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Fire detection and alarm systems for buildings

Part 6. Code of practice for the design and installation of fire detection and alarm systems in dwellings

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This document contains 42 pages

Committees responsible for this British Standard

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AEA Technology
British Cable Makers' Confederation
British Fire Protection Systems Association Ltd.
British Fire Services' Association
British Telecommunications plc
Chartered Institution of Building Services Engineers
Chief and Assistant Chief Fire Officers' Association
Consumer Policy Committee of BSI
Department of Health
Department of the Environment (Building Research Establishment)
Department of the Environment (Central Advice Unit)
Department of the Environment (Property and Buildings Directorate)
Electrical Contractors' Association
Home Office
Institute of Fire Safety
Institution of Electrical Engineers
Institution of Fire Engineers
London Fire and Civil Defence Authority
Loss Prevention Council
Ministry of Defence
National Association of Fire Officers
National Caravan Council Limited
National Inspection Council for Electrical Installation Contracting
National Quality Assurance
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Engineering Industries Association
Professional Lighting and Sound Association

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Foreword

This Part of BS 5839 has been prepared by Subcommittee FSM/12/1, Installation and servicing, under the direction of Technical Committee FSM/12, Fire detection and alarm systems. No existing standard is superseded but, whereas BS 5839 : Part 1 provides recommendations for fire detection and alarm systems in buildings generally, this Part of BS 5839 should now be used for specific guidance on fire detection and alarm systems in dwellings.

In the United Kingdom, between 70 % and 80 % of all fire deaths and injuries occur in dwellings, a total of approximately 600 deaths and more than 10,000 injuries per annum. Many of those who die are the most vulnerable in the community, namely the elderly, the socially deprived, and the very young. The installation of a fire detection and alarm system in a dwelling can substantially reduce the risk of death or serious injury from fire. Indeed, the overall downward trend in annual fire deaths in dwellings during the 6 years immediately preceding the publication of this Part of BS 5839 is almost certainly attributable in part to the increasing use of smoke alarms. The level of deaths and injuries remains, however, above a level that society regards as acceptable. It has been estimated that, in dwellings without smoke detectors, a substantial proportion of the fatalities from fire could be avoided if smoke detectors were installed.

In recent years, there has been substantial growth in the use of automatic fire detectors, particularly self-contained smoke alarms, for the protection of life in dwellings. There is evidence to suggest that this is reducing the number of deaths from fire. The installation of automatic fire detectors is normally required in new dwelling houses, flats and maisonettes in order to satisfy building regulations. In existing houses in multiple occupation, the installation of an automatic fire detection and alarm system may be required by the enforcing authorities. These factors have given rise to the need for a suitable code of practice, as BS 5839 : Part 1 does not contain recommendations on domestic smoke alarms (other than in the form of an Appendix), nor does it address the special design requirements for domestic fire alarm installations.

The guidance in this standard is not intended for occupiers of dwellings, but is intended for architects and other building professionals, enforcing authorities, contractors and others responsible for implementing fire precautions in dwellings. It has been assumed in the drafting of this Part of BS 5839 that the execution of its provisions will be entrusted to appropriately qualified and experienced persons.

As a code of practice, this Part of BS 5839 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Compliance with a British Standard does not of itself confer immunity from legal obligations. In particular, attention is drawn to building regulations and, in the case of houses in multiple occupation, to the relevant housing legislation.

Code of practice

1 Scope

This Part of BS 5839 gives recommendations for the planning, design and installation of fire detection and alarm systems in dwellings and dwelling units that are designed to accommodate a single family, and in houses in multiple occupation which comprise a number of self-contained units each designed to accommodate a single family. The recommendations apply to both new dwellings and existing dwellings. Recommendations for routine attention are also given.

The systems covered in this Part of BS 5839 range from those comprising a single self-contained smoke alarm to systems of the type described in BS 5839 : Part 1. The recommendations of this Part of BS 5839 may also be applied to the fire detection components of combined domestic fire and intruder alarm systems or fire and social alarm systems.

This Part of BS 5839 applies to forms of dwelling including bungalows, multi-storey houses, individual flats and maisonettes, mobile homes, sheltered houses, NHS housing in the community for mentally handicapped or mentally ill people (as defined in Health Technical Memorandum 88 [1]), mansions, and houses divided into several self-contained single-family dwelling units. It does not apply to hostels, caravans or boats (other than permanently moored boats used solely as residential premises), or to the communal parts of purpose-built sheltered housing and blocks of flats or maisonettes.

This Part of BS 5839 is intended for use by architects and other building professionals, enforcing authorities, contractors and others responsible for implementing fire precautions in dwellings. It is not intended for occupiers, for whom advice is published by the Home Departments[1)]. However, recommendations are given for simple systems which may be installed by non-specialists.

The recommendations refer principally to fire detection and alarm systems installed for the purpose of life safety. However, recommendations are given for systems that are also intended to protect property.

2 References

2.1 Normative references

This Part of BS 5839 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 34. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this Part of BS 5839 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Part of BS 5839, the following definitions apply.

3.1 access room

A room through which passes the only escape route from an inner room.

3.2 addressable system

A system in which signals from each detector and/or call point are individually identified at the control panel.

3.3 circulation area; circulation space

An area or space, including a stairway, mainly used as a means of passage between a room and an exit from the building.

3.4 detector

A component of a fire detection and alarm system that contains at least one sensor which constantly, or at frequent intervals, monitors at least one physical and/or chemical phenomenon associated with fire, and that provides at least one corresponding signal to initiate a warning.

NOTE. This definition is intended to include smoke alarms (see **3.25**).

3.5 dwelling

A unit of residential accommodation occupied (whether or not as a sole or main residence):

a) by a single person or by people living together as a family; or

b) by persons who do not live together as a family, but who live in self-contained single-family flats or maisonettes within the unit.

NOTE. The definition in a) is more restricted than that used in the documents supporting building regulations. The definition in b) relates only to some types of house in multiple occupation and specifically excludes hostel type accommodation, for which BS 5839 : Part 1 is more appropriate.

[1)] The Home Office (in England and Wales), the Scottish Home and Health Department and the Northern Ireland Office.

3.6 final circuit

A circuit connected to current-using equipment, or to a socket-outlet or socket-outlets or other outlet points for the connection of such equipment.

3.7 final voltage (of a battery)

The voltage at which the cell manufacturer considers the cells to be fully discharged at the specified discharge current.

3.8 control equipment

Equipment that, on receipt of a fire signal, controls the giving of a fire alarm by one or more of the following:

a) fire alarm sounders;

b) indicating equipment;

c) a transmitter which is capable of transmitting fire alarm signals to a remote location.

3.9 indicating equipment

Equipment that provides visual indication of any fire alarm or fault warning signal received from control equipment.

3.10 fire alarm sounder

A component of a fire detection and alarm system for giving an audible warning of fire.

3.11 fire detection and alarm system

A system that comprises a means for automatically detecting one of the characteristic phenomena of fire and a means for providing a warning to occupants.

NOTE. This definition is intended to include fire detection and alarm systems that comprise one or more smoke alarms, as well as systems that comprise separate detectors, alarm sounders and control equipment.

3.12 fire-resisting construction

Construction that is able to satisfy for a stated period of time some or all of the appropriate criteria given in the relevant parts of BS 476.

3.13 fire risk

A combination of the probability of fire occurring and the magnitude of the consequences of fire.

NOTE. This differs from the definition in BS 4422, which defines fire risk as the risk of fire occurring. However, the above definition accords with the definition of risk used in other standards and with that used in the safety field by organizations such as the Health and Safety Executive (HSE).

3.14 flat

A dwelling, forming part of a larger building, that has all its rooms on one level or not more than half a storey height apart.

3.15 house in multiple occupation

A house that is occupied by persons who do not form a single household.

3.16 habitable room

Any room in a dwelling other than a kitchen, utility room, bathroom, dressing room or WC.

3.17 inner room

A room from which escape is possible only by passing through another room (the access room: see **3.1**).

3.18 maisonette

A dwelling, forming part of a larger building, which includes rooms on two or more levels that are more than half a storey height apart.

3.19 maximum alarm load

The maximum electrical load imposed on the power supply to the fire detection and alarm system by the simultaneous operation of all alarm devices, any visible and audible indications at any control and indicating equipment, etc., when fire signals are generated by the maximum number of detectors that can simultaneously give them.

3.20 mobile home

A transportable unit of living accommodation that does not meet the requirements for construction and use of road vehicles but that retains means for mobility.

3.21 monitored wiring

Wiring in which an open circuit will result in a fault warning (but not an alarm of fire), while a short circuit will result either in a fault warning or an alarm of fire.

NOTE. This definition differs from that in BS 5839 : Part 1, in which monitored wiring is defined in such a way that an open circuit or a short circuit both result in a fault warning but not an alarm of fire. For some systems, this Part of BS 5839 recommends that monitoring be in accordance with the definition in BS 5839 : Part 1 (see **14.2**).

3.22 normal supply

The supply from which the fire detection and alarm system is expected to obtain its power.

3.23 sheltered housing

A block or group of dwellings, with each dwelling incorporating its own cooking and sanitary facilities, designed specifically for persons who might require assistance, e.g. elderly people, and where some form of assistance is available at all times.

NOTE 1. This should not be taken as implying that assistance need be provided on the premises.

NOTE 2. Sheltered housing usually includes amenities common to all occupiers, such as living rooms, guest rooms, etc., which are outside the scope of this Part of BS 5839.

3.24 smoke

Particulate and aerosol products of combustion, whether this be of the smouldering or open flame type.

3.25 smoke alarm

A device containing within one housing all the components, except possibly the energy source, necessary for detecting smoke and for giving an audible alarm.

3.26 social alarm system

A system that provides facilities for alarm initiation, signal transmission, alarm reception, reassurance and assistance, for use by elderly and other persons considered to be living at risk.

3.27 standby supply

An electricity supply that provides power to the fire detection and alarm system when the normal supply fails.

3.28 zone

A subdivision of the protected premises such that the occurrence of a fire within it will be indicated by a fire alarm system separately from a fire in any other subdivision.

NOTE. A zone is separately indicated to assist in location of the fire and to assist fire-fighters.

4 Risk analysis

4.1 General

A fire detection and alarm system, although it can do nothing to reduce the incidence of fire, can help to lessen the resultant loss in terms of injury to occupants or damage to property. However, the system should be regarded as just one component of a properly engineered approach to fire safety. System design should take into account the contribution of all other fire precautions to the reduction of the risk.

In order to maximize the cost-benefit of a fire detection and alarm system, it is essential that the system design be appropriate to the fire risk.

Accordingly, the design of any fire detection and alarm system installed in accordance with this Part of BS 5839 should be based on a good understanding of fire risk in dwellings. A high fire risk demands high reliability in the early detection of fire and warning of occupants, regardless of where the fire starts, and high reliability on the part of the system to operate correctly when required; a low fire risk might not justify the cost, complexity and extent of such a system. For example, at one extreme, the single occupant of a small bungalow might be adequately protected at very low cost by the installation of one mains-operated smoke alarm, whereas the risk to which the families in a six-storey house in multiple occupation are exposed would warrant much greater expenditure on a more complex and comprehensive system.

It is therefore essential that the design of the system, particularly in respect of factors such as the number and siting of detectors and the form of power supply, takes into account the following probabilities:

a) the probability of fire occurring;

b) the probability of injury or death of occupants if fire occurs;

c) the probability of the system operating correctly at the time of a fire;

d) the probability of early detection and warning of occupants in the event of fire.

NOTE 1. The combination of a) and b) may be regarded as the fire risk (see **3.13**).

NOTE 2. c) may be regarded as the system reliability

NOTE 3. d) may be regarded as a form of success rate for the system.

NOTE 4. A significant increase in c) or d) is likely to involve additional cost and system complexity.

System design should ensure that there is an appropriate balance between the fire risk and the system reliability and success rate (see figure 1).

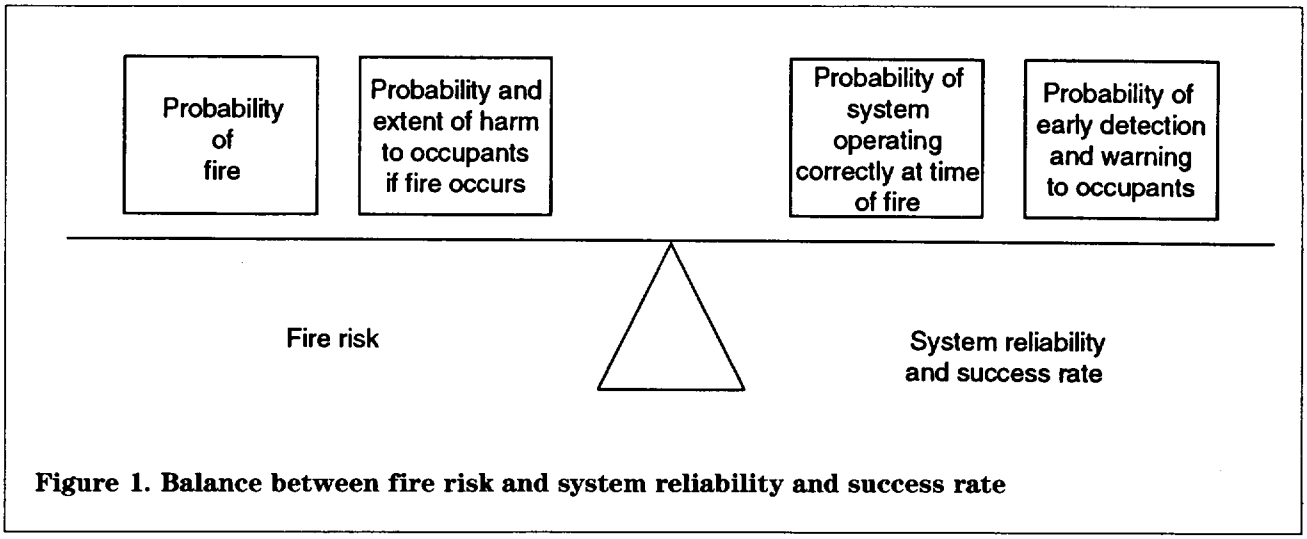

Figure 1. Balance between fire risk and system reliability and success rate

The factors that should be considered in formulating a qualitative assessment of fire risk are given in **4.2** and **4.3**; the implications of the various factors on system design are also described. Clause **8** contains guidance on the grades and types of system (see clauses **6** and **7**) that are considered generally appropriate for generic types of dwelling covered by this Part of BS 5839.

