LPCB®

Loss Prevention Standard

LPS 1280: Issue 1.1

Testing procedures for the LPCB approval and listing of duct smoke detectors using point smoke detectors

This standard specifies requirements, test methods and performance criteria for duct smoke detectors that consist of a point smoke detector inside a sampling unit. The function of duct smoke detectors is to detect smoke in ventilation ducts in order to prevent the spread of smoke in a ventilation system. The sampling unit draws air from the duct by differential pressure arising from the airflow in the duct. The point smoke detector shall comply either with EN 54-73 or Annex D of this standard.

bre

CONTENTS **PAGE**

PARTICIPATING ORGANISATIONS

This standard was approved by the LPC Fire and Security Board and Expert Group X. The following organisations participated in the preparation of this standard:-

Association of British Insurers
Association of Building Engineers
Association of Chief Police Officers
Association for Specialist Fire Protection
British Automatic Fire Sprinkler Association
British Fire Protection Systems Association
British Security Industry Association
BT
Chief Fire Officers Association
Door & Hardware Federation
Electrical Contractors Association
European Fire Sprinkler Network
Health & Safety Executive
Home Office
Metronet
Risk Engineering Data Exchange Group
Royal and Sun Alliance
Royal Institution of Chartered Surveyors

REVISION OF LOSS PREVENTION STANDARDS

Loss Prevention Standards will be revised by issue of revised editions or amendments. Details will be posted on our website at www.redbooklive.com

Technical or other changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments. (See amendments table on page 38)

The issue number will be given in decimal format with the integer part giving the issue number and the fractional part giving the number of amendments (e.g. Issue 3.2 indicates that the document is at Issue 3 with 2 amendments).

USERS OF LOSS PREVENTION STANDARDS SHOULD ENSURE THAT THEY POSSESS THE LATEST ISSUE AND ALL AMENDMENTS.

FOREWORD

This standard identifies the evaluation and testing practices undertaken by LPCB for the purposes of approval and listing of products. LPCB listing and approval of products and services is based on evidence acceptable to LPCB:-

- that the product or service meets the standard
- that the manufacturer or service provider has staff, processes and systems in place to ensure that the product or service delivered meets the standard

and on:-

- periodic audits of the manufacturer or service provider including testing as appropriate
- compliance with the contract for LPCB listing and approval including agreement to rectify faults as appropriate

NOTES

Compliance with this LPS does not of itself confer immunity from legal obligations. Users of LPSs should ensure that they possess the latest issue and all amendments.

LPCB welcomes comments of a technical or editorial nature and these should be addressed to "the Technical Director" at enquiries@breglobal.co.uk.

The BRE Trust, a registered charity, owns BRE and BRE Global. BRE Global and LPCB (part of BRE Global) test, assess, certificate and list products and services within the fire and security sectors. For further information on our services please contact BRE Global, Watford, Herts. WD25 9XX or e-mail to enquiries@breglobal.co.uk

Listed products and services appear in the LPCB "List of Approved Products and Services" which may be viewed on our website: www.redbooklive.com or by downloading the LPCB Red Book App from the App Store (for iPhone and iPad), from Google Play (for Android devices) or from the Windows Store (for Windows 8 Phones and Tablets from 2014).

1 INTRODUCTION

Duct smoke detectors are used to provide supplementary detection in a fire detection and fire alarm system. They are intended for the detection of smoke in ventilation ducts and are often associated with dampers/shutters to isolate the fire and prevent the spread of smoke within a building.

Duct smoke detectors are generally mounted to the external surface of the protected duct and are equipped with sampling tubes that enable, by means of differential pressure, sufficient smoke to be drawn into a sampling chamber. A point smoke detector placed in the sampling chamber provides the means of detecting and signalling the presence of smoke.

This standard has been drafted to allow the evaluation of duct detectors that use a point smoke detector complying with and assessed to the requirements of EN 54-7[3]. The standard also recognises that duct detectors may exist that use a special purpose detection element that may not have been previously assessed to EN 54-7[3]. Annex D has been added to cover the additional tests that would be required to assess such detectors.

Tests have been included to verify leakage under various stress conditions as well as the ability of the design to withstand expected levels of vibration. The response performance of duct detectors can also vary significantly with air velocity and orientation of the sampling arrangements. Provision has therefore been made in verifying the duct detector response time to exercise these parameters within the limits declared by the manufacturer.

This standard has been drafted specifically for duct smoke detectors using point smoke detectors and sampling tubes, hence great care should be taken in interpreting results of these tests when applied to detectors using different techniques.

2 SCOPE

This standard specifies requirements, test methods and performance criteria for duct smoke detectors that consist of a point smoke detector inside a sampling unit. The function of duct smoke detectors is to detect smoke in ventilation ducts in order to prevent the spread of smoke in a ventilation system. The sampling unit draws air from the duct by differential pressure arising from the airflow in the duct. The point smoke detector shall comply either with 54-7[3] or Annex D of this standard.

Although this standard covers duct smoke detectors that include electronics associated with the operation of dampers and or shutters to isolate the fire and prevent the spread of smoke within a building, it does not specify the requirements for the functions implemented by such units.

For duct smoke detectors working on different principles, or duct smoke detectors incorporating point smoke detectors operating on a principle different from that specified in 54-7[3], this standard should only be used for guidance.

NOTE Certain types of point detectors used in duct smoke detectors contain radioactive materials. The national requirements for radiation protection differ from country to country and they are not specified in this standard.

3 DEFINITIONS

For the purposes of this document, the following definitions and those given in EN 54-1[1].

3.1 Response threshold value

Aerosol density in the duct in the proximity of the inlet sampling tube at the moment that an alarm signal is generated, when tested as described in Clause 5

NOTE The response threshold value may depend on signal processing in the detector and / or control equipment

3.2 Sampling unit

Apparatus that takes samples from the moving air-stream within a duct via an inlet tube. The air sample is transported to a point smoke detector and returned to the duct via an outlet tube

4 REQUIREMENTS

4.1 Compliance

In order to comply with this standard the duct smoke detector shall meet the requirements of this Clause, which shall be verified by visual inspection or engineering assessment. The duct smoke detector shall be tested as described in Clause 5 and shall meet the requirements of the tests. The point smoke detector shall either comply with EN 54-7[3] or with Annex D of this standard.

4.2 Individual alarm indication

Each duct smoke detector shall be provided with an integral red visual indicator, by which the individual detector, which released an alarm, may be identified. Where other conditions of the duct smoke detector may be visually indicated, they shall be clearly distinguishable from the alarm indication, except when the duct smoke detector is switched into a service mode.

The visual indicator shall be visible from a distance of 6 m directly in front of the indicator, in an ambient light intensity up to 500 lux.

4.3 Connection of ancillary devices

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

4.4 Monitoring of detachable detectors

If the detector is detachable from the sampling unit, a means shall be provided for a remote monitoring system to detect and signal its removal.

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

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

a) for each setting, at which the manufacturer claims compliance with this standard, the duct smoke detector shall comply with the requirements of this standard, and access to the adjustment means shall not be possible except by the use of a code or special tool or by removing the point smoke detector;

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

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

4.7 Marking

Each duct smoke detector shall be clearly marked with the following information:

a) the number of this standard;

b) the name or trademark of the manufacturer or supplier;

c) the model designation (type or number);

d) the wiring terminal designations;

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

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

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

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

4.8 Data

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

The data shall include:

a) the range of operating differential pressure between the inlet and outlet tubes and the recommended method for measuring this pressure;

b) the range of operating duct air velocities;

c) the range of applicable duct sizes for specified tube lengths;

d) the model(s) of point smoke detector for which the duct smoke detector meets the requirements of this standard;

e) the range of smoke sensitivities which complies with this standard (see 4.6 b))

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

5 TEST METHODS

5.1 General

5.1.1 Atmospheric conditions for tests

Unless otherwise stated in a test procedure, the testing shall be carried out after the test specimen has been allowed to stabilise in the standard atmospheric conditions for testing as described in IEC 60068-1: 1988 + A1: 1992[4] as follows:

a) temperature: (15 to 35) °C;

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

c) air pressure: (86 to 106) kPa.

