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PROPERTY INSURANCE COMMITTEE Prevention Specifications

**Specifications for fire detection and fire alarm systems
Requirements and test methods for multisensor detectors, which
respond to smoke and heat, and smoke detectors with more than
one smoke sensor**

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(EFSAC endorsed)

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1. SCOPE AND FIELD OF APPLICATION

This CEA specification specifies requirements, test methods and performance criteria for multisensor detectors, which respond to smoke and heat, and smoke detectors with more than one smoke sensor, for use in fire detection and fire alarm systems installed in buildings.

This CEA specification is a revision of, and replaces, CEA 4021: 1999-06. This revision has been prepared to take account of the fact that EN 54-5:1976 and EN 54-7: 1982, referred to in CEA 4021: 1999-06, have been replaced by EN 54-5: 2000 and EN 54-7: 2000, respectively.

CEA 4021: 1999-06 will be withdrawn in June 2003 (i.e. at the same time as the national versions of EN 54-5: 1976 and EN 54-7: 1982 are officially withdrawn) until then either version of the specification can be used.

NOTE: Certain types of detector contain radioactive materials. The national requirements for radiation protection differ from country to country and they are not therefore specified in this specification. Such detectors should, however, comply with the national requirements, which should be in line with the recommendations of the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD).

2. REFERENCES

This CEA specification incorporates by dated or undated reference, provisions from other publications. These normative 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.

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

EN54-5:2000 Fire detection and fire alarm systems - Part 5: Heat detectors - Point detectors

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

OECD Recommendations for ionization chamber smoke detectors in implementation of radiation protection standards. Nuclear Energy Agency, Organisation for Economic Co-operation and Development, Paris, France. (1977).

3. DEFINITIONS

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

- **multisensor detector:** A detector which responds to more than one phenomenon of fire;
- **sensor:** Part of a detector sensitive to one phenomenon of fire. (N.B. For this specification only the phenomena smoke and heat are considered).

4. REQUIREMENTS AND TEST METHODS

4.1 Sensor combinations

A large variety of combinations of sensors is possible in multisensor detectors. However, only a limited number of such sensor combinations are available in fire detectors, which are in series production. It has also to be considered, that not all possible combinations make sense with respect to the increase of fire detection performance and reducing the number of false alarms. Therefore this specification deals with detectors which are available today and, at present, it is restricted to multisensor detectors, which respond to smoke and heat (i.e. with at least one smoke and one heat sensor) and smoke detectors with more than one smoke sensor.

Detectors with the following combinations of sensors are considered:

- a) Detectors with more than one smoke sensor;
- b) Detectors with at least one smoke and one heat sensor, where the heat sensor(s) enhances the smoke response characteristics;
- c) Detectors with at least one smoke and one heat sensor, where each sensor, with its associated circuitry, fulfils the relevant part of the European Standard EN 54 (i.e. EN 54: Part 7 and EN 54: Part 5).

4.2 Basic Standards

Requirements and test methods from standards, already available for point detectors are used, where possible (e.g. EN 54 series):

For detectors as described under 4.1 a), b) or c), the requirements and test methods for the smoke sensing part as given in the CEN standard EN 54: Part 7 are used.

For detectors as described under 4.1 c) (i.e. where the manufacturer specifies that the detector also responds to heat alone, to produce a fire alarm signal and fulfils the requirements of the CEN Standard EN 54: Part 5), then the requirements and test methods of EN 54: Part 5 are used as well.

Additional requirements are given in Clauses 4.3, and 5 and some additional explanations of the test methods and requirements are given in Clause 5.3.

4.3 General requirements

4.3.1 Compliance

In order to comply with this specification:

- detectors, as specified under Clause 4.1, shall meet the requirements of EN 54-7, and Clauses 4.3.2 to 4.3.5, they shall be tested as described in Clause 5 and shall meet the requirements of the tests;
- detectors, as specified under Clause 4.1 c), shall, in addition, comply with the requirements of EN 54-5.

4.3.2 On-site sensitivity adjustment

If there is provision for on-site-adjustment of the detectors sensitivity, then:

- a) for all of the settings, at which the manufacturer claims compliance with this specification, EN 54-5 and/or EN 54-7, the detector shall comply with the appropriate requirements 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, EN 54-5 or EN 54-7, 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.
- c) In either of the above cases, it shall be possible to determine what sensitivity settings have been selected.

NOTE : These adjustments may be made at the detector or at the control and indicating equipment.

4.3.3 Fire sensitivity

In addition to meeting the fire sensitivity requirements of EN 54-7, detectors as mentioned in Clauses 4.1 b) and 4.1 c) shall respond to the test fire specified in Clause 5.6.

4.3.4 Sensor stability

Each sensor with its associated circuitry shall remain stable during and/or after environmental tests etc.

The stability for:

- a) smoke sensors and their associated circuitry, in detectors as mentioned in Clause 4.1, shall meet the requirements for the ratios as specified in EN 54-7 for the different tests;
- b) heat sensors and their associated circuitry, in detectors as mentioned in Clause 4.1 c), shall meet the requirements for the response times as specified in EN 54-5 for the different tests;
- c) the signals produced by heat sensors and their associated circuitry, in detectors as mentioned in Clause 4.1 b), shall not deviate by more than 30%, or a greater value for which the manufacturer can demonstrate that this deviation does not influence the response threshold value of the smoke sensor by a factor greater than 1,6, when compared before and after the environmental tests mentioned in Clause 5.5.3.

