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(पाँचवां पुनरीक्षण)

Selection, Installation and Maintenance of Automatic Fire Detection and Alarm System — Code of Practice

(Fifth Revision)

ICS 13.220.20

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FOREWORD

This Indian Standard (Fifth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Fire Fighting Sectional Committee had been approved by the Civil Engineering Division Council.

The purpose of a fire detection and alarm system is to detect fire at the earliest practicable moment and to give an alarm so that appropriate action can be taken (for example, evacuation of occupants, summoning the fire fighting organization, triggering of extinguishing processes, etc). An alarm system may be activated by automatic detection devices or by manual operation of manual call points.

This standard was first published in 1962 and revised in 1976, 1988, 1999 and 2008. The last revision included modifications with regard to terminology, inclusion of probe type high temperature bi-metal heat detector, optical smoke detector, spark/ember detector, UV flame detector, IR flame detector, etc, and figures for arrangement for smoke detectors and addressable fire detection and alarm systems.

The general principles given below are a guide to design and construct of fire detection and alarm systems. A fire detection and alarm system should:

a) detect quickly enough to fulfil its intended functions;

b) reliably transmit the detection signal;

c) translate this signal into a clear alarm indication that will attract the attention of the user in an immediate and unmistakable way and indicates the location of fire and initiates operation of ancillary service, such as fire extinguishing system;

d) remain insensitive to phenomena other than those where its function is to detect; and

e) signal immediately and clearly and supervise fault that might jeopardize the correct performance of the system.

A fire detection and alarm system should be reliable and not be liable to disturbance by any other systems whether associated with it or not, should not be rendered inoperative partially or totally by the fire or the phenomenon which it is designed to detect before the fire has been detected and should be able to fulfil its functions without errors or omissions.

Compliance of components with this standard does not necessarily ensure the compatibility of components with each other. Compatibility should be considered when designing a system. Satisfactory operation of an installed system should be tested after the completion of the installation.

Any fault affecting a part of fire detection and alarm system should not result in cascades of other faults in the system as a whole or should not create indirect hazards inside/outside the system.

Multiplexed fire detection systems can be used provided, the basic operation concepts given in this standard are fulfilled.

Although automatic fire detection alarm devices can be a valuable part of a property's fire protection system, they are not considered a substitute for automatic sprinklers or other automatic extinguishing systems. Automatic detection and proper notification may, however, provide firefighters with enough advance notice (sms, email notification etc) to improve their chances of controlling and extinguishing a fire. Otherwise, it can result in extensive fire, water, and smoke damage. A series of product specification standards as parts of IS/ISO 7240 on various components of fire detection and alarm systems have been formulated, as follows:

Part 2	Control and indicating equipment
Part 3	Audible alarm devices
Part 4	Power supply equipment
Part 5	Point-type heat detectors
Part 6	Carbon monoxide fire detectors using electro-chemical cells
Part 7	Point-type smoke detector using scattered light, transmitted light or ionization
Part 8	Point-type fire detectors using a carbon monoxide sensor in combination with a heat sensor

(*Continued on third cover*)

Indian Standard

SELECTION, INSTALLATION AND MAINTENANCE OF AUTOMATIC FIRE DETECTION AND ALARM SYSTEM — CODE OF PRACTICE

(Fifth Revision)

1 SCOPE

1.1 This standard covers the planning, design, selection, installation and maintenance of fire detection and alarm systems. It is applicable to simple systems with a few manual call points as well as to complex installations comprising addressable control and indicating panels, non-addressable detectors, manual call points, control and indication panels, etc. It covers systems capable of providing signals to initiate, in the event of a fire, the operation of ancillary services, such as fire extinguishing systems and other necessary precautions but it does not cover the ancillary services. It covers fire detection and alarm systems installed in buildings of different types including those installed in industries.

1.2 This standard covers minimum level of protection. Nothing in this standard prevents the installation of systems designed for higher degree of protection, for special risks, etc.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards.

3 TERMINOLOGY

For the purpose of this standard, the following definitions and those given in IS 8757 shall apply:

3.1 Acknowledge — To confirm that a message or signal has been received, such as by the pressing of a button or the selection of a software command.

3.2 Activation Device (Initiating Device) — A device capable of being operated automatically or manually to initiate an alarm such as a detector, a manual (fire alarm) call point or a pressure switch.

3.3 Addressable Device — A fire alarm system component with discrete identification that can have its status individually identified or that is used to individually control other functions.

3.4 Addressable System — A system in which signals from detectors, manual call points, or other devices (both input and output module) are individually identified at the control and indicating equipment. The signal includes health and operating status (power up/activation/fault) of detectors, manual call point and modules.

3.5 Alarm Signal — A signal indicating an emergency condition requiring immediate action, such as a signal indicative of a fire or smoke.

3.6 Alarm Notification Zone — A sub-division of the protected premises, in which the fire alarm notification can be given separately, and independently, of a fire alarm notification in any other alarm zone.

3.7 Alert Tone — An attention-getting signal to alert occupants of a pending transmission of a voice message or a signal used to alert occupants to evacuate an area.

3.8 Annunciator — A unit containing one or more indicator lamps, alphanumeric displays, or other equivalent means like mimic panel and graphical station in which each indication provides status information about a circuit, condition, or location.

3.9 Approved — Acceptable to the authority having jurisdiction.

3.10 Audibility — Property of a sound that allows it to be heard among other sounds in the background.

3.11 Automatic Fire Detection and Alarm System — A fire Alarm system comprising components and sub-systems required for automatically detecting carbon monoxide, smoke, heat or fire, initiating an automatic alarm for fire and initiating other actions as required.

NOTE — The system may also include manual fire alarm call points.

3.12 Automatic Fire Signal — An indication of an alarm of fire or smoke originated by an automatic device, given audibly and/or visibly.

3.13 Authority Having Jurisdiction — The organization, office, or individual responsible for approving design, equipment, materials, an installation or a procedure.

3.14 Ceiling — The upper surface of a space, regardless of height. Areas with a suspended ceiling have two ceilings, one visible from the floor and one above the suspended ceiling.

3.14.1 *Dual Pitched Roof* — also known as a gable roof which is pitched in two different directions from the highest point. Curved or domed ceilings can be considered peaked with the slope figured as the slope of the chord from highest to lowest point. A gable is the generally triangular portion of a wall between the edges of a dual-pitched roof.

3.14.2 *Level* (*Smooth*) *Ceilings* — Ceilings that are level or have a slope of less than or equal to 1 in 8.

3.14.3 *Mono-pitched Roof* — is a single-sloping roof surface, often not attached to another roof surface. Mono-pitched roofs are sometimes called a shed roof or lean-to roof.

3.14.4 *Sloping Ceiling* — A ceiling that has a slope of more than 1 in 8.

3.14.5 *Saw Tooth Type Roof* — A roof comprising a series of mono-pitched roofs with vertical surfaces glazed and facing away from the equator. The sloping surfaces are opaque, shielding the inmates and property inside from direct sunlight. This sort of roof admits natural light into a building and is also known as north-light roof.

3.14.6 *Shapes of Ceilings* — The shapes of ceilings can be classified as sloping or smooth.

3.14.7 *Smooth Ceiling* — A ceiling surface uninterrupted by continuous projections, such as solid joists, beams, or ducts, extending more than 100 mm below the ceiling surface.

3.15 Ceiling Height — The height from the continuous floor of a room to the continuous ceiling of a room or space.

3.16 Circuit — An assembly of fire alarm components supplied from the same control equipment and protected against over current by the same protective device(s) or current limitation arrangements.

3.17 Circuit Interface — A circuit component that interfaces initiating devices or control circuits, or both; notification appliances or circuits, or both; system control out-puts; and other signalling line circuits to a signalling line circuit.

3.18 Circulation Area — An area used mainly as a means of access between a room and an exit from the building or compartment.

3.19 Coded Signal — A signal pulsed in a prescribed code for each round of transmission, which conveys information on the location from which the status-change signal originated.

3.20 Commissioning — A process by which it is determined that the installed system meets the defined requirements.

3.21 Fire Command Centre (FCC) — A room permanently staffed 24 × 7 by qualified and trained fire personnels within or near the premises at risk for the receipt of emergency calls and equipped with means for indicating the situation in each of the protected premises, and the communications needed for transmission of calls for assistance to emergency services. Such centres also connect using two-way communication systems with the fire exit staircases and refuge areas.

3.22 Control Unit — A system component that monitors inputs and controls outputs through various types of circuits.

3.23 Conventional Device — An initiating device or notification appliance that cannot be individually identified or selected for control by the fire alarm system.

3.24 Detection Zone — A sub-division of the protected premises such that the occurrence of smoke or heat or fire within it will be indicated by a fire alarm system separately from an indication of fire in any other sub-division.

3.25 Detector — A device suitable for connection to a circuit that has a sensor that responds to a physical stimulus such as heat or smoke or flame or carbon monoxide.

Various types of detectors are as follows (*see* also Fig. 1):

3.25.1 *Air Sampling and Duct Detectors* — Devices designed to detect smoke by sampling air from the protected area or from within HVAC ducts. Air sampling detectors use a network of piping or tubing to draw air from the monitored area into a central detector housing, where an aspiration fan pulls the air through sampling ports for analysis of combustion or smouldering products. Duct detectors are installed within or adjacent to air ducts and monitor the air moving through the ductwork using sampling tubes or sensing elements to detect smoke and typically initiate control actions such as fan shutdown or damper closure.

3.25.2 *Air Sampling Type Detector* — A detector that consists of a piping or tubing distribution network that runs from the detector to the area(s) to be protected. An aspiration fan in the detector housing draws air from the protected area back to the detector through air sampling ports, piping, or tubing. At the detector, the air is analysed for combustion and smouldering products.

3.25.3 *Line Type Detector* — A detector in which detection is continuous along a path.

3.25.3.1 *Point or Spot Type Detector* — A detector in which the detecting element is concentrated at a particular location.

3.25.3.2 *Duct detector* — The duct probe unit is a detector, which has been designed, for use in situations where the standard smoke, heat and flame types cannot be used. Primarily, it is used for detecting the presence of smoke in extract ventilation ducting systems. The detector operates in a similar way to aspirating detectors.

3.25.4 *Dual IR* (*IR/IR*) *Flame Detector* — This detector compares the threshold signal in two infrared ranges. Often one sensor looks at the 4.4 µm carbon dioxide (CO_2) emission, while the other sensor looks at a reference frequency. Sensing the CO_2 emission is appropriate for hydrocarbon fuels; for non-carbon based fuels, for example, hydrogen, the broadband water bands are sensed.

3.25.5 *Electrical Conductivity Heat Detector* — A line-type or spot-type sensing element in which resistance varies as a function of temperature.

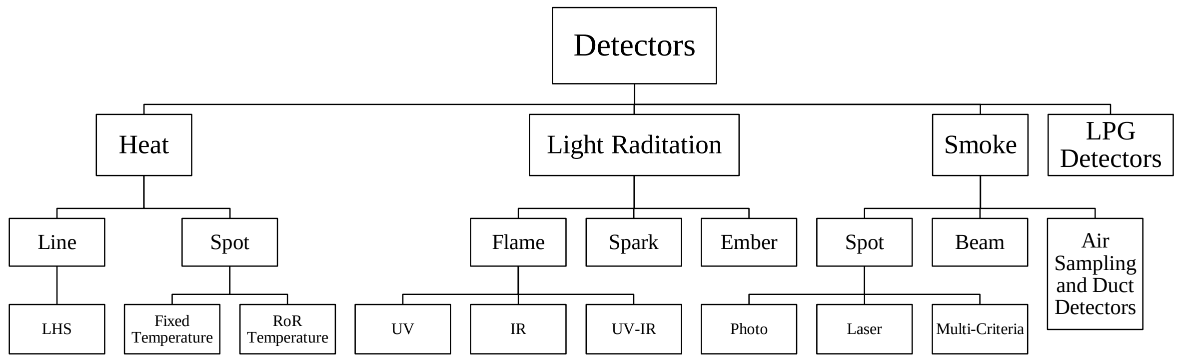
3.25.6 *Fixed Temperature Detector* — A device that responds when its operating element becomes heated to a pre-determined level.

3.25.7 *Flame Detector* — A radiant energy-sensing fire device that detects the radiant energy emitted by a flame.

3.25.8 *Fire Gas Detector* — A detector that detects gases produced by the fire.

3.25.9 *Heat Detector* — A fire device that detects either abnormally high temperature or rate of temperature rise, or both.

3.25.10 *IR Flame Detector* — Infrared (IR) flame detectors monitor the infrared spectral band for specific patterns given off by hot gases. A single-frequency IR flame detector is typically sensitive to wavelengths around 4.4 micrometres, which is a spectral characteristic peak of hot carbon dioxide as is produced in a fire.



LPG — Liquified petroleum gas

LHS — Linear heat sensing

RoR — Rate of rise

UV — Ultraviolet rays

IR — Infra red

FIG. 1 VARIOUS TYPE OF DETECTORS

3.25.11 *IR3 Flame Detector* — Triple-IR flame detectors compare three specific wavelength bands within the IR spectral region and their ratio to each other. In this case one sensor looks at the 4.4 µm range while the other sensors look at reference wavelengths both above and below 4.4 µm. This allows the detector to distinguish between non-flame IR sources and actual flames which emit hot CO_2 in the combustion process. As a result, both detection range and immunity to false alarms can be significantly increased.

3.25.12 *Linear Heat Sensing Cables* (*LHS Cables*) — Linear heat detection cable is a combination of advanced polymer and digital technologies that can detect heat conditions anywhere along the length of the cable.

3.25.13 *Multi-Sensor Detector* — A device that monitors more than one physical and/or chemical phenomenon associated with fire. Typical examples are a combination of a heat and smoke detectors or a combination of heat and gas detectors.

3.25.14 *Photoelectric Light Obscuration Smoke Detector* — The principle of using a light source and a photosensitive sensor onto which the principal portion of the source emissions is focused. When smoke particles enter the light path, some of the light is scattered and some is absorbed, thereby reducing the light reaching the receiving sensor. The light reduction signal is processed and used to convey an alarm condition when it meets preset criteria.

3.25.15 *Photoelectric Light-Scattering Smoke Detector* — The principle of using a light source and a photosensitive sensor arranged so that the rays from the light source do not normally fall onto the photosensitive sensor. When smoke particles enter the light path, some of the light is scattered by reflection and refraction onto the sensor. The light signal is processed and used to convey an alarm condition when it meets preset criteria.

3.25.16 *Projected Beam-Type Detector* — A type of photoelectric light obscuration smoke detector wherein the beam spans the protected area. A device which senses smoke by projecting a light beam from a transmitter/receiver unit across the protected area. These detectors can be further made reflective by installing a reflector that returns the light signal back to the transmitter/receiver unit. Smoke entering the beam path will decrease the light signal causing an alarm.

3.25.17 *Rate-of-Rise Detector* — A device that responds when the temperature rises at a rate exceeding a predetermined value.

3.25.18 *Rate Compensation Detector* — A detector that responds when the temperature of the air surrounding the detector reaches a pre-determined level, regardless of the temperature rise.

3.25.19 *Smoke Detector* — A device that detects visible or invisible particles of combustion.

3.25.20 *Spark/Ember Detector* — A radiant energy-sensing fire device that is designed to detect sparks or embers, or both. These devices are normally intended to operate in dark environments and in the infrared part of the spectrum.

3.25.21 *UV Flame Detector* — A UV flame detector makes use of ultraviolet sensitive photocathode for detecting flame. It has a narrow spectral sensitivity of 185 nm to 260 nm, which is insensitive to visible light.

3.25.22 *UV/IR Flame Detector* — Detector sensitive to both UV and IR wavelengths, and detect flame by comparing the threshold signal of both ranges. This helps minimize false alarms.

3.25.23 *Carbon Monoxide Detector* — A detector which senses concentration levels of CO to warn of the presence of fire.

3.25.24 *LPG/CNG/PNG Gas Leak Detectors* — A Detector which senses leaked flammable LPG/CNG/PNG from cylinders/pipelines deployed in kitchens to warn of a possible explosion.

3.26 Display — The visual representation of output data, other than printed copy.

3.27 Ember — A particle of solid material that emits radiant energy due to either to its temperature or the process of combustion on its surface.

3.28 Emergency Voice/Alarm Communications — Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as alert and evacuation signals pertaining to a fire (and also life safety) emergency, to the occupants of a building.

3.29 End-of-line Device — A device installed at the end of a circuit for the purpose of providing resistance or capacitance back to the fire alarm control unit to monitor fault conditions.

3.30 Evacuation — The withdrawal of occupants from a building.

3.31 Evacuation Plan — A part of an emergency management plan dealing with the safe and orderly evacuation of building occupants.

3.32 Evacuation Signal — A distinctive signal intended to be recognized by the occupants as requiring evacuation of the building.

3.33 Exit Plan (or Fire Exit Plan) — A plan for the emergency evacuation from the premises.

3.34 False Alarm — An alarm of fire or smoke that is, false, because the fire reported does not and did not exist. This false alarm may arise by malicious, mistaken or accidental intent.

3.35 Fault Signal — A distinctive audible and visual signal indicating an occurrence of a fault within the system (for example, a break in an electric circuit, short circuit or fault in a power supply).

3.36 Field Wiring — Conductors that are installed to connect a product to source(s) of supply, devices, other products, and loads; which also has an enabling system to identify if the wiring is open or short.

3.37 Fire Alarm Control and Indicating Equipment — Equipment through which fire detectors may be supplied with power and/or communications (recorded/voice messages) and typically perform the following:

a) Used to accept a detection signal and actuate a fire alarm signal;

b) Able to pass on the fire detection signal, through the fire alarm routing equipment, to the firefighting organization or to automatic extinguishers;

c) Used to supervise the system by monitoring the correct functioning of the system including — circuit integrity, detectors and notification appliances; and

d) Used to provide power to all fire alarm detection and notification system equipment, charge batteries and maintain uninterrupted operation irrespective of a.c. power outage for at least 24 h of normal operation.

3.38 Fire Alarm Signal — A signal initiated by a fire alarm-initiating device such as a manual call point, automatic fire detector, water flow switch, or other device in which activation is indicative of the presence of a fire or fire signature.