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

5.1.2 Operating conditions for tests

If a test method requires a specimen to be operational, then the specimen shall be connected to suitable supply and monitoring equipment with characteristics as required by the manufacturer's data. Unless otherwise specified in the test method, the supply parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value, or if not stated the mean of the specified range. If a test procedure requires a specimen to be monitored to detect any alarm or fault signals, then connections shall be made to any necessary ancillary devices (e.g. through wiring to an end-of-line device for conventional detectors) to allow a fault signal to be recognised.

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

5.1.3 Mounting arrangements

The specimen shall be mounted by its normal means of attachment in accordance with the manufacturer's instructions. If these instructions describe more than one method of mounting then the method considered to be the most unfavourable shall be chosen for each test.

The duct smoke detector mounting arrangement shall not be disturbed between successive tests that are required to prove conformance.

5.1.4 Tolerances

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

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

The specimen, on which the response threshold value is to be measured, shall be installed in accordance with the manufacturer's instructions, in the smoke tunnel described in Annex A, using a test aerosol as specified in Annex B. The sampling tube length shall be selected as the manufacturer's longest length of tube that will fit the test tunnel, unless otherwise specified in the test procedure. The position of the specimen in the tunnel and the orientation of the sampling tube relative to the airflow shall be those specified by the manufacturer, unless otherwise specified in the test procedure.

Before commencing each measurement the smoke tunnel shall be purged to ensure that the tunnel and the specimen are free from the test aerosol.

Unless otherwise specified in the test procedure:

- the air velocity in the proximity of the inlet sampling tube shall be 5 ms-1 during the measurement,
- the air temperature in the tunnel shall be (23 ± 5) °C and shall not vary by more than 5 K for all the measurements on a particular detector type.

The specimen shall be connected to its supply and monitoring equipment as described in 5.1.2, and shall be allowed to stabilise for a period as specified by the manufacturer.

The test aerosol, as described in Annex B, shall be introduced into the tunnel such that the rate of increase of aerosol density is between 0.015 dB m^{-1} min^{-1} and 0.1 dB m^{-1} min^{-1}.

The rate of increase in aerosol density shall be similar for all measurements on a particular duct smoke detector type.

The aerosol density at the moment that the specimen gives an alarm shall be recorded as m (dB m-1). This shall be taken as the response threshold value.

5.1.6 Air leakage test method

The air leakage test apparatus is shown in Annex E.

The specimen to be tested shall be fixed to a rigid flange plate, in accordance with the manufacturer's instructions. The length of the inlet (and outlet) sample tubes shall be as specified 5.1.5. The flange plate shall be designed to form an airtight seal when fitted on the test apparatus whose depth shall be adequate to accommodate the sampling tubes. A separate inlet with an ON/OFF valve shall be provided in the side of the base of the test apparatus to connect a pump to depressurise it below the outside air pressure. There shall also be means of monitoring the differential air pressure inside the test apparatus compared to the air pressure outside the test apparatus. The differential air pressure in the test apparatus shall be decreased to -1.13 kPa (11.3 cm of water) at a rate not exceeding -0.90 k Pa/minute and the valves to the pump closed. The subsequent increase in differential air pressure over time t,

where:

$t = 60 \times \frac{(V_1 + V_2)}{V_2}$ seconds

V1 = internal volume of the test leakage apparatus

V2 = internal volume of the duct smoke detector

shall be recorded as ΔP(-).

Once the air pressure has been returned to ambient conditions the differential air pressure in the test apparatus shall be increased to +3 kPa (30 cm of water) at a rate not exceeding +2.4 kPa/minute. The subsequent decrease in differential air pressure over time t, where t is calculated using the formula above, shall be recorded as ΔP(+).

5.1.7 Provision for tests

The following shall be provided for testing compliance with this standard:

a) 6 specimens;

b) the data required in 4.8.

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

5.1.8 Test schedule

The specimens shall be tested according to the test schedule in Table 1. After the reproducibility test, the least sensitive specimen shall be numbered 6 and the others 1 to 5 arbitrarily.

Table 1: Test schedule		
Test	**Clause**	**Specimen No(s)**
Repeatability	5.2	One chosen arbitrarily
Reproducibility	5.3	All specimens
Air leakage: low temperature	5.4	1
Air leakage: high temperature	5.5	1
Vibration (endurance)	5.6	2
Sulphur dioxide (SO2) corrosion	5.7	3
Impact	5.8	4
Shock (operational)	5.9	5
Fire sensitivity	5.10	6

5.2 Repeatability

5.2.1 Object

To show that the duct smoke detector has stable behaviour with respect to its sensitivity even after a number of alarm conditions.

5.2.2 Test procedure

Measure the response threshold value of the duct smoke detector as described in 5.1.5 six times.

The specimen's orientation shall be the same for all six measurements.

The maximum response threshold value shall be designated m_{max}, the minimum value shall be designated m_{min}.

5.2.3 Requirements

The measured response threshold values shall be not less than 0.05 dB m^{-1} and the ratio of m_{max} to m_{min} shall not be greater than 1.6

5.3 Reproducibility

5.3.1 Object

To show that the sensitivity of the duct smoke detector does not vary unduly from specimen to specimen and to establish response threshold value data for comparison with the response threshold values measured after the environmental tests.

5.3.2 Test procedure

Measure the response threshold value of each duct smoke detector as described in 5.1.5.

The mean of these response threshold values shall be calculated and shall be designated $\overline{m}$.

The maximum response threshold value shall be designated m_{max}, the minimum value shall be designated m_{min}.

5.3.3 Requirements

The ratio of the response threshold values $m_{max} : \overline{m}$ shall not be greater than 1.33, and the ratio of the response threshold values $\overline{m} : m_{min}$ shall not be greater than 1.5.

The measured response threshold values shall be not less than 0.05 dB m^{-1}.

5.4 Air Leakage, Low Temperature

5.4.1 Object

To demonstrate that the sealing method of the duct smoke detector sampling unit is not unduly affected by low ambient temperatures appropriate to the anticipated service environment.

5.4.2 Test procedure

5.4.2.1 Reference

The test apparatus and procedure shall be as described in IEC60068-2-1:1990+A1: 1993+A2: 1994 Test Ab[5], and as described below.

5.4.2.2 State of specimen during conditioning

The specimen shall be mounted as described in 5.1.3 to the air leakage apparatus described in 5.1.6 but shall not be supplied with power during conditioning.

5.4.2.3 Conditioning

The following conditioning shall be applied:

Temperature: (-10 ± 3) ºC

Duration: 16 hours

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

During the last hour of the conditioning duration, while the specimen is at the conditioning temperature, the air leakage test as described in 5.1.6 shall be performed.

5.4.3 Requirements

The pressure ΔP(-) in the specimen after time *t*, shall not change by more than 0.11kPa *(1.1 cm of water)* and the pressure ΔP(+) in the specimen after time t, shall not change by more than 0.3kPa (3.0 cm of water) during the test.

5.5 Air Leakage, High Temperature

5.5.1 Object

To demonstrate that the sealing method of the duct smoke detector sampling unit is not unduly affected by high ambient temperatures appropriate to the anticipated service environment.

5.5.2 Test procedure

5.5.2.1 State of specimen during conditioning

The specimen shall be mounted as described in 5.1.3 to the air leakage apparatus described in 5.1.6 but shall not be supplied with power during conditioning.

5.5.2.2 Conditioning

The following conditioning shall be applied:

Temperature: (55 ± 2) °C

Duration: 16 hours

During the last hour of the conditioning duration, while the specimen is at the conditioning temperature, the air leakage test as described in 5.1.6 shall be performed.

5.5.3 Requirements

The pressure ΔP(-) in the specimen after time *t*, shall not change by more than 0.11 kPa *(1.1 cm of water)* and the pressure ΔP(+) in the specimen shall not change by more than 0.3 kPa (3.0 cm of water) during the test.

5.6 Vibration, sinusoidal (endurance)

5.6.1 Object

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

5.6.2 Test procedure

5.6.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-6:1995+Corr.: 1995 Test Fc[6], and as described below.

5.6.2.2 State of specimen during conditioning

The specimen shall be mounted on a rigid flange plate as described in 5.1.6, but shall not be supplied with power during conditioning. Sampling tubes of the length used in 5.1.5 shall be fitted. The vibration shall be applied to the flange plate in each of three mutually perpendicular axes, in turn. The specimen shall be mounted so that one of the three axes is perpendicular to its normal mounting axis.

