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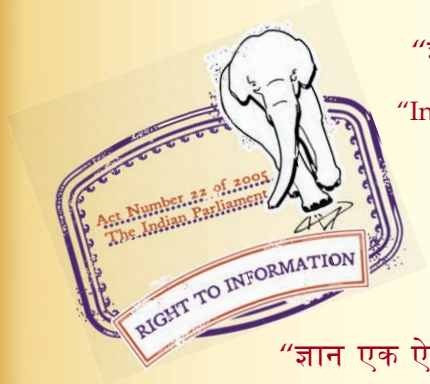
IS 11360 (1985): Specification for smoke detectors for use in automatic electrical fire alarm system [CED 22: Fire Fighting]



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IS : 11360 - 1985
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Indian Standard

SPECIFICATION FOR SMOKE DETECTORS FOR USE IN AUTOMATIC ELECTRICAL FIRE ALARM SYSTEM

UDC 614·842·435 : 654·924·56

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 5

February 1986

Indian Standard

SPECIFICATION FOR SMOKE DETECTORS FOR USE IN AUTOMATIC ELECTRICAL FIRE ALARM SYSTEM

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(*Continued on page* 19)

Indian Standard

SPECIFICATION FOR SMOKE DETECTORS FOR USE IN AUTOMATIC ELECTRICAL FIRE ALARM SYSTEM

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 July 1985, after the draft finalized by the Fire Fighting Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Property damage caused by a fire is directly related to (a) intensity of fire and (b) duration of fire. The intensity of fire depends upon the time available for its growth, type and geometrical configuration of combustibles, ventilation, etc. The duration of fire depends upon the quantity of combustible and the point at which extinction process starts.

0.3 Life risk is predominantly posed by smoke and other toxic products of combustion which travel faster and farther than fire. The amount of combustion products and speed of their travel is directly proportional to the intensity of fire.

0.4 In order to ensure life safety, and reduce property loss there is a need to detect fires in an incipient stage, which will provide a reasonable interval of time for inmates to escape to a place of safety and which will give a reasonable chance to fire fighters to control and extinguish the fire with minimum loss.

0.5 Fires are detected by utilizing the various physical and chemical changes produced by it. One of the predominent phenomenon in the early growth stage of fire is production of invisible aerosols and smoke. The probes which detect the invisible aerosol and smoke are called smoke detectors. A system which utilizes such devices to initiate audio and visual alarm is called 'automatic smoke and fire detection system'. Certain types of devices, which detect fires by oxidisable gases such as those released by burning materials fall outside scope of this standard.

0.6 The aim of standardization of any device is to ensure that the quality of material is good, and that the equipment performs its task under the conditions it may be subjected to during its usage. It is, therefore, necessary to prepare an Indian Standard on smoke detectors

covering specifications so as to enable the users to choose a standard device and also to help the indigenous manufacturers to manufacture standard detector heads. Detail of installations is being covered separately.

0.7 The disposal of the ionization detectors and marking on them for the presence of radioactive material shall be in a manner acceptable to the Department of Atomic Energy, Government of India and relevant statutory provisions.

0.8 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers general constructional features, performance requirements and test methods for optical and ionization types of smoke detectors intended for indoor installations to ensure the maintainability of their performance under different environmental conditions.

2. DEFINITIONS

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Ionization Chamber — A chamber having two electrodes across it for power connection, open to air and containing radioactive material to generations within the air inside so that an ionization current flows through the chamber whenever a potential difference exists between the electrodes.

2.2 Ionization Smoke Detector — A detector employing ionization chamber(s) as sensing means for detecting aerosols given off by fires.

2.3 Optical (Photo-electric) Smoke Detector — A detector whose operation is based on 'light attenuation by smoke' and/or 'light scattering by smoke' principle.

2.4 Response Threshold Value (r.t.v.) — The smoke (aerosols) concentration at which the detector initiates alarm.

*Rules for rounding off numerical values (*revised*).

