

BS EN 54-27:2015



BSI Standards Publication

Fire detection and fire alarms systems

Part 27: Duct smoke detectors

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National foreword

This British Standard is the UK implementation of EN 54-27:2015.

Clause 5.6.6 of this standard defines a non-operational leakage test method using under pressures - in excess of those observed in most ducts. However, in order to pass the test it is allowed to block the cable entries - thus excluding them from the leakage test. In some devices leakage through the cable entries may adversely affect the detector's sensitivity to smoke. Users are advised to consider the potential negative effects of leakage through the cable entries before deploying products approved to this standard.

The UK participation in its preparation was entrusted by Technical Committee FSH/12, Fire detection and alarm systems, to Technical Subcommittee FSH/12/2, Fire detectors.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Fire detection and fire alarms systems - Part 27: Duct smoke detectors

Systèmes de détection et d'alarme incendie - Partie 27 :
DéTECTEURS de fumées dans les conduits

Brandmeldeanlagen - Teil 27: Rauchmelder für die
Überwachung von Lüftungsleitungen

This European Standard was approved by CEN on 11 January 2015.

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Foreword

This document (EN 54-27:2015) has been prepared by Technical Committee CEN/TC 72 “Fire detection and fire alarm systems”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2015 and conflicting national standards shall be withdrawn at the latest by March 2019.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports basic requirements of EU Regulation 305/2011.

For relationship with EU Regulation(s), see informative Annex ZA, which is an integral part of this document.

Information on the relationship between this European Standard and other standards of the EN 54 series is given in EN 54-1.

EN 54, *Fire detection and fire alarm systems*, consists of the following parts:

- *Part 1: Introduction;*
- *Part 2: Control and indicating equipment;*
- *Part 3: Fire alarm devices — Sounders;*
- *Part 4: Power supply equipment;*
- *Part 5: Heat detectors — Point detectors;*
- *Part 7: Smoke detectors — Point detectors using scattered light, transmitted light or ionization;*
- *Part 10: Flame detector — Point detectors;*
- *Part 11: Manual call points;*
- *Part 12: Smoke detectors — Line detectors using an optical light beam;*
- *Part 13: Compatibility assessment of system components;*
- *Part 14: Guidelines for planning, design, installation, commissioning, use and maintenance [CEN Technical specification];*
- *Part 16: Voice alarm control and indicating equipment;*
- *Part 17: Short circuit isolators;*
- *Part 18: Input/output devices;*
- *Part 20: Aspirating smoke detectors;*
- *Part 21: Alarm transmission and fault warning routing equipment;*

- *Part 22: Resettable line type heat detectors;*
- *Part 23 Fire alarm devices — Visual alarm devices;*
- *Part 24: Components of voice alarm systems — Loudspeakers;*
- *Part 25: Components using radio links;*
- *Part 26: Point fire detectors using carbon monoxide sensors;*
- *Part 27: Duct smoke detectors [the present document];*
- *Part 28: Non-resettable line type heat detectors;*
- *Part 29: Multi-sensor fire detectors — Point detectors using a combination of smoke and heat sensors;*
- *Part 30: Multi-sensor fire detectors — Point detectors using a combination of carbon monoxide and heat sensors;*
- *Part 31: Multi-sensor fire detectors — Point detectors using a combination of smoke, carbon monoxide and optionally heat sensors.*

NOTE This list includes standards that are in preparation and other standards may be added. For current status of published standards refer to www.cen.eu.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Duct smoke detectors (DSD) are used as part of a fire detection and fire alarm system or as a stand-alone actuator for a fire protection system to sample the air within air ducts of a building. Detection of smoke can be used as a signal to the connected control and indicating equipment and can be used as a signal to an air-handling system to prevent the spread of smoke within the building.

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

The performance of DSD is assessed from results obtained in specific tests. This document is not intended to place any other restrictions on the design and construction of such equipment.

An example for a stand-alone system is given in Figure K.1. The configuration of a fire detection and fire alarm system is given in EN 54-1.

Annex L gives information on power supply. These requirements are system requirements or requirements on other components respectively and do not concern the product requirements of the DSD.

1 Scope

This European Standard specifies requirements, test methods and performance criteria for fire detectors which detect smoke in air ducts in buildings as a part of a fire detection and fire alarm system or as an actuator for a fire protection system.

Duct smoke detectors with special characteristics and developed for specific risks are not covered by this document.

NOTE Certain types of detector contain radioactive materials. The national requirements for radiation protection differ from one member state to another and are not specified in this standard.