5.6.2.3 Conditioning

The following conditioning shall be applied:

Frequency range:	(10 to 150) Hz
Acceleration amplitude:	10 m s^{-2} (≈1.0 g_n)
Number of axes:	3
Sweep rate:	1 octave min-1
Number of sweep cycles:	20 per axis

5.6.2.4 Final measurements

After the conditioning the air leakage test shall be performed as described in 5.1.6.

Following this, the response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test, as described in 5.3, shall be designated m_{max}, and the lesser shall be designated m_{min}.

5.6.3 Requirements

a) The pressure ΔP(-) in the specimen after time *t*, shall not change by more than 0.11kPa *(1.1 cm of water)* and the pressure ΔP(+) in the specimen after time t, shall not change by more than 0.3kPa (3.0 cm of water) during the test.

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

c) The ratio of the response threshold values $m_{max} : m_{min}$ shall not be greater than 1.6;

d) The response threshold value shall be not less than 0.05 dB m^{-1}.

5.7 Sulphur dioxide (SO_2) corrosion

5.7.1 Object

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

5.7.2 Test procedure

5.7.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-42:1982 Test Kc^8, except that the conditioning shall be as described below.

5.7.2.2 State of specimen during conditioning

The specimen shall be mounted as described in 5.1.3 to the flange plate of the air leakage apparatus described in 5.1.6, with the sampling tube attached as described in 5.1.5. It shall not be supplied with power during the conditioning, but it shall have un-tinned copper wires, of the appropriate diameter, connected to sufficient terminals, to

allow the final measurement to be made, without making further connections to the specimen.

5.7.2.3 Conditioning

The following conditioning shall be applied:

Temperature:	(25 ± 2) ºC
Relative humidity:	(93 ± 3) %
SO_2 concentration:	(25 ± 5) ppm (by volume)
Duration:	21 days

5.7.2.4 Final measurements

Immediately after the conditioning, the specimen shall be subjected to a drying period of 16 h at (40 ± 2) ºC, ≤ 50% RH, followed by a recovery period of at least 1 h at the standard laboratory conditions. After this, the air leakage test shall be performed as described in 5.1.6 and the response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated $m_{\max}$, and the lesser shall be designated $m_{\min}$.

5.7.3 Requirements

a) The pressure ΔP(-) in the specimen after time *t*, shall not change by more than 0.11kPa *(1.1 cm of water)* and the pressure ΔP(+) in the specimen after time t, shall not change by more than 0.3kPa (3.0 cm of water) during the test.

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

c) The ratio of the response threshold values $m_{max} : m_{min}$ shall not be greater than 1.6;

d) The response threshold value shall be not less than 0.05 dB m^{-1}.

5.8 Impact

5.8.1 Object

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

5.8.2 Test procedure

5.8.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-63:1991[9].

5.8.2.2 State of specimen during conditioning

The specimen shall be mounted as described in 5.1.3 to a rigid flange plate as described in 5.1.6, but shall not be supplied with power during conditioning.

5.8.2.3 Conditioning

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

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

The following conditioning shall be applied:

Impact energy:	(0.5 ± 0.04) J
Number of impacts per point:	3

5.8.2.4 Final measurements

After the conditioning:

a) the air leakage test shall be performed as described in 5.1.6,

b) the function of any component considered to have been damaged shall be tested.

5.8.3 Requirements

The pressure ΔP(-) in the specimen after time *t*, shall not change by more than 0.11kPa *(1.1 cm of water)* and the pressure ΔP(+) in the specimen after time t, shall not change by more than 0.3kPa (3.0 cm of water) during the test.

5.9 Shock (operational)

5.9.1 Object

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

5.9.2 Test procedure

5.9.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-27:1987 Test Ea[7], except that the conditioning shall be as described below.

5.9.2.2 State of specimen during conditioning

The specimen shall be mounted as described in 5.1.3 to a rigid flange plate as described in 5.1.6. The specimen shall be connected to its supply and monitoring equipment as described in 5.1.2. Sampling tubes of the length used in 5.1.5 shall be fitted. The shock will be applied to the flange plate in each of three mutually perpendicular axes.

5.9.2.3 Conditioning

For specimens with mass ≤ 4.75 kg (with tubes fitted) the following conditioning shall be applied:

Shock pulse type:	Half sine
Pulse duration:	6 ms
Peak acceleration:	10 x (100 – 20*M*) ms^{-2} (*M* is the specimen's mass in kg)
Number of directions	3
Pulses:	3

No test is applied to specimens with a mass >4.75 kg

5.9.2.4 Measurements during conditioning

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

5.9.2.5 Final measurements

After the conditioning the air leakage test shall be performed as described in 5.1.6.

Following this, the response threshold value shall be measured as described in 5.1.5.

The greater of the response threshold value measured in this test and that measured for the same specimen in the reproducibility test, shall be designated m_{max}, and the lesser shall be designated m_{min}.

5.9.3 Requirements

a) No alarm or fault signal shall be given during conditioning or the additional 2 min.

b) The pressure ΔP(-) in the specimen after time *t*, shall not change by more than 0.11kPa *(1.1 cm of water)* and the pressure ΔP(+) in the specimen after time t, shall not change by more than 0.3kPa (3.0 cm of water) during the test.

c) The ratio of the response threshold values $m_{max} : m_{min}$ shall not be greater than 1.6;

d) The response threshold value shall be not less than 0.05 dB m^{-1}.

5.10 Fire sensitivity tests

5.10.1 Object

To demonstrate that the duct smoke detector has adequate sensitivity to typical smoke types which can be present in duct applications.

5.10.2 Test procedure

5.10.2.1 Reference

The test apparatus and procedure shall be as described in Annex A. Instrumentation shall be as described in Annex C.

5.10.2.2 Test fires

The specimens shall be subjected to the two 54-7[3] test fires TF2 and TF4. The type, quantity and arrangement of the fuel and the method of ignition are specified in Annex F and Annex G for each test fire, along with the end-of-test condition and the test validity criteria.

It is permissible, and may be necessary, to adjust the quantity, condition (e.g. moisture content) and arrangement of the fuel and/or burning rate to obtain the required smoke density within the duct smoke tunnel measuring volume.

5.10.2.3 State of specimen during conditioning

The specimen shall be mounted as specified in 5.1.3 in the duct smoke tunnel (see Annex A).

NOTE Where the tube length specified by the manufacturer exceeds or is less than the width of the test tunnel, the sampling tube length should be adjusted to equal the width of the test tunnel. The adjusted tube length should provide the same number and size of equally spaced holes, as per the manufacturer's longest or shortest tube, whichever is appropriate.

The specimen shall be connected to its supply and monitoring equipment, as specified in 5.1.2, and shall be stabilized in its quiescent condition before the start of each test fire.

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

The duct smoke tunnel shall be operated at air velocities of 1 m/s and 20 m/s or at the maximum and minimum air velocities as specified by the manufacturer within this range.

5.10.2.4 Initial conditions

IMPORTANT — The stability of the air and temperature affects the smoke flow within the room. This is particularly important for the test fires which produce low thermal lift for the smoke (e.g. TF2). If it is necessary for people to be in the room at the beginning of a test fire, they should leave as soon as possible, taking care to produce the minimum disturbance to the air.

Before each test fire, ventilate the room and duct with clean air until it is free from smoke.

Switch off the room ventilation system and smoke tunnel fan(s), and close all doors, windows and other openings Then allow the air in the room to stabilize and verify that the following conditions are satisfied:

— air temperature, T: (23 $\pm$ 5) °C,

— airflow velocity: negligible,

— smoke density (ionization): y ≤0,05,

— smoke density (optical): m ≤ 0,02 dB/m.

Switch on the smoke tunnel and adjust the air velocity in the working section to that required for the test, allowing the air flow to stabilize for a minimum of 2 min.

5.10.2.5 Measurements during conditioning

The fire parameters, y_a and m_a within the working volume (see Fig. H2) shall be measured throughout the duration of each test fire and recorded, continuously or at least once per second, as a function of time from the start of the test.

