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PROPERTY INSURANCE COMMITTEE
Prevention Specifications

Specifications for spark detection systems Requirements and test methods for spark detectors

CEA 4035: June 2001 (en)

(EFSAC endorsed)

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INTRODUCTION

This CEA technical specification covers spark detectors for the use in spark detection, spark segregation or spark extinguishing systems. The object of such systems is that sparks, which may be originated by production processes and be transported with other materials (e.g. sawdust, metal dust, powder, flour etc.) through conveyor equipment (e.g. ducts), shall be detected, so that spark segregation or spark extinguishing systems and/or the shut down of machinery can be activated automatically. If the detector optics can become dirty by the transported material, the use of automatic cleaning or scavenging air equipment is recommended. Sparks of different sizes and temperatures have to be considered. It is anticipated that a single spark, containing sufficient energy to ignite surrounding materials, will have to be detected. The necessary sensitivity of a spark detector may therefore depend on its planned application and on the flammability of the transported material inside the duct or silo.

It may be necessary to distinguish between spark detectors sensitive to daylight and those, which are not. Daylight sensitive detectors may only be installed in closed and dark conveyor ducts or other equipment

1 SCOPE AND FIELD OF APPLICATION

This CEA specification specifies requirements, test methods and performance criteria for spark detectors for use in spark detection systems installed in buildings.

2 REFERENCES

This CEA specification 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 specification only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

IEC 60068-1 Environmental testing - Part 1: General and guidance (sixth edition 1988 + A1:1992).

IEC 60068-2 Basic environmental testing procedures: Part 2 Tests :

60068-2-1 Tests A: Cold. (Fifth edition 1990, including amendments A1: 1993 & A2: 1994);

60068-2-2 Tests B: Dry heat. (Fourth edition 1974, including amendments A1: 1993 & A2: 1994);

60068-2-3 Test Ca: Damp heat, steady state (Third edition 1969 + A1:1984);

60068-2-6 Test Fc: Vibration (sinusoidal). (Sixth edition 1995, including Corr.1995);

60068-2-18 Test R: Water (First edition 1989 + A1:1993)

60068-2-27 Test Ea: Shock (Third edition 1987);

60068-2-30 Test Db: Damp heat, cyclic. (Second Edition 1980, including Amendment No.1 1985);

60068-2-42 Test Kc: Sulphur dioxide test for contacts and connections. (Second edition 1982);

60068-2-56 Test Cb: Damp heat, steady state, primarily for equipment. (First edition 1988);

60068-2-75 Test Eh: Impact, Spring Hammer. (First edition 1997).

EN 54-1 Fire detection and fire alarm systems, Part 1: Introduction (1996).

EN 50130-4 Alarm systems, Part 4: Electromagnetic compatibility, Product family standard: Immunity requirements for components of fire, intruder and social alarm systems (1995, including Amendment A1:1998).

3 DEFINITIONS AND ABBREVIATIONS

3.1 Definitions

For the purposes of this CEA specification, the following definitions and those given in EN 54-1: 1996 apply:

- **spark detector:** a detector, sensitive to a particle containing thermal energy, able to ignite surrounding materials
- **conditioning**: The exposure of a specimen to environmental conditions in order to determine the effect of such conditions on the specimen.
- **recovery**: Treatment of a specimen, after conditioning, in order that the properties of the specimen may be stabilised before measurement.

3.2 Abbreviations

For the purposes of this CEA specification, the following abbreviations apply:

- **CIE**: Control and indicating equipment.
- **EMC**: Electromagnetic compatibility.
- **ppm**: Parts per million.

4 REQUIREMENTS

4.1 Compliance

In order to comply with this specification the spark detectors shall meet the requirements of this clause, which shall be verified by inspection and engineering assessment, shall be tested as described in clause 5 and shall meet the requirements of the tests.

4.2 Connection of ancillary devices

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

4.3 Monitoring of detachable detectors

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

4.4 Manufacturer's adjustments

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

4.5 On-site adjustment of response behaviour

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

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

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

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

4.6 Marking and data

4.6.1 Marking

Each spark detector shall be clearly marked with the following information:

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

b) the model designation (type or number);

c) the wiring terminal designations;

d) some mark(s) or code(s) (e.g. a serial No. or batch code), by which the manufacturer can identify, at least, the date or batch and place of manufacture, and the version number(s) of any software, contained within the device.