3.39 Fire Alarm System — A combination of components for giving an audible and visible and/or other perceptible alarm of fire. The system may also initiate other ancillary action.

3.40 Floor — Area contained on each storey of the building.

3.41 Fire Rating — The classification of indicating in time (hours) the ability of a structure or component to withstand a standardized fire test. This classification does not necessarily reflect performance of rated components in an actual fire.

3.42 Fire Safety Functions — Building and fire control functions that are intended to increase the level of life safety for occupants or to control the spread of the harmful effects of fire.

3.43 Flame — Rapid, self-sustaining and subsonic propagation of combustion in a gaseous medium, usually with emission of light. A body or stream of gaseous material involved in the combustion process and emitting radiant energy at specific wavelength bands determined by the combustion chemistry of the fuel. In most cases, some portion of the emitted radiant energy is visible to the human eye.

3.44 Flame Detector Sensitivity — The distance along the optical axis of the detector at which the detector can detect a fire of specified size and fuel within a given time frame.

3.45 Ground Fault — Circuit impedance to ground sufficient to result in the annunciation of a trouble condition.

3.46 Maintenance — Repair service, including periodic inspections and tests, required to keep the fire alarm system and its component parts in an operative condition at all times, and the replacement of the system or its components when they become undependable or inoperable for any reason.

3.47 Mass Notification System — A system used to provide information and instructions to people, in a building, area site, or other space.

3.48 Manual Call Point — A manually operated device used to initiate an alarm signal. It can be manual alarm system or part of automatic alarm system.

3.49 Mimic Panel — A panel in which the floor/area plans of the premises are projected to reduced scale to enable easy identification of the sector/on fire zone.

3.50 Networked System — Fire alarm systems in which several control and indicating equipment units are interconnected and are able to exchange information are suitably monitored and controlled with communication path redundancy (such as peer to peer connection).

3.51 Non-resettable Detector with Exchangeable Elements — A fire detector which after response requires the renewal of a component or components to restore it to its normal state of readiness to detect.

3.52 Non-resettable Detector without Exchangeable Elements — A fire detector which after response cannot be restored from its alarm state to its normal state of readiness to detect, and must be replaced.

3.53 Notification Appliance — Any audible, tactile, or visual signal or any combination thereof employed to indicate a fire, supervisory, or trouble condition.

3.54 Notification Appliance Circuit — A circuit or path directly connected to a notification appliance and monitored by fire alarm panel.

3.55 Notification Zone — An area covered by notification appliances that are activated simultaneously.

3.56 Online Health Monitoring of Equipment — IoT technologies which monitor health of fire safety systems and fire protection equipment from cloud services (web access or mobile application), providing online access to the data anywhere ensuring corrective action when required.

3.57 Power Supply — A part of the fire alarm control panel or sub-panel to source of electrical operating power, including the circuits and terminals connecting it to the dependent system components.

3.58 Protected Premises — The physical location protected by a fire alarm system.

3.59 Public Address System — An electronic amplification system with a mixer, amplifier, and loudspeakers, used to reinforce a given sound and distributing the 'sound' to the general public in and around a building.

3.60 Reset — A control function that attempts to return a system or device to its normal non-alarm state.

3.61 Resettable Detector — A fire detector which after response and on cessation of the conditions that caused the response, may be restored from its alarm state to its normal state of readiness to detect, without the renewal of any component.

3.62 Search Distance — The distance which has to be travelled by a searcher within a zone in order to determine visually the position of fire.

3.63 Sector — A subdivision of the protected premises larger than a zone. A larger floor may be demarcated into sectors that is addressed part of the floor. A sector will normally contain many zones.

3.64 Short Circuit Isolators — Devices which may be connected into a transmission path of a fire detection and fire alarm system, to limit the consequences of low parallel resistance faults between the lines of this transmission path.

3.65 Signal — A signal that results from the manual or automatic detection of an alarm condition.

3.66 Signalling Line Circuit — A circuit or path between any combination of circuit interfaces, control units, or transmitters over which multiple-system input signals or output signals, or both, are carried.

3.67 Signalling Line Circuit Interface — A system component that connects a signalling line circuit to any combination of initiating devices, initiating device circuits, notification appliances, notification appliance circuits, system control outputs, and other signalling line circuits.

3.68 Smoke — Visible suspension in atmosphere of solid and/or liquid particles resulting from combustion or pyrolysis.

3.69 Spacing — A horizontally measured dimension related to the allowable coverage of fire detectors.

3.70 Spark — A moving particle of solid material that emits radiant energy due to either to its temperature or the process of combustion on its surface.

3.71 Spark/Ember Detector Sensitivity — The number of watts (or the fraction of a watt) of radiant power from a point source radiator, applied as a unit step signal at the wavelength of maximum detector sensitivity, necessary to produce an alarm signal from the detector within the specified response time.

3.72 Standby Supply — A power supply, commonly from a rechargeable battery, which is automatically connected to the fire alarm system when the normal power supplied to the system fails.

3.73 Stratification — The phenomenon where the upward movement of smoke and gases ceases due to the loss of buoyancy.

3.74 Supervising Station — A facility that receives signals and at which personnel are in attendance at all times to respond to these signals.

3.75 Supervisory Signal — A signal indicating the need of action in connection with the supervision of watchmen, sprinkler and other extinguishing systems or equipment, or with the maintenance features of other protective systems.

3.76 Supplementary Device — A device intended to be connected to a supplementary device circuit.

3.77 Supplementary Device Circuit — A circuit provided by a product for controlling a device, the operation of which is supplementary to the primary initiating and indicating devices of the control unit.

3.78 Trouble Signal — A signal initiated by the fire alarm system or device indicative of a fault in a monitored circuit or component. The trouble signals initiated can be open circuit, ground fault, or short circuit.

3.79 Wavelength — The distance between the peaks of a sinusoidal wave. All radiant energy can be described as a wave having a wavelength. Wavelength serves as the unit of measure for distinguishing between different parts of the spectrum. Wavelengths are measured in microns (µm), nanometre (nm), or angstroms (Å).

3.80 Zone — A defined area within the protected premises. A zone can define an area from which a signal can be received, an area to which a signal can be sent, or an area in which a form of control can be executed.

4 GENERAL REQUIREMENTS

4.1 A fire alarm system normally consists of a control panel linked to a number of components–fire detectors, manual call points, sounders, relay modules, repeater panel (annunciator), etc connected thereto by cables. Various components of fire detection and alarm systems, if provided, shall conform to the respective standard mentioned in Table 1. The equipment and cables of automatic fire detection and alarm system shall be independent of any other system or cables, and shall not be shared with any other system.

Table 1 Components of Fire Detection and Alarm Systems

(*Foreword*, *Clause* 4.1)

Sl No.	Component of Fire Detection and Alarm System	Ref to Part of IS/ISO 7240
(1)	(2)	(3)
i)	Control and indicating equipment	Part 2
ii)	Audible alarm devices	Part 3
iii)	Power supply equipment	Part 4
iv)	Point-type heat detectors	Part 5
v)	Carbon monoxide fire detectors using electro-chemical cells	Part 6
vi)	Point-type smoke detector using scattered light, transmitted light or ionization	Part 7
vii)	Point-type fire detectors using a carbon monoxide sensor in combination with a heat sensor	Part 8
viii)	Point-type flame detectors	Part 10
ix)	Manual call points	Part 11
x)	Line type smoke detectors using a transmitted optical beam	Part 12
xi)	Compatibility assessment of system components	Part 13
xii)	Point type fire detectors using scattered light, transmitted light or ionization sensors in combination with a heat sensor	Part 15
xiii)	Sound system control and indicating equipment	Part 16
xiv)	Short circuit isolators	Part 17
xv)	Input/output devices	Part 18
xvi)	Aspirating smoke detectors	Part 20
xvii)	Routing equipment	Part 21
xviii)	Smoke detection equipment for ducts	Part 22
xix)	Visual alarm devices	Part 23
xx)	Fire alarm loudspeakers	Part 24
xi)	Components using radio transmission paths	Part 25
xii)	Point type fire detectors using a smoke sensor in combination with a carbon monoxide sensor and, optionally, one or more heat sensors.	Part 27
xiii)	Video fire detectors	Part 29
xiv)	Resettable line-type heat detectors	Part 31

4.2 Conventional Fire Alarm System

Conventional fire alarm systems are normally used in small building applications where exact point identification of the device in alarm is not considered necessary. A conventional fire alarm panel is linked to a number of circuits of fire detectors and manual call points, normally called as detection zones, and a number of A.V. notification devices or alarm circuits. The control panel drives detection zones and sounder circuits, provides LCD/LED indications of fire, fault or normal conditions and contains switches to allow the sounders to be activated or silenced and the detectors to reset following an alarm. Size of the conventional panels is normally referred by number of detection zones. Each zone can be connected with conventional detectors not exceeding 20. Conventional fire alarm panel shall comply with IS/ISO 7240 (Part 2) and IS/ISO 7240 (Part 4).

4.3 Addressable Fire Alarm System

Addressable fire alarm systems are used in larger and complex buildings. These systems offer benefits in speed of detection, identification of location of fire. An addressable fire alarm panel is connected to a number of circuits of intelligent detectors, manual call points, monitor and relay modules normally called as signalling line circuit (Loop). The control panel communicates to each device on loop and appropriate signal is initiated based on state of each device and displays detailed information on alarm, fault or normal conditions. All Initiating and notification devices shall be supervised, synchronized, and any disconnection or failure shall cause trouble indication on fire alarm control panel. Addressable fire alarm panel shall comply with IS/ISO 7240 (Part 2) and IS/ISO 7240 (Part 4).

4.4 Detection Zones

4.4.1 *General*

4.4.1.1 In most of the buildings an alarm of fire may initiate a number of different activities, for example, provision of assistance, commencement of firefighting operations and emergency evacuation procedures, summoning of fire brigade, etc. It is essential that these activities are well co-ordinated. In the pre-planning of emergency procedures for a building it is therefore important, for ease of communication and synchronization of effort, to fix a convenient number of easily identifiable sectors/zones, which the building can be divided.

4.4.1.2 In order to direct those responding to a fire alarm signal to the area of fire, all buildings need to be divided into compartments. The zones need to be small enough for a fire to be located quickly. Even if the system is addressable, zoning indications needs to be provided as this often provides a quicker indication of the location of a fire than typical addressable text displays. Zone indicators also provide a simple 'at a glance' overview of the extent of fire or smoke spread. Also this would enable fire fighters who are not familiar with the building to proceed to the location of fire.

4.4.1.3 For Large Infrastructure, especially residential, the public address system should be operated in conjunction with the fire alarm system. Like fire alarm system, the public address system is also divided into zones to enable the fire fighter to talk to any particular floor/area/zone and listen to messages of people from that floor. It also facilitates making announcement in the whole building. In some cases, different evacuation messages are sent to different floors by advance public address systems. However, while designing such systems, it is recommended that there is seamless automatic interface between the fire detection system and the public address system and the nomenclature followed for zoning for both these systems are simple, same and equivalent to avoid any confusion and facilitate ease of operation. Another important aspect while interfacing fire alarm and public announcement zones is to make sure that during usage of public address system in a particular zone, the fire alarm hooter of that particular zone should automatically go off failing which public address/evacuation procedures cannot be implemented effectively.

4.4.2 Requirements for detection zones that contain non-addressable automatic detection system:

a) The floor area of a single zone shall not exceed 2 000 m^2 for conventional system and the floor area of a single zone shall not exceed 3 000 m^2 for addressable system;

b) If the total area of a building is less than 300 m^2, a zone can cover more than one floor;

c) Voids if any above or below the floor area of a room can be included in the same zone as of the room provided that the voids and the room constitute a single compartment.

d) The search distance that is the distance that has to be travelled by anyone responding to a fire alarm signal after entry to the zone in order for the location of the fire to be determined visually, shall not exceed 30 m. The distance should be a direct line, without any deviations like an 'L' shape;

e) Automatic fire detectors within any enclosed stairwell lift well or other enclosed shaft-like structures shall be considered as a separate zone to place detector at the top of shaft;

f) If manual call points are located on the landings of an enclosed staircase, such points at each level shall be incorporated within the zone that serves the adjacent accommodation on that level;

g) The detectors and manual call points within sectors/zones shall be wired to the control and indicating equipment;

h) The entire electrical installation pertaining to the entire fire alarm system as described above shall be independent of other systems;

j) When a signal of fire is given it is necessary that there shall be no confusion about the zone from which it is received;

k) To facilitate response by persons providing assistance, the zone shall be small enough for a fire to be located quickly;

m) It is advisable to provide adequate fire separation between the zones;

n) In the case of two stage alarms, clear and unambiguous signals shall indicate the emergency procedure to be adopted throughout each zone;

p) If the requirement of detectors or call points is less than 20 in any area, the division of the area into zones is not necessary. Similarly, partitioning is not necessary if the number of zones is not more than 4;

q) For larger systems covering more than one building it may be necessary to create sectors in addition to zones in order to restrict the number of zones from which alarms originate simultaneously or in succession;

r) It is not always possible to provide definite guidelines regarding the requirements for the division of sectors, etc, as stated above due to the fact that the configurations are not the same for all risks. The division into zones and/or sectors shall be decided based on careful consideration on the type of risk and accessibility of zones in respect of main circulation routes and the main control and indicating equipment;

s) In general, the signals used in different zones in the same premises shall be the same unless the background noise in one or more zones is such as to require different sounders;

t) The zoning arrangement for systems in multiple occupations shall take into account the fact that the premises may not all be occupied at the same time. No zone shall include areas in more than one occupancy;

u) Remote indicator lamps outside doors of rooms, cabins, etc within a zone may be useful, if doors are likely to be locked. Making an area easier to search, the use of remote indicator lamps reduce the need for a large number of smaller zones;

w) Where a special risk is present within a large protected area, that is a spray painting booth in engineering workshop and it is considered important to obtain rapid identification of fire in that risk, such special risk shall be deemed as a separate zone;

y) Where a zone extends beyond a single compartment, the zone boundaries shall be the boundaries of the fire compartments; and

NOTES

1 It is permissible to have two complete fire compartments in one zone, or two complete zones in one fire compartment.

2 It is not permissible to have a zone, which extends into parts of two compartments, or a compartment, which extends into parts of two zones.

z) If the arrangement of an area is complex and time is likely to be wasted in search for the fire, notwithstanding any limits shown above, the area shall be further sub-divided into zones that are easier to search.

4.4.3 *Size and Number of Zones* (*Protected Only with Manual Call Points*)

a) In systems containing only manual call points, location of a fire is usually known to the person operating the call point. As it is often difficult to get information in time to the safety personnel, the restriction on the size and number of zones shall also apply to the systems protected with manual call points only; and

b) To prevent misleading indication of the position of the fire, it is advisable that manual call points be indicated in the control equipment separately from the detectors in zones, which are protected, by both detectors and manual call points. It is strongly recommended that the circuits for the detectors and the call points shall be different in case of conventional detection systems.

4.4.4 *Additional Requirements for Detection Zones that contain Addressable Automatic Detection System*

4.4.4.1 Addressable fire alarm systems are used in larger and complex buildings. These systems offer benefits in speed of detection, identification of location of fire. An addressable fire alarm panel is connected to a number of circuits of intelligent detectors, manual call points, monitor and relay modules normally called as signalling line circuit (loop).

4.4.4.2 The control panel communicates to each device on loop and appropriate signal is initiated based on state of each device and displays detailed information on alarm, fault or normal conditions. Size of the addressable panel is normally referred by number of signalling line circuits. Additional requirements are as follows:

a) The circuit loop shall be of class A wiring. Class A wiring by definition has a return loop. T-tapping may be used from the loop as class B wiring. (*see* Fig. 2A, Fig. 2B, Fig. 2C and Fig. 2D);

b) Number of addressable detectors and devices per loop shall be as per manufacturer recommendation. The number of detectors per loop shall consider addition of sensors after performance based review and not exceeding 80 percent of the full capacity of the system. Based on the manufacturer's design some devices need external power (which shall be backed up as a critical load), while other devices are supported by loop power;

c) An isolator prevents entire communication loop from being disabled when a short circuit occurs. This is accomplished by isolating that part of the loop containing the short from the remainder of the circuit. It is necessary to provide a pair of fault isolators for every 20 detectors in the loop (OR) area protected by devices between any two isolators is no greater than 2 000 m^2 and these devices are in the same floor level. When an isolator is connected before and after a device it provides fault protection to all other devices on the loop;

d) Two fault isolators in a fully addressable system shall not remove protection for the number of detectors as per the capacity of the manufacturer and in other words, maximum area of coverage for a single loop shall not exceed 10 000 m^2. The maximum number of detectors shall not be installed to exceed 80 percent of the manufacturer's capacity; and

e) All trouble signals shall be reported at the control panel within 10 s of their occurrence.

4.5 Notification Appliances

4.5.1 The sounders for fire alarm shall be electronic hooters or horns or electric bells having a frequency range of 500 Hz to 3 000 Hz sweep. The sound of the fire alarm shall be continuous although the frequency and amplitude may vary. If a two tone alarm is used, at least one of the major frequencies shall be within the frequency range of 500 to 1 000 Hz. The distribution of fire alarm sounders shall be such that the alarm is heard in all occupiable areas. Sleeping area shall have a 520 Hz square wave for awakening. The audible notification appliances shall comply with IS/ISO 7240 (Part 3).