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

Record the time of response (alarm signal) of each specimen along with the fire parameters y_a and m_a at the moment of response.

5.10.3 Requirements

The specimen shall generate an alarm signal, in each test fire, at the minimum and maximum air velocities before the specified end of test condition is reached.

6 PUBLICATIONS REFERRED TO:

This Standard incorporates by dated or undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

Reference number	ISO/IEC Publication	Year	Title	EN/HD/Other	Year
1	-	-	Fire detection and fire alarm systems — Part 1: Introduction.	EN 54-1	1996
2	-	-	Alarm Systems, Electromagnetic compatibility — Product family standard: Immunity requirements for components of fire, intruder and social alarm systems + A1:1998, A2:2003.	EN 50130-4	1995
3	-	-	Fire detection and fire alarm systems — Part 7: Smoke detectors — Point detectors using scattered light, transmitted light or ionization	EN 54-7	2000
4	IEC 60068-1	1988	Environmental testing — Part 1: General and guidance (sixth edition) + A1:1992.	EN 60068-1	1994
5	IEC 60068-2-1	1990	Environmental testing — Part 2: Tests — Tests A: Cold (fifth edition), + A1:1993, A2:1994.	EN 60068-2-1	1993
6	IEC 60068-2-6	1995	Environmental testing — Part 2: Tests — Test Fc: Vibration, sinusoidal (sixth edition) + Corr.:1995.	EN 60068-2-6	1995
7	IEC 60068-2-27	1987	Basic environmental testing procedures — Part 2: Tests — Test Ea & Guidance: Shock (third edition).	EN 60068-2-27	1993
8	IEC 60068-2-42	1982	Basic environmental testing procedures — Part 2: Tests — Test Kc: Sulphur dioxide test for contacts and connections (second edition).	-	-
9	IEC 60068-2-63	1982	Basic environmental testing procedures – Part 2: Test methods – Test Eq: Impact, spring hammer.	EN 60068-2-63	1995

Annex A (normative) - Duct smoke tunnel and fire test room arrangement for response measurements

This Annex specifies those properties of the smoke tunnel which are of primary importance for making repeatable and reproducible measurements of response threshold values measured with aerosols and the response of the duct smoke detectors to the test fires.

The smoke tunnel shall have a horizontal working section containing a working volume. The working volume is a defined part of the working section where the air temperature and air flow are within the required test conditions. Conformance with this requirement shall be regularly verified under static conditions, by measurements at an adequate number of points distributed within and on the imaginary boundaries of the working volume. The working volume shall be large enough to fully enclose the sampling portion of duct smoke detector to be tested and the sensing parts of the measuring equipment. The duct smoke detector to be tested shall be mounted in its normal operating position with the air flow in the working volume.

The smoke tunnel shall be located close to the fire test room so as to minimise changes that may occur in the smoke characteristics of the fire (see Annex H). The fire test room shall be as specified in Annex F of 54-7[3]. An arrangement shall be made to transfer unfiltered smoke from the fire test room to the duct. Air from the duct shall be drawn and replaced back into the fire test room in such a way so as to minimise the disturbance to the air in the fire test room. The duct smoke tunnel shall operate so as to draw air from the fire test room at the start and during the fire test.

Both aerosol density measurements, m in dB/m for detectors using scattered or transmitted light, and y (dimensionless) for detectors using ionization, shall be made in the working volume in the proximity of the sensing apparatus.

Means shall be provided for the introduction of the test aerosol such that a homogeneous aerosol density is obtained in the working volume.

Means shall be provided for creating a constant airflow, variable from (1 ± 0.2) m/s to (20 ± 4.0) m/s, throughout the working volume.

Only one specimen shall be mounted in the tunnel, unless it has been demonstrated that measurements made simultaneously on more than one specimen are in close agreement with measurements made by testing specimens individually. In the event of a dispute, the value obtained by individual testing shall be accepted.

Annex B (normative) – Test aerosol for response threshold measurements

A polydisperse aerosol shall be used as the test aerosol. The maximum of the aerosol mass distribution shall correspond to particle diameters between 0.5 µm and 1 µm with the refractive index of the aerosol particles of approximately 1.4.

The test aerosol shall be reproducible and stable with regard to the following parameters:

particle mass distribution;

optical constants of the particles;

particle shape;

particle structure.

NOTE It is recommended that an aerosol generator producing a paraffin oil mist is used. (e.g. using pharmaceutical grade paraffin oil)

Annex C (normative) – Smoke measuring instruments

C.1 Obscuration meter

The response threshold of detectors using scattered light or transmitted light is characterised by the absorbency index (extinction module) of the test aerosol, measured in the proximity of the detector, at the moment that it generates an alarm signal.

The absorbance index is designated m and given the units of decibels per metre (dB m^{-1}). The absorbance index m is given by the following equation:

$$m = \frac{10}{d}\log\left(\frac{P_o}{P}\right) \quad dB\,m^{-1}$$

where:

— d = the distance, in metres, travelled by the light in the test aerosol or smoke, from the light source to the light receiver;

— P_0 = the radiated power received without test aerosol or smoke;

— P = the radiated power received with test aerosol or smoke.

For all aerosol or smoke concentrations up to 2 dB m^{-1}, the measuring error of the obscuration meter shall not exceed 0.02 dB m^{-1} plus 5% of the measured aerosol or smoke concentration.

The optical system shall be arranged so that any light scattered by more than 3° by the test aerosol or smoke is disregarded by the light detector.

The effective radiated power[2] of the light beam shall be as follows:

a) at least 50% shall be within a wavelength range from 800 nm to 950 nm;

b) not more than 1% shall be in the wavelength range below 800 nm; and

c) not more than 10% shall be in the wavelength range above 1,050 nm.

C.2 Measuring ionisation chamber

C.2.1 General

The response threshold of detectors using ionization is characterized by a non dimensional quantity y which is derived from the relative change of the current flowing in a measuring ionization chamber, and which is related to the particle concentration of the test aerosol, measured in the proximity of the detector, at the moment that it generates an alarm signal.

[2] The effective radiated power in each wavelength range is the product of the power emitted by the light source, the transmission level of the optical measuring path in clean air and the sensitivity of the receiver, within this wavelength range.

C.2.2 Operating method and basic construction

The mechanical construction of the measuring ionization chamber is shown in Annex I.

The measuring device consists of a measuring chamber, an electronic amplifier and a method of continuously sucking in a sample of the aerosol or smoke to be measured.

The principle of operation of the measuring ionization chamber is shown in Figure C.1. The measuring chamber contains a measuring volume and a suitable means by which the sampled air is sucked in and passes the measuring volume in such a way that the aerosol/smoke particles diffuse into this volume. This diffusion is such that the flow of ions within the measuring volume is not disturbed by air movements.

The air within the measuring volume is ionized by alpha radiation from an americium radioactive source, such that there is a bipolar flow of ions when an electrical voltage is applied between the electrodes. This flow of ions is affected by the aerosol or smoke particles in a known manner. The relative variation in the current of ions is used as a measurement of the aerosol or smoke concentration.