2 Normative references

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

EN 54-1:2011, *Fire detection and fire alarm systems - Part 1: Introduction*

EN 54-7:2000,¹⁾ *Fire detection and fire alarm systems - Part 7: Smoke detectors - Point detectors using scattered light, transmitted light or ionization*

EN 54-13:2005, *Fire detection and fire alarm systems - Part 13: Compatibility assessment of system components*

EN 54-20:2006,²⁾ *Fire detection and fire alarm systems - Part 20: Aspirating smoke detectors*

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

EN 60068-1:2014, *Environmental testing - Part 1: General and guidance (IEC 60068-1:1988)*

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

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

EN 60068-2-6:2008, *Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)(IEC 60068-2-6:2007)*

EN 60068-2-27:2009, *Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock (IEC 60068-2-27:2008)*

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

EN 60068-2-75:2014, *Environmental testing - Part 2-75: Tests - Test Eh: Hammer tests (IEC 60068-2-75:2014)*

1) EN 54-7:2000 is currently impacted by the stand-alone amendments EN 54-7:2000/A1:2002 and EN 54-7:2000/A2:2006.

2) EN 54-20:2006 is currently impacted by the corrigendum EN 54-20:2006/AC:2008.

EN 60068-2-78:2013, *Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state (IEC 60068-2-78:2012)*

3 Terms, abbreviated terms and definitions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 54-1:2011, EN 54-13:2005 and the following apply.

3.1.1

duct smoke detector

fire detector that monitors the air in an air duct to detect smoke

Note 1 to entry: The combination with additional sensors for different fire phenomena is possible.

3.1.2

response threshold value

aerosol concentration within the duct in the proximity of the specimen at the moment that it generates an alarm signal

Note 1 to entry: The response threshold value can depend on signal processing in the detector and in the control and indicating equipment.

3.1.3

type 1 DSD

point smoke detector mounted inside the duct

3.1.4

type 2 DSD

point smoke detector mounted inside the duct with additional electrical components

Note 1 to entry: Additional electrical components, e.g. visual indicators are not covered by EN 54 standards. Their functions are described e.g. in 4.2.1, 4.2.2, and 4.2.3.

3.1.5

type 3 DSD

point smoke detector mounted outside the duct with additional mechanical means to sample the air

3.1.6

type 4 DSD

point smoke detector mounted outside the duct with additional mechanical means to sample the air and with additional electrical components

Note 1 to entry: Additional electrical components, e.g. visual indicators are not covered by EN 54 standards. Their functions are described e.g. in 4.2.1, 4.2.2, and 4.2.3.

3.1.7

type 5 DSD

aspirating smoke detector with all sampling points inside the duct

3.1.8

type 6 DSD

other types of DSD not complying with type 1 to type 5

Note 1 to entry: This type 6 DSD includes detectors based on EN 54-7 or EN 54-20 with modified sensitivity settings.

3.2 Abbreviated terms

ASD	Aspirating smoke detector
CIE	Control and indicating equipment
DSD	Duct smoke detector
FDAS	Fire detection and fire alarm system
FPC	Factory production control
FPS	Fire protection system

4 Requirements

4.1 General

4.1.1 Duct smoke detectors shall incorporate at least one smoke sensor. The combination with additional sensors for different fire phenomena can be used.

If additional fire sensors for different fire phenomena are implemented in a DSD, these sensors shall be approved in accordance with the corresponding EN 54 standards.

The manufacturer shall specify whether the DSD can directly be used as an actuator for fire protection systems, i.e. stand-alone system or as a part of a FDAS.

The requirements of this clause shall be applied for all six types of DSD. The relevant tests for the different types of DSD are described in Clause 5.

For type 1 DSD to type 4 DSD, the point smoke detector shall be approved to EN 54-7. Otherwise the DSD shall be assessed like a type 6 DSD.

For type 5 DSD, the ASD shall be approved to EN 54-20; otherwise the DSD shall be assessed like a type 6 DSD.

4.1.2 Compliance:

To comply with this standard the DSD shall meet the requirements of Clause 4 which shall be verified by visual inspection or engineering assessment and shall be tested as described in Clause 5 and shall meet the requirements of the tests.