Final system design should preferably be based on the considerations given in **4.2** and **4.3**, particularly if it is proposed to deviate from the guidance given in clause **8** or if there are risk factors additional to those encountered in typical examples of the dwelling types defined in clause **8**. However, in many cases, occupant characteristics and other relevant factors are not known to the designer (e.g. in the case of new dwellings). In such cases, design should be based on the guidance given in clause **8**.

4.2 Assessment of fire risk and implications for system design

In assessing the fire risk, each room in the dwelling should be considered separately. The assessment should be based on recognized fire statistics[2)].

In considering the probability of fire in a room, account should be taken both of statistical data on the relative likelihood of fire in a room of that type (e.g. living room, bedroom), and of all potential sources of ignition within the room. In considering the potential for injury or death to occupants, account should be taken both of statistical data on the relative likelihood of injury or death due to fires that start in a room of that type, and of all occupant characteristics that are relevant to their probability of injury or death from fire.

It should be noted that the level of fire risk in any dwelling covered by this Part of BS 5839 is unlikely to be sufficiently low to obviate the need for a fire detection and alarm system. Accordingly, it is recommended that a system be installed in all dwellings described in clause **1**, whether new or existing, in accordance with the guidance given in this standard.

In assessing the fire risk to which occupants of a dwelling are exposed, the following should be taken into account, along with the design considerations described in clause **5**.

a) The presence of smoke in escape routes is the greatest impediment to safe escape in the event of fire. It is essential that any fire that starts in a circulation area, or smoke that spreads into a circulation area, be detected as early as possible. Smoke detectors should therefore be installed in the circulation areas of all dwellings.

b) In the United Kingdom, approximately 40 % of fires in dwellings involve cooking appliances, but these fires account for only 10 % of the deaths that occur. Approximately 15 % of all fire deaths result from fires that originate in kitchens. However, in single-family dwellings, it is unlikely to be necessary to install detectors in kitchens for the protection of life, but it is essential that a smoke detector be sited in any adjacent circulation space.

c) Smokers' materials are the second most common cause of accidental fires in dwellings. Fires started by smokers' materials are the most common cause of fatalities, resulting in around one third of fatalities in accidental fires. In most cases, the item ignited is bedding or furniture. If occupants are known to smoke, there is greater justification for installing smoke detectors in living rooms and dining rooms, particularly as older furniture may not be resistant to ignition by a smouldering cigarette or a match. If the occupants smoke in bed, consideration should be given to the installation of smoke detectors in bedrooms.

d) Space heating appliances are the second most common cause of fatalities from fire in dwellings. Such fires often result when combustible materials are placed too close to the source of heat. If portable heaters or solid-fuel fires are used during the night, there may be justification for installing smoke detectors in the relevant rooms, particularly if these are bedrooms.

e) Fires caused by electrical appliances and wiring account for approximately 14 % of all fires in dwellings, but result in only around 8 % of deaths. Approximately one fifth of the fires involving electrical appliances (other than cooking or heating appliances) are caused by electric blankets and bed warmers. However, these fires result in as many as two thirds of the fatalities that occur in fires ignited by electrical appliances. Use of electric blankets, particularly by high-risk groups such as the elderly, increases the justification for providing smoke detectors in bedrooms.

f) Arson is a growing problem; the number of maliciously ignited fires in dwellings doubled in the 10 years from 1981 to 1991. Malicious ignition is the second most common cause of all fires in dwellings, although the proportion of deaths that result remains under 10 %. Malicious ignition is a more significant cause of fire in multiple-occupancy dwellings than in single-family dwellings. If malicious fire-raising is a significant possibility, the level of protection

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[2)] A suitable source of statistical information is *Fire Statistics United Kingdom* [*2*], *published annually by the Home Office.*

should be high. If malicious ignition by a third party is considered to be a significant threat (e.g. by passing burning material through a letter box), the system should be capable of providing early warning of a fire inside the dwelling that starts in the vicinity of any entrance door.

g) Elderly people are at significantly greater risk from fire than other age groups. For those aged 80 years or more, the probability of dying from fire is several times that for those aged from 30 to 59 years. Those aged from 60 to 80 years are also at slightly increased risk. Children under 5 years are at greater risk than adults. Dwellings in which the principal occupant is elderly, or in which there is a number of elderly occupants or young children, should be protected to an appropriately high level.

h) Socially deprived occupants on a low income are more likely to suffer death or serious injury from fire than those in higher socio-economic groups. For those most at risk, replacement of batteries in smoke alarms may, of necessity, be a low priority. In these cases, a more reliable power supply for the fire detection and alarm system is essential.

i) It has been estimated that the risk of death from fire in a house in multiple occupation is eight to ten times higher than in a single-family dwelling[3)]. Accordingly, it is essential that there is a high level of protection by a highly reliable fire detection and alarm system in all houses in multiple occupation. It is also essential that a warning is given in the event of a fault that impairs the standard of protection.

j) People with impaired mobility require more time to escape. To allow for this, the system should ensure earlier warning in the event of fire; this may necessitate the provision of detectors in certain rooms as well as in circulation areas.

k) Approximately one half of all fatalities from fire in single-family dwellings occur in the room where the fire originates. In houses in multiple occupation, the proportion is approximately 60 %. In this connection, it should be noted that, if the door of the room where the fire originates is closed, a smoke detector outside the room is unlikely to operate at an early enough stage to prevent loss of life in the room.

l) The combined number of fires originating in living rooms and dining rooms is similar to the number of fires originating in bedrooms. However, nearly half of all fatal fires in dwellings start in living rooms or dining rooms, whereas approximately 30 % start in bedrooms. This suggests that, if detectors are installed within rooms in a dwelling, the living room and dining room should be the first priority, followed by the bedrooms. However, it may be appropriate to reverse these priorities if the fire risk in the living room or dining room is low but occupants smoke in bed, or if bedrooms contain potential sources of ignition such as electric blankets or other electrical appliances.

m) Occupants of dwellings are at greater risk when they are asleep. It is therefore essential that fire detection and alarm systems are capable of operating correctly when occupants are asleep and are capable of arousing occupants from normal sleep.

4.3 Additional considerations for property protection systems

The matters described in **4.2** relate to the risk to life from fire. All systems within the scope of this Part of BS 5839 should be designed to protect occupants in the event of fire. Only in exceptional circumstances (e.g. in a house of historic importance in which no one sleeps) should the objective of the system be solely the protection of property. However, the objective of the system may sometimes be the protection of property as well as of life. A fire detection and alarm system for the protection of property should be able to automatically detect fire and result in the summoning of the fire brigade at an early enough stage in fire development to ensure that, when the fire brigade arrives, the fire is relatively restricted in extent.

If the attendance time of the fire brigade is incompatible with the probable rate of fire spread, and water supplies for fire-fighting are limited, the provision of additional fire protection measures to limit fire development prior to the arrival of the fire brigade should be considered in the case of properties of particular importance (e.g. a historic country mansion).

This clause describes additional considerations that should be taken into account in assessing the risk to property from fire, and the implications for the design of systems intended to protect property as well as life.

[3)] From *Amenity Standards for Houses in Multiple Occupation* [3].

Since a fire that starts anywhere in the house will result in damage, detectors should be provided in some or all rooms of the dwelling. It is unlikely to be sufficient to provide detectors only in circulation areas. The primary considerations should be the probability of fire in each room and the probability that fire will be discovered before significant spread occurs. Accordingly, there may be a need for fire detectors in kitchens, living and dining rooms, for example, as well as in boiler rooms and other infrequently visited areas (e.g. cellars and roof spaces) where there are likely sources of ignition. Table 1 may be used as a basis for prioritizing the areas in which additional detectors should be installed.

There is evidence that the presence of fire detectors can result in a reduction in the amount of damage in the event of fire, provided that prompt action is taken when fire is detected. Even in dwellings protected by smoke alarms, property has on occasions been saved because neighbours heard the alarms when the dwelling was unoccupied. However, a good level of property protection can usually be achieved only if there is a means for automatic transmission of fire signals to the fire brigade when the dwelling is unoccupied (see clause **18**).

5 Design considerations

5.1 Battery-operated smoke alarms

The simplest form of fire detection and alarm system is a single battery-operated smoke alarm. The protection afforded by these devices is obtained at very low cost and they are relatively simple to install in existing dwellings.

Battery-operated smoke alarms conforming to BS 5446 : Part 1 give an audible fault warning before an increase in the internal resistance, or a decrease in the terminal voltage, of the battery prevents correct operation. Provided that the battery is always replaced when necessary, battery-operated smoke alarms can provide a degree of protection at minimal cost. However, the audible fault warning can be disabled by removal of the battery, and failure to then replace the battery results in loss of protection. The socio-economic groups most at risk from fire are those least likely to be able to ensure that a healthy battery is always present. Batteries can also be removed for use in other appliances or to prevent false alarms. The ability of battery-operated smoke alarms to detect a fire some years after initial installation is therefore not considered to be high.

5.2 Mains-powered smoke alarms

Mains-powered smoke alarms are potentially more reliable than battery-operated devices because they require less attention by the user. The cost of the fire detection and alarm system is, however, higher, owing to the need to install a mains power supply to the smoke alarms, and to the higher cost of the smoke alarms themselves. This additional cost and complexity is, nevertheless, justified in the case of fire detection and alarm systems in new dwellings. It is also justified in the case of systems installed in existing dwellings occupied by persons who may not be able to replace batteries soon after the audible fault warning of a battery-operated smoke alarm sounds (e.g. elderly or socially deprived occupants).

Table 1. Relative frequency of fire in rooms within dwellings[1)]

Room	Proportion of all domestic fires
Kitchen	46 %
Bedroom, bedsitting room	15 %
Living room, dining room	14 %
Access area	5 %
Ashpit, refuse area	4 %
Store	2 %
Bathroom, cloakroom, WC	2 %
Roof space	1 %
Laundry	1 %
Airing cupboard, drying cupboard	1 %
Miscellaneous and unknown	9 %

[1)] Based on *Fire Statistics United Kingdom* [2], published by the Home Office.

Mains-powered smoke alarms suffer from the disadvantage that there is no protection when the electrical supply to the circuit supplying the detectors is interrupted. This interruption can occur for any of the following reasons.

a) The electricity supply to the dwelling may be interrupted due to a fault in the public electricity supply. In this case, the fault is unlikely to exist for more than a few hours and, in most areas of the United Kingdom, faults of this type occur infrequently. The proportion of time for which mains-operated detectors are disabled by supply faults is likely to be almost negligible.

b) The electricity supply to the dwelling may be disconnected deliberately by the public electricity supplier in order to carry out essential maintenance or other work. This would normally occur only after occupiers have been notified. Disablement for this reason is infrequent, usually of relatively short duration and normally occurs during the day, when the fire risk to occupants is lower.

c) The electricity supply to the dwelling may be disconnected deliberately by the public electricity supplier for contractual reasons (e.g. failure by the occupier to pay for supplies). Disablement of this type is largely, but not solely, associated with social deprivation.

d) The electricity supply within the dwelling may be disconnected at a coin- or card-operated meter because of the inability of the occupier to pay for further supplies. This is usually associated with social deprivation.

e) The circuit supplying the smoke alarm(s) may be interrupted due to a fault or to the unwanted tripping of a protective device (e.g. a miniature circuit breaker or residual current device), or by deliberate action on the part of the occupier (e.g. due to a previous false alarm).

In order to ensure reliability and provide a suitable means for deliberate disconnection in the event of a fault that results in a prolonged false alarm indication, smoke alarms operated only from a mains supply should be supplied from a dedicated circuit at the dwelling's main distribution board (see **13.6**).

A further disadvantage of smoke alarms operated solely from a mains supply is that, if a fault occurs on the circuit supplying the detectors, a warning is not always given. The smoke alarm(s) could, therefore, unknown to the occupants, remain disconnected for a considerable time. Although this could be overcome by connecting the smoke alarm to a circuit supplying, for example, regularly used lighting, the benefits would be outweighed in many cases by the risk of failure of a lighting circuit due to fire damage, before fire has been detected and adequate warning has been given to occupants.

Fire detection and alarm systems comprising smoke alarms operated solely from a mains supply should preferably incorporate a dedicated visual and/or audible means of indicating mains failure (see **13.6**).

In many typical single-family dwellings in which occupants are not considered to be at high risk from fire, the reliability of mains-operated smoke alarms may be sufficient to provide an adequate degree of protection. However, consideration should be given to the relative frequency of mains supply failures or disconnections and the likelihood that, during such periods, occupants will use methods of lighting, heating and cooking that will increase the fire risk.

5.3 Mains-powered smoke alarms with standby supplies

The reliability of systems comprising mains-powered smoke alarms can be improved by the use of devices that incorporate, within each smoke alarm, a standby supply (e.g. a primary or secondary battery or a capacitor), which powers the smoke alarm when the mains supply is unavailable. The installation of mains-powered smoke alarms with standby supplies should be considered if the reliability of the mains supply is not high, or if the fire risk is likely to be high during periods of failure or disconnection of the mains supply to the dwelling.

Because of its capability to operate in the event of mains failure, a fire detection and alarm system comprising mains-powered smoke alarms that incorporate a standby supply may be connected to a lighting circuit (see **13.5**). This has the advantage that the circuit is unlikely to be disconnected for a prolonged period of time. However, consideration should be given to the difficulty of disabling a smoke alarm that is permanently in the alarm state due to a fault, without isolating lighting.

5.4 Fire detectors supplied with power from a common power supply unit

More effective control and monitoring of a fire detection and alarm system can be provided by connecting all fire detectors to a common power supply, comprising the normal mains, rectified and regulated as appropriate, with a standby supply, such as a secondary battery. Examples of such systems include:

a) one or more smoke alarms operating at extra-low voltage and connected to a control unit at an appropriate location in the dwelling;

b) intruder alarm systems or social alarm systems that incorporate control and indicating equipment to which one or more fire detectors are connected; the detectors can be smoke alarms or fire detectors with independent sounders.

This type of system normally incorporates a secondary battery of a type unsuitable for use in normal domestic appliances and therefore unlikely to be removed for other purposes.

5.5 Systems of a type described in BS 5839 : Part 1

A higher standard of control, monitoring and system availability can be achieved by installing a system of the type recommended in BS 5839 : Part 1. Such systems comprise dedicated fire alarm control and indicating equipment, fire detectors and fire alarm sounders. Where wiring is used to connect the fire detectors and fire alarm sounders to the control and indicating equipment, the wiring is monitored so that a fault indication is given at the control and indicating equipment in the event of specified faults in the wiring. The cost and complexity of these systems is significantly greater than that of the systems described in **5.1** to **5.4**. Systems of the type recommended in BS 5839 : Part 1 may nevertheless be appropriate where the risk is high and a commensurately high level of reliability is required. However, adequate protection of a dwelling may be possible without following all the recommendations of BS 5839 : Part 1.