2.5 Normal Condition — The condition in which the detector is supplied with power being connected to its control and indicating equipment or equivalent power source, but not giving fire or fault signal.

2.6 Alarm Condition — The condition in which the detector is giving signal indicating the existance of fire.

2.7 Low Voltage Detector — A detector requiring a potential of not more than 30 volts dc or 30 volts (rms) ac for operation and is powered from a source whose power is limited to 100 volt-amperes.

2.8 High Voltage Detector — A detector operating on potential in excess of low voltage detector.

3. GENERAL REQUIREMENTS

3.1 A visual indication of normal condition when provided shall be visible from a distance of 6 m.

3.2 A visual indication of detector's alarm condition shall be provided which shall be visible from a distance of 6 m and shall be visually different from the indication(s) of other condition(s).

3.3 Failure of any indicator lamp shall not prevent the detector from emitting fire signal indicating the existence of fire.

3.4 Where separate bases are designed for mounting the detectors, means shall be provided to prevent incorrect alignment and/or incorrect connection(s) of the detector by adopting plugging type systems.

3.5 Terminals for external wires shall be provided which shall allow connections of conductors having nominal cross-sectional area between 0·92 and 2·5 mm^2. Terminals shall rigidly clamp the conductor between metal surfaces with moderate contact pressure and without damage to the conductor. Disconnection shall be possible only with the use of a tool.

3.6 Construction of a low voltage detector including mounting bases if any shall be such that current carrying parts are not exposed to unintended contact.

3.7 A high-voltage detector shall have an overall non-metallic cover. If matallic insulated enclosure and cover are provided the same shall be provided with a ground terminal.

3.8 The openings for smoke entry shall be at least 30 mm below the ceiling level assumed smooth and flat.

4. PERFORMANCE TEST AND CRITERIA FOR CONFORMITY

4.0 A sample of 15 numbers of detectors of each design* selected randomly from production of not less than 200 shall be used for testing and shall be numbered as 1 to 15. The tests (one or more) on the detectors shall be carried out in the order given in test schedule given in Appendix A according to methods given in **4.1** to **4.18**. All the tests are type tests which cover the production of 10 000 members. The detectors shall pass all the tests.

4.1 Directional Dependence — A randomly choosen detector from the sample shall be mounted in the testing tunnel in its normal operating position and with a random orientation with respect to flow direction of the smoke. Its response threshold value (r.t.v.) shall be measured in accordance with Appendix B. It shall then be rotated by 45° about its vertical axis and its r.t.v. shall again be measured. Thus 8 measurements of its r.t.v. in 8 orientations shall be recorded so that rotation of the detector about vertical axis is complete. The ratio of highest r.t.v. and lowest r.t.v. shall not exceed 1 6 and the lowest r.t.v. shall be not less than ·05 dB/m.

NOTE — The direction of highest r.t.v. is the least favourable orientation and the direction of lowest r.t.v. is the most favourable orientation of the detector. In the following tests where determination of r.t.v. is required on the tunnel mounted detector, it shall be made using the least favourable orientation of the detector.

4.2 Reproducibility and Optimal Sensitivity — The r.t.v. of all the detectors of the sample shall be measured as in Appendix B for the least favourable orientation. Detectors shall be graded in order of increasing r.t.v. number 1 having lowest r.t.v. and 15 number having highest r.t.v. The ratio of highest r.t.v. and lowest r.t.v. shall not exceed 1·6 and the lowest r.t.v. shall not be less than ·05 dB/m.

4.3 Stability — Detectors numbered 3 shall be mounted in the tunnel and left energized. Two measurements of r.t.v. shall be made, according to Appendix B after one day of energization. The detector shall be reset and energization restored immediately after the measurement; second measurement of r.t.v. shall be taken after 10 days of energization. Other than the first 2 minutes of energization, the detector shall not give fire or fault alarm and the ratio between the two r.t.v. shall not exceed 1·6 and lowest r.t.v. shall not be less than ·05 dB/m.