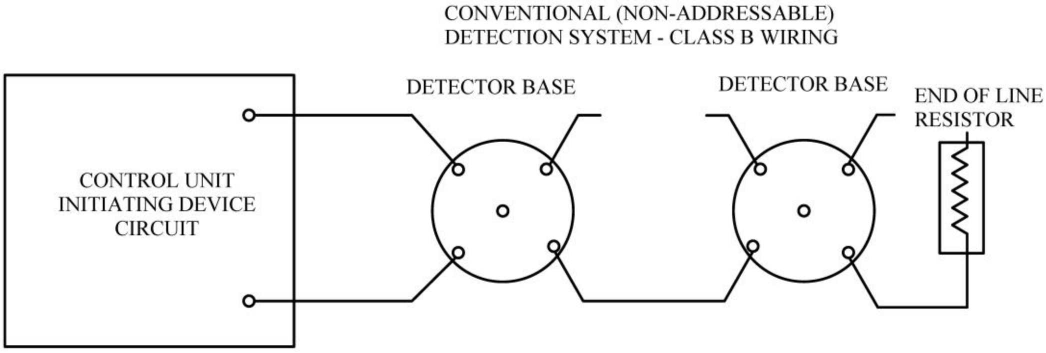


FIG. 2A CORRECT WIRING METHOD — TWO-WIRE DETECTORS

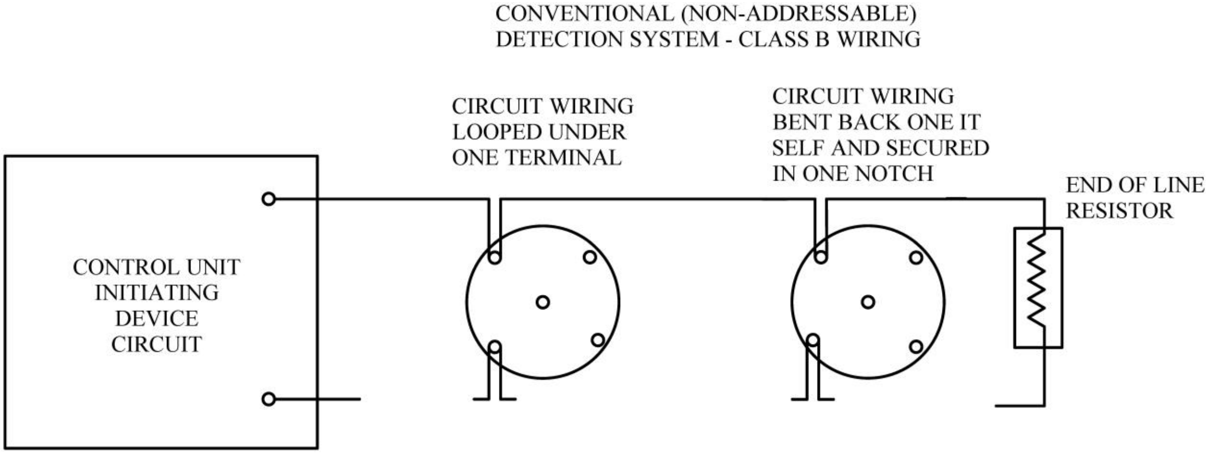


FIG. 2B INCORRECT WIRING METHOD — TWO-WIRE DETECTORS

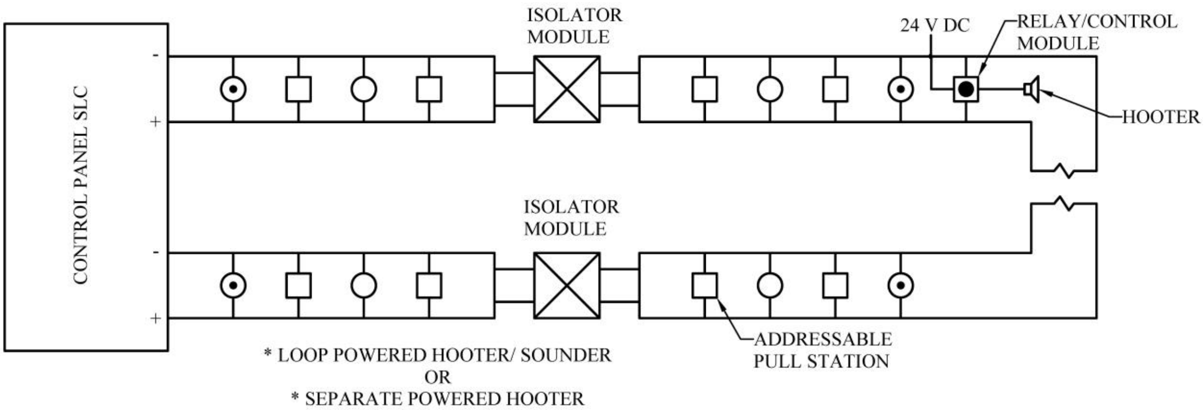


FIG. 2C ADDRESSABLE FIRE DETECTION AND ALARM SYSTEM — CLASS A WIRING

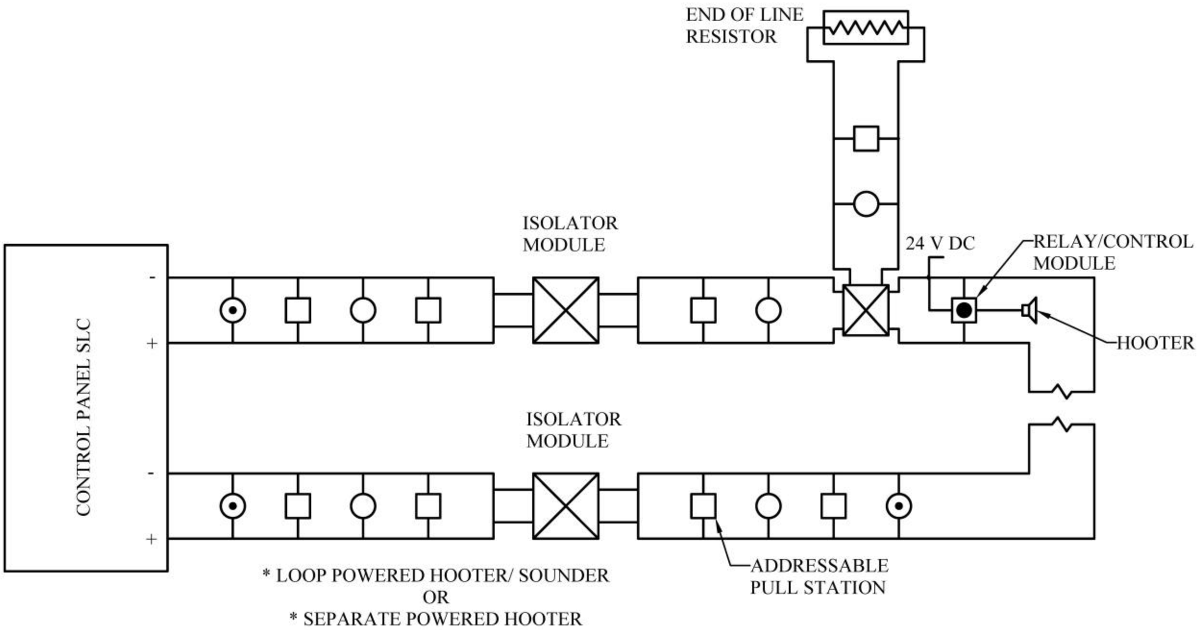


FIG. 2D ADDRESSABLE FIRE DETECTION AND ALARM SYSTEM — CLASS A WITING WITH CLASS TAPPING

FIG. 2 WIRING DETAILS FOR FIRE DETECTION AND ALARM SYSTEM

4.5.2 A minimum sound level of 5 dB (A) above the maximum ambient sound that lasts 60 s or more or 15 dB above the average ambient sound level, whichever is greater. The hooter centre to centre distance shall not exceed more than 30 m however, the spacing of sounder shall be based on the minimum of 75 dB level calculation. Also, the hooter top shall not be installed less than 2 290 mm from finished floor where allowed by floor height or not less than 150 mm from finished ceiling where applicable as per ceiling height for combine audible/visual devices. The hooters shall be provided on the wall and not under the ceiling.

4.5.3 Sounders shall be suitably distributed throughout the building in regard to attenuation of sound caused by walls, floors ceilings and partitions. If the fire routine for the premises requires the audible alarm to awaken sleeping persons, the minimum sound level shall be 75 dB (A) at the bed head with all doors shut. A large number of quieter sounders rather than a few very loud sounders may be preferable to prevent noise levels in some areas from becoming too loud. In sitting sounders in corridors to serve the surrounding rooms, account shall be taken of the attenuation of the sounder frequency of the any dividing element. Most single doors will give attenuation greater than 20 dB. Thus it is unlikely that sounder noise levels in a room will be satisfactory if more than one dividing wall or door separates it from the nearest sounder. At least one sounder for each fire compartment will be necessary. Sound levels shall not exceed 120 dB (A) as sound levels above this range in areas which are occupied may produce hearing damage.

4.5.5 Exit marking audible notification should be located at the entrance to all buildings (public buildings in particular), exits and area of refuge. Exit marking audible notification appliances shall meet or exceed the frequency and sound level settings.

4.5.6 All areas shall have visual alarm indication in addition to audible alarm. The visual alarm devices shall comply with IS/ISO 7240 (Part 23).

4.6 The fire alarm panel and the public address system shall be installed in the entrance lobby of each building and repeaters could be installed in the fire command centre which may or may not be in the entrance lobby. In case of buildings which do not have a homogeneous structure, mimic panels should be installed along with the fire alarm panel in the entrance lobby. The fire alarm panel shall be installed in a prominent place in the entrance lobby where many people can view it without obstruction and shall not be installed inside small/lockable rooms, utility spaces, shafts, or any leftover spaces.

4.7 A fire command centre shall be provided as specified **4.6** with mimic panels, graphic control software with actual position of devices or alternatively, IoT based remote monitoring system may be provided, and it may be integrated with the local fire brigade, if available. In addition, fire command centre shall match the requirement of SP 7 (Part 4). The control room shall have latest version of fire alarm system drawing installed on wall, visible to trained fire officer.

4.8 Zone indication shall be available at the control and indicating equipment even if addressable text is also available.

4.9 Wireless Fire Detection and Alarm Systems (WFDAS)

4.9.1 *Scope*

This shall apply to fire detection and alarm systems employing wireless (radio frequency) communication for transmission of fire, fault and supervisory signals between system components, including but not limited to smoke detectors, heat detectors, manual call points, alarm sounders, visual alarm devices, interface modules and control and indicating equipment, installed within or around buildings.

4.9.2 *System Configuration and Integration*

a) Wireless fire alarm systems may be provided as fully wireless or hybrid systems comprising both wired and wireless components;

b) All wireless components and system architectures shall be compatible and interoperable with the applicable requirements of IS/ISO 7240, as relevant; and

c) Hybrid systems shall ensure seamless integration such that system performance, supervision, fault monitoring and alarm integrity are equivalent to fully wired systems.

4.9.3 *Performance Requirements*

a) Wireless fire alarm systems shall demonstrate reliable and secure communication over radio frequency (RF) paths under normal and adverse operating conditions;

b) The system shall incorporate adequate fault tolerance, redundancy and supervision to ensure continuity of alarm transmission in the event of communication failure, interference or component malfunction;

c) Performance verification shall include, but not be limited to:
   1) Communication integrity and supervision;
   2) Resistance to environmental influences such as temperature, humidity and vibration;
   3) Power supply performance, including primary and secondary power sources and battery life;
   4) Electromagnetic compatibility (EMC) and immunity to interference;

4.9.4 *Design Considerations*

a) A performance-based approach for wireless fire alarm systems may be adopted and shall not prescribe limitations on:
   1) Operating frequency bands;
   2) Transmit power output;
   3) Number of wireless devices; and
   4) Network topology or routing methodology;

b) The system design shall ensure compliance with the required performance, reliability and availability criteria, irrespective of the RF technology adopted;

4.9.5 *Conformance and Verification*

a) Wireless fire alarm systems shall be subject to conformance assessment to verify compliance with performance requirements;

b) Verification methods shall address RF communication reliability, transmission latency, data integrity, supervision intervals and resistance to interference; and

c) Test documentation and certification shall be made available to the Authority Having Jurisdiction (AHJ) upon request.

4.9.6 *Radio Frequency Regulations*

a) Wireless fire alarm systems shall operate only on licence-exempt frequency bands permitted in India, such as 865 MHz to 867 MHz, 868 MHz and 2.4 GHz, as notified by the appropriate regulatory authority; and

b) All wireless fire alarm equipment shall comply with the prevailing wireless planning and coordination (WPC) regulations, and necessary approvals shall be obtained by the manufacturer or original equipment manufacturer (OEM).

4.9.7 *Applications*

Wireless fire detection and alarm systems may be considered suitable for applications including, but not limited to:

a) Heritage and protected buildings where cabling are restricted;

b) Temporary or relocatable structures;

c) Retrofit and renovation projects; and

d) Large campuses or distributed facilities where conventional cabling is impractical or economically unviable.

5 AUTOMATIC FIRE DETECTOR

5.1 The types of detectors covered in the standard are given in **5.1.1** and **5.1.2**.

5.1.1 *Heat Detectors*

Performance and test requirements for heat detectors are given in IS/ISO 7240 (Part 5). Details are as follows:

5.1.1.1 *Fixed temperature detectors*

The fixed temperature heat detectors are designed to operate when the temperature of the detector exceeds a predetermined value.

5.1.1.2 *Rate of rise temperature cum-fixed temperature detector or both*

The detectors are designed to operate within a given time as outlined;

a) When the rate of temperature rise at the detector exceeds a predetermined value regardless of the actual temperature;

b) When temperature at the detector exceeds a predetermined value; and

c) When both values are exceeded.

5.1.1.3 *Probe type high temperature bi-metal heat detector*

Bi-metal heat detectors are resettable and highly suitable to be used above 80 °C where electronic components cannot be used. The following are types of applications for which probe type high temperature heat detectors are suitable.

Generator enclosure, turbine enclosure, oven and furnace area, kitchen wood and other places as per the requirement where automatic fire extinguishing/ suppression systems are used.

5.1.1.4 *Application-heat detectors*

These are suitable for use in situation where sufficient heat is likely to be generated and damage caused by heat generated by the fire constitutes main hazard. This is to be minimized through early detection. In many buildings, especially non air-conditioned buildings, these conditions prevail where heat detectors can be advantageously used. Heat detectors are however, not suitable for protection of places where larger losses can be caused by small fires and where safety of life is involved. For guidance, *see* Annex B.

5.1.2 *Smoke Detectors*

Performance and test standard of smoke detectors are available from IS/ISO 7240 (Part 7). Details are as follows:

5.1.2.1 *Ionization type*

Detectors employing ionization chamber(s) as sensing means for detecting aerosols given-off of by fires. These detectors respond very quickly to smoke composed of very small particles (even those visible to the naked eye). However, they are less sensitive to the dense smoke composed of large particles. The detectors contain a small radioactive source, which ionizes the air within the sampling chamber, which causes a small current to be established. When smoke particles are introduced into the chamber, ions are absorbed onto the surface of the particles, resulting in reduction of current. When the reduction exceeds a preset level, alarm conditions will be reached.

5.1.2.2 *Optical* (*photo electric*) *type*

A detector whose operation is based on light attenuation by smoke and/or light scattering by smoke particles. These detectors respond quickly to large smoke particles but are less sensitive to small particles that do not constitute visible smoke. They detect the visible particles produced in fire by using the light scattering properties of the particles.

The detectors comprise an optical system, which consists of an emitter, and a sensor, each of which have a lens in front, and are so arranged that their optical axes cross in the sampling chamber. The emitter produces a beam of light, which is prevented from reaching the sensor by a baffle.

When smoke is present in the sampling chamber, a proportion of the light is scattered and some reaches the sensor. The light that reaches the sensor is proportional to the smoke density.

5.1.2.3 *High performance optical* (*HPO*) *multi-sensor detectors*

HPO detectors respond to smoke in the same way as standard optical detectors, but, when there is a rapid rate of rise in temperature, their sensitivity is increased so that they also respond to very small smoke particles, more like the ionization type detectors.

Sensitivity of optical smoke detector shall be measured in dB/m; data such as low/medium/high or application area should be asked to revalidate data in measurable terms.

5.1.2.4 *Smoke detectors application*

Ionization smoke detectors respond quickly to smoke containing small particles normally produced in clean burning fires, but may respond slowly to optically dense smoke which may be produced by smouldering materials. Certain materials like PVC, when overheated, produced mainly large particles to which ionization detectors are less sensitive. Optical smoke detectors respond quickly to smoke, that is optically dense. Both types of detectors have a sufficiently wide range of responses to be of general use. While selecting the detector, the requirements given in **5.2** shall be taken into account.

5.1.3 *Air Sampling Type Detector*

5.1.3.1 *Aspiration detector*

A detector that consists of a piping or tubing distribution network that runs from the detector to the areas to be protected. An aspiration fan in the detector housing draws air from the protected area back to the detector through air sampling ports, piping or tubing. At the detector, the air is analysed for fire by products like smoke particles. Typical application of the systems is where a trace of smoke need to be detected, where high airflow can make traditional smoke detector inadequate.

5.1.3.2 *Duct probe unit* (*detector*)

Smoke introduced into this air ducts within a building is most likely to be distributed to several portions of the building along the path of the duct(s). Duct probe unit which is detector, is designed to sense the presence of smoke in the duct. Principle of operation is as follows:

The duct probe unit is a detector, which has been designed, for use in situations where the standard smoke, heat and flame types cannot be used. Primarily, it is used for detecting the presence of smoke or combustion products in extract ventilation-ducting systems. The detector operates in a similar way to aspirating detectors except it does not contain a pump. Instead, it is designed to operate on the venturi effect in the sampling pipe providing optimum airflow through the smoke detector.

The unit is especially recommended for installations in ducts with low airflow. The detector shall be located in the supply air duct down stream of both the fan and the filters shall be installed. The system shall fulfil all the requirements for safe fire detection with airflow speeds from 0.5 m/s to 20 m/s.

The length of the venturi pipe shall be chosen based upon the ventilation width of the duct . The probe is flow direction sensitive and shall be fitted accordingly. The air in the sampling chamber is analysed for the presence of smoke particles, and if found, the unit signals this condition to the control panel to initiate actions like - shut off fans, blowers, air handling systems etc. These actions can facilitate the management of toxic smoke and fire gases throughout the areas served by the duct system.

5.1.4 *Flame Detector*

5.1.4.1 *Spark/ember detector*

A spark/ember-sensing detector usually uses a solid state photodiode or phototransistor to sense the radiant energy emitted by embers. Typically between 0.5 microns and 2.0 microns in normally dark environments. These detectors can be made extremely sensitive (in microwatts), and their response times can be made very short (in microseconds). Spark/ember detectors are installed primarily to detect sparks and embers that could, if allowed to continue to burn, precipitate a much larger fire or explosion. Spark/ember detectors are typically mounted on some form of duct or conveyor, monitoring the fuel as it passes by. Usually, it is necessary to enclose the portion of the conveyor where the detectors are located, as these devices generally require a dark environment. Extraneous sources of radiant emissions that have been identified as interfering with the stability of spark/ember detectors include the following:

a) Ambient light;

b) Electromagnetic interference (EMI, RFI); and

c) Electrostatic discharge in the fuel stream.