5.6 System planning

Regardless of the nature and configuration of the system adopted, the probability of escape by occupants in the event of fire will only be sufficiently high if there is an adequate number of detectors and if the sound level of the audible warning to occupants is sufficient to arouse them from sleep. Recommendations for the siting of fire detectors are given in clause **10**. Recommendations on the sound pressure level of audible warnings are given in clause **12**. In some dwellings, it may not be possible to achieve the standard of audibility recommended in clause **12** unless more than one sounder operates when fire is detected. For example, in dwellings of two or more storeys, or in large single-storey dwellings, the audibility of the alarm given by any one of the two or more smoke alarms that might be required to ensure adequate protection may not be sufficient to alert all occupants, particularly if they are asleep. The smoke alarm in the area of fire origin is, in these cases, unlikely to produce an adequate sound level throughout the house. If two or more smoke alarms are installed, they should normally be interconnected, whether by wiring or radio, to ensure that, when any one device detects fire, all smoke alarms in the dwelling give a fire alarm warning. In new dwellings, all smoke alarms in the dwelling should be interconnected in this manner. In order to comply with the recommendations of clause **12**, the number of smoke alarms required can exceed that necessary to comply with clause **10**. If systems incorporating dedicated alarm sounders are installed, careful consideration should be given to the siting of sounders to ensure compliance with the recommendations of clause **12**.

5.7 Silencing and disablement facilities

5.7.1 Reliability of the system can be affected if the rate of false alarms is high: occupants may disable the system to silence the alarm or avoid further false alarms. The method of disablement could be such as to result in prolonged disablement, long beyond the time necessary to silence or temporarily prevent false alarms. In order to avoid the use of undesirable methods of disablement, all fire detection and alarm systems within the scope of this Part of BS 5839 should be provided with suitable and readily accessible means by which the user can silence fire alarm signals without the use of a tool.

NOTE 1. A fuse does not constitute a suitable means of silencing, since its removal and replacement involve a degree of skill.

NOTE 2. Suitable and readily accessible means of silencing do not include any means involving disconnection of a battery, except in the case of mains-operated smoke alarms with a standby battery that can be removed without the use of a tool. Even in the case of such smoke alarms, the need to remove a battery in order to silence the alarm could be undesirable if occupants are elderly or disabled.

NOTE 3. A 'hush' facility, which greatly reduces the sensitivity of a smoke alarm for a temporary period, is regarded as a suitable means of silencing the alarm in compliance with the recommendations of this clause.

In the case of systems incorporating control and indicating equipment, dedicated facilities may also be provided for disabling the system, for use during periods when false alarms are known to occur (e.g. during certain cooking activities).

Except in the case of systems incorporating control and indicating equipment conforming to BS 5839 : Part 4, the method of silencing may be the same as the method of disablement. In the case of smoke alarms, the silencing control may be combined with the test control.

5.7.2 If a fire detection and alarm system within the scope of this Part of BS 5839 is silenced or disabled, by means of dedicated silencing or disablement facilities specifically provided to comply with the recommendations of **5.7.1**, one of the following conditions should be met.

a) The system should be restored automatically to the normal condition not more than 30 min after the action of silencing or disablement.

b) An audible warning should sound for a minimum of 0.008 s at least every 10 min.

c) In systems with control and indicating equipment, a visual and audible warning should be given at the control and indicating equipment. The audible warning should sound for a minimum of 0.5 s at least every 10 min.

NOTE 1. A miniature circuit breaker on a circuit supplying smoke alarms, but supplying no other electrical equipment except a dedicated mains failure monitor, conforms to the recommendation for a suitable and readily accessible means of silencing, but is not considered to be a dedicated silencing or disablement facility. The recommendations of **5.7.2** do not therefore apply to miniature circuit breakers.

NOTE 2. In the case of smoke alarms connected to a lighting circuit, the option described in **5.7.2b** may be preferable so that continual false alarms due to a permanent detector fault can be prevented without isolating the lighting circuit.

5.8 Monitoring

In many simpler systems which incorporate interconnecting wiring for the supply of power to detectors, or for the interconnection of smoke alarms, the wiring is unmonitored. However, monitoring of wiring reduces the amount of time for which a system is likely to be disabled before a fault in the wiring is discovered. If the risk to life from fire is high, or the wiring is likely to be subject to mechanical damage or damage by rodents, systems that incorporate monitored wiring should be used.

5.9 Test facilities

Even if the wiring of a system is monitored, regular routine testing is important and should be considered at the design stage. It may be desirable to include a means of manually testing any wiring circuits, and such a means should always be provided if wiring or other interconnections are unmonitored. The test facility may be used to test detector operation as well as to confirm the integrity of any external circuit connected to the detector. In systems incorporating manual call points, a manual call point may be used for manually testing detector and/or call point circuits, but the location of the call point on the associated circuit should be such that operation of the call point is an effective test of all wiring of the circuit.

5.10 Compatibility

All the individual components of a fire detection and alarm system should be mutually compatible. Conformity of any individual component to a Part of BS 5839, BS 5445 or BS 5446 does not guarantee that it will work satisfactorily in conjunction with another component conforming to those standards. If the components of an installation are made by different manufacturers, it is essential that compatibility between components is taken into account by the designer. If the fire detection and alarm system is integrated with another system (e.g. an intruder alarm or social alarm system), the recommendations of this standard should take priority over any conflicting recommendations in standards for the other system. Attention is drawn to the recommendations in appendix F of BS 5839 : Part 1 and the recommendations of BS 7807. Although dwellings are outside the scope of BS 7807, the recommendations contained therein may be regarded as a basis for the design of integrated systems in dwellings.

5.11 Compliance with British Standards

In general, all components used in the system should conform to relevant British Standards, and should have undergone type testing to those standards. Components should preferably have approval to a recognized quality approval scheme (comprising third party certification of product conformity to a relevant standard, based on testing and continuing surveillance, together with assessment of the supplier's quality systems against the appropriate standard in the BS EN ISO 9000 series).

Where there is no relevant British Standard, care should be taken to ensure as far as possible that the components are fit for their purpose.

6 Grades of system

This standard covers many types of fire detection and alarm system, which differ widely in cost, complexity, reliability and level of self-monitoring (see clause **5**). Some of the simpler forms of system are not suitable for dwellings in which the fire risk is judged to be high, while expenditure on the most complex systems may be inappropriate for low-risk dwellings (see clause **4**). For the purpose of specifying a fire detection and alarm system and the associated engineering design parameters, this Part of BS 5839 groups systems into six grades. Some of the recommendations of this Part of BS 5839 apply to all grades of system, while other recommendations apply only to particular grades. Annex A lists the clauses that apply to each grade of system. The grades are defined as follows.

Grade A: A fire detection and alarm system which incorporates control and indicating equipment conforming to BS 5839 : Part 4, and which is designed, installed and serviced in accordance with all the recommendations of BS 5839 : Part 1, except those in the following clauses, for which the corresponding clauses of this Part of BS 5839 should be substituted.

Clause/subclause of BS 5839 : Part 1	Corresponding clause/ subclause of BS 5839 : Part 6
7.2b	—
9	12
16.5	13.2
18	19

Grade B: A fire detection and alarm system comprising fire detectors other than smoke alarms, fire alarm sounders, and control and indicating equipment which either conforms to BS 5839 : Part 4 or to annex B of this Part of BS 5839.

Grade C: A system of fire detectors and alarm sounders (which may be combined in the form of smoke alarms) connected to a common power supply, comprising the normal mains and a standby supply, with an element of central control.

Grade D: A system of one or more mains-powered smoke alarms, each with an integral standby supply.

Grade E: A system of one or more mains-powered smoke alarms with no standby supply.

Grade F: A system of one or more battery-powered smoke alarms.

In the case of grade D, grade E and grade F systems, where more than one smoke alarm is installed it is recommended that the smoke alarms are interlinked (see **5.6** and **12.2**).

Guidance documents supporting legislation, and written requirements produced by enforcing authorities, often specify only a minimum level of system engineering, rather than a particular form of system. These grades are defined in such a way that a requirement for one grade of system can be satisfied (normally at higher cost) by the installation of a higher grade of system; for example, if the fire risk justified the installation of a grade C system, it would be acceptable to install a grade A or a grade B system.

7 Level of protection: types of system

7.1 General

Fire detection and alarm systems are usually installed in dwellings to protect life. However, the level of protection afforded to occupants should be related to the fire risk (see clause **4**). The appropriate level may therefore vary considerably. For the purposes of this standard, systems are classified as follows, according to the level of protection that they afford.

Type LD: an automatic fire detection and alarm system intended for the protection of life.

NOTE 1. The designation 'LD' is used to distinguish these systems, which are intended only for dwellings, from type L systems as defined in BS 5839 : Part 1, which are intended for the protection of life in any type of building.

Type LD systems are subdivided into:

type LD1: a system installed throughout the dwelling, incorporating detectors in all circulation spaces that form part of the escape routes from the dwelling, and in all rooms and areas in which fire might start, other than toilets, bathrooms and shower rooms;

type LD2: a system incorporating detectors in all circulation spaces that form part of the escape routes from the dwelling, and in all rooms or areas that present a high fire risk to occupants (see clause **4**);

type LD3: a system incorporating detectors in all circulation spaces that form part of the escape routes from the dwelling.

Type PD: an automatic fire detection and alarm system intended for the protection of property.

NOTE 2. The designation 'PD' is used to distinguish these systems, which are intended only for dwellings, from type P systems as defined in BS 5839 : Part 1, which are intended for the protection of property in any type of building.

Type PD systems are subdivided into:

type PD1: a system installed throughout the dwelling, incorporating detectors in all rooms and areas in which fire might start, other than toilets, bathrooms or shower rooms;

type PD2: a system incorporating detectors only in defined rooms or areas of the dwelling in which the risk of fire is judged to warrant their provision.

A system is rarely installed solely for the protection of property. Accordingly, type PD systems should normally be designed to comply with the recommendations of this Part of BS 5839 for a type LD system, thereby constituting a combined type LD and type PD system. If a system is intended to protect both life and property, and specific recommendations for the two types of system differ, then the system should conform to the recommendations for each of the types. For example, a system whose sole purpose is to provide full-coverage property protection (type PD1) need only have a small number of sounders; but if it is also used to provide coverage of the circulation areas for life safety (type LD3), the number of sounders should be sufficient to give warning throughout the dwelling.

7.2 Systems for the protection of life (type LD)

All dwellings should be provided with an appropriate fire detection and alarm system. The greatest benefit to life safety is given by a full-coverage system (type LD1). Such a system should give the earliest practicable warning of fire to occupants (while avoiding an excessive number of false alarms), wherever ignition may occur. However, a good level of protection can normally be obtained from a type LD2 system, in which detection is only provided at points where the fire risk is high or where combustion products would present a significant hazard to life. A type LD2 system might, for instance, have detectors only in the circulation areas of the dwelling, the living room and any bedroom in which there are significant potential sources of ignition; other areas might be left without detector coverage. The areas protected by a type LD2 system include escape routes, i.e. those areas that would be protected by a type LD3 system.

A type LD3 system is intended only to protect circulation areas that would be used as escape routes, by giving a warning if smoke is detected in these areas, so that occupants can escape before heat or smoke make this impossible. A type LD3 system should not be expected to protect people who might be involved with the fire at ignition or in its early stages. This type of system may not therefore prevent the death or serious injury of occupants in the room where the fire originates; it is intended only to ensure escape for those not immediately involved. If no detector is installed in the room in which fire starts, the time available for evacuation of other areas once fire is detected in the circulation area may be quite short.

In a large family house adapted to provide accommodation for several households in separate self-contained units, a fire in one dwelling unit can be a hazard to occupants of other units. In this case, the fire detection system should normally extend across the boundaries between occupancies or be interconnected with systems in other occupancies. In practice, it is often appropriate for there to be a single integrated fire detection and alarm system that will alert all occupants before a fire in any dwelling threatens the communal escape routes, and that will provide early warning of any fire that starts in these escape routes. This objective is additional to that of enabling occupants of the dwelling in which fire starts to escape before their escape routes become impassable due to heat or smoke (see also **8.5**).

In the case of purpose-built flats or sheltered housing, the degree of compartmentation between occupancies is normally sufficient to ensure that fire is contained in the dwelling of origin for a prolonged period. During this time, other occupants can remain in reasonable safety within their own dwellings. Accordingly, this Part of BS 5839 does not provide recommendations for fire detection systems that incorporate detectors in the communal areas or ancillary accommodation (e.g. plant rooms) within purpose-built flats or sheltered housing. If, however, the provision of detection in these areas is considered desirable, the guidance contained in BS 5588 : Part 1 should be followed and the fire detection systems should conform to the recommendations of BS 5839 : Part 1.

7.3 Systems for the protection of property (type PD)

A fire can start virtually anywhere in a dwelling, although the probability of fire varies significantly from one room to another (see table 1). If the fire is not detected at an early stage, it may grow until it becomes difficult or impossible to extinguish. The highest level of property protection will therefore be given by a type PD1 system (giving full coverage of all parts of the dwelling). In a large house of high value, or with contents of high value, such a system is generally the only type acceptable to fire insurers. The system should have a facility for transmission of fire alarm signals to a remote manned centre (see clause **18**).

A lower level of protection, still giving a useful reduction in fire risk, can sometimes be obtained by the installation of fire detectors only in those parts of the building in which there is significant potential for ignition. A type PD2 system provides partial cover of this sort.

8 Choice of system

8.1 Grade of system

System grade relates to the engineering aspects of the fire detection and alarm system. Higher grades of system tend to provide a greater level of control and monitoring of the system, or greater reliability and availability to perform correctly in the event of fire. The grade of system that should be installed depends on the nature of the dwelling, the level of fire risk and the characteristics of the occupants.

Grade F systems, comprising one or more battery-operated smoke alarms, are the least reliable in the long term because of the need for battery replacement. The system used for new dwellings should be grade E (in which the normal power supply is derived from the mains electricity supply) or higher.

However, because of their low cost and ease of installation, grade F systems (comprising battery-powered smoke alarms) may be considered for installation in existing dwellings. Nevertheless, they should not be installed in dwellings in which the fire risk to occupants is high nor where there cannot be a reasonable certainty that, when the dwelling is occupied, batteries will be replaced within a short time (typically no more than 5 days) of a battery fault warning indication. Otherwise, a system in which the normal supply is derived from the mains should be used (e.g. a grade E system).