The measuring chamber is so dimensioned and operated that the following relationships apply:

$$Z \times \bar{d} = \eta \times y \quad \text{and} \quad y = (\frac{I_0}{I}) - (\frac{I}{I_0})$$

where

I_0 is the chamber current in air without test aerosol or smoke;

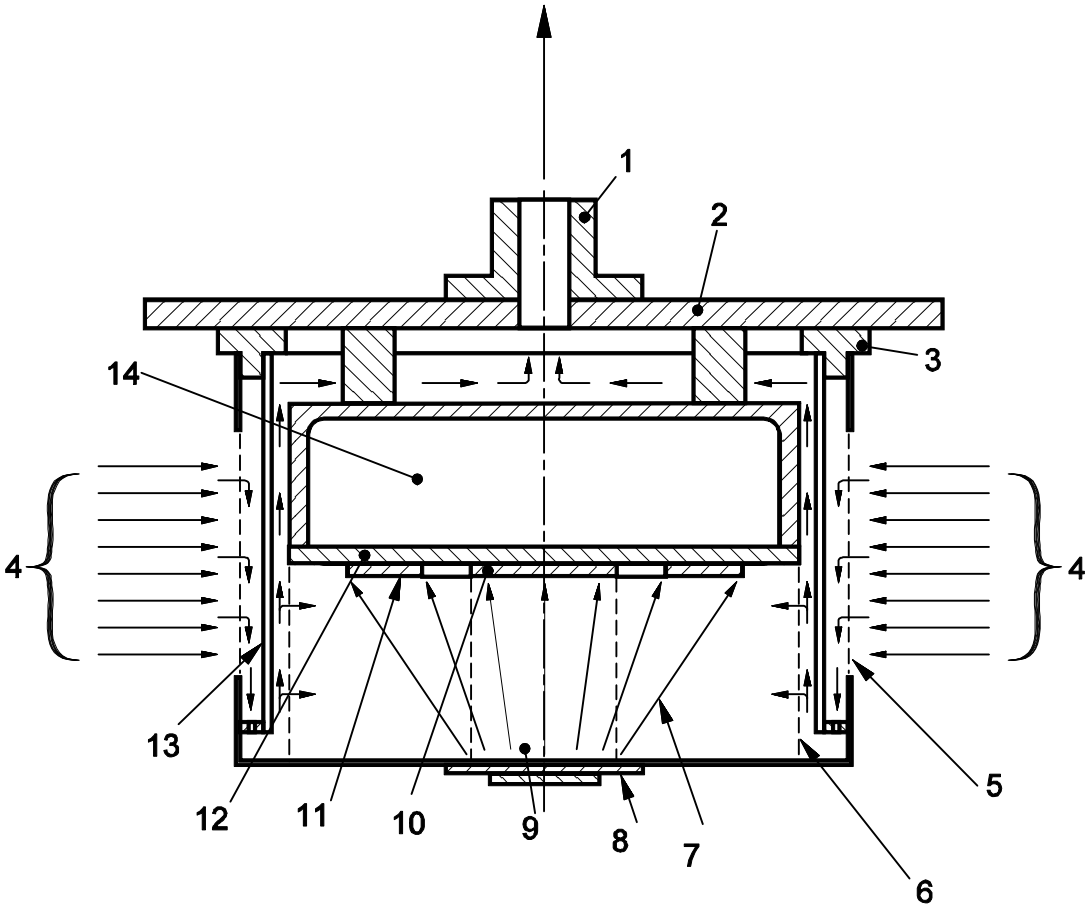
I is the chamber current in air with test aerosol or smoke;

η is the chamber constant;

Z is the particle concentration in particles per m3;

$\bar{d}$ is the average particle diameter.

The non-dimensional quantity y, which is approximately proportional to the particle concentration for a particular type of aerosol or smoke, is used as a measure of response threshold value for smoke detectors using ionization.



Key

1 suction nozzle
2 assembly plate
3 insulating ring
4 air/smoke entry
5 outer grid
6 inner grid
7 α rays
8 α source
9 measuring volume
10 measuring electrode
11 guard ring
12 insulating material
13 windshield
14 electronics

Figure C.1 — Measuring ionization chamber - method of operation

C.2.3 Technical data

a) Radiation source:

Isotope: Americium Am241;

Activity: 130 kBq (3,5 µCi) ± 5%;

Average α energy: 4,5 MeV ± 5%;

Mechanical construction: Americium oxide embedded in gold between two layers of gold, covered with a hard gold alloy. The source is in the form of a circular disc with a

diameter of 27 mm, which is mounted in a holder such that no cut edges are accessible.

b) Ionization chamber:

The chamber impedance (i.e. the reciprocal of the slope of the current vs voltage characteristic of the chamber in its linear region (chamber current ≤ 100 pA)) shall be 1,9 x 10^{11} Ω ± 5 %, when measured in aerosol- and smoke-free air at:

pressure: (101,3 ± 1) kPa;

temperature: (25 ± 2) °C;

relative humidity: (55 ± 20) %;

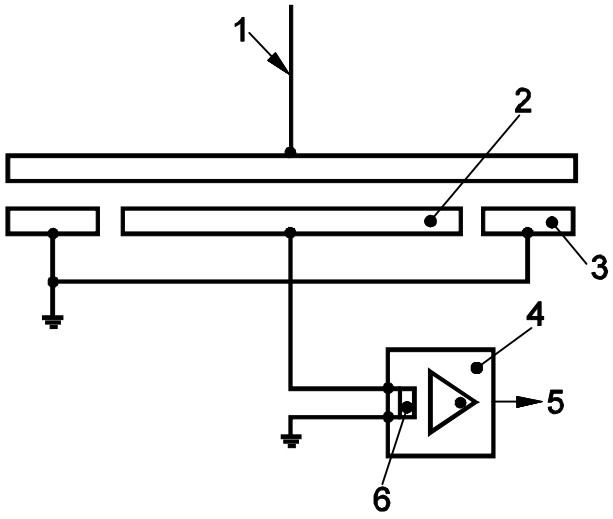
with the potential of the guard ring within ± 0,1 V of the voltage of the measuring electrode.

c) Current measuring amplifier:

The chamber is operated in the circuit shown in Figure C.2, with the supply voltage such that the chamber current between the measuring electrodes is 100 pA in aerosol- or smoke-free air. The input impedance of the current measuring device shall be < 10^9 Ω.

d) Suction system:

The suction system shall draw air through the device at a continuous steady flow of 30 l min-1 ± 10 % at atmospheric pressure.



Key

1 supply voltage
2 measuring electrode
3 guard ring
4 current measuring amplifier
5 output voltage proportional to chamber current
6 input impedance, Z_{in} < 10^9 Ω

Figure C.2 — Measuring ionization chamber - operating circuit

Annex D (normative) – Requirements for duct smoke detectors containing point detectors not approved to EN 54-7[3]

D.1 Introduction

This annex covers the additional test schedule for assemblies that are not approved to EN 54-7[3].

D.2 Additional test schedule

The additional test schedule in Table A1 shall be applied where a duct smoke detector includes a detector assembly that has not been approved as an EN 54-7[3] point detector. When carrying out the tests on the duct smoke detector, they shall be performed according to the test limits applied within EN 54-7[3]. Where the duct smoke detector has a removable detector assembly that can be tested as a separate unit, then the tests shall be applied exactly as described in EN 54-7[3]. Where the tests can only be applied to the complete duct smoke detector, then the required measurements of the response threshold value shall be carried out in accordance with 5.1.5.

Fifteen specimens shall be provided. After the reproducibility test, the four least sensitive specimens (i.e. those with the highest response thresholds) shall be labelled 12, 13, 14 and 15 and the others shall be labelled 1 to 11 arbitrarily.

The following requirements shall be met:

- Clause 4.7 - Protection against the ingress of foreign bodies
- Clause 4.8 - Response to slowly developing fires
- Clause 4.11 - Additional requirements for software controlled detectors

Table D.1 — Additional test schedule for Duct Smoke Detectors containing point detectors not approved to EN 54-7[3]

Test	Clause in EN 54-7[3]	Specimen No(s)	Notes
Reproducibility	5.4	All specimens	1, 4
Variation in supply parameters	5.5	1	1
Dazzling	5.7	2	2
Dry heat (operational)	5.8	3	1
Cold (operational)	5.9	4	1
Damp heat steady state (operational)	5.10	5	1
Damp heat, steady state (endurance)	5.11	6	1
Electrostatic discharge (operational)	5.17	7	1, 3
Radiated electromagnetic fields (operational)	5.17	8	1, 3
Conducted disturbances induced by electromagnetic fields (operational)	5.17	9	1, 3
Fast transient bursts (operational)	5.17	10	1, 3
Slow high energy voltage surge (operational)	5.17	11	1, 3
Fire sensitivity, TF3 and TF5 only	5.18	12, 13, 14,15	5

NOTE 1 Response threshold values shall be measured with the detector assembly mounted in the same orientation as specified by the manufacturer. If several mounting position are possible, the least sensitive orientation should be determined by conducting the directional dependency test described in 5.3 of EN 54-7[3].

NOTE 2 This test only applies to duct smoke detectors that use scattered or transmitted light and do not have a light-tight enclosure.

