_{min}$ shall not be greater than 1,6.

5.11 Impact (operational)

5.11.1 Object

The object of this test is to demonstrate the immunity of the specimen to mechanical impacts upon its surface that it can sustain in the normal service environment and that it can reasonably be expected to withstand.

5.11.2 Test procedure

5.11.2.1 Reference

Use the test apparatus and procedure in accordance with IEC 60068-2-75, Test Ehb.

5.11.2.2 Initial measurements

Before conditioning, measure the r.t.v. in accordance with 5.1.5.

5.11.2.3 State of the specimen during conditioning

Mount the specimen in accordance with 5.1.3 to a rigid structure, as required by IEC 60068-2-75, and connect it to its supply and monitoring equipment in accordance with 5.1.2.

5.11.2.4 Conditioning

Apply impacts 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 shall be taken to ensure that the results from a series of three blows do not influence subsequent series. In case of doubt, disregard the defect and apply a further three blows to the same position on a new specimen.

Use the following test parameters during the conditioning:

— impact energy: (0,5 ± 0,04) J;

— number of impacts per point: 3.

5.11.2.5 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.11.2.6 Final measurements

After the conditioning, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with in 5.1.5.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.11.3 Requirements

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

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio $N_{max} : N_{min}$ shall not be greater than 1,6.

5.12 Vibration, sinusoidal (operational)

5.12.1 Object

The object of this test is to demonstrate the immunity of the specimen to vibration at levels considered appropriate to the normal service environment.

5.12.2 Test procedure

5.12.2.1 Reference

Use the test apparatus and conduct the procedure in accordance with IEC 60068-2-6, Test Fc, and with 5.12.2.2 to 5.12.2.6.

5.12.2.2 Initial measurements

Before conditioning, measure the r.t.v. in accordance with 5.1.5.

5.12.2.3 State of the specimen during conditioning

Mount the specimen on a rigid fixture in accordance with 5.1.3 and connect it to its supply and monitoring equipment in accordance with 5.1.2.

Apply the vibration in each of three mutually perpendicular axes, in turn, and so that one of the three axes is perpendicular to the normal mounting plane of the specimen.

5.12.2.4 Conditioning

Apply the following conditioning:

— frequency range: (10 to 150) Hz;

— acceleration amplitude: 5 m/s^2 (≈ 0,5 g);

— number of axes: 3;

— sweep rate: 1 octave/min;

— number of sweep cycles: 1 per axis.

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

5.12.2.5 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.12.2.6 Final measurements

After the conditioning, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with in 5.1.5.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.12.3 Requirements

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

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio N_{max} : N_{min} shall not be greater than 1,6.

5.13 Vibration, sinusoidal (endurance)

5.13.1 Object

The object of this test is to demonstrate the ability of the specimen to withstand the long-term effects of vibration at levels appropriate to the service environment.

5.13.2 Test procedure

5.13.2.1 Reference

Use the test apparatus and conduct the procedure in accordance with IEC 60068-2-6, Test Fc, and with 5.13.2.2 to 5.13.2.5.

5.13.2.2 Initial measurements

Before conditioning, measure the r.t.v. in accordance with 5.1.5.

5.13.2.3 State of the specimen during conditioning

Mount the specimen on a rigid fixture in accordance with 5.1.3, but do not supply it with power during conditioning.

Apply the vibration to each of three mutually perpendicular axes, one of which is perpendicular to the normal mounting axis of the specimen.

5.13.2.4 Conditioning

Apply the following conditioning:

— frequency range: (10 to 150) Hz;

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

— number of axes: 3;

— sweep rate: 1 octave/min;

— number of sweep cycles: 20 per axis.

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

5.13.2.5 Final measurements

After the conditioning, test the airflow monitoring facility in accordance with 5.1.6 and measure the r.t.v. in accordance with 5.1.5.

Designate the maximum r.t.v. as N_{max} and the minimum as N_{min}.

5.13.3 Requirements

The correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test.

The ratio $N_{max} : N_{min}$ shall not be greater than 1,6.

5.14 Electromagnetic compatibility (EMC) immunity tests

5.14.1 The following EMC immunity tests shall be conducted in accordance with EN 50130-4:1995 + Amendment 1:1998 + Amendment 2:2003:

a) mains supply voltage variations, if the aspirating detector incorporates a mains supply;

NOTE The mains supply voltage variations test can be combined with the variation in supply parameters test (see 5.4).

b) mains supply voltage dips and short interruptions, if the aspirating detector incorporates a mains supply;

c) electrostatic discharge;

d) radiated electromagnetic fields;

e) conducted disturbances induced by electromagnetic fields;

f) fast transient bursts;

g) slow high energy surges.

5.14.2 For the EMC immunity tests, the following shall apply.

a) The functional test, called for in the initial and final measurements, shall be as follows:

   — test of the airflow monitoring facility in accordance with 5.1.6;

   — measure the r.t.v. in accordance with 5.1.5.

b) The required operating condition shall be in accordance with 5.1.2.

c) The acceptance criteria for the functional test after the conditioning shall be as follows:

   — the correct fault signals, in accordance with 4.10, shall be given during the airflow monitoring facility test;

   — the ratio $N_{max} : N_{min}$ shall not be greater than 1,6, where N_{max} and N_{min} are, respectively, the maximum and minimum of the r.t.v. measured in the initial and final measurements.

5.15 Fire sensitivity

5.15.1 Object

The object of this test is to show that the specimen has adequate sensitivity to a broad spectrum of smoke types as required for general application in fire detection systems for buildings and other applications as applicable to the class of detector.

5.15.2 Principle

The specimen is exposed to a series of test fires with a sampling device suitable for room protection and incorporating the “worst-case” arrangement with respect to dilution and transport times, all in accordance with the manufacturer's recommendations. The test fires are those used for assessing point smoke detectors and the number of sampling points in the fire test room shall be that recommended by the manufacturer to cover the same area as a point smoke detector. Sample points not in the fire test room shall draw in clean air during the tests.

NOTE The coverage area of a point smoke detector is determined by national installation requirements.

5.15.3 Test procedure

5.15.3.1 Fire test room

5.15.3.1.1 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.

5.15.3.1.2 The fire test room shall be equipped with the following measuring instruments as indicated in Annex I:

— measuring ionization chamber (MIC);

— obscuration meter.

5.15.3.2 Test fires

The specimens shall be subjected to test fires (as defined in Annexes B to H) in accordance with Table 4.

Table 4 — Fire test requirements for multi-class detectors

Detector class	Combination of configurations	Configuration to use	Test fires to apply (see Annexes B to H)
A only	Config. A[a]	Config. A	TF2A, TF3A, TF4, TF5A
B only	Config. B[b]	Config. B	TF2B, TF3B, TF4, TF5B
C only	Config. C[c]	Config. C	TF2, TF3, TF4, TF5
B and C	Config. B = Config. C[d]	Config. B/C	TF2B, TF3B, TF4, TF5B
B and C	Config. B ≠ Config. C[e]	Config. B	TF2B, TF3B, TF5B
		Config. C	TF2, TF3, TF4, TF5
A, B and C	Config. A = Config. B = Config. C	Config. A/B/C	TF2A, TF3A, TF4, TF5A
A, B and C	Config. A = Config. B ≠ Config. C	Config. A/B	TF2A, TF3A, TF4, TF5A
—	—	Config. C	TF2, TF3, TF4, TF5
A, B and C	Config. A ≠ Config. B = Config. C	Config. A	TF2A, TF3A, TF5A
—	—	Config. B/C	TF2B, TF3B, TF4, TF5B
A, B and C	Config. A ≠ Config. B ≠ Config. C	Config. A	TF2A, TF3A, TF5A
		Config. B	TF2B, TF3B, TF5B
		Config. C	TF2, TF3, TF4, TF5

[a] "Config. A" means the worst-case configuration for the class A testing.

[b] "Config. B" means the worst-case configuration for the class C testing.

[c] "Config. C" means the worst-case configuration for the class C testing.

[d] "=" means that configurations are the same (e.g. Config. A = Config. B means that the configuration used for the class A testing is the same as that for the class B testing).

[e] "≠" means that configurations are different (e.g. Config. B ≠ Config. C means that configuration used for the class B testing is different from that used for the class C testing).

The type, quantity and arrangement of the fuel and the method of ignition are described in Annexes B to H for each test fire, along with the end-of-test conditions and the required profile curve limits. The end-of-test conditions are summarized in Table 5.

Table 5 — Summary of end-of-test obscuration, m, values for the test fires

Test fire	End-of-test obscuration values m dB/m		
	Class A	Class B	Class C
TF2	0,05	0,15	2
TF3	0,05	0,15	2
TF4	n/a	n/a	1,27 $<$ end-of-test $<$ 1,73 (actually, $y = 6$)[a]
TF5	0,1	0,3	0,92 $<$ end-of-test $<$ 1,24 (actually, $y = 6$)

[a] y is the smoke density (ionization).

The development of the test fire shall be such that the profile curves, specifically m against time and m against y (when specified), fall within the specified limits, up to the time when all of the specimens have released an alarm signal or the end-of-test condition is reached, whichever is the earlier. If these conditions are not met, then the test is invalid and shall be repeated. It is permissible, and can be necessary, to adjust the quantity, condition (e.g. moisture content) and arrangement of the fuel to obtain valid test fires.

5.15.3.3 Mounting of the specimens

The design of the sampling device shall incorporate the “worst-case” allowable with respect to the dilution (i.e. the maximum number of sampling points) and transport time (i.e. maximum pipe lengths). This sampling pipe network shall be installed with the worst-case sampling point(s) exposed to the test fires. The number of sampling point(s) in the fire test room shall not exceed the minimum number of points that the manufacturer recommends to cover the same area as a point smoke detector. The sampling points in the fire test room shall be mounted in the designated area as defined in the respective annexes and shall be the “worst-case” sampling points with respect to the system performance in the tests. These may be those points with the longest transport time or those points with the lowest effective sensitivity. The rest of the sampling points shall be arranged outside the fire test room and shall draw in clean air during the tests.

5.15.3.4 Initial conditions

Before each test fire, ventilate the room with clean air until it is free from smoke, so that the conditions specified below are obtained.

Switch off the ventilation system and close all doors, windows and other openings. Allow the air in the room to stabilize, and measure the following conditions before the test is started:

— air temperature, T: $\left(23\ ^{+5}_{-3}\right)$ °C;

— air movement: negligible or stable where the re-circulation fan is operational;

— smoke density (ionization): $y \leqslant 0{,}05$;

— smoke density (optical): $m \leqslant 0{,}02$ dB/m.

The stability of the air and temperature affects the smoke flow within the room. This is particularly important for the test fires that produce low thermal lift for the smoke (e.g. TF2 and TF3). It is therefore recommended that the difference between the temperature near the floor and the ceiling be < 2 °C, and that local heat sources that can cause convection currents (e.g. lights and heaters) be avoided. If it is necessary for people to be in the room at the beginning of the test fire, they should leave as soon as possible, taking care to produce the minimum disturbance to the air.

5.15.3.5 Recording of fire parameters and response values

During each fire test, record the fire parameters in Table 6 continuously or at least once per second.

Monitor the alarm signal given by the specimen, such that the time of response for the specimen to each test fire is recorded along with the fire parameters y_a and m_a at the moment of response.