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

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

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

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

4.6.2 Data

Spark detectors shall be supplied with sufficient technical, installation and maintenance data to ensure their correct installation and operation[1]. This data shall include the parameters necessary to perform the Spark detection performance test (see 5.2). If all of this data is not supplied with each device, then reference to the appropriate data sheet(s) shall be given on, or with each device.

4.7 Documentation

The manufacturer shall prepare and provide design documentation (e.g. drawings, parts lists, block diagrams, circuit diagrams). Where appropriate, this shall include documentation of the signal processing principle.

4.8 Requirements for software controlled devices

4.8.1 General

For spark detectors, which rely on software control in order to fulfil the requirements of this specification, the requirements of 4.5.2, 4.5.3 & 4.5.4 shall be met.

[1] To enable correct operation of the spark detectors, this data should describe the requirements for the correct processing of the signals from the device. 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.

4.8.2 Software documentation

4.8.2.1 The manufacturer shall prepare documentation which gives an overview of the software design. This shall be submitted to the testing authority together with the spark detectors. This documentation shall be in sufficient detail for the design to be inspected for compliance with this specification 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.

4.8.2.2 The manufacturer shall also prepare 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 a 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.).

4.8.3 Software design

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

a) the software shall have a modular structure;

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

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

4.8.4 The storage of programs and data

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

Site-specific data shall be held in memory which will retain data for at least 2 weeks without external power to the device, unless provision is made for the automatic renewal of such data, following loss of power, within 1 hour of power being restored.

5 TESTS

5.1 General

5.1.1 Atmospheric conditions for tests

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

a) temperature : (15 to 35) ºC;

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

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

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

5.1.2 Operating conditions for tests

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

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

5.1.3 Mounting arrangements

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

5.1.4 Functional test

The response of the specimen shall be measured with spark types of
- min. size(s) with minimum temperature(s) which can be detected and
- max. size(s) with minimum temperature(s) which can be detected

at
– max. velocity of the spark
– max. distance of the spark to the test specimen
– max. angle (spark passing the specimen at the max. angle to the optical axis of the sensing element of the specimen).

as specified by the manufacturer. (i.e. as shown in Table 2, Tests 1 & 2).

For the functional test two alternatives should be considered:

a) arrangement between the test house and the manufacturer concerning the used test equipment, provided by the manufacturer or applicant and the measuring procedure within the limits given by this specification;

b) use of measuring equipment as described in annex A.

5.1.5 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 60068-2).

If a requirement or test procedure does not specify a tolerance or deviation limits, then deviation limits of ±5 % shall be applied.

5.1.6 Provision for tests

15 specimens are required to conduct the tests as indicated in the test schedule, see 0. These specimens shall be numbered 1 to 15 arbitrarily.

5.1.7 Test schedule

The specimens shall be tested according to the following test schedule.

Table 1

Test	Clause	Specimen No(s)
Spark detection performance	5.2	1, 2
Variation of supply parameters	5.3	2
Dry heat (operational)	5.4	2
Cold (operational)	5.5	3
Damp heat, Cyclic (operational)	5.6	4
Damp heat, Steady State (endurance)	5.7	5
SO_2 corrosion (endurance)	5.8	6
Shock (operational)	5.9	7
Impact (operational)	5.10	8
Vibration (operational)	5.11	9
Vibration (endurance)	5.12	9
Electromagnetic compatibility, Immunity tests	5.13	10 to 15*

* 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 can be deleted, and a functional test conducted at the end of the sequence of tests. However it should be noted that in the event of a failure, it may not be possible to identify which test exposure caused the failure (See EN 50130-4, clause 4).

5.2 Spark detection performance

5.2.1 Object

To demonstrate the ability of the spark detectors to detect sparks, in accordance with the manufacturer's specification.

5.2.2 Test procedure

The specimens, for which the response is to be measured, shall be mounted to test equipment, agreed on by the test house and the manufacturer or to suitable test equipment as described in Annex A, able to perform the testing under the conditions as described hereafter. The test specimens shall be connected to suitable supply and monitoring equipment in accordance with 5.1.2, and shall be allowed to stabilise for a period of at least 15 minutes, unless

otherwise specified by the manufacturer. For testing the spark detector, the manufacturer has to specify at least the following parameters:

- minimum and maximum velocity of the monitored medium (spark);
- minimum and maximum detection distance(s);
- minimum and maximum view angle;
- minimum and maximum sizes of the sparks with their temperatures, which can be detected;
- maximum response time;

The response of the specimen to a single spark and/or sparks shall be tested against the manufacturer's specification for the parameters under the conditions as given in table 2.