NOTE — Some times, spark detectors and ember detectors are available separately with specific usage/detection abilities; while predominantly they are available as a single detector.

5.1.4.2 *UV flame detector*

UV flame detector makes use of ultraviolet sensitive photocathode for detecting flame. It has a narrow spectral sensitivity of 185 nm to 260 nm, which is insensitive to visible light. These detectors work by detecting the UV radiation emitted at the instant of ignition.

While capable of detecting fires and explosions within 3 milliseconds to 4 milliseconds, a time delay of 2 s to 3 s is often included to minimize false alarms which can be triggered by other UV sources such as lightning, arc welding, radiation and sunlight.

UV detectors typically operate with wavelength shorter than 300 nm. The solar blind UV wavelength band is also easily blinded by oily contaminants.

5.1.4.3 *IR flame detector*

Single or multiple wave length infrared flame detector sense wave length in the infrared spectrum. Almost all the materials that participate in the flaming combustion emit ultraviolet radiation to some degree during flaming combustion, whereas only carbon-containing fuels emit significant radiation at the 4.35 micron CO_2 band used by many detector types to detect a flame.

The following are the types of application for which flame detectors are suitable:

a) High-ceiling, open-spaced buildings such as warehouses and aircraft hangers;

b) Outdoor or semi outdoor areas where winds or draughts can prevent smoke from reaching a heat or smoke detector;

c) Areas where rapidly developing flaming fires can occur, such as aircraft hangers, petrochemical production areas, storage and transfer areas, natural gas installations, paint shops, or solvent areas;

d) Areas needing high fire risk machinery or installations, often coupled with an automatic gas extinguishing system; and

e) Environment that is unsuitable for other types of detectors.

Some extraneous sources of radiant emissions that have been identified as interfering with the stability of flame detectors include the following:

a) Sunlight;

b) Lightning;

c) X-rays;

d) Gamma rays;

e) Cosmic rays;

f) Ultraviolet radiation from arc welding;

g) Electromagnetic interference (EMI, RFI);

h) Hot objects; and

j) Artificial lighting.

5.1.4.4 *Dual IR* (*IR2*) *flame detector*

This detector compares the threshold signal in two infrared ranges. Often one sensor looks at the 4.4 µm carbon dioxide (CO_2) emission, while the other sensor looks at a reference frequency. Sensing CO_2 emission is appropriate for hydrocarbon fuels; for non-carbon based fuels, that is hydrogen, the broadband water bands are sensed.

5.1.4.5 *IR3 flame detector*

Triple-IR flame detectors compare three specific wavelength bands within the IR spectral region and their ratio to each other. In this case one sensor looks at the 4.4 µm range while the other sensors look at reference wavelengths both above and below 4.4 µm. This allows the detector to distinguish between non-flame IR sources and actual flames which emit hot CO_2 in the combustion process. As a result, both detection range and immunity to false alarms can be significantly increased.

5.1.4.6 *UV/IR flame detectors*

These detectors are sensitive to both UV and IR wavelengths, and detect flame by comparing the threshold signal of both ranges. This helps minimize false alarms.

5.1.5 *Line Type Detector*

5.1.5.1 *Projected beam detector* (*smoke*)

An optical beam smoke detector:

a) is a device that uses a projected beam of light to detect smoke across large areas, typically as an indicator of fire. They are used to detect fires in buildings where standard point smoke detectors would either be uneconomical or restricted for use by the height of the building;

b) can overcome some of the limitations of point type detectors in high air movement areas, hostile environments such as temperature extremes, dirt, humidity and corrosive gases; and

c) consist of two units, a transmitter and a receiver, which are displaces apart say 10 m to 100 m. Alternatively, the transmitter and receiver are combined into a single unit and a reflector is used to bounce the transmitted beam back to the receiver.

When a fire breaks out, smoke particles rising upwards interrupt or partly deflect the light beam, thus reducing the strength of the beam received by the receiver unit. When such deflections between 40 percent to 90 percent persist for more than 5 s (or a pre-set value), alarm conditions will be reached.

5.1.5.2 *Linear heat sensing cables* (*heat*)

a) Linear heat sensing can be broadly divided into two categories. Digital or analogue, depending upon the principle by which the sensing cable registers a change in temperature;

b) Digital sensor consists of two core cable in which the conductors are separated by a heat sensitive insulator. When a specified temperature is reached, the cable insulation breaks down and an alarm is indicated. In the case of analogue sensor, cores are separated by a negative temperature co-efficient polymer whose resistance will reduce in proportion to the temperature increase; and

c) These cables are used for detecting fire and overheating in certain specific occupancies such as:

   1) Cables tunnels, trays and vaults;
   2) Material conveyors;
   3) Bulk storage multi-racked areas;
   4) Rim seals of floating roof tanks storing hazardous chemicals; and
   5) A few other special occupancies.

5.1.6 *Carbon Monoxide* (*CO*) *Fire Detector*

5.1.6.1 Carbon monoxide fire detectors use an electrochemical cell to detect the build- up of carbon monoxide generated by fires. The cell operates by oxidizing carbon monoxide on a platinum sensing electrode. Within the electrochemical cell the ions produced by this reaction result in a current flow between electrodes. The electrical output of the cell is directly proportional to the carbon monoxide concentration. When set to normal sensitivity, an alarm signal will be given at a carbon monoxide concentration of 40 ppm (parts per million). Carbon monoxide detector shall comply with IS/ISO 7240 (Part 6) and IS/ISO 7240 (Part 8).

5.1.6.2 Carbon monoxide fire detectors are particularly suitable for detecting smouldering fires and fires within confined spaces, such as bedrooms within a sleeping risk. In the latter application, carbon monoxide fire detectors will provide a higher standard of protection for sleeping occupants than heat detectors, but are less likely to produce false alarms than smoke detectors. The addition of a heat sensor to enhance the sensitivity of the carbon monoxide sensor enables heat-enhanced carbon monoxide detectors to respond to a wider spectrum of fires that generate heat as well as CO. They are also suitable to poorly ventilated basements particularly for other areas of car parking such as electrical rooms, cabins excluding car parking space (to avoid potential false alarm).

5.1.6.3 Carbon monoxide fire detectors are not suitable for fires that generate little or no carbon monoxide. Such fires include the early stages of electrical cable decomposition, where the HPO detector or aspirating fire detector is more suitable. Carbon monoxide fire detectors are also unsuitable for protection of areas where fast burning chemical fires represent the main hazard. In this case, ion chamber or flame detectors are more suitable.

5.1.6.4 Fire alarm control panel should provide life status indication with CO sensor expiration notice.

5.1.7 *Multi-Criteria Detectors*

5.1.7.1 A multi-criteria detector is a detector that contains multiple sensing methods that respond to fire signature phenomena and utilizes mathematical evaluation principles to determine the collective status of the device and generates a single output. Typical examples of multi-criteria detectors are a combination of a heat detector with a smoke detector, or a combination rate-of-rise and fixed-temperature heat detector that evaluates both signals using an algorithm to generate an output such as pre-alarm or alarm. The evaluation can be performed either at the detector or at the control unit. Other examples are detectors that include sensor combinations that respond in a predictable manner to any combination of heat, smoke, carbon monoxide, or carbon dioxide.

5.1.7.2 The purpose of combining sensors this way is to enhance the performance of the system in detection of fire, or its resistance to at least certain categories of false alarm or both.

5.1.7.3 With some multi-criteria fire detectors, it is possible to disable an individual sensor. For example, with a heat and optical combination, the optical sensor might be disabled during the day. Hence adequate care shall be taken to ensure that the protection is not diluted. In some other cases, it is also possible to identify an individual sensor which is advantageous in knowing the source of alarm.

5.2 Choice of Fire Detector

While designing a fire detection system, warning the occupants of an impending danger takes precedence over the occurrence of the false alarms. A high level of false alarms is merely disruptive to occupants and business activities and further may lead to disabling the system. Hence choice of fire detector is a paramount consideration. Following principles shall be considered:

a) Speed of detection required (based on risk analysis);
b) Nature and quantity of combustibles present, their ease of ignition, heat release rate, likely type of combustion (smouldering, flaming, etc) and lastly propensity for smoke generation, smoke type;
c) Anticipated rate of fire growth/spread;
d) Nature of environment within the protected premises;
e) Fire evacuation methodology;
f) Height and geometry of the protected area;
g) Presence of other active and/or passive protection systems within the area; and
h) Susceptibility of the contents to heat, smoke and water.

5.2.1 Fire detectors are designed to detect one or more of three characteristics of a fire that is smoke, heat or radiation (flame). No one type of detector is the most suitable for all applications and final choice is dependent on the individual circumstances. It is often useful to employ a combination of different types of detectors. Most fire detectors are affected not only by the level of the detected phenomena but also by the behaviour of the phenomena with time. In some cases it is the rate of change of phenomena; in others it is the effect, for example delays in smoke entry or thermal lags.

5.2.2 Every fire alarm system can be a compromise. It is possible to increase the sensitivity of detectors but that would probably increase the frequency of false alarms.

5.2.3 It is possible to reduce the losses by reducing the spacing between the detectors or using several types of detectors in the same area but these would increase the cost of the system.

5.2.4 It is possible to increase the frequency of testing but this might lead to increased disturbances on the premises.

5.2.5 Since each type of detector has its own advantages and disadvantages, and no one type of detector is most suitable for all applications, the choice of a detector to be used for a particular application is always a compromise. Final choice will depend primarily on the speed of response required, the need to minimize false alarms and the nature of the fire hazard. However, other factors such as cost, suitability for the environment and maintenance requirements shall also need to be considered.

5.2.6 In any automatic detection system a detector has to discriminate between a fire and the normal environment existing within the building. The system chosen shall have detectors that are suited to the conditions and that provide the earliest reliable warning.

5.2.7 Each type of detector responds at a different rate to different kinds of fire. With a slowly smouldering fire such as the initial stages of a fire involving cardboard, a smoke detector would probably operate first. A fire that evolves heat rapidly and with very little smoke could operate a heat detector before a smoke detector could operate first.

5.2.8 In general, smoke detectors would give appreciably faster responses than heat detectors but may be liable to give false alarms.

5.2.9 A combination of various detectors is necessary. The likely fire behaviour of the contents of each part of the buildings, the processes taking place or planned and the design of the building shall be considered. The susceptibility of the contents to heat, smoke and water damage shall also be considered.

5.2.10 Choice of detectors based on all the above considerations for any particular application has been shown in Annex C (Detector selection guide). However, this shall be purely considered as a guideline for selection.

5.3 Life Safety Installation

5.3.1 Whenever optical density of smoke exceeds 0.1 dB/m (10 m visibility), temperatures rises beyond 66 °C and concentration of carbon monoxide in atmosphere exceeds 0.04 percent, and human survival is endangered. An alarm shall be initiated before these limits are reached so that the occupants are able to escape to safety. Time overriding priority is to be given for detection of smoke because of the following factors:

a) Main threat to life in a fire emergency emanates from smoke and toxic fumes;

b) Smoke and lethal gases travel rapidly to areas away from fire due to strong convection currents threaten the life of the occupants even at far away places; and

c) Detectable quantities of smoke from a hostile fire precede detectable heat level and the development of lethal atmosphere.

5.3.2 In a life safety installation, it is therefore, essential to:

a) pay primary attention to early detection of smoke and to protect escape routes including those areas from which the routes might be hazarded by smoke detectors;

b) ensure operation of detectors on escape route before optical density exceeds; and

c) 0.05 dB/m that is, visibility falls below 20 m; and

d) Take into account any scheme of pressurization/smoke control while providing detectors.

5.3.2.1 Heat detectors are not suitable for detecting fire installation of life safety and in slow burning/air-conditioned premises where temperatures required to operate them may only be reached after the smoke density in the escape route/circulation areas has reached to the critical level.

5.3.2.2 Heat detectors are suitable in compartments where heat producing equipment (for example, kitchen and pantry, etc) are used in closets or other unsupervised spaces compact areas with low value contents.

5.4 Property Safety Installation

5.4.1 During normal occupancy hours, people may not be always present in all parts of the building or they may be on the move or not fully alert. Premises may remain unattended or unsupervised for long and short periods. When fire starts in such areas it gets time to grow to a stage where it cannot be easily extinguished. Installation of fire detectors enables early detection and easy extinction by reducing delay between ignition and start of fire fighting measures. As rapid and extensive loss of property is caused by flaming combustion, detectors shall be efficient in detecting flaming fire to keep losses to a minimum. It is important to minimize incidence of false alarms particularly when detectors are hooked up to actuate means of automatic extinction. Automatic extinction shall generally be initiated only on confirmation of two detecting signals to avoid possibility of false actuation.

NOTE — Due caution should be exercised in buildings that are yet to be finished but fitted with detectors; wherein the detachable bases are fixed before client-opted finishing is done and the detectors be appropriately fixed after finishing in a clean environment.

5.4.2 Computer/EDP centre/other electronic equipment, which has a very high value shall be protected preferably by smoke detectors of aspirating type or multi-criteria detector.

5.4.3 Archives, high value libraries, and museums with high value combustibles shall be protected by combination of heat, flame, smoke detectors. The heat detectors shall be used on the racks and cupboards and smoke detectors in open space on the ceiling. Projected beam detectors or flame detectors or aspiration type may be used where height of the ceiling is more than 9 m.

5.4.4 Flammable liquid in small quantities stored in confined spaces where ambient temperature is high or where chances of rapid heat buildup exist (such as garages, repair shops, store areas, etc) heat or flame detectors shall be provided.

6 SITING OF FIRE DETECTORS

6.1 At the time of installation and prior to commissioning, every fire detector shall be allotted an identification number, preceded by alphabetic initials showing the type of detectors, for example, Z1/SDI/20 meaning smoke detector, ionization, zone 1 to 20th detector. Z2/SDOT/3 meaning smoke detector optical, zone 2, 3rd detector. HFT/4 (Fixed temperature heat detector, 4th detector) HFR rate of rise heat detector, etc. A record of this shall be maintained in the fire command centre.

6.2 Where possibility of stratification exists, the level of stratification shall be determined by measuring the vertical gradient of smoke density and additional detector provided below the stratifying level if considered necessary by the site test.

6.3 Siting and Spacing Requirements of Detectors

6.3.1 *General*

a) Heat and smoke detectors depend on convection to transport hot gases and smoke from the fire to the detectors. Spacing and siting of detectors needs to be based on the need to restrict the time taken for this movement and to ensure that the products of combustion reach the detectors in adequate concentration. In a building, the hottest gas and the greatest concentration of smoke will generally form at the highest parts of the enclosed areas, and it is here, therefore, that heat and smoke detectors need to be sited;

b) There are other constraining factors in siting the detectors like the height of the ceiling (more the height means more cooling of hot gases, thus diluting the performance of the detectors), effects of stratification (where smoke does not rise to the ceiling at all), type of roof with beams extending deep below etc. Air movement within the protected area below the detectors, supply air inlets in the vicinity of detectors, HVAC systems with high air change rates, obstructions in the path of rise of hot gases and smoke like ducts, machinery parts, false ceilings, light fixtures, etc spacing and siting of detectors shall address all these issues for optimum protection;

c) Detector design (unless specifically excluded) shall include all rooms, halls, storage areas, basements, attics, lofts, spaces above suspended ceilings, and other subdivisions and accessible spaces as well as the inside of all closets, lift shafts, enclosed stairways, dumbwaiter shafts, and chutes etc. The detectors shall not be used in naturally ventilated areas;

d) Smoke detectors shall not be installed under following ambient conditions at the site of installation:

   1) Temperature below 0 °C;

   2) Temperature above 38 °C;

   3) Relative humidity above 93 percent; and

   4) Air velocity greater than 1.5 m/s.

   NOTE — The detectors may be provided for temperatures below 0 °C and above 38 °C but the right type of detectors shall be provided which can work under these temperatures.

e) Heat detectors shall be marked for their listed operating temperature and also with their response time index (RTI); and

f) All the components used in the system shall be of a type tested and approved by recognized agencies.

6.3.2 *Siting and Spacing of Detectors* (*common to all types of smoke and heat detectors unless specifically mentioned*)

6.3.2.1 *Flat ceilings*

Under flat ceilings, the horizontal distance between any point in a protected area and the detector nearest to that point shall not exceed listed spacing; or (i) 7.5 m in case of smoke detector and (ii) 5.3 m in case of heat detector. In simple terms, this means that each point within the protected area shall be covered by at least one detector; the coverage of a detector is a circle, cantered on the detector and having a radius of 0.7 times 7.5 m for smoke detectors and 5.3 m for heat detectors.

The sensitive elements of smoke detectors should normally lie within the range of 25 mm to 600 mm from the ceiling, and for heat detectors within the range of 25 mm to 150 mm.

6.3.2.2 *Pitched ceiling* (*Sloping roof*)

In case of a sloping roof or pitched ceiling (where the distance between the top of apex and bottom of the roof exceeds 600 mm), spacing of detectors at or in the vicinity of apex may be spaced between 7.5 m to 8.5 m for smoke detectors.

6.3.2.3 *Perforated ceiling*

Detectors above a perforated false ceiling may be used for protection of the area below the false ceiling if:

a) the perforations are substantially uniform, appear across the complete ceiling and throughout they make up more than 40 percent of the surface;
b) minimum dimension of each perforation in any direction is 10 mm; and
c) thickness of the ceiling is not greater than three times the minimum dimension of each perforation [*see* also **6.3.2.7 (f)**].

NOTE — If any one or more conditions above are breached, underside of the ceiling shall be provided in addition, with detectors as per **6.3.2**.

6.3.2.4 *Honey-comb ceiling*

For honey-comb type ceilings (where a horizontal ceiling consists a series of small cells), detector spacing shall be in accordance with Table 2.

6.3.2.5 *Semi cylindrical arch or a hemispherical dome ceiling*

For a semi cylindrical arch or a hemispherical dome, the radius of cover of a detector in the centre may be increased by 15 percent to 20 percent for the allowed spacing smoke and heat detectors.