4.2 Nominal activation conditions/sensitivity

4.2.1 Individual alarm indication

Each DSD shall be provided with a red visual indicator, by which the DSD can be identified when the associated detector releases an alarm, until the alarm condition is reset manually. Where other conditions of the DSD can be visually indicated, they shall be clearly distinguishable from the alarm indication, except when the DSD is switched into a service mode. The visual indicator shall be visible from outside of the duct from a distance of 6 m in an ambient light intensity up to 500 lx in at least one direction from the DSD. The visual indicator may be integral part of the DSD or remote from DSD.

4.2.2 Additional visual indication (option with requirement)

If the DSD is used as an actuator for a FPS, i.e. stand-alone system then the DSD shall be provided with additional indicators yellow for "fault" and green for "power on". Additional indicators may be integral part of the DSD or remote from DSD.

For operated DSD the additional visual indicator shall be visible from outside of the duct from a distance of 6 m in an ambient light intensity up to 500 lx in at least one direction from the DSD.

4.2.3 Alarm resetting for stand-alone systems (option with requirement)

If the DSD is used as an actuator for a FPS, i.e. stand-alone system then the DSD shall be provided with means for manual resetting. Means for resetting may be integral part of the DSD or remote from DSD.

4.2.4 Connection of ancillary devices (option with requirement)

For all connections to ancillary devices (remote indicators, control relays etc.), open- or short-circuit failures of these connections shall not prevent the correct operation of the DSD.

Where such connections are present the detector shall be assessed in accordance with 5.2.4.

4.2.5 Response to slowly developing fires

For type 1 DSD to type 5 DSD the requirements as given in EN 54-7 and EN 54-20 respectively shall be applied. For type 6 DSD the manufacturer shall specify with which of these European Standards the DSD complies.

4.2.6 Dazzling

The sensitivity of the DSD shall not be unduly influenced by the close proximity of artificial light sources. To confirm this, the detector shall be assessed in accordance with 5.2.6. This test is only applicable to detectors using optical smoke sensors, as ionization chamber detectors are considered unlikely to be influenced.

4.3 Operational reliability

4.3.1 Repeatability

The detector shall have stable behaviour with respect to its sensitivity to smoke after a number of alarm conditions. To confirm this, the detector shall be assessed in accordance with 5.3.1.

4.3.2 Reproducibility

The sensitivity of the detector to smoke shall not vary unduly from specimen to specimen. To confirm this, the detector shall be assessed in accordance with 5.3.2.

4.3.3 On-site adjustment of response behaviour

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

- for each setting at which the manufacturer claims compliance with this standard, the detector shall comply with the requirements of this standard, and access to the adjustment means shall only be possible by the use of a code or special tool or by removing the detector from its base or mounting;
- 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 detector or in the associated data, that if these setting(s) are used, the detector does not comply with the standard.

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

4.3.4 Manufacturer's adjustments

The DSD shall be designed so that the manufacturer's settings can only be changed by special means (e.g. the use of a special code or tool) or by breaking or removing a seal.

4.3.5 Monitoring of detachable detectors

For detachable detectors, means shall be provided to detect the removal of the head from the base, in order to give a fault signal.

4.3.6 Software controlled detectors (when provided)

4.3.6.1 General

DSD which rely on software control shall meet the requirements of 4.3.6.2, 4.3.6.3 and 4.3.6.4.

4.3.6.2 Software documentation

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

- a) a functional description of the main program flow (e.g. as a flow diagram or structogram) including:
 - 1) a brief description of the modules and the functions that they perform;
 - 2) the way in which the modules interact;
 - 3) the overall hierarchy of the program;
 - 4) the way in which the software interacts with the hardware of the detector;
 - 5) the way in which the modules are called, including any interrupt processing.
- b) a description of which areas of memory are used for the various purposes (e.g. the program, site specific data and running data);
- c) a designation, by which the software and its version can be uniquely identified.

4.3.6.3 Design detail

The manufacturer shall have available detailed design documentation, which only needs to be provided if required by the testing authority. It shall comprise at least the following:

- a) an overview of the whole system configuration, including all software and hardware components;
- b) a description of each module of the program, containing at least:
 - 1) the name of the module;
 - 2) a description of the tasks performed;
 - 3) a description of the interfaces, including the type of data transfer, the valid data range and the checking for valid data;

- c) full source code listings, as hard copy or in machine-readable form (e.g. ASCII-code), including all global and local variables, constants and labels used, and sufficient comment for the program flow to be recognized;
- d) details of any software tools used in the design and implementation phase (e.g. CASE-Tools, Compilers etc.).

4.3.6.4 Software design

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

- a) the software shall have a modular structure;
- b) the design of the interfaces for manually and automatically generated data shall not permit invalid data to cause error in the program operation;
- c) the software shall be designed to avoid the occurrence of deadlock of the program flow.