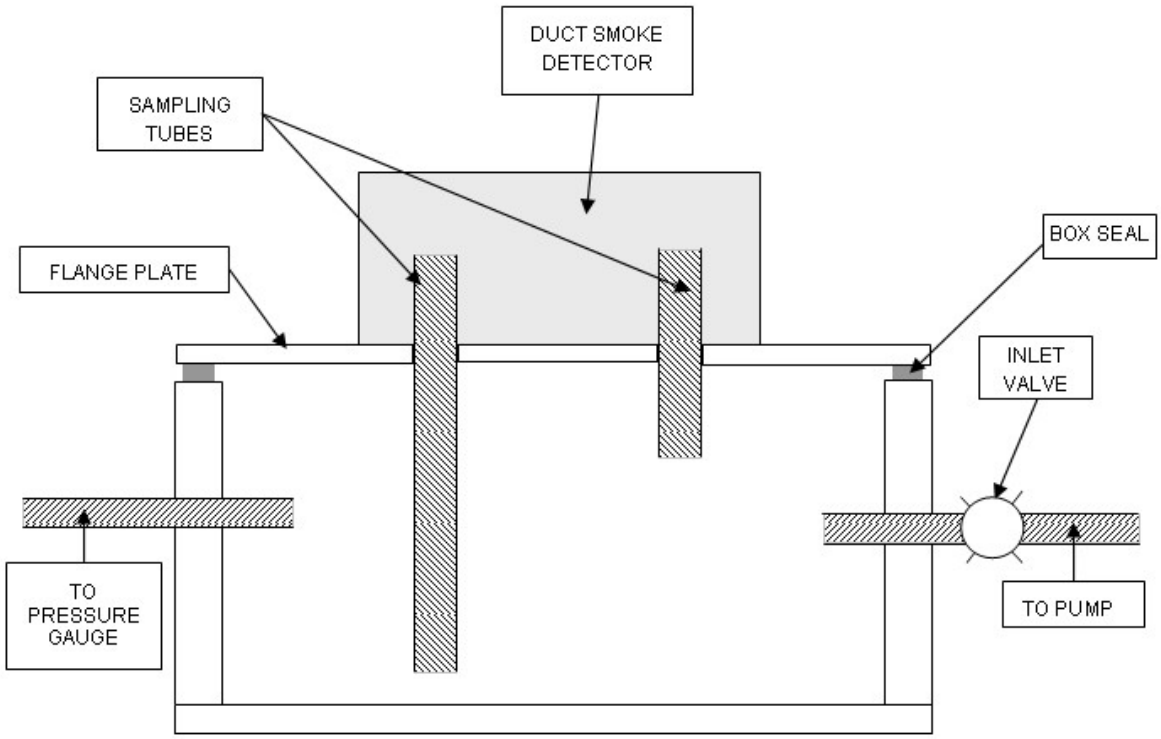
NOTE 3 In the interests of test economy, it is permitted to use the same specimen for more than one EMC test. In that case, intermediate functional test(s) on the specimen(s) used for more than one test may be deleted, and the functional test conducted at the end of the sequence of tests. However, it should be noted that in the event of a failure, it might not be possible to identify which test exposure caused the failure (see Clause 4 of EN50130-4[2].

NOTE 4 May be performed on duct detector or on detector assembly if removable. In the interests of economy, where the detector assembly is removable, only one duct housing may be used with the detector assembly being changed after each test.

NOTE 5 It is expected that this test will be performed on the detector assemblies which have been removed from the duct detector. The detectors shall be arranged such that the side of entry of smoke when the detector assemblies were in the duct detectors, points towards the direction of the test fires.

Annex E (informative) – Air leakage test apparatus

The diagram below is an example of the mounting method of the duct smoke detector to perform the air leakage test as described in Clause 5.1.6.



NOTE 1 The flange plate should be made of corrosion resistant material, i.e. stainless steel.

NOTE 2 Outlets to the vacuum pump and the pressure gauge should be sealed at the entry point to the test apparatus.

Figure E.1 — Sectional View of Air Leakage Test Apparatus

Annex F (normative) – Smouldering (pyrolysis) wood fire (TF2)

F.1 Fuel

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

F.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 hot plate 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.

F.3 Arrangement

The sticks shall be arranged 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 G.1.

F.4 Heating rate

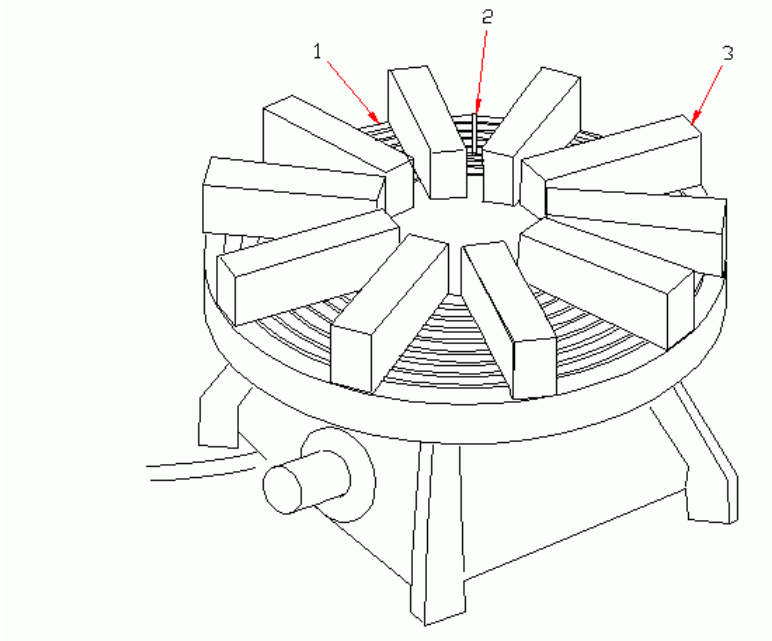
The hotplate shall be powered such that its temperature rises from ambient to 600 °C in approximately 11 min.

F.5 End of test condition

The end-of-test condition, m_E, shall be when m = 0.5 dB/m in the duct tunnel working volume (see Figure I.2) or the specimen has generated an alarm signal, whichever is the earlier. No flaming shall occur before the end-of-test condition has been reached.

F.6 Test validity criteria

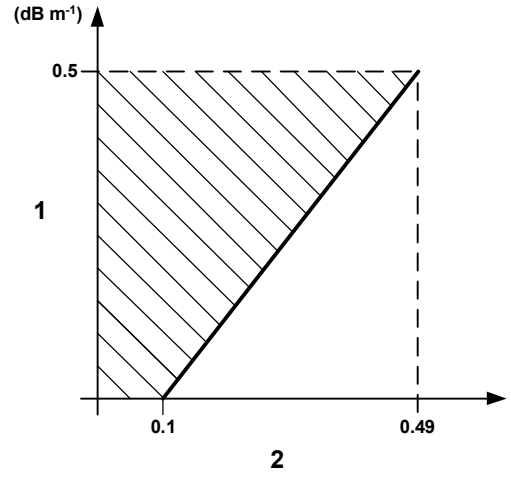
The development of the fire shall be such that the curves of m against y and m against time, t, fall within the limits shown in F.2 and F.3.