Table 2 Spacing of Detector in Honeycombed Ceilings

(*Clause* 6.3.2.4)

Sl No.	Overall Ceiling Height, H	Beam Depth, D	Maximum Distance Between any Point and Nearest Smoke (Heat) Detector	Detector Location	
				W = 4D or Less	W = 4D or More
(1)	(2)	(3)	(4)	(5)	(6)
i)	6 m or less	Less than 10 percent of H	As per flat ceilings	Underside of beams	On structural slab of the cell
ii)	> 6 m	Less than 10 percent of H and 600 mm or less	As per flat ceilings	Underside of beams	On structural slab of the cell
iii)	> 6 m	Less than 10 percent of H and more than 600 mm	As per flat ceilings	Underside of beams	On structural slab of the cell
iv)	3 m or less	More than 10 percent of H	4.5 m (3 m)	Underside of beams	On structural slab of the cell
v)	4 m	More than 10 percent of H	5.5 m (4 m)	Underside of beams	On structural slab of the cell
vi)	5 m	More than 10 percent of H	6 m (4.5 m)	Underside of beams	On structural slab of the cell
vii)	6 m or more	More than 10 percent of H	6.5 m (5 m)	Underside of beams	On structural slab of the cell

6.3.2.6 *Siting of detectors due to internal services*

The following shall be considered:

a) All enclosed staircase shall have one detector at the top of the stairway and on each main landing within the staircase;

b) For open staircases within the building, there shall be a detector at each level within 1.5 m of the floor penetrations;

c) Additional detector shall be placed on the ceiling at a position 1.5 m from any opening, which might act like a flue;

d) Shafts for lifts, escalators or hoists, and any enclosed chutes, shall be treated like open staircases that is there shall be a detector at each level within 1.5 m of the floor penetrations. Lift machine rooms shall be provided with a detector;

e) Detector shall also be provided in cable tunnels, ducts, false floors, air conditioning and AHU room, long air conditioning return ducts and distribution boards;

f) Every compartment (that is, room or cabin) shall have a detector at ceiling level and also under false ceiling if provided;

g) Where there is more than one such compartment per floor, a response indicator shall be installed at the entrance to such enclosures to indicate where the detector has actuated. This arrangement shall also be followed in case of all concealed detectors in false floors, plenums, shafts, tunnels, etc;

h) A detector shall be placed on the protected side of the premises on the ceiling 1.5 m from any door, window or any opening in the wall partitions separating the protected premises from the other premises;

j) Voids as in false ceiling/flooring more than 800 mm shall be protected with detectors with spacing like in normal installation. However, voids as in false ceiling/flooring less than 800 mm height need not necessarily have independent coverage unless the void is such that the spread of fire products between the rooms or compartments take place through it. Bathroom, lavatories, water closets, etc however, need not be protected; and

NOTE — When detectors are installed within false ceilings, testing and maintenance become difficult and are often neglected during routine servicing. Therefore, suitable provisions shall be made to ensure adequate access for inspection, testing, and maintenance of such detectors.

k) Where there are small concealed spaces over rooms, compartments, enclosures, etc, no detectors will be required if the concealed space is less than 5 m^2 in area.

6.3.2.7 *Siting of detectors due to internal obstructions*

The following shall be considered:

a) Detectors shall not be mounted within 500 mm of any walls, partitions or obstructions to flow of smoke or hot gases, such as structural beams and ductwork, where the obstructions are greater than 250 mm in depth;

b) Where partitions or storage racks that reach within 300 mm of the ceiling, they shall be construed as walls that extend to the ceiling for the purpose of siting the detectors;

c) Where structural beams or ductwork for light fittings or any other ceiling attachments, not greater than 250 mm in depth, create obstacles to the flow of smoke, detectors shall not be mounted closer to the obstruction than twice the depth of the obstruction;

d) Similarly, ceiling obstructions such as structural beams, deeper than 10 percent of the overall ceiling height shall be construed as walls for the purpose of siting the detectors for example each bay formed by such beams shall be treated as separate enclosure for provision/spacing of detectors. (less than 10 percent can be taken a flat ceiling);

e) Detectors shall not be mounted within 1 m of any air inlet (supply air inlets of HVAC system) or a forced ventilation system;

f) Where the air inlet is through a perforated ceiling, the ceiling shall be non- perforated for a radius of at least 600 mm around each detector;

g) Detector siting shall be such that a clear space of 500 mm is maintained below each detector;

h) No detector shall be subjected to any interior decoration treatment that is painting, alteration of exterior cover, etc to conform to the environment; and

j) Where detectors are constrained to be fixed to the wall, they shall be sited in such a way that the top of the detection element is between 150 mm and 300 mm below the ceiling and the bottom of the detection element is above the level of door opening.

6.3.2.8 *Other requirements in general*

a) Smoke detectors can be spaced 12 m apart, while heat detectors can be spaced 8 m apart in corridors having width less than 2 m. In corridors wider than 2 m, normal spacing shall be applicable respectively for smoke and heat detectors;

b) For irregular shaped areas, the spacing between the heat detectors may be greater than the determined spacing provided the maximum spacing from the detector to the furthest point of a side wall or corner within its zone of protection is not greater than 0.7 times the determined spacing; and

c) If multi sensors are used, siting and spacing of detectors shall be based on the operation principle of a particular sensor that is for a combined heat/smoke detector, spacing shall be as per the requirements applicable to heat detectors.

6.3.2.9 *Positive alarm sequence* (*PAS*)

6.3.2.9.1 *general*

Positive alarm sequence (PAS) is an alarm management strategy intended to reduce unwanted or false alarms and to prevent unnecessary building evacuations, while ensuring timely response to genuine fire emergencies. PAS shall permit a controlled investigation period prior to initiation of general evacuation alarms, subject to strict supervision and fail-safe provisions.

6.3.2.9.2 *applicability*

a) PAS may be permitted in occupancies where a continuous or trained on-site staff presence is available to promptly investigate alarm signals, such as:

   1) Hospitals and healthcare facilities;

   2) Hotels, business buildings and mixed-use developments;

   3) Educational campuses; and

   4) Industrial and special purpose buildings.

b) PAS shall not be applied where immediate evacuation is critical, including but not limited to high-risk industrial occupancies, hazardous storage areas or buildings without trained supervisory personnel; and

c) Implementation of PAS shall be subject to approval by the Authority Having Jurisdiction (AHJ).

6.3.2.9.3 *sequence of operation*

The Positive Alarm Sequence shall operate as follows:

a) *Initial Alarm Stage*

   Upon activation of an automatic fire detector:

   1) An alarm signal shall be transmitted to the fire alarm control and indicating equipment (FACIE);

   2) Audible and visual indications shall be provided at the fire command centre, security control room or other designated continuously attended location; and

   3) Public evacuation alarms shall remain inhibited during this stage.

b) *Investigation Stage*

   1) A supervised investigation period shall be initiated to allow trained personnel to investigate the cause of alarm.

   2) The maximum investigation period shall not exceed 180 s, unless otherwise permitted by the AHJ.

   3) During this period, the system shall continue to monitor for additional alarm inputs and system faults.

c) *Confirmation and Escalation*

   1) If a second automatic detector operates, or a manual call point is activated during the investigation period, the system shall immediately initiate full alarm and evacuation; and

   2) If the investigation timer expires without manual acknowledgement or reset, the system shall automatically transition to full alarm condition.

6.3.2.9.4 *manual controls and supervision*

a) A manual "Alarm Acknowledge" or "Alarm Silence (PAS)" control shall be provided at the fire command centre or FACIE;

b) Manual silencing or reset shall be permitted only by authorised and trained personnel; and

c) All PAS functions shall be continuously supervised for integrity and fault conditions.

6.3.2.9.5 *fail-safe and reliability requirements*

a) PAS shall be designed on a fail-safe principle such that any system fault, power failure, communication failure or control malfunction shall result in automatic initiation of full alarm.

b) PAS shall not inhibit operation of:

1) Manual call points;

2) Waterflow switches or sprinkler supervisory alarms (where provided); and

3) Fire brigade interface or remote monitoring transmission.

c) PAS shall not impair transmission of alarm signals to the fire command centre, fire brigade panel or remote monitoring station.

6.3.2.9.6 *integration with evacuation and life safety systems*

a) Where PAS is implemented, its interaction with voice evacuation systems, public address systems, smoke control systems, elevators and access control systems shall be clearly defined in the cause-and-effect matrix; and

b) Automatic operation of critical life safety systems such as smoke management, pressurisation and fire lifts shall not be unduly delayed due to PAS unless specifically approved by the AHJ.

6.3.3 *Compensation to the Spacing of Detectors*

6.3.3.1 *Height consideration*

Spacing of 7.5 m for smoke detectors is valid up to a height of 7 m only and that of 5.3 m for heat detectors is valid only up to a height of 5 m. Beyond these heights, spacing between the detectors shall be adjusted as following:

Detector	*Height*	*Spacing*
Smoke detector	Up to 7 m	7.5 m
	7 m to 10 m	5 m
	Above 10 m	Beam/aspiration detector only
Heat detector	Up to 5 m	5.3 m
	5 m to 10 m	3.5 m
	Above 10 m	Heat detectors are prohibited only beam/flame detector shall be used.

6.3.3.2 *High air movement consideration*

a) Spacing between detectors shall be suitably reduced in areas where high air movement or where high air changes prevail. Modified values of spacing are given in the following table:

Air Changes per Hour Inside Block	*Multiplying Factor for Modified*	
	Spacing	*Area Coverage*
Less than 7.5	1.00	1.00
8.5	0.95	0.91
10.0	0.91	0.83
12.0	0.83	0.70
15.0	0.74	0.55
20.0	0.64	0.40
30.0	0.50	0.25
60.0	0.38	0.15

b) Detectors shall not be located within 1.5 m of the vicinity of air supply diffusers and force ventilation system also, the minimum distance of 1.5 m shall be maintained;

c) Detectors shall be so mounted as to favour the air flow towards return air openings; and

d) The above provisions shall not disturb the normal population (count) of detectors, which is provided assuming that air-handling systems are off.

6.3.4 *Requirements for a Cross Check*

a) After designing the detector spacing based on all considerations mentioned in various clauses 6.3.2 and 6.3.3 above, the design shall be cross-checked to ensure that there is at least one smoke detector for every 100 m^2 or one heat detector for every 50 m^2 of the compartment area; and

b) For smooth ceilings, all points on the ceiling shall have a detector within a distance equal to 0.7 times the selected spacing.

6.3.5 *Additional Requirements for Optical Beam Detectors*

The requirements include:

a) Optical beam-type detectors shall be sited in such a way that no point in the protected space is further than 7.5 m from the nearest point of optical beam;

b) Detectors shall be installed within 600 mm from the ceiling where nature of the ceiling is of flat type;

c) In case of a sloping roof or pitched ceiling (where the distance between the top of apex and bottom of the roof exceeds 600 mm), detectors shall be installed at or near the apex and also detectors not at or near the apex shall be spaced at a distance of 8.5 m;

d) Where optical beam type smoke detectors are used at more than 600 mm from ceiling level in order to provide supplementary detection of rising smoke within a high space (like atrium, etc) the width of the area protected on each side of optical beam shall be regarded as 12.5 percent of the height of the above beam from ground level;

e) Where there is a probability of people walking through the beam or where the beam is likely to be obstructed by forklifts, etc, detectors shall be mounted at a suitable height;

f) Transmitters, receivers and/or reflectors shall be mounted on a solid construction which shall withstand vibrations, temperatures or any imposed load;

g) The path length of the optical beam shall be within the limits specified by the manufacturers;

h) Beam detection area shall not exceed the detection zone in which it is installed;

j) The effects of stratification shall be fully evaluated when locating the detectors;

k) If mirrors are used with the projected beams (reflective beam detectors), they shall be installed as per manufacturer's recommendations;

m) Projected beam detectors and their mirrors reflective beam detectors shall be mounted on stable surfaces to prevent false or erratic operation due to vibrations and movements in the vicinity;

n) The beam shall be designed so that small angular movements of the light source or receiver do not prevent operation due to smoke and do not cause nuisance alarms; and

p) The light path of projected beam detectors (reflective beam detectors) shall be kept clear of opaque obstacles at all times.

6.3.6 *Additional Requirements for Aspirating Type Detection Systems*

When a aspirating type smoke detection system is intended to provide general area protection, each aspirating sampling point shall be regarded as a point type smoke detector, provided that a single sampling point has equivalent sensitivity to a point type smoke detector. Accordingly, all requirements specified above are applicable.

However, as the detector actually draws samples of air through sampling points (holes in pipework), it shall be possible to mount the sampling points flush with a ceiling, provided otherwise the system's effectiveness is confirmed by the manufacturer.

If the system is intended to co-exist with other types of detection system for specific application within the protected area, installation shall comply with the manufacturer's specifications.

Maximum air sample transport time from the farthest sampling point shall not exceed 120 s.

Air sampling detectors shall give a trouble signal if the airflow within the enclosure is outside the manufacturer's specified range.

6.3.7 *Siting of Flame Detectors*

6.3.7.1 The location and spacing of the detectors shall be based on sound engineering evaluations taking into account the following:

a) Size of the fire requiring detection;

b) Fuel involved;

c) Sensitivity of detectors;

d) Distance between the fire and detector;

e) Radiant energy absorption of the atmosphere;

f) Presence of other sources of emission;

g) Purpose of detection system; and

h) Response time required.

Certain flame detectors respond to the instantaneous level of radiation received while others depend upon the level received over a period.

In either case the response will depend on the distance between the flame detector and the fire, since the radiation level received is inversely proportional to the square of this distance. Increased distance from the fire will, therefore, lead to an increase in the size of the fire at detection.

A clear line of sight to the area being protected is of great importance but at the same time care must be exercised to avoid a direct line of sight to likely sources of non-fire radiation to prevent false alarms.

6.3.7.2 *Spacing guideline*

Considerations include:

a) Sufficient number of detectors shall be used and they shall be positioned such that no point requiring detection in the hazard area is obstructed or outside the field of view of at least one detector;

b) In applications where, the fire to be detected could occur in an area not on the optical axis of the detector, the distance shall be reduced or alternatively more detectors added to compensate for the angular displacement of the fire;

c) The spacing of the detectors shall vary from fuel to fuel. It is therefore necessary to fix the distances as per the recommendations of the manufacturers;

d) The location of the detectors shall also be such that structural members or any other opaque objects or materials do not impede their line of sight; and

e) When installed outdoors, detectors shall be shielded to prevent diminishing sensitivity due to rain, snow, ice, etc, and allow a clear vision of the hazard area.

6.3.8 *Siting of Spark/Ember Detectors*

6.3.8.1 The location and spacing of the detectors shall be based on sound engineering evaluations taking into account the following:

a) Size of the fire requiring detection;

b) Fuel involved;

c) Sensitivity of detectors;

d) Distance between the fire and detector;

e) Radiant energy absorption of the atmosphere;

f) Presence of other sources of emission;

g) Purpose of detection system; and

h) Response time required.

6.3.8.2 The system design shall specify the size of spark or ember of the given fuel that the system is to detect.

6.3.8.3 Spark detectors shall be positioned so that all the points within the cross section of the conveyance duct, conveyor or chute where the detectors are located, are within the field of view of at least one detector.

6.3.8.4 In any case the response will depend on the distance between the detector and the fire, since the radiation level received is inversely proportional to the square of this distance. Increased distance from the fire will, therefore, lead to an increase in the size of the fire at detection.

6.3.8.5 Ember detectors shall be positioned on top of the conveyor belt such that they can monitor the entire width of the belt. Manufacturer's installation guidance shall be followed.

6.4 Manual Call Points

a) Manual call points shall comply with the IS/ISO 7240 (Part 11);

b) Manual call points shall be so located that, to give an alarm, no person in the premises has to travel distance of more than 30 m to reach them. When manual call points are also installed external to the building, the travel distance shall be not more than 45 m;

c) Where necessary, the travel distance may require to be reduced to less than 30 m, for example where there is difficulty in free access within the risk or in potentially dangerous risks;

d) Call points shall be fixed at a height of 1.4 m above the surrounding floor level, at easily accessible, well-illuminated and conspicuous positions, which are free of obstructions;

e) Where the call points are not visible from the front as in the case of a long corridor, they shall be surface mounted or semi-recessed in order to present a side profile area of not less than 15 mm;

f) Manual call points shall be housed in dust proof and moisture proof enclosure properly sealed with rubber lining;

g) Manual call point shall be located preferably near entry to staircases at various levels; and

h) The glass surface shall be minimum 30 cm^2 in area and glass thickness shall not exceed 2 mm. Once the glass is broken the alarm shall sound on the floor as well as on the Control and Indication equipment and light shall glow to indicate its operation. The alarm shall be maintained by the control and indicating equipment even if someone presses the button subsequently.

6.5 Computer/EDP/Other Electronic Equipment Installed in Air-Conditioned Areas

Fire alarm system and detection network shall, in addition to the requirements of this standard, comply with various provisions of IS 12456. Where the requirements differ, those specified IS 12456 shall prevail.

6.6 Detectors (Smoke) in Ventilation Ducts

a) Smoke detectors or probes shall be installed in straight stretches of ductwork, at a distance from the nearest bend, corner or junction of at least three times the width of the duct;

b) The suitability of the smoke detector for duct type application shall be evaluated within the parameters defined by the manufacturers; and

c) The sampling inlet probe and the holes in the probe shall be arranged, according to the manufacturers specifications, to cover as much of the duct as possible. This provision normally calls for the probe to cover the wider dimension of the duct and the length of the probe shall be at least two-thirds of that dimension.

6.7 Linear Heat Sensing Cables (LHS)

6.7.1 *Cables Tunnels, Trays and Vaults*

6.7.1.1 Each cable tray shall be protected by LHS cables unless the vertical distance between the trays is uniformly less than 500 mm in which case alternate trays (in addition to the top and bottom trays) shall be protected.

6.7.1.2 The LHS cable shall be laid on the cables at the centre-line of the cable-runs either straight along the cables or zigzag and back and forth across the ladder and trays.

6.7.1.3 It is also possible to suspend the LHS cables below the trays so as to be within 200 mm of the cable-runs at a pitch of 1.2 m like a catenary.