If, in a new or existing dwelling, there are likely to be periodic interruptions to the mains supply, whether due to the inability of the occupier to pay for supplies or due to unreliability of the mains electricity supply, a grade D system or higher (in which there is a standby supply) should be installed. Where there is a need for readily accessible control of the fire detection and alarm system, a grade C system or higher should be provided. Where the fire risk calls for a high standard of system monitoring and availability, it may be appropriate to install a grade B system. If the dwelling is very large, or is subdivided into a significant number of dwelling units, a grade A system may be appropriate.

If the purpose of the system is property protection, fire insurers may require a grade A system. However, for smaller properties, a grade B or grade C system may be sufficient.

8.2 Type of system

System type relates to the level of protection afforded to occupants. The type of system that should be installed depends primarily on the fire risk (see clause **4**). All dwellings should be protected to at least the standard afforded by a type LD3 system.

If the risk to occupants from fire in any part of the dwelling is deemed to be high, a type LD2 or type LD1 system should be installed. For example, a type LD2 or type LD1 system should be installed if the occupants suffer from any disability (mental or physical) that could delay their escape from fire. If it is intended to protect reliably any occupant in the room where a fire originates, a type LD2 or type LD1 system should be provided.

In a house in multiple occupation, there may not be the same degree of compartmentation as in purpose-built blocks of flats. As it is impossible to control occupants' activities, and there is no overall supervision of the entire dwelling, it is essential that all occupants are warned before a fire in any self-contained dwelling unit threatens their safety. In order to meet this objective, in all except the smallest houses in multiple occupation, communal areas should be protected by siting detectors generally in accordance with the recommendations of BS 5839 : Part 1 for a type L2 system; these are similar to, but more onerous than, the recommendations of this Part of BS 5839 for a type LD2 system (see table 2).

8.3 Appropriate systems for typical dwellings

Dwellings covered by this Part of BS 5839 can be divided into a number of broad classes. Table 2 shows the minimum grades and types of system recommended for the protection of life in typical dwellings in each class. Attention is however drawn to building regulations which govern fire precautions in new dwellings, and to other legislation concerning fire precautions in certain types of existing dwelling (such as houses in multiple occupation). Where fire precautions are subject to legislative control, the enforcing authority should be consulted before a decision on the appropriate grade and type of system is reached.

Table 3 shows the minimum grades and types of system recommended for the protection of property in typical dwellings. In the case of large dwellings, the installation of a fire detection and alarm system may be required by fire insurers or may be taken into account by the insurer. In this case, the insurer should be consulted before a decision on the grade and type of system is reached.

It is important to note that tables 2 and 3 relate only to typical dwellings in each class and these dwellings are not intended to be comprehensive. If any doubt exists as to the appropriate system for any dwelling, the advice of specialists, such as the fire brigade, fire consultants or, if appropriate, the fire insurer, should be sought, and the choice of system should be based on a risk analysis (see clause **4**).

Table 2. Minimum grade and type of fire detection and alarm system for protection of life in typical dwellings

Class of dwelling	Minimum grade and type of system for installation in:					
	New dwellings conforming to the recommendations of BS 5588 : Part 1[1]		Existing dwellings conforming to the recommendations of BS 5588 : Part 1[1]		Existing dwellings where structural fire precautions are to a lower standard than those recommended in BS 5588 : Part 1[1]	
	Grade	Type	Grade	Type	Grade	Type
Single-family dwellings with no floor greater than 200 m^2 in area						
Bungalow, flat or other single-storey unit	E	LD3	F[2]	LD3[4]	E	LD2[3]
Owner-occupied maisonette or house of two storeys, with no floor level exceeding 4.5 m in height above ground	E	LD3	F[2]	LD3[4]	E	LD2[3]
Rented maisonette or house of two storeys, with no floor level exceeding 4.5 m in height above ground	E	LD3	E[5]	LD3[4]	E[5]	LD2[3]
House in which one floor level is more than 4.5 m above ground	C	LD3	C	LD3[4]	C	LD2[3]
House in which more than one floor level is more than 4.5 m above ground	B	LD2[6]	B	LD2[6]	B	LD2[3][6]
Single-family dwellings with one or more floors greater than 200 m^2 in area						
Single-storey dwelling	C	LD3	C	LD3[4]	C	LD2[3]
Two-storey house with no floor level exceeding 4.5 m in height above ground	B	LD3	B	LD3[4]	B	LD2[3]
House in which one or more floor levels are more than 4.5 m above ground	Grade A, with detectors sited in accordance with the recommendations of BS 5839 : Part 1 for a type L2[6][7] system					

[1] Compliance with national building regulations should be regarded as equivalent to compliance with BS 5588 : Part 1.

[2] Grade E if there is any doubt regarding the ability of the occupier to replace batteries in battery-operated smoke alarms soon after a battery warning is given (see **8.1**).

[3] Detectors should be located so as to compensate for deviations from BS 5588 : Part 1 (for example, a smoke detector should be installed in the access room to a habitable inner room that has no door or window through which escape is possible).

[4] Type LD2 if a risk analysis justifies the provision of additional detectors (see clause **4**).

[5] Grade D if there is a significant likelihood of the electricity supply being disconnected because the occupier is unable to pay for supplies.

[6] Detectors should be installed in any communal kitchen and in any communal living room.

[7] BS 5839 : Part 1 recommends that detectors are installed in escape routes and rooms adjoining escape routes. Notwithstanding the recommendations of BS 5839 : Part 1, detectors may be omitted from rooms adjoining escape corridors of 6 m or less in length.

Table 2. Minimum grade and type of fire detection and alarm system for protection of life in typical dwellings

Class of dwelling	Minimum grade and type of system for installation in:					
	New dwellings conforming to the recommendations of BS 5588 : Part 1[1]		Existing dwellings conforming to the recommendations of BS 5588 : Part 1[1]		Existing dwellings where structural fire precautions are to a lower standard than those recommended in BS 5588 : Part 1[1]	
	Grade	Type	Grade	Type	Grade	Type
Houses in multiple occupation						
Dwelling of one or two storeys with no floor level exceeding 4.5 m in height above ground and no floor greater than 200 m^2 in area	Not applicable		E	LD3[8]	E	LD2[3][8]
Other dwellings:	Not applicable					
Individual dwelling units comprising two or more rooms			E[9]	LD3	E[9]	LD2[3]
Communal areas			Grade A, with detectors sited in accordance with the recommendations of BS 5839 : Part 1 for a type L2 system[6][7]			
Sheltered housing (individual dwelling units only)[11]	C	LD3	C[10]	LD3	C[10]	LD2[3]
NHS housing in the community for mentally handicapped or mentally ill people						
Dwellings of one or two storeys occupied by no more than seven mentally handicapped or mentally ill residents	B	LD1[12]	B	LD1[12]	B	LD1[12]
Other dwellings	Grade A, with detectors sited in accordance with the recommendations of BS 5839 : Part 1 for a type L1 system					

[8] Detectors should be installed in communal circulation routes and within any circulation spaces in individual dwelling units.

[9] The detectors in individual dwelling units may be incorporated within the system installed in communal areas.

[10] Many social alarm systems installed in sheltered housing have facilities for connection, monitoring and separate identification of signals from smoke alarms. If an existing social alarm system does not provide such a facility, it may be acceptable to install a grade E system, provided that any fire signal is relayed to the warden's accommodation (see clause **18**).

[11] See also **18.1**.

[12] Type LD2 may be acceptable for a single-storey building which has an alternative means of escape to a separate exit from the dwelling.

Table 3. Minimum grade and type of fire detection and alarm system for protection of property in typical dwellings

Class of dwelling	Grade	Type
Single-storey dwelling with no floor greater than 200 m^2 in area	C	PD2
Other single-storey dwellings	B	PD1
Dwelling of two or more storeys with no floor greater than 200 m^2 in area	B	PD1
Other dwellings of two or more storeys	A system conforming to the recommendations of BS 5839 : Part 1 for a type P1 system	

8.4 Specification of systems

When specifying a system by reference to this Part of BS 5839, the grade and type of system should always be stated.

The specification for a type PD2 or LD2 system should always include details of the areas and rooms of the dwelling that are to be protected. Where mixed or combined grades or types of system are required in a dwelling, the grade(s) or type(s) of system required in each part of the dwelling should be specified (see also **8.5**).

8.5 Mixed systems

Normally, even in the largest of dwellings, a single fire detection and alarm system should serve the entire dwelling. However, exceptions may be made in some dwellings in order to meet different objectives. An example of such an exception is a house in multiple occupation which has three or more storeys. One objective of installing a fire detection and alarm system is to warn all occupants before a fire in any one dwelling threatens the communal escape routes. This objective could be met by complying with the recommendations of BS 5839 : Part 1 for a type L3 fire detection and alarm system, which involves the installation of smoke detectors within the communal escape routes and either heat or smoke detectors in rooms or areas adjoining the communal escape routes. The purpose of the detectors in the accommodation adjoining the escape routes is only to give a warning to occupants of other dwellings before the fire breaks through the door of the dwelling in which it originates. The detectors within dwellings may be sited on the ceiling or wall close to the dwelling entrance door. The siting and type of detector may not therefore be such as to provide a sufficiently early warning for occupants in the dwelling of fire origin to escape. These occupants could be adequately protected by installing smoke alarms within self-contained dwelling units, following the principles adopted in purpose-built flats. An advantage of this arrangement is that false alarms due to cooking activities in one dwelling are unlikely to result in disturbance of all occupants, particularly if heat detectors rather than smoke detectors are installed in areas adjoining escape routes for the purpose of complying with the recommendations of BS 5839 : Part 1.

Although this arrangement results in a mixture of system grades, it meets both life safety objectives. Alternatively, the objectives could be met by a single system which has detectors sited in accordance with BS 5839 : Part 1 and which incorporates smoke detectors in communal escape routes and in the circulation spaces within dwellings. This arrangement can also simplify maintenance of the system. Similarly, in sheltered housing or blocks of flats, detectors installed within the dwellings are not intended to give a warning in other dwellings (other than, in the case of sheltered housing, a warden's flat: see BS 5588 : Part 1). If, nevertheless, fire detection in either communal escape routes or selected high-risk areas such as plant rooms or communal living rooms is required, an entirely separate system could be installed in these areas (see **7.2**).

Mixed systems might also be acceptable where, for example, a grade B type PD2 system is installed for property protection in one part of a dwelling, while, for protection of life, a grade E type LD3 system is installed throughout the circulation areas of the dwelling.

If two separate systems are installed (e.g. a BS 5839 : Part 1 system supplemented by smoke alarms), it is essential that occupiers are aware of the separate nature of the systems. For example, occupiers of a house in multiple occupation should be aware of the need to maintain any smoke alarms provided in individual dwellings even though a separate system is installed for protection of escape routes.

9 Types of fire detector

9.1 General

Fire detectors are designed to detect one or more of three characteristics of a fire: smoke, heat and flame. These characteristics can be detected in various ways. No single type of detector is the most suitable for all applications and the final choice depends on individual circumstances. In the case of LD2 and LD1 systems, it may be appropriate to use a mixture of types of detector.

All fire detectors will respond to some extent to phenomena other than fire. Recommendations for reducing the incidence of such false alarms are given in clause **11**.

9.2 Smoke detectors

Two classes of smoke detector are commonly used:

a) ionization chamber smoke detectors, which operate on the principle that the electrical current flowing between electrodes in an ionization chamber is reduced when smoke particles enter the chamber;

b) optical smoke detectors, which operate by detecting the scattering or absorption of light by smoke particles.

Some detectors combine both types of sensor, so ensuring that the earliest possible warning is given, regardless of the type of fire.

Smoke detectors installed in dwellings are normally of the point type, which detect smoke at one position; these detectors may operate on optical or ionization chamber principles. Other types of smoke detector include those of the aspirating type, in which air is drawn from a number of positions to a central detector, and the beam type, which work on the optical obscuration principle. Beam detectors are effectively 'line' detectors, since they can detect the presence of smoke in a small part of the beam. Some optical beam smoke detectors can also sense thermal turbulence from a fire, by detecting the refraction of the beam at turbulent interfaces between hot and cold air.

Point smoke detectors should conform to BS 5445 : Part 7. Smoke alarms should conform to BS 5446 : Part 1. Optical beam smoke detectors should conform to BS 5839 : Part 5.

Ionization chamber smoke detectors are particularly sensitive to smoke containing small particles such as are produced in rapidly burning flaming fires. However, they may be less sensitive to the larger particles found in optically dense smoke which may be produced by smouldering materials. Optical smoke detectors are sensitive to the larger, optically active particles found in optically dense smoke, but are less sensitive to the small particles found in clean-burning fires.

Where this Part of BS 5839 recommends the use of smoke detectors, either type of detector is generally suitable, particularly for property protection. However, choice of detector type should take into account both the type of fire that may be expected and the need to avoid false alarms (see clause **11**). When certain materials, such as polyurethane foam, smoulder, they produce relatively large smoke particles to which ionization chamber detectors are comparatively insensitive. Ionization chamber detectors are also less sensitive to smoke that has travelled some distance from the seat of the fire, during which time smoke particles have coalesced to form larger particles. In general, therefore, optical smoke detectors should be installed in circulation spaces, such as hallways and landings. Optical detectors should also be installed in areas in which a likely cause of fire is ignition of furniture or bedding by a cigarette. Ionization chamber detectors may be the more appropriate type for installation in rooms, such as the living room or dining room, where a fast-burning fire may present a greater danger to occupants than a smouldering fire.

Aspirating and beam type smoke detectors are only likely to be appropriate for the protection of mansions and properties of historic importance. In these properties, beam detectors are often suitable for protection of large or high spaces, such as entrance halls, banqueting halls, etc. Aspirating detectors and beam detectors are suitable for protecting areas in which aesthetic considerations preclude the installation of normal point type detectors on decorative ceilings.

9.3 Heat detectors

9.3.1 There are two main types of heat detector:

a) point detectors, which respond to the temperature of the gases in the immediate vicinity of a single point;

b) line detectors, which respond to the temperature of the gases in the vicinity of a line.

Only point heat detectors are likely to be appropriate for installation in most dwellings. Line heat detectors are only likely to be appropriate for consideration in, for example, a long, relatively narrow structure, such as a cellar or cable tunnel.

Both point and line detectors can be categorized as follows:

1) those using fixed-temperature (static) elements, which operate when they reach a preselected threshold temperature;

2) those using rate-of-rise of temperature elements, which operate when their temperature rises at an abnormally fast rate.

9.3.2 Heat detectors with fixed-temperature elements should be used where ambient temperatures are likely to fluctuate rapidly over short periods (e.g. kitchens). Rate-of-rise heat detectors, incorporating fixed-temperature elements, should be used in all other situations.

Point heat detectors used in areas where the ambient temperature is normal should conform to BS 5445 : Part 5. In high-temperature areas (e.g. boiler rooms), detectors conforming to BS 5445 : Part 8 should be used.