Key

1 grooved hotplate
2 temperature sensor
3 wooden sticks

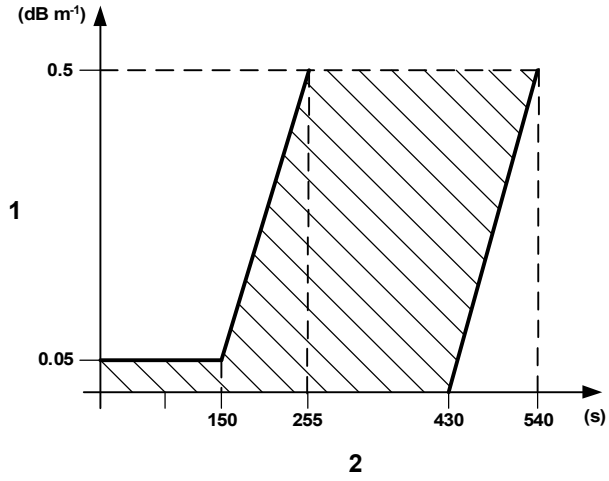
Figure F.1 — Arrangement of sticks on hotplate



Key

1 m value
2 y value

Figure F.2 — Limits of m against y, Fire TF2



Key

1 m value
2 Time

Figure F.3 — Limits of m against time, Fire TF2

Annex G (normative) – Flaming plastics (polyurethane) fire (TF4)

G.1 Fuel

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

G.2 Arrangement

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

G.3 Ignition

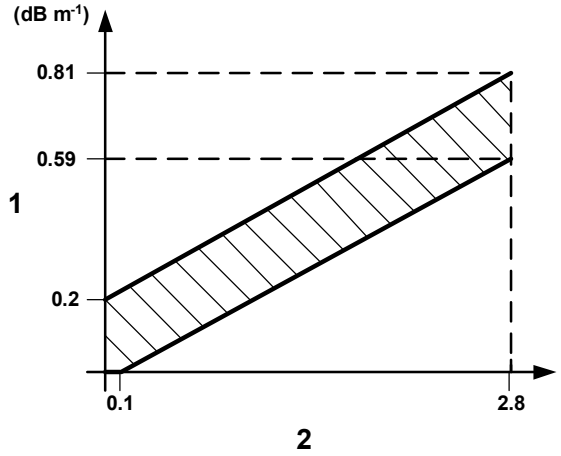
The mats shall normally be ignited at a corner of the lower mat, however the exact position of ignition may be adjusted to obtain a valid test. A small quantity of a clean burning material (e.g. 5 cm^3 of methylated spirit) may be used to assist the ignition.

G.4 End of test condition

The end-of-test condition, m_E, shall be when m = 0.7 dB/m in the duct tunnel working volume (see Figure I.2) or the specimen has generated an alarm signal, whichever is the earlier.

G.5 Test validity criteria

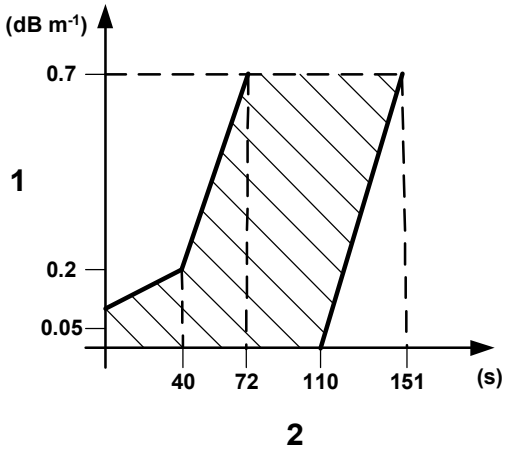
The development of the fire shall be such that the curves of m against y and m against time, t, fall within the limits shown in G.1 and G.2.



Key

1 m value
2 y value

Figure G.1 — Limits of m against y, Fire TF4



Key

1 m value
2 Time

Figure G.2 — Limits of m against time, Fire TF4

Annex H (informative) – Information concerning the construction of the smoke tunnel

Smoke detection equipment for ducts described in this standard respond when the signal(s) from one or more smoke sensors fulfil certain criteria. The smoke concentration at the sensor(s) is related to the smoke concentration surrounding the sampling tube(s) but the relation is usually complex and dependent on several factors, such as orientation, mounting, air velocity, turbulence, rate of rise of smoke density etc. The relative change of the response threshold value measured in the smoke tunnel is the main parameter considered when the stability of duct smoke detectors is evaluated by testing in accordance with this standard.

Many different smoke tunnel designs are suitable for the tests specified in this standard but the following points should be considered when designing and characterising a smoke tunnel:

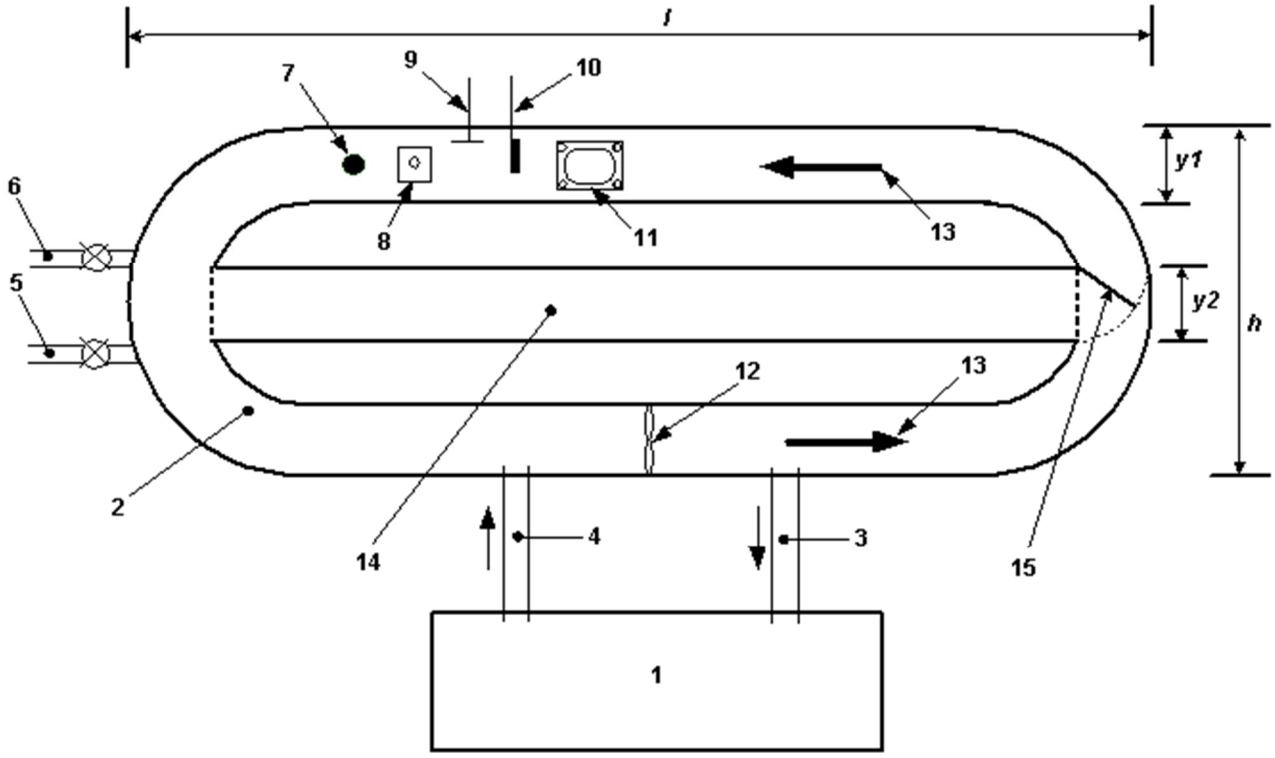
The response threshold value measurements require increasing aerosol density until the detector responds. This can be facilitated in a closed circuit smoke tunnel.

As the smoke tunnel will also be used in the test fires, a facility for drawing and re-circulating smoke in the fire test room is also required. The design of the smoke extraction system is critical to enable sufficient volume of smoke to enter the smoke tunnel and to achieve the required smoke concentration within the sensing volume before the fire test fuel burns out. The amount of fuel burnt may need to be adjusted accordingly.

An example of a re-circulating smoke tunnel used in conjunction with an EN 54-7[3] fire test room is shown in Figures H.1 and H.2.

Special attention should be given to the arrangement of the elements in the working volume in order to avoid disturbance of the test conditions e.g. due to turbulence. The suction through the MIC creates a mean air velocity of approximately 0.04 m s-1 in the plane of the entrance openings in the chamber housing. However, the effect of the suction will be negligible if the MIC is placed 10 cm to 15 cm downstream of the detector position.

It is recommended that the volume flow rate, at which the smoke is extracted from the fire test room, is kept as constant as possible for all tests irrespective of the air velocity required. This may be achieved by feeding air from the fire test room into the test tunnel at a constant rate and using a regulating mechanism, such as a by-pass duct, which maintains the air velocity in the working section at the desired rate.