4.4 Repeatability — Detectors numbered 2 and numbered 14 shall be tested. The r.t.v. of each detector shall be measured 6 times keeping a time interval of 30 minutes between two successive measurements and making the tunnel and detector free from smoke before every

*The detail drawings, of each component with type of material to be indicated on each design (*see* **6.5**).

measurement according to Appendix B. Detector shall be reset immediately after measurement of r.t.v. For each detector, ratio between its highest r.t.v. and lowest r.t.v. shall not exceed 1·6.

NOTE — For both the detectors average value of r.t.v. shall be calculated on the basis of this test and designated as $\bar{M}_2$ and $\bar{M}_{14}$.

4.5 Endurance — Detectors numbered 4, 12 and 13 shall be tested for endurance. The tests shall be conducted keeping detectors energized in their normal operating conditions. During the test carried out as follows, the detectors shall be kept in a room free of smoke and air-draughts:

a) Power supply of detector numbered 4 shall be interrupted 50 times with interruption interval of 1s and interval of 10s between successive interruptions. Where applicable, engagement and disengagement of base plate and removal and replacement of cover shall be made.

b) Detector numbered 12 shall be subjected to 1 000 power interruption cycles of 5s 'on' and 5s 'off' duration at a rate not exceeding 10 cpm.

c) Detector numbered 13 shall be powered at voltage exceeding 10 percent of the maximum voltage. It shall be brought into alarm condition by smoke insertion. Fifty cycles shall be repeated at a rate not exceeding 6 cpm.

There shall be no electrical and mechanical malfunctioning of the detector. For each detector the r.t.v. measured following one test according to Appendix B and its r.t.v. measured under **4.2** shall not differ by a factor greater than 1·6.

4.6 Supply Voltage Variation — Detector numbered 2 ($\bar{M}_2$) shall be tested according to Appendix B. Where upper and lower limit of supply voltage are prescribed, the r.t.v. shall be determined at both the limits. If only one nominal value of supply voltage is given, r.t.v. shall be measured first by reducing the voltage by 15 percent and then by raising the voltage by 10 percent of the nominal value. Neither reduced voltage r.t.v. nor raised voltage r.t.v. shall differ by a factor greater than 1·6 from $\bar{M}_2$.

4.7 Insulation Resistance — Detector numbered 9 shall be mounted in its normal fastening on a metal plate of at least 2 mm thickness and having surface area at least 5 times of the mounting source of the detector. With the plate shorted to ground terminal of the source, a dc voltage shall be applied between the plate and terminals of the detectors which are interconnected. Starting from zero volt, the voltage shall be applied at a rate of 100 V/s to a maximum of 500 $\pm$ 10 volts dc. The maximum voltage shall remain applied for 1 minute. Insulation resistance shall

then be determined. Thereafter it shall be subjected to the following climatic conditions for 10 days, care shall be taken against water condensation or mist formation on the detector:

Temperature = 42 ± 2°C
RH = 92 ± 3 percent

After the conditioning, the detector shall be kept under room condition for 1 hour. Insulation resistance shall be measured again as described above. The detector shall not show insulation resistance less than 10 M ohm in the first measurement and not less than 1 M ohm in second measurement.

4.8 Vibration — Detector numbered 5 shall be tested as in IS : 2175-1977*. Detector shall not emit a fire or fault signal during and after the test and the r.t.v. measured following the test according to Appendix B and its r.t.v. measured under **4.2** shall not differ by a factor greater than 1·6 and no mechanical damage/failure shall occur.

4.9 Shock — Detector numbered 6 shall be subjected to shock as in IS : 2175-1977*. Detector shall not initiate a fire and fault signal as a result of shock and its r.t.v. measured after the test according to Appendix B and the r.t.v. measured as in **4.2** shall not differ by factor greater than 1·6.

4.10 High Temperature — Detector numbered 2 shall be mounted in the tunnel in its normal operating conditions with its normal fastening. The temperature of air flow in the tunnel shall be raised to 55 ± 1°C at a rate not exceeding 1°C/min. The maximum level of the temperature shall be maintained for 3 h, and then r.t.v. shall be measured according to Appendix B. Detector shall not initiate fire or fault signal during the test and the r.t.v. measured at elevated temperature shall not differ by a factor greater than 1·6 from $\overline{M}_2$ (*see* **4.4**).