Table 6 — Parameters to be recorded during test fires

Parameter	Symbol	Unit
Temperature change	ΔT	K
Smoke density (ionization)	Y	Dimensionless
Smoke density (optical)	m	dB/m

5.15.4 Requirements

The aspirating smoke detector shall generate an alarm signal, in each test fire, before a time T_t after the specified end-of-test condition is reached, where the correction time T_t is the transport time for the sampling point(s) in the fire test room, up to a maximum of 60 s.

5.16 Mechanical strength of pipe

Sampling pipes that are not classified and marked in accordance with IEC 61386-1 to at least class 1131 shall be tested in accordance with Table 7 for the classes in Table 2, or the manufacturer shall provide evidence that the sampling pipes have been tested and meet the requirements of this subclause.

NOTE An example of suitable evidence that the pipe meets this requirement is a test report, approval certificate or a declaration of conformity from the manufacturers of the pipe, even though it is not marked in accordance with IEC 61386-1.

Table 7 — Mechanical tests for sampling pipe

Test	Subclause of IEC 61386-1:2008	Class	Severity
Compression test	10.2	1	125 N
Impact test	10.3	1	0,5 kg, 100 mm height to fall
Resistance to heat	12.2	31	−15 °C to +60 °C

The impact test shall be conducted at the minimum temperature (i.e. −15 °C).

The pipe is deemed to have passed the resistance to heat test if any crushing of the pipe does not reduce the internal diameter to less than 80 % of its original value.

6 Test report

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

a) identification of the specimen tested;

b) reference to this part of ISO 7240 (i.e. ISO 7240-20:2010);

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

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

e) details of any deviation from this part of ISO 7240 or from the International Standards to which reference is made, and details of any operations regarded as optional;

f) details of the method used by the manufacturer for determining the classification of any installed system;

g) details of the method used by the testing authority to determine the r.t.v.;

h) reference to the commercial datasheet(s) relevant to 4.13 of this part of ISO 7240.

Annex A
(informative)

Apparatus for response threshold value measurements

A.1 General

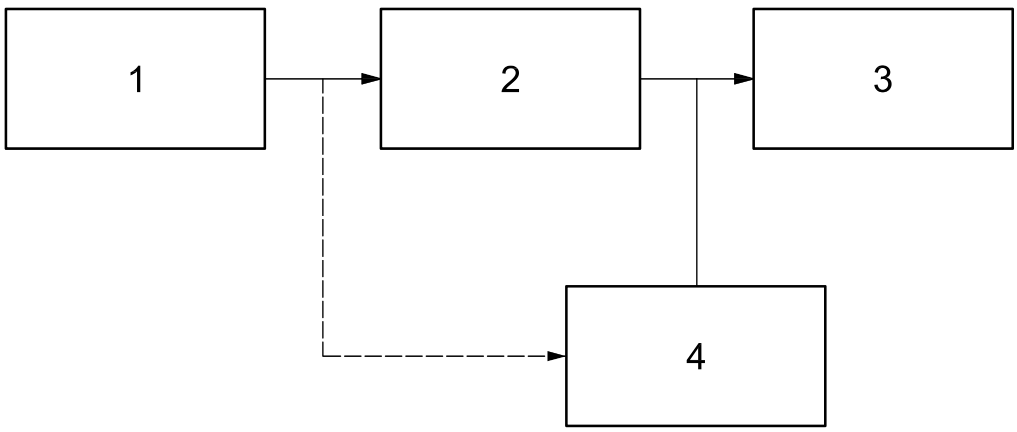
To measure the r.t.v. of an a.s.d., it is essential to be able to generate an aerosol in a precisely controlled manner so that the detector can be subjected to sampled air with a slowly and consistently increasing aerosol concentration, and to be able to obtain a measure of the concentration, which is essentially proportional to the particle-number concentration.

To test the wide range of types and classes of a.s.d., either it should be possible to adjust the test apparatus to give a wide range of airflow rates and aerosol concentrations, or different sets of test apparatus should be utilized to suit the various types and classes of a.s.d.

It is essential that the test apparatus used be capable of generating repeatable results.

The following three examples are provided for the guidance of the test houses. All three consist of four main functional blocks: aerosol generation, aerosol dilution, aerosol measurement and the specimen (see Figure A.1).

Measurement of the aerosol concentration entering the specimen is not mandatory but is recommended.



Key

1 aerosol generator

2 dilution stage

3 specimen

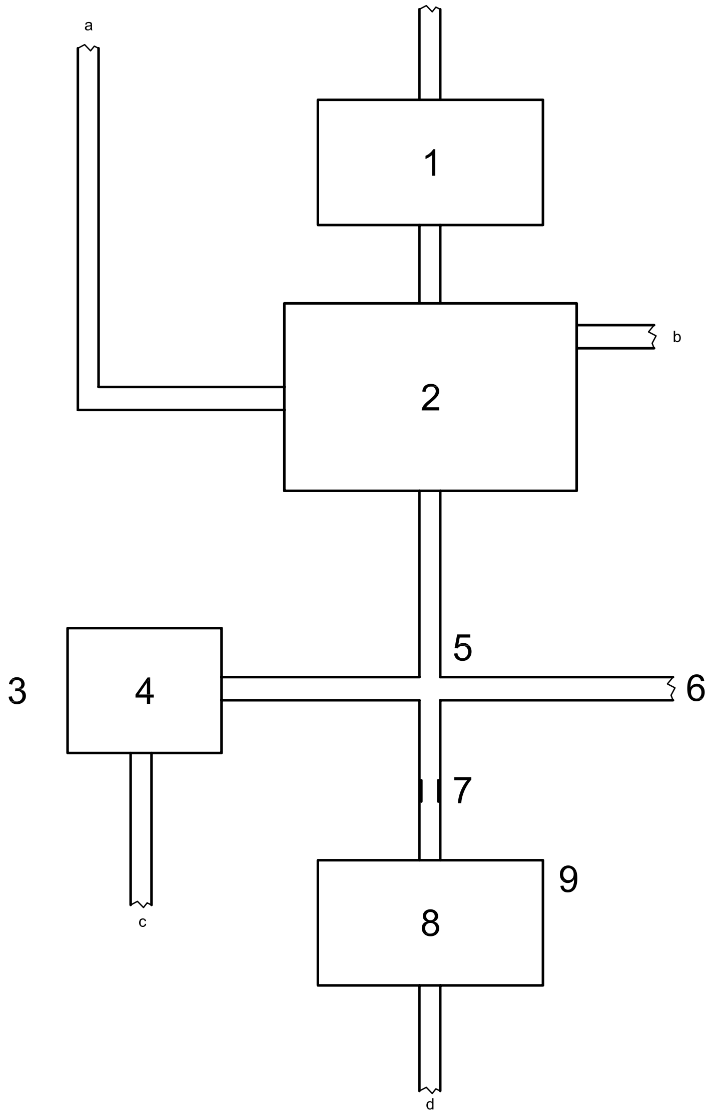
4 aerosol measurement

Figure A.1 — Functional block diagram for measuring r.t.v.

A.2 r.t.v. measurement apparatus — Example 1

The apparatus described below allows wide adjustment of the aerosol concentration and direct measurement of the concentration entering the specimen. As such, it is particularly suited to generating and measuring the low aerosol concentrations needed for testing the more sensitive aspirating smoke detectors.

The apparatus uses compressed air to provide a highly controlled dilution stage and a c.p.c. to directly measure the very low concentration of aerosol entering the specimen (see Figure A.2).



Key

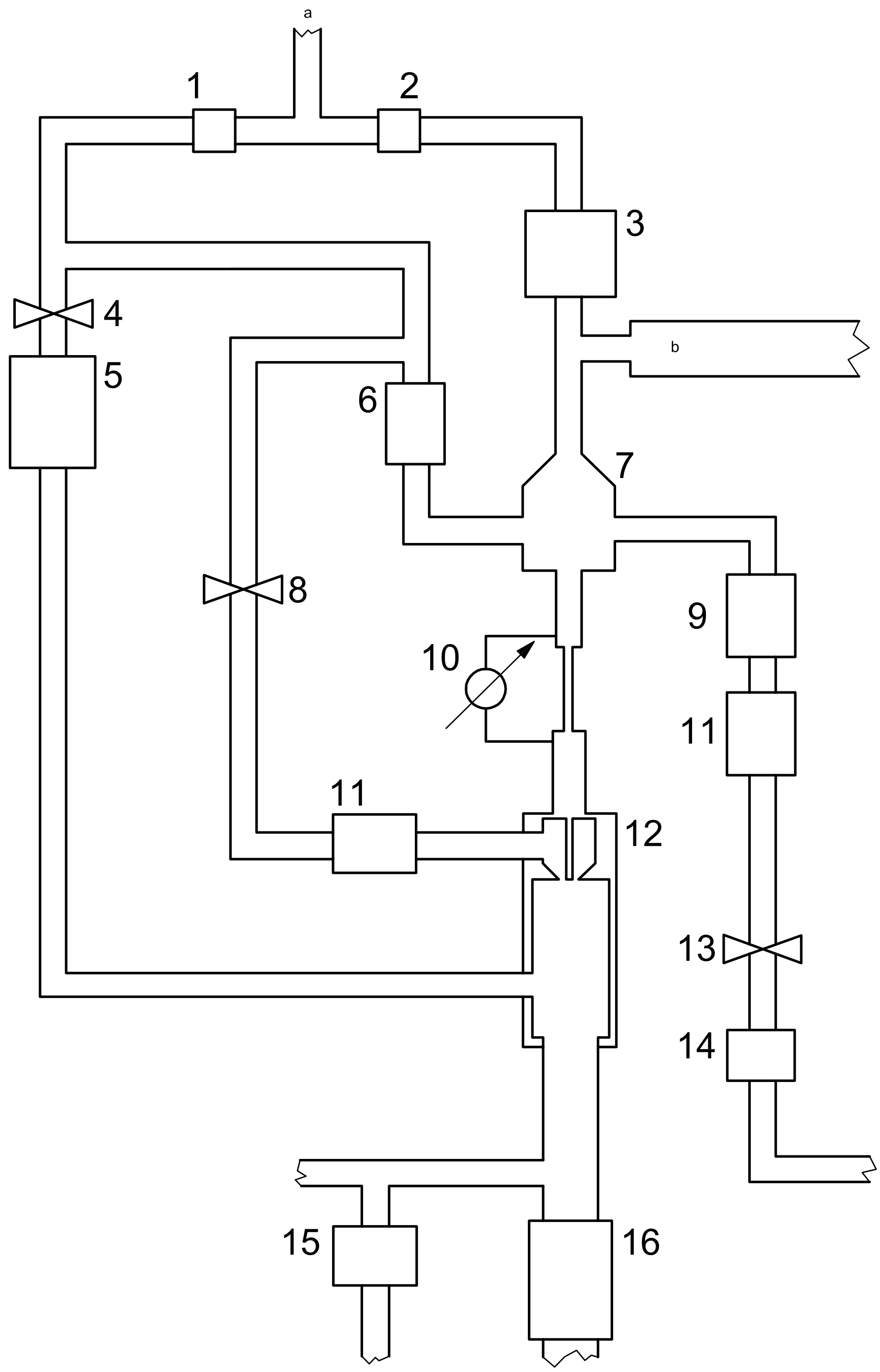
1 aerosol generator
2 controllable aerosol dilution
3 aerosol measurement
4 c.p.c.
5 junction
6 vent
7 restriction
8 specimen
9 a.s.d. under test

a Compressed-air supply.
b Aerosol waste.
c c.p.c. exhaust.
d a.s.d. exhaust.