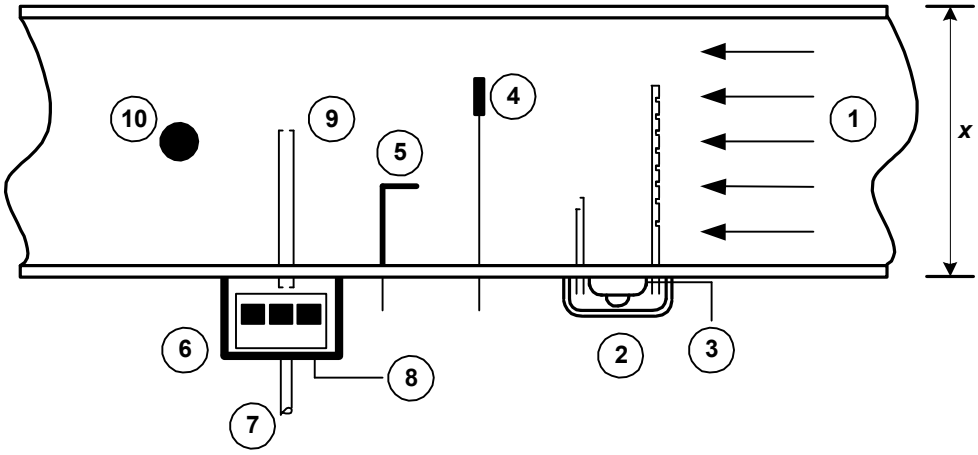


Key

1 EN 54-7[3] fire test room
2 smoke tunnel
3 return duct to fire test room
4 extract duct from fire test room
5 clean air intake
6 air exhaust
7 obscuration meter
8 MIC and sampling tube
9 temperature sensor
10 flow sensor
11 duct smoke detector under test
12 fan
13 airflow
14 by-pass duct
15 airflow regulator

Dimensions in metres	
l	*10*
h	*2*
Y1	*0.3*
Y2	*0.3*

Figure H.1 — Example of duct smoke tunnel and fire test room arrangement, side view



Key

1 airflow
2 detector under test
3 supply and monitoring equipment
4 flow sensor
5 temperature sensor
6 MIC enclosed within sealed box
7 MIC suction
8 MIC control and measuring equipment
9 MIC sampling tube
10 obscuration meter

Dimension in metres	
x	*0.5*

Figure H.2 —— Duct tunnel, working section, top view

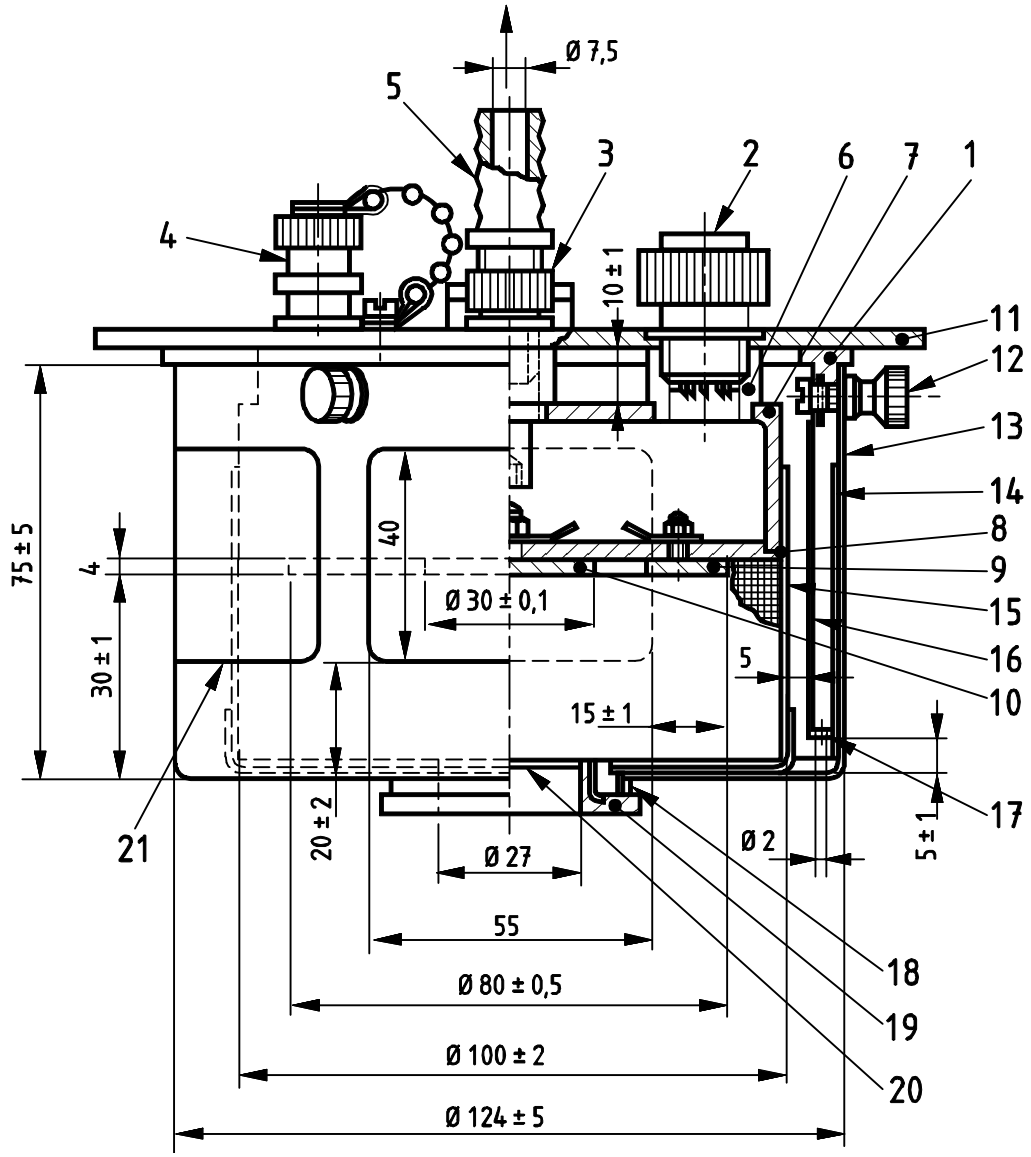
Annex I (informative) - Information concerning the construction of the measuring ionization chamber

The mechanical construction of the measuring ionisation chamber[1)] is shown in Figure I.1. The functionally important dimensions are marked with their tolerances. Further details of the various parts of the device are given in Table I.1.

Table I.1 — List of parts of the measuring ionization chamber

Reference No.	Item	Number provided	Dimensions, Special features	Material
1	Insulating ring	1		Polyamide
2	Multipole socket	1	10-pole	
3	Measuring electrode terminal	1	To chamber supply	
4	Measuring electrode terminal	1	To amplifier or current measuring device	
5	Suction Nozzle	1		
6	Guide socket	4		Polyamide
7	Housing	1		Aluminium
8	Insulating plate	1		Polycarbonate
9	Guard ring	1		Stainless steel
10	Measuring electrode	1		Stainless steel
11	Assembly plate	1		Aluminium
12	Fixing screw with milled nut	3	M3	Nickel plated brass
13	Cover	1	Six openings	Stainless steel
14	Outer grid	1	Wire 0,2 mm diameter 0,8 mm internal mesh width	Stainless steel
15	Inner grid	1	Wire 0,4 mm diameter 1,6 mm internal mesh width	Stainless steel
16	Windshield	1		Stainless steel
17	Intermediate ring	1	With 72 equispaced holes each 2 mm diameter	
18	Threaded ring	1		Nickel plated brass
19	Source holder	1		Nickel plated brass
20	Source	1	27 mm diameter	See C.2.3
21	Openings on the periphery	6		

3) The measuring ionization chamber is fully described in "Investigation of ionization chamber for reference measurements of smoke density" by M. Avlund, published by DELTA Electronics, Venlighedsvej 4 DK-2970 Hørsholm, Denmark.



NOTE 1 See Table I.1 for the list of parts.

NOTE 2 Dimensions without a tolerance marked are recommended dimensions.

Figure I.1 — Mechanical construction of the measuring ionization chamber

Amendments Issued Since Publication

DOCUMENT NO.	AMENDMENT DETAILS	SIGNATURE	DATE
LPS 1280-1.1	1. New front cover 2. Title added to header 3. Notes amended on Page 3 4. Repagination 5. Update to copyright information	DC	Jan. 2014