4.3.6.5 The storage of programs and data

The program necessary to comply with this standard and any preset data, such as manufacturer's settings, shall be held in non-volatile memory. Areas of memory containing this program and data shall be designed such that they can only be written to by the use of some special tool or code and not during normal operation of the detector.

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

4.4 Tolerance to supply voltage — Variation in supply parameters

The DSD shall function correctly within the specified range(s) of the supply parameters as specified in 5.4.1.

4.5 Performance parameters under fire conditions — Fire sensitivity

The DSD shall have adequate sensitivity to incipient type fires that may occur in buildings. To confirm this, the DSD shall be assessed in accordance with 5.5.1.

4.6 Durability of Nominal activation conditions/sensitivity

4.6.1 Temperature resistance

4.6.1.1 Dry heat (operational)

The DSD shall function correctly at high ambient temperatures. To confirm this, the detector shall be assessed in accordance with 5.6.1.1.

4.6.1.2 Cold (operational)

The DSD shall function correctly at low ambient temperatures. To confirm this, the detector shall be assessed in accordance with 5.6.1.2.

4.6.2 Humidity resistance

4.6.2.1 Damp heat, steady-state (operational)

The DSD shall be capable of withstanding long term exposure to a high level of continuous humidity. To confirm this, the DSD shall be assessed in accordance with 5.6.2.1.

4.6.2.2 Damp heat, steady-state (endurance)

The DSD shall be capable of withstanding long term exposure to a high level of continuous humidity. To confirm this, the DSD shall be assessed in accordance with 5.6.2.2.

4.6.3 Corrosion resistance — Sulfur dioxide (SO₂) corrosion (endurance)

The DSD shall be capable of withstanding the corrosive effects of sulfur dioxide as an atmospheric pollutant. To confirm this, the sensing element shall be assessed in accordance with 5.6.3.1.

4.6.4 Shock and vibration resistance

4.6.4.1 Shock (operational)

The DSD shall function correctly when submitted to mechanical shocks which are likely to occur in the service environment. To confirm this, the DSD shall be assessed in accordance with 5.6.4.1.

4.6.4.2 Impact (operational)

The DSD shall function correctly when submitted to mechanical impacts which it may sustain in the normal service environment. To confirm this, the DSD shall be assessed in accordance with 5.6.4.2.

4.6.4.3 Vibration, sinusoidal (operational)

The DSD shall function correctly when submitted to vibration at levels appropriate to its normal service environment. To confirm this, the DSD shall be assessed in accordance with 5.6.4.3.

4.6.4.4 Vibration, sinusoidal (endurance)

The DSD shall be capable of withstanding long exposure to vibration at levels appropriate to the service environment. To confirm this, the DSD shall be assessed in accordance with 5.6.4.4.

4.6.5 Electrical stability — EMC, immunity tests (operational)

The DSD shall operate correctly when submitted to electromagnetic interference. To confirm this, the DSD shall be assessed in accordance with 5.6.5.1.

4.6.6 Air leakage

The DSD shall function correctly such that any air leakage of the DSD does not adversely affect its sensitivity, when monitoring a duct with negative pressure relative to the environment. To confirm this, the DSD shall be assessed in accordance with 5.6.6.

5 Testing, assessment and sampling methods

5.1 General

5.1.1 Atmospheric conditions for tests

Unless otherwise stated in a test procedure, the testing shall be carried out after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing as described in EN 60068-1:2014 as follows:

- a) temperature: 15 °C to 35 °C;
- b) relative humidity: 25 % to 75 %;
- c) air pressure: 86 kPa 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 a specimen to be operational, then the specimen shall be connected to suitable supply and monitoring equipment with characteristics as required by the manufacturer's data. Unless otherwise specified in the test method, the supply parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value, or the mean of the specified range. If a test procedure requires a specimen to be monitored to detect any alarm or fault signals, then connections shall be made to any necessary ancillary devices (e.g. through wiring to an end-of-line device for conventional detectors) to allow a fault signal to be recognized.

Where a DSD has different sensitivity settings, the following shall apply for test in accordance with Table 1:

- a) for the reproducibility test of 5.3.2 the highest and lowest sensitivity settings shall be used;
- b) the fire sensitivity test of 5.5.1 shall be carried out at the lowest sensitivity setting;
- c) for all other tests in Table 1 the sensitivity of the specimen shall be set at the highest sensitivity setting.