Figure A.2 — Block diagram of the apparatus — Example 1 for measuring r.t.v.

The aerosol generator generates a polydisperse paraffin mist as specified in ISO 7240-7:2003, Annex B. The aerosol passes into a dilution system where it is mixed with clean air in a manner that allows precisely adjustable dilution. The diluted aerosol is then presented to the specimen and a c.p.c., which measures the aerosol at the same concentration as that entering the specimen. The flow rate through the aerosol generator/dilution system is set so that it just exceeds the sum of the flows required by the specimen and the c.p.c. with the excess flowing out of the vent (see Figure A.2, key item 6). This allows the specimen and the c.p.c. to draw the aerosol from the same point, which is at approximately atmospheric pressure. Both the c.p.c. and the specimen operate with their own aspirating pumps. The restriction (see Figure A.2, key item 7) is added to simulate the pressure drop of the sampling pipe system and to allow the flow through the specimen to be within the manufacturer's specifications. The distances from the junction (see Figure A.2, key item 5) to the c.p.c. and to the specimen should be short, so that the c.p.c. and specimen effectively measure the same aerosol density at the same time.

Figure A.3 shows further details of a suitable test apparatus.



Key

1 pressure reduction (200 kPa)
2 pressure reduction (600 kPa)
3 aerosol generator
4 principal fresh-air valve
5 fresh-airflow meter
6 flow controller
7 mixing nozzle
8 secondary fresh-air valve
9 particle filter
10 orifice meter
11 flow meter
12 dilution
13 aerosol waste valve
14 pump
15 c.p.c.
16 aspirating smoke detector

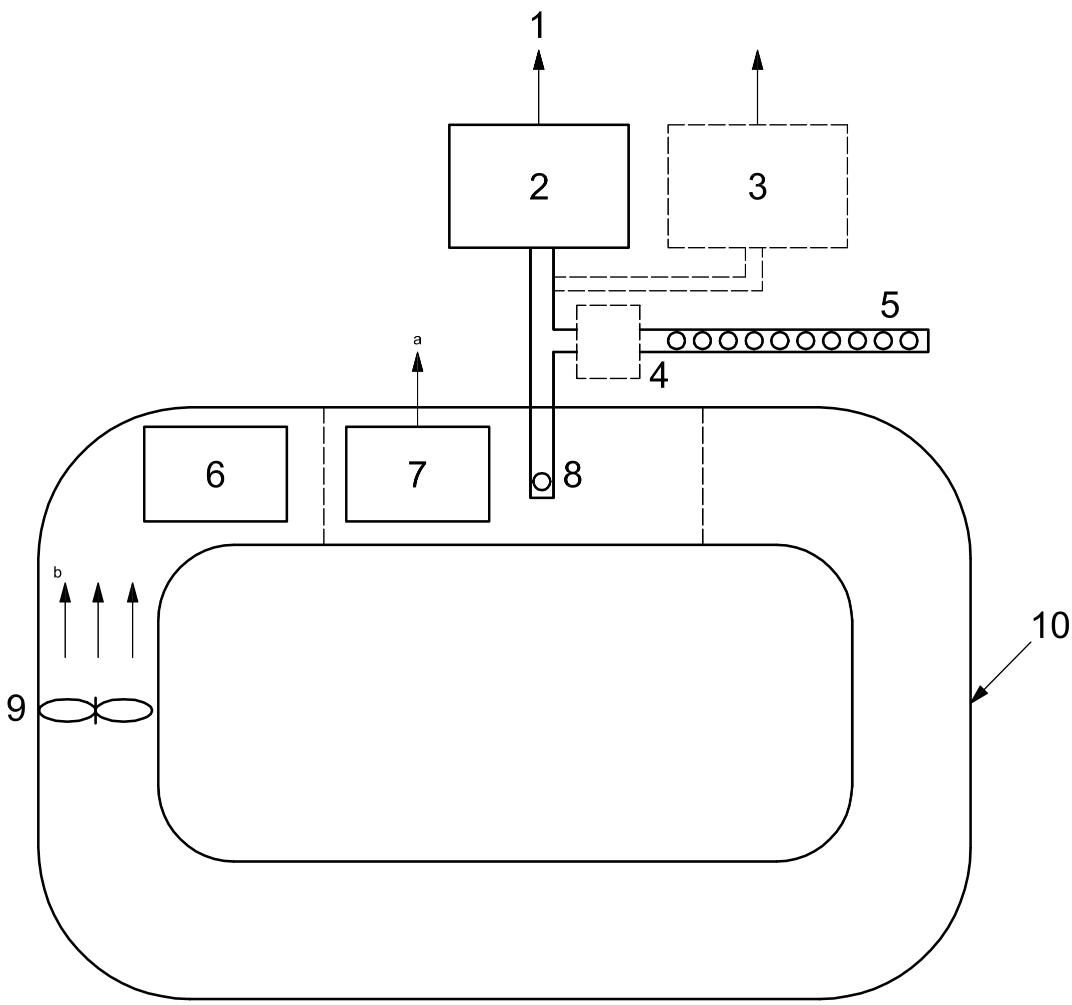
[a] Compressed-air (800 kPa).
[b] Waste aerosol.

Figure A.3 — Detailed arrangement of the apparatus — Example 1 for measuring r.t.v.

Although the set-up appears rather complex, it has been designed to be able to produce a wide range of overall flow rates, ranges of aerosol concentrations and rates of increase of aerosol concentration. The principal fresh-air valve (see Figure A.3, key item 4) is used to set the clean airflow rate, which effectively sets the overall flow rate since this is large when compared to the aerosol flow rate. Adjustment of the secondary fresh-air valve (see Figure A.3, key item 8) and the aerosol waste valve (see Figure A.3, key item 13) allows setting the overall range of aerosol concentration. These valves can all be set to appropriate positions for a particular type of aspirating detector and should not normally be adjusted during a series of measurements. The flow controller (see Figure A.3, key item 6) is an electronically controlled mass-flow controller, which is used to control the dilution. By adjusting this flow controller, the aerosol concentration presented to the specimen can be controlled from effectively zero to a maximum value, depending on the settings of the valves (see Figure A.3, key items 4, 8 and 13).

A.3 r.t.v. measurement apparatus — Example 2

The apparatus described in Figure A.4 uses the smoke tunnel described in ISO 7240-7:2003, Annex A, as the aerosol generator and first stage of dilution. The aerosol concentration in the tunnel is measured using the instruments described in ISO 7240-7:2003, Annex C. A second stage of dilution is arranged using an appropriate sampling device, which mixes clean air drawn from the laboratory environment with test aerosol drawn from the smoke tunnel.



Key

1 supply and monitoring equipment
2 specimen
3 reference detector (optional)
4 fine filter (optional)
5 dilution:
1 sampling point in the smoke tunnel
n sampling points outside
6 aerosol generator
7 aerosol measurement
8 working volume
9 fan
10 smoke tunnel (see ISO 7240-7)

[a] *N* aerosol concentration.

[b] Air flow.

Figure A.4 — Arrangement of the apparatus — Example 2 for measuring r.t.v.

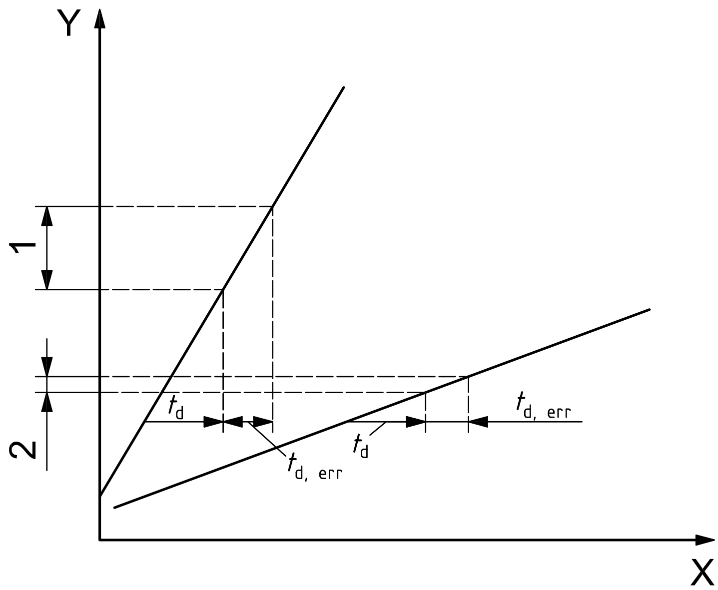
It is important to keep in mind that the aerosol concentration measured in the smoke tunnel is not a direct measurement of the aerosol concentration entering the specimen. As such, it is essential that other parameters that can affect the measurement remain constant. The dilution achieved with the sampling device should be consistent and repeatable. The following are some considerations for achieving repeatable, reliable results using the apparatus shown in Figure A.4.

— It is essential that the tunnel does not leak and potentially contaminate the clean air entering the sampling device.

— It is recommended that the same physical sampling device be used in all measurements so that minor variations in the sampling device do not affect the measurements recorded.

— It is recommended that the sampling device be arranged such that it is as short as is practically possible to minimize the transport time.

The rate of rise of the aerosol concentration in the tunnel should be consistent and sufficiently slow to ensure that the delays inherent to the detector (including the transport delay of the sampling device and other processing delays) do not affect the results. Figure A.5 illustrates the fact that the delays, t_d, with variability, $t_{d, err}$, means that a fast rate of rise in the tunnel results in a higher and less accurate r.t.v. measurement than a slow rate of rise.



Key

X time

Y smoke concentration, y or m

1 error/variability in r.t.v measurement using a fast rate of rise

2 error/variability in r.t.v measurement using a slow rate of rise

t_d a.s.d. inherent delay

$t_{d,err}$ error/variability in measuring delay time

Figure A.5 — Graph showing effect of rate of rise on r.t.v. accuracy

Due to the possible inaccuracies in the test apparatus shown in Figure A.4, as a precaution, it is recommended that, where possible, a “reference sample” of the specimen be arranged in series or parallel with the specimen (as appropriate to the particular design of a.s.d.). Such a reference sample provides confirmation that any changes in the measured r.t.v. are a function of the experiment (hot, cold, damp heat, etc.) as opposed to the test apparatus and conditions. Where the specimen does not have an output that is essentially proportional to aerosol concentration, it is recommended that another suitable instrument be used, such as an alternative a.s.d. device.

Annex B
(normative)

Smouldering (pyrolysis) wood fire (TF2)

B.1 Fuel

The fuel consists of approximately 10 dried beechwood sticks (moisture content ≈ 5 %), each stick having dimensions of 75 mm × 25 mm × 20 mm.

B.2 Hotplate

The hotplate shall have a 220 mm diameter grooved surface with eight concentric grooves with a distance of 3 mm between grooves. Each groove shall be 2 mm deep and 5 mm wide, with the outer groove 4 mm from the edge. The hotplate shall have a rating of approximately 2 kW.

The temperature of the hotplate shall be measured by a sensor attached to the fifth groove, counted from the edge of the hotplate, and secured to provide a good thermal contact.