Table 2

Test		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Velocity	Max.	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**
	Min.					**X**	**X**				
Distance	Max.	**X**	**X**			**X**	**X**				
	Min.			**X**	**X**			**X**	**X**	**X**	**X**
Angle	Max.	**X**	**X**	**X**	**X**	**X**	**X**				
	Mid.							**X**	**X**		
	Min.									**X**	**X**
Spark size and (*temperature*)	Max.(*min.*)	**X**		**X**		**X**		**X**		**X**	
	Min.(*min.*)		**X**		**X**		**X**		**X**		**X**
NOTES:		Lowest energy Basic sensitivity		Highest count frequency (Max. angle) Count frequency checking		Lowest count frequency		Mid angle Angle checking (with tests 3 & 4)		Min angle	

5.2.3 Requirements

At each test in accordance with table 2, the test specimen shall respond within the specified response time.

5.3 Variation in supply parameters

5.3.1 Object

To demonstrate the ability of the spark detectors to function correctly at the upper and lower limits of the supply parameters specified by the manufacturer.

5.3.2 Test procedure

The test specimen shall be connected to suitable supply and monitoring equipment, as specified by the manufacturer. To test the response, a functional test in accordance with 5.1.4 shall be performed at the upper and lower limits of the supply parameter (e.g. voltage) range(s) specified by the manufacturer.

If it is not possible, to adjust the supply voltage to the upper and lower limits, then the response of the specimen shall be tested at the worst case conditions of the line impedance, line loading and the supply voltage to the supply and monitoring equipment allowed by the manufacturer's specification.

5.3.3 Requirements

At each functional test, the test specimen shall respond within the specified response time.

5.4 Dry heat (operational)

5.4.1 Object

To demonstrate the ability of the spark detectors to function correctly at high ambient temperatures, which may occur for short periods in the service environment.

5.4.2 Test procedure

5.4.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-2:1974 + A1:1993 + A2:1994 Test Bb, and as described below.

5.4.2.2 Initial measurements

Before conditioning, the functional test shall be performed as described in 5.1.4.

5.4.2.3 State of the specimen during conditioning

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

5.4.2.4 Conditioning

The following conditioning shall be applied to detectors for indoor use:

Temperature: (+55 ± 2) °C

Duration: 16 hours

The following conditioning shall be applied to detectors for outdoor use:

Temperature: (+70 ± 2) °C

Duration: 16 hours

5.4.2.5 Measurements during conditioning

The specimen shall be monitored during the conditioning period to detect any unwanted or unspecified functioning.

During the last hour of the conditioning period, the specimen shall be exposed to a response test, made with a radiation source representing the parameters (e.g. energy, view time, movement etc.), able to bring the specimen into the alarm condition. The source used and it's application shall be agreed between the manufacturer and the test house.

5.4.2.6 Final measurements

After a recovery period of at least 1 hour at laboratory conditions, the functional test shall be performed as described in 5.1.4

5.4.3 Requirements

No alarm or fault signals shall be given during the conditioning, except as required by the test in the last hour.

In the response test, made during the last hour of the conditioning, and the functional tests the specimen shall respond within the specified response time.

5.5 Cold (operational)

5.5.1 Object

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

5.5.2 Test procedure

5.5.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-1:1990 + A1:1993 + A2:1994 Test Ab, and as described below.

5.5.2.2 Initial measurements

Before conditioning, the functional test shall be performed as described in 5.1.4.

5.5.2.3 State of the specimen during conditioning

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

5.5.2.4 Conditioning

The following conditioning shall be applied to detectors for indoor use:

Temperature: (–10 ± 3) °C

Duration: 16 hours

The following conditioning shall be applied to detectors for outdoor use:

Temperature: (–25 ± 3) °C

Duration: 16 hours

5.5.2.5 Measurements during conditioning

The specimen shall be monitored during the conditioning period to detect any unwanted or unspecified functioning.

During the last hour of the conditioning period, the specimen shall be exposed to a response test, made with a radiation source representing the parameters (e.g. energy, view time, movement etc.), able to bring the specimen into the alarm condition. The source used and it's application shall be agreed between the manufacturer and the test house.

5.5.2.6 Final measurements

After a recovery period of at least 1 hour at laboratory conditions, the functional test shall be performed as described in 5.1.4.

5.5.3 Requirements

No alarm or fault signals shall be given during the conditioning, except as required by the test in the last hour.

In the response test, made during the last hour of the conditioning, and the functional tests the specimen shall respond within the specified response time.