NOTE Difficulties to determine highest or lowest sensitivity can result in a need to test at additional settings.

5.1.3 Mounting arrangements

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

5.1.4 Tolerances

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 EN 60068).

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

5.1.5 Response threshold value

The specimen for which the response threshold value is to be measured shall be installed in the aerosol tunnel, described in Annex A, in its normal operating position, by its normal means of attachment.

This measurement can only be taken where the sampling apparatus of the DSD can fit inside the aerosol tunnel. Where the sampling apparatus is too large, other arrangements with the manufacturer should be taken.

Before commencing each measurement, the aerosol 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 temperature in the tunnel shall be $(23 \pm 5) ^\circ\text{C}$ and shall not vary by more than 5 K for all the measurements on a particular DSD type.

Unless otherwise specified by the manufacturer, the specimen shall be connected to its supply and monitoring equipment as specified in 5.1.2, and shall be allowed to stabilize for a period of at least 15 min.

The test aerosol, as described in Annex B, shall be introduced into the tunnel such that the rate of increase of aerosol density is as follows:

- for DSD incorporating detectors using scattered or transmitted light, in decibels per metre per minute:

$$0,015 \leq \frac{\Delta m}{\Delta t} \leq 0,1$$

- for DSD incorporating detectors using ionization, per minute:

$$0,05 \leq \frac{\Delta y}{\Delta t} \leq 0,3$$

NOTE These ranges are intended to allow the selection of a convenient rate, depending upon the sensitivity of the DSD, so that a response can be obtained in a reasonable time.

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

The tests on the DSD specimen shall be conducted at the air velocity of $1 \text{ m/s} \pm 0,2 \text{ m/s}$.

The response threshold value for types 1 to 4 DSD is the aerosol density (m or y) at the moment that the specimen gives an alarm. This shall be recorded as m , expressed in decibels per metre, for detectors using scattered or transmitted light, or as y for detectors using ionization (see Annex C).

For type 5 DSD the response threshold value N shall be measured in accordance with EN 54-20.

For type 6 DSD either of the above methods can be used to determine the response threshold value.

Designate the greater of the response threshold value as $y_{\max}$ or $m_{\max}$ or $N_{\max}$ the lesser as $y_{\min}$ or $m_{\min}$ or $N_{\min}$.

5.1.6 Provision for tests

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

- 12 specimens;
- data required in Clause 9.

The specimens submitted shall be deemed representative of the manufacturer's normal production with regard to their construction and calibration. This implies that the mean response threshold value of the 12 specimens, found in the reproducibility test (see 5.3.2) should also represent the production mean, and that the limits specified in the response threshold value test should also be applicable to the manufacturer's production.

5.1.7 Reduced function tests

Where the test procedure requires a reduced function test, the detector shall be exposed to a source of smoke which is sufficient to cause an alarm response from the DSD. The nature of the source used and the duration of the exposure shall be appropriate to the product in question.

If possible the additional functions shall be tested at the same time at which the response threshold value is measured. In this case, there is no need for an additional smoke source.

5.1.8 Test schedule

The specimens shall be tested in accordance with the following test schedule (see Table 1). After the reproducibility test, the least sensitive specimen (i.e. this with the highest response threshold) for the lowest sensitivity setting shall be numbered 12 and the others 1 to 11 arbitrarily.

If DSD contains components which have been already tested and approved in accordance with EN 54 standards, the test results can be taken into account. In Table 1 it is defined which tests are carried out for the different types of DSD.

Table 1 — Test schedule

Test	Subclause	Specimen No(s)	Type of DSD
Repeatability	5.3.1	One chosen arbitrarily	3, 4 and 6
Reproducibility	5.3.2	All specimens	1 to 6
Variation in supply parameters	5.4.1	1	2, 4 and 6
Dazzling	5.2.6	2	6
Dry heat (operational)	5.6.1.1	3	2, 3, 4 and 6
Cold (operational)	5.6.1.2	4	2, 3, 4 and 6
Damp heat, steady-state (operational)	5.6.2.1	5	2, 3, 4 and 6
Damp heat, steady-state (endurance)	5.6.2.2	6	2, 3, 4 and 6
Sulfur dioxide (SO ₂) corrosion (endurance)	5.6.3	7	2, 3, 4 and 6
Shock (operational)	5.6.4.1	8	2, 3, 4 and 6
Impact (operational)	5.6.4.2	9	2, 3, 4 and 6
Vibration, sinusoidal (operational)	5.6.4.3	10	2, 3, 4 and 6
Vibration, sinusoidal (endurance)	5.6.4.4	10	2, 3, 4 and 6
Air leakage ^a	5.6.6	3, 4, 6, 7, 8, 9 10	3, 4 and 6
Electromagnetic compatibility (EMC), Immunity tests (operational)	5.6.5.1	1, 2, 11	2, 4 and 6
Fire sensitivity	5.5.1	12	1 to 6
^a Air leakage test is undertaken after the corrosion, dry heat, cold, damp heat, shock, impact and vibration tests.			