B.3 Arrangement

Arrange the sticks radially on the grooved hotplate surface, with the 20 mm side in contact with the surface such that the temperature probe lies between the sticks and is not covered, as shown in Figure B.1.

B.4 Heating rate

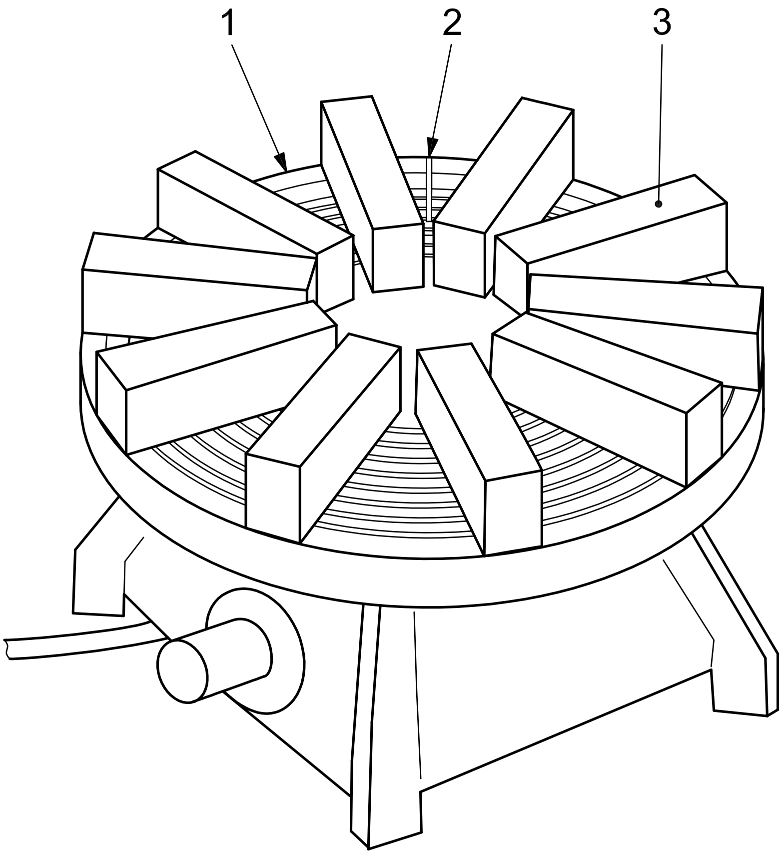
The hotplate shall be powered such that its temperature rises from ambient to 600 °C in approximately 11 min.

B.5 End-of-test condition

The end-of-test condition, m_E, shall be when $m = 2$ dB/m.

B.6 Test validity criteria

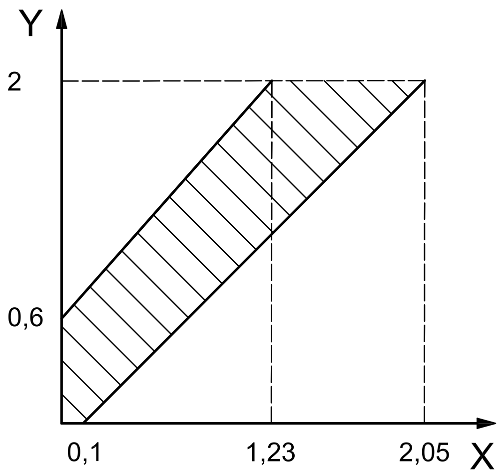
No flaming shall occur before the end-of-test condition has been reached. The development of the fire shall be such that the curves of m against y, and of m against time, t, fall within the limits shown in Figures B.2 and B.3, respectively, up to the time when m equals the end-of-test condition or the specimen has generated an alarm signal, whichever is the earlier.



Key

1 grooved hotplate
2 temperature sensor
3 wooden sticks

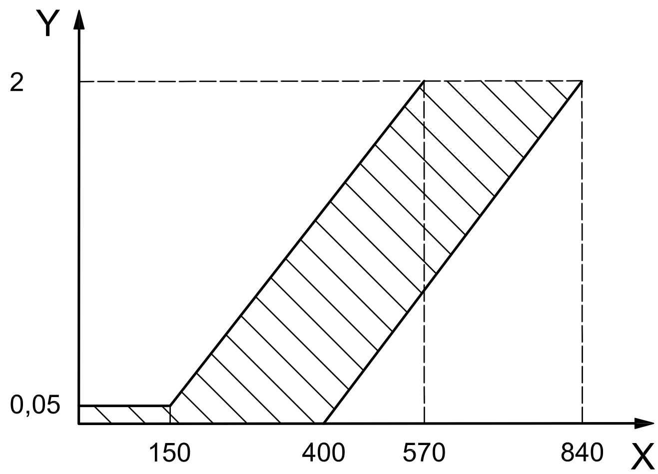
Figure B.1 — Arrangement of sticks on the hotplate



Key

X *y*-value
Y *m*-value, expressed in decibels per metre

Figure B.2 — Limits for *m* against *y*, fire TF2



Key

X time, *t*, expressed in seconds
Y *m*-value, expressed in decibels per metre

Figure B.3 — Limits for *m* against time, *t*, fire TF2

Annex C
(normative)

Reduced smouldering pyrolysis wood fires (TF2A and TF2B)

C.1 Fuel

The fuel consists of three or more dried beech wood sticks (moisture content ~ 5 %), each stick having dimensions of approximately 75 mm × 25 mm × 20 mm.

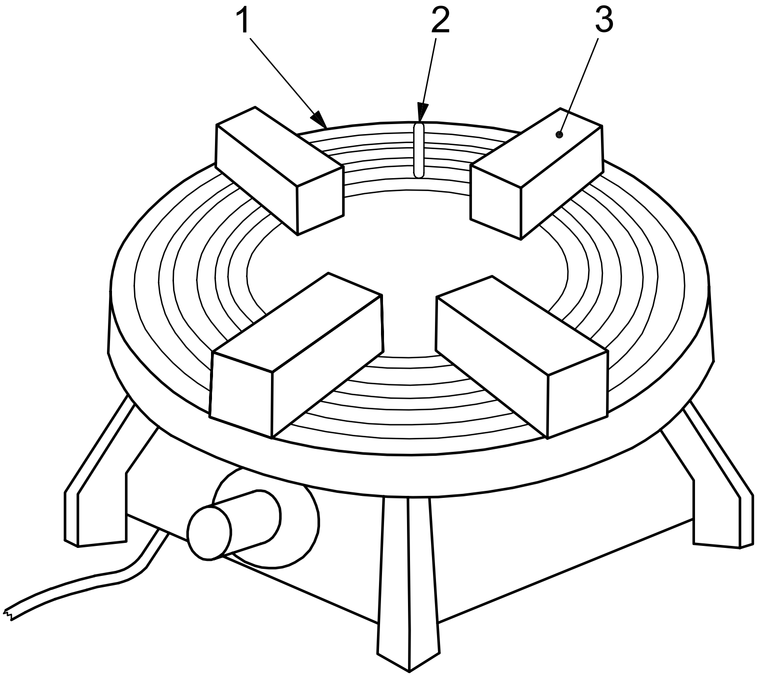
C.2 Hotplate

The hotplate shall have a 220 mm diameter grooved surface with eight concentric grooves with a distance of 3 mm between grooves. Each groove shall be 2 mm deep and 5 mm wide, with the outer groove 4 mm from the edge. The hotplate shall have a rating of approximately 2 kW.

The temperature of the hotplate shall be measured by a sensor attached to the fifth groove, counted from the edge of the hotplate, and secured to provide a good thermal contact.

C.3 Arrangement

Arrange the sticks radially on the grooved hotplate surface, with the 20 mm side in contact with the surface such that the temperature probe lies between the sticks and is not covered, as shown in Figure C.1.



Key

1 grooved hotplate

2 temperature sensor

3 3 (or more) wooden sticks

Figure C.1 — Arrangement of the sticks on the hotplate

C.4 Heating rate

The hotplate shall be powered such that its temperature rises from ambient to 500 °C in approximately 11 min.

NOTE For the TF2 test (used for class C a.s.d.), the target temperature is 600 °C.

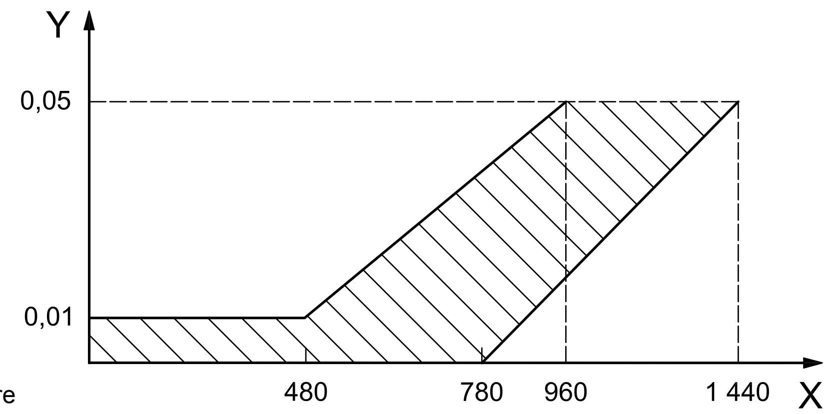
C.5 End-of-test condition

The end-of-test condition, $m_{E,}$ for class A using TF2A shall be when $m = 0{,}05$ dB/m.

The end-of-test condition, $m_{E,}$ for class B using TF2B shall be when $m = 0{,}15$ dB/m.

C.6 Test validity criteria

No flaming shall occur before the end-of-test condition. The development of the fire shall be such that the curves of m against time for TF2A and TF2B fall within the limits shown in Figures C.2 and C.3, respectively, up to the time when m equals the end-of-test condition or the specimen has generated an alarm signal, whichever is the earlier.

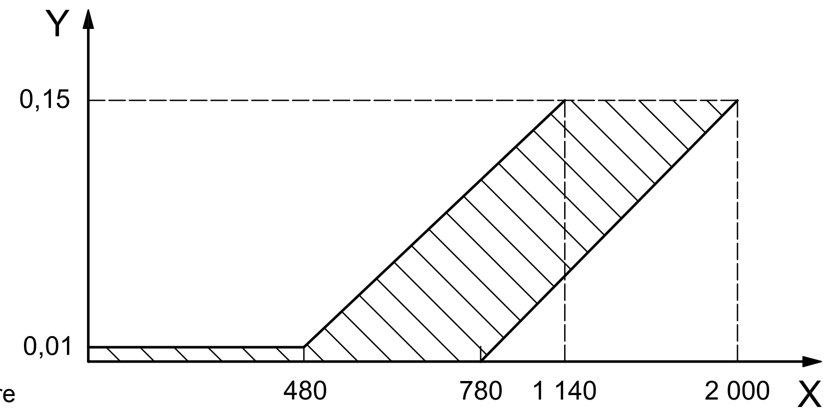


Key

X time, t, expressed in seconds

Y m-value, expressed in decibels per metre

Figure C.2 — Limits for m against time, t, fire TF2A



Key

X time, t, expressed in seconds

Y m-value, expressed in decibels per metre

Figure C.3 — Limits for m against time, t, fire TF2B

Annex D
(normative)

Glowing smouldering cotton fire (TF3)

D.1 Fuel

The fuel consists of approximately 90 pieces of braided cotton wick, each of length approximately 80 cm and weighing approximately 3 g. The wicks shall be free from any protective coating and shall be washed and dried, if necessary.