4.3.5 Electromagnetic Compatibility (EMC), Immunity tests

NOTE: For approval by certain European approval bodies, the Radiated electromagnetic fields test (see EN 54-7, Clause 5.17 b) and EN 54-5, Clause 5.18 b)) is extended as follows: (a) the field strength is increased to 30 V/m in the frequency ranges 415 MHz to 466 MHz and 890 MHz to 960 MHz, and (b) the total frequency range is extended up to 2000 MHz.

4.3.6 Documentation

The manufacturer shall prepare and provide design documentation (e.g. drawings, parts lists, block diagrams, circuit diagrams), which shall include documentation of the signal processing principle and the combination of the sensors (see Clause 4.1).

5 TESTS

5.1 General

Detectors specified in Clause 4.1 shall be tested in accordance with EN 54-7 and as specified hereafter. Detectors specified in Clause 4.1 c) shall, in addition, be tested in accordance with EN 54-5.

5.2 Measurement of response threshold values and/or response times

Generally the methods as described in the standards mentioned in Clause 4.2 shall be used.

Dependent on the requirement that all sensors with their associated circuitry shall remain stable, it is necessary to establish measurement techniques, which allow the measurement of the response threshold values, response times or the signal production of a given sensor independently from other sensors. This means in practice, measuring the response of one sensor with nearly no influence or the smallest possible cross influence to other sensors present.

This can be achieved, at present, by using a procedure, necessarily provided by the manufacturer, which allows the assessment of each sensor and its circuitry independently or, where possible, by adaptation of the measuring technique so that one sensor can be adequately stimulated with almost no effect on the other sensor (e.g. for detectors as specified in Clause 4.1 a), equipped with an ionization and optical smoke sensor, different aerosols may be used).

5.3 Explanation of test method Directional dependence (see EN 54-7, Clause 5.3 & EN 54-5, Clause 5.2)

Concerning the measuring of the directional dependence, it is up to the laboratory to set the starting point(s) (zero degree position(s)).

5.4 Detectors with circuit isolators

For detectors, which incorporate circuit isolators, a functional test shall be carried out before and after each of the environmental tests.

The functional test consists of the activation of the isolating function (e.g. by a short circuit), to check the correct operation of the isolator.

NOTE: This is to ensure that the circuit isolator still functions after the environmental tests. Further requirements (e.g. functioning with partial short circuit) for the performance of the circuit isolators is specified in other specifications.

5.5 Test of a heat sensor, which enhances the response characteristics of a detector

5.5.1 Directional dependence

Detector No 2 shall be mounted in the heat tunnel described in EN 54-5 Annex A. The response of the heat sensor shall be measured at a rate of rise of air temperature of 10 K min^{-1} . Measurements shall be made in eight different orientations with the specimen being rotated about a vertical axis by 45° between successive measurements. Before each measurement the specimen shall be stabilised at 25°C .

NOTE: For detectors which are also as specified in Clause 4.1 c) and use the same heat sensor for both enhancing the characteristics of the smoke detection and for the heat detector response, the stabilisation temperature used may be the typical application temperature for the appropriate heat detector class taken from Table 1 of EN 54-5.

The response of the heat sensor can be assessed in terms of the time taken to reach a certain signal level or the change in signal level produced in a certain time. The precise procedure is to be agreed between the test house and the manufacturer.

Requirement :

The ratio of the maximum to the minimum of the response values measured at the eight orientations shall not exceed 1,3 or a greater value, for which the manufacturer can demonstrate, that this deviation does not influence the response threshold value of the smoke sensor by a factor greater than 1,6.

5.5.2 Minimum response times

If, a detector as specified in Clause 4.1 b) is able to respond to heat alone to produce a fire alarm signal, the response times of detector No. 2 shall be measured, in accordance with EN 54-5 Clauses 5.3 and 5.4 but only at the most sensitive orientation, as determined in the tests of Clause 5.5.1.

Requirement:

For the test in accordance with EN 54-5 Clause 5.3, the detector shall not respond before 54°C .

For the test in accordance with EN 54-5 Clause 5.4, the detector shall not respond before reaching the lower limit of response times for Class A1, as shown in EN 54-5 Table 4.

5.5.3 Stability

The stability of each heat sensor with its associated circuitry shall be assessed at rates of rise of air temperature of 3 K min^{-1} and 20 K min^{-1} before and after the following environmental tests:

- a) Dry heat (operational);
- b) Damp heat, steady state (operational);
- c) Shock (operational);
- d) Sulfur dioxide (SO_2) corrosion (endurance).

Requirement :

The requirement of Clause 4.3.4 c) shall be met.

5.6 Flaming liquid (decalin) fire

Detectors as mentioned in Clauses 4.1 b) and 4.1 c) shall be subjected to the following additional flaming liquid test, which produces dark smoke but with a small temperature increase. This test shall be conducted in the same manner as the other test fires described in EN 54-7 but with the following details:

Fuel: Approximately 170 g Decalin (decahydronaphthalene, $C_{10}H_{18}$) (Purity >95%);

Arrangement: The decalin shall be burnt in a square steel tray with dimensions of approximately 120 mm long x 120 mm wide x 20 mm high;

Ignition: By flame or spark, using an ignition additive of approximately 5 g of ethyl alcohol;

End of test: $y_E = 6$;

Fire parameters

at end of test: $(m/y)_E = 0,28 \text{ dB/m} \pm 15\%$;

max. temperature rise $\Delta T_E \leq 6 \text{ K}$;

If the end of test is reached before all of the detectors have responded, the test is only considered valid if an m value of 1,7 has been reached.

Requirement:

All four specimens tested shall respond before the end of test is reached.