6.7.1.4 Where the width of the tray exceeds 1 m, two LHS cables shall be laid on the trays as above. Alternatively, cables maybe laid in an zigzag fashion in which case pitch of the zigzag profile shall not exceed 1.2 m.

6.7.1.5 It is always necessary to install two LHS cables below the lower most trays because accumulation of filth, rubbish and waste in such areas is a distinct possibility rendering them fire-prone.

6.7.2 *Belt Conveyors*

6.7.2.1 The following fire situations are considered for the protection of the conveyors with LHS cables.

a) Stationery conveyor;
b) Moving conveyor;
c) Belt roller friction;
d) Belt friction with adjoining portions of the structures; and
e) Spill of fuel, lubricants and the like on the return belt.

6.7.2.2 The method of mounting the LHS cables under the above circumstances depends upon convenience of mounting as well as the vulnerability of the LHS cables.

6.7.2.3 The LHS cables shall be mounted as close to the risks mentioned above as possible that is on both sides of the belt rollers, or above the material carrying belt on separate supports or combination of both depending on the circumstances.

6.7.3 LHS cables are normally used in conjunction with water spray systems, sprinkler systems (both in cable cellars and material conveyors) and foam systems (in case of floating roof tanks storing hazardous liquids). The resettable line-type heat detectors shall conform to IS/ISO 7240-31.

7 INSPECTION, TESTING AND MAINTENACE

7.1 General

7.1.1 Even a well-designed and properly installed automatic fire alarm system will not be able to render reliable and trouble-free service unless high standard of maintenance and supervision are ensured during the entire service period of the system. Regular inspections and scheduled preventive maintenance are critical and shall include all the components of the system.

7.1.2 The IoT and M2M technologies may also be adopted which introduces prospects for fire preparedness monitoring in infrastructure with deployed fire detection systems. The connection of the fire alarm panel to a cloud-based monitoring server for the purpose of tracking fire incidents and their mean recovery time by security/fire safety personnel, as well as fault occurrences and their mean restoration time by maintenance entities, offers a significant advantage over manual monitoring conducted via periodic inspections.

7.1.3 The building admin should guard against any change in the system components and configuration after its approval by the authority having jurisdiction. The authority having jurisdiction approves the number of devices, panel configuration, cable routing and every aspect of the system including zoning and software zoning. During regular operation, isolating, modifying, or removing any system components should be strictly avoided without permission of the authority having jurisdiction.

7.2 Initial Installation Inspection Tests

7.2.1 After installation, a visual inspection of all the detectors shall be made to make sure that they are properly sited. Each detector shall be inspected to ensure that it is properly mounted and connected.

7.2.2 Restorable heat detectors and restorable elements of combination detectors shall be tested with a heat source or in accordance with the manufacturer's published instructions, making sure that the sensing element is not damaged. After each heat test, the detector shall be reset. Precautions shall be taken to avoid damage of the non-restorable fixed temperature element of a combination rate of rise/fixed temperature detector. The heat source should not have the potential to ignite a fire, and live flame should not be used.

7.2.3 Non-resettable fixed temperature heat detectors which are not to be heat-tested shall be tested mechanically or electrically for fire alarm function.

7.2.4 Heat detectors with replaceable fusible alloy element shall be tested first by removing the element to see whether contact operate properly and then re-inserting them in proper position.

7.2.5 In periodic testing, all detectors shall be visually examined for damage or other conditions (such as heavy coats of paints, etc) likely to interface with the correct operation.

7.2.6 Each smoke detector shall be tested to initiate an alarm at its installed location with smoke or other approved, apparatus that generates simulated smoke or suitable aerosols around the detector which demonstrates that the smoke from outside of the detector can enter the chamber and initiate an alarm. It should be ensured that the material used does not cause damage to or affect the subsequent performance of the detector.

7.2.7 In order to ensure that each smoke detector is within its sensitivity range, it shall be tested using any one of the following:

a) a calibrated test method;

b) a manufacturer's/supplier's approved calibrated sensitivity test instrument;

c) approved control equipment arranged for the purpose;

d) other approved calibrated sensitivity test method; and

e) fire alarm control panel (FACP) sensitivity report.

7.2.7.1 Detectors found to have sensitivity outside the approved range shall be replaced.

NOTE — Detector sensitivity cannot be tested or measured using any spray/smoke producing device that administers an unmeasured concentration of aerosol/smoke into the detector.

7.3 Servicing/ Periodical Maintenance

7.3.1 To ensure that regular and reliable servicing/maintenance of the systems and its components is carried out, any of the following methods shall be adopted:

a) Through a agreement/contract with the competent contractor who shall attend to the maintenance/repair, when necessary, promptly;

b) Where no such service contract can be entered into for any reason, at least one qualified employee of the user with suitable experience of electrical equipment shall undergo special training to deal with all aspects of basic servicing and maintenance, including routine sensitivity tests/checks of the detectors, as and when required; and

c) IoT based health monitoring of the system to assist facility managers in absence of site employee, which shall provide the real time health of the system.

7.3.2 For all institutional occupancies, such as hospitals; and for hotels, old people's homes, etc, the provision shall include a requirement that an engineer shall be on call at all times and that request over the telephone for emergency service shall be executed promptly, within 24 h. Serving arrangement shall be made immediately on completion of the installation whether the premises are occupied or not. If the premises are not occupied, special precautions shall be taken, if necessary, to protect the system against damage by dampness or other causes.

7.4 Maintenance Schedule

7.4.1 It is the responsibility of the user of the equipment to ensure that proper instructions are obtained from the manufacturer/supplier or installer regarding the routine attention and test procedures. For guidance refer, SP 7 (Part 12).

7.4.2 The routine to be adopted in individual premises may vary with the use of the premises; equipment installed in corrosive or dirty environmental conditions will need to be checked more thoroughly and at more frequent intervals than that in clear and dry situations. Care shall be taken that all equipment are properly reinstated after testing. The occupants of the premises shall be notified of any test of the system that may result in the sounders being operated.

7.4.3 *Daily Attention by User*

A check shall be made every day to ascertain that:

a) the panel indicates normal operation; if not, that any fault indicated is recorded in the log book and is receiving urgent attention;

b) any fault warning recorded the previous day has received attention; and

c) the fire alarm panel is not completely non-functional due to situations like burnt fuses, faulty power supply, inadvertent switching off etc.

7.4.4 *Weekly Attention by the User*

A check should be done every week to ensure that the events that occurred in the week gone by are addressed with a correct solution. Check the solution and ascertain that the system continues to function with all features.

7.4.5 *Quarterly Inspection and Test by the User*

The following check-list and test sequence shall be carried out:

a) Entries in the log book since the previous inspection shall be checked and any necessary action taken;

b) Batteries and their connections shall be examined and tested to ensure that they are in good serviceable condition;

c) Where applicable, secondary batteries shall be examined to ensure that the specific gravity of electrolyte in each cell is correct. Necessary remedial action shall be taken and an appropriate entry made in the log book. Care shall be taken to ensure that hydrometers, vessels, etc, used in the servicing of alkaline secondary cells are not contaminated by acid and vice versa, as contamination of electrolyte can ruin a cell;

d) Primary batteries, including reserves, shall be tested to verify that they are satisfactory for a further period;

e) The alarm function of control and indicating equipment shall be checked by the operation of a trigger device in each zone as described. The operation of alarm sounders and any link to a remote manned centre shall be tested. An ancillary functions of the control panel shall also be tested where practicable. All fault indicators and their circuits shall be checked preferable by simulation of fault conditions. The control and indicating equipment shall be visually inspected for signs of moisture ingress and other deterioration;

f) A visual inspection shall be made that structural or occupancy changes have not affected the requirements for the sting of trigger devices (manual call points, smoke detectors and heat detectors). The visual inspection shall also confirm that a clear space of at least 750 mm radius is preserved in all directions below every detector, that the detectors are preferably sited and that all manual call points remain unobstructed and conspicuous; and

g) In presence of online IoT health monitoring system, these all records can be kept on cloud for anytime access of past records without manuals.

Any defect shall be recorded in the logbook and reported to the responsible person, and action shall be taken to correct it.

7.4.6 *Annual Inspection Tests*

7.4.6.1 In order to ensure the operational integrity, a fire alarm system shall have an inspection, testing and maintenance program. Inspection, testing and maintenance program shall satisfy requirements given herein and conform to the manufacturer's published instructions.

7.4.6.2 The purpose for periodic inspections is to assure that obvious damages or changes that might affect the system operability are visually identified. The purpose for periodic testing is to statistically assure operational reliability. Any deficiencies noted during the inspection of system shall be corrected. If a deficiency is not corrected at the conclusion of system inspection, testing, or maintenance, the system owner or the owner's designated representative shall be informed of the impairment in writing within 24 h.

7.4.6.3 Before proceeding with any testing, all persons and facilities receiving alarm, supervisory, or trouble signals and all building occupants shall be notified of the testing to prevent unnecessary response.

7.4.6.4 At the conclusion of testing, those previously notified (and others, as necessary) shall be notified that testing has been concluded.

7.4.6.5 Table 3 gives the description of method and periodicity for inspection and Table 4 provides testing of schedule fire alarm system and its related equipment.

Table 3 Inspection Schedule

(*Clause* 7.4.6.5)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
i)	All equipment	Annually	Ensure there are no changes that affect equipment performance. Inspect for building modifications, occupancy changes, changes in environmental conditions, device location, physical obstructions, device orientation, physical damage, and degree of cleanliness.
ii)	Control equipment:		
	a) Fire alarm systems monitored for alarm, supervisory, and trouble signals		
	1) Fuses	Annually	Verify a system normal condition.
	2) Interfaced equipment	Annually	
	3) Lamps and LEDs	Annually	
	4) Primary (main) power supply	Annually	
	5) Trouble signals	Semi-annually	
	b) Fire alarm systems unmonitored for alarm, supervisory, and trouble signals		
	1) Fuses	Weekly	Verify a system normal condition.
	2) Interfaced equipment	Weekly	
	3) Lamps and LEDs	Weekly	
	4) Primary (main) power supply	Weekly	
	5) Trouble signals	Weekly	
iii)	In-building fire emergency voice/alarm Communications equipment	Semi-annually	Verify location and condition.
iv)	Batteries		
	a) Lead-acid.	Monthly	Inspect for corrosion or leakage. Verify tightness of connections. Verify marking of the month/year of manufacture (all types). Visually inspect electrolyte level.
	b) Nickel-cadmium	Semi-annually	
	c) Primary (dry cell)	Monthly	
	d) Sealed lead-acid	Semi-annually	
v)	Remote annunciators	Semi-annually	Verify location and condition
vi)	Remote power supplies	Annually	Verify proper fuse ratings, if any. Verify that lamps and LEDs indicate normal operating status of the equipment.
vii)	Initiating devices		Verify location and condition (all devices). Verify that in-line filters, if any, are clean. Verify that sampling system piping and
	a) Air Sampling		
	1) General	Semi-annually	

Table 3 (*Concluded*)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
	2) Sampling system Semi-annual piping and sampling ports	Semi-annually	fittings are installed properly, appear airtight, and are permanently fixed. Confirm that sampling pipe is conspicuously identified. Verify that sample ports or points are not obstructed.
	b) Duct detectors		
	1) General	Semi-annually	Verify that detector is rigidly mounted. Confirm that no penetrations in a return air duct exist in the vicinity of the detector. Confirm the detector is installed so as to sample the airstream at the proper location in the duct.
	2) Sampling tube	Semi-annually	
	c) Electromechanical releasing devices	Semi-annually	
	d) Fire extinguishing system(s) or suppression system(s) switches	Semi-annually	Verify proper orientation. Confirm the sampling tube protrudes into the duct in accordance with system design.
	e) Manual call points	Semi-annually	Verify no point requiring detection is obstructed or outside the detector's field of view.
	f) Heat detectors	Semi-annually	
	g) Radiant energy fire detectors	Quarterly	Verify no point requiring detection is obstructed or outside the detector's field of view.
	h) Video image smoke and fire detectors	Quarterly	Verify beam path is unobstructed.
	j) Smoke detectors (excluding one and two family dwellings)	Semi-annually	
	k) Projected beam smoke detectors	Semi-annually	
	m) Supervisory signal devices	Quarterly	
	n) Waterflow devices	Quarterly	
viii)	Fire alarm control interface and emergency control function interface	Semi-annually	Verify location and condition.
ix)	Notification appliances		Verify location and condition (all appliances).
	a) Audible appliances	Semi-annually	Verify that the candela rating marking agrees with the approved drawings.
	b) Audible textual notification appliances	Semi-annually	
	c) Visible appliances	Semi-annually	
	1) General		
	2) Candela rating		
x)	Exit marking audible notification appliances	Semi-annually	Verify location and condition

Table 4 Testing Schedule

(*Clause* 7.4.6.5)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
i)	All equipment	Annually	*See* Table 3 for inspection schedule
	Control equipment and transponder		
	a) Functions	Annually	Verify correct receipt of alarm, supervisory, and trouble signals (inputs); operation of evacuation signals and auxiliary functions (outputs); circuit supervision, including detection of open circuits and ground faults; and power supply supervision for detection of loss of a.c. power and disconnection of secondary batteries.
	b) Fuses	Annually	Verify rating and supervision
	c) Interfaced equipment	Annually	Verify integrity of single or multiple circuits providing interface between two or more control units. Test interfaced equipment connections by operating or simulating operation of the equipment being supervised. Verify signals required to be transmitted at the control unit.
	d) Lamps and LEDs	Annually	Illuminate lamps and LEDs
	e) Primary (main) power supply	Annually	Disconnect and test all secondary (standby) power under maximum load, including all alarm appliances requiring simultaneous operation. Reconnect all secondary (standby) power at end of test. Test redundant power supplies separately.
ii)	Fire alarm control unit trouble signals		
	a) Audible and visual	Annually	Verify operation of control unit trouble signals. Verify ring-back feature for systems using a trouble-silencing switch that requires resetting.
	b) Disconnect switches	Annually	If control unit has disconnect or isolating switches, verify performance of intended function of each switch. Verify receipt of trouble signal when a supervised function is disconnected.
	c) Ground-fault monitoring circuit	Annually	If the system has a ground detection feature, verify the occurrence of ground- fault indication whenever any installation conductor is grounded.
	d) Transmission of signals to off-premises location	Annually	Actuate an initiating device and verify receipt of alarm signal at the off-premises location. Create a trouble condition and verify receipt of a trouble signal at the off-premises location. Actuate a supervisory device and verify

Table 4 (*Continued*)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
			receipt of a supervisory signal at the off-premises location. If a transmission carrier is capable of operation under a single- or multiple-fault condition, activate an initiating device during such fault condition and verify receipt of an alarm signal and a trouble signal at the off-premises location.
iii)	Secondary (standby) power supply	Annually	Disconnect all primary (main) power supplies and verify the occurrence of required trouble indication for loss of primary power. Measure or verify the system's standby and alarm current demand and verify the ability of batteries to meet standby and alarm requirements using manufacturer's data. Operate general alarm systems a minimum of 5 min and emergency voice communications systems for a minimum of 15 min. Reconnect primary (main) power supply at end of test.
iv)	Battery tests		Prior to conducting any battery testing, verify by the person conducting the test, that all system software stored in volatile memory is protected from loss.
	a) Lead-acid type		
	1) Battery replacement	Annually	Replace batteries in accordance with the recommendations of the alarm equipment manufacturer or when the recharged battery voltage or current falls below the manufacturer's recommendations.
	2) Charger test	Annually	With the batteries fully charged and connected to the charger, measure the voltage across the batteries with a voltmeter. Verify the voltage is as specified by the equipment manufacturer.
	3) Discharge test	Annually	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery.
	4) Load voltage test	Semi-annually	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery.

Table 4 (*Continued*)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
	5) Specific gravity	Semi-annually	Measure as required the specific gravity of the liquid in the pilot cell or all of the cells. Verify the specific gravity is within the range specified by the manufacturer. Although the specified specific gravity varies from manufacturer to manufacturer, a range of 1.205–1.220 is typical for regular lead-acid batteries, while 1.240–1.260 is typical for high performance batteries. Do not use a hydrometer that shows only a pass or fail condition of the battery and does not indicate the specific gravity, because such a reading does not give a true indication of the battery condition.
	b) Nickel-cadmium type		
	1) Battery replacement	Annually	Replace batteries in accordance with the recommendations of the alarm equipment manufacturer or when the recharged battery voltage or current falls below the manufacturer's recommendations.
	2) Charger test	Annually	With the batteries fully charged and connected to the charger, place an ampere meter in series with the battery under charge. Verify the charging current is in accordance with the manufacturer's recommendations for the type of battery used. In the absence of specific information, use 1/30 to 1⁄25 of the battery rating.
	3) Discharge test	Annually	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery.
	4) Load voltage test	Semi-annually	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery. Verify the float voltage for the battery as per manufacturer's specification.
	c) Sealed lead-acid type		
	1) Battery replacement	Annually	Replace batteries in accordance with the recommendations of the alarm equipment manufacturer or when the recharged battery voltage or current falls below the manufacturer's recommendations.

Table 4 (*Continued*)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
	2) Charger test	Annually	With the batteries fully charged and connected to the charger, measure the voltage across the batteries with a voltmeter. Verify the voltage is as specified by the equipment manufacturer.
	3) Discharge test	Annually	With the battery charger disconnected, load test the batteries following the manufacturer's recommendations. Verify the voltage level does not fall below the levels specified. Load testing can be by means of an artificial load equal to the full fire alarm load connected to the battery.
	4) Load voltage test	Semi-annually	Verify the battery performs under load, in accordance with the battery manufacturer's specifications.
v)	Conductors — metallic		
	a) Stray voltage	N/A	Test all installation conductors with a volt/ohmmeter to verify that there are no stray (unwanted) voltages between installation conductors or between installation conductors and ground. Verify the maximum allowable stray voltage does not exceed the level specified in the published manufacturer's instructions for the installed equipment.
	b) Ground faults	N/A	Test all installation conductors, other than those intentionally and permanently grounded, for isolation from ground per the installed equipment manufacturer's published instructions.
	c) Short-circuit faults	N/A	Test all installation conductors, other than those intentionally connected together, for conductor-to conductor isolation as per the published manufacturer's instructions for the installed equipment. Also test these same circuits conductor-to-ground.
	d) Loop resistance	N/A	With each initiating and indicating circuit installation conductor pair short-circuited at the far end, measure and record the resistance of each circuit. Verify that the loop resistance does not exceed the limits specified in the published manufacturer's instructions for the installed equipment.
	e) Circuit integrity	N/A	For initial and reacceptance testing, confirm the introduction of a fault in any circuit monitored for integrity results in a trouble indication at the fire alarm control unit.