4.11 Low Temperature — Detector numbered 14 shall be put inside a suitable chamber/enclosure and connected to its control and indicating equipment. The air temperature in the chamber shall then be reduced to a minimum of 0 ± 1°C at a rate not exceeding 1°C per/min. The detector shall be kept in the condition of minimum temperature for 1 h to allow its temperature to stabilize. Care shall be taken against formation of any condensation or mist on the detector. After 3 h stabilization, detector shall be taken out and kept at room conditions for 5 to 6 h. Following the conditioning its r.t.v. shall be measured in accordance with Appendix B. During exposure to depressed temperature

*Specification for heat sensitive fire detectors for use in automatic electrical fire alarm system (*first revision*).

detector shall not release fire or fault alarm and the r.t.v. measured following the test shall not differ by a factor greater than 1·6 (*see* **4.4**).

4.12 Humidity — Detector numbered 7 shall be kept inside a suitable humidity/climatic chamber and connected to its control and indicating equipment. Following climatic conditions shall be created inside the test chamber:

Temperature	= 30 ± 2°C
RH	= 85 ± 5 percent
Duration of exposure	= 7 days

Care shall be taken against formation of mist and condensation on the detector. Detector shall be transferred to the tunnel within 1 h of removal from the chamber and its r.t.v. measured according to Appendix B. The r.t.v. measured after the exposure and r.t.v. of the detector in **4.2** shall not differ by a factor greater than 1·6 and no fire or fault signal shall be released.

4.13 Air Movement — The r.t.v. of detector numbered 14 shall be determined according to Appendix B increasing the air flow in the tunnel to velocity of 1 ± 0·2 m/s using the least and most favourable orientations of the detectors. To investigate operation of the detector under air breeze, the tunnel mounted detector shall be subjected to an aerosol free air flow at a velocity of 5 ± 0·5 m/s and then to a gust lasting 2s at a velocity of 8 ± 0·8 m/s. Neither of the r.t.v. measured at air velocity of 1 m/s shall not differ by a factor greater than 1·6 from $\overline{M}_4$ and no fire or fault signal shall be emitted (*see* **4.4**).

4.14 Corrosion — Detector numbered 8 shall be mounted unenergized with its normal fastening in the apparatus described in IS : 2175-1977* and left for 24 h in the corrosive atmosphere produced following the procedure and conditions described therein. It shall then be taken out and conditioned for 7 days in a climate given below and its r.t.v. measured according to Appendix B.

Temperature	= 25 × 3°C
RH	= 60 ± 5 percent

The r.t.v. measured after corrosion and r.t.v. of the detector measured in **4.2** shall not differ by a factor greater than 1·6.

*Specification for heat sensitive fire detectors for use in automatic electrical fire alarm system (*first revision*).

4.15 Ambient Light — Detector numbered 9 shall be subjected to 20 cycles of light intensity produced by a 150 watt incandescent lamp placed at a distance of 0·5 metres. Each cycle shall consist of 10 s 'on' and 5 s 'off' conditions. On completion of cycles illumination shall remain directed on to the detector for 10 min. The detector then shall be placed in direct sunlight for 10 min. The r.t.v. shall be measured. The r.t.v. of the detector measured following the test according to Appendix B shall not differ by a factor greater than 1·6 from $\overline{M}_9$ and no fire fault signal shall be emitted (*see* **4.4**).

4.16 Transient — Detector numbered 10 shall be energized and kept in its normal operating condition in a room free of smoke and air draughts and shall be subjected to:

a) 500 power supply interruptions each of approximately 1s duration at a rate not exceeding 6 cpm.

b) the following transients generated at a distance of about 0·30 m from the mains power point of the detector:

   1) transient by a transformer of 230 V 50 Hz input and about 8 kV, 20 mA, 50 Hz output terminating into two approximately 0·38 m long and 2·1 mm^2 solid copper conductors held rigidly in vertical position and formed in a taper starting with a 3 mm separation at the bottom (adjacent to transformer output) and extending to 30 mm at the top.