Heat detectors conforming to BS 5445 : Part 5 or BS 5445 : Part 8 always have fixed-temperature elements, and may additionally contain rate-of-rise elements. Heat detectors not containing fixed-temperature elements are unlikely to respond to very slow-growing fires and should therefore not be used.

NOTE. At present, there are no standards for self-contained domestic heat detectors.

9.3.3 Heat detectors respond much more slowly to fire than smoke detectors (see **9.2**), but are significantly less likely to give false alarms. They also require less maintenance than smoke detectors (see clause **24**). They are not suitable for installation in circulation areas that form the communal escape routes from a dwelling. The application for heat detectors depends on the system type. The following recommendations apply.

a) *Type LD3 systems*

Since detectors are installed only in the escape routes, heat detectors should not be used.

NOTE 1. In the case of grade A systems and systems conforming to the recommendations of BS 5839 : Part 1 for a type L system, it may be necessary to install detectors in rooms or areas adjoining escape routes; heat detectors may be used for this application.

b) *Type LD2 systems*

If a risk analysis (see clause 4) or the guidance in table 2 justifies the provision of fire detectors in a kitchen, boiler room, or other area (except a circulation area) in which smoke detectors would be likely to give false alarms, heat detectors should be used.

c) *Type LD1 systems*

A heat detector should be installed in every kitchen, boiler room or other area (except a circulation area) in which smoke detectors would be likely to give false alarms.

NOTE 2. In the case of LD2 and LD1 systems, heat detectors may be installed instead of smoke detectors in rooms other than those stated in b) and c), provided that the construction enclosing the room (including the door of the room) can resist fire for a sufficient time after operation of the heat detector to enable occupants to escape safely. However, a heat detector is unlikely to operate early enough to save the life of anyone asleep in the room in which it is installed. Moreover, a heat detector in the room of fire origin may not give sufficient warning for occupants to escape safely if the door to that room is open.

d) *Type PD systems*

Heat detectors may be used in the following areas:

1) where smoke detectors would be likely to give false alarms;

2) areas in which the potential for serious financial loss is low, provided that these areas are separated from other parts of the property by fire-resisting construction and that the fire brigade attendance time is no more than 10 min.

9.4 Flame detectors

Flame detectors detect the infra-red or ultra-violet radiation from flame. They cannot detect smouldering fires, and their response to such fires will be delayed until the onset of flaming. As they use radiative transfer from the fire, instead of the convective transfer required by heat or smoke detectors, they can be wall-mounted and do not need to be on the ceiling.

In general, flame detectors are not suitable for the protection of life in domestic buildings. However, in some applications, particularly under high ceilings in mansions or historic properties, their ability to detect fire when mounted on walls can be used to advantage, usually in combination with smoke detectors. Such applications can require specialized knowledge.

10 Location and siting of detectors

10.1 Coverage

10.1.1 *General*

The level of protection required in any dwelling should be based on an analysis of the risk to life from fire (see clause **4**).

10.1.2 *Type LD systems*

For most single-family dwellings or dwelling units, a type LD3 system will provide a reasonable standard of protection (see **8.3**). In a type LD3 system, smoke detectors should be sited in the circulation areas (normally hallways and staircases) that form the escape routes. In a typical single-storey dwelling, only one detector is necessary. In a typical two- or three-storey dwelling, an LD3 system normally comprises two or three smoke detectors respectively (i.e. one on each level). However, if there are long hallways or corridors, the installation of additional smoke detectors may be necessary (see **10.2.3**).

In houses of four or more storeys, a type LD2 system is normally appropriate. In addition to the smoke detectors required to comply with the recommendations for a type LD3 system (i.e. one or more detectors in the circulation routes at each floor level), a heat detector should be installed in each kitchen, and a detector (heat or smoke) should be installed in each living room. Type LD2 systems are also appropriate if the risk analysis (see clause **4**) justifies the installation of detectors in particular rooms. In selecting the appropriate type of detector for any room, consideration should be given to the speed of detection required, the likely type of fire (see clause **9**) and the need to avoid false alarms (see clause **11**).

A type LD1 system is appropriate where the highest level of protection is required from a system conforming to the recommendations of this Part of BS 5839. For example, a type LD1 system may be needed if the characteristics of the occupants (e.g. physical or mental disability) increase the risk from fire. In a type LD1 system, detectors should be installed in all circulation areas and all rooms or areas in which fire might start, other than toilets, bathrooms or shower rooms. Such areas include roof voids, unless it can be determined that there are no significant sources of ignition within the void and no readily combustible materials such as stored items.

10.1.3 ***Type PD systems***

If fire starts in an unoccupied area, it may grow, if undetected, to a stage where it cannot easily be extinguished. Since any area of a dwelling may be unoccupied at some time, for maximum protection, total coverage should be provided. Every portion of the dwelling should be suitably protected and each effectively enclosed space should be considered separately, although toilets, bathrooms and shower rooms need not have independent coverage. Such a system, giving total coverage for property protection, is a type PD1 system. However, even in the case of a type PD1 system, it may exceptionally be acceptable to omit detectors from areas in which there is no combustible material and no source of ignition (e.g. a disused cellar or attic in which all electricity supplies are permanently disconnected).

If the fire risk is not sufficiently high in some rooms to justify the provision of automatic detectors, a type PD2 system, covering only parts of the dwelling, can significantly reduce the probability of fire loss, at a lower installation cost than that for a type PD1 system. Detectors should be installed in areas where ignition sources or easily ignitable materials are present, where fire could spread rapidly, where supervision is absent, or where the consequences of loss or damage would be serious. Detectors are not essential in areas which contain few combustibles or ignition sources, have frequent supervision and have good structural fire separation from the remainder of the dwelling. It should not be assumed that a type PD2 system need only include detectors in rooms containing high-value articles, such as works of art. Detectors are likely to be necessary in all areas in which fire might start and develop to an extent where it cannot be extinguished before loss of the high-value contents.

In areas protected by a type PD2 system, the spacing and siting of detectors should generally be the same as for a type PD1 system. If a fire starting outside the protected area spreads into it, the fire growth rate in the protected area is likely to be much higher than if the fire had been started in the protected area by a small ignition source. Although the system in the protected area would respond quickly, the rate of growth would probably be such that a high loss would ensue before fire-fighting could start. In order to prevent such spread, areas protected by a type PD2 system should be separated from unprotected areas by fire-resisting construction.

Before a fire detection and alarm system is installed for insurance purposes, there should be early consultation with the insurers. In particular, agreement should be reached on any areas that are to be unprotected.

10.2 Location, siting and spacing

10.2.1 ***General***

For type LD systems, detectors should be located in accordance with **10.2.2**. For both type LD and PD systems, the siting and spacing of detectors, in areas in which protection is to be provided, should be in accordance with **10.2.3** and **10.2.4**

10.2.2 ***Location***

In type LD systems, at least one smoke detector should generally be located between the sleeping area(s) and the most likely sources of fire (living room and kitchen). In circulation areas, no door to a room should be further than 7.5 m from the nearest smoke detector. In a single-storey dwelling protected by one detector, the detector should be as close as possible to the living accommodation. However, where smoke alarms are installed, siting should take into account the need for the sound level of the smoke alarm(s) to be sufficient in all bedrooms (see clause **12**). Where there are rooms (other than a toilet, bathroom or shower room) on either side of a bedroom, a detector should be sited on the ceiling in the hall or corridor midway between the doors to these rooms. In a multi-storey house, at least one smoke detector should be located on the ground floor between the staircase and any rooms in which fire might start. A smoke detector should also be located on each main landing. In open-plan accommodation, where a stair may be open to a living/dining area, the living/dining area should be treated as a circulation area.

In the case of type LD1 and LD2 systems, additional detectors should be provided. For type LD2 systems, detectors should be provided in all rooms and areas that present a high fire risk to occupants. For type LD1 systems, detectors should be sited in all rooms and areas in which fire might start, other than toilets, bathrooms or shower rooms (see **10.1.2**)

10.2.3 *Spacing*

Under flat horizontal ceilings, the horizontal distance from any point in the protected area to the detector nearest to that point should not exceed 5.3 m for heat detectors and 7.5 m for smoke detectors. For line or beam detectors, the distance should be taken as the distance to the nearest point on the line or beam.

10.2.4 *Mounting position*

Smoke detectors should preferably be mounted on ceilings and should be located at least 300 mm horizontally from any wall or light fitting unless, in the case of light fittings, there is test evidence to prove that the proximity of the light fitting will not adversely affect the efficiency of the detector. Ceiling-mounted detectors should be located so that their sensitive elements are between 25 mm and 150 mm below the ceiling in the case of heat detectors, or between 25 mm and 600 mm below the ceiling in the case of smoke detectors.

If ceiling mounting is impractical, in small rooms and short hallways detectors may alternatively be mounted on a wall, provided that:

a) the top of the detection element is between 150 mm and 300 mm below the ceiling;

b) the bottom of the detection element is above the level of any door opening;

c) the manufacturer's instructions state that the detector is suitable for wall mounting.

If the ceiling temperature in any area is significantly higher than ambient temperature, smoke that has travelled some distance from the fire, and so cooled, can have difficulty in reaching a ceiling mounted detector. This situation can arise, for example, in dwellings with ceiling heating systems. It can also occur in hot weather if the space above the ceiling is open to outside air and the ceiling is poorly insulated. In these circumstances, consideration should be given to wall mounting. For similar reasons, detectors should not be mounted on a poorly insulated external wall. Detectors should not be mounted adjacent to, or directly above, heaters or air-conditioning vents.

Detectors should be mounted in positions that are reasonably accessible for maintenance. This is particularly important in the case of smoke alarms which incorporate a battery or which have a test or silence control. Such detectors should not, for example, be mounted above a stairwell.

11 False alarms

False alarms are common in domestic fire detection and alarm systems, and are a potential barrier to increased use of automatic fire detection in dwellings. Frequent false alarms can also be a cause of long-term disablement of detectors by householders. Accordingly, installation design should aim to minimize false alarms. There should also be facilities to enable the user to silence alarms and, in some cases, to disable detection when false alarms are likely (see **5.7**). Many false alarms can be avoided by careful siting of detectors and careful selection of detector type. However, the need to avoid false alarms should never take priority over the need for early detection of fire.

The most common cause of false alarms in dwellings is smoke and other fumes from kitchens. Optical smoke detectors are less likely than ionization chamber detectors to respond to fumes from cooking. The smoke detector nearest to a kitchen should normally be of the optical type.

False alarms from smoke detectors may also be caused by steam or very dense tobacco smoke. Optical smoke detectors are more likely to be prone to such false alarms than ionization chamber detectors. In rooms, such as a living room or dining room where people may smoke, the use of an ionization chamber detector may be more appropriate, unless the need for early detection of fire makes the use of an optical detector essential.

Heat detectors are much less prone than smoke detectors to false alarms. Heat detectors should be used in preference to smoke detectors in rooms such as kitchens, laundry rooms and boiler rooms, where normal activities can cause smoke detectors to operate. In these rooms, fixed-temperature heat detectors should be used, owing to possible fluctuations in temperature, which could cause false alarms if heat detectors with a rate-of-rise element were installed.

Heat detectors may also be appropriate in dusty areas, such as roof voids or cellars, in which smoke detectors could become polluted. However, heat detectors are not suitable for use in escape routes, as they are unlikely to provide a warning early enough to permit escape (see **9.3**).

If heat detectors are installed in rooms with a high ambient temperature (more than 40 °C), the use of high-temperature heat detectors conforming to BS 5445 : Part 8 may be necessary. In order to avoid false alarms, the fixed operating temperature of a heat detector should be at least 20 °C above, but not more than 35 °C above, the normal ambient temperature in the room in which the detector is installed.

12 Alarm devices and audibility

12.1 Audible alarm devices

Self-contained smoke alarms include an integral sounder. In other cases, a reliable audible alarm device, such as a bell or electronic sounder, should be installed.

Many commercially available electronic sounders produce a greater sound output than a bell. However, the sound output of electronic sounders tends to be more direction-dependent than that of a bell, and the high output on the axis of the electronic sounder is not always achieved at right angles to the axis.

If a common sounder provides both fire alarm signals and other warning signals within an integrated system (see **5.10**), the fire alarm signal should be clearly distinguishable from any other alarm signal. Except in the case of self-contained smoke alarms installed in the same dwelling as a grade A, B or C system, all fire alarm sounders in the building should produce an identical alarm signal.

12.2 Audibility

A fire detection and alarm system only provides satisfactory protection of life if it is capable of rousing the principal occupants of the dwelling from sleep (e.g. the adult occupants in a typical single-family dwelling). No particular sound pressure level is certain to rouse all occupants of a dwelling in all circumstances. Depth of sleep varies during the course of the sleep period and also varies from one person to another. BS 5839 : Part 1 recommends that, if an audible alarm is intended to arouse sleeping persons, a sound level of 75 dB(A) should be achieved at the bedhead when all doors are shut, although this will not guarantee that every person will be awakened, particularly if they are under the influence of alcohol or drugs.

Most fire detection and alarm systems in dwellings comprise smoke alarms, which are usually fitted in the circulation areas, such as hallways and landings. BS 5446 : Part 1 requires that the sound output of a smoke alarm be at least 85 dB(A) at 3 m. Most domestic doors attenuate sound by around 20 dB; greater attenuation may occur in the case of solid doors, such as fire doors. It is therefore unlikely that a smoke alarm on, for example, the upstairs landing of a two-storey house will produce a sound level of 75 dB(A) at the bedhead in each bedroom, particularly if the bedroom doors are shut. There appears to be no evidence to show that lives are being lost due to inadequate audibility of the fire alarm signal from smoke alarms, except where people are incapacitated to such a degree that even much higher sound levels would not waken them. This may be because, in their own homes, people can be roused by an unusual sound of relatively low level compared with the sound level that may be required to wake them in premises with which they are unfamiliar (e.g. a hotel).

In general, therefore, a type LD fire detection and alarm system should either be capable of producing a sound level of approximately 85 dB(A) at the doorway to each bedroom (with the door open), or have within the bedroom a sounder or smoke alarm that will operate whenever fire is detected anywhere in the dwelling. If, however, occupants suffer from impaired hearing, a higher sound level may be necessary. A higher sound level may also be necessary if bedroom doors attenuate sound by significantly more than 20 dB. This can, for example, be the case in a house in multiple occupation, in which all bedroom doors are likely to be fire doors. In some houses in multiple occupation, ambient noise levels or other factors may justify the need for a sound level of 75 dB(A) at the bedhead of each bedroom within a dwelling unit, particularly in the event of a fire in an area outside that dwelling unit.