5.2 Nominal activation conditions/sensitivity

5.2.1 Individual alarm indication

A visual inspection of a specimen shall be conducted to verify that the detector meets the requirements for individual alarm indication as specified in 4.2.1.

The specimen shall be checked for adequate visibility in an ambient light intensity of 500 lx.

5.2.2 Additional visual indication (when provided)

A visual inspection of a specimen shall be conducted to verify that the detector meets the requirements for additional visual indication as specified in 4.2.2.

The specimen shall be checked for adequate visibility in an ambient light intensity of 500 lx.

5.2.3 Alarm resetting for stand-alone system (when provided)

An engineering assessment shall be carried out for the correct resetting for a stand-alone system. A manual reset of a specimen shall be conducted to verify that the detector meets the requirements for resetting for stand-alone system as specified in 4.2.3.

5.2.4 Connection of ancillary devices (when provided)

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

An engineering assessment shall be carried out for the correct operation of the DSD as specified in 4.2.4.

5.2.5 Response to slowly developing fires

The behaviour of the DSD to slowly developing fires shall be assessed to meet the requirements of 4.2.5.

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

The detector shall be deemed to meet the requirements of 4.2.5 if this assessment shows that:

- a) for any rate of increase in smoke density R , which is greater than $A/4$ per hour (where A is the detector's initial uncompensated response threshold value), the time for the detector to give an alarm does not exceed $1,6 \times A/R$ by more than 100 s; and
- b) the range of compensation is limited such that, throughout this range, the compensation does not cause the response threshold value of the detector to exceed its initial value by a factor greater than 1,6.

NOTE Further information about the assessment is given in Annex M.

5.2.6 Dazzling

5.2.6.1 Object of test

To show that the sensitivity of the DSD is not unduly influenced by the close proximity of artificial light sources, this test is applied only to:

- type 6 DSD using scattered light or transmitted light;

— sensing elements of the DSD which are installed outside the duct.

5.2.6.2 Test procedure

The specimen shall be mounted as specified in 5.1.3 and shall be connected to its supply and monitoring equipment as specified in 5.1.2. The dazzling apparatus (see Annex D) shall be installed over the portion of the specimen mounted outside the duct, such that the smoke then is applied:

- a) the response threshold value shall be measured as specified in 5.1.5;
- b) four lamps shall be switched ON simultaneously for 10 s and then OFF for 10 s, this shall be repeated 10 times;
- c) four lamps shall be switched ON again and, after at least 1 min, the response threshold value shall be measured as specified in 5.1.5, with the lamps ON;
- d) then the four lamps shall be switched OFF.

The function test shall be carried out to verify that the additional electrical and/or mechanical components influencing the DSD response behaviour operate within the manufacturer's specification.

The maximum response threshold value shall be designated $m_{\max}$ or $N_{\max}$ and the minimum response threshold value $m_{\min}$ or $N_{\min}$.

5.2.6.3 Requirements

During the periods when the lamps are being switched ON and OFF, and when the lamps are ON before the response threshold value is measured, the specimen shall not emit either an alarm or a fault signal.

The ratio of the response thresholds $m_{\max} : m_{\min}$ or $N_{\max} : N_{\min}$ shall be not greater than 1,6.

The additional electrical and/or mechanical components influencing the DSD response behaviour shall function correctly within the manufacturer's specification.

5.3 Operational reliability

5.3.1 Repeatability

5.3.1.1 Object of test

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

5.3.1.2 Test procedure

The response threshold value of the specimen to be tested six times shall be measured as specified in 5.1.5.

The maximum response threshold value shall be designated $y_{\max}$ or $m_{\max}$ or $N_{\max}$, the minimum value $y_{\min}$ or $m_{\min}$ or $N_{\min}$.

5.3.1.3 Requirements

The ratio of the response threshold values $y_{\max} : y_{\min}$ or $m_{\max} : m_{\min}$ or $N_{\max} : N_{\min}$ shall be not greater than 1,6.