   2) transient by energization of an electrical drill rated 230 V, 50 Hz, approx 1 A.

   3) transient by energization of a soldering gun rated 230 V, 0·3 A, 50 Hz.

   4) transient by energization of an electric bell rated 230 V, 50 Hz.

Detector shall not raise false alarm and its intended operation shall not be impaired.

4.17 Dust — Detector numbered 11 shall be mounted using a metal support for its normal fastening in a chamber of internal volume of at least 0·09 m^3 and the chamber shall be closed. Sixty gram of cement dust (*see* IS : 269-1976*) maintained at 20-50 percent RH shall be circulated inside the chamber for 15 minutes by means of compressed air or blower producing an air flow of velocity 0·25 m/s. The detector shall be removed and energized.

*Specification for ordinary and low heat Portland cement (*third revision*).

Detector may raise a fire or fault signal. If not, the detector shall be mounted in the tunnel and its r.t.v. measured as in Appendix B. If r.t.v. is found to have been increased, the increase shall not be greater than a factor of 1·6 from its r.t.v. measured under **4.2**. The r.t.v. may reduce to any limit.

4.18 Fire Test — Detectors numbered 1, 2, 14 and 15 shall be subjected to four test fires specified in **4.18.1** to **4.18.4**, each fire being lit once in the centre of the floor of the test room described in **4.18.1**. The detectors and the optical density (OD) meter (*see* Appendix E) shall be positioned on the ceiling of the room as in **4.18.1**. A clearance of 4 m shall be maintained between base/bottom of the combustible and the ceiling. Before starting a test fire, the room shall be cleared of smoke. Detectors and OD meter shall be energized and kept in their normal operating conditions. Time shall be counted from the moment of ignition of a test fire and build up of optical density shall be recorded every 20 s until optical density crosses the value 2·0 dB/m or its maximum is attained for sufficient time. From this data the temporal mean value of optical density shall be calculated over an interval of 60 s. The temporal mean values of OD shall be plotted against time and the plot shall be referred to as 'profile curve' of the test fire.

4.18.1 *Test Room* — The test room shall have following dimensions:

Lenth (*L*)	7 m *Min*, 11 m *Max*
Width (*W*)	7 m *Min*, 8 m *Max*
Ceiling height (*H*)	4 m *Min*, 4·8 m *Max*

Ceiling shall be flat and smooth with no physical obstruction. All openings in the room (doors, windows, ventilators, smoke extractors, etc) shall be kept closed during test to make it free from draughts. Detectors and OD meter shall be mounted using their normal fixings, on the ceiling of the room at a distance of 3 m from the ceiling centre (CC). The angle between longitudinal axis of the ceiling and the line joining the detector to CC shall not exceed 30°. OD meter shall be mounted on the longitudinal axis of the ceiling at a distance of 3 m from CC (*see* Fig. 1).

4.18.2 *Fast Burning Wood Fire* — Fiftyfour sticks made of commonly used teak wood and size specified below shall be stacked in the form of a rectangular crib shown in Fig. 2. The specifications of sticks and crib shall be:

Stick size	20 × 20 × 250 mm
Conditioning	Sticks shall be conditioned for 72 h in an air circulating oven at 50°C
Spacing between sticks	26 mm

Number of sticks per layer	6
Number of layers	9
Water content	Not exceeding 15 percent
Ignition	10 ml of methyl alchol in 40 mm diameter dish at the centre of the base of the crib. The two middle sticks of the bottom layer shall be omitted to allow the insertion of the dish.