In single-family dwellings, a lower sound level is acceptable in other areas of the house. No minimum sound pressure level is recommended, but it should be ensured that the occupants are likely to be able to hear the alarm signal under most foreseeable circumstances in all areas of the house in which it is necessary to provide a warning. In order to maximize the sound levels produced throughout a house protected by smoke alarms, it is preferable that the smoke alarms are interlinked so that when one smoke alarm detects fire an audible warning is given by all smoke alarms. When smoke alarms are installed in new dwellings, they should always be interlinked.

Occupants should not be subject to sound pressure levels greater than 110 dB(A), since this can lead to disorientation.

12.3 Frequency

The integral sounder of most smoke alarms produces a sound with a frequency in excess of 2000 Hz. The major frequencies of bells and electronic sounders used in fire alarm systems are often at least one octave lower. Age and damage to hearing reduce the sensitivity of the ear, particularly to frequencies above 2000 Hz. High-frequency sounds are also subject to greater attenuation by partitions, dividing walls and doors. An increase in frequency by one octave (so doubling it) can increase the attenuation by walls by around 5 dB, although the corresponding change in attenuation by doors is not as great. Fire alarm sounder frequencies (including those used in smoke alarms) should therefore ideally lie in the range 500 Hz to 1000 Hz. However, most commercially available smoke alarms currently incorporate a sounder which produces a frequency outside this range. When such smoke alarms are used, this nominal frequency should not exceed 3500 Hz.

12.4 Alarm signals for people with impaired hearing

Impairment of hearing does not necessarily result in complete insensitivity to sound. Even people with severe hearing impairment may clearly perceive some conventional alarm sounders, although the higher frequencies produced by most smoke alarms may be less perceptible. However, if occupants' hearing is seriously impaired, audible alarms may be insufficient to alert them in the event of fire, particularly if they are asleep. In such cases, other means of giving warning should be provided. These may include visual alarms and vibrating devices which can, for example, be fitted under mattresses or pillows. If visual alarms comprise flashing lights, the flashing rate should be in the range 30 to 120 cycles per minute.

Careful consideration is necessary when selecting an alarm device, and tests are often needed before a final decision is made. It is essential that the warning signal is suitable for those whom it is intended to alert, even if they are asleep.

NOTE. Technical advice on the selection of suitable devices can be obtained from the Royal National Institute for the Deaf, 105 Gower Street, London WC1E 6AH or the National Deaf Children's Society, 4 Church Road, Edgbaston, Birmingham B15 3TD.

In commercial occupancies, vibrating devices, linked to the fire detection and alarm system by radio and worn on the person, are sometimes given to deaf occupants. There are now available radio paging devices specifically for use in dwellings and these should be considered especially if a large dwelling is shared by a number of occupants whose hearing is impaired, or in the case of, for example, a mansion with one or more occupants whose hearing is impaired.

13 Power supplies

13.1 General

Fire detection and alarm systems designed in accordance with this Part of BS 5839 rely on electrical power for their operation. No source of electrical power is totally reliable; every source will at some time fail, even if only for a limited period. If the fire detection and alarm system has only a single source of supply (as is the case in grade E and grade F systems), the system will be totally disabled when this supply fails. Nevertheless, provided action is taken to rectify the failure soon after it occurs, the probability of a fire occurring during the relatively short period of disablement is very low. A system with a single source of supply is, therefore, sufficient in most typical single-family dwellings. However, if the fire risk (see **3.13**) is high, or the frequency or duration of power supply failures is significant, the provision of a standby supply (e.g. a grade D system) may be justified.

In general, a high reliability is given by a normal supply from mains electricity, backed up by a battery-powered standby supply which is connected automatically in the event of mains failure. The standby supply may, however, comprise another source of power, such as a capacitor. In general, batteries can supply power to the system for an appreciably longer period than a capacitor. However, capacitors do not need to be replaced at regular intervals and can be recharged to full capacity in a relatively short period of time.

The standby supplies recommended in **13.2** to **13.5** are satisfactory in most cases, but greater capacities are sometimes required, e.g. in dwellings in which occupants could be deprived of mains electricity for periods greater than 72 h because they cannot pay for supplies. The possible frequency and duration of interruptions to the normal supply, whether due to faults or disconnection, should be investigated and taken into account in specifying the capacity of the standby supply.

13.2 Grade A systems

Power supplies for grade A systems should conform to the recommendations of clause **16** of BS 5839 : Part 1 : 1988, with the exception of **16.5**. The standby supply should be capable of automatically maintaining the system in normal operation (but giving an audible and visual indication of mains failure) for a period of 72 h, after which sufficient capacity should remain to supply the maximum alarm load (see **3.19**) for at least 15 min. It is not recommended that this period be reduced in dwellings with an automatically started emergency generator. However, if a dwelling is never left unattended (e.g. a mansion in which staff are always present and can arrange for rectification of a supply failure), the period of normal operation sustained by the standby supply may be reduced from 72 h to 24 h.

13.3 Grade B systems

13.3.1 *Normal supply*

The normal supply for the system should be derived from the public electricity supply, transformed or modified as necessary. The mains power should be supplied from an independent circuit at the dwelling's main distribution board. No other electrical equipment should be connected to this circuit. Connection to the mains supply should be via a protective device (e.g. a fuse or miniature circuit breaker) reserved solely for the purpose. The protective device should be labelled 'FIRE ALARM: DO NOT ISOLATE'.

Normally, the protective device should be fed from the dead side of the main isolating device for the dwelling. However, in the case of large dwellings with complex electrical distribution systems on which all work is likely to be carried out only by qualified electricians, type PD systems may be fed from either the live side or the dead side of a main isolating device. If the system is fed from the live side, a label reading as follows should be placed on the main isolating device:

'WARNING: THE FIRE ALARM SUPPLY REMAINS LIVE WHEN THIS SWITCH IS TURNED OFF'.

The circuit serving the fire detection and alarm system should preferably not be protected by any residual current device (r.c.d.). If r.c.d. protection is necessary for reasons of electrical safety (e.g. in a TT installation as defined in BS 7671), any r.c.d. that could isolate the fire detection and alarm system from its supply should be dedicated to that system.

13.3.2 *Standby supply*

The mains supply should be backed up by a standby supply able to support the system while faults in the mains supply are corrected. The normal and standby supplies should each be capable of supplying the maximum alarm load (see **3.19**), irrespective of the condition of the other supply. The standby supply should normally be a secondary battery with an automatic charger. The battery should be of a type that has an expected life of at least 4 years under the conditions of use likely to be experienced in the fire alarm system. Automotive lead-acid batteries (i.e. the type normally used for starting service in cars) are not suitable for fire alarm service and should not be used.

The standby supply should be capable of automatically maintaining the system in normal operation (but giving an audible and visual indication of mains failure) for a period of 72 h, after which sufficient capacity should remain to support the maximum alarm load for 15 min.

13.3.3 *Battery charger*

The battery charger for the standby supply should be compatible with the batteries used, and should be capable of recharging a battery from its final voltage to a capacity sufficient to comply with the recommendations of **13.3.2** within a charging period of 24 h.

13.4 Grade C systems

Power supplies for grade C systems should conform to the recommendations of **13.3**, except that:

a) The wording of the labels described in **13.3.1** may be amended to indicate the nature of any other system with which the fire detection and alarm system is integrated (e.g. to read 'FIRE/INTRUDER ALARM: DO NOT ISOLATE').

b) The standby supply should be capable of automatically maintaining the system in normal operation for a period of 72 h (while giving the fault warning recommended in **15.5**), after which sufficient capacity should remain to support the maximum alarm load for 4 min or to maintain visual fault warnings of the form and duration recommended in **15.5**, whichever load is the greater.

NOTE. For intruder alarm systems, BS 4737 : Parts 1 and 2 recommend a standby capability of only 8 h of normal operation. Modifications to an intruder alarm system may therefore be necessary if it is to incorporate a fire detection and alarm facility. If a system is incapable of conforming to the recommendations of this clause, it may be appropriate to regard it as a grade E system.

13.5 Grade D systems

The normal supply for smoke alarms in a grade D system should be derived from the public electricity supply to the dwelling. The mains supply to the smoke alarms should take the form of either:

a) an independent circuit at the dwelling's main distribution board, in which case no other electrical equipment should be connected to this circuit (other than a dedicated monitoring device installed to indicate failure of the mains supply to the smoke alarms); or

b) a separately electrically protected, regularly used local lighting circuit.

If smoke alarms are of a type that may be interconnected, all smoke alarms should be connected on a single final circuit.

The standby supply for the smoke alarms may take the form of a primary battery, a secondary battery or a capacitor. The capacity of the standby supply should be sufficient to power the smoke alarm(s) in the quiescent mode for at least 72 h (while giving an audible warning of power supply failure), after which there should remain sufficient capacity to provide a fire warning for a further 4 min.

If a dwelling is likely to be subject to deliberate disconnection of the mains supply, and the standby supply is automatically rechargeable, a standby supply with 72 h duration is usually sufficient. However, in a very few cases, periods of disconnection may exceed 72 h. In such cases, provision of a standby supply of greater duration should be considered.

An audible warning should be given at least once every minute if the capacity of the standby supply falls below that required to provide the recommended standby duration. In the event of mains failure, the audible warning of standby supply failure should persist for at least 15 days, unless a visual indication (e.g. extinguishment of a normally illuminated indicator) is given at the smoke alarm. If such a visual indication is given, the audible warning need persist for only 72 h.

13.6 Grade E systems

13.6.1 The power supply for smoke alarms in a Grade E system should be derived from the public electricity supply to the dwelling. The mains supply to the smoke alarm(s) should comprise a single independent circuit at the dwelling's main distribution board. No other electrical equipment should be connected to this circuit (other than a dedicated monitoring device installed to indicate failure of the mains supply to the smoke alarms: see **13.6.2**).

13.6.2 Grade E systems should preferably incorporate a dedicated visual and/or audible means of indicating mains failure. Mains failure could, for example, be indicated by the extinguishment of a continuously illuminated or flashing light-emitting diode on each detector. Alternatively, the warning could comprise a visual indication (e.g. extinguishment of a normally illuminated indicator lamp, or the illumination of a fault warning lamp) by a dedicated mains failure monitor connected to the smoke alarm circuit. The circuit design of any mains failure monitor should incorporate a continuous audible warning, and there should be facilities for occupants to silence this warning. The circuit serving the smoke alarms should preferably not be protected by any r.c.d. If r.c.d protection is required for reasons of electrical safety, either of the following conditions should be satisfied.

a) The r.c.d should serve only the circuit supplying the smoke alarms.

b) The r.c.d protection of a fire alarm circuit should operate independently of any r.c.d protection for circuits supplying socket outlets or portable equipment.

13.7 Grade F systems

The batteries of smoke alarms in grade F systems should be capable of supplying the quiescent load of the smoke alarm, together with the additional load resulting from weekly testing, for at least 1 year. An audible fault warning should be given before an increase in the internal resistance or a decrease in the terminal voltage of the battery prevents correct operation. The audible fault warning should sound for at least 0.5 s once every 10 min.

When the battery fault warning commences, the batteries should have sufficient capacity to give a fire alarm signal for at least 4 min or to sustain the battery fault warning for at least 30 days, whichever is the greater. In the latter case, the smoke alarm need not be capable of detecting a fire and giving an initial alarm for a period greater than 72 h after a battery fault warning is first given.

13.8 Batteries: safety considerations

For all types of batteries, the manufacturer's recommendations regarding use and disposal should be followed. If lithium batteries are used in fire detection and alarm systems, the designer of the equipment should give consideration to any special safety features that should be incorporated. Guidance is contained in HSE Guidance Note GS 43 [4]. User instructions for the system (see **22**) should include any relevant advice regarding the hazards of lithium batteries and the appropriate methods of disposal. Lithium batteries can present an explosion hazard if they are subject to severe overheating. Consideration should be given to safety features (e.g. vents) to prevent batteries from exploding in the event of fire.

14 Wiring

14.1 General

A fire detection and alarm system in which components are interconnected will not fulfil its functions unless these interconnections operate correctly. In most systems, the interconnections take the form of wiring, but other means, such as radio signals, may be used. Recommendations for radio-linked systems are given in clause **19**.

In most single-family dwellings, any interconnections between components are not required to function for prolonged periods during a fire. Accordingly, the use of fire-resisting cables may not be necessary. However, wiring should be protected (either by siting, by choice of suitable cables or by additional protection) from exposure to mechanical damage, particularly if the wiring is unmonitored.

In the case of interconnected smoke alarms, circuit design should be such that open or short circuits on the signalling wiring that interconnects the smoke alarms cannot prevent the smoke alarms from functioning individually.

14.2 Grade A systems

Wiring should conform to the recommendations of clause **17** of BS 5839 : Part 1. All interconnections (e.g. between detectors or sounders and control and indicating equipment) should be monitored as recommended by BS 5839 : Part 1.

14.3 Grade B systems

Wiring should conform to the recommendations of clause 17 of BS 5839 : Part 1, except that prolonged operation of any cable during a fire is not generally necessary. However, cables linking sounders to control equipment, and cables that, if damaged, would result in total loss of power to the control equipment, should be:

a) as described in **17.3**a or **17.3**b of BS 5839 : Part 1; or

b) protected against fire by burial in the structure of the building (e.g. by 'chasing in' to plaster finishes); or

c) installed only in areas of very low fire risk (e.g. cavities in which there are no sources of ignition or no readily combustible materials); or

d) be separated from any significant fire risk by a wall, partition, ceiling or floor having fire resistance of at least 15 min (in terms of integrity and insulation) when tested in accordance with the relevant part of BS 476 with exposure to fire on the side of the construction remote from the cable.

14.4 Grade C systems

Wiring should be suitable for the current and voltage of the circuits concerned. The electrical characteristics of the wiring should be in accordance with the relevant recommendations of BS 7671. The types of cable used should not be readily susceptible to mechanical damage under the conditions in which they are installed. If cables are not sufficiently robust to withstand the likely effects of foreseeable impact, abrasion or rodent attack, additional protection against mechanical damage should be provided. Protection against mechanical damage may be provided by the building construction (e.g. by capping under plaster) or by installation in conduit, ducting or trunking. Such protection should always be provided if wiring is not monitored.

Wiring need not be fully monitored (see **3.21**), but the provision of monitoring should be considered (see **5.8**). In particular, a short circuit on the wiring should ideally give rise to either a fault warning or a fire warning.

14.5 Grade D and grade E systems

The mains supply to smoke alarms, and any interconnecting wiring between smoke alarms, may comprise any cable suitable for domestic mains wiring. The cable should be installed in accordance with the relevant recommendations of BS 7671. Conductors used for interconnection of smoke alarms should be readily distinguishable from those supplying power (e.g. by colour coding).