5.6 Damp heat, cyclic (operational)

5.6.1 Object

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

5.6.2 Test procedure

5.6.2.1 Reference

The test apparatus and procedure shall be generally as described in IEC 60068-2-30:1980 + A1:1985 Test Db, using the variant 1 test cycle and controlled recovery conditions, and as described below.

5.6.2.2 Initial measurements

Before conditioning, the functional test shall be performed as described in 5.1.4.

5.6.2.3 State of the specimen during conditioning

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

5.6.2.4 Conditioning

The following conditioning shall be applied to detectors for indoor use:

Lower Temperature:	(25 ± 3) °C
Upper Temperature:	(40 ± 2) °C
Relative humidity:	
at lower temperature	> 95 %
at upper temperature	(93 ± 3) %
Number of cycles:	2

For detectors for outdoor use the upper temperature shall be (55 ± 2) °C

5.6.2.5 Measurements during conditioning

The specimen shall be monitored during the conditioning period to detect any unwanted or unspecified functioning.

During the last hour of the conditioning period, the specimen shall be exposed to a response test, made with a radiation source representing the parameters (e.g. energy, view time, movement etc.), able to bring the specimen into the alarm condition. The source used and it's application shall be agreed between the manufacturer and the test house.

5.6.2.6 Final measurements

After the recovery period, the functional test shall be performed as described in 5.1.4.

5.6.3 Requirements

No alarm or fault signals shall be given during the conditioning, except as required by the test in the last hour.

In the response test, made during the last hour of the conditioning, and the functional tests the specimen shall respond within the specified response time.

5.7 Damp Heat, steady state (endurance)

5.7.1 Object

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

5.7.2 Test procedure

5.7.2.1 Reference

The test apparatus and procedure shall be as described in IEC 60068-2-56:1988 Test Cb, or IEC 60068-2-3:1969 + A1:1984 Test Ca, and as described below.

5.7.2.2 Initial measurements

Before conditioning, the functional test shall be performed as described in 5.1.4.

5.7.2.3 State of the specimen during conditioning

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

5.7.2.4 Conditioning

The following conditioning shall be applied:

Temperature:	(40 ± 2) C
Relative Humidity:	(93 ± 3) %
Duration:	21 days

5.7.2.5 Final measurements

After a recovery period of at least 1 hour at laboratory conditions, the functional test shall be performed as described in 5.1.4.

5.7.3 Requirements

No alarm or fault signals shall be given on reconnection of the specimen.

In the functional tests, the specimen shall respond within the specified response time.

5.8 Sulphur dioxide (SO_2) corrosion (endurance)

5.8.1 Object

To demonstrate the ability of the spark detectors to withstand the corrosive effects of sulphur dioxide as an atmospheric pollutant.

5.8.2 Test procedure

5.8.2.1 Reference

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

5.8.2.2 Initial measurements

Before conditioning, the functional test shall be performed as described in 5.1.4.

5.8.2.3 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3. It shall not be supplied with power during the conditioning, but it shall have untinned 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.

5.8.2.4 Conditioning

The following conditioning shall be applied:

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

5.8.2.5 Final measurements

Immediately after the conditioning, the specimen shall be subjected to a drying period of 16 hours at 40 °C, ≤ 50 % RH, followed by a recovery period of at least 1 hour at laboratory conditions. After this recovery period, the functional test shall be performed as described in 5.1.4.

5.8.3 Requirements

No alarm or fault signals shall be given on reconnection of the specimen.

In the functional tests, the specimen shall respond within the specified response time.

5.9 Shock (operational)

5.9.1 Object

To demonstrate the immunity of the spark detectors 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 generally as described in IEC 60068-2-27:1987 Test Ea, except that the conditioning shall be as described below.

5.9.2.2 Initial measurements

Before conditioning, the functional test shall be performed as described in 5.1.4.

5.9.2.3 State of the specimen during conditioning

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

5.9.2.4 Conditioning

For specimens with a mass ≤ 4.75 kg the following conditioning shall be applied. No test is applied for specimens with a mass > 4.75 kg.:

Shock pulse type:	Half sine
Pulse duration:	6 ms
Peak acceleration $\hat{\mathbf{A}}$:	$\hat{\mathbf{A}} = 10 \times (100 - 20M)$ m s^{-2} (Where M is the specimen's mass in kg)

Number of directions: 6

Pulses per direction: 3

5.9.2.5 Measurements during conditioning

The specimen shall be monitored during the conditioning period and for an additional 2 minutes after this to detect any unwanted or unspecified functioning.