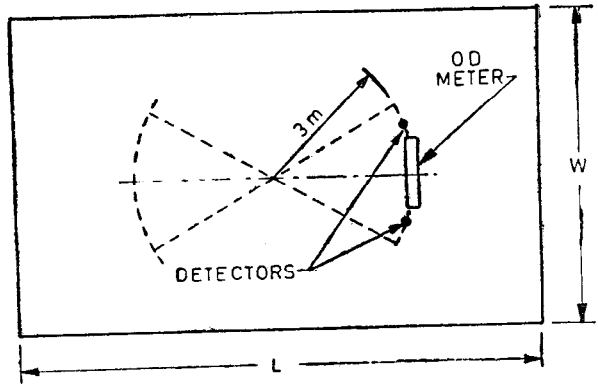

FIG. 1 POSITION OF DETECTORS AND OD METER

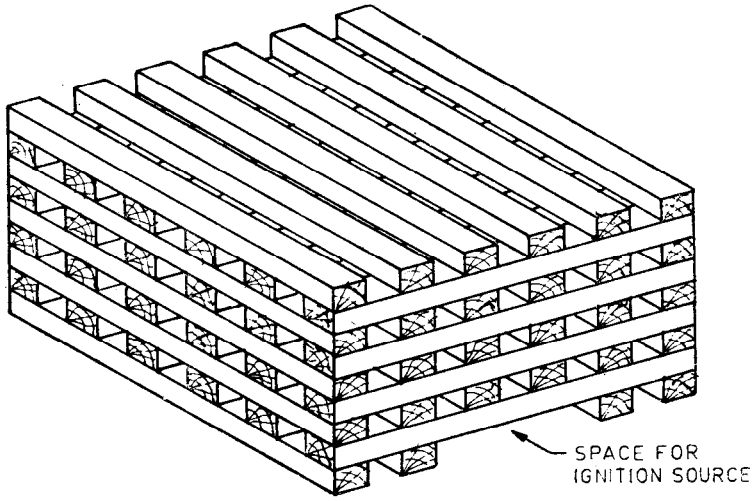

FIG. 2 CRIB

Let T' be the point on the time axis of the profile curve of the test fire at which optical density is 0·80 dB/m and above which it is greater than or equal to this value. A line drawn parallel to time axis and at point where OD is equal to 0·80 dB/m shall help locate T. Let T_1 be the time of a detector's operation. Then T_1 shall be less than T + 20 s for each detector.

4.18.3 *Burning Plastic Fire* — Three mats of soft polyurethane foam having a density of 20 kg/m^3 approximately shall be placed on a flat aluminium foil whose edges are folded up. The mats shall not contain any fire inhibitant. The dimensions of each mat shall be 0·5 × 0·4 × 20 m and shall be placed one over the other to form a pile. The pile shall be ignited by a small fire at one corner.

Let T' be the point on the time axis of the profile curve of the test fire at which optical density is 1·0 dB/m and above which it is greater than or equal to this value. A line drawn parallel to time axis and at point where OD is equal to 1·0 dB/m shall help locate T. Let T_1 be the time of a detector's operation. Then T_1 shall be less than T' + 20 s for each detector.

4.18.4 *Liquid Hydrocarbon Fire* — Fifty millilitres of petroleum spirit/ petrol shall be burnt in a square metal tray having base area of 0·01 m^2 and wall height of 20-30 mm.

Let T' be the point on the time axis of the profile curve of the test fire at which optical density is 1·0 dB/m and above which it is greater than or equal to this value. A line drawn parallel to time axis and at point where OD is equal to 1·0 dB/m shall help locate T. Let T_1 be the time of a detector's operation. Then T_1 shall be less than T + 20 s for each detector.

4.18.5 *Slow Burning Wood Fire* — The test fire is described in **4.18.1** except for:

Spacing between sticks	12 mm
Number of sticks per layer	8
Number of layers	11

Let T' be the point on the time axis of the profile curve of the test fire at which optical density is 1·1 dB/m and above which it is greater than or equal to this value. A line drawn parallel to time axis at OD equal to 1·1 dB/m shall help locate T. Let T_1 be the time of a detector's operation. Then T_1 shall be less than T + 20 s for each detector.