Table 4 (*Continued*)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
			Open one connection at not less than 10 percent of the initiating devices, notification appliances and controlled devices on every initiating device circuit, notification appliance circuit, and signalling line circuit. Confirm all circuits (initiating device circuits, signalling line circuits and notification appliance circuits) perform as per the requirements for Class A or Class B pathways.
		Annually	For periodic testing, test each initiating device circuit, notification appliance circuit, and signalling line circuit for correct indication at the control unit. Confirm all circuits (initiating device circuits, signalling line circuits and notification appliance circuits) perform as per the requirements for Class A or Class B pathways.
vi)	Initiating devices		
	a) Electromechanical releasing device		
	1) Non restorable-type link	Annually	Verify correct operation by removal of the fusible link and operation of the associated device. Lubricate any moving parts as necessary.
	2) Restorable-type link	Annually	Verify correct operation by removal of the fusible link and operation of the associated device. Lubricate any moving parts as necessary.
	b) Fire extinguishing system(s) or suppression system(s) alarm switch	Annually	Operate the switch mechanically or electrically and verify receipt of signal by the fire alarm control unit.
	c) Fire–gas and other detectors	Annually	Test fire–gas detectors and other fire detectors as prescribed by the manufacturer and as necessary for the application.
	d) Heat detectors		
	1) Fixed-temperature, rate-of-rise, rate of compensation, restorable line, spot type (excluding pneumatic tube type)	Annually	Perform heat test with a heat source or in accordance with the manufacturer's published instructions. Assure that the test method for the installed equipment does not damage the non restorable fixed-temperature element of a combination rate-of-rise/fixed-temperature element detector.
	2) Fixed-temperature, Non restorable line type	Annually	Do not perform heat test. Test functionality mechanically and electrically. Measure and record loop resistance. Investigate changes from acceptance test.
	3) Fixed-temperature, non restorable spot type	See Method	After 15 years from initial installation, replace all devices or have 2 detectors per 100 laboratory tested.

Table 4 (*Continued*)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
			Replace the 2 detectors with new devices. If a failure occurs on any of the detectors removed, remove and test additional detectors to determine either a general problem involving faulty detectors or a localized problem involving 1 or 2 defective detectors.
	4) Non restorable (general)	Annually	Do not perform heat tests. Test functionality mechanically and electrically.
	5) Restorable line type, pneumatic tube only	Annually	Perform heat tests (where test chambers are in circuit), with a heat source or in accordance with the manufacturer's published instructions of the detector or conduct a test with pressure pump.
	6) Single- and multiple-station heat alarms	Annually	Conduct functional tests according to manufacturer's published instructions. Do not test non restorable heat detectors with heat.
	e) Manual call points	Annually	Operate manual call points per the manufacturer's published instructions. Test both key-operated pre-signal and general alarm manual call points.
	f) Radiant energy fire detectors	Semi-annually	Test flame detectors and spark/ember detectors in accordance with the manufacturer's published instructions to determine that each detector is operative. Determine flame detector and spark/ember detector sensitivity using any of the following: 1) Calibrated test method. 2) Manufacturer's calibrated sensitivity test instrument. 3) Listed control unit arranged for the purpose. 4) Other approved calibrated sensitivity test method that is directly proportional to the input signal from a fire, consistent with the detector listing or approval. If designed to be field adjustable, replace detectors found to be outside of the approved range of sensitivity or adjust to bring them into the approved range. Do not determine flame detector and spark/ember detector sensitivity using a light source that administers an unmeasured quantity of radiation at an undefined distance from the detector.
	g) Smoke detectors — functional test		
	1) In other than one- and two- family dwellings,	Annually	Test smoke detectors in place to ensure smoke entry into the sensing chamber and

Table 4 (*Continued*)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
	system detectors		an alarm response. Use smoke or a product acceptable to the manufacturer or in accordance with their published instructions. Other methods listed in the manufacturer's published instructions that ensure smoke entry from the protected area, through the vents, into the sensing chamber can be used.
	2) Single- and multiple-station smoke alarms connected to protected premises systems	Annually	Perform a functional test on all single- and multiple-station smoke alarms connected to a protected premises fire alarm system by putting the smoke alarm into an alarm condition and verifying that the protected premises system receives a supervisory signal and does not cause a fire alarm signal.
	3) System smoke detectors used in one- and two-family dwellings	Annually	Conduct functional tests according to manufacturer's published instructions.
	4) Air sampling	Annually	Test with smoke or a product acceptable to the manufacturer or in accordance with their published instructions. Test from the end sampling port or point on each pipe run. Verify airflow through all other ports or points.
	5) Duct type	Annually	Test duct smoke detectors that use sampling tubes to ensure that they will properly sample the airstream in the duct using a method acceptable to the manufacturer or in accordance with their published instructions.
	6) Projected beam type	Annually	Test the detector by introducing smoke, other aerosol, or an optical filter into the beam path.
	7) Smoke detector with built- in thermal element	Annually	Operate both portions of the detector independently as described for the respective devices.
	8) Smoke detectors with control output functions	Annually	Verify that the control capability remains operable even if all of the initiating devices connected to the same initiating device circuit or signalling line circuit are in an alarm state.
	h) Smoke detectors- sensitivity testing (In other than one- and two-family dwellings, system detectors)	Semi-annual	Perform any of the following tests to ensure that each smoke detector is within its marked sensitivity range: 1) Calibrated test method. 2) Manufacturer's calibrated sensitivity test instrument. 3) Listed control equipment arranged for the purpose. 4) Smoke detector/control unit arrangement whereby the detector

Table 4 (*Continued*)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
			causes a signal at the control unit when its sensitivity is outside its listed sensitivity range. 5) Other calibrated sensitivity test method approved by the Authority Having Jurisdiction.
	j) Carbon monoxide detectors/carbon monoxide alarms for the purposes of fire detection	Annually	Test the devices in place to ensure CO entry to the sensing chamber by introduction through the vents, to the sensing chamber of product acceptable to the manufacturer or in accordance with their published instructions.
	k) Initiating devices, Supervisory		
	1) Control valve switch	Annually	Operate valve and verify signal receipt to be within the first two revolutions of the hand wheel or within one-fifth of the travel distance, or as per the manufacturer's published instructions.
	2) High- or low-air pressure switch	Annually	Operate switch and verify receipt of signal is obtained where the required pressure is increased or decreased a maximum 70 kPa from the required pressure level.
	3) Room temperature switch	Annually	Operate switch and verify receipt of signal to indicate the decrease in room temperature and its restoration to room temperature.
	4) Water level switch	Annually	Operate switch and verify receipt of signal indicating the water level raised or lowered a maximum 70 mm from the required level within a pressure tank. Also verify its restoral to required level.
	5) Water temperature switch	Annually	Operate switch and verify receipt of signal to indicate the decrease in water temperature and its restoration room temperature.
	m) Mechanical, electrosonic, or pressure- type waterflow device	Semi-annually	Water shall be flowed through an inspector's test connection indicating the flow of water equal to that from a single sprinkler of the smallest orifice size installed in the system for wet-pipe systems.
	n) Multi-sensor fire detector or multi-criteria fire detector or combination fire detector	Annually	Test each of the detection principles present within the detector (for example, smoke/heat/CO, etc) independently for the specific detection principle, regardless of the configuration status at the time of testing. Also test each detector in accordance with the published manufacturer's instructions. Test individual sensors together if the technology allows individual sensor responses to be verified. Perform tests as described for the respective devices by introduction of the physical

Table 4 (*Concluded*)

Sl No.	Component	Periodic Frequency	Method
(1)	(2)	(3)	(4)
			phenomena to the sensing chamber of element, and an electronic check (magnets, analogue values, etc) is not sufficient to comply with this requirement. Confirm the result of each sensor test through indication at the detector or control unit. Where individual sensors cannot be tested individually, test the primary sensor. Record all tests and results.

7.4.7 In case of new residential, commercial, IT buildings with multiple occupancy, some portions/zones may remain unoccupied or closed for long periods of time. In such cases, it is recommended that the power to such premises be switched off by the owner or the building administrator to prevent any occurrence of fire due to short circuit caused by movement of any rodents, birds, insects etc. It is mandatory for the owner of such premises to leave a backup key with the neighbours or building admin so that in an emergency the area can be accessed and any fire occurrence can be addressed at an early stage.

7.4.8 In case of buildings with multiple occupancy which are new and are being gradually occupied by the tenants/owners, the fire alarm system is subjected to constant disruption due to activities like construction of false ceiling/ furniture/ painting/ civil works etc. The building admin of such buildings should clearly indicate this to the residents by putting up necessary boards and through other communication channels.

7.5 Cleaning and Maintenance

Detectors require periodic cleaning to remove dust or dirt that has accumulated. The frequency of cleaning depend upon the type of detector and local ambient conditions. In any case, the interval shall not exceed a period of 3 months. For each detector, the cleaning, checking, operating and sensitivity adjustment shall be attempted only after consulting manufacturer's instructions. These instructions shall detail methods such as creating vacuum to remove loose dust and insects, and cleaning heavy greasy deposits, following partial disassembly or the cleaning or the washing of detectors to remove contamination, the sensitivity test requirements in accordance with the relevant clauses shall be performed.

7.6 Tests Following an Alarm or Fire

All detectors suspected of exposure to a fire conditions shall be tested in accordance with the provisions contained in this standard pertaining to annual inspection tests. In addition, a visual check of the battery charger shall be carried out to ensure perfect serviceability. However, a check shall be made to the extent of damage, if any, to the cables and other components and also the operation of the systems as a whole.

7.7 System Disconnection During Testing

Care shall be taken to minimize the disruption of the normal use of the building by alarm sounding during detector testing. If detectors are removed for testing or servicing, replacement detectors shall be provided.

7.8 Spares

It may not be necessary to keep spares in premises other than covers for manual call point and fuses and other essential spares which shall be worked out based on installation.

ANNEX A

(*Clause* 2)

LIST OF REFERRED STANDARDS

IS No.	*Title*
IS/ISO 7240	Fire detection and alarm systems:
(Part 2) : 2017	Control and indicating equipment
(Part 3) : 2020	Audible alarm devices
(Part 4) : 2017	Power supply equipment
(Part 5) : 2018	Point-type heat detectors
(Part 6) : 2011	Carbon monoxide fire detectors using electro-chemical cells
(Part 7) : 2023	Point-type smoke detector using scattered light, transmitted light or ionization
(Part 8) : 2014	Point-type fire detectors using a carbon monoxide sensor in combination with a heat sensor
(Part 10) : 2012	Point-type flame detectors
(Part 11) : 2011	Manual call points
(Part 12) : 2022	Line type smoke detectors using a transmitted optical beam
(Part 13) : 2020	Compatibility assessment of system components
(Part 15) : 2014	Point type fire detectors using scattered light, transmitted light or ionization sensors in combination with a heat sensor
(Part 16) : 2007	Sound system control and indicating equipment
(Part 17) : 2020	Short circuit isolators
(Part 18) : 2017	Input/output devices
(Part 20) : 2010	Aspirating smoke detectors
(Part 21) : 2005	Routing equipment
(Part 22) : 2017	Smoke detection equipment for ducts
(Part 23) : 2013	Visual alarm devices
(Part 24) : 2016	Fire alarm loudspeakers
(Part 25) : 2010	Components using radio transmission paths
(Part 27) : 2018	Point type fire detectors using a smoke sensor in combination with a carbon monoxide sensor and, optionally, one or more heat sensors'
(Part 29) : 2017	Video fire detectors
(Part 31) : 2022	Resettable line-type heat detectors
8757 : 2021	Glossary of terms associated with fire safety (*second revision*)
12456 : 2004	Fire protection of electronic data processing installations — Code of practice (*first revision*)
SP 7	National building code of India:
(Part 4) : 2016	Fire and life safety
(Part 12) : 2016	Asset and facility management

To access Indian Standards click on the link below:

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ANNEX B

(*Clause* 5.1.1.4)

VARIOUS TYPES OF FIRE ALARM SYSTEMS

(*Informative*)

B-1 GENERAL

Three types of fire alarm detection systems are available and requirements prescribed under are applicable to all. These types are conventional systems; addressable systems; and digital addressable system;

Irrespective of type of system selected, requirements set out in **4** and **6** still apply for the installation. In premises where the evacuation of personnel is more difficult, such as in residential care; the importance of providing accurate and unambiguous information in certain occupancies such as hotels, hospitals and residential care can be provided only by addressable systems. Brief description of all the systems are as under.

B-2 CONVENTIONAL SYSTEM

B-2.1 General Description

a) A conventional or two–state detector is a detector, which gives one of two states relating to either normal or fire alarm conditions. Conventional systems provide a number of two wire circuits onto which conventional detectors and call points are connected. Similarly, separate two wire circuits are also provided for the purpose of connecting sounders (or alarm bells) to the system;

b) The primary function of the control and indicating equipment (C&IE) is to indicate the location of a fire as precisely as possible. To achieve this objective, detectors are grouped into detection zones, with each detector zone being connected to the C&IE by a separate circuit, which also has a separate indicator on the control panel; and

c) Each detector includes an integral light emitting diode (LED) indicator, which illuminates when the device is in the fire alarm condition. If an indicator on the C&IE indicates a fire in a detection zone, the detection zone must be physically searched until the detector with the illuminated LED is found. Detectors installed out of view normally have a remote LED indicator.

B-2.2 Zones

a) If zoning were to be extended to the limit, each circuit would have only one detector connected, and the exact location of the fire could be established at the C&IE without the need to physically search the zone. To do this with conventional detectors and a conventional control panel would be prohibitively expensive because of the number of detection zones required on the C&IE and the large amount of installation work involved; and

b) In conventional systems, all the detectors on a detection zone circuit continuously communicate with the C&IE. When one detector goes into the fire alarm state, the voltage on the circuit drops and all other detectors on that detection zone become disabled. During this period no further signals from other detectors in the detection zone can be received at the C&IE.

B-2.3 Detectors and Manual Call Points

a) Point smoke detectors and heat detectors used in conventional systems shall conform to the requirements of various parts of IS/ISO 7240 series as referred in **2**;

b) Manual break glass call points shall conform to the requirements of this standard. This standard recommends the use of ‘manual call points, which require only one action to operate them (that is breaking the glass automatically sets off the fire alarm system). However, if manual call points are likely to be subject to casual malicious operation (for example in some schools, malls and public places, etc), a variation may be accepted by the fire authorities, whereby on next time a hinged plastic cover is fitted to each call point. The cover then has to be lifted before the glass can be broken; and

c) The standard states that the removal of a detector on a circuit should not prevent the operation of any break glass call point. In a conventional system, unless the system is designed in such a way that removal of every detector from a detection zone circuit does not disable other devices that remain connected, it will be necessary to either connect manual call points on a separate circuit from fire detectors or to install all call points as the first devices on the circuit, with any automatic fire detectors 'downstream' of these.

B-3 ADDRESSABLE SYSTEMS

B-3.1 General Description

a) An addressable system is one using addressable detectors and/or call points, signals from which are individually identified at the control panel; and

b) In a simple addressable system, the C&IE can provide a number of two wire circuits onto which addressable detectors and call points may be connected. The two-wire circuit should be connected to form a loop in order to provide circuit integrity. In addition to this, line isolators should be distributed around the loop to ensure compliance with this standard.

B-3.2 Operation of Addressable Systems

a) In an addressable system, multiplex communication techniques allow each detector to independently signal its status back to the control panel. Since each detector has its own identity (or address) the control panel, in addition to providing the normal detection zone, may also be configured to give a customer defined character message to each detector. This is especially useful to any observer who is not familiar with the layout of the site. The customized messages are usually displayed on a LCD display alongside the visual detection zone indicators;

b) In operation, the control panel sends out the first address and then waits a pre-set time for a reply. Each detector compares the address sent out by the control panel with its own pre-set address and the one that matches the address sends back its status. If a particular detector address is not found within the pre-set time because the device has been either disconnected or removed, the control panel indicates a fault. Similarly, if the detector address is found but the device fails to operate correctly (that is reply) within the pre-set time then the control panel also indicates a fault;

c) The control panel then sends out the next address, and so on until all devices have been addressed, and then it repeats the whole cycle again; and

d) It is recommended to give consecutive addresses to detectors in each other's vicinity with the view of ease of identification and maintenance. The cabling method adopted should be such that cable do not run across multiple compartmentation zones. The cable should enter one compartmentation zone from a point, cover the entire zone and exit from that zone out from the same point before entering into the next single compartmentation zone.

e) All the addressable detectors, Manual call points, monitor module, control modules shall be supervised by panel.

B-3.3 Detectors and Manual Call Points

a) Addressable detectors and manual call points must conform to the same standards as mentioned under conventional systems;

b) The removal of a detector on a circuit will not prevent the operation of any break glass call point. This is achieved in an addressable system because removal of a detector does not cause any break in the circuit. The removal of the detector in sensed by the absence of a 'reply' when the detector is polled by the C&IE; and

c) A contact monitor module is another device which can be used on an addressable system. This device is used for monitoring very simple items that provide a closing or opening no-volt contact, for example a sprinkler flow valve.

B-3.4 Output Devices

a) Besides handling input devices that is detectors and call points, addressable systems can also handle output devices on the addressable loop. This is possible because part of the address message from the control panel can be a command instruction to an output device, signalling it to turn its output ON or OFF. A typical application of this would be a sounder module used to drive a number of sounders (or bells), and/or visual alarm devices, or a plant interface module used to shut down a piece of electrical plant. Input devices on the circuit ignore all command instructions sent to output devices;

b) It is also acceptable to connect interface modules to conventional circuits. These modules allow conventional detectors on spur detector circuits to be connected to an addressable zone circuit and monitor the status of typically 20 conventional detectors. The conventional detectors on the spur communicate with the interface module and should any detector go into alarm, the interface module signals to the control panel that an alarm condition has occurred. These modules are also often used to upgrade old conventional systems, by utilizing the existing wiring, although new wiring should always be used where possible; and

c) In order to provide short circuit protection and comply with the requirements of the code, isolators must be fitted at appropriate positions on an addressable loop.