5.9.2.6 Final measurements

After the conditioning and the additional 2 minutes, the functional test shall be performed as described in 5.1.4.

5.9.3 Requirements

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

In the functional tests, the specimen shall respond within the specified response time.

5.10 Impact (operational)

5.10.1 Object

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

5.10.2 Test procedure

5.10.2.1 Reference

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

5.10.2.2 Initial measurements

Before conditioning, the functional test shall be performed as described in 5.1.4.

5.10.2.3 State of the specimen during conditioning

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

5.10.2.4 Conditioning

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

Care should be taken to ensure that the results from a series of three blows do not influence subsequent series. In case of 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: $(0{,}5 \pm 0{,}04)$ J

Number of impacts per point: 3

5.10.2.5 Measurements during conditioning

The specimen shall be monitored during the conditioning period and for an additional 2 minutes after this to detect any unwanted or unspecified functioning.

5.10.2.6 Final measurements

After the conditioning and the additional 2 minutes, the functional test shall be performed as described in 5.1.4.

5.10.3 Requirements

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

In the functional tests, the specimen shall respond within the specified response time.

5.11 Vibration, sinusoidal, (operational)

5.11.1 Object

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

5.11.2 Test procedure

5.11.2.1 Reference

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

5.11.2.2 Initial measurements

Before conditioning, the functional test shall be conducted as described in.5.1.4

5.11.2.3 State of the specimen during conditioning

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

The vibration shall be applied in each of three mutually perpendicular axes, in turn, The specimen shall be mounted so that one of the three axes is perpendicular to its normal mounting plane.

5.11.2.4 Conditioning

The following conditioning shall be applied:

Frequency range:	(10 to 150) Hz
Acceleration amplitude:	5 m s^{-2} (≈0,5 g_n)
Number of axes:	3
Sweep rate:	1 octave/min.
Number of sweep cycles:	1

NOTE. The vibration operational and endurance tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis. Only one initial and one final measurement need then be made.

5.11.2.5 Measurements during conditioning

The specimen shall be monitored during the conditioning period to detect any unwanted or unspecified functioning.

5.11.2.6 Final measurements

After the conditioning, the functional test shall be performed as described in 5.1.4.

5.11.3 Requirements

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

In the functional tests, the specimen shall respond within the specified response time.

5.12 Vibration, sinusoidal (endurance)

5.12.1 Object

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

5.12.2 Test procedure

5.12.2.1 Reference

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

5.12.2.2 Initial measurements

Before conditioning, the functional test shall be performed as described in 5.1.4.

5.12.2.3 State of the specimen during conditioning

The specimen shall be mounted as described in 5.1.3 on a rigid fixture but shall not be supplied with power during conditioning.

The vibration shall be applied in each of three mutually perpendicular axes, in turn, The specimen shall be mounted so that one of the three axes is perpendicular to its normal mounting axis.

5.12.2.4 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.
Number of sweep cycles:	20

NOTE. The vibration operational and endurance tests may be combined such that the specimen is subjected to the operational test conditioning followed by the endurance test conditioning in one axis before changing to the next axis. Only one initial and one final measurement need then be made.

5.12.2.5 Final measurements

After the conditioning, the functional test shall be conducted as described in 5.1.4.

5.12.3 Requirements

No alarm or fault signals shall be given on reconnection of the specimen.

In the functional tests, the specimen shall respond within the specified response time.

5.13 Electromagnetic Compatibility (EMC), Immunity tests

EMC, immunity tests shall be carried out as described in EN 50130-4:1995 + A1:1998. This will mean conducting the following tests:

1) Mains supply voltage variations[2] - If the spark detectors incorporate a mains supply;

2) Mains supply voltage dips and short interruptions - If the spark detectors incorporate a mains supply;

3) Electrostatic discharge;

4) Radiated electromagnetic fields[3];

5) Conducted disturbances induced by electromagnetic fields;

6) Fast transient bursts;

7) Slow high energy surges.

For these tests the following shall apply:

a) The functional test, called for in the initial and final measurements, shall be performed as described in 5.1.4.;

[2] If applicable, the Mains supply voltage variations test can be combined with the Variation in supply parameters test (see 5.3).

[3] In the Radiated electromagnetic fields test, the field strength is increased to 30 V/m in the frequency ranges 415 to 466 MHz and 890 to 960 MHz, and the total frequency range is extended up to 2000 MHz.

b) The acceptance criteria shall be that:

- No unwanted or unspecified function shall occur during conditioning; and
- In the functional tests, the specimen shall respond within the specified response time.