5. MARKING

5.1 Each detector shall be marked to indicate its type, power supply requirements (upper and lower limit), date of manufacture, maximum period between two successive services or inspections, name of the manufacturer. Ionization detectors shall be invariably marked for the existence radioactivity inside and its strength and type of source.

5.1.1 The detector may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

6. DATA AND INSTRUCTIONS

6.1 Instructions and technical specification for all accessories required to be connected to the detector and effecting its operation shall be supplied on or with the detector to ensure that the detector operate under correct electrical characteristics, is connected to specified equipment(s) through permissible cables and inter-connections only.

6.2 Wiring diagrams for understanding the installation of detectors showing at least two detectors in connection, and instructions for testing and maintenance shall also be supplied with the detector.

6.3 Procedure to be followed for disposal of an ionization detector shall be invariably stated and supplied with the detector (*see* **0.7**).

6.4 Description of circuit operation under normal alarm and fault conditions and to detectors in dismantled/unassembled form shall be submitted.

6.5 Engineering drawings together with other relevant details of design and material(s) used shall be submitted which define the product.

6.6 Whether during testing, power shall be supplied to the detector for warm up and the period to be observed.

APPENDIX A

(*Clause* 4.0)

TEST SCHEDULE

Tests	*Clause No.*	*Detector Number* (*marked as mentioned in* **4.2**)														
General requirements	3	All Detectors														
Directional dependence	4.1	One detector randomly selected from sample														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Reproducibility and optimal sensitivity	4.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Stability	4.3			x												
Repeatability	4.4		x (M2)												x (M14)	
Endurance	4.5				x								x	x		
Supply voltage variation	4.6		x													
Insulation resistance	4.7									x						
Vibration	4.8					x										
Shock	4.9						x									
High temperature	4.10		x													
Low temperature	4.11															x
Humidity	4.12							x								
Air movement	4.13															x
Corrosion	4.14									x						
Ambient light	4.15										x					
Transients	4.16											x				
Dust	4.17												x			
Full scale fires	4.18		x		x										x	x

APPENDIX B

(*Clauses* 4.1 *to* 4.17)

RESPONSE THRESHOLD VALUE (r.t.v.)

B-1. The response threshold value (r.t.v.) shall be measured in a wind tunnel specified in Fig. 6 of IS : 9972-1981*. The air velocity in the tunnel shall be 0·2 ± ·05 m/s and air temperature shall be 25 ± 5°C unless otherwise required in specific tests. The detector shall be mounted on the top horizontal section of the tunnel using its normal fastening. Unless otherwise specified in the test the detector shall be mounted in its least favourable orientation with respect to air flow as determined by directional dependence test specified in **4.1**. Prior to every measurement of r.t.v. the tunnel and the detector shall be clear of aerosols. The detector shall be powered by connecting it to its control and indicating equipment or equivalent source of supply. A warm up period if specified, shall be observed before starting measurement(s). The smoke shall be generated as specified in **B-2**. At the moment the detector initiate alarm, density of smoke shall be measured using smoke measuring instrument specified in Appendix C and recorded as the r.t.v. of the detector. The optical density meter shall be kept close to the detector.

B-2. A circular hot plate or equal electric heating arrangement shall be provided in the heating section of the tunnel and circular filter papers (one over the other) such as Whatman No. 2 or similar ones weighing between 80 to 110 g per m^2 shall be placed on the plate. The diameter of the bundle of the papers shall not exceed the diameter of the plate. Smoke shall be generated by initiating and sustaining smouldering of the papers. The amount of the papers used and the temperature of the heater shall be adjusted so that smoke is generated by smouldering/ charring of papers at a slow pace. Optical density (absorbance index) of smoke shall increase at a rate not exceeding 0·2 dB/m per minute to a maximum value of at least 1·5 dB/m when measured according to method given in Appendix D using readings of the optical density meter. All measurements of r.t.v. shall be completed by one type of filter paper. No parameter/specification of the paper (its type, thickness, weight, etc) shall be altered during tests. Rate of increase of optical density of smoke, once selected initially, shall not vary significantly during tests.