B-4 MICROPROCESSOR SYSTEMS

B-4.1 General Description

a) In practice all addressable systems are of the analogue type. A microprocessor system is one, which uses analogue addressable detectors, each, of which give an output signal representing the value of the sensed phenomenon. The output signal may be a truly digital signal or a digitally encoded equivalent of the sensed value. The decision as to whether the signal represents a fire or not is made at the C&IE;

b) Apart from the way in which analogue addressable detectors operate, and the C&IE communication principles employed, all system design elements of addressable systems (*see* **B-3.2** above) also apply to analogue addressable systems;

c) Conventional and two state addressable detectors can signal only two output states, normal and fire alarm; and

d) Consequently, with these detectors it is impossible to ever establish how close the device is to an alarm condition, or whether the localized environmental conditions (which probably contain dust and dirt) are causing deteriorating changes in the detector's sensitivity, thereby adversely affecting its performance. However, an addressable system can offer a number of system performance improvements over both conventional and simple (non-analogue) addressable type systems, details of which are highlighted in the following subsections.

B-4.2 Operation of Analogue Addressable Detectors

a) The output of an addressable detector is variable and is a proportional representation of the sensed effect of fire, that is smoke, heat, carbon monoxide or flame. Transmission of this output from the detector is usually in the form of an analogue current;

b) In digital systems however this output is expressed and transmitted in data-bits using zeros and ones. The communication of the data is made more secure using frequency shift keying (FSK), thereby ensuring a high level of discrimination between these different bit values;

c) When the detector is interrogated or addressed by the control panel, the analogue detector responds with an output value rather than a status value as in the case of conventional detectors;

d) In an analogue addressable system therefore, the analogue addressable detectors are simply acting as transducers, which relay information (back to the control panel) concerning temperature, smoke density, etc. Microprocessor based circuitry in the control panel interprets the data received and decides whether or not to indicate an alarm, pre-alarm, normal or fault condition;

e) In order that the system raises an alarm in the event of a fire, the analogue value out-put from the detector must be in the alarm condition (that is, above the alarm threshold) for a period equal to the time taken to complete three successive address sequences, typically 15 s. This technique of scanning the sensor three times before raising an alarm is a useful way of helping to reduce false alarms from short-term electrical or physical transients, without causing an excessive delay in actual alarm transmission; and

f) As the output from each detector is an analogue value, the alarm threshold level can be controlled (or set) by software within the CIE. This software is usually stored in non-volatile memory when the system is being configured during installation.

ANNEX C

(*Clause* 5.2.10)

DETECTOR SELECTION GUIDE

C-1 The advantages and disadvantages of various types of detectors which serve as guide towards their selection are given below:

Sl No.	*Type of Detector*	*Suitability and Merits*	*Unsuitability and Demerits*
(1)	(2)	(3)	(4)
i)	Smoke Detectors (General)	Slow burning fires, smouldering fires. For most of the areas where principal fire hazard *is not* from the presence of flammable liquids. Fires involving wood, paper, textile, etc. in earlier stages.	Not sensitive for clean burning fires which does not produce smoke particles; areas in which the principal fire hazard *is* the presence of flammable liquids or gases that produce little smoke during a fire.
	a) Ionisation smoke detector	General purpose smoke detector – better for smoke containing small particles such as rapidly burning fast flaming fires.	Less sensitive to the larger particles found in optically dense smoke of similar mass, such as can result from smouldering fires including those involving polyurethane foam, or overheated PVC. Areas subject to smoke, steam, dust or dirt during normal use. Usage of these detectors are on way to phase out due to
	b) Optical smoke detector	General purpose smoke detector – better for smouldering fires.	Areas subject to smoke, steam, dust or dirt during normal use.
	c) Light scattering type (smoke)	Sensitive to light coloured smoke.	Less sensitive to very dark smoke which absorbs light rather than scattering it.
	d) Light obscuration type (smoke)	Sensitive to very dark smoke which absorbs light rather than scattering it.	Areas subject to smoke, steam, dust or dirt during normal use.
	e) Photo-thermal multi-criteria detector	General purpose detector – good for smouldering and fast flaming fires, optically dense smoke.	Areas subject to smoke, steam, dust or dirt during normal use. Less sensitive to small particles found in clean burning fires that produce little visible smoke.
	f) Optical beam smoke detector	Large and high rooms, open plan spaces with relatively high ceilings (for example warehouses). Fires not involving production of smoke (with built in thermal turbulence detection). Suited for applications where anticipated fire would produce black smoke. Sensitive to cumulative obscuration presented by a smoke field.	Areas subject to smoke, steam, dust or dirt during normal use. Less sensitive to colour of smoke. Cannot detect clean colourless smoke
	g) Aspirating (Air-sampling) type smoke detector	They are suitable for use where usage of other types of smoke detectors present difficulties such as aesthetics, height and temperature of the enclosure.	Air-sampling detectors are not suitable if the air movement due to HVAC requirements is outside the range specified by the manufacturers.

Sl No.	*Type of Detector*	*Suitability and Merits*	*Unsuitability and Demerits*
(1)	(2)	(3)	(4)
		Sampling points can be located almost anywhere unlike detectors which cannot be installed on walls, storage racks, machinery space, floor voids etc. Each sampling point is a detector itself. Suitable for cold storage. Higher sensitivity levels, ease of installation and most suitable for protection of high value and critical equipment.	
ii)	Heat Detectors (General)	Clean burning fires such as those involving certain flammable liquids. Areas subject to smoke, steam, dust or dirt during normal use. Fires that evolve heat and flame rapidly. Suitable for rooms where heat producing equipment like kitchen, pantry, boilers, DG sets, etc are installed/used.	Unlikely to respond to smouldering and slow burning fires, unsuitable for high value areas where a small fire can cause major damage. Areas in which presence of smoke can pose a potential threat to the occupants.
	a) Rate of rise heat detector	Areas subject to smoke, steam, dust or dirt during normal use.	Areas subject to rapid changes of temperature or temperatures over 43 °C.
	b) Fixed temperature heat detector	Areas subject to smoke, steam, dust or dirt and rapid changes of temperature during normal use.	
iii)	Multi-sensor fire detectors	Combines the characters of two types of detectors, each of which responds to different physical and/or chemical characteristics of result/effect/residue of combustion/fire in contrast to false alarms without the occurrence of fire/combustion. The purpose of combining sensors in this way is to enhance the performance of the system in detection of fire or its resistance to at least certain categories of false alarms or both. There is significant potential for reduction of many types of false alarm. It is also possible to disable an individual sensor depending on the circumstances at the place of installation.	
iv)	Flame detectors (General)	High ceiling, open spaced buildings like Warehouses/aircraft hangers. Outdoor/semi-outdoor areas. Areas where rapidly developing flames occur like petrochemical/ refinery/gas installations/paint shops, etc.	Not sensitive to smouldering/ slow burning fires and hence cannot be called general purpose detectors. Not suitable for the type of fires where, flaming can occur only after substantial release of smoke.
	a) Infrared flame detector	Same as above, these detectors penetrates through smoke well. High speed, moderate sensitivity. Suitable for indoor/outdoor applications.	Affected by temperature range in the vicinity, subject to false alarms caused by blackbody radiation like heaters, incandescent lamps, halogen lamps, flickering sunlight, etc and hence usage in such areas to be avoided. Sensitive to IR radiation from sources like any hot surface, ovens, furnaces, lamps, etc also and due care shall be taken while

Sl No.	*Type of Detector*	*Suitability and Merits*	*Unsuitability and Demerits*
(1)	(2)	(3)	(4)
			installation.
	b) Ultraviolet flame detector	Highest speed, highest sensitivity. Suitable for indoor applications	Not sensitive for high ceiling, etc as the radiation from fire is attenuated by smoke. Random UV radiation from sources such as lightning, arc welding, etc can cause false alarms and hence usage in such areas to be avoided. Blinded by thick smoke and oil vapours on optics.
	c) IR/IR flame detector	High speed, moderate sensitivity, low false alarm rate, most suitable for chemical and hydrocarbon flames in particular as signal received is processed at two sensors. Suitable for indoor/outdoor applications.	Somewhat affected by temperature range in the vicinity, suffer from atmospheric attenuations, especially on long range detection applications.
	d) UV/IR detector	Highest speed, highest sensitivity and low false alarm rate.	Blinded by thick smoke and oil vapours on optics. Suitable for indoor/outdoor applications.
	e) IR/IR/IR (IR3) detector	Highest speed, highest sensitivity, lowest false alarm rate. Most suitable for chemical and hydrocarbon flames in particular as signal received is processed at three sensors.	No significant disadvantages. Suitable for indoor/ outdoor applications.
	f) Spark Detector	Spark detectors are suitable for detection of sparks some types of duct or conveyor, monitoring the fuel, etc as it passes by. Usually, it is necessary to enclose the portion of the conveyor where the detectors are located, as these devices generally require a dark environment.	Extraneous sources of radiant emissions that have been identified as interfering with the stability of spark detectors include (a) ambient light, (b) electromagnetic interference (EMI, RFI), and (c) electrostatic discharge in the fuel stream.
	g) Ember detector	Same as above except that ember detectors can also detect fires in lit environment like coal conveyors, etc.	Detector window clarity shall always be ensured.
v)	Linear heat sensing cables	Cables tunnels, trays and vaults, material conveyors. Bulk storage multi-racked areas. Rim seals of floating roof tanks storing hazardous chemicals, and a few other special occupancies.	Not suitable at all applications other than what is specified.
vi)	Wireless Smoke Detectors	Ideal for locations with limited infrastructure. Perfect for retrofitting or areas where installation of wired systems is challenging.	Not recommended for environments with high RF interference. Not suitable for high-risk environments where immediate response is critical (for example, high-rise buildings, large industrial spaces with complex fire safety

Sl No.	*Type of Detector*	*Suitability and Merits*	*Unsuitability and Demerits*
(1)	(2)	(3)	(4)
			needs). Wireless systems provide flexibility but should be deployed in situations where reliability, performance, and RF compatibility are guaranteed.

ANNEX D

(*Foreword*)

INFORMATION ON ONLINE HEALTH MONITORING OF FIRE PROTECTION SYSTEMS

D-1 The system combines online monitoring of fire protections equipment and fire safety systems based on Internet of Things (IoT). These systems are designed to acquiring the real-time information of fire assets working condition, improving the reliable prediction mechanism in traditional fire monitoring system.

D-2 A perception terminal based on IoT is developed and the fire real-time monitoring and control system can be designed. This system can acquire the real-time working condition information of fire alarm system — fault or alarm state, fire hydrant systems — main line pressure, pumps on-off records, trip status, fire extinguishing facilities, such as pressure, location and obstruction etc, current and voltage of the electric equipment, valve switch, relay action, alarming message, it can upload the collected data to the monitoring centre through the C/S (client/server) architecture.

D-3 System lifespan records can be obtained and proactive actions can be taken in case of frequent repeat of events. Various notifications parameters based on hierarchy/escalations can be set to ensure rapid action can be taken in case of emergency. A fire safety evaluation model based on ontology with the usage of protege is established, which facilitate the on-line monitoring and control of building fire protection information, the prediction of electrical fire and improve building safety level evaluation.

ANNEX E

(*Foreword*)

COMMITTEE COMPOSITION

Fire Fighting Sectional Committee, CED 22

Organization	*Representative(s)*
In Personal Capacity (*House No. 1933, Sector-4, Urban Estate, Gurugram*)	DR K. C. WADHWA (***Chairperson***)
Advance Firetec and Research Lab Private Limited, New Delhi	SHRI SUBIR K. NANDI
Agni Controls, Chennai	SHRI D. BALACHANDRAN SHRI ARUN KUMAR (*Alternate*)
Airports Authority of India, New Delhi	SHRI ARVIND KUMAR SHRI P. K. DESHMUKH (*Alternate*)
Central Industrial Security Force, New Delhi	SHRI SUDHIR KUMAR
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CSIR - Central Building Research Institute, Roorkee	DR HARPAL SINGH SHRI SHORAB JAIN (*Alternate*)
Directorate General of Quality Assurance, New Delhi	CONTROLLER JT CONTROLLER (*Alternate*)
Engineers India Limited, New Delhi	SHRI AMITABH KISHORE SHRI GYASUDDIN (*Alternate* I) SHRI AKASH DEEP PATEL (*Alternate* II)
Fire and Emergency Services, Kolkata	SHRI ABHIJIT PANDEY SHRI KAMAL NANDY (*Alternate*)
Fire and Security Association of India, Chennai	SHRI HEMANT KHADSE SHRI LAKSHMI PRASAD C (*Alternate*)
FM Engineering International India Limited Branch, Bengaluru	SHRI SRIKANTH YAJJALA SHRI YASSAR NABEEL MOHAMED (*Alternate*)
Gunnebo India Private Limited, Thane	SHRI JOHNSON MATHEW SHRI SAMIR MISRI (*Alternate* I) SHRI YOGESH JADHAV (*Alternate* II)
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Institute of Fire Engineers India, New Delhi	PRESIDENT SHRI U. S. CHHILLAR (*Alternate* I) SHRI PRADEEP KUMAR (*Alternate* II)

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K. V. Fire Chemicals India Private Limited, Navi Mumbai	SHRI RAJESH SABADRA SHRI UDAY K. SHROFF (*Alternate*)
Maharashtra Fire Services, Mumbai	SHRI SANTOSH S. WARICK SHRI KIRAN HATYAL (*Alternate*)
Ministry of Home Affairs, New Delhi	SHRI PRASHANT LONKAR SHRI MORESHWAR KUDKILWAR (*Alternate*)
National Association of Fire Officers, Mumbai	SHRI M. V. DESHMUKH SHRI SOURABH CHOWDHURY (*Alternate*)
National Fire Service College, Nagpur	DR ANANT R SONTAKE
Oil Industry Safety Directorate, Noida	SHRI MURARI MOHAN PRASAD SHRI NAWAL. K. PANDEY (*Alternate*)
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RESQ Technologies, Ahmedabad	SHRI ROHIT V. SHAH
Safex Fire Services Limited, Mumbai	SHRI JITENDRA SHAH SHRI SANDIP SHAH (*Alternate*)
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Swastik Synergy Engineering Private Limited, Mumbai	SHRI MUKESH D. SHAH SHRI KUNAL ZATAKIA (*Alternate* I) SHRI VARUN SHAH (*Alternate* II)
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Member Secretary
SHRI RAJESH CHOUDHARY
SCIENTIST C/ASSISTANT DIRECTOR
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Panel for Fire Detection Alarms and Suppression System, CED 22 : P4

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Agni Controls, Chennai	SHRI D. BALACHANDRAN SHRI SELVAKUMAR BALACHANDRAN (*Alternate*)
Astral Poly Technic Limited, Ahmedabad	SHRI RITESH PATEL SHRI MANOJ DHAR (*Alternate*)
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Directorate General of Quality Assurance, New Delhi	COLONEL SABIR HANDEKAR COL N. K. N RAO (*Alternate*)
East Corporation, Thane	SHRI HEMANT KHADSE
Engineers India Limited, New Delhi	SHRI AMITABH KISHORE SHRI GYASUDDIN (*Alternate* I) SHRI NISHANT SINGLA (*Alternate* II)
F.M. Engineering International India Branch, Bengaluru	SHRI SRIKANTH YAJJALA SHRI YASSAR NABEEL MOHAMED (*Alternate*)
Fire Safe India Foundation, Mumbai	SHRI M. V. DESHMUKH
Fire and Emergency Services, Kolkata	SHRI ABHIJIT PANDEY
Fogtec Brandschutz GmbH and Company, Mumbai	SHRI JACKSON JOSE

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Institute of Fire Engineers India, New Delhi	PRESIDENT DR G. C. MISRA (*Alternate*)
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Nohmi Bosai India Private Limited, Gurugram	SHRI AJIT RAGHAVAN
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TTS Consultant, Kolkata	SHRI TARAK CHAKRABORTY
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(Continued from second cover)

Part 10	Point-type flame detectors
Part 11	Manual call points
Part 12	Line type smoke detectors using a transmitted optical beam
Part 13	Compatibility assessment of system components
Part 15	Point type fire detectors using scattered light, transmitted light or ionization sensors in combination with a heat sensor
Part 16	Sound system control and indicating equipment
Part 17	Short circuit isolators
Part 18	Input/output devices
Part 20	Aspirating smoke detectors
Part 21	Routing equipment
Part 22	Smoke detection equipment for ducts
Part 23	Visual alarm devices
Part 24	Fire alarm loudspeakers
Part 25	Components using radio transmission paths
Part 27	Point type fire detectors using a smoke sensor in combination with a carbon monoxide sensor and, optionally, one or more heat sensors
Part 29	Video fire detectors
Part 31	Resettable line-type heat detectors

This revision is taken up to incorporate suitable references to the above Indian standards apart from incorporation of latest developments in the field of automatic fire detection and alarm systems. The following are the major changes made in this revision:

a) Information regarding conventional fire alarm system and addressable fire alarm system have been covered in detail;

b) Additional requirements for the detection zones that contain addressable fire alarm system have been included;

c) Smoke detectors and its types such as ionization type, optical (photoelectric) and air sampling type smoke detector have been updated and explained in detail;

d) Information regarding flame detector also has been updated;

e) Detector types such as line type detector, carbon monoxide fire detector and multicriteria detector have been added and explained in detail;

f) The principles to be followed while choosing a fire detector have been updated;

g) Siting and spacing of detectors have been updated and modified;

h) Maximum distance between any point and the nearest smoke/heat detector and its location with respect to height of ceiling have been updated in Table 1;

j) Provisions regarding linear heat sensing cables (LHS) have been included;

k) Schedule of maintenance has been updated with modified table of inspection;

m) Information on various types of fire alarm systems have been introduced in Annex B;

n) Terminology has been brought up-to-date;

o) An informative Annex D for information on online health monitoring of fire protection systems has been included.

The composition of the Committee responsible for the revision of this standard is given in Annex E.

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, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of specified value in this standard.

Bureau of Indian Standards

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: CED 22 (26193).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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