D.2 Arrangement

Fasten the wicks to a ring approximately 10 cm in diameter and suspended approximately 1 m above a non-combustible plate, as shown in Figure D.1.

Dimensions in metres

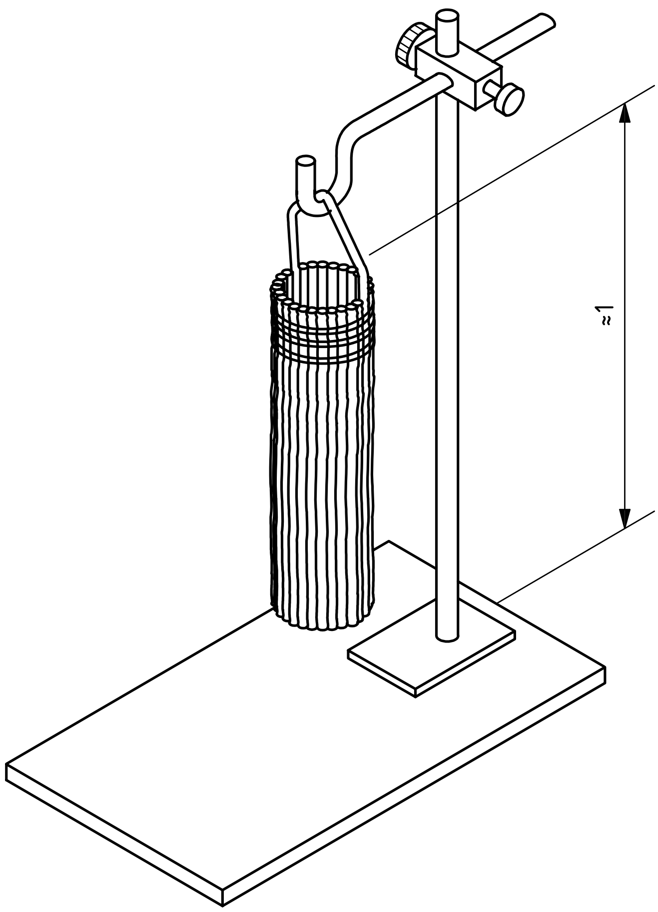


Figure D.1 — Arrangement of cotton wicks

D.3 Ignition

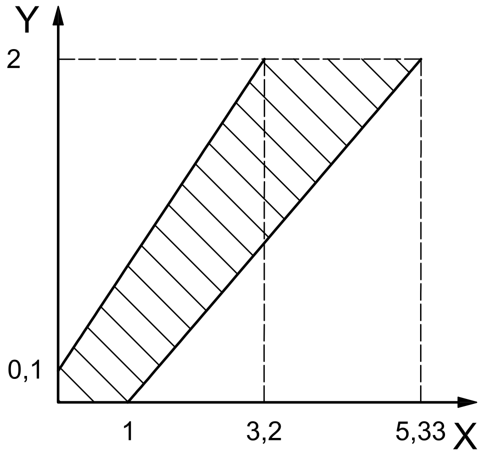
Ignite the lower end of each wick so that the wicks continue to glow. Blow out any flaming immediately. Start the test time when all wicks are glowing.

D.4 End-of-test condition

The end-of-test condition, m_E, shall be when $m = 2$ dB/m.

D.5 Test validity criteria

The development of the fire shall be such that the curves of m against y and of m against time, t, fall within the limits shown in Figures D.2 and D.3, respectively, up to the time when m equals the end-of-test condition or the specimen has generated an alarm signal, whichever is the earlier.

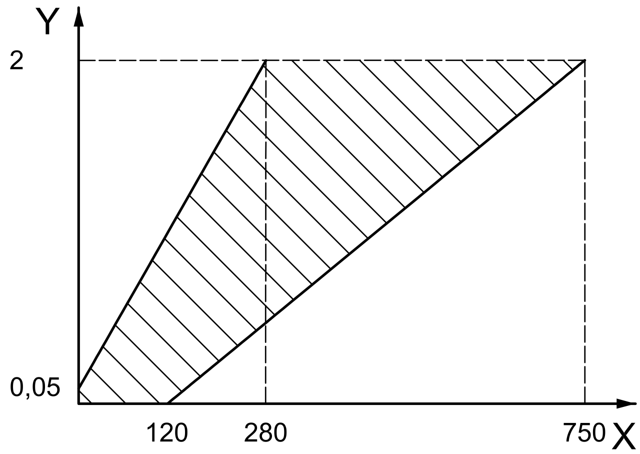


Key

X y-value

Y m-value, expressed in decibels per metre

Figure D.2 — Limits for m against y, fire TF3



Key

X time, t, expressed in seconds

Y m-value, expressed in decibels per metre

Figure D.3 — Limits for m against time, t, fire TF3

Annex E
(normative)

Reduced glowing smouldering cotton fire (TF3A and TF3B)

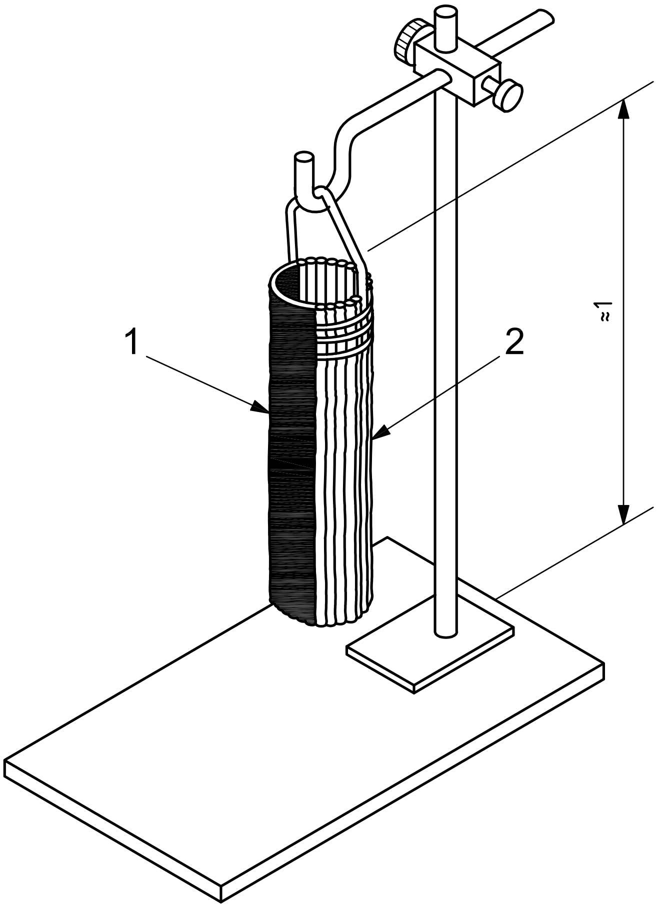
E.1 Fuel

The fuel consists of approximately 30 or 40 pieces of braided cotton wick, each of length approximately 80 cm and weighing approximately 3 g. The wicks shall be free from any protective coating and shall be washed and dried, if necessary.

E.2 Arrangement

Fasten the wicks to a ring approximately 10 cm in diameter and suspended approximately 1 m above a non-combustible plate. Position the wicks adjacent to one another and complete the open part of the arc using a curved sheet of non-combustible material to achieve a complete "chimney", as shown in Figure E.1.

Dimensions in metres



Key

1 curved sheet of non-combustible material

2 cotton wicks

Figure E.1 — Arrangement of the cotton wicks

E.3 Ignition

Ignite the lower end of each wick so that the wicks continue to glow. Blow out any flaming immediately. Start the test time when all wicks are glowing.

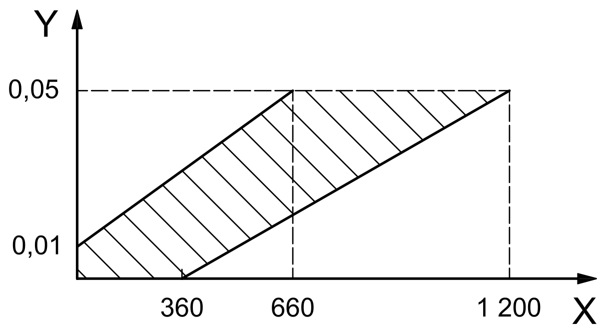
E.4 End-of-test condition

The end-of-test condition, m_E, for class A using TF3A shall be when $m = 0{,}05$ dB/m.

The end-of-test condition, m_E, for class B using TF3B shall be when $m = 0{,}15$ dB/m.

E.5 Test validity criteria

No flaming shall occur before the end-of-test condition. The development of the fire shall be such that the curves of m against time for TF3A and TF3B fall within the limits shown in Figures E.2 and E.3, respectively, up to the time when m equals the end-of-test condition or the specimen has generated an alarm signal, whichever is the earliest.

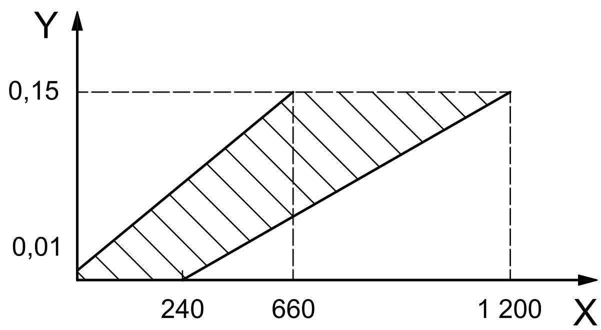


Key

X time, t, expressed in seconds

Y m-value, expressed in decibels per metre

Figure E.2 — Limits for m against time, t, fire TF3A



Key

X time, t, expressed in seconds

Y m-value, expressed in decibels per metre

Figure E.3 — Limits for m against time, t, fire TF3B

Annex F
(normative)

Flaming plastics (polyurethane) fire (TF4)

F.1 Fuel

The fuel consists of mats of soft polyurethane foam, without flame-retardant additives and having a density of approximately 20 kg/m^3. Three mats, approximately 50 cm × 50 cm × 2 cm, are usually sufficient. However, the quantity and dimensions of the fuel may be adjusted to obtain valid tests.

F.2 Conditioning

Maintain the mats in a humidity not exceeding 50 % for at least 48 h prior to test.

F.3 Arrangement

Place the mats one on top of another on a base formed from aluminium foil with the edges folded up to provide a tray.

F.4 Ignition

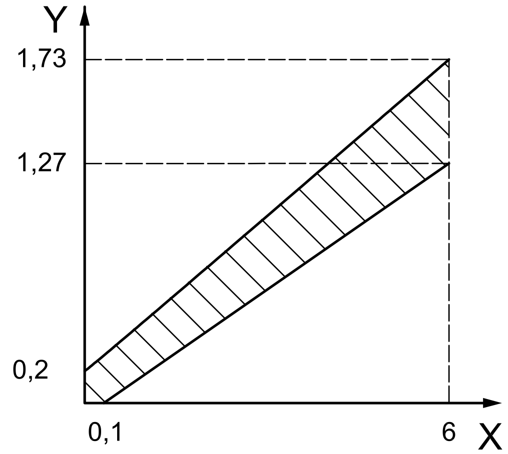
The mats shall normally be ignited at a corner of the lower mat; however, the exact position of ignition may be adjusted to obtain a valid test. A small quantity of a clean-burning material (e.g. 5 cm^3 of methylated spirit) may be used to assist the ignition.