Since the wiring of grade D and grade E systems is normally unmonitored, cable should be protected against damage in any areas where it may be subject to impact, abrasion or rodent attack.

Protection against mechanical damage may be provided by the building construction (e.g. by capping under plaster) or by installing the wiring in conduits, ducting or trunking.

14.6 Grade F systems

If battery-operated smoke alarms are interconnected, any type of cable suitable for the voltage and current concerned may be used. Since the interconnecting wiring is normally unmonitored, cable should be protected against damage in any areas where it may be subject to impact, abrasion or rodent attack. Protection against mechanical damage may be provided by the building construction (e.g. by capping under plaster) or by installing the wiring in conduits, ducting or trunking.

15 Control and indicating equipment

15.1 General

Grade A and grade B systems incorporate equipment for the reception, indication, control and relaying of signals originating from fire detectors or manual call points connected to them, and for the activation of alarm sounders and alarm signalling devices. Grade C systems incorporate a means for central control of the fire detection and alarm system; the control facility may also include the facilities provided in grade A and grade B systems.

15.2 Siting

Control and indicating equipment should be sited close to the normal entrance to the dwelling. In the case of grade B and grade C systems, the equipment may be hidden from view (e.g. in a cupboard). Unless it is situated in a secure area or enclosed within a secure cabinet, control and indicating equipment should normally be sited so that all controls are at least 1.5 m above floor level, to prevent casual tampering by children. However, in dwellings occupied by wheelchair-bound people, it may be necessary to site the control and indicating equipment at a lower level.

15.3 Grade A systems

Control and indicating equipment should conform to BS 5839 : Part 4.

15.4 Grade B systems

Control and indicating equipment should conform either to BS 5839 : Part 4 or to annex B.

15.5 Grade C systems

Control and indicating equipment should be capable of supplying power to the fire detectors and any alarm sounders in accordance with **13.4**.

The control equipment should provide at least the following:

a) a silencing facility (see **5.7**);

NOTE 1. The operation of this facility may disable the system, for example, by isolating smoke alarms from the power supply or by isolating a sounder circuit.

b) a visual indication of failure or disconnection of the normal power supply. The indication should be in either of the following ways:

1) a normally illuminated indicator is extinguished;

2) a fault indicator is illuminated.

The system should be capable of maintaining the visual indication for at least 15 days. An audible warning should be given when (or before) the standby battery capacity falls below that required to comply with the recommendations of **13.4**b. If the audible warning is intermittent, it should sound at least once every minute and should persist for at least 72 h after the standby battery no longer has the capacity to perform in accordance with **13.4**b.

NOTE 2. The audible warning may be given as soon as the mains supply fails.

If additional visual indicators are provided, they should be clearly labelled to identify their function.

The operation of any sounder or alarm circuit should not be prevented by any defect in a visual indicator and should not depend on the operation of any indicator.

NOTE 3. Enhanced facilities, such as monitoring of wiring, may also be provided.

16 Manual call points

16.1 General

In most single-family dwellings the provision of manual call points is not necessary. However, if people are present in the room where a fire originates, they will normally detect the fire before it is detected automatically. Accordingly, in very large houses (e.g. country mansions) and houses in multiple occupation, manual call points should be installed in both type LD and type PD systems. The manual call points should conform to BS 5839 : Part 2. The method of operation of all manual call points in an installation should be identical unless there is a special reason for differentiation. It should be possible to operate the call point without use of a striker. Operation of the call point without the use of a striker should not give rise to the risk of injury (e.g. laceration of fingers by broken glass). The delay between operation of a call point and the operation of alarm sounders should not exceed 3 s.

16.2 Siting

Where manual call points are appropriate, they should be located on exit routes. A call point should be provided at each exit to open air. On any storey above or below ground level, call points should be located either at the entrances to staircases (i.e. exits from the storey) or on staircase landings; the option selected should be consistent throughout the dwelling. From any point in the dwelling, it should not be necessary to travel more than 30 m to reach the nearest call point. Additional call points may therefore be necessary where, for example, long corridors exist.

In general, call points should be fixed at a height of 1.4 m above the floor, at easily accessible and conspicuous positions free from obstruction. They may be flush-mounted in locations where they will be seen easily, but where they will be viewed from the side (e.g. in corridors), they should be surface-mounted or semi-recessed in order to present a side profile area of not less than 750 mm^2.

If the principal occupants of the dwelling are disabled people with impaired mobility, call point siting and method of operation should take into account the nature of the occupants' disabilities. In some cases, an alternative method of operation (e.g. ceiling cord switches, etc.) may be desirable.

17 Zoning and other means for identification of the source of alarm conditions

17.1 General

In a large dwelling, particularly if the layout is complex, it is desirable that the fire alarm indicating equipment indicates the area of the dwelling from which the alarm originates. Even in the case of an addressable system, zone indication can help the fire brigade, and others unfamiliar with the layout and designation of rooms, to locate the fire quickly and efficiently. However, in most typical single-family dwellings, the subdivision of the dwelling into zones for indication purposes is not essential, particularly if the fire detection and alarm system is addressable.

In the case of a house in multiple occupation with fire detectors in one or more of the individual occupancies into which the house is subdivided, it should be possible for those responding to a general alarm condition to readily identify the location of alarm origin. If the individual occupancies are multi-room dwelling units, the allocation of a zone for each dwelling unit may be appropriate.

However, other methods of identification may be adopted, particularly when the individual occupancies are small in area. These may include the use of an addressable alarm system, the provision of remote indicator lights outside each occupancy or the ready availability of a master key (e.g. held by a landlord or warden) to enable a search of all occupancies to be made.

17.2 Grade A systems

The dwelling should be subdivided into zones in accordance with clause 7 of BS 5839 : Part 1, with the exception of 7.2b.

17.3 Grade B systems

In a two-storey dwelling with one or both floors exceeding 200 m^2 in area, each floor should be treated as a separate zone. Other dwellings may be subdivided into zones, but, in most cases, this is unlikely to make a significant contribution to life safety, particularly if an addressable system is installed.

17.4 Grade C systems

Dwellings in which grade C systems are installed do not normally need to be subdivided into zones.

18 Remote transmission of alarms

18.1 General

For a fire detection and alarm system to give the maximum benefit, particularly in relation to protection of property, its alarm should be passed on to the fire brigade with the shortest possible delay. In most dwellings, it is sufficient for the fire brigade to be summoned by occupants, using the public telecommunications operator's emergency service (e.g. the 999 emergency number). Automatic transmission of signals to a remote manned centre (e.g. an alarm company central station, from where the fire brigade is summoned) is not normally necessary. Indeed, if all domestic fire detection and alarm systems had facilities for such automatic transmission of alarms, false alarms would impose a serious burden on fire brigades. Nevertheless, if occupants suspect that a fire alarm signal may have resulted from a fire, the fire brigade needs to be summoned without delay.

In sheltered housing, alarm signals from individual dwelling units should be relayed to the same location as alarm signals from any social alarm systems installed in the dwelling units. However, in the first instance, it may not always be appropriate to summon the fire brigade on receipt of an alarm signal at any on-site warden's facility.

If consideration is given to automatic transmission of signals to the fire brigade, the fire brigade should be consulted.

18.2 Grade A, grade B and grade C systems

Facilities for automatic transmission of alarm signals to the fire brigade should be provided, whether directly or via a remote manned centre ('central station'), under the following circumstances:

a) if the occupants are disabled to a degree that would be likely to preclude their evacuation in the event of fire to a place of safety, without outside assistance;

b) if the occupants suffer from a disability (e.g. speech impairment) that would preclude communication by telephone with the fire brigade;

c) if the system is a type PD system (whether or not it is also designed to conform to the recommendations for a type LD system).

18.3 Grade D, grade E and grade F systems

Automatic transmission of alarms to a remote location is not normally appropriate, except in the case of sheltered housing.

18.4 Signal discrimination

If the fire detection and alarm system is integrated with another system (e.g. an intruder alarm or social alarm system) and both systems share a single communications link to a remote manned centre, the transmission system should be designed so that fire alarm signals can be separately identified at the remote manned centre.

In the case of sheltered housing, fire alarm signals from dwelling units should, at any site monitoring panel provided for use by a warden, be clearly distinguishable from other alarm signals that can be relayed from the dwelling, and distinguishable from alarm signals from any other dwelling.

NOTE. If smoke detectors are retrofitted to an existing social alarm system that has no facilities for discrimination between different types of alarm signal, the recommendation for distinguishable signals need not be followed, provided that the pre-planned response by the warden to signals from the fire detection and alarm system in any dwelling is identical to the pre-planned response to other alarm signals.

18.5 Means for automatic transmission of alarms

Some methods of automatic transmission of alarm signals to fire brigades and central stations are described in appendix A to BS 5839 : Part 1. Any remote manned centre, other than a fire brigade control room, to which alarm signals are transmitted should conform to the recommendations of BS 5979.

In the case of type PD systems, if the potential loss in the event of fire is high, the method of transmission adopted should, if practicable, incorporate monitoring of any telecommunications lines between the protected dwelling and the remote manned centre, and monitoring of any transmission equipment external to the dwelling. If lines or equipment fail, a fault warning should be given at a continuously manned point, usually at

the remote manned centre. If the automatic transmission system is intended to satisfy the requirements of fire insurers, or will be taken into account in considering insurance underwriting, the method of transmission should be discussed with the fire insurer.

If the alarm is transmitted to the fire brigade via a remote manned centre, users should satisfy themselves that the method of communication used between the remote centre and the appropriate fire brigade is reliable. The 999 public emergency call service can normally be used only if the remote manned centre and the dwelling are in the same fire authority area. If the public switched telephone network is used, it is important that the fire brigade number is one reserved by the brigade for emergency calls. Calls should never be routed via a fire brigade administrative number.

Transmission of the alarm should not be prevented by the act of silencing alarm sounders, nor should it depend on the state of any silencing switch.

Transmission equipment should preferably be installed in an area of low fire risk. The area should preferably be protected by automatic fire detection and should always be protected if the area is not of low fire risk.

NOTE. An electrical distribution equipment cupboard is not an area of low fire risk.

18.6 Disablement of remote transmission facilities

If there are facilities for automatic transmission of fire alarm signals to the fire brigade (either directly or via a central station), a means should be provided for disablement of the transmission facility, for use during periods of testing, maintenance or potential false alarms. In grade B and grade C systems, there should be a ready means, at or near the control equipment, of discovering whether the transmission facility is disabled. In grade A systems, disablement of the transmission facility should result in a visual and audible indication. The audible warning may be the same as the fault warning, but it should not be possible to silence this warning until the connection is restored. If intermittent, this signal should sound for a minimum of 0.5 s at least once every 15 s.

If the fire detection and alarm system is a requirement of fire insurance, or will be taken into account by the fire insurer in considering insurance underwriting, the method of disablement and the use of the disablement facility should be discussed with the fire insurer.

18.7 Summoning of the fire brigade by occupants

Whether or not there is a facility for automatic transmission of alarms, in the event of fire the occupants of the dwelling will always need to ensure that the fire brigade is summoned, by means of an emergency call from the dwelling or from a place of safety nearby. Care should therefore be taken to ensure that the alarm sound level in the vicinity of any telephone likely to be used to summon the fire brigade is not so high that it could interfere with the making of a telephone call.

19 Radio-linked systems

19.1 General

In grade A, grade B and grade C systems, control equipment and other components of the fire detection and alarm system, such as detectors, manual call points and sounders, are normally interconnected by means of wiring. However, some or all of these interconnections may be made by radio links. In radio-linked systems, the normal power supply to the control and indicating equipment is derived from a mains supply, while the power supply to detectors and manual call points is usually provided by a primary battery, with a second primary battery as a reserve. Signals from detectors and manual call points are transmitted to the control equipment by radio. The power supply to alarm sounders may be provided by means of a conventionally wired circuit emanating from the control equipment; alternatively, the interconnection between the control equipment and the alarm sounders may be by radio, in which case the normal power supply to each sounder may be derived from a mains supply or be provided by a primary battery.

In grade D, grade E and grade F systems, radio may be used for interconnection of smoke alarms.

Some of the recommendations applicable to wired systems, particularly those for power supplies (see clause **13**) and fault monitoring, are unsuitable for, or cannot be applied to, radio-linked systems. In such cases, the recommendations of **19.2** to **19.4** should be followed.

19.2 Choice of system

Radio-linked systems have both advantages and disadvantages. A number of these are listed in **18.1.3** and **18.1.4** of BS 5839 : Part 1. Before adopting such a system for any specific application, the advantages and disadvantages should be carefully considered.

In the context of a dwelling, the major advantage is the ease of installation and the avoidance of the need to damage or disfigure décor in order to install wiring; the latter advantage is of particular benefit in historic buildings and buildings with ornate finishes. The most significant disadvantage is the need to replace batteries in each of the many battery-operated components that usually exist in a large installation. This makes radio-linked systems less suitable for applications in dwellings in which occupants may not be able to replace batteries (e.g. due to financial constraints, or to physical or mental disability) or in which occupants are not directly responsible for supervision of the fire detection and alarm installation (e.g. a house in multiple occupation). However, the use of lithium batteries, which have a longer life than conventional batteries, can greatly reduce the frequency of battery replacement.

19.3 Grade A, grade B and grade C systems

Grade A, B and C systems should conform to the recommendations of clause **18** of BS 5839 : Part 1, except that the power supply to sounders may, other than in the case of a house in multiple occupation, conform to the recommendations of **18.2.3** of BS 5839 : Part 1 instead of **18.2.2**.

There should be at least 30 days warning of the impending failure of any primary battery which is incorporated in a power supply for sounders. In determining the point in battery discharge at which the warning should be given, it should be assumed that, during the 30 days, there will be false alarms each of 30 min duration at the rate of one false alarm per 10 detectors per annum. The warning should conform to the recommendations of **18.2.3** of BS 5839 : Part 1.

If a grade A system is installed in a house in multiple occupation, all batteries used as the normal supply to manual call points and detectors should be capable of supplying the following loads for at least 5 years before warning of impending failure of the battery is given:

a) the quiescent load of detectors and manual call points;

b) the additional load resulting from routine weekly testing;

c) the load from false alarms, each of 5 min duration, at the rate of two false alarms per detector per annum.

In this case, the batteries should be changed by the servicing organization before the failure warning is likely to be given (see clause **22**).

In houses in multiple occupation, power supplies for any discrete alarm sounders should conform to the recommendations of **18.2.2** of BS 5839 : Part 1.