5.14 Enclosure protection (only for detectors for outdoor use)

5.14.1 Object of the test

To demonstrate that the spark detector is adequately protected against the ingress of water.

5.14.2 Test procedure

5.14.2.1 Reference

The test apparatus and the test procedure shall be as described in IEC 60068-2-18:1989 and IEC 60068-2-18/A1:1993, test Rb2.1.

5.14.2.2 State of the specimen during conditioning

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

5.14.2.3 Conditioning

The following test condition shall be applied

Spray nozzle angle α:	$\pm$ 90°
Tube oscillating angle β:	$\pm$ 180°
Water flow per nozzle:	0,10 dm^3 min^{-1}
Nozzle orifice diameter:	0,40 mm
Over pressure:	80 kPa
Duration:	10 min

5.14.2.4 Measurement during conditioning

The specimen shall be monitored during the conditioning period to detect any unwanted or unspecified functioning.

5.14.2.5 Final measurements

After conditioning, the functional test shall be performed as described in 5.1.4

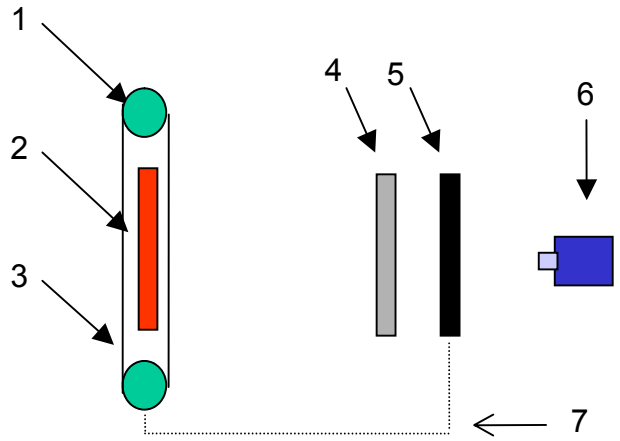
5.14.3 Requirements

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

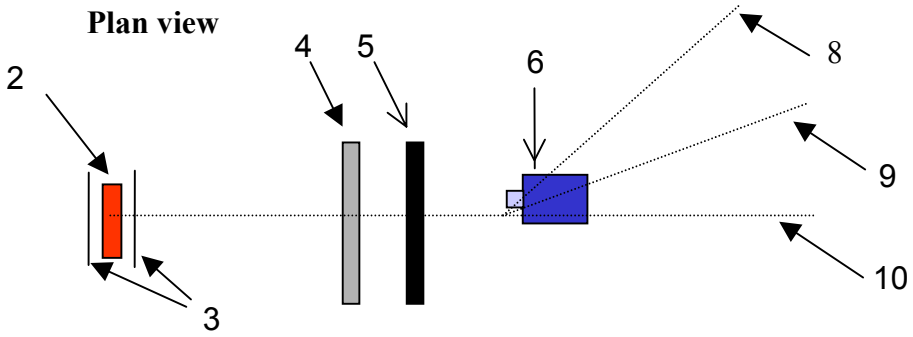
In the functional tests, the specimen shall respond within the specified response time.

Annex A (informative) Example of test equipment for performance test

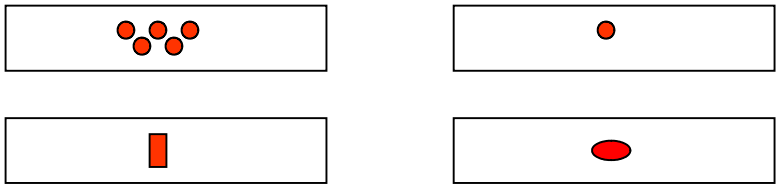
Possible arrangement of a test equipment on an optical bench, if necessary, in a dark room protected against daylight or other light sources.



Plan view



Side view showing the detector with mid. view angle



Examples of belts

Key:

1. belt drive with speed control (≤ 50 m/s)
2. radiator, temperature controlled (400 to 1000)°C
3. belt
4. attenuator (by distance)
5. aperture
6. spark detector
7. synchronisation for belt and aperture
8. optical axis of detector for max. view angle
9. optical axis of detector for mid. view angle
10. optical axis of apparatus and optical axis of detector for min. view angle (i.e. 0°)

Figure 1 – Example of test equipment for performance test on spark detectors