*Specification for automatic sprinkler heads.

APPENDIX C

(*Clause* B-1)

SMOKE MEASURING INSTRUMENT

C-1. A smoke measuring instrument employed shall be stable with time and with changes of environmental conditions which might occur between two measurements It shall give a reading that is directly proportional to smoke concentration. This reading may be obtained directly or by mathematical manipulation of the meter's output. For testing of detectors based on 'light obscuration' principle the meter is described in Appendix E. The ionization detector shall be tested employing ionization chamber as the smoke measuring device provided conditions of linearity and stability are met. Similarly a scatering type smoke detector shall be tested using a 'scatering chamber' as the smoke measuring device provided the condition of linearity and stability are met, when no ionization chamber or smoke scatering chamber are available for testing these two type of detectors, the meter described in Appendix E shall be employed.

APPENDIX D

(*Clause* B-2)

OPTICAL DENSITY OF SMOKE

D-1. The meter detailed in Appendix E shall be employed for the measurement of the optical density. The optical density of smoke is defined as:

$$\text{OD (in dB/m)} = 10/l \log_{10} I_0/I_e$$

where

l = the length of the light path affected by the smoke, m;

I_e = light intensity seen/measured by the sensor with smoke; and

I_0 = the light seen/measured by the sensor without smoke.

APPENDIX E

(*Clauses* C-1 *and* D-1)

OPTICAL DENSITY METER

E-1. The schematic diagram of the optical density meter is given in Fig. 3. It shall essentially consist of a light source (lamp) to give a uniform and constant beam of light and a light sensor placed at some distance from the source in the line of the beam to receive light output from the source. To obtain light, beam of uniform density lamp is used in conjunction with collimating lenses L_1 and L_2. Collimating lenses L_3 and L_4 shall be used with sensor. The distance between L_2 and L_3 shall not exceed 1·1 m. The aperture of the diaphragms D_1 and D_2 and the focal lengths of L_2 and L_3 shall be such that light scattered by more than 5° from its original path shall not be received by the sensor.

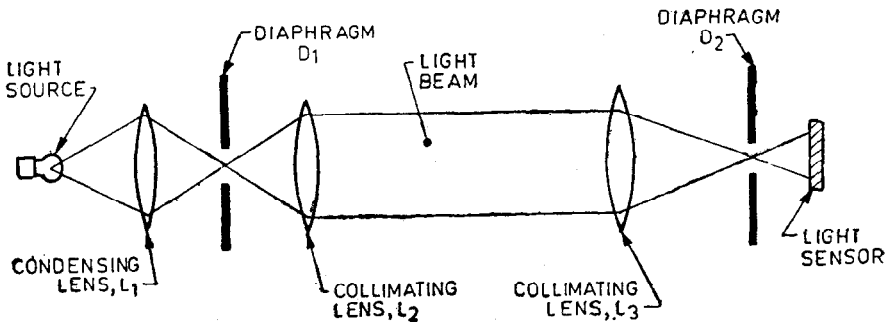

FIG. 3 SCHEMATIC DIAGRAM OF OPTICAL DENSITY METER

E-2. LIGHT SENSOR

E-2.1 A photovoltaic (*selenium* barrier layer type) cell of approximately 25 mm diameter active area shall be used as the sensor. The spectoral response of the photocell shall be as closed as possible to the response of human eye. Its range shall be at least from 350 nanometre to at least 660 nanometre with a peak between 530 and 580 nanometre.

E-3. LIGHT SOURCE

E-3.1 A tungsten filament automotive (or auto) lamp shall be used as a light source and shall be energized from a constant voltage and constant current source. The operating voltage selected shall be approximately half of its rated voltage to get a light beam of uniform intensity.

Photocell shall give an output that is directly proportional to smoke concentration.

(*Continued from page* 2)

Code of Practice for Fire Fighting Equipments and Fire Alarm System Subcommittee, BDC 22 : 4

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2