F.5 End-of-test condition

The end-of-test condition, y_E, shall be when $y = 6$.

F.6 Test validity criteria

The development of the fire shall be such that the curves of m against y, and of m against time, t, fall within the limits shown in Figures F.1 and F.2, respectively, up to the time when m equals the end-of-test condition or the specimen has generated an alarm signal, whichever is the earlier.

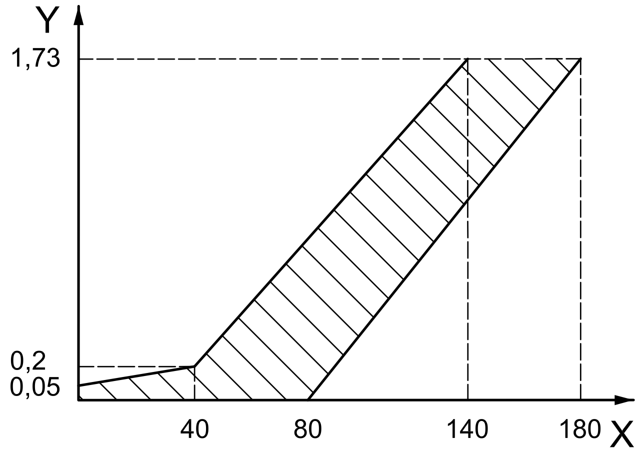


Key

X y-value

Y m-value, expressed in decibels per metre

Figure F.1 — Limits for m against y, fire TF4



Key

X time, t, expressed in seconds

Y m-value, expressed in decibels per metre

Figure F.2 — Limits for m against time, t, fire TF4

Annex G
(normative)

Flaming liquid (*n*-heptane) fire (TF5)

G.1 Fuel

The fuel consists of approximately 650 g of a mixture by volume of *n*-heptane (purity $\geqslant$ 99 %) with approximately 3 % of toluene (purity $\geqslant$ 99 %). The precise quantities may be varied to obtain valid tests.

G.2 Arrangement

Burn the heptane/toluene mixture in a square steel tray with dimensions of approximately 33 cm × 33 cm × 5 cm.

G.3 Ignition

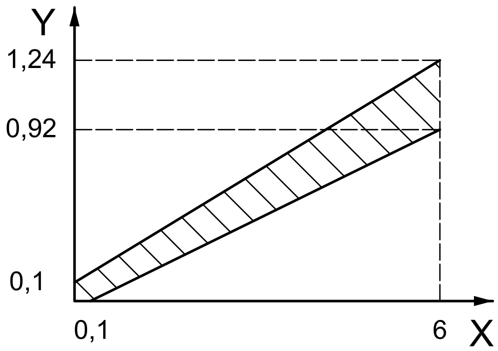
Ignition shall be by flame or spark.

G.4 End-of-test condition

The end-of-test condition, y_E, shall be when $y = 6$.

G.5 Test validity criteria

The development of the fire shall be such that the curves of m against y, and of m against time, t, fall within the limits shown in Figures G.1 and G.2, respectively, up to the time when y equals the end-of-test condition or the specimen has generated an alarm signal, whichever is the earlier.

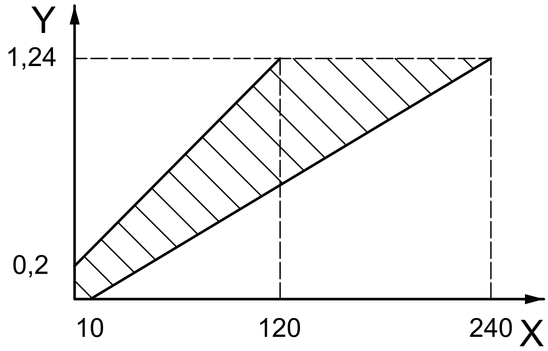


Key

X y-value

Y m-value, expressed in decibels per metre

Figure G.1 — Limits for m against y, fire TF5



Key

X time, t, expressed in seconds

Y m-value, expressed in decibels per metre

Figure G.2 — Limits for m against time, t, fire TF5

Annex H
(normative)

Reduced flaming liquid (*n*-heptane) fire (TF5A and TF5B)

H.1 Fuel

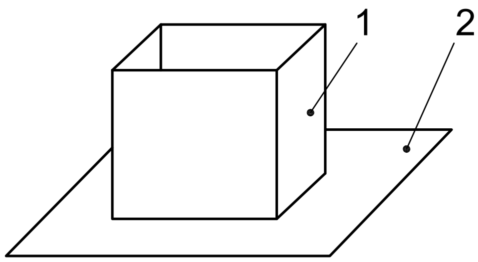
The fuel consists of approximately 200 ml (TF5A) or 300 ml (TF5B) of *n*-heptane (purity ⩾ 99 %), by volume. The precise quantities may be varied to obtain valid tests.

NOTE The use of toluene in the *n*-heptane is not accepted, since the presence of toluene in the fuel significantly modifies the behaviour of the fire, giving an initial peak burn, which is not suitable for reduced test fires.

H.2 Arrangement

For TF5A, the *n*-heptane shall be burnt in a square, 2 mm thick, steel tray with dimensions of approximately 100 mm × 100 mm × 100 mm placed on a 2 mm thick sheet metal base with dimensions of approximately 350 mm × 350 mm, as illustrated in Figure H.1.

For TF5B, the *n*-heptane shall be burnt in a square, 2 mm thick, steel tray with dimensions of approximately 175 mm × 175 mm × 100 mm placed on a 2 mm thick sheet metal base with dimensions of approximately 350 mm × 350 mm, as illustrated in Figure H.1.



Key

1 tray

2 base plate

Figure H.1 — Arrangement of the tray for test fires TF5A and TF5B

The base plate may be the tray used in TF5 and is needed to act as a heat sink to avoid boiling of the small quantities of fuel used in the reduced test fires.

H.3 Ignition

Ignition shall be by flame or spark, etc.

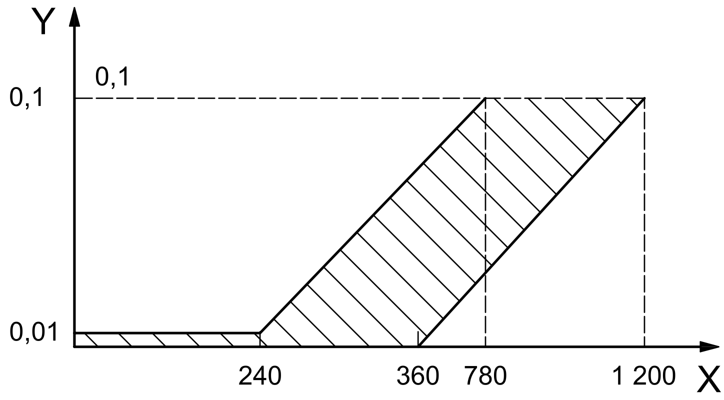
H.4 End-of-test condition

The end-of-test condition, m_E, for class A using TF5A shall be when $m = 0,1$ dB/m.

The end-of-test condition, m_E, for class B using TF5B shall be when $m = 0,3$ dB/m.

H.5 Test validity criteria

The development of the fire shall be such that the curves of *m* against time, *t*, for TF5A and TF5B fall within the limits shown in Figures H.2 and H.3, respectively, up to the time when *m* equals the end-of-test condition or the specimen has generated an alarm signal, whichever is the earlier.

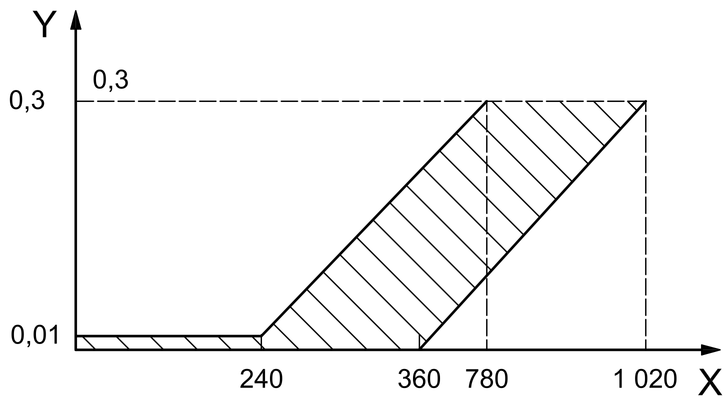


Key

X time, *t*, expressed in seconds

Y *m*-value, expressed in decibels per metre

Figure H.2 — Limits for *m* against time, *t*, fire TF5A



Key

X time, *t*, expressed in seconds

Y *m*-value, expressed in decibels per metre

Figure H.3 — Limits for *m* against time, *t*, fire TF5B

Annex I
(normative)

Fire test room and ventilation system

I.1 Fire test room

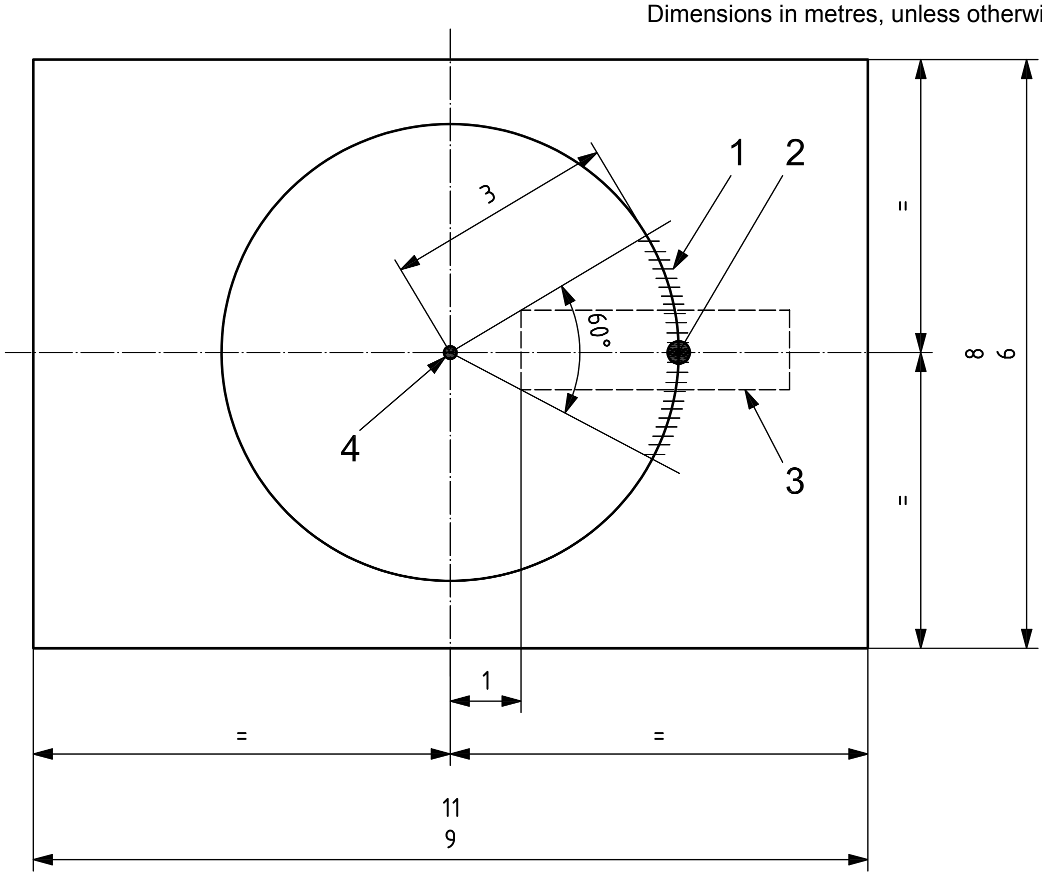
The sampling point, the MIC, the temperature probe and the measuring part of the obscuration meter shall all be located within the volume shown in Figures I.1 and I.2.