5.3.2 Reproducibility

5.3.2.1 Object of test

To show that the sensitivity of the DSD 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.

5.3.2.2 Test procedure

The response threshold value of each of the test specimens shall be measured as specified in 5.1.5.

The mean of these response threshold values shall be calculated and shall be designated y_{mean} or m_{mean} or N_{mean} .

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

5.3.2.3 Requirements

The ratio of the response threshold values $y_{\text{max}} : y_{\text{mean}}$ or $m_{\text{max}} : m_{\text{mean}}$ or $N_{\text{max}} : N_{\text{mean}}$ shall be not greater than 1,33, and the ratio of the response threshold values $y_{\text{mean}} : y_{\text{min}}$ or $m_{\text{mean}} : m_{\text{min}}$ or $N_{\text{mean}} : N_{\text{min}}$ shall be not greater than 1,5.

5.3.3 On-site adjustment of response behaviour

A visual inspection shall be conducted to verify that the DSD meets the requirements for on-site adjustment of response behaviour as specified in 4.3.3.

5.3.4 Manufacturer's adjustments

A visual inspection of a specimen shall be conducted to verify that the DSD meets the requirements for manufacturer adjustments as specified in 4.3.4.

5.3.5 Monitoring of detachable detectors

A visual inspection of a specimen shall be conducted to verify that the DSD meets the requirements for manufacturer adjustments as specified in 4.3.5.

5.3.6 Software controlled devices

For detectors that rely on software for their operation, an assessment of the documentation provided by the manufacturer shall be conducted to verify that the device complies with the requirements specified in 4.3.6.

5.4 Tolerance to supply voltage

5.4.1 Variation in supply parameters

5.4.1.1 Object of test

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

5.4.1.2 Test procedure

The response threshold value of the specimen shall be measured as specified in 5.1.5, at the upper and lower limits of the supply parameter (e.g. voltage) range(s) specified by the manufacturer.

The maximum response threshold value shall be designated $y_{\max}$ or $m_{\max}$ or $N_{\max}$; the minimum $y_{\min}$ or $m_{\min}$ or $N_{\min}$.

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

The function test shall be carried out to verify that the additional electrical and/or mechanical components influencing the DSD response behaviour operate within the manufacturer's specification.

5.4.1.3 Requirements

The ratio of the response threshold values $y_{\max} : y_{\min}$ or $m_{\max} : m_{\min}$ or $N_{\max} : N_{\min}$ shall not be greater than 1,6.

The additional electrical and/or mechanical components influencing the DSD response behaviour shall function correctly within the manufacturer's specification.

5.5 Performance parameters under fire conditions

5.5.1 Fire sensitivity

5.5.1.1 Object of test

To show that the DSD has adequate sensitivity to visible smoke types required for general applications in fire detection systems for buildings.

5.5.1.2 Test procedure

5.5.1.2.1 Principle of test

The DSD is exposed to a series of test fires with a "worst case" arrangement with respect to the length of additional mechanical means to sample the smoke, the number and size of holes or slots etc. The manufacturer shall, in agreement with the test laboratory and certification body, specify the "worst case" configuration for the tests.

The specimen shall be mounted in a duct leading from the fire test room (see Annex E and I) and shall be exposed to three test fires designed to produce smoke representative of the type that may impair visibility in a building, at two duct air velocities. All three test fires shall be conducted at the following two duct air velocities at $(1 \pm 0,2)$ m/s and at $(20 \pm 2,0)$ m/s.

5.5.1.2.2 Test fires

The specimens shall be subjected to the three test fires TF2D, TF4D and TF8D. The type, quantity and arrangement of the fuel and the method of ignition are specified in Annexe F, Annex G and Annex H 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 to obtain valid test fires.

5.5.1.2.3 Mounting of specimens

The specimen shall be mounted in the tunnel for fire tests (see Annex E and Annex I) as specified in 5.1.3.

Where additional mechanical means to sample the smoke (e.g. a sampling tube) from the duct are used and the tube length specified by the manufacturer exceeds the width of the test tunnel, the sampling tube length shall be adjusted to equal the width of the test tunnel. The adjusted tube length shall provide the same detection characteristics, e.g. air pressure, number and size of equally spaced holes or slots, as per the manufacturer's longest or shortest sampling tube, whichever is appropriate to be the worst case.

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

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.