19.4 Grade D, grade E and grade F systems

The power supplies recommended in **13.5** to **13.7** may be used to power radio links between smoke alarms, provided that this does not reduce the life or duration of a battery or capacitor supply below those recommended in **13.5** and **13.7**.

20 Electromagnetic interference

20.1 Generated interference

Alarm systems should be designed and installed so that they do not cause radio interference in excess of the limits specified in the Directives 89/336/EEC [5] and 92/31/EEC [6], and in BS EN 50081-1.

20.2 Received interference

Particular care should be taken in the design and installation of the fire detection and alarm system to avoid interference from other equipment, particularly hand-held radio transmitters and portable telephones, external sources such as lightning, and power transients. Such interference can affect the normal operation of the fire alarm system.

The type of cable used in addressable systems, the method of cable termination and, where appropriate, the materials from which items such as junction boxes are constructed, should be such as to avoid undue interference from electromagnetic fields. Manufacturers' data provided with systems should include information on the susceptibility of the system to electromagnetic fields. In addressable systems, care should be taken to avoid mutual interference between circuits.

21 Installation

21.1 Grade A systems

Systems should be installed, tested and commissioned in accordance with section three of BS 5839 : Part 1.

21.2 Grade B, grade C, grade D and grade E systems

21.2.1 *General*

Systems should be installed generally in accordance with BS 7671 by a competent person, as defined in HSE booklet HS(R) 25 [7]. All detectors and sounders should be rigidly and permanently fixed to walls or ceilings.

21.2.2 *Cable holes*

Where cables pass through walls, a smooth clearance hole should be provided. If additional mechanical protection is necessary, a smooth-bore sleeve should be sealed into the wall. Care should be taken to ensure that the ends of the sleeve are free from sharp edges which could damage cables during installation. Where appropriate, cable penetrations should be fire-stopped.

21.2.3 ***Joints in cables***

Joints in cables, other than those contained within enclosures of equipment, should be avoided wherever possible. Where a joint in a cable is unavoidable, it should be enclosed in a suitable and accessible junction box. In grade B and grade C installations, the junction box should be labelled 'fire alarm' to avoid confusion with other services. Jointing and termination methods should be chosen to minimize any reduction in reliability below that of the unjointed cable.

21.2.4 ***Surface wiring***

Surface-laid cables should be neatly run and securely fixed at suitable intervals in accordance with the cable manufacturer's recommendations.

21.3 Grade F systems

Systems are normally installed by the occupier or other non-specialist. Detectors should be rigidly fixed to permanent construction. Any interconnecting wiring should be installed and routed so that mechanical damage is avoided.

21.4 Certification

Unless the system is installed by the occupier, the installer should certify that the installation conforms to the recommendations of this Part of BS 5839 for the relevant grade and type of system. If deviations have been agreed, a statement of those deviations should be included on the certificate. A model certificate is given in annex C.

22 User instructions

The supplier of the equipment should provide the occupier of the dwelling (or the owner in the case of a house in multiple occupation) with written information on the following:

a) operation of the system;

b) action in the event of a fire alarm signal;

c) avoidance of false alarms;

d) action in the event of a false alarm;

e) routine testing of the system;

f) servicing and maintenance of the system (including intervals at which any batteries should be replaced);

g) the need to keep a clear space around all detectors and manual call points;

h) special precautions relevant to any lithium batteries used in the system;

i) checking the system on reoccupation of the dwelling after a vacation, etc.;

j) the need to avoid contamination of detectors by paint.

The operating instructions should be sufficient to enable a lay person to understand fully the use of all controls and the meaning of all visual and audible signals that the system is capable of giving. The instructions should describe the circumstances under which silencing and disablement facilities should be used, but should stress the importance of maintaining the system in the normal state, in which fire can be detected and alarm signals given.

The recommended action in the event of fire should stress the importance of ensuring that all occupants leave the dwelling as quickly as possible and that the fire brigade is summoned immediately; it should be made clear that the brigade should be summoned regardless of the size of the fire and regardless of whether there is a facility for transmission of alarms to a remote manned centre.

Guidance should be given to the user concerning common causes of false alarms and their avoidance. The user should be advised to take precautions to prevent false alarms and damage to detectors by contamination during work that gives rise to dust, smoke, paint spray, etc. The means for resetting after false alarms should be made clear in the instructions.

23 Routine testing

The instructions should make clear that the user is responsible for routine testing of the system. Grade A systems should be tested in accordance with **29.2.4** of BS 5839 : Part 1. Other systems should be tested at least every month by operating all alarm sounders in the dwelling. In the case of smoke alarms, the monthly test may be carried out by use of a test button on each of the smoke alarms installed in the dwelling. If the dwelling has been unoccupied for a period during which the normal and standby supply (if provided) could have failed, the occupier should check immediately on reoccupying the dwelling that the system has not suffered total power failure.

All detectors should be tested at least once every year to ensure that they respond to smoke. In grade A, grade B and grade C systems, this test may be carried out on behalf of the user by any specialists with whom there is a contract for periodic servicing of the system. Tests should not involve the use of open flame or any form of smoke or aerosol that could contaminate the detection chamber or the electronics of the detector. Suitable test aerosols are available.

24 Servicing and maintenance

Grade A systems should be serviced and maintained in accordance with clause **29** of BS 5839 : Part 1. Grade B and grade C systems should be serviced every 6 months in accordance with the supplier's instructions. The smoke alarms in grade D, grade E and grade F systems should be cleaned periodically in accordance with the manufacturer's instructions. In most environments, detectors should be cleaned annually in-situ, in accordance with the manufacturers' instructions. Where experience shows that undue deposits of dust or dirt are likely to accumulate, servicing and cleaning may need to be more frequent.

Annexes

Annex A (informative)

Guide to recommendations applicable to each grade of system

Table A.1 lists the clauses or subclauses of this standard which apply to particular grades of fire detection and alarm system, and those which apply to all grades of system.

Annex B (normative)

Control equipment for grade B systems

B.1 General

This annex gives the functional requirements for control and indicating equipment for grade B systems.

NOTE. It is presumed that most control panels for grade B systems will not have facilities for zone indication, or will have facilities for indication of no more than two zones. However, nothing in **B.2** to **B.17** is intended to preclude the use of multi-zone equipment or addressable systems, for which these recommendations are equally applicable.

B.2 Indications of fire

The operation of one or more fire detectors or manual call points should result in the following:

a) power being supplied to alarm sounder circuit(s);

b) the illumination of a red visible indicator clearly labelled with the word 'FIRE';

c) the operation of a sounder within the control and indicating equipment;

d) the operation of any other functions provided, e.g. the changeover of volt-free relay contacts.

None of the responses specified in items a) to d) should be prevented by the simultaneous operation of two detectors, or by the operation, at a rate not exceeding one detector every 2 s, of any further detectors up to the maximum number of detectors that can be connected to the control and indicating equipment (as specified by the manufacturer).

B.3 Response time

Any delay in the responses listed in **B.2** should be limited as follows.

a) Response to a detector should occur not more than 10 s after the point at which the detector is required to operate by the appropriate Part of BS 5445 or BS 5839.

b) The delay in the response to the operation of a manual call point should not exceed 3 s.

B.4 Silencing

A clearly labelled switch should be provided to silence the responses described in **B.2**a and **B.2**c. The alarm should not be automatically silenced or cancelled. Operation of the silencing switch should not cancel the responses described in **B.2**b and **B. 2**d. The operation of silencing the alarms should cause the indicating equipment to give a visual and audible indication until the switch is restored to the normal position or, if the silencing facility is a biased switch, until the fire detection and alarm system is reset. The visual indication may be the same as that for a fault warning, provided that labelling makes this evident. The audible warning should sound for a minimum of 0.5 s at least once every 10 min.

B.5 Manual restarting of the alarm after silencing

After the fire alarm signal has been silenced, it should be possible to restart the sounders, either by restoring the silencing switch to its normal position or, if the silencing facility is a biased switch, by resetting the system while detectors or manual call points remain in the alarm condition.

B.6 Priorities

An alarm of fire should not be inhibited or delayed by any other indication that the equipment may be giving, e.g. a fault warning.

B.7 Resetting

The visible indication described in **B.2**b, and the operation of any ancillary function as described in **B. 2**d, should persist until the system is manually reset by use of a reset switch at the control equipment.

Table A.1 Recommendations relevant to grades of system

Grade of system	Relevant clauses and subclauses	
	Specific to particular grades	Common to all grades
A	5.5, 13.2, 13.8, 14.2, 15.1-15.3, 16, 17.1, 17.2, 18, 19.1-19.3, 21.1	1-4, 5.6-5.11, 6-12, 13.1, 14.1, 20, 21.4, 22-24
B	5.5, 13.3, 13.8, 14.3, 15.1, 15.2, 15.4, 16, 17.1, 17.3, 18, 19.1-19.3, 21.2	
C	5.4, 13.4, 13.8, 14.4, 15.1, 15.2, 15.5, 16, 17.1, 17.4, 18, 19.1-19.3, 21.2	
D	5.3, 13.5, 13.8, 14.5, 19.4, 21.2	
E	5.2, 13.6, 14.5, 19.4, 21.2	
F	5.1, 13.7, 13.8, 14.6, 19.4, 21.3	

B.8 Fault warnings

Fault warnings should be given in at least the following ways.

a) An audible warning should be given from a sounder situated within the control and indicating equipment. The sound level should be not less than 50 dB(A) at a distance of 1 m from the control equipment. The audible warning may be identical to that used to indicate a fire condition. If the audible indication of fault is intermittent, it should sound for at least 0.5 s every 5 s. A facility should be provided to silence the audible fault warning. This facility may be the same as that used to silence fire alarm signals, provided that it comprises a biased switch or other arrangement fulfilling the same function and that labelling makes this clear.

b) An amber visible indicator should be illuminated on the indicating equipment.

Fault indications may be suppressed during an alarm condition, but in this case any faults remaining after the alarm condition has been cancelled and the system has been reset should cause the fault indication to be restored.

The fault warnings described in a) and b) should be given within 100 s of any one of the following occurrences:

1) short circuit or disconnection of the connection to the normal power supply, or other total loss of power from such a normal power supply;

2) short circuit or disconnection of the standby power supply;

3) short circuit or disconnection of any battery charging equipment;

4) short circuit or disconnection of the leads to detectors, call points or alarm sounders external to the control equipment unless, in the case of a short circuit, this results in an alarm of fire;

5) cessation of any scanning or interrogating process within the control equipment;

6) rupture of any fuse or operation of any protective device such as to result in a fire alarm not being given as indicated in **B.2**.

B.9 Disablement

Facilities may be provided for isolating detectors or for disabling the fire alarm sounders (including the control sounder). A facility for isolating detectors may be combined with the reset control; a facility to disable fire alarm sounders may be combined with the silencing control.

The operation of any facility for disabling fire alarm sounders should be indicated visually. The visible indicator should be amber and may be the same as that used to provide a fault warning. It should be impossible to cancel the visual indication until the sounders are restored to the normal condition.

The operation of any facility that isolates detectors should be indicated visually and audibly. Both the visual and audible indication may be those used to provide a fault warning. The audible warning may be silenced, in which case the control for silencing may be that used to silence a fault warning.

B.10 Software-controlled equipment

Software-controlled equipment should conform to **3.8** of BS 5839 : Part 4.

B.11 Indication of power supply

A green visible indicator should be illuminated when the normal power supply is operating. This indication should be extinguished if the normal supply fails.

B.12 Visual indicators

The operation or failure of one indicator should not prevent the proper and separate operation of any other indicator. The operation of any sounder, alarm circuit or other related function (see **B.2**d) should not be prevented by any visual indicator defect and should not depend on the operation of any indicator.

Red and green indicators should not be used to indicate conditions other than fire or healthy status of the normal power supply respectively. The function of each visible indicator should be clearly identified on the control panel.

B.13 Manual controls

All manual controls should be clearly labelled to indicate their function and should be so arranged as to reduce the risk of inadvertent operation.

B.14 Electrical safety

The control and indicating equipment should conform to **5.1** of BS 5839 : Part 4.

B.15 Transition between power supplies

Transitions between the main and standby supplies (and vice versa), or the reduction of mains voltage to a level outside its normal range, should not cause any change in any indications, warnings or outputs being given by the control and indicating equipment, other than those relating to the power supplies.

B.16 Recovery from total power failure

The system should be automatically restored to its normal working condition (although fault warnings may need to be reset manually) within 10 min of the restoration of the normal power supply following the failure of both the normal supply and the standby supply.

B.17 Marking

If control and indicating equipment for grade B systems which meets all the recommendations of **B.2** to **B.16** is marked with a reference to this Part of BS 5839, it should be marked 'BS 5839 : Part 6 : 1995 : annex B'.

Equipment which does not meet all the recommendations of **B.2** to **B.16** should not be marked with any reference to BS 5839 : Part 6.

Annex C (informative)

Model installation certificate

The following is an example of a certificate which can be used for certifying that a fire detection and alarm system has been installed in accordance with the recommendations of this standard.

Certificate of installation and commissioning of the fire detection and alarm system at:

Address .....

.....

.....

It is certified that the fire detection and alarm system at the above address conforms to the recommendations of BS 5839 : Part 6 for a type ....., grade ..... system, other than in respect of the following deviations:

The entire system has been tested for satisfactory operation.

Instructions in accordance with the recommendations of clause **22** of BS 5839 : Part 6 have been supplied to:

.....

Signed ..... Date .....

For and on behalf of.....

List of references (see clause 2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 476	*Fire tests on building materials and structures*
BS 5445 :	*Components of automatic fire detection systems*
BS 5445 : Part 5 : 1977	*Heat sensitive detectors — point detectors containing a static element*
BS 5445 : Part 7 : 1984	*Specification for point-type smoke detectors using scattered light, transmitted light or ionization*
BS 5445 : Part 8 : 1984	*Specification for high temperature heat detectors*
BS 5446 :	*Components of automatic fire alarm systems for residential premises*
BS 5446 : Part 1 : 1990	*Specification for self-contained smoke alarms and point-type smoke detectors*
BS 5588 :	*Fire precautions in the design, construction and use of buildings*
BS 5588 : Part 1 : 1990	*Code of practice for residential buildings*
BS 5839 :	*Fire detection and alarm systems for buildings*
BS 5839 : Part 1 : 1988	*Code of practice for system design, installation and servicing*
BS 5839 : Part 2 : 1983	*Specification for manual call points*
BS 5839 : Part 4 : 1988	*Specification for control and indicating equipment*
BS 5839 : Part 5 : 1988	*Specification for optical beam smoke detectors*
BS 5979 : 1993	*Code of practice for remote centres for alarm systems*
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Part 6. Code of practice for the design and installation of fire detection and alarm systems in dwellings

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