The sampling point shall be located on the 3 m arc (see Figure I.1, key item 1). The optimum position is marked as key item 2.

The ventilation system shall be located in the position marked as key item 3 in Figure I.1. The direction of the airflow produced by this system shall be toward the test fire (located at the position marked as key item 4 in Figure I.1). The description of the ventilation system is given in I.2.

The sampling point, the MIC and the mechanical parts of the obscuration meter shall be at least 100 mm apart, measured to the nearest edges. The centre line of the beam of the obscuration meter shall be at least 35 mm below the ceiling.

Dimensions in metres, unless otherwise indicated



Key

1 sampling point and measuring instruments (see Figure I.2)

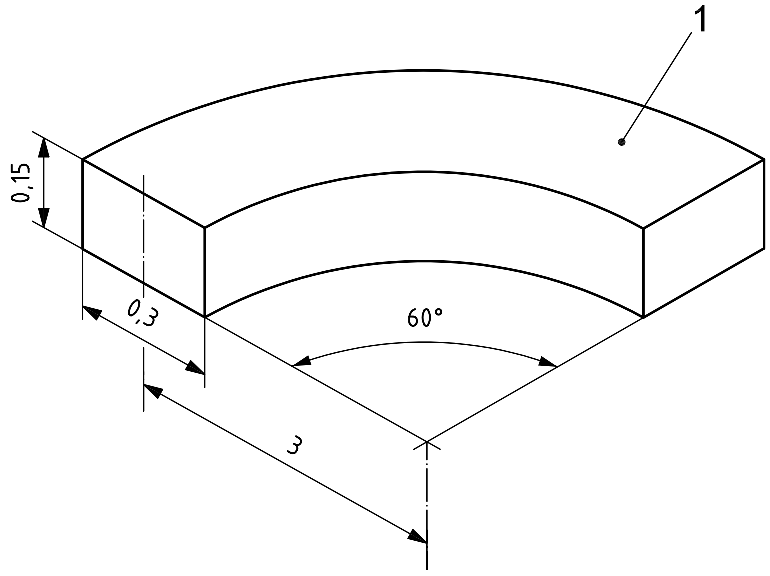
2 optimum position of the sampling point

3 ventilation system (see Figure I.3)

4 position of test fire

Figure I.1 — Plan view of the fire test room

Dimensions in metres, unless otherwise indicated



Key

1 ceiling

Figure I.2 — Mounting position for instruments and specimens

I.2 Ventilation system

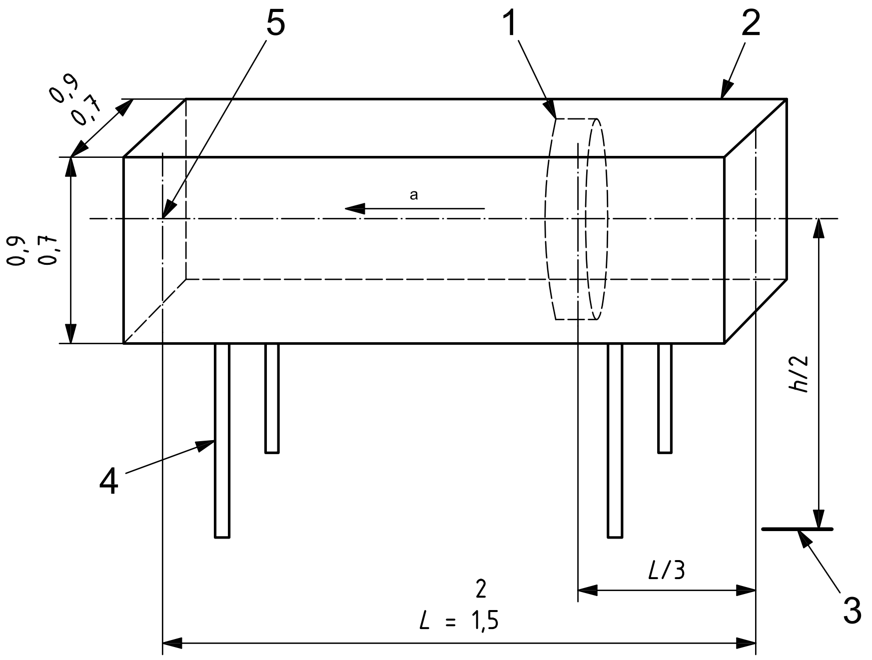
As a consequence of the low quantity of aerosols generated by reduced fire tests, it is necessary, for the reduced fire tests TF2A, TF2B, TF3A, TF3B, TF5A and TF5B, to introduce in the fire test room a ventilation system to increase the homogeneity of the atmosphere close to the sampling points. The following specifies those characteristics of the ventilation system which are of primary importance.

The ventilation system consists of a square duct opened in both extremities (see Figure I.3).

A fan is located in the duct as described in Figure I.3. The diameter of the fan shall be as close as possible to the dimensions of the sides of the square section of the duct. At the location of the fan, the section of the duct not occupied by the fan shall be closed. The axis of the fan shall be the same as the axis of the square duct.

The ventilation system shall create an airflow at (1,0 ± 0,2) m/s at the output of the duct (the airflow direction is given in Figure I.3). Conformity with this requirement shall be regularly verified during the fire tests by measurements at the centre of the duct output section (see key item 5 in Figure I.3).

Dimensions in metres



Key

1 fan

2 square duct

3 ground

4 stand

5 location of the flow velocity measurement

L length of the duct

h height of the fire test room (as described in ISO 7240-7:2003, 5.18.3.1)

a Air flow.

Figure I.3 — Ventilation system

Annex J
(informative)

Information concerning the requirements for the response to slowly developing fires

A simple a.s.d. operates by comparing the signal from the sensor with a certain fixed threshold (alarm threshold). When the sensor signal reaches the threshold, the a.s.d. releases an alarm signal. The smoke density at which this occurs is the r.t.v. for the a.s.d. In this simple a.s.d., the alarm threshold is fixed and does not depend on the rate of change of sensor signal with time.

It is known that the sensor signal in clean air can change over the life of the detector. Such changes can be caused, for example, by contamination of the sensing chamber with dust or by other long-term effects such as component ageing. This drift can, in time, lead to increased sensitivity and eventually to false alarms.

It can be considered beneficial, therefore, to provide compensation for such drift to maintain a more constant level of r.t.v. with time. It is assumed that the compensation is achieved by increasing the alarm threshold to offset some or all of the upward drift in the sensor output.

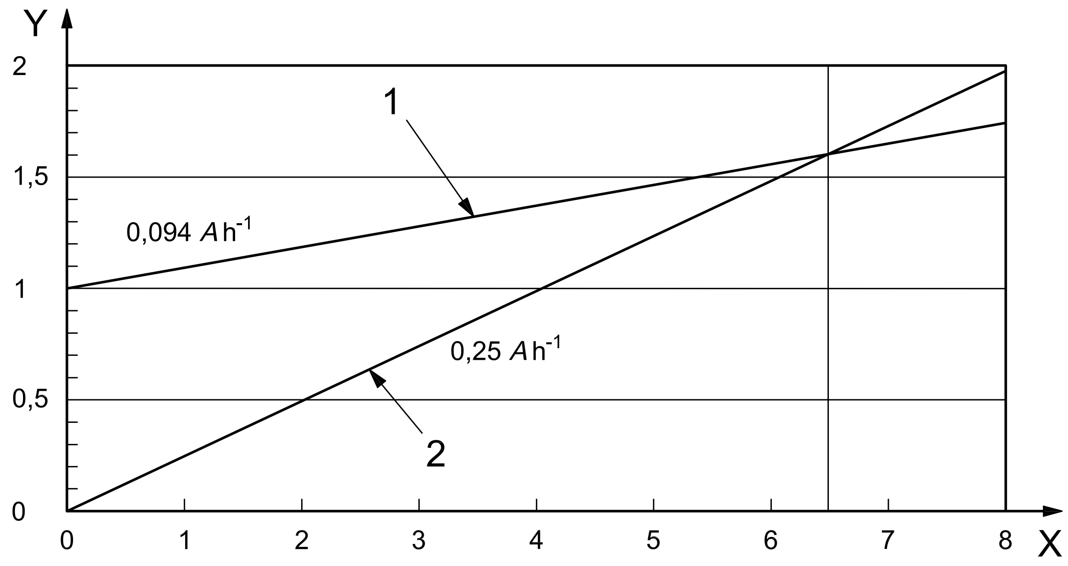
Any compensation for drift reduces the sensitivity of the detector to slow changes in the sensor output, even if these changes are caused by a real, but gradual, increase in smoke level. The object of 4.7 is to ensure that the compensation does not reduce the sensitivity of a slowly developing fire to an unacceptable degree.

For the purposes of this part of ISO 7240, it is assumed that the development of any fire that presents a serious danger to life or property will be such that the sensor output will change at a rate of at least $A/4$ per hour, where A is the nominal r.t.v. of the detector. The response to rates of change less than $A/4$ per hour is not specified in this part of ISO 7240 and there is, therefore, no requirement for the detector to respond to these lower rates of change.

To avoid restricting the way in which compensation is achieved, 4.7 requires only that the time to alarm for all rates of change greater than $A/4$ per hour does not exceed 1,6 times the time to alarm if the compensation were not present.

If the threshold increases in a linear fashion with time in response to a rise in the sensor signal and if the extent of the compensation is not limited, then the maximum rate of compensation allowed can be seen from Figure J.1 to be $0{,}6A/6{,}4 = 0{,}094A/\text{h}$, since at this compensation rate the sensor output reaches the compensated threshold in exactly 6,4 h.

Although it has been assumed above that the threshold is compensated linearly and continuously, it is not necessary that the process be linear or continuous. For example, the stepwise adjustment shown in Figure J.2 also meets the requirement since, in this case, an alarm is reached in 6 h, which is less than the limiting value of 6,4 h.