5.5.1.2.4 Initial conditions

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

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

- air temperature, T : $(23 \pm 5) ^\circ\text{C}$
- smoke density (ionization): $y \leq 0,05$
- smoke density (optical): $m \leq 0,02 \text{ dB/m}$

The air inlet for the fire test room shall be opened, the tunnel for fire tests shall be switched on and the air velocity in the working section shall be adjusted to that required for the test allowing the air flow to stabilize for minimum of 2 min.

5.5.1.2.5 Recording of the fire parameters and response values

During each test fire, the fire parameters as given in Table 2 shall be measured in the working volume of the duct (see Figure E.1) and recorded as a function of time from the start of the test. Each parameter shall be recorded continuously or at least once per second.

Table 2 — Fire parameters

Parameter	Symbol	Units
Temperature change	ΔT_a	$^\circ\text{C}$
Smoke density (optical)	m_a	dB/m

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.

The time of response (alarm signal) of each specimen, along with ΔT_a and m_a , the fire parameters at the moment of response shall be recorded. A response of the DSD after the end of test condition is ignored.

5.5.1.3 Requirements

The specimen shall generate an alarm signal, in each test fire, at each velocity, before the specified end-of-test condition is reached.

5.6 Durability of Nominal activation conditions/sensitivity

5.6.1 Temperature resistance

5.6.1.1 Dry heat (operational)

5.6.1.1.1 Object of test

To demonstrate the ability of the DSD to function correctly at high ambient temperatures appropriate to its application which may occur for short periods in the service environment.

5.6.1.1.2 Test procedure

5.6.1.1.2.1 Reference

The test apparatus and the procedure shall be as specified in EN 60068-2-2:2007, Test Bb, and in 5.6.1.1.2.2 to 5.6.1.1.2.5.

5.6.1.1.2.2 State of specimen during conditioning

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

The function test shall be carried out to verify that the additional electrical and/or mechanical components influencing the DSD response behaviour operate within the manufacturer's specification.

5.6.1.1.2.3 Conditioning

The following conditioning shall be applied:

- temperature: Starting at an initial air temperature of $(23 \pm 5) ^\circ\text{C}$, increase the air temperature to $(55 \pm 2) ^\circ\text{C}$;
- duration: 2 h.

NOTE Test Bb of EN 60068-2-2:2007 specifies rates of change of temperature of $< 1 \text{ K/min}$ for the transitions to and from the conditioning temperature.

5.6.1.1.2.4 Measurements during conditioning

The specimen shall be monitored during the conditioning period to detect any alarm or fault signals. During the last 10 min of the conditioning the specimen shall be subjected to the reduced function test in accordance with 5.1.7.

5.6.1.1.2.5 Final measurements

After the recovery period of at least 1 h the response threshold value shall be measured as specified in 5.1.5.

The maximum response threshold value measured in this test and that measured for the same specimen in the reproducibility test shall be designated y_{max} or m_{max} or N_{max} , and the minimum y_{min} or m_{min} or N_{min} .

5.6.1.1.3 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 until the response threshold value is measured.

The ratio of the response threshold values $y_{\max} : y_{\min}$ or $m_{\max} : m_{\min}$ or $N_{\max} : N_{\min}$ shall be not greater than 1,6.

The additional electrical and/or mechanical components influencing the DSD response behaviour shall function correctly within the manufacturer's specification.

5.6.1.2 Cold (operational)

5.6.1.2.1 Object of test

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

5.6.1.2.2 Test procedure

5.6.1.2.2.1 Reference

The test apparatus and the procedure shall be as specified in EN 60068-2-1:2007, Test Ab, and in 5.6.1.2.2.2 to 5.6.1.2.2.5.

5.6.1.2.2.2 State of specimen during conditioning

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

The function test shall be carried out to verify that the additional electrical and/or mechanical components influencing the DSD response behaviour operate within the manufacturer's specification.

5.6.1.2.2.3 Conditioning

The following conditioning shall be applied:

- temperature: $(-10 \pm 3) ^\circ\text{C}$;
- duration: 16 h.

NOTE Test Ab of EN 60068-2-1:2007 specifies rates of change of temperature of $< 1 \text{ K/min}$ for the transitions to and from the conditioning temperature.

5.6.1.2.2.4 Measurements during conditioning

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

A reduced function test in accordance with 5.1.7 shall be conducted during the last hour of conditioning to test the smoke detection functionality of the DSD.

5.6.1.2.2.5 Final measurements

After a recovery period of at least 1 h at the standard atmospheric conditions, measure the response threshold value as specified in 5.1.5.