Key

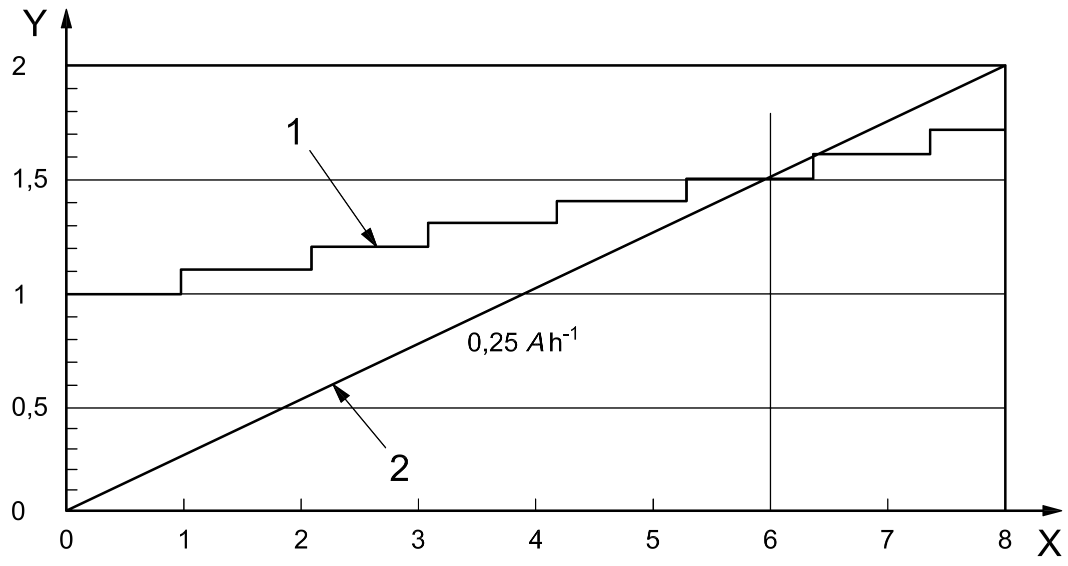
X time, expressed in hours

Y relative alarm threshold (relative to A)

1 compensated alarm threshold

2 sensor output

Figure J.1 — Linear compensation — Limiting case



Key

X time, expressed in hours

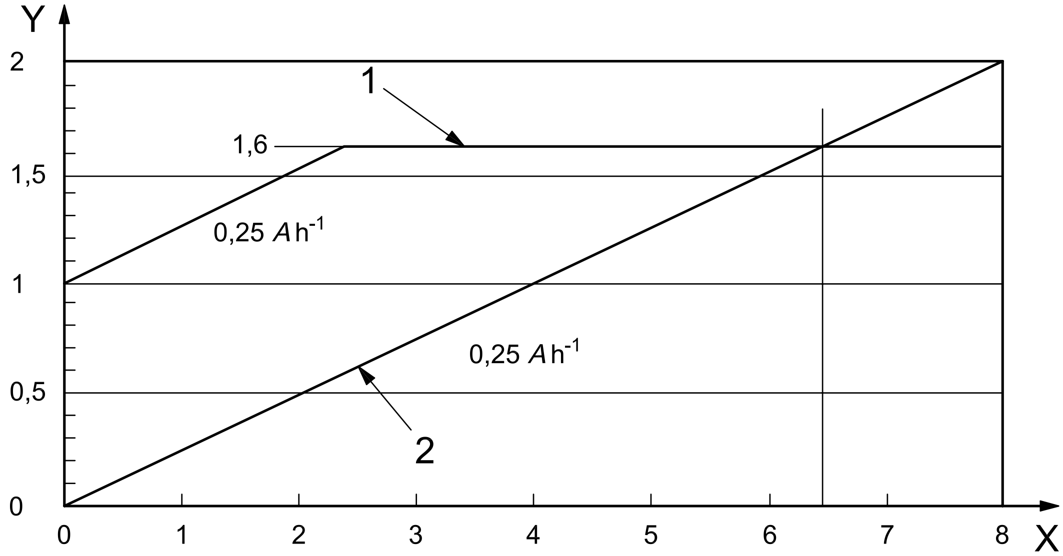
Y relative alarm threshold (relative to A)

1 compensated alarm threshold

2 sensor output

Figure J.2 — Stepwise compensation — Limiting case

Furthermore, it is not necessary to limit the rate of compensation to 0,094A/h if the extent of the compensation is restricted to 0,6A. The relatively rapid rate of compensation shown in Figure J.3 also meets the requirement in reaching an alarm condition in 6,4 h. In this case, the maximum rate of compensation is limited only by the requirements of the test fires.



Key

X time, expressed in hours

Y relative alarm threshold (relative to A)

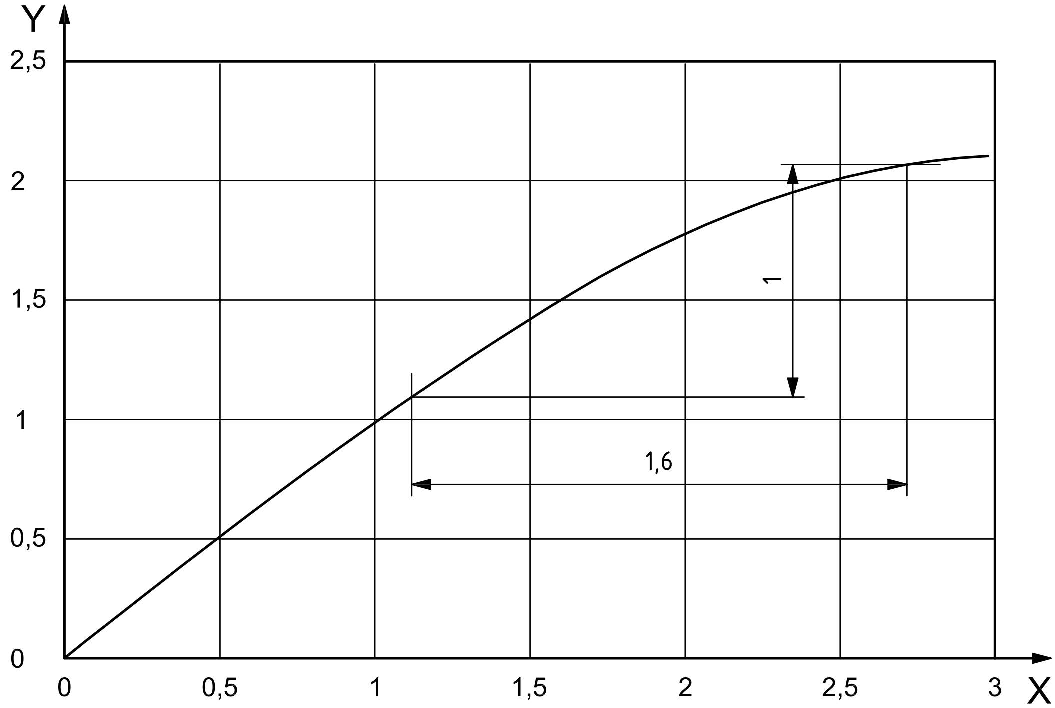
1 compensated alarm threshold

2 sensor output

Figure J.3 — High-rate, limited-extent compensation

The requirements of 4.7 allow considerable freedom in the way in which compensation for slow changes is achieved. However, it is recognized that in any practical a.s.d. the range over which the output of the sensor is linearly related to smoke (or other stimulus which is equivalent to smoke) is finite. If the range of compensation takes the sensor output into this non-linear region, then the sensitivity of the a.s.d. can become degraded to an unacceptable degree.

As an example, consider a detector having the transfer characteristic shown in Figure J.4, in which both axes are expressed in terms of r.t.v. A. The non-linearity of the characteristic causes the effective sensitivity to be reduced at higher values of the stimulus. In this instance, it is necessary to limit the compensation to less than 1,1 $\times A$, since, to produce a change of A in the output, it is necessary to increase the stimulus from 1,1 $\times A$ to 2,7 $\times A$. This reduction in sensitivity by a factor of 1,6 represents the maximum allowed in accordance with 4.7.



Key

X stimulus

Y output

Figure J.4 — Example of non-linear transfer characteristic

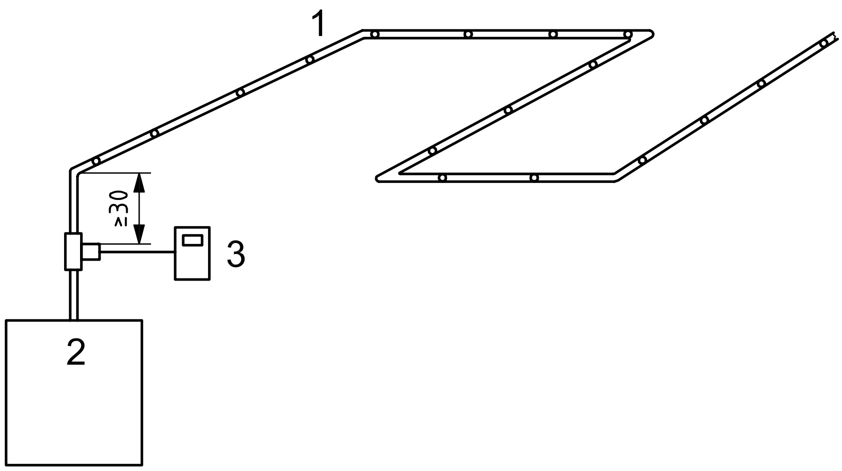
Annex K
(informative)

Apparatus for airflow monitoring test

K.1 General

This annex describes the apparatus and procedure for the airflow monitoring test.

Dimensions in centimetres



Key

1 worst-case sampling device (defined by manufacturer)

2 specimen

3 anemometer

Figure K.1 — Airflow measuring with worst-case pipe network

K.2 Airflow measuring with worst-case sampling device

Measure the airflow with worst-case sampling device using the equipment shown in Figure K.1 as follows.

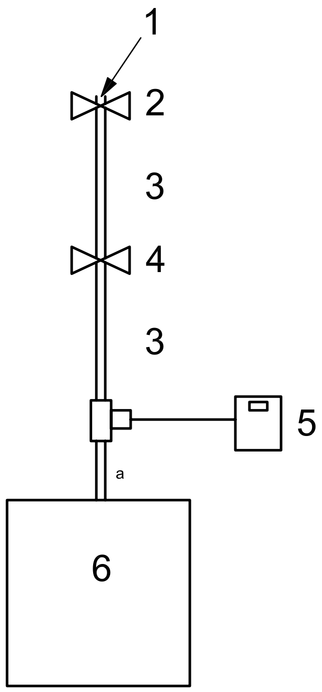
a) Set up the specimen in accordance with the manufacturer's instructions.

b) Measure the normal airflow value, F_n, using a suitably calibrated flow meter, such as an anemometer, with the worst-case sampling device (as defined by the manufacturer for the fire tests).

c) There is no sampling point between the specimen and the anemometer.

d) The minimum distance between the anemometer and the first sampling point is 30 cm.

NOTE In this example, the airflow value is the air speed, expressed in metres per second, which is directly correlated with the volumetric airflow as required in 5.1.6.



Key

1 open pipe
2 secondary flow control valve
3 test pipe network (1 m to 2 m without sampling points)
4 primary flow control valve
5 anemometer
6 specimen

[a] Minimum distance 30 cm.

Figure K.2 — Airflow measuring with test pipe network

K.3 Airflow monitoring test with test pipe network

Carry out the airflow monitoring test with test pipe network using the equipment shown in Figure K.2 as follows.

a) Set up the specimen with test pipe network.

b) Set the secondary flow control valve (see Figure K.2, key item 2) to middle position. This allows variation of the airflow value in both directions (± 20 %) when required.

c) Using the primary flow control valve (see Figure K.2, key item 4), adjust the flow rate until the reading is within ± 10 % of the normal airflow value (F_n as measured in K.2) to give the test flow value, F_t.

The same test pipe network is used for the environmental tests in which the airflow monitoring is tested.

Bibliography

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

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

[3] EN 54-20, *Fire detection and fire alarm systems — Part 20: Aspirating smoke detectors*

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